IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Study On Anatid Population Diversity At Mangalajodi And Its Surrounding Marshlands Of Chilika Lake, Odisha

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***Abstract*:** Wetlands are important habitats for group of birds, those use it for feeding, resting, shelter, social interactions, breeding, nesting, and rearing of their young. These are broadly defined as wetland birds, which includes waterfowl, shorebird or waders and seabirds. Birds belonging to family Anatidae and Order Anseriformes are called anatids which are exclusively waterbirds, and are an ideal indicators of the health of a wetland habitat and the biodiversity richness of these productive ecosystems. Regular monitoring and population study of anatids plays significance in solving many ecological issues of wetlands. Mangalajodi, and its surrounding marshland located at northern end of Chilika lake, is one of the Important Bird and Biodiversity Areas and is renowned for carrying different species of birds and also plays a pivotal role in maintaining a constant population of anatids in Central Asian Flyway. A detailed population diversity study of anatids was carried out for 6 years from Sept 2017 to August 2023. Species richness, Relative abundance and Shannon–Weiner index of each species was measured in each zone of study area and overall study area. Study showed species like Northern Pintail, Gadwall, Garganey, and Northern Shoveler were predominant while Falcated Teal, Common Shelduck, and Baer's Pochard, have negligible or zero relative abundance. The Shannon Diversity Index was highest in Bhusandpur and Balipatpur, but Mangalajodi, despite its species richness, showed lesser evenness. Certain anatids that were completely absent or infrequent may be due to gaps in conservation efforts. The data indicate geographic variability in habitat and the necessity for zone-specific wetland management to preserve avian diversity and support rare species.

***Index Terms* - Wetlands, Waterbirds, Species richness, Relative abundance, Wetland management.**

I. INTRODUCTION

Wetlands are shallow water bodies in which water keeps up for most part of the year. These are complex hydrological and biogeochemical systems that have distinct ecosystems between the terrestrial and aquatic ecosystem **(Stewart, 2016).** Wetlands are most productive ecosystems, with rich biodiversity from the tiniest microbes to highly evolved mammals and also supports agricultural activities, fisheries and tourism **(Prasad et al. 2002).** Wetlands are important habitats for group of birds, those use it for feeding, resting, shelter, social interactions, breeding, nesting, and rearing of their young. These are broadly defined as wetland birds, which includes waterfowl, shorebird or waders and seabirds. Birds belonging to family Anatidae and Order Anseriformes are called anatids which are exclusively waterbirds, and are an ideal indicators of the health of a wetland habitat and the biodiversity richness of these productive ecosystems. There are about 174 species of waterbirds in the family Anatidae. These include ducks (*Anas* spp.), geese (*Anser, Branta* spp.), swans (*Cygnus*), teals, and pochards, which are spread out over about 43 genera. These species are very cosmopolitan and can be found in many different types of waterbodies, including freshwater lakes, brackish lagoons, marshes, and even coastal areas **(Akbari et al., 2018; Skieresz-Szewczyk & Jackowiak, 2016)**. Anatids are very important to wetland ecosystems from an ecological point of view. Many Anatids eat plant seeds and invertebrates, which helps spread seeds through endozoochory. Experiments with dabbling ducks like Teals show that a large number of the seeds they eat stay viable after digestion. This affects the diversity

of plants and the regrowth of wetlands. These interactions show how important they are for keeping plant communities healthy, moving nutrients around, and moving energy around **(Nie et al., 2022; Wongsriphuek et al., 2008)**. Factors such as water quality, depth, and plant structure influence their distribution and population size. Generally, high population levels indicate a healthy environment, while low levels suggest declining ecosystem health (**De et al., 2018; Baumgart et al., 2021; Shi et al., 2024**).

Regular monitoring and population study of anatids plays significance in solving many wetland ecology issues. As these group of birds are mostly migratory and involves annual large-scale, seasonal movements between breeding and non-breeding areas in definite routes called flyways. The Central Asian Flyway (CAF) extends across approximately 30 countries from Arctic Russia to the Indian Ocean, encompassing the breeding grounds of Siberia and Central Asia, down to wintering habitats in South Asia, including India and the Maldives. Over 180–300 migratory bird species utilize this aerial route, many of which are Anatidae (**De et al., 2018; Gilbert et al., 2006; Iverson et al., 2011; Nourani et al., 2015**). The study area plays a pivotal role in maintaining a constant population of anatids in CAF. Mangalajodi, located at northern end of Chilika lake, is one of the Important Bird and Biodiversity Areas (IBA) and is renowned for the presence of different bird populations there. From a survey, **Daoun et al. (2024)** reported more than 200 seasonal avifauna species, signifying the ecological significance and substantial biodiversity of the area. There are only a few reports on comprehensive and census studies on Anatidae in Mangalajodi, but from the previous studies, Anatidae are consistently present during specific seasons. **(Changder et al., 2015; Daoun et al., 2024; Pati et al., 2018)**.

II. STUDY AREA

Mangalajodi village is located 5 km away from Tangi in Khurda district and 60 km from Bhubaneshwar. It is one of the villages on bank of Chilika Lake. The extensive wetlands have a main broad channel running north to south for about four kilo meters with numerous side channels branching and then again looping back to form a criss-crossing maze of reed-lined waterways. There is an embankment (also serving as a Nature Trail) which runs alongside for about 2 kilo meters at the end of which is a Watch Tower erected by the Forest Department.

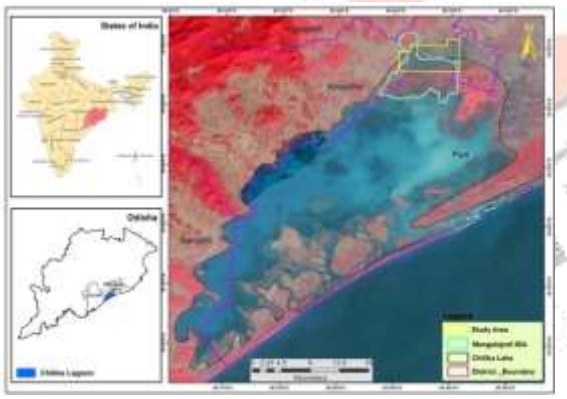

Figure. 1: Map of study area (Source – compiled by author)

The study area Mangalajodi (19^0 53.755‘-19^0 54.823’N: 85^0 26.184' -85^0 26.332'E) and its surrounding marshland up to Bhusandpur is approximately a 40 sq. km wet meadow and primarily a freshwater zone adjoining the northern sector of Chilika lake connected by water channels cut through the reed beds with the brackish waters of Chilika lake **(Changder et al., 2015) (Figure 3.3).** This region is dominated by vegetation such as *Typha angustata,, Typha elephantina* and *Phragmites karka,* which contribute to extensive reed beds and marshes **(Maity & Ghoshal, 2018; Ashaharraza & Patnaik, 2018; Tougas-Tellier et al., 2015)**.

This site as a significant global wetland habitat has been recognized as (IBA) Important Bird and Biodiversity Area, on the basis of a set of internationally accepted criteria. The area is classified under A1 + A4i + A4iii criteria of IBA **(Pattanaik, 2008**). The region currently supports the second-largest gathering of migratory birds in northern Chilika. Mangalajodi was notorious for poaching activities, but recent community led conservation initiatives have made this place a haven for migratory birds (**Changder et al., 2015; Daoun et al., 2024; Maity & Ghoshal, 2018**). Though not officially protected. However, since last several years, the local community supported by the Forest Department, Chilika Development Authority and many NGOs are been actively engaged in bird and their habitat protection.

III. MATERIALS AND METHODS

3.1 Zonation and Grid wise Demarcation of Study Area

The total area considered for purpose of research work from Mangalajodi to Bhusandpur is approximately 10 km in length and 4 km in width (40 sq. km.). For better understanding of study area and execution of study methodology the research area was plotted with 1 sq. km grid. Hence, a total of 40 grids were plotted on the study area. Again the study area was divided into five different zones, 1-Mangalajodi, 2-Sundarpur, 3-Abhimanpur, 4-Balipatpur and 5-Bhusandpur each of 8 sq. km area and plotted with 8 grids of 1 sq. km size.

3.2 Study Duration and Sampling Season

The research work was carried out from September 2017 to August 2023, spanning for six years. The study year was divided into 4 seasons, Autumn (September to November), Winter (December to February), Summer (March to May) and Monsoon (June to August). The survey and sampling work for population study of anatids and habitat study was carried out during the migratory season, that range from month of September to May and continue during autumn, winter and summer season. Study and sampling was not conducted during monsoon season from June to August month because the present research work focused only on the migratory period.

3.3 Line-transect Combined Estimation Protocol

Surveys were conducted along transect routes. Study area was divided into 3 horizontal line transects in east - west direction and 5 vertical line transects in north - south direction. Counting stations in each type of transect were spaced 1 km apart to each other. Along the counting stations point count and block count method was adopted depending upon the congregation rate of birds. To obtain encounter sampling of bird communities, whether seen or heard, observation on each counting station was carried out for 15 to 20 minutes.

Direct sighting for small flocks and block count technique for large flocks was carried out. The observations were made between 06:00 am and 11.00 am in the morning and between 14:30 pm and 17.30 pm in the afternoon. Species of birds those spent the daylight hours in agricultural landscapes were counted as they flew to or from their roost sites at dawn or dusk, as they often follow traditional flight lines to reach or leave the site.

3.4 Data Analysis and Diversity Indices

Each species of anatids those were encountered during population survey in 5 zones, were again studied further on basis of their abundance. The abundance rate was categorized into highly abundant, less abundant and least abundant. Year wise (from Sept 2017 to August 2023) Species richness, Relative abundance and Shannon–Weiner index of each species was measured in each zone of study area and overall study area, which was again co-related with each other and also with population of Chilika lake.

IV. RESULTS

4.1 Species Richness

The total number of different species that is encountered in a certain area is known as Species Richness. It refers to the number of unique species.

If S is the number of species seen, Species Richness = S

In our study Species Richness, S = 22

It is a simple way to measure biodiversity. Richness is easy to understand, but it doesn't tell you how many members of each species are there or how evenly they are distributed in a particular area **(Muro et al., 2022; Yetis et al., 2021)**.

22 different species of anatids were encountered from the five zones considered for our study. Species Richness of anatids of study area and whole Chilika lake from 2017-18 to 2022-2023 is given in **Table 1**.

Table 1: Species richness of anatids of study area and Chilika lake from year 2017-2018 to 2022-2023 (Source – compiled by author)

Location	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Study Area	17	18	20	20	18	17
Chilika lake	18	18	20	20	18	18

4.2 Relative Abundance

Relative abundance is the percentage or proportion of the individuals that belong to each species.

Formula

Relative Abundance (%) = $(n_i/N)\times 100$

Where n_i = Number of individuals of species i

- N = Total number of individuals in the community

When this measure is used along with species richness, it shows the evenness in ecological structure **(Ghasemi et al., 2012; Hu et al., 2019)**. The relative abundance (%) was computed by dividing the number of birds in each species by the total number of birds in that year, and then multiplying the result by 100%. Relative Abundances in zones in different years from 2017-18 to 2020-23 showed dominant species, such as the Northern Pintail, Gadwall, Garganey, and Northern Shoveler which consistently contribute high percentages each year, and Eurasian Wigeon contributing to some extent are clearly highlighted in the **Figure 1 and 2**.

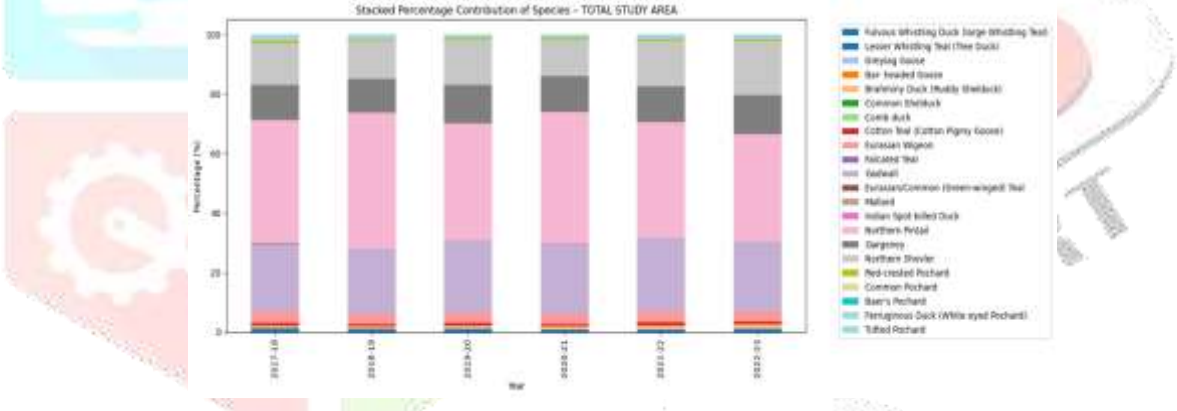

Figure 1: Relative Abundances of All Species From 2017-2018 to 2022-2023 in all 5 Zones Combined (Source – compiled by author)

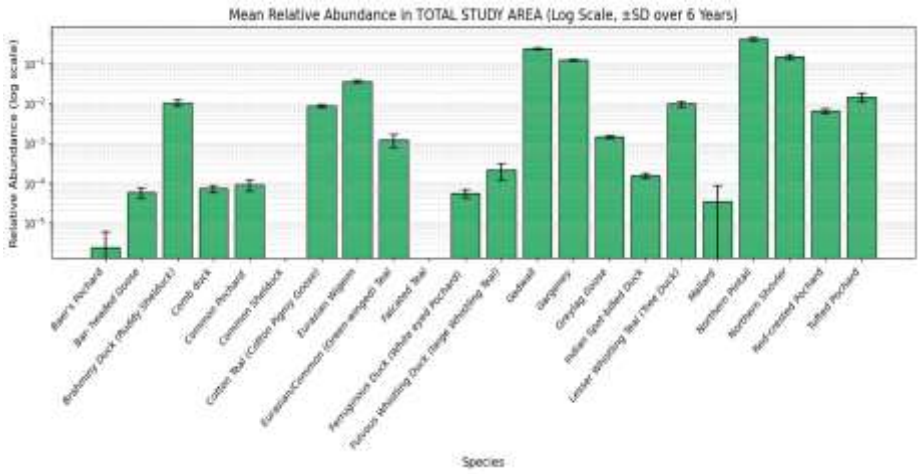

Figure 2: Mean relative abundances (standard deviation) of individual species all zones combined from 2017-2018 to 2022-2023 (Source – compiled by author).

The Anatidae community in the study area had a typical ecological structure, with a few common dominant species and several rarer ones. The Northern Pintail (42.1%), Gadwall (21.8%), Northern Shoveler (14.5%), Garganey (12.0%), and Eurasian Wigeon (3.1%) were the most abundant species among different anatids. This trend might be due to their feeding habits, as they can eat a wide range of foods and can live in a variety of places **(Table 2).**

Table 2: Relative abundance of different anatid species in study area (Source – compiled by author)

Species	Total Count	Percentage	Cumulative %
Northern Pintail	97,421	42.1%	42.1%
Gadwall	50,376	21.8%	63.9%
Northern Shoveler	33,546	14.5%	78.4%
Garganey	27,672	12.0%	90.4%
Eurasian Wigeon	7,277	3.1%	93.5%
Rest 17 species	14,929	6.5%	100.0%

4.3 Diversity Index and Species Richness of Anatids

The Shannon Index (H′) measures the uncertainty or entropy associated with determining the species identity of a randomly selected individual. It incorporates both richness and evenness elements. This index is a combined measure of richness & evenness.

Formula:

$$H' = -\sum_{n=1}^{n} (pi^* \ln\ p_i)$$

Where: n = The Quantity of species,

Pi = Percentage (Relative Abundance) of species.

An elevated H′ indicates increased variety, influenced by a bigger number of species and/or more even Relative Abundances **(Daly et al., 2018; Dickman, 1968; Engel et al., 2022; Strong, 2016)**.

Species richness and the Shannon Diversity Index of each sector were calculated annually from 2017–18 to 2022–23. Only migratory periods from September to May were considered for calculation. The Shannon Index was found to be in the range of 1.41 to 1.87 across different zones, as well as Chilika in different years. Bhusandpur (1.8692 in 2017–18) and Balipatpur (1.8371 in 2017–18) had shown the greatest diversity. The overall study area, combining all five zones, had shown an increase in diversity, moving from 1.6312 in 2017–18 to 1.6677 in 2022–23 **(Figure 3).**

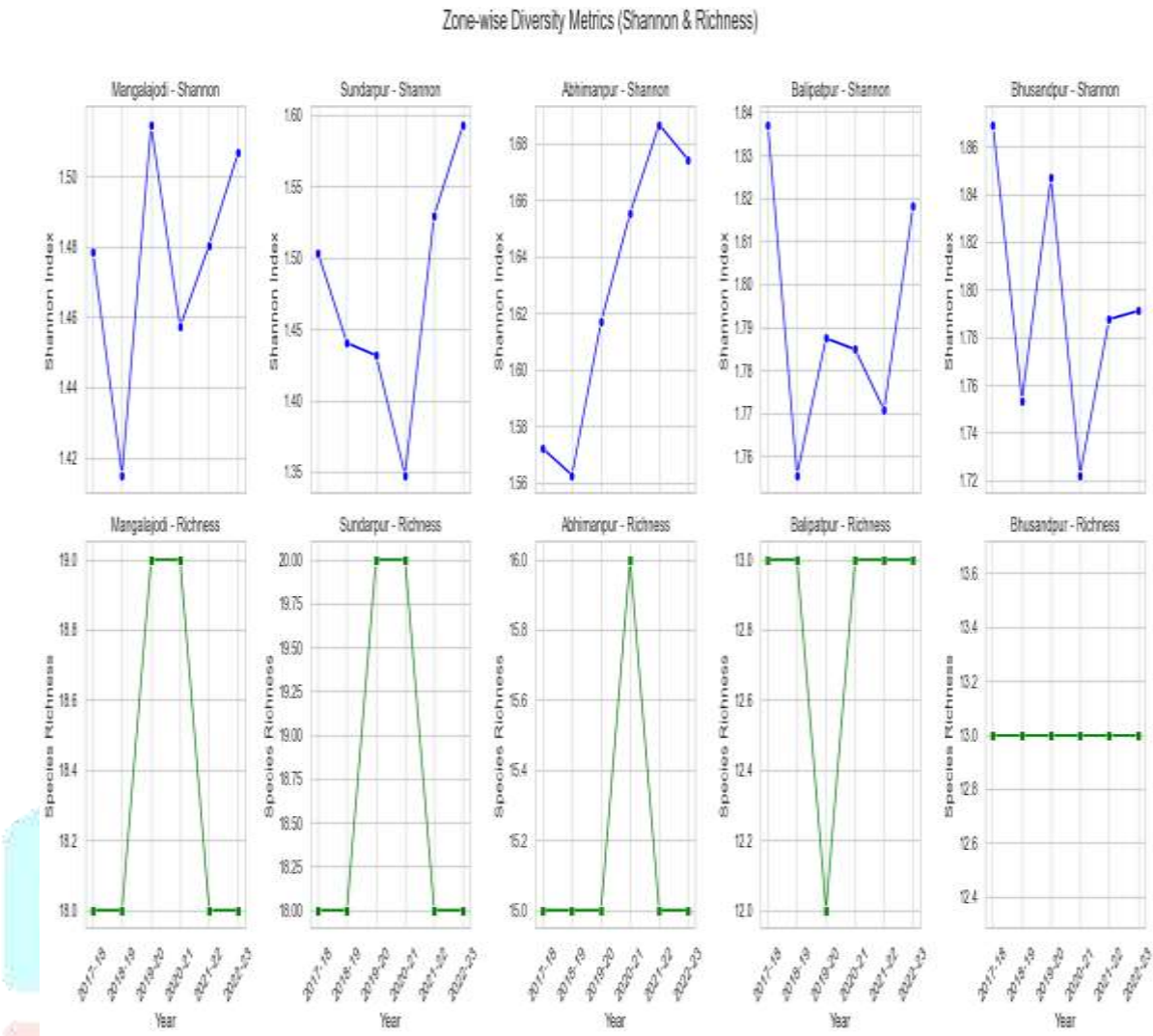

Figure 3: Zone-wise comparisons of shannon diversity and species richness across all zones from 2017-2018 to 2022-2023

(Source – compiled by author).

V. DISCUSSION

Certain zones, such as Mangalajodi and Sundarpur, had shown higher abundance of dabbling ducks, such as Northern Pintail, Gadwall, and Northern Shoveler, which might be due to factors like favourable conditions, such as shallow waters and abundant submerged vegetation. The wetland characteristics and rich foraging habitat of these zones were responsible for their high abundance.

In the case of the Shannon Index, Bhusandpur and Balipatpur have shown higher diversity than areas like Mangalajodi, where we found dominant species (e.g., Northern Pintail) with reduced evenness. In Bhusandpur and Balipatpur, species richness remained fairly stable across zones and years, suggesting that overall community structure was maintained, though shifts in dominance patterns occurred. Zones like Bhusandpur and Balipatpur showed higher Shannon diversity than more abundant zones like Mangalajodi, likely due to a more even species distribution.

The low prevalence of vulnerable threatened species such as the Common shelduck, Baer's pochard, and Comb duck suggests possible inadequate habitat, disturbance, or their scarcity in the area. Places like Abhimanpur, which have few different species or lack certain species, could improve by adding better habitats (like deeper water areas and plant zones) and managing human activities. Temporal stability in diversity indices indicates environmental resilience, but conservation initiatives are essential for maintaining species evenness and their conservation.

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