SUMMARY

Birds are ideal bio-indicators and useful models for studying a variety of environmental parameters. The aquatic avifauna always finds its way to the wetlands and where they get all the necessary requirements ranging from the food, habitat, resting, nesting cover etc. The distribution and population size of the aquatic avifauna always depends on the health of the wetlands. The wetland in the Lower Assam is also home for several migratory and residential waterbirds. In Lower Assam the wetland like Deepor Beel, Kapla Beel, Jengdia Beel, Puthimari Beel, Kapla Beel, Urpod Beel, Dhir Beel, Wetland of Manas National Park are important that harbors numbers of endangered migratory and residential avian fauna. However no such detailed study on wetland birds has been carried out in the wetlands of Lower Assam. Thus the present study has been emphasize with the topic “Studies on the Diversity and Abundance of Aquatic Avifauna in Protected and Unprotected Wetlands of Lower Assam”. The main objective of the research were (1) Evaluate the diversity and abundance of aquatic avifauna and its population status in four selected wetlands of Lower Assam viz. Deepor Beel Wildlife Sanctuary, Kapla Beel, Puthimari Beel, River system of Manas National Park, (2) Evaluate the habitat preference and its utilization pattern of aquatic avifauna in the study, (3) Evaluate the food and feeding habits of aquatic avifauna in the study area, (4) Evaluate the threat factors prevailing in the wetlands of lower Assam and their impact on aquatic avifauna.
The thesis has been explained through six chapters. The first chapter describes about the introduction of the topic, review of literature and aims and objectives, the second chapter describes about the study area and the methods. The third chapter emphasizes on the population status and species diversity and abundance of the aquatic avifauna in the four wetlands of Lower Assam. In the fourth Chapter, the habitat utilization pattern of the aquatic avifauna has been described and the 5th chapter describes about the feeding ecology of aquatic avifauna in the study area. The sixth chapter describes about the conservation perspective of the aquatic avifauna threat factors and the last or the seventh chapter describes about the.

CHAPTER-I: GENERAL INTRODUCTION

This chapter describes about the role and importance of the wetland and avian community in maintaining the health of the ecosystem. Again this chapter emphasizes on the role of the wetland, need of the wetland conservation, wetland ecosystem, threat to the wetland. It also emphasizes on the benefits of the studying avian population and their habitat. Finally justifies the need of the present study in the wetland of the lower Assam.

CHAPTER-II STUDY AREA AND METHODS

This chapter describes about the study area location, physiographic attributes of the study areas, shows the GIS map of the study area. The study has been carried out in Beki River inside Manas National Park, Deepor Beel WLS, Kapla Beel and Puthimari Beel. This chapter also describes about different methods used for the study and data collection on the diversity of aquatic avifauna and abundance among
with their habitat use pattern, food and feeding ecology in the wetland of the lower Assam.

CHAPTER-III: POPULATION STATUS DIVERSITY AND ABUNDANCE

The annual total population of the aquatic avifauna in all the four wetland found to be different during the study period the annual total aquatic avifauna population was found to be high in Deepor Beel WLS (49492 individuals), followed by the water birds abundance of Beki River System in MNP (43054 individuals), Puthimari Beel (33273 individuals) and minimum annual population abundance was found in Kapla Beel (22233 individuals). Study revealed that, there were also population fluctuations of wetland birds in all the wetlands in different seasons of the year.

The analysis of Shannon wiener diversity index shows that, during the pre monsoon season, the species diversity index was higher in Beki River of MNP (H' = 3.555), followed by Kapla Beel (H' = 3.37), Puthimari Beel (H' = 3.336) and minimum diversity can be reported in Deepor Beel WLS (H' = 2.654). During the monsoon season the species diversity was maximum in the Beki River of MNP (H' = 3.467), followed by Puthimari Beel (H' = 3.422), Kapla Beel (H' = 2.806) and Deepor Beel WLS (H' = 2.638) respectively. During the retreating monsoon season, the speceis diversity of the aquatic avifauna were found to be high in Beki River of MNP (H' = 3.497), followed by Puthimari Beel (H' = 3.392), Deepor Beel WLS (H' = 3.36) and lastly by Kapla Beel (H' = 3.068). During the winter season the species diversity of the aquatic avifauna was high in the Puthimari Beel (H = 3.807), followed by Beki
River of MNP ($H' = 3.613$), Kapla Beel ($H' = 3.603$) and minimum of Deepor Beel WLS ($H' = 3.466$). The analysis of Pearson Correlation between air ambient temperature and avifauna abundance shows that with declining monthly average temperature the abundance in the Beki River System in MNP (-0.24715), Deepor Beel WLS (-0.58562), Kapla Beel (-0.65095) and Puthimari (-0.84133) has negative correlation. Hence the aquatic avifauna population in all the four wetland has increases with the fall of the declining monthly average temperature. The Pearson Correlation analysis also showed that with the average monthly humidity of the wetlands encourage the increase population size of aquatic avifauna in Beki River System of MNP (-0.66674), Deepor Beel(-0.39569), Kapla Beel(-0.54249) and Puthimari (-0.58565) respectively.

The top twenty abundant aquatic avifauna in Beki River system of MNP were Jungle Myna- *Acridotheres fuscus* (10.01 %), Asian openbill stork-*Anastomus oscitans* (9.41 %), Common Myna-*Acridotheres tristis* (7.81 %), Pond heron-*Ardeola grayii* (7.57 %), Cattle egret-*Bubulcus ibis* (7.09 %), Red-whiskered Bulbul-*Pycnonotus jocosus* (5.86 %), Little egret-*Egretta garzetta* (5.21 %), Large egret-*Ardea alba* (4.69 %), Little Cormorant-*Phalacrocorax niger* (3.82 %), Common King fisher-*Alcedo atthis* (2.17 %), Whiskered Tern-*Chlidonias hybridus* (1.98 %), Black headed gull-*Larus ridibundus* (1.41 %), House swift-*Apus affinis* (1.08 %), Whitebreasted king fisher-*Haleyon smyrnensis* (1.02 %), Indian Coarser-*Cursorius cursorius* (0.76 %), Alpine pipit-*Anthus spinolletta* (0.76 %), White Wagtail-*Motacilla alba* (0.76 %), Lesser Adjutant-*Leptoptilos javanicus* (0.75 %),
The analysis of annual relative abundance of top twenty aquatic avifauna in Deepor Beel WLS were Large whistling Teal-Dendrocygna bicolor (27.42 %), Asian openbill stork-Anastomus oscitans (7.33 %), Little egret-Egretia garzetta (6.89 %), Cattle egret-Bubulcus ibis (6.13 %), Pond heron-Ardeola grayii (4.93 %), Large egret-Ardea alba (4.81 %), Little Cormorant-Phalacrocorax niger (4.58 %), Little grebe-Podiceps ruficolis (4.58 %), Common King fisher-Alcedo atthis (1.38 %), Common snipe-Gallinago gallinago (1.16 %), Pied king fisher-Ceryle rudis (1.16 %), White Wagtail-Motacilla alba (1.16 %), Temmincks stint-Callidris subminuta (1.05 %), Palm swift-Cypsiurus parvus (1.03 %), Striped tit Babbler-Macronous gularis (1.03 %), Storkbilled King fisher-Haleyon capensis (0.94 %), Yellow Wagtail-Motacilla flava (0.89 %), Wood cock-Scolopax rusticola (0.89 %), Common Myna-Acrideres tristis (0.89 %), Eurasian sparrow hawk-Accipiter nisus (0.89 %) etc. In Kaplabeel, the top twenty abundant aquatic avifauna were Asian openbill stork-Anastomus oscitans (11.41 %), Cattle egret-Bubulcus ibis (9.03 %), Large whistling Teal-Dendrocygna bicolor (8.62 %), Little Cormorant-Phalacrocorax niger (7.43 %), Pond heron-Ardeola grayii (5.14 %), Large egret-Ardea alba (4.99 %), Yellow Wagtail-Motacilla flava (3.53 %), White Wagtail-Motacilla alba (2 %), Small panticole-Glareola lacta (1.64 %), Little grebe-Podiceps ruficolis (1.49 %), White breasted waterhen-Amaurornis phoenicurus (1.44 %), Lesser Adjutant-Leptoptilos javanicus (1.43 %), Red wattled Lapwing-Vanellus indicus (1.36 %), Red-whiskered Bulbul-Pycnonotus jocosus (1.25 %), Forest
wagtail- *Motacilla indica* (1.15 %), Storkbilled King fisher- *Haleyon capensis* (1.11 %), Blackheaded myna- *Sturnus malabaricus* (1.11 %), Jungle Myna- *Acridotheres fuscus* (1.08 %), Spangled Drongo- *Dicrurus hottentottus* (1.04 %) etc. In Puthimari beel, the top twenty aquatic avifauna were -Lesser whistling Teal- *Dendrocygna javanica* (15.08 %), Cattle egret- *Bubulcus ibis* (11.71 %), Large egret- *Ardea alba* (6.22 %), Little egret- *Egretia garzetta* (5.84 %), Little Cormorant- *Phalacrocorax niger* (4.96 %), Pond heron- *Ardeola grayii* (4.18 %), Asian openbill stork- *Anastomus oscitans* (2.95 %), Blackheaded myna- *Sturnus malabaricus* (2.24 %), Common Myna- *Acridotheres tristis* (2.06 %), Whitebreasted king fisher- *Haleyon smyrnensis* (1.81 %), Common King fisher- *Alcedo atthis* (1.76 %), Red wattled Lapwing- *Vanellus indicus* (1.41 %), Pallas fish eagle- *Haliastus leucoryphus* (1.39 %), Red-whishkered Bulbul- *Pycnonotus jocosus* (1.23 %), White breasted waterhen- *Amauromis phoenicurus* (1.19 %), River Tern- *Sterna aurantia* (1.17 %), Coucal- *Centropus sinensis* (1.09 %), Purple swamphen- *Gallicerax cinerea* (1.04 %), Water Rail- *Rallus aquaticus* (1.03 %), Alpine pipit- *Anthus spinoletta* (1 %) etc.

**CHAPTER-IV: HABITAT UTILIZATION PATTERN**

The study revealed that the aquatic avifauna in the wetland of Lower Assam utilized altogether six major habitat types, those were such as, (i) Emergent Vegetation, (ii) Free Floating Vegetation, (iii) Open Water (iv) Submerged Vegetation (v) Mudflat and (vi) Transition Zone. Study revealed that, the water birds uses maximum of 39.17 % open water habitat, followed by 21.03 % emergent vegetation habitat, 18.51 % transition zone habitat, 15.89 % mud flat habitat, 5.39 % free floating...
vegetation annually in the Beki river inside the Manas National Park. The water birds rarely used the submerged vegetation as habitat. The study revealed that the water birds annually uses maximum of 33.65% open water habitat, followed by 21.81% emergent vegetation habitat, 18.68% transition zone habitat, 15.77% mudflat habitat, 7.32% submerged vegetation habitat and minimum of 2.77% free-floating vegetation habitat in the Deepor Beel WLS. The study revealed that the water birds uses maximum of 35.93% Open Water habitat, followed by 26.75% emergent vegetation habitat, 18.35% mudflat habitat, 13.17% transition habitat, 2.94% free floating vegetation and minimum of 2.86% submerged vegetation habitat annually in the Kapla beel. The study revealed that the water birds uses maximum of 37.76% Open Water habitat, followed by 25.92% Emergent vegetation habitat, 18.09% mudflat, 12.33% transition habitat, 3.21% Free Floating Vegetation and minimum of 2.69% by submerged vegetation annually in the Puthimari Beel.

CHAPTER-V: FOOD AND FEEDING OF AQUATIC AVIFAUNA

This chapter emphasizes on the food and feeding patterns of the aquatic avifauna in all the four studied wetlands of lower Assam. The study revealed that the total food consumed by aquatic avifauna was maximum of 157 species in Deeporbeel WLS, followed by Kapla Beel (154 species), Puthimari Beel (153 species) and minimum by Beki River System in MNP (128 species).

In Beki River, annual diet contribution by Fish (46.09%) was maximum followed by Arthropod (19.53%), Plants (9.37%), Amphibia (8.59%), Lizard (6.25...
%, Reptile (3.12 %), Molluscs (3.12 %), Fresh Water Prawm (2.34 %) and least by Crustacea (Crabs)(1.56 %). In Deepor Beel WLS Fish (40.76%) contributed the maximum which was followed by Plants (22.29 %), Arthropod (15.92 %), Amphibia (7.01 %), Lizard (5.73 %), Molluscs (2.55 %), Reptile (2.54 %), Fresh Water Prawm (1.91%) and minimum by Crustacea (Crabs)(1.27 %). In Kapla Beel annulay Fish (40.25 %) contributed the maximum which was followed by Plants (22.72 %), Arthropod (16.23 %), Amphibia (7.14 %), Lizard (5.19 %), Reptile (2.59 %), Molluscs (2.59 %), Fresh Water Prawm (1.94 %) and least by Crustacea (Crabs)(1.29 %). In the Puthimari Beel, of the total annual food species taken Fish (39.86 %) contributed maximum, which was followed by Plants (22.87 %), Arthropod (16.33 %), Amphibia (7.18 %), Lizard (5.22 %), Reptile (2.62 %), Molluscs (2.62 %), Fresh Water Prawm (1.96 %), Crustacea (Crabs)(1.31 %).

Based on the annual relative feeding frequency the top ranking twenty food item of aquatic avifauna species in Beki river, MNP were *Amblyphyrynigon mola* (3.33 %), *Puntius ticto* (3.31 %), *Schizothoracichthys progastus* (3.27 %), *Bracidri verio* (3.2 %), *Parluciosoma daniconius* (3.08 %), *Danio devario* (3.05 %), *Botia derio* (2.97 %), *Chanda ranga* (2.88 %), *Puntius conchonius* (2.81 %), *Brachidenio rario* (2.16 %), *Tor putitora* (1.97 %), *Puntius chola* (1.9 %), *Chanda nama* (1.89 %), *Pseudombasis ranga* (1.63 %), *Channa gachua* (1.49 %), *Tor tor* (1.44 %), *Noemacheulus savona* (1.43 %), *Garra lamta* (1.42 %), *Psudotrophis aetheronoides* (1.41 %), *Xenentodon cancila* (1.4 %). Top ranking twenty food species in Deepor Beel WLS were *Puntius ticto* (4.26 %), *Bracidri verio* (3.48 %), *Amblyphyrynigon mola*.
mola (3.21 %), Danio devario (2.92 %), Pseudombasis ranga (2.68 %), Chanda ranga (2.26 %), Chanda nama (2.18 %), Brachidenio rario (2.17 %), Puntius conchonius (2.11 %), Psudotrophis aetheronoides (1.97 %), Danio aequipinnatus (1.65 %), Colisa fasciatus (1.59%), Barilius bola (1.55 %), Puntius tetrarupagus (1.53 %), Botia derio (1.49%), Channa punctatus (1.49%), Xenentodon cancila (1.49 %), Channa gachua (1.49 %), Colisa lalia (1.47 %), Labeo gonious (1.45 %). Top ranking twenty food species in Kapla Beel were Danio devario (4.27 %), Botia derio (3.88 %), Puntius ticto (3.78 %), Chanda ranga (3.67 %), Parluciosoma daniconius (3.54 %), Monopterus cuchia (3.41%), Bracidri verio (3.38 %), Chanda nama (3.16 %), Brachidenio rario (2.84 %), Labeo gonious (2.49 %), Labeo calbasu (2.46 %), Puntius chola (2.28 %), Puntius conchonius (1.82 %), Labeo rohita (1.66 %), Amblypharyngoden mola (1.59 %), Channa gachua (1.59 %), Acantholobitis botia (1.58 %), Barilius bola (1.53%), Mystus vittatus (1.41 %). Top ranking twenty food species in Puthimari Beel were Amblypharyngoden mola (4.42 %), Bracidri verio (3.83 %), Puntious ticto (3.69 %), Danio devario (3.43%), Pseudombasis ranga (3.3 %), Chanda ranga (2.98 %), Chanda nama (2.55 %), Brachidenio rario (2.54 %), Puntius conchonius (2.45 %), Psudotrophis aetheronoides (2.36 %), Danio aequipinnatus (2.27 %), Channa gachua (2.25%), Barilius bola (1.87%), Puntius tetrarupagus (1.85 %), Botia derio (1.61 %), Colisa lalia (1.57 %), Xenentodon cancila (1.57 %), Parluciosoma daniconius (1.47%), Labeo gonious (1.34 %), Acantholobitis botia (1.34 %).
The food selection pattern of the aquatic avifauna in Beki River showed a unique dietary spectrum during the period of the study. The study showed that, upto the rank of 10 of the food species based on the annual relative feeding frequency constituted 30.06 % of the total annual diet, upto the level of top 20 rank of the food species constituted 46.04 % of the total annual diet, whereas the rest 108 species constituted 53.96 % of the total annual diet. In Deepor Beel WLS upto the rank of 10 of the food species based on the annual relative feeding frequency constituted 27.24 % of the total annual diet, upto the level of top 20 rank of the food species constituted 42.44 % of the total annual diet, whereas the rest 137 species constituted 57.42 % of the total annual diet. In Kapla Beel upto the rank of 10 of the food species based on the annual relative feeding frequency constituted 34.42% of the total annual diet, upto the level of top 20 rank of the food species constituted 51.69% of the total annual diet, whereas the rest 134 species constituted 48.31% of the total annual diet. In upto the rank of 10 of the food species based on the annual relative feeding frequency constituted 31.55 % of the total annual diet, upto the level of top 20 rank of the food species constituted 48.69 % of the total annual diet, whereas the rest 133 species constituted 51.06 % of the total annual diet.

CHAPTER-VI: CONSERVATION PERSPECTIVE

This chapter deals with the conservation and recommendation for the aquatic avifauna and wetlands of western Assam. Study revealed that there were altogether 12 major threats recorded for the wetlands and aquatic avifauna of wetlands in lower Assam. These threats were (1) reduction of open water space, (2) excessive growth
of vegetation, (3) hunting, (4) trapping & killing of birds, (5) agriculture conversion, (6) extensive fishing, (7) eutrophication, (8) encroachment, (9) land conversion for development activities, (10) blockage of feeder channel, (11) industrial sewage, (12) siltation. This chapter also describes detailed traditional trapping devices and its mechanism used by local people in the Lower Asaam, also the intensity of treats to the aquatic avifauna in each of the wetlands of lower Assam viz. Beki River in Manas National Park, Deepor Beel WLS, Kapla Beel, Puthimari Beel. This chapter emphasizes on the importance of the habitat and the site specific conservation efforts for the conservation of the aquatic avifauna in the protected and the unprotected wetlands in the lower Assam. Finally the chapter ends with the recommendation for reduction of the effect of the threat factors prevailed for the conservation of the aquatic avifauna.