

Faunal diversity and conservation aspects in an aquatic ecosystem, Kondakarla fresh water lake, Visakhapatnam, Andhra Pradesh, India

Dr. J. Jagatheeswari

L.R.G. Government Arts College for women, Tirupur, Tamilnadu, India.

Abstract

To evaluate the present status of Kondakarla lake faunal diversity like fishes, amphibians, reptiles and birds diversity in Kondakarla freshwater lake, Visakhapatnam, Andhra Pradesh, India, was studied for a period of 3 years from 2009-2012. Bio diversity and its conservation are regarded as one of the natural resources. Kondakarla fresh water lake ecosystem inhabits several aquatic organisms. Change in water quality due to pollution put the fauna under stress. Loss of bio diversity used as an indicator of environmental degradation. This contribution focuses on the bio diversity and their conservation aspects in Kondakarla fresh water lake ecosystem, Visakhapatnam, Andhra Pradesh, India.

Keywords: Bio diversity, sustainable development, conservation and management, Kondakarla fresh water lake, Visakhapatnam.

Introduction

Today wetlands (natural or human modified) provide staple food (rice and fish) for more than half of the world's human population. Over-exploitation of wetland resources (harvesting, fishing and hunting) causes decline of many plants and animals. Land use practices such as agriculture mining, regulation of water flows, disposal of domestic sewage and industrial effluents degrade and reduce the wetland habitats. In this context the present study has been chosen to evaluate the present status of Kondakarla lake fishes, amphibians, reptiles and birds diversity as well to protect the biological resources.

Materials and methods

Study Area

Kondakarla Lake is the second largest natural fresh water lake in Andhra Pradesh located at a distance of 42 km from Visakhapatnam and 7 km from Anakapalle. It is situated between 17°35'30" and 17°36'02" latitudes and 82°59'27" and 83°10" longitude. The Lake receives water from Sarada River and excess water runs off into Bay of Bengal through man made canals. A number of villages are situated around the lake. The lake was spread over an area of 30 sq.km, completely filled with water during rainy season. The depth of the lake earlier was about 25 ft as per records and now it is not more than 15 ft.

Sampling

Biodiversity of fishes

Sampling was done at fortnightly intervals for limnological characteristics. Collected fishes were packed, labelled in separate polythene bags, placed in ice box and transported to laboratory within 12 hours for the purpose of identification. Taxonomical identification and classification was done on the basis of morphometric characteristics upto species level. The fish specimens were identified following regional keys, Mirza, (2003) [11]. Immediately on reaching the laboratory fishes were separated according to the species and live fishes were killed in a solution of formaline.

The identification of the species was done mainly on the basis of the colour pattern, specific spots or marks on the surface of the body, shape of the body, structure of various fins and fin formula etc

Biodiversity of amphibians

Frogs were collected through visual encounter survey and sampling of breeding site. Samples were preserved in 8% formaldehyde solution for fixation and preservation. The field characteristic noted down according to the guide lines given by Chanda. S.K. (2002) [5], Reptile's survey is taken through visual encounter survey.

Biodiversity of Reptiles

Reptile's survey is taken through visual encounter survey. The snake is identified with the help of the standard reference books. The scientific names of snakes are according to Whitaker & Captain (2004) [10].

Biodiversity of Birds

In the present study the observations were made in the selected study area. Regular visit were made to the study area. The data were collected by using direct as well as indirect methods in order to study the presence population status, local threats, distributions and importance of agricultural lands in distribution and diversity of avian fauna.

Classification of Habitat Types

The study areas were frequently visited to observe the bird's fauna by using 7 x 50 and 8 x 40 binoculars. On each sampling day observations were made between 6 to 10 a.m. and 4 to 6 p.m. Habitat type was evaluated with the vegetation composition, distribution patterns, community structure and ecological succession of plant communities through transects of selective sizes (10m X 10m to 50m X 50m) were laid in the study area.

(1) Open waters of muddy shores and sand bars: Most of these lake areas are open shallow waters of exposed muddy flats

and sand bars are colonized with patchy vegetation of submerged hydrophytes and emergent weeds.

(2) Deep shallow lake bed areas: The areas consist of deep shallow lake bed areas water depth ranges from 2 to 3 meters with submerged hydrophytes, mesophytes and macrophytic aquatic species.

(3) Wet borders of river channels and discharging drains: These habitats are located nearer to river channels and drainage outlets with dense growth of climax plant communities of reed mace and emergent species in the water spread areas.

(4) Lake fringes and marginal areas: The areas where the lake are polluted due to industrial effluents, sewerage flows and domestic wastes leads to degradation of lake habitats are dominated by shrubs and thorny tree species.

The status of each bird species was determined in relation to habitat, migration and distribution based on the systematic field surveys by using with standard survey techniques. Bird species were sampled in all habitat types as per the methods followed by direct data collection, visits were made once or twice in a month early in the morning till sun set. For indirect data collection, hunters, wildlife, local residents, farmers and other knowledgeable persons were interviewed about the present and past status of the birds, threats and effect of human population and urbanization on birds diversity. The field characteristic noted down according to the guide lines given by Achar and Nayak (2000) [1].

Identification of birds was done with the help of key reference books (Ali. 1996) [2] Feeding activities of these birds were also noted down to get an idea about the food items consumed by these birds and feeding status. Status of each bird's species in relation to period of occurrence, activity patterns and abundance classed were assigned based on the following criteria.

A-Abundant: Seen very commonly in all suitable habitats and observed in every field visit during the study

C-Common: Seen commonly in the study area in all suitable habitats in most of the visits during the study

VR-Very Rare: Seen only once or twice in specific habitats and found on a few visits during the study.

The bird species migratory status was classified in to:

R-Resident Species: which are found in the study areas at all seasons of the year.

LM- Local Migrants: Species which are found in the study area in a particular period

M-Migrants: Species which visit the study areas only during winter months for breeding purposes.

Diversity Measures

The indices were calculated to know variation among the birds. The species diversity Index is calculated by using Shannon-Wiener Index (H). Species richness (SR) was calculated by using the formula:

The species diversity index is calculated by using **Shannon – Wiener Index (H)**

$$(1) \quad H = - \sum_{i=1}^s P_i \log P_i$$

Where 'S' represents the number of species and 'Pi' denotes the proportion of the total number of individuals of the i th species

Species Richness (SR) was calculated using the formula:

$$(2) \quad SR = \frac{S - I}{\log e N}$$

Where S = number of species, Log N is the natural logarithm of total number of Individuals of all species in the count.

Simpson Index was calculated by using the formula

$$(3) \quad \text{Simpson Index } D = \frac{N(N-1)}{\sum n(n-1)}$$

Where

D = Diversity Index

N = Total number of Individuals of all species

n = Individual species number

To find out the similarity in bird species composition between habitat types the Similarity Index was applied.

Results

Faunal diversity

Among the faunal groups the birds species were highest in number (68species) with 64.15% contribution in abundance, density rather than other groups such as Fishes, 26 species (24.52%), Amphibians, 3 species (2.83%),Reptiles, 9 species (8.49%) respectively

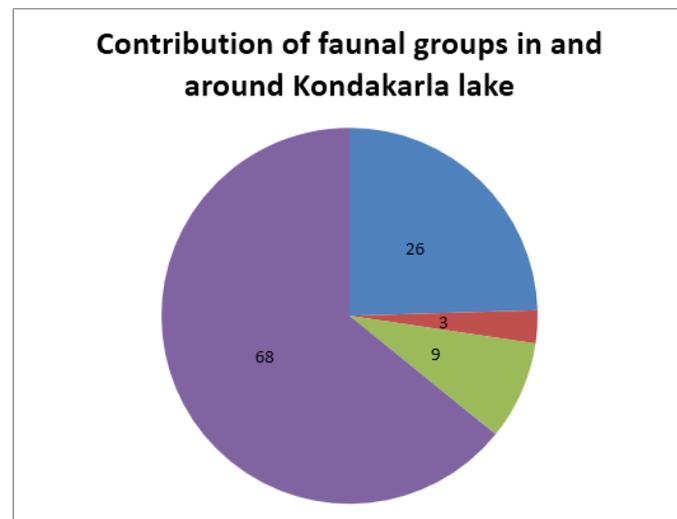


Fig 1: Distribution of faunal groups

In habitat wise distribution fishery fauna was always confined to interior lake habitats and in the present study a total of 26 species of fishes were documented from lake environments belonging to families, Notopteridae (*Notopterus notopterus*), Anguillidae (*Anguilla bengalensis*), Cyprinidae(*Cyprinus carpio*, *Catla Catla*, *Labeo rohita*, *Puntius ticto ticto*, *Puntius sophore*, *Osteobrama vigorsii*, *Ctenoptergo idella*, *Cyprinus mrigala*, Bagridae (*Mystus gulio*, *Mystus vittatus*, *Mystus cavasius*), Siluridae(*Wallago attu*, *Ompok bimaculatus*), Heteropneustidae (*Heteropneustus fossilis*), Mugilidae (*Rhinomugilcorsula*), Belonidae (*Xenotodon cancila*), Poeciliidae (*Gambusia affinis*),

Mastacembelidae (*Macrognathus Pancalus*), Cichlidae (*Tilapia mossamica*, *etroplus suratensis*), Anabantidae (*Anabas testudineus*), Belonitidae (*Colisa fasciatus*) and Channidae (*Channa striatus*, *Channa punctatus*).

Distribution and status of amphibians

The amphibians are distributed in the emergent weeds and agricultural lands of the lake ecosystem. Three species of amphibians belongs to family Ranidae (*Rana cyanophlyctis*), Hylidae (*Hyla annectans*) and Bufonidae (*Bufo melanostictus*) were documented during the survey

Distribution and status of Reptiles

9 species of Reptiles belongs to 8 families were documented during the survey. Families like Elapidae 1 species (*Naja naja*), Pythonidae 1 species (*Python molurus*), Colubrid *notuspiscator*), Varanidae 1 species (*Varanus monitor*), Agamiidae 1 species (*Calotes versicolor*), Chamaeleonidae 1 species (*Chamaeleo zeylancicus*) and Trionychidae 1 species (*Lissemys punctata*).

Reptiles like the fresh water snake *Tropidonotus piscater* are confined to lake waters and the terrestrial reptile species (*Naja naja*, *Lissemys punctata*) are occasionally found in and around the lake

Distribution and status of birds

A total of 68 species of birds were documented during the survey (Table-1) belongs to 31 Families were noted. Among these 68 species of birds, 35 species of birds are aquatic habitats and 33 species of birds were terrestrial.

Habitat utilisation

Among the bird species 40 species were common, 17 species were abundant, 8 species were rare and 3 species were very rare. Resident category species were dominated in all the habitat of the lake with the species composition from the families of Podicipedidae, Little Grebe (*Trachybaptus ruficollis*), Phalacrocoracidae, little cormorant (*Phalacrocorax niger*), Anhingidae, Snake Bird (*Anhinga melanogaster*) and Ardeidae-

Grey Heron, *Ardea cinerea*, Purple Heron, *Ardea Purpurea*, Indian Pond Heron, *Aredeola grayii*, Cattle Egret, *Babulcus ibis*, Little Egret, *Egretta garzetta*, Large Egret, *Ardea alba*.

The local migrants were visited the lake habitats very frequently for shelter and feeding. L. migrants like Family, Ciconiidae (Painted Stork, *Ibis Leococephalus*, Asian Open bill Stork, *Anastomus oscitans*). The migrant category belong to Family, Anatidae (Brahminy Shelduck (Duck, *Tadona ferruginea*, Northern Pintail, *Anas acuta*, Common Teal, *Anas crecca*, Lesser Whistling Teal, *Dendrocygna javanicus*, Northern Shoveller, *Anas clypeata*, Tufted Duck, *Aythya fuligula*, Cotton Teal, *Nettapus coromandelianus*) were visited the lake during Winter months for shelter and breeding.

The terrestrial habitat species of birds were mostly consists of passerine birds categories like Families of: Caridae, Spotted Dove, *Streptopelia chinensis*, Blue Rock Pigeon, *Columba livia*; Pisttaciidae, Rose Ringed Parakeet, *Psittacula krameri*; Cuculidae, Pied Crested Cuckoo, *Clamator jacobinus*; Sturnidae, Common Myna, *Acridotheres tristis*, Bank Myna *Acridotheres ginginianus*; Corvidae, White belled Tree pie *Dendrocitta leucogastra* were found at marginal areas of the lake for roosting and shelter.

The non-passerine species of families Piscidae, Lesser Golden backed Woodpecker, *Dinopium benghalense*, Dicruridae, Black Drongo, *Dicrurus macrocercus*, Corvidae, House crow, *Corvus splendens*, Jungle crow, *Corvus Macrorhynchos*, Tamaliinae, Common Babbler, *Turdoides caudatus*, Passerinae, House Sparrow, *Passer Domesticus*, Strigidae, Spotted Owlet, *Athene brama* were feeding on lake fauna.

In habitat utilization wise, 35 species of aquatic habitats were observed in shallow lake bed areas followed by the open waters and mud flats recorded 34 species. Besides these, river channels and discharging drains were contributed with 28 species and marginal areas of lake fringes were represented by 25 species respectively. 24 species are present in all habitats. Bird diversity of the lake ecosystem was determined based on diversity indices. Comparatively shallow water of lake bed showed highest number of birds and number of birds are less in lake fringes (Table.1)

Table 1: Relationships of Total bird population, Species richness and Equally Common Species in Kondakarla lake Habitats during the study period

S. No	Habitat Type	Diversity Indices	Study Period		
			2009-10	2010-11	2011-12
1.	Open waters and mud flats	1. Species richness	4.448002048	4.341339	3.980857
		2. Simpson's Index	10.68547588	10.71324	11.46302
		3. Shannon wiener Index	0.20277615	0.2031	0.20627
2.	Shallow waters of Lake bed	1. Species richness	4.54835135	4.361288	4.15164
		2. Simpson's Index	10.81455665	10.96221	11.07263
		3. Shannon wiener Index	0.20325097	0.2039	0.20463
3.	River channels and Drains	1. Species richness	1.6414763	1.513825	1.356568
		2. Simpson's Index	10.51070979	10.73463	10.68092
		3. Shannon wiener Index	0.20140387	0.20239	0.20203
4.	Marginal Areas and Lake fringes	1. Species richness	1.280190958	1.154701	1.030776
		2. Simpson's Index	11.03901274	10.869	10.67769
		3. Shannon wiener Index	0.20447154	0.20351	0.20335

Fishery fauna of 26 species is confined to interior lake, the amphibians of 3 species distributed in the Emergent weeds and agricultural lands of the lake ecosystem. Whereas Among the Reptile species, the fresh water snake *Tropidonotus piscater* are confined to lake waters. The Terrestrial Reptile species (*Naja*

naja, *Lissemys punctata*) are occasionally found in the nearby marginal areas of the lake. Among 68 species of birds, 35 species of birds are aquatic habitats and 33 species of birds are terrestrial in habitat.

The open water lake ecosystem were utilized by the birds like ducks, coots and cormorants are seen at the middle of the lake where the water level is highest during the southwest monsoon. The shallow water zones provides very good habitat for the migratory water fowl and local migrants and also it provides variety of food items to the egrets, herons, storks and common coots. Aquatic habitats consists of 66 species and terrestrial consists of 40 species were observed. Comparatively shallow water of lake bed showed highest number of birds and number of birds are less in lake fringes (Table1).

Conclusion

Conservation and Management of Lake Habitats

For maintenance of biological diversity, rehabilitation of endangered and endemic species, fisheries development and to enhance birds, fishes, amphibians, and reptiles diversity the following restoration measures suitable for habitat restoration of Kondakarla Lake.

By protecting the lake from biological interference the ecological diversity of the lake is maintained. For protection of the lake from human interference it is proposed to engage the local people as protection watchers who live in villages and providing information about any activity of poachers and encroachers, Rehabilitation of Migratory birds, Enhancement of Fishery Fauna, Afforestation in Lake Habitats, habitat restoration measures, Water, shed Management, Survey and Demarcation and awareness and Education

Discussion

The lake provides habitat for a diversity of life including significant population of fish, migratory birds, aquatic macrophytes, benthos, Invertebrates and Plankton that are of use to man and animals. Fish assemblages have been used as an indicator of environmental degradation (Arunachalam, 2000) [3]. Fish diversity in streams and rivers is considered as a diagnostic tool to highlight the impact of environmental changes (Das and Chakrabarty, 2007) [6] Fish responds to changes in its environment whether it is human induced or natural (Han 2007) [7].

Conservation programmes help fish production to be more sustainable while at the same time maintain diversity snakes. Habitat loss resulting from urbanization poses threat to nearly half of the reptilian species. In and around Kodakarla Lake is an excellent foraging ground for snakes due to abundance of prey species such as rodents and frogs. But the population is reduced because of habitat at loss includes deforestation that especially affects tree dwelling species such as Bamboo pit viper, Cat and Vine Snakes

Due to this agricultural fields and vegetation along the lake, the area is rich in avian fauna. Wetlands provide suitable habitats for birds. These habitats, however, are declining all over the world. Water resource development is a major cause for this decline. Dams are being constructed by diverting large rivers to produce hydro-electricity, assist navigation and control floods. Such changes have affected estuarine and coastal ecology and reduce the amount of water reaching flood plain wetlands, affecting their ecology (Kingsford 2000) [9].

During the survey, a total of 68 species of birds were recorded. At present, the lake shores are used for permanent cultivation affecting estuarine ecosystem and wetland birds. This leads to a big threat from the survival of species and maintenance of diversity. Similar destruction was also observed in Lake

Victorial (Kairu 2001) [8] within the bearable limits. Destruction of the habitats also results in the elimination or migration of species. Destruction of wildlife habitat by urbanization, pollution of water air and noise are probably some other potential problems for the birds in the future.

Avifauna of kondakarla lake were studied by Bharatha lakshmi (2001) [4] revealed that the lake is once known as a paradise of migrating birds, but now there is comparatively less. Generally factors such as pollution, siltage, profuse growth of aquatic weeds, biotic disturbance etc, affect the diversity of the avian fauna. A lot of silt through erosion is getting accumulated in the lake. Lake waters covered by excessive vegetation almost throughout the year. Pollutants, mostly of organic origin from adjacent sugar factories, sewage also enters the lake. Uncontrolled fishing depletes the food source of wetland birds. Destruction of trees causes the depletion of avian population.

Kondakarla Lake drew national attention due to the indulgence of man leading to cultural eutrophication of the lake. Around the lake varied activities prevail ranging from sewage entry through drains, sediment deposition through rivers and creeks. Industrial effluents are released from the nearby industries of leather, dairy, parboiled and sugar factories and agricultural wastes including fertilizers and pesticides. The lake is surrounded by densely populated human habitations which mainly depend on agriculture and fishing.

Protection and conservation of major wetlands critically important waterfowl on their traditional migratory flyways is the first priority. Most of these wetlands have essentially been natural ecosystems stabilized over the years and have retained their natural characteristics. In an ideal situation it would be most appropriate to maintain their natural process as far as possible or at least restore or improve if they are found degraded due to various reasons. However, in recent activities such as drainage, pollution, habitat alteration and industrialization, leaving behind only small fractions of once pristine habitats, particularly large wetlands. Under these circumstances active management of wetland is called for and justified.

Management of a wetland of international importance especially for migratory birds requires a thorough knowledge of not only the ecology of that particular wetland but also of the migration, feeding ecology and general behavior of waterfowl. While the management of the wetland itself is pretty straight forward, where the manager needs to manipulate the water flow systems as retain a particular character of the wetland, providing appropriate niches and food chains to a multitude of species arriving and departing at different times of the season rather complex and more challenging.

General principles of wetland management are discussed elsewhere in this manual. In this chapter some specific issues related to management of migratory waterfowl will be attempted, though some general issues having a significant bearing on the ecology of migratory waterfowl will also be touched upon.

Migrating waterfowl have three basic requirements at their wintering sites. These are Suitable habitat, Adequate food supply and Safety from predators including disturbances from man. Shallow lake bed areas provide very good habitats for the diversity of water fowl. The low depth of lake bed is an ideal habitat for many large and small water birds. The aquatic vegetation of the habitats provides good feeding and breeding cover for aquatic bird's fauna.

The large expands of aquatic reeds providing good breeding cover for many water birds as well as terrestrial birds mostly resident category birds like coots, moorhens, purple herons breed in the thick zone of vegetation. The marginal areas and wet boarders provide wise variety of food items which attract number of small size birds.

The wetlands in particular freshwater lake ecosystem provide an abundant continuous source of food to nesting, migratory water fowl and resident and local migrants. Hence conservation and managements of the lake habitats is considered to be at most importance for the conservation of associated fauna diversity.

At present these wetlands are under severe threat by man in a multiple way such as the discharge of pesticides, herbicides, nutrients from domestic sewage. Hydrological alternation by cannels, roads, poaching and scaring of water fowl on agriculture lands or intense life stock grazing.

Over exploitation of flora in and around the lake area should be minimized. Some selected areas which represent high diversity of water fowl should be protected and developed into suitable habitats like agriculture exploitation of the lake habitats and its surrounding areas should not be allowed. Entry of effluents into the lake should be checked and properly maintained annually. Afforestation activity should be intensified along the catchment areas which provide good roosting and breeding sites for number of water fowl. Environmental awareness and eco development programs should be organized at the grass root level so has to create awareness about the important of wetland and water fowl conservation.

Acknowledgement

My sincere thanks with deep sense of gratitude to Professor B. Kishore, M.Sc., Ph.D., Andhra University, Visakhapanam for his valuable guidance, constant encouragement for his manifold contribution. I am grateful to Dr. P.S. Raja Sekhar M.Sc., M.Phil., Ph.D, Asst. Professor, Department of Environmental Biology for his valuable guidance, constant encouragement for providing the necessary facilities and co-operation. My heartfelt thanks to my husband Sri M. Rajavel, my children, my parents and all the family members for their help.

References

- 1 Achar KP, Nayak G. A field guide to the Birds of Dakshina Kannada. A Decennial Publication of Bhuvanendra Nature Club, India, 2000.
- 2 Ali S. The Book of Indian Birds. 12th Edition. Oxford University Press. Delhi, 1996.
- 3 Arunachalam M. Assemblage structure of stream fishes in the Western Ghats (India), *Hydrobiologia*, 2000; 430:1-31.
- 4 Bharatha Lakshmi B. Avifauna of Kondakarla lake near Visakhapatnam Andhrapradesh. *J Nat con.* 2001; B(1):107-115.
- 5 Chanda SK. Handbook of Indian Amphibians. Zoological Survey of India, Kolkatta, 2002, 335.
- 6 Das SK, Chakrabarthy D. The use fish community structure as a measure of ecological degradation. Study in two tropical rivers of India. *Biosystem*, 2007; 90:188-196.
- 7 Han CC. Spatial and temporal variations of two cyprinids in a subtropical mountain reserve a result of habitat disturbance. *Ecology of Freshwater Fish*. 2007; 16:393-403.
- 8 Kairu JK. Wetland use and impact on lake Victoria, Kenya region Lakes and reservoirs. *Resource and Management*, 2001; 6:117-125.
- 9 Kingsford RT. Review; ecological impacts of dams, water diversions and river management on foodplain wetlands in Australia. *Australia Ecology*. 2000; 25:109-127.
- 10 Whitaker R, Captain. Snakes of India. The field guide. Chennai, India: Droco Books, 2004.
- 11 Mirza MR. Check list of Freshwater fishes of Pakistan. *Pakistan Journal of Zoology: Supplement Series*. 2003; 3:1-30.