CHAPTER – SIX

SUMMARY AND CONCLUSION

6.1 SUMMARY

The present study entitled "Limnological Study of the Urpod Beel, Goalpara Assam with special reference to Planktonic Diversity" based on collection and their identification, numerical density, diversity indices and their correlation against different parameters have been established.

The Urpod beel is a natural lake situated at Agia in the Goalpara district of Assam, located approximately 25° 33' to 26° 12' N latitude and 90 ° 7' to 91° 5' E longitude respectively, connected to the river Brahmaputra.

The present endeavour has been confined on the:

Physico-chemical analysis of Water

➢ The Physico-chemical analysis of water studied are Water Temperature, Transparency, p^H, DO, BOD, Free CO_2, Total Alkalinity, Total Hardness, Ca, Mg, Cl, Bicarbonate, Total Dissolved Solids, Total Suspended Solids, Na, K, SO_4, NO_3, PO_4, N, Zn, Cu, Cr and Cd. The seasonal fluctuation of the water parameters has been studied in four different seasons (pre-monsoon, monsoon, post-monsoon and winter) in five different sites of the beel.

➢ Seasonal fluctuation of water temperature at the maximum of 26.92°C ± 2.07 during monsoon and the minimum 13.30°C ± 1.28 during winter was recorded during the study.

➢ The higher transparency level (57.7 ± 0.2 cm) during monsoon and the lower of (42.2 ± 0.17 cm) in winter season was noted. The lower transperancy in winter is due to low level of water, heavy siltation and increase of organic matter as well to

fishing activity against one high level of water due to influx of rain water in monsoon.

➢ The beel water is found slightly alkaline to moderately acidic in nature which exhibits an identical trend with the natural floodplain wetlands of Assam.

➢ Maximum DO was recorded in winter and post-monsoon season and minimum was in pre-monsoon and monsoon season. No significant variation is found in the BOD value.

➢ In this observation, the Free CO_2 showed marginal seasonal variation with the lowest level (6.1 ± 0.2 mgl^{-1}) in monsoon and the highest (6.5 ± 0.19 mgl^{-1}) was in pre-monsoon. The higher rate of decomposition during pre-monsoon season due to rapidly receding water level and higher temperature followed by scanty rains, were probably responsible for higher CO_2 and reduced O_2 content. The presence of algal bloom in the monsoon season may be the reason for low level of CO_2.

➢ The seasonal fluctuation of total alkalinity showed the similar trend with that of Free CO_2. The minimum value of Bicarbonate was found in monsoon season (29.3 ± 0.12 mgl^{-1}) and the maximum (34.3 ± 0.12 mgl^{-1}) value was found in pre-monsoon season. The bicarbonate alkalinity was enhanced by increased FCO_2 concentration.

➢ Total Hardness depends on the concentration of carbonate and bicarbonate salts of calcium and magnesium (temporary hardness) or sulphate, chloride or other anions of mineral acids (permanent hardness). Water of the Urpod beel was found to be soft to moderately soft ($27.1 \pm 0.16 - 35.6 \pm 0.23$ mgl^{-1}).

➢ Calcium was found in all the natural waters and its main source is weathering of rocks from which it leaches out. During the study period its maximum value was in the pre-monsoon and monsoon (18.52 ± 0.61 and 16.69 ± 0.90 mgl^{-1}). Increase of Ca in the beel might be due to the input of sewage, drainage water and fertilizers from nearby rice field during pre-monsoon and monsoon.

- Chloride has been reported as a chemical indicator for pollution and thereby it could well be inferred that Urpod beel remained fresh to its possible level. During the study period the results of Cl level in this beel was low (5.1 ± 0.34 to 7.5 ± 0.08 mgl^{-1}).

- TDS values of the beel water was found in the range of (12.5 ± 0.25 to 19.9 ± 0.13 mgl^{-1}), which is the indicative of the unpolluted water body.

- During the monsoon period, the beel water showed the maximum value of TSS (67.6 ± 0.16 mgl^{-1}) and maintains almost at this level in all the seasons.

- The most important inorganic nitrogen compound in water is NO_3. In the present findings the NO_3 value has been observed at range variation of 0.80 ± 0.44 to 0.98 ± 0.19 in winter and pre-monsoon seasons respectively and it was within the desirable limit during the study period.

- Higher level of PO_4 acts as a limiting nutrients responsible for the process of eutrophication and leads to ultimate degradation of an aquatic ecosystem. During the course of the study the PO_4 concentration was low in the Beel water. The maximum of $0.16 \pm 0.01 mgl^{-1}$ was recorded in pre-monsoon season.

- The amount of SO_4 as the highest quantity was found during pre-monsoon (6.4 mgl^{-1}) and the lowest during winter 4.5 mgl^{-1}. The source of SO_4 in fresh water has been happened to be naturally occurring, possibly as a result of the breakdown of leaves of vegetation specifically the macrophytes.

- The nutrients like Ca, Mg and Cu were examined and their higher concentration were observed during pre-monsoon period. The amount of Na in the Urpod beel has been found without significant changes throughout the year. K has been recorded that under limited level (1.45 mgl^{-1} in winter) in the beel water. The present finding has been able to demonstrate the equivalency order of cations in the Urpod beel as Ca > Mg > K > Na.

➤ The beel water showed the presence of negligible quantity of the heavy metals like Cu, Cd and Cr and the concentration of Zn in the beel water was found in bellow the permissible level (0.26mgl^{-1}).

Phytoplankton Diversity

➤ The phytoplankton community of the beel all together comprised of 61 species under 41 genera, 18 families, 8 orders and 5 different classes namely Cyanophyceae, Chlorophyceae, Bacillariophycea, Xanthophyceae and Euglanophyceae during the course of investigation.

➤ The class chlorophyceae comprises of 30 species belonging to 20 genera, 8 families under 3 orders. Class Cyanophyceae is comprised of 15 species belonging to 10 genera, 4 families, and 2 orders. The class Bacillariophyceae follows Cyanophyceae with 10 species, 8 genera belongs to 4 families under one order. Class Euglanophyceae is comprised of 4 species, 2 genera belong to one family and one order. Xanthophyceae is constituted by 2 species, one genus under one family and one order.

➤ The abundance of Chlorophyceae is evaluated in the range of 923 ± 58.34 in winter to 1104.6 ± 66.82 ul^{-1} during pre-monsoon in the first year of observation, while the next year it was 696.2 ± 78.76 in post-monsoon and 1515.2 ± 82.00 ul^{-1} in pre-monsoon season. The seasonal trend of abundance in terms of numerical density of Chlorophyceae has been observed as Monsoon > pre-monsoon > winter > post-monsoon in the first year and as pre-monsoon > monsoon > winter > post-monsoon in second year of observation. The highest growth of Chlorophyceae was contributed by *Volvox aureus, Micrasterias foliacea, Closterium calosporum, Ankistrodesmus falcatus* and *Tetraedron pusillum.*

➤ The higher abundance of Cyanophyceae was found in the range of 424.8±23.84 – 606.2 ±18.51 ul^{-1} during monsoon of the first year of observation while the next

year it was 438.8 ±83.38 – 714 ±58.30 ul^{-1} in pre-monsoon. The seasonal trend of Cyanophyceae was observed as Monsoon > winter > pre-monsoon > post-monsoon in the first year and it was as pre-monsoon > monsoon > winter > post-monsoon in the second year of the obsevation. The dominant species were *Anabaena orientalis, A. fertilissima, Nostoc mascorum* and *Microcystis aeruginosa.*

➢ The abundance of Bacillariophyceae was found in the range of 205.6 ± 37.09 in post-monsoon to 299 ± 27.90 ul^{-1} in monsoon in the first year against 189.4 ± 32.54 ul^{-1} in winter to 351.8 ± 42.58 ul^{-1} in pre-monsoon season of the second year of observation. The seasonal trend of Bacillariophyceae had been assessed as monsoon > pre-monsoon > winter > post-monsoon in the first year and as pre-monsoon > monsoon > post-monsoon > winter in second year of observation. The highest growth of Bacillariophyceae was attributed by *Navicula rhynchocephala* and *Nitzschia* sp.

➢ The abundance of Xanthophyceae was recored in minimum range of 51±12.71 ul^{-1} in post-monsoon and in maximum range of 87.6 ± 7.96 ul^{-1} in pre-monsoon of the first year, and in the 2nd year its minimum value was 32.8±10.82 ul^{-1} in post-monsoon and maximum 66.6 ± 7.32ul^{-1} in pre-monsoon period. The seasonal trend for Xanthophyceae has presented as pre-monsoon > monsoon > winter > post-monsoon and as pre-monsoon > winter > monsoon > post-monsoon in first and second year of observation respectively.

➢ The abundance of Euglanophyceae was found to be in the range of 100.6 ul^{-1} ± 21.80 in post-monsoon and 168.2± 9.47ul^{-1} in pre-monsoon against the second year of observation the range of 94.0± 6.32ul^{-1} in post-monsoon to 195.8±18.79 ul^{-1} in pre-monsoon seasons. The seasonal trend for Euglenophyceae had been arranged as pre-monsoon > monsoon > winter > post-monsoon for both first and second year of observation.

Zooplankton Diversity

- The zooplankton community of the beel all together comprised of 44 species under 29 genera, 20 families, 7 orders and 5 different classes namely Protozoa, Rotifera, Copepoda, Cladocera and Ostracoda during the course of investigation.

- The class Cladocera and Rotifera had been found to be the most diverse groups during the study period. Class Cladocera comprised with 14 species, 7 genera belonging to 4 families under 2 orders. Class Rotifera was comprised of 13 species, 10 genera of 8 families under one order. Class Protozoa followed Rotifera with 8 species, 5 genera belongs to 5 families under two orders. Class Copepoda was comprised of 7 species, 5 genera belong to two families and one order. Class Ostracoda was constituted by 2 species, two genera under one family and one order.

- The seasonal observation of zooplankton population during the period of investigation reveals that among the five classes, Cladocera had been found as the most dominant group. Variation of zooplankton abundance that occurred in different seasons are in the following trend:

  Monsoon – Cladocera >Rotifera > Protozoa > Copepoda >Ostracoda

  Pre-monsoon – Cladocera >Rotifera > Protozoa > Copepoda >Ostracoda

  Post-monsoon –Rotifera > Cladocera > Protozoa > Copepoda > Ostracoda

  Winter – Cladocera >Rotifera > Protozoa > Copepoda

- The abundance of Protozoa was found in the range value of 163 ± 35.24 in monsoon – 397.4 ± 35.27 ul^{-1} in winter during the first year of observation, while in the next year it was 161.6 ± 17.43 in monsoon – 442.6 ± 23.18 ul^{-1} in post-monsoon season. The seasonal trend of Protozoa had been observed as Monsoon < Pre-monsoon < Post-monsoon < winter in the first year of observation and in the second year the trend was Monsoon < Pre-monsoon < winter < Post-monsoon. The highest growth of Protozoa was contributed by *Arcella discoides, A. vulgaris, Difflugia corona* and *Centropyxis minuta.* Protozoa showed significant positive

correlation with Cladocera and Total zooplankton in pre-monsoon season. Protozoa is significantly correlated with Total zooplankton in monsoon season.

➢ The abundance of Rotifera was found in the range of 219.6±66.79 in monsoon and 519.4 ± 69.25 ul^{-1} in post-monsoon season during the first year of observation, while in the next year it was 248±37.58 in pre-monsoon and 643 ±34.44 ul^{-1} in winter season. The seasonal trend of Rotifera was observed as Monsoon < Pre-monsoon < winter < Post-monsoon in the first year and in the second year the trend was Pre-monsoon < Monsoon < Post-monsoon < winter. The highest growth of Rotifera was contributed by *Lecane lunaris, Horaella brehmi, Testudinella patina* and *Trichocera procellus.*

➢ The abundance of Copepoda was found in the range of 123.6±5.86 in monsoon – 297.2 ± 36.27 ul^{-1} in post-monsoon and 141 ± 11.73 in pre-monsoon as well 451 ± 10.01 ul^{-1} in winter season. The seasonal trend of Copepoda was monsoon < pre-monsoon < winter < post-monsoon in the first year, while in the second year the trend was pre-monsoon < monsoon < post-monsoon < winter. The highest growth of Copepoda was contributed by *Mesocyclops leuckarti* (male & female) and *Cyclopoid copepoidide.*

➢ The abundance of Cladocera was found in the range of 238 ± 34.52 in monsoon and 581.8 ± 44.52 ul^{-1} in winter during the first year, while in the next year it was 301.4 ± 53.13 in monsoon and 747.8 ± 83.98 ul^{-1} in winter. The seasonal trend of Cladocera had been observed as monsoon < pre-monsoon < post-monsoon < winter in the first year of observation. And in the second year the trend was monsoon < pre-monsoon < post-monsoon < winter. The highest growth of Cladocera was contributed by *Acroperus harpae, Macrothrix spinosa, M. triseralis* and *Alona ractengula.* Cladocera was significantly correlated with Total zooplankton in pre-monsoon season. Cladocera showed significant positive correlation with Total zooplankton in monsoon season and post-monsoon season.

Cladocera was also significantly correlated with Total zooplankton in winter season.

➢ The abundance of Ostracoda was found in the range of 18.8 ± 9.36 in pre-monsoon and 29.4 ± 11.22 ul^{-1} in monsoon during the first year of observation, while in the next year it was 18.8 ± 4.49 in pre-monsoon and 27 ± 7.0 ul^{-1} in post-monsoon. The seasonal trend of Ostracoda had been observed as pre-monsoon < post-monsoon < monsoon in the first year of and in the second year the trend was pre-monsoon < monsoon < post-monsoon. The species *Centrocypris* and *Heterocypris* were observed in both the year of investigation.

Macrophytic Diversity

➢ Study of macrophytic community had been conducted in five different study sites during the period of March, 2014- February, 2016 covering four seasons of a year to find out dibersity of macrophyte species.

➢ 82 species belonging to 60 different genera and 33 families were recorded from Urpod beel with their reproductive phase. Out of 82 species 4 species were from Pteridophytes belonging to 4 families and others were Angiosperms. Among the Angiosperms 38 species were Dicotyledons under 18 families and 40 species are from Monocotyledons under 11 families.

➢ Among the observed Macrophytes, 20 species were belonging to Marshy amphibious (MA), 15 species were Floating aquatic (FA), 20 species were Submerged aquatic (SA), 21species were Emergent aquatic (EA) and 6 species were found as Free floating (FF).

➢ Family Poaceae is dominated with 10 species followed by Hydrocharitaceae with 6 species and Cyperaceae with 5 numbers of species followed by Nymphaceae, Onagraceae, Polygonaceae and Lamnaceae with 4 species in each; Menyanthaceae, Convolvulaceae, Scrophularaceae, Commelinaceae, Araceae, Potamogetonaceae are with 3 species in each; Halograceae, Apiaceae, Asteraceae, Lentibularace,

Amaranthaceae, Caratophyllaceae, Pontederiaceae, Alismataceae are of with 2 species each and other 14 families viz Nelumbonaceae, Oxalidaceae, Trapaceae, Boraginacea, Podostemaceae, Najadaceae, Erioculaceae, Equisetaceae, Marsiliaceae, Azolaceae, Salviniaceae are monospecific.

➢ Based on IVI value *Azolla pinnata* (13.78 ± 5.63)*, Salvinia natans* (12.76± 4.83)*, Ipomoea aquatic* (10.68±3.14)*, Echhornia crassipes* (10.8±1.31)*, Lemna perpusilla* (10.02±3.24)*, Marsilea quadrifolia* (9.08±2.72)*, Hygroryza aristata* (8.98 ±2.57)*, Hydrila verticillata* (7.98 ± 1.78)*, Centela asiatica* (7.96 ±3.42)*, Alternanthera sessilis* (7.32±3.31)*, Polygonum hydropiper*(7.38±1.68)*, Euryale ferox* (7.24±3.64)*, Sagittaria sagittifolia* (7.16 ±2.88) have been recorded as the dominant species of the beel irrespective of sites and seasons .

➢ Correlation analysis has been performed among the studied physico-chemical parameters of water to find out the interrelationships among them and the planktonic groups.

➢ CCA has been able to project the influence of 16 parameters on the richness of dominant species of phytoplankton and zooplankton in Urpod beel.

6.2 CONCLUSION

The Urpod beel of Goalpara, Assam may be considered as rich aquatic ecosystem with potential planktonic diversity. Its partial deep and partial shallow water as well the presence of high land may attribute richness to the beel itself. The area of water of the beel offers diverse variety of habitat for phytoplankton, zooplankton and macrophytes, where no major group has been found as dominant. The group diversity of various species is found throughout the year irrespective of both spatial and temporal variations. During summer large parts of the beels are covered by aquatic vegetation like water hyacinth, aquatic grasses, water lilies and other submerged, emergent and floating vegetation. Thus this wet land has been able to

prove its worthiness for its supporting many aquatic organisms and plays an important role in maintaining the environmental quality of the areas and its vicinity hence demands its conservation. Investigation on the physico-chemical analysis of water quality and planktonic and macrophytic diversity in Urpod beel through light on certain aspects, the physical parameters like p^H, Na. K, Cl, Mg, Ca etc have been recorded within the permissible limit hence an assumption could be extended that the beel is not in immediate threat of eutrophication yet further in depth study is required to understand the wetland specific characters.