

A Comparative study of Biodiversity in three different sites of Banda District

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Introduction

The term “wildlife” is commonly referred to wild and undomesticated animals in their natural habitats. Ecologically wildlife means all flora and fauna in their natural habitats. According to Wildlife (Protection) Act of India 1972, wildlife includes any animal, bees, butterflies, and moth, crustaceans, fish and aquatic and land vegetation which forms part of a habitat.

Flora refers to the plant life found in a particular region. It is naturally occurring or the indigenous native plant life. Fauna is all the animal life present in a particular region. Flora and fauna are connected to each other through food chain and energy flow.

Flora and Fauna has played an integral role in the survival of human. Humans have always been dependent on flora and fauna from the times of its origin, after all we humans are hetrotropic organism we can not prepare our own food we have to rely on nature. Don't be confused with cooking even for that we need raw material. Nature provides us food, medicine, commercial products, recreational pleasure, ecological benefits, cultural and religious value, educational source etc.

Nature is full of facinating creature, one such creatures are birds or as biologist calledaves. Most modern orders of birds evolved and diversified during the last 65 million years following the demise of the non-avian dinosaurs and pterosaurs at the Cretaceous- Paleogene boundary.

Birds are found everywhere they breed on all of the continents on Earth and have adapted to almost every habitat. Birds occupy a huge variety of habitats and are found at the extremes of latitude and land elevation. This great diversity of land-, water- and seabird species is distributed across the world, and some of the smallest nations have rich bird faunas.

Birds are important for ecological functioning of our environment such as indicators of pollution, seed dispersal, scavenging and as predators of insect pests (Shimelis and

Afework 2009). They are among the best monitors of environmental changes and have been used to evaluate the environment throughout the history as “bio monitors”. Hence they are the good indicators of ecological status of any given ecosystem and are good indicator for studying the structure and composition of habitat (Bilgrami 1995 and Burel et al. 1998).

Unfortunately increasing humans activities such as agriculture practices, deforestation, illegal trade, water poisoning, illegal dumping, soil pollution plantation of commercial tree, over fishing, food scarcity, over grazing of land, use of pesticides, pollution from households and industrial discharges and agricultural run-off etc, are rapidly wiping away the habitat of birds.

The term habitat refers to an area with the resources and conditions present to produce occupancy by a given organism (Hall, L. S., P. R. Krausman, & M. L. Morrison. 1997). These resources and conditions include food, water, cover, and any special factors needed by a species for survival and reproductive success. (Leopold, A. 1933. Game Management. Charles Scribner's Sons, New York) Since habitat is organism-specific, the appropriate mix of abiotic and biotic components necessary for successful reproduction and survival varies by species (Hall, L. S., P. R. Krausman, & M. L. Morrison. 1997)

OBJECTIVES

The main aim of the study is to gather information on relative abundance of animals in three selected sites. The study emphasis on the distribution of animals in suburban, natural and damaged forest area and to gain information about how human activities has affected the abundance and diversity of species.

- To identify the various species of birds, butterflies and mammals present in this area.
- To make an inventory of the various species observed in the study area and to determine the density and abundance of these species.
- To identify major threats and threatened species of the area.

3 REVIEW OF LITERATURE

Diversity in animals inhabiting the area reflect habitat productivity and the effects of human footprints on wildlife and habit. Availability of food, water and habitat are one of the many numerous factors that are responsible for distribution and abundance of animals According to a number of studies (MacArthur & MacArthur, 1961; Willson, 1974; Dean, 2000; Dewalt, Maliakal & Denslow, 2003), vegetation structure (also known as physiognomy) was shown to have a noticeable effect on bird communities in both species composition and abundances of bird. Studies have also shown that floristics (plant species composition) may have an effect on avian demography (McGrigal & McComb, 1995; Fairbanks, 2004). Flood plain is very important water bird breeding habitat (Anthony 1997).these are an area where the land and river interface. These areas are hotspots of aquatic and terrestrial biodiversity, with a wide range of floral structures (trees, shrubs, and grasses) and fauna (mammals, birds, amphibians, and reptiles) (Ward et al., 2002; Amitha Bachan, 2003; Capon et al., 2016).

The number of breeding bird species increases from urban to suburban, rural, and natural areas (Fontana, S., Sattler, T., Bontadina, F. & Moretti, Ortega-Álvarez, R. & MacGregor- Fors, Wuczyński, Bezzel, E). A few studies indicated that urbanization did not reduce bird species richness (i.e., the number of bird species) due to an abundant food supply, but rather increased the number of birds in a few dominant bird species (Jokimäki, J., Suhonen, J., Inki, K. & Jokinen,). One of the main characteristics of urban areas is the numerical dominance of a few abundant bird species which means a lower species evenness.(Bezzel, E.)

This study was carried out to collect baseline data on the species richness, relation of different land type or habitat to diversity of birds and other animals. This study also focused on the affect of anthropological disturbance on the diversity of birds and animals. Anthropological disturbance such as clearing of trees for the agriculture purpose,,

setting up of man-made fire on the grassland, filling of natural water bodies etc. Whole study was based on the hypothesis, that species richness is affected by level of disturbance and Species richness increase with increase habitat area.

Seasonal variation in climatic pattern has direct impact on bird species richness. The structural and functional organization of ecosystem changes as accordance to change in seasons which has direct impact on avian diversity. A seasonal change in species diversity of birds occurs in forests due to their foraging behavior (Robertson and Hackwell 1995). Estimation of abundance and density is the foundation for understanding changes in habitat associations and population changes (Norvell et al. 2005). A key element in the study of diversity is the relative abundance of different species at a site (Bennett 1999).

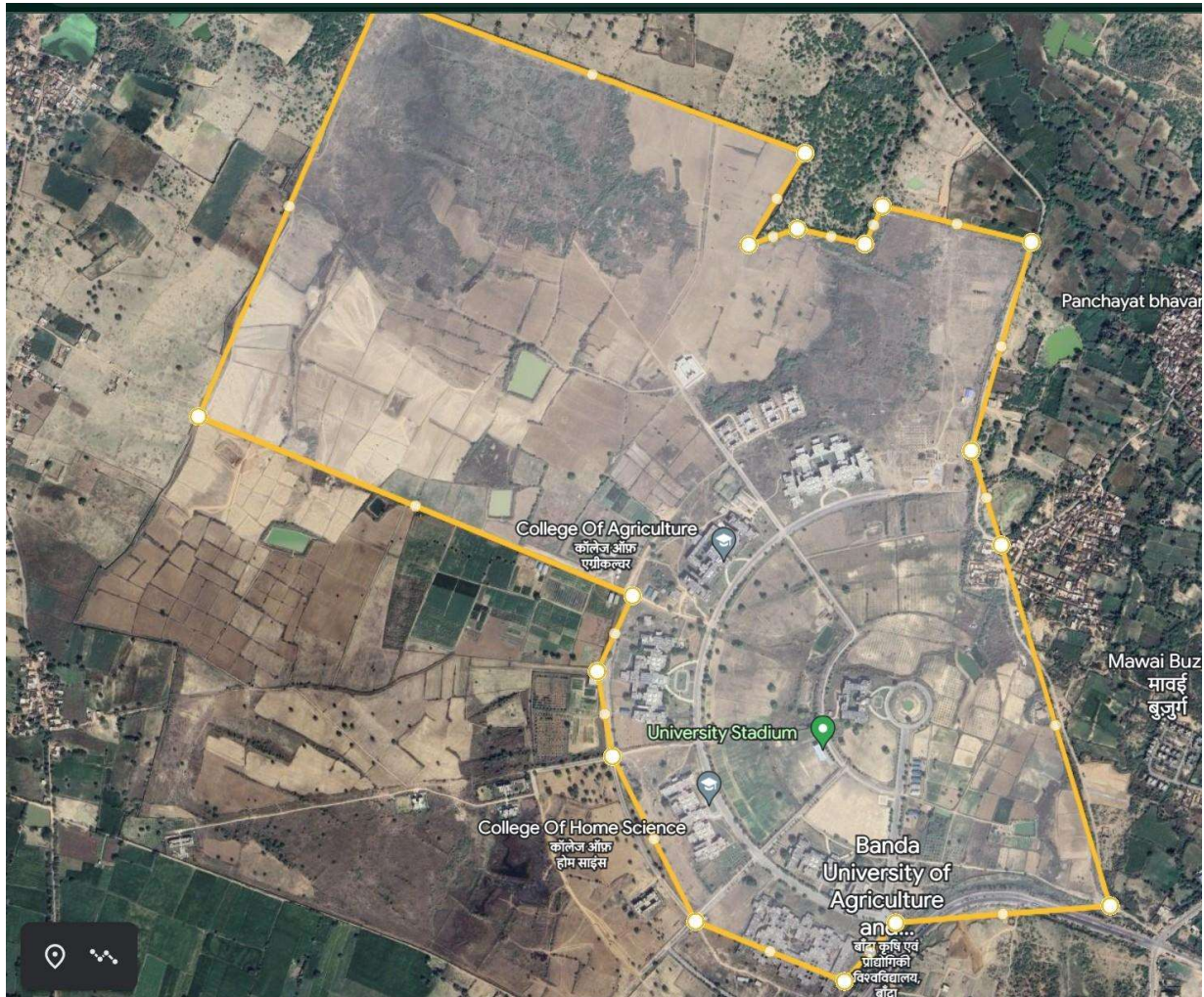
Many bird species are habitat specific and respond especially to habitat structure (MacArthur et al. 1962, MacArthur 1964). Different land use practices influence the habitat, structure and composition of species (Boren et al. 1999, Brawn et al. 2001). Estrada et al. (1997) studied the distribution of birds in different land use types where they found more species in cultivated land, followed by forests, fences and pasture land. Waltert et al. (2005) observed higher diversity of birds in forest than farm land. Martin and Blackburn (2010) and Khanal (2008) documented higher species richness of birds along cultivated lands than forest. Fardila and Sjarjadi (2012) said that though the land use and other aspects of environments are interrelated, forest always has higher species richness of birds than other land cover. Basnet (2010) after analyzing the species richness and composition of breeding birds concluded more species richness can be found in moderately disturbed area than in disturbed one. Bird diversity is peak at intermediate level of human settlement primarily because of colonization of intermediately disturbed forest by early successional native species (John 2005).

SELECTION OF SITE

Study Area

The study was conducted in three different sites of Banda District

Site A: DESTROYED FOREST AREA



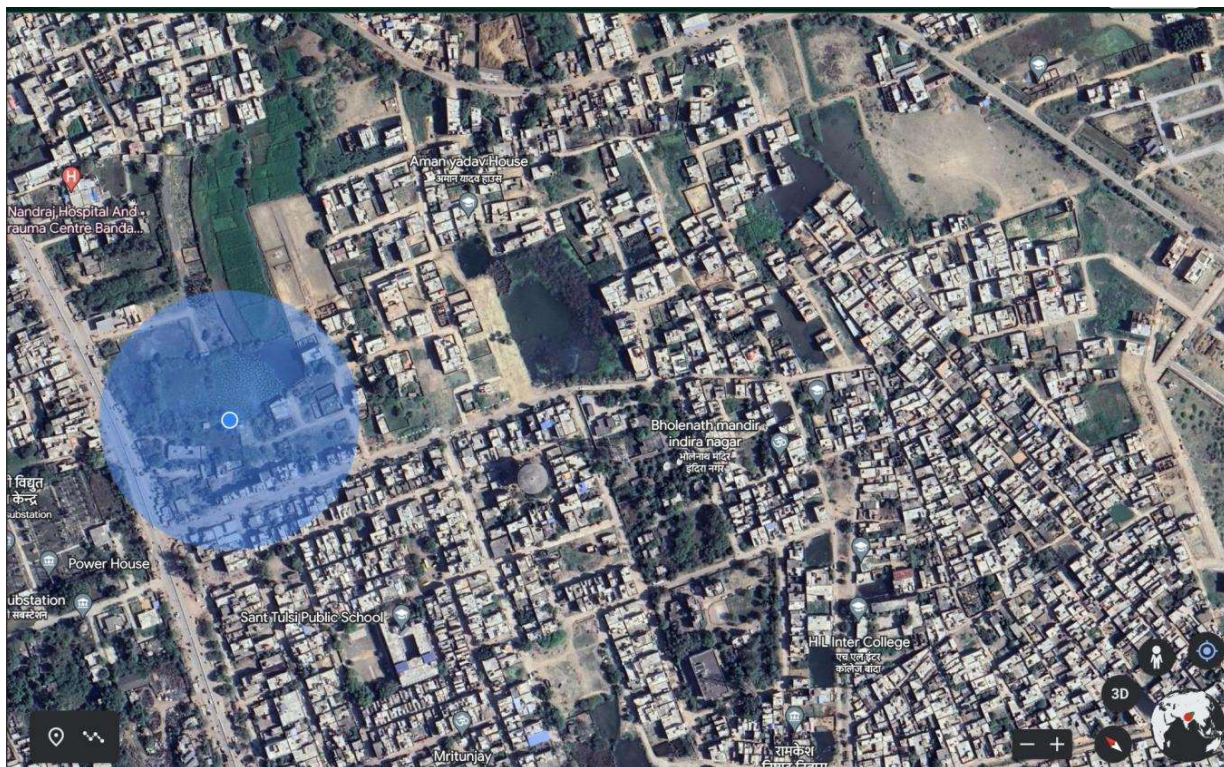
This site is dominated by acacia sp tree, shrubs of lantana, and coarse tall grass distributed over the entire area. This selected site has sparsely distributed, large trees of mahua, lasoda, neem, shisham, fig sp., khajoor/Taad etc. These heavy crown trees were favorable resting and nesting spot for big birds like asain-openbill, woollyneck- stork, eagle etc.



Tall, wide spread grasses that spread all over the campus use to be perfect safe cover for the small birds like rain quail, gray florican, red avadavat, silverbill munia etc, Acaia trees are inhabited by weaver birds which are now rarely spotted in campus. These thick forest of acacia were perfect cover for the blue bull, hyena etc. Now a days hyena are not visible in the campus. Campus also had few small inland water bodies that were frequently visited by water birds like sarus crane, lesser whistling duck, and animals like wild boar, hyena etc



Site B: SUBURBAN CITY



Any city goes through changes in slow and gradual way. Construction of roads, big buildings crowded housing all these aspects of development takes time, thus the changes that occurs in the environment are slow and this assist number of bird species to adopt to this changes. Birds that we call city birds do not show any reduction in population rather then that they thrive this may be probably due to easy access to food, Whereas, water birds are slowly declining due to increasing level of pollution.

Site C: FLOOD PLAINS AND NATURAL SHRUBLAND



Shrub land along the bank of a river can be a diverse and dynamic ecosystem, providing important ecological benefits and supporting a wide range of plant and animal. It is dominated by shrubs, with scattered trees and herbaceous plants growing in the under canopy. The shrubs in this type of ecosystem are typically adapted to dry and semi-arid conditions, with deep root systems that allow them to access water stored in the soil. Shrubs are often spaced far apart, allowing for plenty of sunlight to reach the ground and support the growth of a diverse under canopy of grasses and wildflowers. The river provides a source of moisture for the plants growing in the ecosystem and supports a variety of aquatic species such as fish, amphibians, and water birds. In addition, the riverbank itself is an important habitat for a variety of wildlife, including reptiles, mammals, and birds.

MATERIALS USED

1. Canon 700D DSLR Camera
2. Birds of the Indian Subcontinent By Richard Grimmet, Carol Inskipp and Tim Inskipp (Field Guide) 7
3. Binocular – Nikon Aculon 8 x 42
4. Notepad
5. Pen

SURVEY METHOD

The method which was used to observe was All Out Search Method. This is carried out randomly going around the study area and recording the birds, butterfly, and mammals. In case of river it was going along the coast and in case of lake it was by going around the lake. While in case of estimation within the city it was road side counting and for plain area it was going in all out search method and did diversity count. The Survey was conducted in each of the places at various times but mostly at the time of 06:00 AM to 10:00 AM. Survey was not done during harsh weather and rainy days.

Threat Assessment

Wildlife is facing various types of threats. There are multiple threats which operate alone or are intr-linked, and more often one threat triggers several others. With a constantly changing environment, all organism need to adapt to new temperature, climate and other atmospheric conditions, as well as should develop capacity to overcome the natural catastrophic events like earthquakes, landslides, volcanic eruptions, several storms and other natural calamities, In addition to these abiotic stresses, species are further challenged to adapt to several biotic stresses like intra and inter-specific competition, predation, parasitism, disease, etc. Wildlife is also threatened by different anthropogenic activities like degradation, fragmentation, and destruction of habitat, poaching, spreading of invasive species and diseases. Each threat, in combination with others, puts additional stress on already weakened ecosystem and threatens the existence of several wild flora and fauna thriving therein. For example, rapid population expansion has led to the conversion of various natural landscapes into human habitations and agricultural lands, thereby degrading and reducing habitat of many wild faunas. If a species is unable to successfully cope with these stressors through successful adaptation, then the individuals often fail to reproduce successfully and die, as a consequence, the entire species might face extinction. In the recent evolutionary history, many species have already become extinct and numerous others are on the verge of extinction. Many scientists believe that we are now experiencing the 'sixth mass extinction' in the history of life on earth. Some of the major wildlife threats are-

1. Habitat Loss
2. Overexploitation
3. Grazing by Livestock
4. Mining activities
5. Forest fire
6. Construction of Roads and Railways Tracts
7. Pollution, Global Warming and Climate Change
8. Diseases

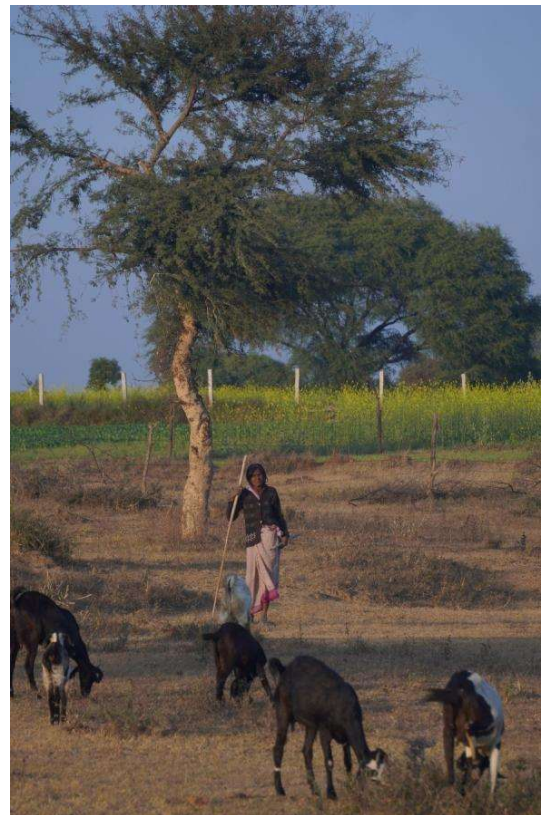
Habitat Loss

Habitat loss is the major threat to the wildlife throughout the globe. Once a particular area is altered by human activities, it may no longer be able to provide food, water, cover (shelter) and place to raise young for the resident species, thus posing a threat to their survival.



Grazing by Livestock

Livestock grazing has severely threatened our wildlife and their habitats in various ways. The decline of wild herbivore population is the most noticeable effect as they have to compete with a livestock for food. Over grazing often eliminate palatable natural plant species leaving only the unpalatable natural vegetation for wildlife herbivores. As a result, regeneration of trees and plant species composition of the area are affected. Heavy grazing increase soil erosion in the forest areas. Besides, livestock grazing aids in the spread of communicable disease from domestic to wild animals often causing death of wild ungulates.



Mining Activities

Mining activities leads to large scale habitat loss and take several toll in many wildlife habitats. Wild animals that require large home range are sensitive to disturbance. Small scale mining such as sand mining destroy ecological habitat in forest, river, pond. Mining increases, the run-offs during monsoon and also pollutes the rivers and streams that flow through mining areas. Mud from the mining areas add siltation load to lotic ecosystem. It decreases the water holding capacity of the water reservoir.



The photo shows a view of an open pit mine where soil is being extracted. The surrounding landscape is disrupted and scarred, and the scale of the operation highlights the magnitude of the environmental impact caused by sand mining.



The photo highlights the significant environmental damage caused by sand mining, including the destruction of habitats, erosion of beaches, and depletion of groundwater resources.

Forest Fires

Forest fire is one of the major threat to wildlife. Repeated forest fire are mainly caused by grazers, minor forest produce collectors, hunters. Cattle grazers set fire in the dry pastures in the hope of new flush of grass for their livestock. Honey collectors accidentally set fire in their urgency to smoke out bees from the hives. Ground fires burn the under growths leading to a shortage of food for herbivores. Fires destroy seedling, affecting regeneration of native plant species and replace edible plant species with inedible exotic species like parthenium and lantana. Forest fire kill numerous small, slow-moving and ground-nesting species of mammals, birds, reptiles, insects etc.



The photo shows the aftermath of a devastating forest fire, with charred trees and blackened soil stretching out as far as the eye can see. The devastation is almost complete, with only a few scattered trees remaining intact

Construction of Roads and Railways Tracks

Roads and railway track often break the contiguity of forest, resulting in the fragmentation and act as physical barriers restricting the free movement of animals. Road and railway lines running through forests lead to the accidents and often death of several wild animals, which are being hit by fast-moving vehicles and trains.



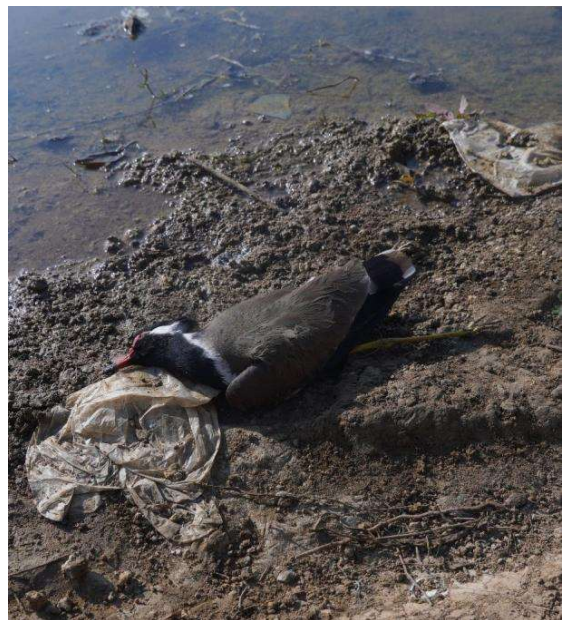
The photo depicts a tragic scene of a wild animal lying lifeless on the side of the road, presumably having been hit by a vehicle.

Pollution, Global Warming and Climate Change

Pollution often kill or impair the health of several species of wild animals. Dumping of solid wastes often destroys several wetlands, marshes, and grasslands. Changing climate might create favourable condition for the spread of several invasive species. Many species shows shifting of ranges in search of favourable climate and are termed as climate refugees. The area with favourable climate then show evidence of higher competition for resources between the natives and refugees.



Photo of a sprawling garbage dump, with mountains of waste and debris piled up.



Picture of lifeless red-wattled lapwing bird lying by the side of a polluted body of water.

Diseases

Wildlife populations are often affected by a series of emerging diseases, some of which lead to serious declines and pose significant threat to their conservation. Disease caused by or carried by invasive species are particularly threatening, as native wildlife may have no natural immunity to them. Though diseases are a normal phenomenon in nature, but human interventions can directly lead to disease outbreaks in wildlife.



Pigeon suffering from viral disease

Overexploitation

Overexploitation is defined as the irrational and over use of several species of wild flora and fauna by the people for their self-interested need. Overexploitation not only threatens the survival of species that is collected from nature, but it also leads to the depletion of many other species that are dependent on that very species for survival.



People Fishing in the river

8. Data Analysis

All the collected data were tabulated in an excel sheet and analyzed by using appropriate statistical tools. Following statistical tools were used:

Shannon-Wiener's Diversity Index

Shannon Weiner diversity index was used to calculate the species diversity of particular area which is calculated as: $H' = -\sum (n_i / N) \log (n_i / N)$

Or, if $P_i = n_i / N$

Where,

H = Index of species diversity

P_i = the proportion of individuals in the i th species = n_i / N

n_i = Importance value for each species (number of individuals)

N = Total importance value (Total number of individuals)

Evenness index

To calculate whether species were distributed evenly across seasons and across different land use type, evenness index was used. It was determined by the equation

$$E = H' / \log S$$

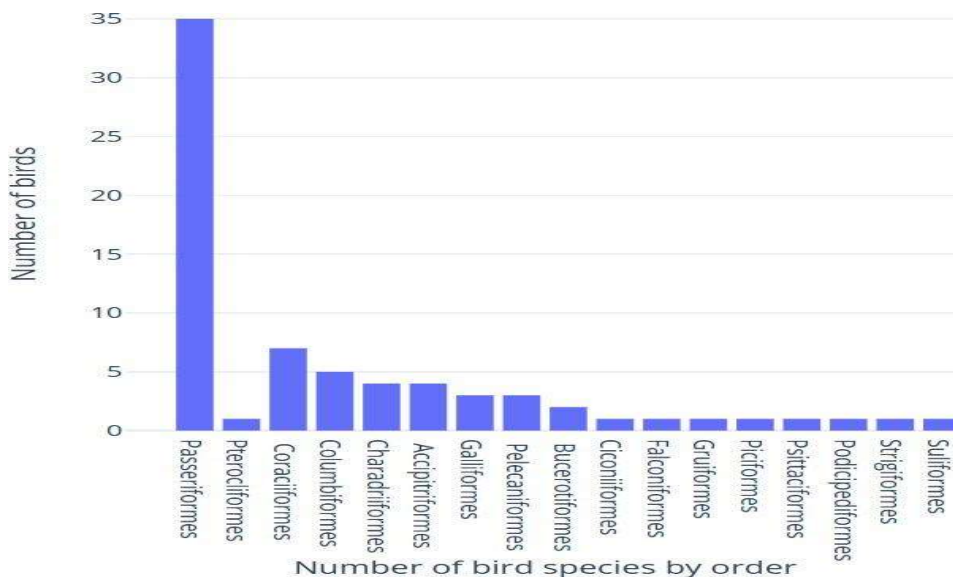
Where, H' = Shannon-Wiener's diversity index.

S = Species richness is the total number of species

RESULTS AND DISCUSSION

Species richness of birds at Site A (Destructed Forest Area)

Biodiversity is the variety and difference among living organisms and includes genetic diversity within and between species and of ecosystems. The variety of all living things is a contraction of biological diversity. Biodiversity can be measured on many biological levels ranging from genetic diversity within a species to the variety of ecosystems on Earth, but the term most commonly refers to the number of different species found in a defined area. A total of 72 species of birds were recorded from Site A belonging to 17 orders and 25 families. Order Passeriformes has highest diversity (35 species from 19 family) followed by Coraciiformes (7 species and 4 family), Columbiformes (5 species and 1 family), Charadriiformes (4 species and 4 family), Accipitriformes (4 species and 1 family), Galliformes (3 species and 1 family), Pelecaniformes (3 species and 1 family), Bucerotiformes (2 species and 2 family), Ciconiiformes, Falconiformes, Gruiformes, Piciformes, Podicipediformes, Psittaciformes, Pterocliiformes, Strigiformes, Suliformes, all these has (1 species and 1 family). Wild Mammals species recorded from site were golden jackal, Common moongose and Indian hare. A total number of 20 species of butterflies were recorded from site A.

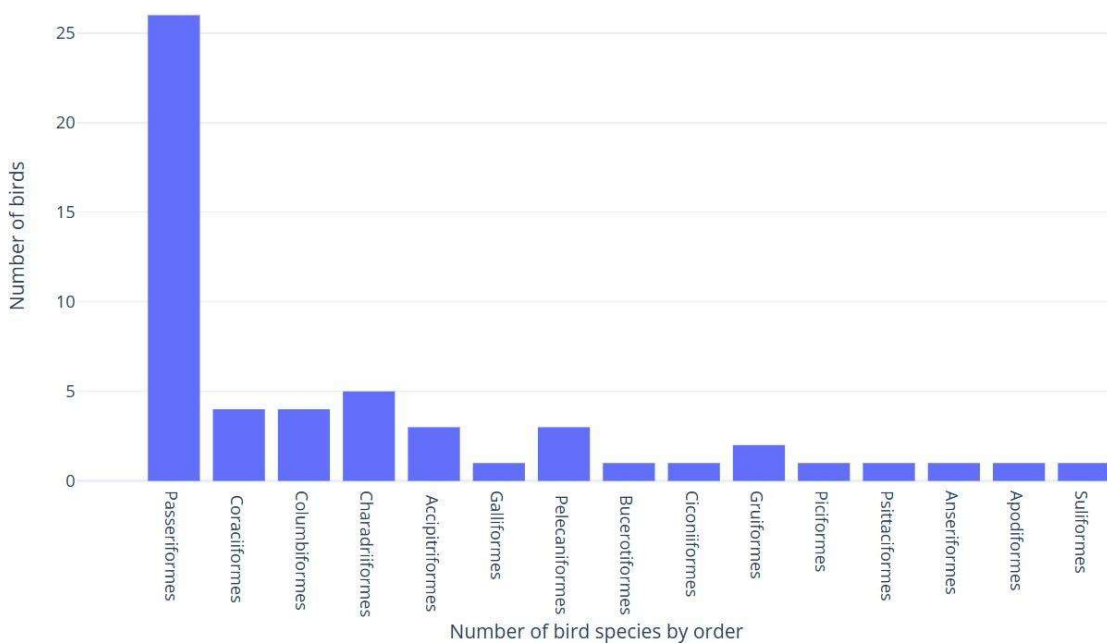


Species Richness for Site B (Suburban City)

A total of 57 species of birds were recorded from Site 2 belonging to 15 orders and 34 families. Order Passeriformes has highest diversity (26 species from 14 family) followed by Charadriiformes (5 species and 4 family), Pelecaniformes (3 species and 1 family), Coraciiformes (4 species and 3 family), Columbiformes (4 species and 1 family), Accipitriformes (3 species and 1 family), Gruiformes (2 species and 1 family), Anseriformes, Bucerotiformes, Ciconiiformes, Galliformes, Piciformes, Psittaciformes, Suliformes, and Apodiformes all has (1 species and 1 family).

Wild Mammals species recorded from site were golden jackal and Common moongose, Rhesus Monkey, Northern Plain Langur, Small Indian Civet, Indian Hare and Nilgai. A total number of 19 species of butterflies were recorded from site B.

Number of bird species in different orders



Species Richness for Site C (Flood Plains and Natural Shrubland)

A total of 115 species of birds were recorded from Site 3 belonging to 18 orders and 50 families (Appendices 1). Order Passeriformes has highest diversity (48 species from 20 family) followed by Charadriiformes (14 species and 6 family),Coraciiformes (9 species and 4 family), Pelecaniformes (7 species and 2 family), ,Columbiformes (6 species and 1 family), Gruiformes (5 species and 2 family), Accipitriformes (4 species and 1 family), Anseriformes, Ciconiiformes, Strigiformes, and Galliformes, has (3 species and 1family), Bucerotiformes, Suliformes, and Piciformes has (2 species and 2 family), Psittaciformes, Podicipediformes, Falconiformes, and Apodiformes all has (1 species and 1 family).

Wild Mammals species recorded from site were golden jackal, Common moongoose.A total number of 22 species of butterflies were recorded from site C.

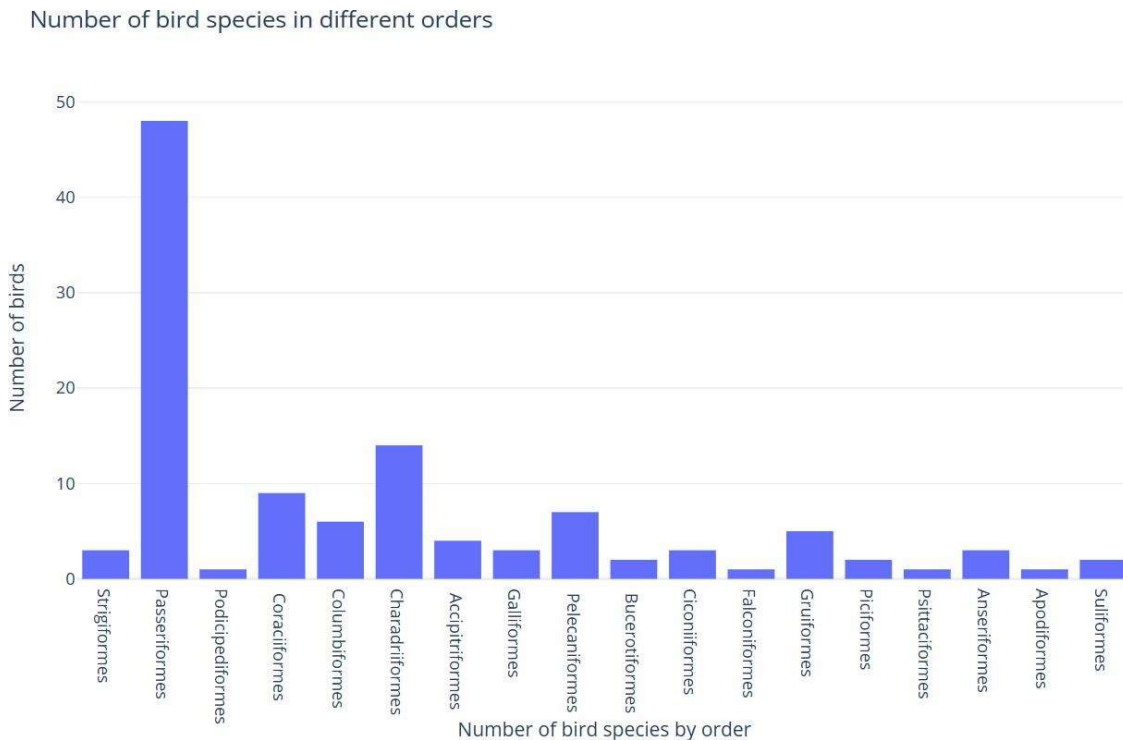


TABLE – 1 Avian Species richness and evenness in three different sites

Site	Family	Order	No. of species	No. of individuals	Shannon' s index	Evenness index
A	25	17	72	741	3.93	0.92
B	34	15	57	833	3.75	0.93
C	50	18	115	1529	4.28	0.90

In this study, diversity refers to the number of various bird species found. Species evenness and species diversity are both important measures of biodiversity in a community, and they are closely related to each other.

Species diversity is a measure of the variety of different species present in a community, and it includes both species richness (the number of different species present) and species evenness (the relative abundance of different species). In other words, species diversity takes into account both the number of species and their relative abundance.

Species evenness is specifically a measure of the relative abundance of different species in a community, and it is a component of species diversity. A high species evenness indicates that the individuals of different species are distributed relatively evenly, while a low species evenness indicates that some species are much more abundant than others.

Overall, a diverse community with high species richness and evenness is generally considered to be more stable and resilient to disturbances, as different species are able to fill different ecological roles and support one another. Conversely, a less diverse community with low species richness and evenness may be more vulnerable to disturbances, as the loss of a dominant species or group of species could have a major impact on the community as a whole.

Shannon winner diversity index showed that site A were more diverse than site B and C

Birds species are cosmopolitan but they are very sensitive to the climatic and also habitat factors. They are also very good indicators of variety of factors like urbanization, pollution etc.

Bird diversity and abundance are strongly associated with productive, lush habitat that is structurally diverse with different canopy levels and various ages and species of trees and shrubs. Butterflies are also highly sensitive to changes in their environment. They are, in fact, so sensitive to climate change, pollution, and habitat degradation that they serve as valuable indicators of potentially harmful environmental shifts. Butterflies share unique relationships with the plants and animals around them. Caterpillars eat mainly leaves, and each species tends to feed on only one type of plant. If this plant is lost through habitat destruction or a change in climate, it can spell disaster for the survival of the butterfly species that is dependent upon the plant. Butterflies are important pollinators, although they are less efficient pollinators than honeybees. They also fill a vital role in the food web by serving as a food source for birds, lizards, snakes, and other predators.

In ken river (site C): there were a lot of water birds indicating that the area is still rich in its bird species but a trend of the very common water birds and not the other water birds. This indicating that the water quality is degrading over the period of time. It can be confirmed with the excessive sand mining and city sewage line and other waste are allowed to mix with the river water. Mining can alter the river bed, force the river to change course, erode banks, and cause flooding. It causes river and estuary deepening, as well as the expansion of river mouths and coastal inlets. Mining harms wildlife by removing basking and egg-laying habitat.

City waste mixed with various other waste that flows into the river causing huge eutrophication chains and slowly floating algae have become established. As we all know it's the starting stage of hydro sere succession which is followed by slowly filling up of water with shrubs, land taking over ending with a thick forest. Hence we could say that the

environment is under stress from external factors and its effect could be seen in the bird quantity and quality. In Shrubland forest adjoining the riverbank we could see a variety of birds being present including various common and rare birds that aren't seen in urban areas. This indicates to us that the area has very less or minimal urban grounds or urbanization. From Desert Wheatear, Lesser Goldenback Woodpecker, Oriental Turtle Dove, Southren Grey Shrike to Copper-Smith Barbett a variety of birds including a rare sighting of forest owlet, Eurasian eagle owl. The area is a cover with shrub, bushes and sparsely distributed trees It also has area land having dense tree cover and has a small pond. This area of study has diverse species of butterfly as comparison to other to areas of study.

In suburban city (site B): we could see a large number of birds but not as diverse as in the Site C forest areas. Some common urban bird species include pigeons, sparrows, starlings, and crows, which are adapted to living in human-dominated environments and often feed on human waste and discarded food. Other species that found in cities include raptors such as kite, shikra, waterfowl such as common moorhen, and white-breasted waterhen. City also support unique bird populations, such as lesser-whistling duck, black-winged stilt, sandpipers, wire-tail swallow, barn swallow etc. These birds can be seen in marshy areas, present in the city. Butterfly can be found in parks, gardens, and other green spaces. we could see a large population of birds but not diverse as study area C. This indicate that urbanization can pose challenges for birds, such as habitat loss and increased exposure to pollution and other hazards. This can lead to the decline of certain species and the emergence of others that are better adapted to urban environments.

Destructed Forest Area (Study area A): This site has avian and butterfly diversity better than the study area B but the number of birds' population is less as compare to study area C and is almost as same as that of study area B. This similarity in the shannon diversity index of study area A and B indicates that the species diversity if study area a is declining and that

is due to disturbance in fcaused by human activities such as deforestation, forest fire, grazing, and agriculture greatly have impacted the ecosystem. Disturbance in a forest can have significant impacts on bird diversity, affecting both the abundance and composition of bird communities. Disturbance in a forest result in the loss of bird habitat, result in small, isolated patches of forest that are unable to support the same bird species diversity as larger, contiguous areas of forest. Forest disturbance can alter the structure and composition of vegetation, which can impact the availability of food and nesting sites for different bird species. clearing of understory vegetation can impact ground-nesting birds, while removal of large trees can affect species that nest in tree cavities. Overall, disturbance in a forest can lead to a decline in bird diversity.

TABLE – 2 Mammals and Butterflies Species richness in three different sites

Site	No. of mammal species	No of butterflies species
1	1	12
2	2	19
3	7	22

TABLE – 3 Threatened Species

CR	EN	VU	NT
	Egyptian Vulture	Sarus crane	Black-headed Ibis
			Ferruginous Duck
			Painted Stork
			Woolly-necked Stork
			River lapwing
			Asian Openbill

CR	Critically Endangered
EN	Endangered
VU	Vulnerabe
NT	Near-Threatened

TABLE – 4 List of birds recorded in different areas of study.

S.No	Common Name	Site 1	Site 2	Site 3	Average No. Of species
1	Ashy Prinia	11	8	18	12.3
2	Ashy-crowned Sparrow Lark	33		40	24.3
3	Asian Koel	5	3	8	5.3
4	Asian Openbill			15	5
5	Asian Pied Starling	25	38	28	30.3
6	Bank Myna	20	29	18	22.3
7	Barn Swallow	15		13	6
8	Baya Weaver	13			4.3
9	Black -Winged Stilt		58	80	46
10	Black Drongo	6	1	8	5
11	Black Kite	2	1	5	2.6
12	Black Redstart	7	5	9	7
13	Black-crowned Night Heron		3	14	5.6
14	Black-headed Ibis		10	8	6
15	Black-winged Kite	2		6	2.6
16	Brahminy Starling	14	16	24	18
17	Bronze-winged Jacana		4	8	4
18	Cattle Egret	15	11	39	21.6
19	Chestnut-bellied Sandgrouse	2			0.6
20	Chestnut-shoulder Petronia			1	0.3
21	Citrine Wagtail		2	3	1.6
22	Common Hawk Cuckoo			1	0.3
23	Common Hoopoe	6		8	4.6
24	Common Kestrel	1		2	3
25	Common Kingfisher	1		3	1.3
26	Common Moorhen		14	21	11.6
27	Common Myna	35	39	45	39.6
28	Common Pigeon	45	27	25	32.3
29	Common Redshank			1	0.3
30	Common Sandpiper	1		8	3
31	Common Stonechat	8		11	6.3
32	Common Tailorbird		5	1	2

33	Common Woodshrike	1			0.3
34	Coppersmith Barbet	1	3	5	3
35	Cotton Pygmy-goose			13	4.3
36	Crested Lark	14		12	8.6
37	Desert Wheatear			4	1.3
38	Egyptian Vulture	3	2	5	3.3
39	Eurasian Collared Dove	18	3	20	13.6
40	Eurasian Coot			2	0.6
41	Eurasian Eagle Owl			1	0.3
42	Eurasian Thick knee	6			2
43	Ferruginous Duck			2	0.6
44	Gray Francolin	5	8	8	7
45	Great Cormorant			1	0.3
46	Great Egret		1	3	1.3
47	Greater Coucal	2	1	3	2
48	Greater Painted-snipe			1	0.3
49	Green Bee-eater	13	18	26	19
50	Green Sandpiper	1		8	3
51	House Crow	27	30	22	26.3
52	House Sparrow	60	45	39	48
53	house Swift		13		4.3
54	Indian Courser	5			0.8
55	Indian Golden Oriole	4		2	2
56	Indian Grey Hornbill	2	3	5	3.3
57	Indian Peafowl	13		6	6.3
58	Indian Pond Heron	17	10	8	11.6
59	Indian Robin	24	8	18	16.6
60	Indian Roller	3		8	3.6
61	Indian Silverbill	6	29	35	23.3
62	Jacobin Cuckoo			1	0.3
63	Jungle Babbler	31	9	24	21.3
64	Jungle Crow			3	1
65	Jungle Owlet		5	2	1.1
66	Large Grey Babbler	38		44	27.3
67	Laughing Dove	33	46	29	36
68	Lesser Goldenback			2	0.6

	Woodpecker				
69	Lesser Whistling duck		13	38	17
70	Lesser Whitethroat	8	1	4	4.3
71	Little Cormorant		1	3	1.3
72	Little Egret	3	5	22	10
73	Little Grebe			1	0.3
74	Little Ringed Plover			22	7.3
75	Long-tailed Shrike		5	6	3.6
76	Marsh Sandpiper			1	0.3
77	Oriental Magpie Robin	6	10	22	12.6
78	Oriental Turtle Dove		1	8	3
79	Oriental White-eye	3	5	2	3.3
80	Paddyfield Pipit		33	49	27.3
81	Painted Stork			18	6
82	Pheasant-tailed Jacana			3	1
83	Pied Kingfisher		1	18	6.3
84	Pied Stonechat		8	18	8.6
85	Plain Prinia		8	6	4.6
86	Purple Heron		1	5	2
87	Purple Sunbird	5	11	18	11.3
88	Purple Swamphen			2	0.6
89	Rain Quail		3	2	1.6
90	Red Avadavat		5	11	5.3
91	Red Collared Dove			24	8
92	Red Wattled Lapwing	24	29	38	30.3
93	Red-rumped Swallow		6	19	8.3
94	Red-vented Bulbul	33	24	26	27.6
95	Red-whiskered Bulbul	29	30	20	26.3
96	Rose-ringed Parakeet	19	23	33	25
97	Rosy starling			5	1.6
98	Rufous Treepie	3		5	2.6
99	Sarus Crane		3	8	3.6
100	Scaly Breasted Munia	8	25	40	24.3
101	Shikra	3	2	8	4.3
102	Southren Grey Shrike	3		5	2.6
103	Spotted Dove			3	1

104	Spotted Owlet		6	5	3.6
105	Sulphur-bellied Warbler	1		1	0.6
106	Taiga Flycatcher	1		2	1
107	Temminck's Stint			1	0.3
108	Thick-billed Flowerpecker		2		0.6
109	White Wagtail	19	7	39	21.6
110	White-breasted Waterhen		14	27	13.6
111	White-browed Wagtail	11	6	28	15
112	White-throated Kingfisher	8	13	8	9.6
113	Wire-Tailed Swallow		5	8	4.3
114	Wood Sandpiper	1	5	17	7.6
115	Woolly-necked Stork	2		10	4
116	Yellow- Wagtail		1	5	2
117	Yellow-eyed Babbler	6		11	5.6
118	Yellow-footed Green Pigeon	8	13	10	10.3
119	Yellow-wattled Lapwing			8	2.6
120	Zitting Cisticola	1		3	1.2

TABLE – 5 List of mammals and butterfly recorded in different areas of study.

S No	Common Name	Site 1	Site 2	Site 3
Mammals				
1	Rhesus Monkey			1
2	Northern Plain Langur			2
3	Small Indian Civet			1
4	Indian Grey Mongoose	5	3	6
5	Golden Jackal	3	2	3
6	Indian Hare	2		2
7	Nilgai			8
Butterflies				
1	Blue Pansy		(✓)	(✓)
2	Caper white	(✓)	(✓)	(✓)
3	Common Castor	(✓)	(✓)	(✓)
4	Common Grass Yellow	(✓)	(✓)	(✓)
5	Common Gull	(✓)	(✓)	(✓)
6	Common Jay	(✓)	(✓)	(✓)
7	Common Mormon	(✓)	(✓)	(✓)
8	Common Red Flash			(✓)
9	Common Rose Butteefly		(✓)	(✓)
10	Danaid Eggfly		(✓)	(✓)
11	Gray Pansy	(✓)	(✓)	(✓)
12	Veined Perriot		(✓)	(✓)
13	Indian Jezebel	(✓)		(✓)
14	Lemon Pansy		(✓)	(✓)
15	Lime Swallowtail	(✓)	(✓)	(✓)
16	Meadow Brown			(✓)
17	Mottled Emigrent	(✓)	(✓)	(✓)
18	Pea Blue		(✓)	(✓)
19	Plain Tiger	(✓)	(✓)	(✓)

20	Tailed Jay		(♂)	(♂)
21	Tawny Coster		(♂)	(♂)
22	White Orange-tip	(♂)	(♂)	(♂)

**TABLE – 6 Total Orders and Families of the Birds Recorded in
Study Area**

S.N	Order / No of species	Family	No of species
	Accipitriformes	Accipitridae	4
	Anseriformes	Anatidae	3
	Bucerotiformes	Upupidae	1
		Bucerotidae	1
	Charadriiformes	Burhinidae	
		Rostratulidae	1
		jacanidae	2
		Recurvirostridae	1
		Charadriidae	3
		Scolopacidae	6
		Glareolidae	1
	Ciconiiformes	Ciconiidae	3
	Columbiformes	Columbidae	7
	Coraciiformes	Coraciidae	1
		Alcedinidae	3
		Meropidae	1
		Cuculidae	4
	Falconiformes	Falconidae	1
	Galliformes	Phasianidae	3
	Gruiformes	Rallidae	4
		Gruidae	1
	Passeriformes	Vangidae	1
		Laniidae	2
		Dicruridae	1
		Icteridae	1
		Corvidae	3
		Hirundinidae	3
		Alaudidae	2

		Pycnonotidae	2
		Cisticolidae	4
		Phylloscopidae	1
		Sylviidae	1
		Leiothrichidae	2
		Paradoxornithidae	1
		Zosteropidae	1
		Sturnidae	4
		Muscicapidae	7
		Dicaeidae	1
		Nectariniidae	1
		Passeridae	2
		ploceidae	1
		Estrildidae	3
		Motacillidae	5
	Pelecaniformes	Threskiornithidae	1
		Ardeidae	6
	Piciformes	Megalaimidae	1
		Picidae	1
	Podicipediformes	Podicipedidae	1
	Psittaciformes	Psittaculidae	1
	Pterocliiformes	Pteroclididae	1
	Strigiformes	Strigidae	3
	Suliformes	Phalacrocoracidae	2
	Apodiformes	Apodiadeae	1

Conclusion

Biodiversity is the variety and difference among living organisms and includes genetic diversity within and between species and of ecosystems. The variety of all living things is a contraction of biological diversity. Biodiversity can be measured on many biological levels ranging from genetic diversity within a species to the variety of ecosystems on Earth, but the term most commonly refers to the number of different species found in a defined area. A comparative study of avian diversity across different habitats and regions can provide important insights into the factors that influence bird populations and the overall health of ecosystems. Overall, the study of biodiversity has revealed that different species have varying ecological requirements and respond differently to changes in habitat and environmental conditions. For example, forest-dwelling birds may be more vulnerable to habitat fragmentation and deforestation, while wetland birds may be more sensitive to changes in water quality and habitat degradation. The comparative study of biodiversity has also shown that the impacts of human activities such as urbanization, agriculture, and climate change can have significant impacts on bird populations, with some species declining in abundance and others expanding their range or adapting to changing conditions. Conservation efforts such as habitat restoration, protection of remnant forests and wetlands, and reduction of non-native species and predators are crucial for maintaining diversity and supporting healthy ecosystems. Additionally, public education and outreach efforts can help raise awareness of the importance of bird conservation and inspire action to protect these important and valuable species.

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