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SUMMARY

- Present research work focused more on the qualitative, qualitative and bio-ecological aspects of avian diversity that can be used to understand fluctuations in ecosystems functions and help in prioritization of areas for conservation.
- In order to conserve local bird population's knowledge of local population structure and status of bird is essential.
- Such a data on species composition, relative abundance, and habitat relations would provide managers with baseline data for establishing monitoring programs and setting management goals for priority species.
- Therefore, present work would help to understand ecological relations between bird species and land-cover types across spatial and temporal scales.
- The birds are ideal bio-indicators and useful models for studying a variety of environmental problems. Even birds also have an impact on cropland ecosystem. Therefore in the present study substantial work has been carried out in these contexts. Especially 1) avian diversity, 2) aquatic migratory birds, 3) special studies on breeding success, 4) circadian rhythms, 5) behaviour of birds, 6) habitat of local birds and their interaction in the ecosystem and 7) birds as indicator for weather change have studied.

1 AVIAN DIVERSITY

- The checklist of the birds of the local area with their statuses was worked by reliable methods used in bird census determination. Therefore exact estimation of total populations of each avian species was determined in abundance status.
- This also helped in assessing and comparing the status of the avifauna in that ecosystems.
- This study has provided valuable data for comparison.
- The field studies showed varied avifauna in the local area with 133 species, belonging to 101 genera, 44 families spread over 14 orders.
- The species recorded more than 50% of total observations from a particular habitat were treated as species of that habitat.
- Riverine-terrestrial habitat species number was 81, human habitation it was 89, in wetland habitat were 39, in hilly area 51 and terrestrial habitat 73, the number of species recorded were located in the local area. Very few species was exclusive, large overlapping with 13 common species to all habitats.
- Abundance status showed Very Common 2 sp, Common 48 sp, Uncommon 23 sp, Occasional 7 sp, Rare 33 sp and stray 19 sp in the local area.

- Residential status of birds noted was Resident 86 sp, Resident Migratory 31 sp, Migratory 14 sp and Local Migratory 2 sp during three year study period.
- Shannon's-Weaver diversity index showed 0.87 habitat diversity, 0.66 residential status diversity and 0.87 abundance status diversity by-

$$H' = n \log n - \sum f i \log f i$$

- Globally threatened species recorded in study area were Spot-billed Pelican *Pelecanus philippensis*, Great Indian Bustard *Ardeotis nigriceps*, White-naped Tit *Parus nuchalis* and a nearly threatened Lesser Flamingo *Phoenicopterus minor*.

2 WETLAND MIGRATORY BIRDS

- One of the most spectacular events in the life history of number of birds is the migration. It is enthralling subject of the study of bird life.
- Bird migration described as "Changes of habitat periodically recurring and alternating in direction, which tend to secure optimum environmental conditions at all times." The clockwork regularity with which the arrivals and departure of migratory birds takes place every year.
- Migratory birds were seen in study area only during the winter months, they arrive in autumn, chiefly between October and November and leave

again for their northern breeding grounds before our hot weather commences, in March or April.

- In the study area 24 species of wetland migratory birds belonging to 12 families from 4 orders were identified mostly in the Dheku dam, and nearby water bodies. Out of total wetland migratory bird species 15 belonged to single order Cinconiformes, 6 to Anseriformes, 2 to Gruiformes and only 1 to Passeriformes.
- Diversity of migratory birds in relation to location of wetlands revealed that Dheku dam supported the highest number of species (14 sp), Followed by Galmudi dam (10 sp), Chandeshwary dam (6 sp) and Belgaon dam (3 sp).
- Species wise analysis indicated that Common Coot *Fulica atra* was the most dominant species during three year study period.
- Second most dominant species was Marsh Sandpiper *Tringa stagnatilis*, while third most dominant species was Brahminy Shelduck *Tadorna ferruginea*, followed by Nothern Shoveller *Anas clypeata* > Greylag Goose *Anser anser* > White Wagtail *Motacilla alba*.
- Monthly analysis of winter stay of migratory birds showed that February was the peak month with 24.91% birds during three year study period, Followed in March 19.23%, January 18.55%, December 16.56%, November 11.62% and October 9.14% of the abundance.

- Very few number of migratory birds observed in the month of April and still less exceptionally in July, June and May in some seasons and no any migratory bird found in the month of August and September throughout study period in the wetlands of local area.
- While year wise analysis of abundance during October to March indicated that about 22,964 migratory birds visited wetlands of local area, among which 30.56% in 2004-05, 50.24% in 2005-06 and 19.21% during 2006-07 of the study period.
- In October to March 2004-05 total 22 species, in 2005-06 total 18 species and in 2006-07 total 13 species visited to wetlands of local area.
- *Fulica atra*, *Limosa limosa* and *Motacilla alba* arrived in the beginning of winter among all visitor birds and lastly departed was *Platalea leucoradia*.
- Besides, 21 migratory bird species also recorded from terrestrial habitat of local study area.
- The study of food availability as well as environmental parameters of local area has gained immense importance as seasonal phenomenon of avian migration correlated with its changes in different seasons.
- Food availability in the area such as zooplankton and phytoplankton population in surface layer was collected for a period of two years.

- The corelationship of zooplankton and phytoplankton with their environment and in relation to arrival and departure of migratory birds showed a definite relationship.
- The numerical abundance of zooplankton during migratory stay of birds from October to April was higher in contrast to phytoplankton.
- The lowest abundance of zooplankton was found in September during which there was no any migratory bird found in the local wetlands.
- The highest abundance of zooplankton recorded in March during which there were large number of migratory birds recorded in the local wetlands.
- The lowest density of phytoplankton was found in December-January during which there were maximum number of migratory birds found in the local wetlands.
- The highest density of phytoplankton was found in November during which there was very few migratory birds present in the local wetlands.
- Zooplankton population composed of major groups namely Rotifera, Cladocera, Copepoda, Ostracoda and Nauplius larvae. The annual average percentage composition of these groups showed that the Rotifera was dominant followed in order by Nauplius larvae > Cladocera > Copepoda > Ostracoda.
- The phytoplankton population counted five major groups namely Cynophyceae, Bacillariophyceae, Chlorophyceae, Euglenophyceae and

Dinophyceae. The annual average percentage composition of these groups subsequently followed Cynophyceae.

- Although Dheku dam stocked with large number of fishes which feed on plankton; there is higher food availability for migratory bird populations.
- Various environmental parameters exhibited certain interesting correlationship with each other and also affects on avian migration.
- Migratory period of birds from October to April showed certain relationship with daylength, when it was short most of the birds arrived in the local area and departed when longer.
- Photoperiod also influence on number of day to day activities of birds such as food searching, feeding, resting, movement, growth and development.
- Atmospheric temperature affects water temperature in turn it affects on various factors such as availability of food, evaporation of water etc.
- Relative humidity also plays an important role in various activities of birds.
- Average recorded rainfall of local area was 531mm during three year monsoon period affected mildly on arrival and abundance of migratory birds.

3 SPECIAL STUDIES ON BREEDING SUCCESS

- Special studies on breeding success of Brahminy Myna *Sturnus pagodarum* and Indian Shikra *Accipiter badius* were carried out during study period.
- Various life history stages such as nesting season, nesting habitat, clutch size, incubation period, hatching period, hatchlings, nestlings, fledglings and fledging period were observed.
- In these birds both parents took part in nest construction and domestic duties.
- *Sturnus pagodarum* is a local migratory bird species during breeding season late April to early may start nest building activities at human habitation. Most of these birds reoccupy the nest on successive seasons and add more material or reconstruct the nest at same spot or site.
- This bird species lay eggs in May to June in every year. The average clutch size of two years was 3.8±0.25, clutches hatched over a period of 3 to 4 days, with 23± 2.61days incubation period. Whereas the fledgling period 39.8±1.71 days with 2.0±0.63 (Mean ± SD) fledglings.
- The breeding success of *S. pagodarum* was 45.65% in this suburban habitat of the local area.
- *Accpiter badius* is a resident bird species, in which courtship flights follows mating and nest building during December-January and

reoccupancy rate was higher about 50% in third year if there is no any disturbance.

- Female by March stopped hunting, spent most of their time near nest, laid eggs in dry season from March to April day after day regularly.
- The average clutch size was 2.3±0.53 (Mean ± SD).
- Only female incubated eggs whereas male provided food and protection from intruders to incubating female.
- The incubation period was 36 days, followed by hatching took place day after day.
- Young emerged with natal down, plumage developed after a week.
- The reproductive success was 41%, and nesting success was 88.89% during three year study period.

4 CIRCADIAN RHYTHMS

- Rhythmicity is the rule of nature and birds are no exceptions, because many activities of birds are correlated with day-night cycles that are daily pattern of circadian rhythms.
- Birds are most active early in the morning and have definite awakening hours apparently determined by light, photoperiod, weather and temperature.
- There was a rhythmic clockwork regularity and punctuality in the daily activities of Brahminy Shelduck *Tadorna ferruginea*.

- This bird species started their daily activities at early in the morning for feeding in water.
- While during afternoon hours when temperature increased to its maximum, these birds get together for rest on mud spit for hours and again disperse for feeding in definite groups till sunset. Again in evening hours with definite groups' moves to mud spit till next morning.
- This clockwork regularity followed in definite groups of individuals to feeding and resting place by choosing some direction during afternoon and evening hours.

5 BEHAVIOUR OF BIRDS

- Behaviour of birds is largely directed towards self- and racial-survival. It is, in effect, an internally directed system of activities that strives to maintain the life stability in face of many environmental hazards.
- This involves all of a bird's activity, but observed for most common such as feeding, roosting, pair bond, nesting and clutch size.
- Study of food and feeding behaviour of birds is very important in the betterment of rural economy, and its relevance in diversifying traditional agriculture, to better use of birds feeding habit in agriculture, is one of the aspects supporting to the eco-friendly agriculture.

- Food and feeding behaviour of birds showed different food preference with lack of competition, differences in feeding methods as well as variations in the feeding associations.
- On the basis of percentage of food preferred by bird species arbitrary classified as insectivorous, granivorous, fruit eating, necterivorous, predatory, fish eating and scavenger birds.
- The most important economic value of birds is suppression and destruction of insects and other pests from the agriculture and corresponding habitats.
- *Pavo cristatus* predominantly fed on animal matter mostly on ground, in the cropland, under vegetation and on leaf litter by picking and chasing methods. These birds feed in pairs or with their own groups of individuals, some times accompanied by *Acridotheres tristis*, *Bulbulcus ibis* and *Turdoides caudatus*.
- *Alcedo atthis* is predatory feeding on fishes, crabs, prawns, tadpoles, lizards etc, for feeding it dives from its searching place to capture prey. It feeds mostly single or at some exceptional times in pairs, prefers areas close to water on perch or wires over hanging the water and scans it for hours by diving, flying and chasing methods. Some times feeding accompanied by *Dicrurus macrocercus, Lanius schach* and *Merops orientalis.*

- Roosting is also characteristics feature of most of the avian species which living in aggregations with one or more other species.
- Anumber of bird species of diverse orders and families and with a diversity of habits and habitats roosts together for at least a part of the year.
- Such roosting habit is beneficial to the birds, provides protection against enemies by antipredatory warning signals and does not causes competition for food in most cases.
- Field study pointed six mixed and six isolated communal roosts, out of which 9 roosts were constant and 3 were seasonal roosts of birds from local area.
- Sexual selection in males and females is greatly influenced by the relationship between the number of mating partners and it also affects on reproductive success of the pairing partners.
- Pair bonding is well studied by colour banding to leg of birds.
- Colour banded pairs of Brahminy Myna *Sturnus pagodarum* remained together year after year showing monogamy type of pair bonding.
- Studies on *S. pagodarum* showed successive brood monogamy in the regional area by sampled young from three sequential broods of 18 pairs.
- Nest building is one of the most interesting outdoor activities in the study of breeding of birds.

- There are 10 different types of nests of different residential bird species of the local area.
- These are simple scrapes, twig nests, suspended nests, nest in leaves stitched together, tree holes, nests in excavated tunnels, cup shaped nests, nests in crevices of house wall, float nests and nest near water.
- One of the most common characteristics of these nests was concerned with the safety of eggs and young, therefore all birds selected safe nesting site, which was major factor that governed the successful rearing of chicks.
- Besides some unusual nests are also observed in case of some birds such as *Sturnus pagodarum, Streptopelia senegalensis* etc.
- The crude birth rate in birds may be measured by the number of eggs in the clutch, the term used for a group of eggs laid and incubated more or less together by one pair.
- The number of eggs in a clutch is approximately constant for a species and not varied very widely.
- We recorded clutch-sizes of 15 bird species belonging to 10 different families spread over 5 orders.
- In most of the cases egg laying started between March and July.
- In local residential birds the average clutch of different species ranges from 2 to 8 and a clutch of 3 to 4 is the most frequent.

6 HABITAT OF LOCAL BIRDS AND THEIR INTERACTION IN THE ECOSYSTEM

- We studied interactions of birds in the cropland habitat. Altogether 39 different species of insectivorous (22), granivorous (13) and bird of prey (4) visited millet (Jowar) *Sorghum sp* cropland during the period of observations.
- During study period on each day the number of species visiting the millet (Jowar) *Sorghum sp* cropland varied between 16 to 24, with total number of individuals varied between 178 to 312 and showed differences in morning and evening hours.
- In the morning hours the number of species visiting to millet (Jowar) cropland varied between 9 to 17 and the number of individuals between 89 to 152, whereas in evening hours it was 6 to 11 species and individuals 34 to 68 in a single millet (Jowar) cropland.
- Birds species visiting to the cropland were insectivorous feeding on insect spent most of the time in the field and other animal food present on the tender grained cobs.
- Among 13 granivorous birds 5 species of birds were obtained their food by gleaning or scratching waste damed cobs.
- Whereas remaining 8 species were actually seen plucking at and eating grains from the cobs.

- Only three species Rosy Starling *Sturnus rosesus*, Yellow throated sparrow *Petronia xanthocollis*, Common Myna *Acridotheres tristis* causing serious damage to the millet (Jowar) cropland.
- The members of bird species established interrelation through their co-operation that is beneficial coactions.

7 BIRDS AS INDICATOR FOR WEATHER CHANGE

- Birds respond to changing environmental conditions, most of them was identified and served as ideal bio-indicator for climate change as response indicator from the natural environment.
- Response variables studied particularly from Hawk Cuckoo *Hierococcyx varius*, House Crow *Carvus splendens,* Brahminy Myna *Sturnus pagodarum*, Indian Shikra *Accipiter badius*, Pied crested Cuckoo *Clamator Jacobinus*, Indian Peafowl *Pavo cristatus* and White Wagtail *Motacilla alba* of the local area.
- Arrival of Common Hawk Cuckoo *Hierococcyx varius* realized by its specific loud streaming call at the outset of spring indicates end of spring and yet coming monsoon of the area.
- Nest structure and densities of *Carvus splendens* indicated low and high rainfall in the area.

- Egg laying dates of *Sturnus pagodarum* and *Accipiter badius* correlated with the availability of food for nestlings when they leave the nest indicating monsoon-insect food relationship.
- Pied crested Cuckoo Clamator jacobinus is the most believable bio-indicator as its arrival suggest the beginning of monsoon in the area.
- Whereas a loud specific Keon....Keon....Keon.... call of *Pavo cristatus* is a reliable avian indicator for immediate rainfall and at most of the times the bird seems to be in dancing mood.
- Appearance of Motacilla alba in early October indicated end of monsoon period.
- Besides, arrival and departure of various migratory birds also served as a ideal bio-indicator of weather change.