CHAPTER-V

DISCUSSION:

Wetlands are extremely important for the continued existence of diverse populations of wildlife. A large number of species are wetland-dependent. Recent researches have also shown that wetland ecosystem services are vital for human well-being. But at the same time no other ecological system is more threatened today than the wetlands. Wetlands are more vulnerable to human interference than any other habitat due to 1) regional water level is usually manipulated and easily altered and because of which many wetland plant communities are effected as because of differences in water level. A relatively small interference caused by abstraction of water, drainage, or civil-engineering works may have enormously magnified biological consequences. 2) the economic services provided by wetlands has led to rapid changes in demographic pattern, in an around the wetlands within the last few decades which has resulted in encroachment, injudicious exploitation of the wetland resources and consequently becoming a threat to most of the wetland ecosystems of the world, 3) industrial, agricultural and municipality runoff may change the water quality of wetlands, as most of the runoffs, including rain water, find its way to the wetland ecosystems, thus organic or inorganic matter in sewage causes oxygenation problems as well as can cause plant and animal deaths or, by transfer in food chains, unexpected consequences for human beings. There is an enormous variety of wetland ecosystems throughout the world. The species in the community are often different, but the basic structure of the ecosystem is similar where hydrology plays an important role in the functioning of wetland ecosystems. Wetlands form as a result of certain hydrologic conditions which cause the water table to saturate or inundate the soil for a certain amount of time each year. Wetland loss and degradation through hydrologic alteration by man has occurred historically through stream channelization, drainage, dredging, ditching, levees, deposition of filled material, stream diversion, ground water withdrawal, impoundment etc.

As wetlands are drained or hydrologically altered, habitat fragmentation may result in changes in species composition as wetlands species are replaced by upland species, loss of large, wide-ranging species, loss of genetic integrity when isolated habitats are too small to support viable populations, reduced populations of interior species that can only reproduce in large tracts, and increased number of competitor,
predator, and parasitic species tolerant to disturbed environments. Many researches have
demonstrated that the wetlands of Assam have lost much of their historical extent, structure and
function. This is largely due to the influence of many factors over a long duration of time.
From the point of the protection and sustainable utilization of resources, many
investigations and studies on the biodiversity of various types of natural wetlands have
been carried out worldwide.

The Sonitpur district of Assam has been selected for the present investigation as
the ecological study of the wetlands of the district have so far been remain almost
completely ignored. According to the National Wetland Atlas, Assam (2010), in terms of
total wetland area (% wetland area), Sonitpur is the leading district possessing 83427 ha
of area of wetland which constitute 10.9% of the total wetland of Assam. The district is
situated between 26° 30’ N to 27° 02’ N latitudes and 92° 17’ E to 93° 47’ E longitudes in
the northern bank of river Brahmaputra covering an area of 5255.2 km² (492145 ha) that
accounts for 6.27% of the geographical area of the state. Total wetland area in the district
is 83427 ha that includes 980 small wetlands (<2.25 ha). River/stream occupies 94.52% of
wetlands. The other major wetland type area waterlogged - natural (2.22%) and ox-
bow lakes (1.04%). There are 23 tank/pond types of wetlands covering 84 ha. Most of the
wetlands are found to exist in the southern side of the district along the bank of the river,
Brahmaputra. The ecology of the wetlands of the district is profoundly influenced by
monsoons, which create a characteristic pattern of seasonality, predictable periods of
drought and water scarcity during the dry season alternate with intervals of increased
discharge, when flood plains are inundated during the monsoons.

All the fifteen wetlands included in the present investigation were mainly ox-bow
type floodplain wetlands ranging between 8ha (Kauribeel and Boralimora wetlands) and
35ha (Borakota, Bhedelimora and Raumari wetlands) in area. Among the various factors,
depth of wetlands was found to play a significant role in the wetland characters. The
average depth was found to be 6.13mt and 1.31mt during summer and winter season
respectively. The variation in the depth of the wetlands of the district is largely due to the
blockage or destruction of the inlet-outlet and heavy sedimentation in some of the
wetlands of the present investigation. This can be explained in the case of Sildubi,
Baliduar, Raumari and Bosasimalu wetlands, where maximum depth and minimum rate
of sedimentation were recorded. Moreover, wetlands which have more macrophytic plant
species infestations and distantly situated from the rivers as feeder channels have also
found to have minimum depth during the summer and winter seasons as was observed in Bhedelimora, Dhandi, Gereki, Kadamani, Kauribeel and Neja wetlands. The hydropperiod of some of the wetlands of the district have also been influenced by the demographic changes around the wetlands of the district and construction of dykes and roads since post independent India. Encroachment and agricultural activities in and around the wetlands of Sonitpur district have also become a threat for the sustainable sustinence of some of the wetlands of the district in near future (Plate No.-8). The high rate of sedimentation can also be attributed to the large scale of deforestation in the district and its neighboring state of Arunachal Pradesh for the last few decades. The wetlands which are situated towards the northern side of the district have received more eroded soil and silt particles from Arunachal Pradesh than the wetlands lying in the southern side of the district. This can be explained in the case of Borbeel, Serpabeel, Nabeel, Karibeel, Torabeel Borakota wetlands etc.

The wetlands of the district have a distinct pattern of aquatic plant communities in accordance with the environmental variations as (1) ecotone species, (2) rooted emergent hydrophytes, (3) rooted hydrophytes with floating leaves, (4) submerged floating hydrophytes, (5) rooted submerged hydrophytes, (6) free floating hydrophytes and (7) marshy plant species. A total of 279 plant species under188 genera and 64 families have been recorded and identified during the present investigation from the fifteen wetlands of the Sonitpur district (Table-5). The flora of the lentic wetlands zones of the district were characterized by typical macrophytes. The notable plant species under the different categories found in the wetlands of the district under study as marshy or moist soil species were Alocasia cucullata Schott, Alocasia indica Schott, Axonopus compressus (Sw)Beauv, Cenchrus ciliaris L., Colocasia esculenta (L.) Schott., Diplazium esculantum (Retz.) Sw, Fimbristylis aestivalis (Retz.), Fragaria indica Andrews., Hydrocotyle sibthorpioidesThumb., Ipomoea carnea Jacq., Jussieua repens L., Panicum maximum Jacq., Polygonum barbatum L., P. glabrum Willd., Rumex maritimus L. Spilanthes peniculata Wall ex.etc. The free floating ones were Azolla pinnata, Eichhornia crassipes Solms-Laub., Hygroryza aristata Nees., Lemma oligorrhiza Kurz., L. polyrrhiza L., Pistia stratiotes L., Salvinia molesta D.S., Wolffia arrhiza Wimm etc., the rooted hydrophytes with floating leaves ones were Euryale ferox Salisb., Marsilea quadrifolia L., Nymphaea alba L., N. nouchali Burn.fsyn., N. stellata Willd., Ottelia alismoides (L.) Pers., Trapa bispinosa Roxb., T. natans L. etc., the submerged floating hydrophytes were Aponogeton undulatus Roxb., Ceratophyllum demersum L., C. tuberculatum Cham., Najas indica

In the light of study of the Importance Value Indexes revealed that the wetlands under investigation were dominated by relatively few plant species like Colocasia esculanta (L) Schott., Eichhornia crassipes Solms-Laub., Hymenachne assamica Hitch., Ipomoea carnea Jacq., Monochoria hastata (L) solms-Laub., Nymphaea nouchali Burn., syn., Sagittaria sagittifolia L. etc. in majority of the wetlands. The exotic invasive species like Eichhornia crassipes Solms-Laub is found to be the dominant plant species in majority of the wetlands of the present investigation. In Gereki wetland, Eichhornia crassipes Solms-Laub has shown least value of IVI and this may be due to the intensive agricultural practices throughout the year in and around the wetland.

The study revealed that the similarities of species composition in the wetlands of the study area depend on the size and structure, hydrology and extent of disturbance in the wetlands or in other words healthy existence of the wetland habitats was a prime factor for resemblances among the wetlands of the district. This was clearly observed in the case of Bosasimalu, Raumari and Baliduar wetlands. These three wetlands were of the same kinds in their bigger sizes, better hydrological conditions and lesser amount of underlying disturbances in comparison to the other wetlands of the district. Similar findings were reported earlier where the water level was the main factor in controlling the species diversity, evenness and community change rate in the aquatic ecosystems. In such ecosystems, variations in water level may affect species composition (Naselli-Flores and Barone, 1997; Donagh et. al. 2009). The manifestation of degradation of wetlands of the
study area as depicted in the categorical distinction of wetlands on the basis of said parameters were clearly observed and may be placed under three categories of wetlands in the district of sonitpur viz.; (1) Highly disturbed eg. Bhedelimora, Gereki and Neja wetlands (2) disturbed eg. Borsola, Borakata, Kadamani, Sitalmari, Sildubi, Boralimora, Kharoi, Dhandi, and Kauribeel wetland, and 3) Less disturbed wetlands eg. Bosasimalu, Raumari, Baliduar wetlands. In the same way the similar trend of dissimilarities among the wetlands of the Sonitpur district were exhibited. The species richness, species diversity and the evenness indices values of the wetlands under investigation indicated again the importance of the size, healthy ecotone region, length of hydroperiod and anthropogenic disturbances which have become the key factors in maintaining structure and function of the wetlands of the district. The higher values of evenness index in most of the wetlands indicated the less variation in the species composition in those wetlands under investigation. The wetlands like Bosasimalu, Raumari and Baliduar which have shown higher values of all the above mentioned parameters were not only occupying large areas (Table- 3) but also have contained water for a considerable period of time of the year and possessed wider, less disturbed ecotone region, where edge effect of three environmental domains i.e. water, land and moist conditions played a significant role in better regulation of these wetland habitats. This also created environmental heterogeneity in the form of spatial variation in those wetland habitats. The heterogeneous habitats provide more niches and diverse ways of exploiting the environmental resources, and thus increase the species diversity, which is also reported earlier by Bazzaz (1975) and Simpson (1949). But despite of having large size and uniform periodic hydroperiod, wetlands like Borakata, Dhandi, Sitalmari, Kauribeel and Boralimora have not been able to shown higher level of indices value, because of either high rate of sedimentation, and degraded ecotone regions or excessive biotic interferences in these wetlands. These wetlands were also affected by the dykes as these wetlands are bounded by dykes unlike in Bosasimalu, Raumari, Baliduar and Sildubi. These wetlands are infested by excessive growth of exotic macrophytes like *Eichhornia crassipes* and *Ipomea carnea*. It is known that, especially in highly productive ecosystems like wetlands and river systems, species diversity can be maintained only when some species are eliminated regularly (Looy *et al.*, 2003). Moreover, virtually there were no ecotone regions in wetlands like Sitalmari and Sildubi during the rainy season as these wetlands were bounded immediately by highlands. Excessive cultivation in the ecotone regions during the post monsoon season onwards might also be a reason for poor species compositions in these wetlands. The
sedimentation and cultivation in the surrounding wetland areas drastically decrease the volume of hydroperiod (Luo et al., 1997). Watershed cultivation, and its associated influence on the wetland hydroperiod, was also associated with an increase in the prevalence of exotic species. Otherwise, these wetlands could have been the treasure house for native aquatic plant communities as these wetlands have the basic and unique floodplain wetlands' characteristics. Wetlands like Gereki, Bhedelimora, and Neja became relic wetlands of the district. These wetlands were severely affected by the anthropogenic factors as the buffer zones of these wetlands have been either encroached or under intensive agriculture in the forms of tea gardens, paddy cultivation etc. The inlet-outlet of the wetlands has been destroyed largely due to the construction of roads and human settlements. Smith and Haukos (2001) has also reported the same result and emphasised on the importance of species-area relationship in species composition. Reduction in species diversity largely due to change in land use and habitat has also been reported by Sala et al. (2000); Sax and Gaines (2003).

The phenological activities of plants correspond to the gradual increase in both temperature and amount of water in the study sites. The vegetative and reproductive phenological events of hydrophytes have shown their maximum during premonsoon, monsoon and post monsoon seasons and most of the ecotone plant species have shown their maximum manifestation of phenological events during winter and premonsoon seasons. The present investigation revealed that Alocasia cucullata Schott., Alternanthera philoxeroides (Mart) Griseb, Amaranthus spinosus (L.), Colocasia esculenta (L.) Schott., Commelina benghalensis L., Cyperus rotundus L, Diplazium esculentum (Retz.) Sw, Eichhornia crassipes Solms-Laub., Enhydra fluctuans Laur., Fimbristylis aestivalis (Retz), Hydrilla verticillata (L.F.) Royle., Hygroryza aristata Nees., Hymenachne acutigluma (Steed)Gillil., H. assamica Hitch., Ipomoea aquatica Forsk., I. carnea Jacq. Mimosa pudica L., Monocharia hastata (L) solms-Laub., Nymphaea alba L., N. nouchali Burn. syn., N. stellata Willd., Nymphoides cristata (Roxb)O.Kuntze., Panicum maximum Jacq., Pistia stratiotes L., Polygonum barbatum L., P. glabrum Willd., Sagittaria sagitifolia L., Salvinia molesta D.S., Solanum nigrum L., S. torvum Swartz., Utricularia aurea Lour., Xanthium strumarium L. etc were found to be common plant species in almost all the wetlands of the present investigation and most of them were present throughout the year. But the plant species like Potamogeton nodosus Poir. was observed only in Bosasimalu wetland while Potamogeton pectinatus L. was restricted to Raumari and Baliduar wetlands and this species was found abundantly in Raumari wetland. In the
present investigation it was observed that composition of plant species varied seasonally and number of species was higher during the summer.

The average water temperature of the wetlands of the district ranged between 31.4°C to 17.3°C in summer and winter respectively. During summer, the temperature rise and the fall during winter indicated that there was a close parallel between air and surface water temperature variations. It has shown strong positive correlation with conductivity and BOD, and positive correlation with TDS, TSS, DOM and turbidity (P<0.01) whereas the strong negative correlation has observed with pH and DO (p<0.01) during summer. In winter, it has shown significant positive correlation with BOD and TDS (P<0.01). The average pH ranged between 5.5 to 6.5 during summer and 7.33 to 8.23 in winter season. The pH values have shown strong negative relationship with BOD (p<0.01) and it has positive significant relationship with DO and DOM (p<0.01) during summer. But, it showed significant positive relation with BOD and TSS (P<0.01) and negative relationship with DO (p<0.01) during winter. The negative relationship of pH with DO have also reported by Datta et al. (1991). In general, the pH value of wetlands of Sonitpur district lay within the permissible limit. There was considerable increase in turbidity from non-monsoon months to monsoon months. The increase in suspended matters could be attributed to the ongoing degrading activities, domestic discharge and riverine input. Turbidity has strong correlation with conductivity, BOD and TSS (P<0.01) of the study sites during summer and winter whereas it has shown strong positive correlation with pH and TDS (P<0.01) during winter. Turbidity was found to have poor negative relation with DO (P<0.05) in both the seasons. In most of the cases the maximum DO were recorded in winter season. Higher values of DO in water during winter could be attributed to lower values of temperature and photosynthetic activities of phytoplankton. DO showed significant negative relationship with BOD and TDS (p<0.01) in summer and winter seasons. The higher BOD values during summer were seen in the wetlands of the district. Its lower value during the winter might be due to retarded bacterial activity affected by decreased light intensity and temperature. It had significant positive relationship with TDS, TSS and DOM during summer and winter (P<0.01). The mean range values of TDS during summer and winter were recorded as 336.93 mg/l to 417.20 mg/l and 242.80 mg/l to 297.23 mg/l respectively and showed positive relationship with TSS (P<0.05) but has no significant relation during winter. The present study showed that maximum values of TDS during summer were due to surface runoff and minimum values during winter season due to insolubility at low
temperature. The mean range of TSS values during summer and winter have found as 1683.83mg/l to 2399.67 mg/l and 181.63 mg/l to 373.23 mg/l respectively. The specific conductivity showed significant positive relationship with TDS, TSS and BOD (P<0.01) in both the seasons and negative relationship with pH during summer (P<0.05) and with DO during summer and winter at P<0.05 2-tailed significant level (Table-13.1 and 13.2).

The range of biomass production of macrophytes in waterspread regions during summer and winter for the entire periods was found to be 17.5 gm/m²/month (Gereki) to 38.8 gm/ m²/month (Raumari) and -9.2 gm/ m²/month (Gereki) to 4.8 gm/ m²/month (Raumari) respectively. Accordingly, the range of biomass of ecotone regions during the summer and winter seasons was recorded as 1.8 gm/ m²/month (Sitalmari) to 20.8 gm/ m²/month (Raumari) and 4.7 gm/ m²/month (Raumari) to 1.6 gm/ m²/month (Sitalmari) respectively. The range of gross primary productivity (GPP) of phytoplankton during the summer and winter were showed as 312.5 mgC/m³/hr (Bosasimalu) to 212.5 mgC/m³/hr (Neja) and 368.75 mgC/m³/hr (Raumari) to 112.5 mgC/m³/hr (Gereki) respectively. Likewise, the range of net primary productivity (NPP) during those seasons showed as 200 mgC/m³/hr (Bosasimalu) to 131.25 mgC/m³/hr (Sitalmari) and 262.5 mgC/m³/hr (Raumari) to 81.25 mgC/m³/hr (Borakota) respectively. The maximum and minimum GPP during summer was observed as 312.5 25 mgC/m³/hr in Bosasimalu (2009), 300 25 mgC/m³/hr in Bosasimalu and Rumari (2010), and 212.5 25 mgC/m³/hr in Neja (2010), 218.75 25 mgC/m³/hr in Kadamani and Kharoi (2009), 225.0 25 mgC/m³/hr in Neja (2011) respectively. The present investigation revealed that the GPP, NPP values of phytoplankton community were found to be higher in winter and the community respiration values were higher during summer. This can be attributed to the high growth of phytoplankton during post monsoon period till the onset of winter season. The turbulence in the water realm of the wetlands under the influence of nearby rivers during the period of monsoon and summer can also be attributed to the less production rate in the wetlands of the present study. The low temperature during winter may be the cause of lesser values of community respiration. In majority of the wetlands under study the productivity of macrophytes in ecotone regions was found to be higher during the winter seasons. This can be explained in the case of wetlands like Borakota, Borsola, Bhedelimora, Gerki wetlands etc. It could be attributed to the percentage of coverage of the wetland areas by water in both the seasons.
The mean percentage value of total organic carbon in soils was recorded as 2.33%. The maximum and minimum values of organic carbon were recorded in Sitalmari (3.81%) and Kharoi wetland (0.47 %) respectively.

The inorganic Nitrogen varied from 0.029 % to 0.289% having a mean of 0.176 %. The maximum and minimum values of Nitrogen were recorded in Sitalmari (0.289 %) and Kharoi wetland (0.029 %) respectively. The importance of phosphates in aquatic bodies is well established. In the present study the total Phosphates content ranged between 2.6 ppm to 20.45 ppm having a mean of 6.53 ppm. The maximum and minimum values of total Phosphorus contents were recorded in Gereki (20.45 ppm) and Sildubi wetland (2.6 ppm) respectively. The total Pottassium content ranged from 14.1 to 165.9 ppm having a mean of 74.74 ppm. The maximum and minimum values of Pottassium contents were found to be in Gereki (165.9 ppm) and Kharoi wetland (14.1 ppm) respectively (Table11). These variations of amount of nutrient of the wetlands of the district Sonitpur can be attributed to extent of agricultural runoff and sewage that entered in these two wetlands. The wetlands which are used partially as agricultural land particularly during summer for rice cropping and during winter for winter crops found to have more nutrients than others. This may be explained in the case of Sitalmari, Gereki, Sildubi and Kharoi wetlands. However, the wetlands that showed maximum values of nutrient contents cannot be considered as highly productive wetlands as other factors are concerned.

The wetlands which are situated in the vicinity of tea gardens of the district, Sonitpur, have been selected for the detection of any residual pesticides that may enter into the nearby wetlands from the tea gardens. The study revealed that soil and water samples of five different sites have possessed varying degree of concentration of Aldrin, α-HCH, β-HCH, α-endosulfan, β-endosulfan, bifenthrin, chlorpyrifos, endosulfan-sulphate, ethion, lindane, o.p-DDD, p.p-DDD, p.p-DDE. The maximum value of organochlorine pesticides (OCP) in soil sample was found in Kadamani wetland (190.98 ng/kg) and minimum value was observed in Borsola wetland (94.28ng/kg).The chlorpyrifos and α–HCH in soil samples were found to be most abundant in Kadamani (140.55ng/kg) and Bosaimalu wetland (27.01ng/kg) respectively. The β-HCH (20.22ng/kg) and lindane (8.46ng/kg) were found only in Azolasesuti wetland. The highest concentration of total DDTs (p.p-DDD, p.p-DDD and o.p-DDD) were found in Kadamani (7.64ng/kg) wetland. Where as, the total HCHs (α-HCH, β-HCH) was abundant in
Azolasuti (33.70ng/kg). Aldrin was detected in three wetlands and the maximum value has shown by Sitalmari wetland (16.30ng/kg). The α-endosulfane, β-endosulfan, ethion and lindane were detected each in one wetland only (Table-12.1). Likewise in the water samples, the OCPs concentration in the surface water was found to be highest in Kadamani wetland (2.359ng/l) and in the bottom water it was found to be in the case of Azolasuti wetland (0.994ng/l). The Kadamani wetland has shown maximum concentration of total DDTs (0.88ng/l) and HCHs (1.33ng/l) in surface water sample. Whereas the total DDTs and HCHs in bottom water sample was observed highest value in Azolasuti wetland (0.079ng/l) and in Kadamani wetland (0.150ng/l) respectively. The highest concentration of β-endosulfan (.768ng/l) in bottom water was detected in Kadamani wetland. The highest concentration of aldrin (.030ng/l) in both the surface and bottom water samples was detected in Borsola wetland (Table-12.2). The present study indicated that the wetlands closer to tea gardens eg; Kadamani, Azolasuti and Sitalmari wetland contain highest amount of pesticides in its soil and water samples. Significantly the wetlands like Borsola and Bosasimalu which are situated comparatively more distantly from the tea gardens than the earlier mentioned ones also possessed notable amount of pesticides. This might be due to the nature of topography of the district Sonitpur where most of the drainage of the district from near the tea gardens ultimately finds its way into the wetlands taken into considerations for the present investigation.