Influence of hydrochemistry on biotic components of the Batticaloa lagoon, Sri Lanka

Harris J.M, Vinobaba P
Department of Zoology, Eastern University, Sri Lanka, Vantharumoolai, Chenkalady - 30350
harriseusl@gmail.com
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ABSTRACT

Identification of abiotic variables that influence on biotic components in the lagoon is one of the main challenges in ecology because biotic components show variations in abundance as an adaptive response to changes in chemical, physical and biological characteristics of the habitats. An important characteristic of the lagoon is its biological diversity because physical, chemical (abiotic) measurements reflects water quality at a given time while biological assessment reflects conditions that have exited in a given environment over a long period of time. The present study investigated the prevailing condition of water quality to identify possible abiotic factors that effect on the biotic variables of the Batticaloa lagoon. In situ measurements of chemical, physical parameters of the lagoons measured were measured routinely from 9th July 2010 to 22nd June 2011. Averages of the results indicated chemical parameters of dissolved oxygen (3.65 ± 0.40 to 13.99 ± 0.64 mg/L), phosphorus (0.31 ± 0.06 to 0.52 ± 0.18mg/L), nitrate (1.07 ± 0.32 to 3.98 ± 0.22 mg/L), nitrite (58.33 ± 9.27 to 72.08 ± 6.90mg/L), and pH (8.01 ± 0.02 to 8.16 ± 0.05) and physical characteristics like salinity (15.50 ± 1.65 to 29.16 ± 0.89 ppt), density (1.01 ± 0.00 to 1.02 ± 0.01 gcm-3), surface water velocity (0.10 ± 0.01 cms-1 to 0.13 ± 0.01 cms-1), turbidity (5.68 ± 1.25 to 37.69 ± 1.83FTU), temperature (31.58 ± 0.60°C to 33.45 ± 0.19°C) varied widely. Simultaneously were collected existing biotic components (finfish, shellfish and jelly fish) on the sampling points. Analysis elucidated the existing conditions were found to have strong impact on biological parameters. Furthermore, seasonal changes and anthropogenic influences also significantly affect the biotic components. This information and observation of this study will be very crucial to the biological life of the lagoon for formulating management policies (Master plan for Batticaloa lagoon) in future with other sectors.

Keywords: Abiotic, biological, dissolved oxygen, lagoon, planktons.

1. Introduction

Lagoon is a peculiar semi enclosed water body found between the sea and river delta (Silva, 1996). Lagoon in the tropics harbor a rich fish biomass consisting of autochthonous fauna confined to brackish water ends and allochthonous fauna coming from the marine and fresh water environment. Apart from these direct tangible flows of economic benefits, lagoon also provides a variety of indirect services to local communities, which enhance economic significance, these ecosystems by many folds. Moreover, lagoon ecosystems are a complex dynamic one this is due to nonlinear interactions of biological, chemical and hydrodynamic processes. Biotic and abiotic factors combine to create a system or more precisely, an ecosystem. Abiotic conditions of the lagoon also inevitably have an effect on life in the lagoon ecosystem. However the abiotic water quality parameters play a key role to support existence of biological parameter. Biotic and abiotic factors are interrelated. If a single factor
is changed, perhaps by pollution or natural phenomenon, it impacts the availability of other resources within the system. The biological analysis of coastal waters will describe clearer figurine the existence of the pollutant materials impact to the community of the organism which are living in the waters. Where they will decrease the number of the biota diversity. Biotic and abiotic studies of this lagoon that allow a better comprehension of the dynamics of aquatic ecosystems are of great importance for the preservation and conservation of these environments.

1.1 Study site

The Batticaloa lagoon is the longest brackish water lagoon in the east coast of Sri Lanka situated between 7° 24’ - 7° 46’N and 81° 35’ - 81° 49’E. The lagoon is about 23 miles (36.8 km) long along meridian axis and it varies widely 0.5 km to 4 km and the average water depth is around 1.5m (Scot, 1989) while the lagoon is shallow in most of the areas (< 2m). The lagoon is the direct recipient water body of about 19 tanks, 5 major lakes, 8 rivers numerous irrigational channels and many drainage basins and has become dominant morphological features of the watershed.

In this work, we attempt to identify possible regulatory mechanisms biotic components by hydro chemistry of the lagoon. These characteristics prompt fast responses of the species to habitat variations concerning chemical, physical and biological factors. In this paper, we evaluate impact of spatial and temporal variations of the hydro chemical parameters on finfish, shellfish and jelly fish distribution.

2. Materials and method

The present study was conducted for one year from 9th July 2010 to 22nd June 2011 over the wet and dry seasons. 7 sampling points were previously defined based on the different biotypes in the lagoon shown in figure 1 by their different characteristics of lagoon such as salinity regime, topography, depth, and human impact level and marked as “SL₁ – SL₇” (Sampling sites).

![Figure 1: Batticaloa lagoon and sampling locations](image-url)

Surface water samples for hydro chemical parameters were collected fortnightly from the selected locations by dipping well labeled sterilized plastic containers of 250 ml to about 6-10
cm below the surface film and analyzed according to the standard method. Salinity, density, pH and dissolve oxygen are measured in-situ. Rest of the water samples collected were transported to the laboratory and processed immediately. All hydro chemical parameters of water were measured by suitable instruments as shown in the table 1.

**Table 1: Water quality parameters and measuring instruments with unit**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Instrument</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>Hanna HI 93703 C microprocessor turbidity meter</td>
<td>Formazine Turbidity Unit (FTU).</td>
</tr>
</tbody>
</table>
| Salinity        | Portable ATAGO, S/MillE Hand Refractometer      | Parts per thousand (ppt) or %
| Density         | Portable ATAGO, S/MillE Hand Refractometer      | g/cm³                          |
| Temperature     | Hanna portable HI 98128 Temperature meter       | Celsius (°C)                   |
| pH              | Hanna portable HI 98128 water proof pH meter    | pH units                       |
| Nitrate         | Hanna portable HI 93728 Nitrate ISM (Low range) | Parts per million (ppm) or mg/L|
| Nitrite         | Hanna portable HI 93708 Nitrite ISM (High range)| Parts per million (ppm) or mg/L|
| Phosphate       | Hanna portable HI 93713 Phosphate ISM (Low range)| Parts per million (ppm) or mg/L|
| Dissolved oxygen| Hanna portable HI 8043 Dissolved Oxygen Meter   | Parts per million (ppm) or mg/L|

Fin fish and shell fish species collected with the help of fishermen using cast net at the sampling locations. The fish distribution was determined by recording the fish catch from the fishermen at the sampling sites. There was a great difficulty in collecting all varieties of available fish and shellfish species at the sampling location. The fin fish and shell fish species caught were identified to the lowest taxonomic level using FAO species identification field guide for fishery purpose of Sri Lanka by George et al., 1994 and Munro, 1955.

**2.1 Statistical analysis**

All statistical analyses were performed using statistical package Minitab 15.0. Pearson correlations were used to evaluate the relation between biotic and abiotic components. Hydro chemical abiotic parameters of both dry and wet season were compared using two tail two
sample student t-test. All the data presented in the tables were mean of the sampling campaign with standard deviations.

3. Results and discussion

From the results obtained high dispersion of standard deviation as shown in Table 2 indicates that variability in physico-chemical abiotic composition of the lagoon between the sampling sites were influent by temporal variations that may cause likely by anthropogenic pollutants sources or climatic factors. Evidently, those parameters play an important role in providing suitable conditions for the biotic component.

**Table 2:** Variation of hydro chemical parameters at sampling sites with standard deviation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SL₁</th>
<th>SL₂</th>
<th>SL₃</th>
<th>SL₄</th>
<th>SL₅</th>
<th>SL₆</th>
<th>SL₇</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity (‰)</td>
<td>32.41±0.01*</td>
<td>21.00±0.84</td>
<td>18.38±0.27</td>
<td>19.16±0.52</td>
<td>18.57±0.33</td>
<td>26.79±0.51</td>
<td>25.37±0.63</td>
</tr>
<tr>
<td>Temp (°C)</td>
<td>33.27±0.28</td>
<td>33.71±0.28</td>
<td>33.81±0.29</td>
<td>32.77±0.52</td>
<td>31.84±0.28</td>
<td>32.92±0.34</td>
<td>33.84±0.58</td>
</tr>
<tr>
<td>Turbidity (FTU)</td>
<td>6.61±0.18</td>
<td>7.28±1.18</td>
<td>14.52±0.61</td>
<td>8.12±0.34</td>
<td>13.64±1.27</td>
<td>17.35±1.23</td>
<td>37.01±2.87</td>
</tr>
<tr>
<td>Velocity (cm/s)</td>
<td>0.12±0.01</td>
<td>0.12±0.01</td>
<td>0.13±0.01</td>
<td>0.11±0.01</td>
<td>0.11±0.01</td>
<td>0.11±0.01</td>
<td>0.09±0.00</td>
</tr>
<tr>
<td>Density (g/cm³)</td>
<td>1.02±0.01</td>
<td>1.02±0.01</td>
<td>1.01±0.00</td>
<td>1.01±0.00</td>
<td>1.02±0.00</td>
<td>1.01±0.00</td>
<td>1.01±0.00</td>
</tr>
<tr>
<td>DO (mg/L)</td>
<td>11.65±0.57</td>
<td>13.38±0.16</td>
<td>8.39±0.29</td>
<td>7.15±0.77</td>
<td>8.71±0.48</td>
<td>9.68±0.54</td>
<td>4.08±0.87*</td>
</tr>
<tr>
<td>pH (Units)</td>
<td>8.38±0.12*</td>
<td>7.85±0.02</td>
<td>7.85±0.33</td>
<td>7.19±0.05</td>
<td>8.24±0.41</td>
<td>7.87±0.06</td>
<td>8.24±0.18</td>
</tr>
<tr>
<td>Nitrate (mg/L)</td>
<td>2.81±0.49</td>
<td>2.41±0.31</td>
<td>3.68±0.53</td>
<td>1.17±0.34</td>
<td>2.47±0.38</td>
<td>2.52±0.46</td>
<td>3.49±0.94*</td>
</tr>
<tr>
<td>Nitrite (mg/L)</td>
<td>85.08±5.20</td>
<td>62.17±6.31</td>
<td>71.50±9.86</td>
<td>55.08±9.03</td>
<td>55.18±4.27</td>
<td>50.37±5.27</td>
<td>62.67±7.18</td>
</tr>
<tr>
<td>Phosphate(mg/L)</td>
<td>0.39±0.05</td>
<td>0.57±0.04</td>
<td>0.46±0.09</td>
<td>0.33±0.08</td>
<td>0.36±0.41</td>
<td>0.24±0.07</td>
<td>0.49±0.67</td>
</tr>
</tbody>
</table>

*Indicates parameters and sampling sites showing statistical significance (p<0.05)

Fish are appropriate indicators of trends in aquatic environment because of the impact they have on the distribution and abundance of other organisms in the water they inhabit (Olopade, 2001). A total of 5689 fish specimens were collected, belonging to 93 species representatives of 45 families. The lagoon has rich fish diversity, mostly brackish water species, some truly brackish-water, marine water and a few freshwater species. Mullets and Cat fish are the major brackish water fish shown in the figure 2. This variation may be attributed to human activities alter abiotic parameters of the lagoon. As a result loss of some fish species due to inhibition of their movement from the marine or fresh water environment to the brackish environment and also loss of the feeding ground. *Etroplus* and *Tilapia* were the dominated catch because they are found in every part of the lagoon. However *Nematolosa nasus* quite abundance in SL₁ due to the high salinity. On the other hand *Puntius sarana* found only in SL₂ due to the low salinity. Moreover, *Hemiramphus* found in abundance at SL₂ where the location abundance with benthic aquatic vegetation on which it feeds. Families
Mugilidae, Clupeidae and Cichilidae were recorded in both seasons. After the monsoon the fry of all species of mullets enter the lagoon in enormous numbers, but the survival rate of the fry is very low. The juveniles use the lagoon as nursery.

![Figure 2: Images of Mugil cephalus (Mullet), Nematalosa nasus (Koi), Arius arius (Cat fish)](image)

**3.1 Salinity**

The nature of the longitudinal salinity gradient is an important factor in the successful recruitment of larval and juvenile fish (Bulger *et al.*, 1993). As a general rule, widely-varying salinity regimes tend to select for a low-abundance and low-diversity suite of species, which are adapted to a broad range of ionic concentrations (*e.g.* euryhaline species). According to the present study, wide fluctuations of salinity range were noted at SL2 and SL3 from 10‰ to 28‰ and 7‰ to 19‰ respectively. Therefore, euryhaline fishes are *Chanos chanos* and *Caranx* sp are caught in this area, is an additional piece of evidence to indicate higher salinity in this region. The bar mouth openings cause radical alteration of not only the salinity but also physical and chemical conditions including drastic reduction of water volume, perishing of freshwater communities transported to the sea, passive and active entrance of marine species into the lagoon, and osmotic stress to freshwater, brackish, and marine species (Suzuki *et al.*, 2002).

The mean salinity was not identical along the sampling stations. The seasonal variation of salinity indicated that there was significant difference (p<0.05) at the 95% confidence level between the seasons. It is also clear from the Pearson correlation analysis indicated that there is strong negative correlation (r = -0.987) was found between the rainfall and salinity. Consequently, shifting salinity gradient can affect the distributions of macro benthos (Boesch, 1977). This salinity gradient paves the path for euryhaline fishes at this location of SL4. When the rainfall was heavy during the period November to December fresh water species such as *Channa* sp and *Puntius* sp were noted. Also at high salinity locations *Lutjanus* sp were observed. Generally, brackish waters salinity is often considered as an overriding factor. In particular, the threshold between oligohaline and mesohaline conditions which represents the lower limit for brackish water species abundance and also the upper limit for freshwater species is linked to major physiological changes for organisms (Remane and Schlieper, 1971).

**3.2 Nitrate**

An important characteristic of lagoon is its biological diversity. Odiete *et al.*, (2003) reported, chemical measurements reflects water quality at a given time while biological assessment reflects conditions that have existed in a given environment over a long period of time. The average nitrate measures along the lagoon which within the recommended value supports the healthy aquatic life except the locations SL4 and SL7. Because of those locations were
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exceeded the recommended threshold level. The increased concentration of nitrate in aquatic system has heightened the toxic effect to fish community. Based on the correlation test with most abundance species with nitrate concentration decline in fish abundance was observed at the segments SL4 and SL7 with above the nitrate level 2.00 – 3.00 mg/L. Frequent fish kill (Nematalosa nasus) was noted due the eutrophic condition at SL7 during the dry season. However Oreochromis sp and Plueronectus sp are found to be abundance species in those locations. Mean nitrate showed lower levels during the dry season ranging from 1.07 ± 0.32 mg/L to 2.28 ± 0.22 mg/L and 2.63 ± 0.32 mg/L to 3.98 ± 0.27 mg/L during the wet season. The seasonal variation of nitrate was significant (p<0.05) at the 95% confidence level. The lower value in the dry season (might be explained by the high uptake of nitrate by aquatic plants during photosynthesis. The highest mean nitrate level (3.98 ± 0.27 mg/L) recorded at area between slaughter house and shrimp farm (SL7) might be indicative of high excrement of shrimp farm effluents and slaughter house wastes. The nitrate content found in location SL7 shows that area is fairly polluted. The concentration of different forms of nitrogen give useful indication of level of micronutrients in the water and hence their ability to support plant growth. High nitrate content in water helps favours the growth of weeds (Eichhornia sp) in certain area (SL5) of the lagoon. This condition attracts more herbivores fishes like Mugil cephalus and Etroplus towards this location for hiding places from their predators.

3.3 Turbidity

The lagoon water is quite clear in the dry season but turbid at the peak of rainy season. In all sampling points the mean turbidity during wet season found to be higher than dry season. The mean turbidity variation ranging from 5.68 ± 1.25 to 37.69 ± 1.83 FTU. The high mean turbidity (37.69 ± 1.83 FTU) was recorded at area between shrimp farm and slaughter house (SL7) during the wet season. Seasonal variation of turbidity was significant (p<0.05) at the 95% confidence level. This present observation of higher turbidity in the wet season than the dry season might probably be due to increased sediment load from surface run-off and natural erosion from the surroundings. However, suspended sediment can smother benthic organisms and habitats when it settles, and can cause mechanical and abrasive impairment to the gills of fish and crustaceans. Suspended sediment also transports contaminants like particulate nutrients and can lead to dissolved oxygen depletion in the water column if it is caused by particulate organic matter. Overall, unnaturally high turbidity levels due to shrimp farm effluents and waste disposal can lead to a reduction in the fish catch and diversity of other species at SL5 and SL7 due to fish has emigrated to other neighboring ecosystem to avoid injured caused by the suspended particles.

3.4 Dissolve Oxygen

Dissolve Oxygen (DO) level along the lagoon was within the recommended threshold level (3.00 – 5.00 mg/L) which being able to support sensitive aquatic life. The results acquired from statistical test shown nitrate and phosphate were negatively correlated with (r = -0.73 and r = -0.43) DO. The observed circumstances suggest that biodegradation and decomposition of organic constituents from shrimps farms (SL7) and agricultural runoff (SL3) will lead to depletion of DO. Hence, there is an increase in the oxygen demand and a decline of DO level in those locations. Biodegradation of organic matter at SL3 was considered contributes to secondary effect which accelerated DO depletion and may not pose direct physiological distress to fish community. Prolonged exposure to low DO levels may not directly kill an organism, but will increase its susceptibility to other environmental stresses. However below 5.00 mg/L may lead to unfavourable condition for fish community. The DO
level which satisfactory for most stages and activities in the life cycle for fresh water fish or tropical biota is 5 mg/L (Alabaster and Lloyd, 1982). Aerobic decomposition of organic matter by microbes causes depletion of oxygen from an aquatic system. DO was strongly correlated (r = 0.68) with fish abundance. During the course of study two fish kills were noticed. One of which found in SL1, cause of death was due to the decomposition of seasonally abundant water hyacinth by the depletion of DO. The other kill was noticed at SL5, due to the depletion of DO by the algal blooming.

3.5 pH

The average level of pH measured along the sampling sites lay within the range of recommended level (6.5 – 8.5) to support aquatic life. Based on the obtained results, lagoon fish community has been safely acclimated and increase in number within the pH level ranged from 7.50 – 7.85. The concentration of hydrogen ion in aquatic system was not the limitation factor which inhibits the distribution of fish. There was spatial variation but not seasonal significant difference (p>0.05) at the 95% confidence level found between the locations. Generally, the high pH was found in the northern sector of the lagoon (SL1), the general alkaline state is partly due to the influence of seawater. In this segment species composition composed of both marine and brackish water. The depletion of carbon dioxide due to photosynthesis might have raised the pH of water column may cause the lagoon water into slightly higher alkaline condition.

3.6 Temperature

Mean water temperatures remained fairly constant throughout the study period. The slight variations were due to different times of sampling as the ambient temperature influenced the temperatures of the samples. The shallow condition (mean depth 0.65m) of the lagoon gives rise to influence its temperature by air temperature and thermal conditions. Water temperature in turn influences dissolved oxygen concentrations, as well as the physiology of lagoon species variation and patterns of migration (Woodward, 1987). Different species have different optimal temperatures for migration, spawning, egg incubation and juvenile growth, and different lethal temperature criteria (Beschta et al., 1987). Since fish are poikilothermic (cold-blooded) their metabolic rate and food needs increase with higher water temperature. If adequate food is not available, fish will lose weight and eventually die, even if temperatures do not reach lethal levels.

3.7 Surface water velocity

The mean higher surface velocity of 0.13 ± 0.01 cms⁻¹ recorded at SL2 and mean lower surface velocity recorded at SL7 due to the stagnant condition of the water. Dilution and dispersal processes of pollutants have inhibited by slow current flow rate and limited of vertical turbulent. Thus, indirectly effected the distribution and abundance of fish. As the depth is reduced by the sediments settle out by suspension, then automatically velocity of the water is reduced. However, Batticaloa lagoon has seasonal surface water movement and it is high during the rainy season.

3.8 Density

Density fairly constant throughout sampling period therefore there is no appreciable variation observed. Likewise as there is no substantial variation in temperature hence it has not
affected the density because of water changes its density in respect to its temperature, but not on a linear scale, and not even continuously in one direction (Garrison and Shaw, 1956). In addition, mixing fresh water and salt water plays a major role in the determination density of Batticaloa lagoon. Fishes from the fresh water end enjoy the density range of less than 1.005 g/cm³. But most brackish water fishes can tolerate the entire range from 1.000 to 1.025g/cm³; these include fish such as scats, and catfishes (Fine and Millero, 1973). According to present observation density varies ranging from 1.000 to 1.020 g/cm³ at Batticaloa lagoon. This variation did not make any appreciable impact on the brackish water fish, However salinity fluctuation makes euryhaline fish to migrate to brackish water areas.

3.9 Nitrite

The seasonal variation of nitrite was not significant (p>0.05) at the 95% confidence level except the location of SL5. Though there was more nitrite content in SL7, it is immediately converted into nitrate by the denitrifying organism as such nitrite content at this location appears to be low. Therefore this variation did not much influence on fish distribution at this location.

3.10 Phosphate

Phosphate level of the Batticaloa lagoon is within the tolerable level. The seasonal variation of phosphate was not significant (p>0.05) at the 95% confidence level except the location SL7. The phosphate levels, though not very high, have the potential to cause eutrophication. However, in certain locations (SL5 & SL7) over enrichment with phosphorus and nitrogen causes a wide range of problems, including algal blooms, loss of oxygen, fish kills, loss of other aquatic vegetation, and loss of biodiversity including species important to commercial, sport fisheries and shellfish industries. These eutrophic symptoms are indicative of degraded water quality conditions that can adversely affect the use of lagoon resources. The low variation in phosphate concentrations may be the result of some buffering mechanism whereby phosphorus is released from or absorbed by the sediments depending on its concentration in the overlying waters. However in certain instance higher levels recorded were due to excessive domestic and raw sewage discharges. This helps in growth of the weeds in the lagoon.

3.11 Crustacean

A few economical important shrimp and crab species seem to complete their life cycle in the Batticaloa lagoon. Shrimps are dominant in number; crabs are abundant in species from its surrounding intertidal zone. Scylla serrata was abundant at SL3 & SL4. Portunus pelagicus found in the high salinity regions. There are quite a lot of shrimp larva. Six species shrimp and 2 species of crabs are recorded few of them shown in the figure 3. Penaeus monodon, Penaeus indicus are common in all location. However, Penaeus semisulcatus, Metapenaeus sp and Macrobrachium rosenbergii sp are quite abundant. Two species of Metapenaeus are present. Those are Metapenaeus monoceros and Metapenaeus dobsoni.

The timing (phenology) of lagoon processes will also be affected by temperature increase. Developmental and reproductive timing in shellfish as evidenced by early gonad maturation. Several economically important shellfishes were recorded in the Batticaloa lagoon, however, there is no appreciable changes were noticed in the maturation and migration of the shellfishes as the temperature fluctuate within a narrow range. The white shrimp seems to be
more tolerant to fluctuations in salinity than the other Penaeidae species. Therefore it was noted throughout the sampling period in the SL5 & SL6. It is fast growing and because of its tolerance. However high saline conditions (<27‰), low content is dissolved oxygen (>3ppm) and wide fluctuations of temperature strongly affect the growth and the mortality rate at the area between the slaughter house and shrimp farm (SL7). Green Crab (Scylla serrata) fishing continues throughout the sampling period due the ability to tolerate extreme environmental condition but reaches its peak during the wet season falling from October – December. Intensive fishing took place during the breeding season in the wet season removed large quantities of gravid females (egg berried female) which is the reason for reduced its abundance during wet season.

**Figure 3**: (a). *Peneaus indicus*, (b). *Scylla serrata*, (c). *Portunus pelagicus*, (d). *Peneaus semisulcatus*, (e). *Peneaus monodon*, (f). *Macrobrachium rosenbergii*

3.12 Jellyfish

Lagoon jellyfish (*Mastigia* sp) is another one of the more interesting species in Batticaloa Lagoon. 4 different types of jelly fish noted during the sampling period but is not identified up to the species level. The lagoon jellyfish also maintains a symbiotic relationship with unicellular algae called Zooxanthellae. These algae are photosynthetic and use sunlight to produce carbon rich nutrition. The lagoon jellyfish then absorbs the nutritional leftovers from this process of photosynthesis. Quantity of jellyfish noted in abundance at SL6 because of the high turbidity and also jelly fish and its medusa raised in getting entangled in the fishermen’s net causing the depletion of the species in this location. Furthermore lagoon jellyfish depend on this source of food, although it does not provide them with all the nutrition they need, and so the lagoon jellyfish also feed on planktons and zooplanktons in these locations. This also might cause the low abundance of zooplankton in SL6.

4. Conclusion

The findings of this study show that combination effects of anthropogenic pollutants and hydro chemical parameters have affected the biotic community and reduce the numbers and species of the study sites. Further deterioration will aggravate the presence environment of Batticaloa lagoon threaten the existence aquatic life. This is also linked to the physical and chemical state of the water in the lagoon. Seasonal changes also have a great impact on the fish abundance and distribution of the lagoon. Partial impoundments and causeway across the lagoon also influence on the migration of some fishes.
4.1 Recommendation

Lagoon systems are places of great biological importance where fishery is concern. Therefore need long term observation to assess the fish distribution and abundance of Batticaloa lagoon in order to give a good insight into the state of biological production in the stem and the physico-chemical characteristics in evaluating future changes that may occur in response to increasing pollution in the lagoon.

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5. References


