Chapter - 7

SUMMARY AND RECOMMENDATION

7.1 Summary

The choice of Idukki reservoir for limnological study has obvious reasons. The Idukki hydro-electric project is the biggest man made project in Kerala, which is the main source of electricity for Kerala state and the entire water is used for power generation and irrigation purpose. The present study on Idukki reservoir entitled “Studies on Physico-chemical characteristics, Plankton diversity and Ichthyofauna of Idukki reservoir, Kerala, India” was undertaken to assess the seasonal and spatial variations in some important physico-chemical parameters, diversity and density of phytoplankton and zooplankton as well as fish fauna of Idukki reservoir to evaluate the present status of the reservoir. Therefore, the present study would be an immense use for evaluating the expecting changes in the physico-chemical and biological parameters, serving as a useful data bank for future studies and also for planning future course of development of fishery in this reservoir.

The Idukki reservoir is roughly ‘V’ shaped and when it full will have a water spread area of 23.1 sq. miles (59.83 sq.km) and this storage regulates the
yield of over 250.7 sq.miles (1649.3 sq.km) of Periyar and Cheruthoni catchments. The Idukki hydro-electric project has 3 dams - Idukki arch dam across Periyar, the largest river in Kerala; Cheruthoni straight concrete gravity dam across the tributary River Cheruthoni and Kulamavu dam across Kilivallithodu. 16 stations were selected for sampling and samples for physico-chemical analysis and plankton were collected from the water surface bimonthly for a period of 3 years (February 2007 to January 2010). Fishes were also sampled bimonthly from all the 16 stations during this period with the help of fishermen using gillnet. The water analysis and identification of the plankton and fishes were done adopting the standard methods and keys.

For the convenience of analysis, the annual data was divided into 3 seasons, Premonsoon (February-May), Monsoon (June-September) and Postmonsoon (October-January) and applied to ANOVA using standard statistical package. The variations were significant if $P < 0.05$ and non significant if $P > 0.05$. To find out the correlation between parameters the annual averages were applied to Pearson correlation. The correlation between the physico-chemical parameters, total phytoplankton, phytoplankton groups, total zooplankton and zooplankton groups with the physico-chemical factors were analysed. The species diversity indices, viz., Shannon-Weiner diversity index ($H'$), Margalef’s index ($d$), Pielou’s evenness index ($J'$) and species richness ($S$) were computed for plankton and fish.

Significant seasonal and spatial variations were observed in the case of atmospheric temperature, water temperature, turbidity, electric conductivity, transparency, pH, chloride, calcium, magnesium, nitrate and sulphate where as the parameters such as DO, free CO$_2$, total hardness, total alkalinity, TDS, COD, BOD, sodium, potassium, phosphate and iron were not showed much spatial variations in the reservoir. COD and BOD were not showed seasonal
variation too. Mercury, Cadmium, zinc and copper were found below traceable level. H₂S was also not obtained in the reservoir during the period of study.

The mean seasonal variation of all the physico-chemical parameters except turbidity, DO, nitrate, phosphate, sulphate and iron were showed highest values during premonsoon season, lowest during monsoon season and moderate during postmonsoon season. The parameters such as turbidity, DO and nitrate were recorded high in monsoon season, low in premonsoon and moderate in postmonsoon. The highest phosphate content was noticed in postmonsoon season and low in premonsoon while it was not recorded in monsoon season. Sulphate was recorded only in premonsoon season whereas iron was observed in premonsoon and postmonsoon seasons.

During the present investigation, seasonwise analysis showed that the average of rainfall in the watershed of Idukki reservoir was found higher in the monsoon season (652.87mm) followed by postmonsoon (125.43mm) and it was very low in premonsoon period (83.21mm). The atmospheric temperature showed high average value in premonsoon season (31.69°C), low in monsoon (25.80°C) and moderate in postmonsoon season (28.56°C). Water temperature was also high in premonsoon period (29.19°C) while low during monsoon (24.14°C) and moderate in postmonsoon (26.90°C). The higher water temperature during summer season may be due to the clear atmosphere, bright sunshine (greater solar radiation), air temperature and low water level. The mean value of water transparency in premonsoon was 384.13 cm and that in the monsoon was 74.50 cm. The mean transparency measured in postmonsoon was 209.09 cm. Monsoon season registered significantly higher turbidity values (1.46 NTU), compared to postmonsoon (0.99 NTU) and premonsoon seasons (0.01 NTU) in the current study. The highest mean value of EC was recorded in premonsoon season (55.56 µS/cm), minimum in monsoon season.
The average value of TDS was recorded as 33.79 ppm, 27.89 ppm and 18.94 ppm during premonsoon, postmonsoon and monsoon season respectively. The average of pH during the study period registered high in premonsoon period (7.87), minimum in monsoon (7.03) and moderate in postmonsoon (7.48). The higher concentration of pH during summer season, in Idukki reservoir could be attributed to decreased water level, high temperature, enhanced rate of evaporation and increased photosynthesis.

The DO was maximum (8.44 mg/l) during monsoon season and minimum (7.09 mg/l) during premonsoon season. High DO in monsoon season can be attributed to low temperature which helps the water to hold high O₂ in the dissolved state. In postmonsoon, the average of DO was 7.65 mg/l. Free CO₂ showed the highest mean value of 2.18 mg/l in premonsoon season, lowest value of 1.95 mg/l in monsoon season and moderate value of 2.09 mg/l in postmonsoon period. The average alkalinity recorded in the present study was highest in premonsoon season (31.52 mg/l) and lowest in monsoon (18.60 mg/l). The mean alkalinity value observed in postmonsoon season was 22.19 mg/l. The average of chloride concentration was maximum (9.61 mg/l) during premonsoon and minimum (7.13 mg/l) during monsoon. The moderate value (7.83 mg/l) was observed in postmonsoon season. The mean of total hardness in the reservoir was found to be high during premonsoon season (10.76 mg/l) than postmonsoon (8.24 mg/l) and monsoon season (6.79 mg/l). Premonsoon season registered higher calcium concentration (8.11 mg/l), compared to the postmonsoon (6.38 mg/l) and monsoon seasons (5.59 mg/l). The highest average value of magnesium recorded in premonsoon season was 2.68 mg/l, lowest in monsoon period (1.20 mg/l) and moderate during the postmonsoon (1.87 mg/l).
Seasonal analysis of COD in the reservoir revealed that the highest value of 3.17 mg/l in premonsoon season and lowest (3.08 mg/l) in monsoon season. COD in postmonsoon season was recorded as 3.10 mg/l. BOD values recorded in the reservoir were comparatively higher during premonsoon season (0.56 mg/l) than postmonsoon (0.49 mg/l) and monsoon (0.47 mg/l). High concentration of sodium obtained during premonsoon period with the average of 1.21 mg/l whereas low (0.53 mg/l) in monsoon season. The average value of sodium recorded in postmonsoon period was 0.84 mg/l. Premonsoon season registered higher potassium values (0.75 mg/l), compared to the monsoon (0.64 mg/l) and postmonsoon seasons (0.61 mg/l). The average values of nitrate were recorded as 0.11 mg/l, 0.07 mg/l and 0.02 mg/l during monsoon, postmonsoon and premonsoon seasons respectively. Phosphate content was below detectable level in monsoon season whereas postmonsoon period showed a maximum average value of 0.02 mg/l. The mean value of phosphate noticed in premonsoon season was 0.01 mg/l. Sulphate concentration was found mere minimum in almost all stations studied and in many stations the values were recorded near zero. The seasonal average of sulphate in the surface water was highest (0.013 mg/l) during premonsoon season and lowest (0.003 mg/l) during postmonsoon season. Sulphate content was not recorded in monsoon season during the entire period of study. Seasonal analysis of iron content in the reservoir revealed that the highest value of 0.013 mg/l was noted in premonsoon where as the lowest value of 0.006 mg/l in postmonsoon season. But the amount of iron was below traceable level during monsoon period at all stations.

Plankton forms an important food source for fish in aquatic ecosystem and help the knowledge on the abundance, composition and seasonal variations of the same is an essential prerequisite for fish culture and
development of fisheries in Idukki reservoir. A detailed study on the quantitative and qualitative abundance and seasonal variations of the plankton in Idukki reservoir based on samples collected from all the selected study sites were considered.

During the present study, five groups of phytoplankton namely, Chlorophyceae (Green algae), Bacillariophyceae (Diatoms), Cyanophyceae (Blue-green algae), Dinophyceae (Dinoflagellates) and Desmids were recorded in the reservoir. A total of 37 species, belonging to 31 genera were found in the reservoir where both Bacillariophyceae and Chlorophyceae recorded with 11 species in each of them, while Cyanophyceae, Dinophyceae and Desmids were recorded with 5, 2 and 8 species respectively. A total phytoplankton number of 1627.37/l was recorded in the reservoir. Chlorophyceae (590.15/l) dominated the phytoplankton groups in terms of number/litre constituting 36.26% of the total phytoplankton. The next dominant group was Bacillariophyceae (489.03/l) which made up 30.05% and was distantly followed by Desmids (322.03/l) that comprised of 19.79%, Cyanophyceae (165.25/l) with 10.15% and Dinophyceae (60.91/l) constituted only 3.74% of the phytoplankton population. Among phytoplankton species, Ankistrodesmus falcatus was the most abundant (285.44/l) constituting 17.54% of the total phytoplankton in the reservoir.

The average of 3 years study showed that phytoplankton was abundant in the reservoir during premonsoon season (747.30/l) followed by postmonsoon season (662.56/l) while the monsoon season showed the lowest (217.51/l). The phytoplankton abundance during summer season in the reservoir could be attributed to the prolonged day length, high intensity of light penetration, increased pH, high temperature, low water level and low rainfall. During premonsoon season, Chlorophyceae was the dominated group.
in the reservoir (275.30/l) and which constituted 36.82% of the total phytoplankton. It was followed by Bacillariophyceae 224.47/l (30.02%), Desmids 137.70/l (18.42%), Cyanophyceae 76.05/l (10.17%) and Dinophyceae 33.78/l (4.52%) respectively. A total of 30 phytoplankton species were recorded in this season and the most dominant species among Chlorophyceae was *Ankistrodesmus falcatus* (18.57%).

During monsoon season, Dinophyceae group was not recorded in the reservoir. The dominant group in this season was Chlorophyceae (80.08/l) which constituted 36.82% of the total phytoplankton. The next dominant group was Bacillariophyceae 61.15/l, contributed 28.11% and it was followed by Desmids (23.77%) and Cyanophyceae (11.30%). The density of Desmids and Cyanophyceae in this season was 51.70/l and 24.58/l respectively. Only 8 species were observed in this season and the most dominant species was *Ankistrodesmus falcatus* which constituted 26.22% of the population. In postmonsoon season, Chlorophyceae, the dominant group (234.77/l) accounted for about 35.43% of the total phytoplankton in the reservoir. Bacillariophyceae (203.41/l) represented 30.70%, Desmids (132.63/l) contributed 20.02%, Cyanophyceae (64.62/l) made up 9.75% and Dinophyceae (27.13/l) constituted 4.09% of the total phytoplankton in this season. 36 species of phytoplankton were recorded in this season in Idukki reservoir. *Ankistrodesmus falcatus* was found to be dominant among phytoplankton species during postmonsoon (13.53%).

In Idukki reservoir high species richness was recorded in postmonsoon season whereas it was low in monsoon season. The premonsoon season showed moderate species richness in the reservoir. Margalef's richness and Shannon-Wiener diversity indices also showed high values in postmonsoon season, low in monsoon season and moderate in premonsoon season. The high
species diversity in postmonsoon may be due to the favourable environmental conditions and sufficient water in the reservoir. The Pielou’s evenness values were high during monsoon season in the reservoir. Evenness values were low during premonsoon season and moderate during postmonsoon season. The high species evenness in monsoon season may be due to the increased water spread and ample turbulence in this season. Low evenness in premonsoon season probably due to the shrinkage of water spread of the reservoir.

The total phytoplankton and each group were positively correlated with atmospheric temperature, water temperature, transparency, electrical conductivity, TDS, pH, free CO$_2$, total alkalinity, chloride, total hardness, calcium, magnesium, COD, BOD, sodium, potassium, phosphate and sulphate whereas negatively correlated with turbidity, DO and nitrate. Chlorophyceae group was represented by 11 species belonging to 11 genera, viz, *Desmidium quadratum*, *Pediastrum duplex*, *Arthrodesmus menoides*, *Ankistrodesmus falcatus*, *Spirogyra* sp., *Coelastrum microporum*, *Chlorella vulgaris*, *Tetraedron proteiforme*, *Clamydomonas* sp., *Ulothrix zonata* and *Rhizoglonium* sp. In Idukki reservoir, the most dominant species among Chlorophyceae was *Ankistrodesmus falcatus* (48.37%).

Among seasons, the highest average density of Chlorophyceae was noticed in premonsoon season (275.30/l) while, low incidence was recorded in monsoon season (80.08/l). Moderate density (234.77/l) was observed during postmonsoon season. During premonsoon season, 7 species of Chlorophyceae were recorded. *Pediastrum duplex*, *Arthrodesmus menoides*, *Tetraedron proteiforme* and *Clamydomonas* sp. were not observed at any station. *Ankistrodesmus falcatus* was the most abundant species recorded from the reservoir during this season which constituted 50.41% of total Chlorophyceae. During monsoon season, only 2 species of Chlorophyceae - *Ankistrodesmus*
Ankistrodesmus falcatus and Chlorella vulgaris - were recorded from the reservoir. Ankistrodesmus falcatus was the most abundant species in this season which constituted 71.22% of total Chlorophyceae. During postmonsoon season, all the 11 species of Chlorophyceae were observed in the reservoir. Like other seasons, Ankistrodesmus falcatus was the most abundant species recorded in this season with a contribution of 38.18% of total Chlorophyceae.

The Bacillariophyceae group was represented by 11 species (9 genera) viz, Fragilaria virescens, Navicula cuspidata, Navicula sp., Melosira granulata, Cyclotella bodanica, Cyclotella meneghiniana, Pinnularia acrosphaeria, Amphora ovalis, Diatoma vulgare, Stauroneis phoenicenteron and Asterionella Formosa in the reservoir. The most dominant species among Bacillariophyceae was Cyclotella bodanica (28.48%). Seasonwise analysis showed that the highest average density of Bacillariophyceae was recorded in premonsoon season (224.47/l) whereas the lowest was noticed in monsoon season (61.15/l). It was moderate (203.41/l) during postmonsoon season.

During premonsoon season, 10 species of Bacillariophyceae were recorded in the reservoir. Cyclotella bodanica was the most abundant species recorded in this season which constituted 29.25% of total Bacillariophyceae. During monsoon season, only 3 species of Bacillariophyceae (Navicula cuspidata, Melosira granulata and Cyclotella bodanica) were recorded in the reservoir. Cyclotella bodanica was the most abundant species in this season which constituted 46.28% of the total Bacillariophyceae. During postmonsoon season, all the 11 species of Bacillariophyceae were recorded in the reservoir and Cyclotella bodanica was the most abundant species, which constituted 22.29% of total Bacillariophyceae.

Desmids were represented by 8 species in 4 genera viz, Euastrum ansatum, Closterium sp., Staurastrum dentatum, Staurastrum tohopekaligense,
Staurastrum sp., Cosmarium supergranatum, Cosmarium viridis and Cosmarium subtumidum. The most dominant species among this group was Staurastrum tohopekaligense (48.76%). Highest density of Desmids was registered in premonsoon season (137.70/l), low incidence was recorded in monsoon season (51.70/l) and moderate density 132(.63/l) was in postmonsoon. During premonsoon season, 7 species of Desmids were recorded from the reservoir, Cosmarium subtumidum was not observed at any station. Staurastrum tohopekaligense was the most abundant species recorded in this season which constituted 52.65% of total Desmids. During monsoon season, Desmids group was represented by only 2 species - Staurastrum dentatum and Staurastrum tohopekaligense - in which Staurastrum tohopekaligense was the most abundant which constituted 63.62% of total Desmids. In the reservoir, all the 8 species of Desmids were observed during postmonsoon season (Table 4.2). Staurastrum tohopekaligense was the most dominant species which contributed 38.92% of the total Desmids.

The group Cyanophyceae was represented by 5 species belonging to 5 genera, viz., Aphanocapsa sp., Croococcus turgidus, Oscillatoria sp., Nostoc linckia and Anabaena sphaerica. The most dominant species among Cyanophyceae was Oscillatoria sp. (59.22%). The highest average seasonal density of Cyanophyceae was noticed in premonsoon season (76.05/l) whereas the low density was recorded in monsoon season (24.58/l). Moderate density of 64.62/l was observed during postmonsoon season. Four species of Cyanophyceae (except Croococcus turgidus) were recorded in the reservoir during premonsoon season. Oscillatoria sp. was the most abundant species in this season which constituted 55% of the total Cyanophyceae. During monsoon season, only one species - Oscillatoria sp. - was recorded from the reservoir. During postmonsoon season, four species of Cyanophyceae (except
Anabaena sphaerica) were recorded from the reservoir. Oscillatoria sp. was the most abundant species in this season and it constituted 48.67% of the total Cyanophyceae.

The group Dinophyceae was represented by only 2 species belonging to 2 genera viz, Ceratium hirudinella and Peridinium cinctum. The most dominant species among Dinophyceae was Ceratium hirudinella (69.32%). Total Dinophyceae in the reservoir was found to be high in premonsoon season (33.78/l) but was not recorded in monsoon season. During postmonsoon season the density of this group was found to be 27.13/l. During premonsoon season, Ceratium hirudinella and Peridinium cinctum were observed in the reservoir. Ceratium hirudinella constituted 66.79% of total Dinophyceae. Ceratium hirudinella and Peridinium cinctum were recorded in the reservoir during postmonsoon, Ceratium hirudinella was found to be more (72.47%) in this season.

Four different groups such as Rotifera, Copepoda, Cladocera and Ostracoda were represented the zooplankton community in Idukki reservoir during the present study. 19 species belonging to 14 genera of zooplankton and Nauplii were identified, of which 7 species (5 genera) belongs to Rotifera, 6 species (4 genera) belongs to Cladocera, 5 species (4 genera) and Nauplii belongs to Copepoda and 1 (1 genera) belongs to Ostracoda. A total zooplankton number of 319.68/l was recorded in the reservoir and the Copepoda constituted the largest group in terms of number of organisms/l (114.45/l) making the average percentage composition of 35.80% in total zooplankton population. It was followed by Rotifera (111.89/l), Cladocera (83.86/l) and Ostracoda (9.48/l). The groups such as Rotifera, Cladocera and Ostracoda constituted 35%, 26.23% and 2.97% respectively of the total
zooplankton. Among zooplankton, *Nauplius* larva was the most abundant (51.50/l) constituting 16.11% of the total zooplankton in the reservoir.

The average density of zooplankton in the reservoir was observed high during premonsoon season (123.36/l) and low during the monsoon (76.74/l). Moderate density was observed during postmonsoon season (119.58/l) throughout the investigation period. The higher summer population densities of zooplankton in Idukki reservoir was coincided with the peak of phytoplankton density, high temperature and low rain fall. During premonsoon season, the most dominant group observed in the reservoir was Copepoda (59.45/l), which constituted 48.19% of the total zooplankton. Rotifera was the second dominant group with the number 53.63/l and it contributed 43.48%. Cladocera and Ostracoda were contributed very less population density in this season and they represented only 6.35/l (5.14%) and 3.93/l (3.19%) respectively. A total of 15 species and *Nauplii* were recorded in this season and the most dominant species was *Keratella tropica* (20.10%).

In monsoon season, Ostracoda were not recorded in the reservoir. Cladocera was the most dominant with the number of 49.66/l and it contributed about 64.69% of the total zooplankton population in this season. It was followed by Copepoda (19.53%) and Rotifera (15.75%) with the density of 14.99/l and 12.09/l respectively. 10 species of zooplankton and *Nauplius* larvae were observed in this season and the most dominant species was *Daphnia pulex* (19.32%). During postmonsoon season, all the 4 groups were recorded in the reservoir. Rotifera was the dominant group (46.17/l) and contributed 38.61% of the total zooplankton. This group was followed by Copepoda (40/l) represented 33.46%, Cladocera (27.85/l) contributed 23.29% and Ostracoda (5.55/l) made up only 4.64% of the total zooplankton. 17
species and Nauplii were recorded in this season from the reservoir and Nauplius larvae were found to be dominant (12.76%) among zooplankton.

The study showed that species richness was high during postmonsoon, low in monsoon and moderate in premonsoon season. The Margalef's richness value and Shannon-Weiner diversity index (H’) were also recorded high during postmonsoon season, whereas it was low during monsoon season and moderate during premonsoon season. The high species diversity and richness observed during postmonsoon season may be due to the suitable environmental factors, ample food resources and high water spread in the reservoir. Pielou’s evenness value was found to be relatively high during monsoon season, low during premonsoon and moderate during postmonsoon in the reservoir. High species evenness in monsoon may be due to the high water spread and wind action. Total zooplankton and the groups Copepoda, Rotifera and Ostracoda were showed positive correlation with atmospheric temperature, water temperature, transparency, electrical conductivity, TDS, pH, free CO₂, total alkalinity, chloride, total hardness, calcium, magnesium, COD, BOD, sodium, potassium, sulphate, phosphate and iron whereas negatively correlated with turbidity, DO and nitrate. Cladocera group were positively correlated with turbidity, DO and nitrate. They showed negative correlation with atmospheric temperature, water temperature, transparency, electrical conductivity, TDS, pH, free CO₂, total alkalinity, chloride, total hardness, calcium, magnesium, COD, BOD, sodium, potassium, sulphate, phosphate and iron.

The group Copepoda was represented by 5 species belonging to 4 genera and Nauplius larvae in the reservoir. They were Mesocyclops leuckarti, Mesocyclops sp., Tropocyclops prasinus, Heliodiaptomus viduus and Diaptomid calanoid. The most dominant among Copepoda was Nauplius
larvae (41.32%). During premonsoon season, all the 6 species and Nauplius larvae were observed in the reservoir. Nauplius larvae were the most abundant in this season which constituted about 41.31% of total Copepoda. During monsoon season, only 2 species of Copepoda (Mesocyclops leuckarti and Nauplius larvae) were recorded and the most dominant was Nauplius larvae (77.92%). During postmonsoon season, the species Heliodiaptomus viduus was not recorded in the reservoir. The Nauplius larvae were the most abundant among Copepoda in this season, which constituted 38.14% of total Copepoda.

Rotifera was represented by 7 species belonging to 5 genera, such as Brachionus falcatus, Brachionus forficula, Brachionus caudatus, Filinia longiseta, Polyarthra sp., Keratella tropica and Lecane sp. The most abundant species among Rotifera was Keratella tropica (12.41%). During premonsoon season, all species except Lecane sp. were recorded in the reservoir. Keratella tropica was the dominated species in this season which constituted 46.22% of total Rotifera. During monsoon season, only 3 species of Rotifera were recorded in the reservoir. Brachionus falcatus was the most dominant species in this season which constituted 49.38% of total Rotifera. During postmonsoon season, all the 7 species of Rotifers were observed in the reservoir and Keratella tropica was the dominant species (32.23%). Cladocerans were represented by Daphnia carinata, Daphnia pulex, Ceriodaphnia cornuta, Moina brachiata, Moina micrura and Alona pulchella in the reservoir. The species Daphnia pulex was the dominant among the Cladocera with 36.06%. During premonsoon season, only three species (Daphnia carinata, Daphnia pulex and Ceriodaphnia cornuta) were recorded in the reservoir with Daphnia pulex (4.32/l) as the chief component. Cladocera group was found abundantly in monsoon season with an average number of 49.66/l, which contributed 64.69% of total zooplankton. During monsoon season, Cladocera group was
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represented by all the 6 species and the dominated species was *Daphnia pulex* (29.86%). During postmonsoon season, 5 species of Cladocerans (except *Alona pulchella*) were observed in the reservoir with *Daphnia pulex* as the dominated species constituting 39.82%. Only one species of Ostracoda (*Stenocypris* sp.) was recorded in the reservoir during the investigation period. *Stenocypris* sp. was recorded its highest count with 5.55/l in postmonsoon season and the lowest density of 3.93/l in premonsoon season. They were not recorded in monsoon period in the reservoir.

In the present study, total 19 species of fish belonging to 18 genera, 11 families and 6 orders were recorded in the reservoir. Cypriniformes, Siluriformes, Atheriniformes, Perciformes, Channiformes and Mastacembeliformes were the 6 orders and in which Siluriformes were represented by 4 families, Cypriniformes and Perciformes were comprised of 2 families each, whereas other orders were represented by single family each. The family Cyprinidae was found to be the most diverse, represented by 9 species and the remaining families were represented by a single species each. The fish recorded from the Idukki reservoir were *Aplocheilus lineatus*, *Barilius bakeri*, *Catla catla*, *Channa gachua*, *Cirrhinus cirrhosa*, *Clarias batrachus*, *Cyprinus carpio*, *Heteropneustis fossilis*, *Labeo rohita*, *Mastacembelus guentheri*, *Mystus vittatus*, *Nemacheilus rupecola*, *Ompok bimaculatus*, *Oreochromis mossambicus*, *Parambassis dayi*, *Puntius melanampyx*, *Puntius vittatus*, *Rasbora daniconius* and *Tor khudree*.

The average number of fish (abundance) obtained from the reservoir during the 3 years of study showed that the species *Ompok bimaculatus* recorded the highest catch with the number of 387/year, followed by *Cirrhinus cirrhosa* with number 355/year and *Oreochromis mossambicus* with the average number of 148/year. The species *Ompok bimaculatus* also
predominated as per relative abundance (20.05%) followed by *Cirrhinus cirrhosa* (18.34%) and *Oreochromis mossambicus* (7.62%). In Idukki reservoir, *Channa Gachua* recorded the highest biomass of 143.91 kg/year during the three years of study and it was followed by *Tor khudree* (81.66 kg/year) and *Cyprinus carpio* (69.04 kg/year). The relative biomass of *Channa Gachua, Tor khudree* and *Cyprinus carpio* was 34.08%, 19.34% and 16.35% respectively.

ANOVA showed significant variation while comparing the mean abundance of fish obtained in different seasons. Premonsoon season recorded the highest abundance of fish with the number of 863 followed by postmonsoon (613 nos) and the lower abundance was registered in monsoon (458 nos). The abundance of fish species in the dry season may be due to the reduced water level, high rate of transparency and increased availability of food. During premonsoon season, *Ompok bimaculatus* was the most dominant species with the number of 225. During monsoon season also, *Ompok bimaculatus* was the most dominant species in the reservoir with the number of 66. During postmonsoon season, *Cirrhinus cirrhosa* was most abundant with the average number of 125. While comparing the relative abundance of fish obtained in different seasons premonsoon season contributed 44.62% of the total fish catch followed by postmonsoon (31.70%) and monsoon season recorded the lowest (23.68%). During premonsoon *Ompok bimaculatus* recorded the highest value of 26.09%. In monsoon season also *Ompok bimaculatus* registered with the highest abundance of 14.43%. During postmonsoon season *Cirrhinus cirrhosa* recorded the highest relative abundance of 20.36%.

Monsoon season recorded the highest biomass (204.51 kg) whereas premonsoon and postmonsoon seasons showed more or less similar values.
with 111.96kg and 101.79kg respectively. *Channa gachua* recorded the highest biomass in all seasons with 80.47 kg in monsoon, 33.16 kg in premonsoon and 30.28 kg in postmonsoon. While comparing the relative biomass of fish obtained in the three seasons, monsoon season recorded the highest biomass (48.43%) followed by premonsoon with 27.46% while postmonsoon recorded 24.11%. *Channa gachua* contributed the highest biomass in all seasons with 39.35% in monsoon, 29.75% in postmonsoon and 28.60% in premonsoon.

Species richness showed more or less similar values in 3 seasons with slight higher values during postmonsoon. Margalef’s richness index values recorded high values during monsoon and postmonsoon season than that recorded during premonsoon season. The Shannon-Weiner diversity values showed both postmonsoon and monsoon seasons recorded higher values than that recorded at premonsoon. The Pielou’s evenness values were observed high during monsoon season in the reservoir. Evenness values were low during premonsoon season and moderate during postmonsoon season. The high diversity index (Shannon-Weiner, species richness and Margalef’s richness) observed during postmonsoon and monsoon may be due to the sufficient water and food resources whereas the low diversity recorded during premonsoon may be due to the shrinkage of the water spread in the reservoir. The high evenness recorded during monsoon season may be due to the high water spread and distribution in this season.

### 7.2 Recommendations

1. The present results will serve as an authentic database for further studies in the Idukki reservoir.
2. Being the largest reservoir in Kerala, Idukki reservoir can be turned as the important fish production site in the state.

3. There is a need to have appropriate policy and guidelines on fish stocking and other management measures with strict monitoring of size at stocking and harvesting.

4. A holistic approach may be followed involving various departments and user groups such as KSEB, forest, irrigation, agriculture, fisheries and environment to provide congenial conditions for fisheries.

5. Recognizing fisheries as a mandatory activity in reservoir, steps should be taken for the effective management and adoption of natural options for stock and species enhancement of reservoir fisheries including the pens and cages.

6. Since fishing rights in Idukki reservoir is given only to the tribal community living nearby the reservoir, steps should be taken to organize this tribal community by forming a Cooperative Society for the fisheries development of the reservoir and in improving the socio-economic condition of the member fishermen.

7. The state government should provide sufficient funds to the Society to enable them to run the Society and to procure modern crafts and operate good quality nets.

8. A small well equipped field laboratory may be established at Idukki reservoir for monitoring the productivity, hydrobiological parameters and other ecological conditions of the reservoir. The data on the stocking of fish seeds, fish production and socio-economic conditions of fishermen should also be maintained by the laboratory.