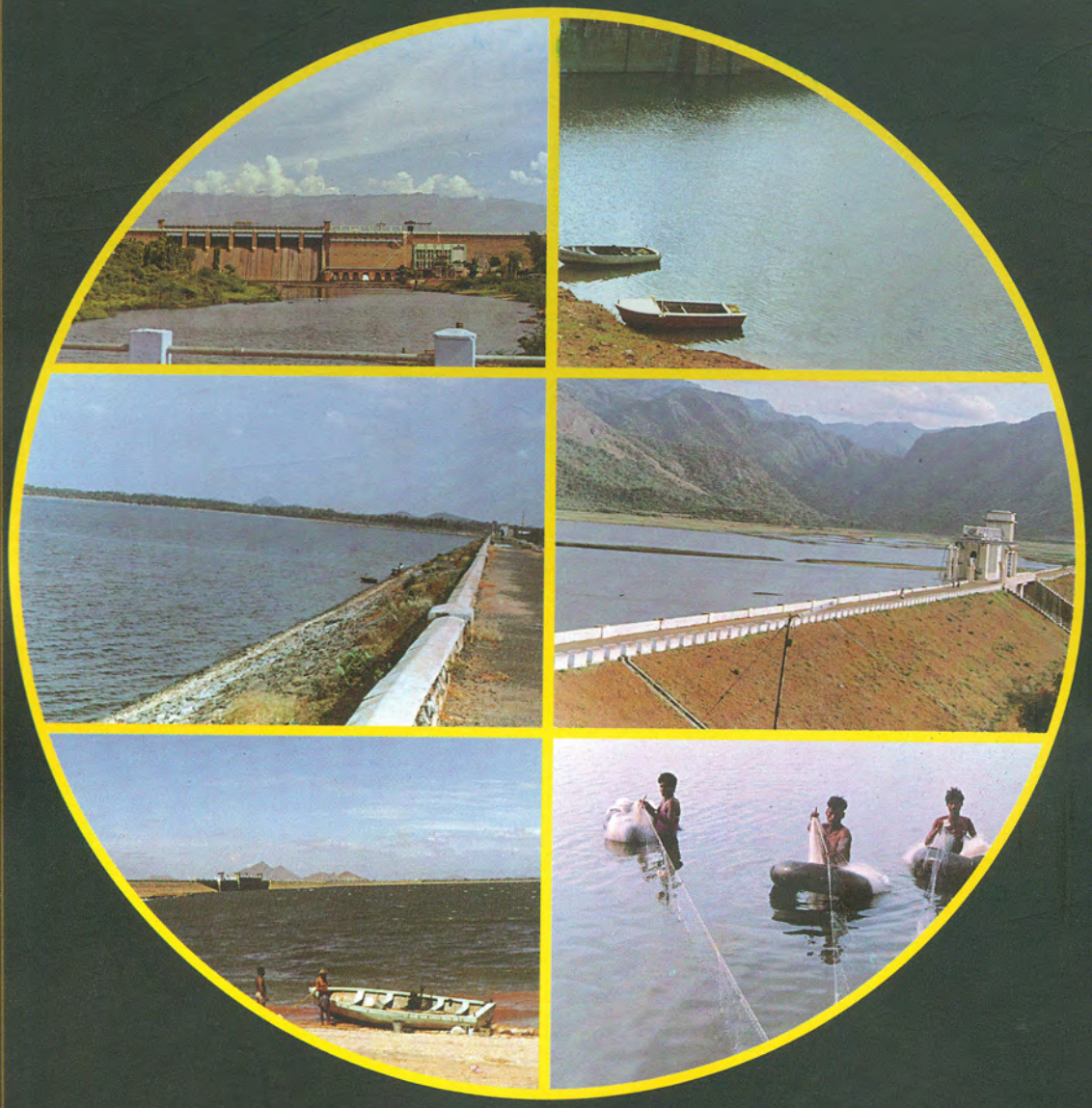
Ecology and Fisheries of Selected Reservoirs in Tamil Nadu



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ECOLOGY AND FISHERIES OF SELECTED RESERVOIRS IN TAMIL NADU

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Foreword

Reservoirs constitute the most important inland fisheries resource in India. At present, the country has more than three million ha of man-made impoundments, created primarily for irrigation, power generation, industrial water supply and a variety of other purposes. However, those water bodies are equally important from a fisheries perspective. In view of the increasing demand for the water, more and more reservoirs are being created throughout the country. The area is expected to double in ten years. Apart from the sheer magnitude of the resource, the importance of reservoirs as a fisheries resource, stems from the fact that they are amenable for various forms of enhancement. Enhancement technologies have a significant role to play in the inland fisheries scenario of India. Enormous quantity of fish can be produced from reservoirs with low investment and minimum environmental degradation by practicing enhancement. It has been estimated that 1.5 lakh t of additional fish can be produced from reservoirs by marginally increasing the yield rates through enhancements. Reservoir fishery is also relevant from the socioeconomic point of view. Yield hike achieved through technological upgradation is equitability distributed among large number of fishers in reservoirs. Thus, reservoirs offer scope for growth with equity, making an ideal tool for achieving nutritional and food security for one of the weakest sections of our society.

Shri V. K. Murugesan and his team of Scientists at Coimbatore have done a commendable job in surveying 19(nineteen) reservoirs of Tamil Nadu and creating a wealth of valuable data and information. Productivity of the reservoirs depends upon the combined effect a number of abiotic and biotic factors. Studies on these factors and assessment of biological production potential of the reservoirs are the essential pre-requisites for developin fisheries management norms. The current investigations have helped to update our database of ecology and fisheries of reservoirs. I am confident that the management guidelines suggested in this bulletin will be very useful to the fishery managers in the country in general and Tamil Nadu in particular.

I place on record the valuable cooperation received from the officials of the Department of Fisheries, Government of Tamil Nadu and the Tamil Nadu Fisheries Development Corporation for conducting the studies. Thanks are also due to the officials of the Public works department for providing morphometric and meteorological date.

Director
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1. INTRODUCTION

Tamil Nadu state is situated on the eastern side of the southern tip of the Indian peninsula. It has two major regions (i) the eastern coastal plain and (ii) the hilly terrain (the Western Ghats) in the west and the north. The hilly ranges of the Western Ghats acquire names such as the Nilgiris, Palani and Anaimalai in different regions. The slopes of these hills are rain-fed and many east flowing rivers originate from here. The Cauvery, which is the largest river system of the state, springs from Brahmagiri hills in the Western Ghats of Karnataka, flows South-eastward direction in Karnataka and Tamil Nadu, and finally enters into the Bay of Bengal. The Bhavani, the Noyyal and the Amaravathi are the main tributaries joining the Cauvery. The other important rivers, which have sizeable water potential, are Palar, Penniar, Vellar, Vaigai, Vaippar, Chittar and Tambaraparani. In addition, there are more than 23 seasonal rivers and streams. Apart from these east flowing rivers, there are a few west flowing rivers such as Mullaiperiyar, Nirar, Parambikulam, Sholaiyar and Aliyar (Fig. 1). The water potential of all these rivers depends on the rainfall during the southwest and northeast monsoon, which are restricted to a short period of the year. It is therefore essential to conserve the runoff rainwater for effective utilization during the pre- and post-monsoon period.

Tamil Nadu is harnessing its water resources by constructing multi-purpose river projects. The Periyar dam was the first one constructed in the then Madras Presidency between 1887 and 1895 to divert water from West to East in a trans-basin. A few more reservoirs had been constructed during British rule. Mettur dam was the highest masonry structure in Asia and the largest in the World at the time of its construction (1929-34) across the river Cauvery. After independence, as many as 67 big, medium and small dams have been constructed through five-year plans. In addition to river valley projects, thousands of small reservoirs (major and minor tanks) have also been created by several agencies at different periods of time. A recent enumeration reveals the existence of 69 reservoirs with a total water spread area of 58452 ha, 8837 major irrigation tanks with a combined area of 300278 ha and over 38000 minor tanks and ponds whose area has not been assessed exactly (Sugunan, 1995).

Apart from their utility in irrigation, power generation, domestic and industrial requirements, the reservoirs are the most important inland fishery resources, offering great scope for both culture and capture fishery activities. The state with the tropical climate with optimum temperature and bright sunshine is normally expected to be conducive for higher biological production, including fish production. However, the actual yield of fish from these vast resources has been disappointingly low. As it has been observed by several authors, assessment of biological potential of the reservoirs, which have separate ecological entity with their own production processes, is a pre-requisite for fisheries management and development. In order to assess the production potentialities of the reservoirs in Tamil Nadu, investigations on the ecology and fisheries of selected reservoirs located in different river basins have been carried out through a rapid survey. In the light of this study, guidelines for better management of the resources have been suggested.

2. RESERVOIRS SELECTED FOR INVESTIGATIONS

Extensive studies on the ecological aspects and fisheries of certain reservoirs in Tamil Nadu such as Mettur, Bhavanisagar, Sathanur, Aliyar and Thirumoorthy have already been made by several workers (Ganapathy, 1955, Sreenivasan 1966,1969 and Selvaraj *et al.*, 1997,2000). Exempting the above reservoirs, nineteen partially studied reservoirs *viz.* Parambikulam, Thoonakadavu, Peruvaripallam, Amaravathi, Palar-Poranthalar, Uppar, Pilloor, Gunderipallam, Varattupallam, Sandynulla, Vaigai, Vembakottai, Manimuthar, Pechiparai, Krishnagiri, Vidur, Willington, Odathurai and Orathupalayam located in different river basins have been selected for the present rapid survey (Fig.2).

3. SAMPLING PROCEDURE:

The survey was conducted at quarterly intervals and the nineteen reservoirs under three batches were investigated during 1996-2000. Each reservoir represented once with four samplings per annum. The basic data on the rainfall, morphometry and hydrology of the reservoir were collected from the Public Works Department. The fisheries data were obtained from the fishery authorities concerned. Sampling and analysis for water and soil quality, biotic communities and primary productivity were carried out following standard methods (APHA, 1980 and Subhas Chandra Bose, 1998). Nitrate, Ca, Mg and hardness content of water were estimated only for a few reservoirs.

4. LOCATION, MORPHOMETRY AND HYDROLOGY OF THE RESERVOIRS

The reservoirs in Tamil Nadu selected for the present rapid survey based on their geographic location may be broadly categorized as follows:

1. River valley projects with their catchment area in Western Ghats have been built for the prime purpose of power generation. In this category, Parambikulam, Thoonakadavu, Peruvaripallam and Pilloor are hydel projects, whereas Pechiparai and Manimuthar are meant for flood control as well as for irrigation purpose. Save for Thoonakadavu and Peruvaripallam, these reservoirs are perennial and deep by virtue of their being located in the high rainfall regions.

2. Reservoirs situated in the rain shadow, plateau region, are shallow to medium depth and they are constructed for the dual purpose of irrigation and domestic use. Krishnagiri, Palar-Poranthalar, Uppar, Amaravathy, Gunderipallam, Varattupallam, Vaigai, Odathurai and Orathupalayam fall under this group.

3. Dams built in the terrain of the tableland with similar aim of plateau reservoirs are highly seasonal and shallow impoundments. They are Vidur, Willington and Vembakottai.
4. Sandynulla, situated in Nilgiri hills is a cold water reservoir created for flood control.

Among these reservoirs, Parambikulam, Vaigai, Pechiparai, Krishnagiri and Willington are medium reservoirs (1000 to 5000 ha) and the remaining are small reservoirs (< 1000 ha). These multipurpose river projects, built either across the main rivers or their tributaries with their water source in the Western Ghats, are situated between latitudes of 8° 29' N and 12° 30' N and longitudes of 76° 35' E and 79° 41' E at an elevation ranging from 38 to 2143 m above MSL. Parambikulam, Thoonakadavu and Peruvaripallam are built on the western slopes of the Western Ghats across the rivers flowing towards west. These dams divert the water towards east benefitting Tamil Nadu and Kerala, preventing a large amount of monsoon water hitherto going waste into the Arabian Sea.

Parambikulam, water first enters into Thoonakadavu reservoir through an unlined horse-shoe shaped tunnel of 2480 m long and then into Peruvaripallam through an open channel of 5711.5 m length. Pechiparai and Manimuthar are clear, less turbid reservoirs with catchment area of thick forest teeming with rubber estates at Pechiparai. The rest of the reservoirs are across the rivers or their tributaries originating from the eastern slopes of the Western Ghats. Amaravathy, Palar-Poranthalar, Uppar, Gunderipallam, Krishnagiri, Varattupallam, Odathurai and Orathupalayam are located on the Cauvery basin, whereas Vaigai on Vaigai river. Vaigai dam is an integral part of Periyar hydro-electric scheme and also an extension of the existing Periyar irrigation system. Odathurai, a small productive reservoir with 5680 ha of catchment area, is being enriched with the runoff from the surrounding paddy fields which are pressed into service of intensive cultivation. Orathupalayam reservoir across Noyyal river is alarmingly polluted due to effluents generated from hundreds of textile, dyeing and bleaching units located in and around Tirupur town. Vidur and Willington depending mostly on the northeast monsoon for their water source are under constant threat of drying up due to monsoon failure.

The salient features of morphometry and hydrology of reservoirs are given in Table-1. Among these reservoirs, Pechiparai is the oldest reservoir built during 1895-1906 and Orathupalayam is of recent origin constructed during 1986-94. Vaigai is the largest reservoir (2419 ha) and Gunderipallam is the smallest reservoir (61 ha). However, the gross capacity of Parambikulam is the highest (504.66 M.cu.m), followed by Vaigai (192.57 M.cu.m), Manimuthar (156.07 M.cu.m) and Pechiparai (150.26 M.cu.m). Odathurai has the least gross capacity of 1.28 M.cu.m. Krishnagiri has the highest catchment area of 542843 ha followed by Vaigai (225330 ha), Orathupalayam (221555 ha), Vidur (129800 ha) and Pilloor (119140 ha). Peruvaripallam has the minimum catchment area (1580.0 ha), followed by Vembakottai (2691 ha). Higher values of the ratio of catchment area to the reservoir area (C/A) in case of Orathupalayam(532.7),Krishnagiri(434.9),Vidur(162.7),Uppar(199.5),Gunderipallam(118.4), Amaravathy (98.7), Varattupallam(75.0) and Palar-Poranthalar(50.0) indicate the possibilities of higher allochthonous inputs into these reservoirs. The allochthonous inputs are expected to be very low in Peruvaripallam (5.4), Vembakottai (5.8) and Willington 8.3, as the values of the C/A ratio of these reservoirs are low.

5. ECOLOGY OF THE RESERVOIRS

Reservoir productivity largely depends on the climatic, the edaphic and the hydrological characteristics. Among the climatic and meteorological factors, the atmospheric air temperature and the rainfall play an important role in altering the productivity of the reservoirs.

5.1 Atmospheric air temperature:

The air temperature regulates the thermal budget of the reservoirs, which in turn influences the biological activities of the biota therein. The air temperature at the reservoirs ranged from 16.5° to 33.0° C. The minimum values were often recorded during November to January with mild cold weather prevailing in the state. Similarly, higher values of air temperature were encountered during April to July or September to October when hot weather conditions occur. The moderately higher air temperature recorded at these reservoirs influenced water temperature, favouring higher biological production. The air temperature was minimum (16.5° C to 24.0° C) at Sandynulla reservoir located in the Nilgiri hills at an elevation of 2143 m above MSL.

5.2 Rainfall:

The state receives rainfall due to two rain-bearing winds, the southwest monsoon (June – September) and the northeast monsoon (October – December). The northeast monsoon is more important to the state than the southwest monsoon in contrast to the rest of the country where southwest monsoon brings heavy downpour. Parambikulam, Thoonakadavu, Peruvaripallam, Pechiparai, Pilloor and Krishnagiri located in the thick forest regions of the Western Ghats received more rainfall (1038.4–2046.2 mm) mainly due to southwest monsoon. Amaravathy, Palar-Poranthalar, Vaigai, Vembakottai and Manimuthar in the rain shadow region of the Western Ghats enjoyed a medium rainfall ranging from 736.1 to 991.0 mm. Uppar reservoir situated in the central region received the least rainfall of 583 mm. Vidur and Willington reservoirs in the coastal region received a higher rainfall of 1692.1 and 1795.5 mm respectively mainly due to northeast monsoon during the survey period. Water level in the reservoirs fluctuated depending upon the rainfall in the catchment areas.

5.3 Reservoir depth:

It is generally believed that the depth of the reservoir influences the productivity and that shallow reservoirs are more productive than the deeper ones. The mean depth calculated from the gross capacity and area of the reservoir at FRL for the reservoirs ranged from 1.57 m in Odathurai to 24.3 m in Parambikulam. Though the mean depth of Thoonakadavu and Peruvaripallam was less, they received water from Parambikulam and hence, they did not dry up during summer. However, reservoirs such as Palar-Poranthalar, Uppar, Gunderipallam, Varattupallam, Vaigai, Vembakottai, Vidur, Willington, Odathurai and Orathupalayam with low mean depth were often subject to drought induced water stress.

Shallow reservoirs faced large amplitude of water level fluctuations, which was the primary factor determining its ecological status.

5.4 Inflow and discharge:

The inflow and discharge of water indicate the flushing rate, which regulates the productivity. Among the reservoirs studied, the flushing rate was highest (91.84) in Krishnagiri and lowest (0.55) in Sandynulla.

6. SOIL QUALITY

In aquatic ecosystems, the sediments are in a complex mileau with the overlying water. They influenced the water chemistry and vice versa. In the present study, the major chemical characteristics of the soil from the reservoirs were investigated (Table-2), as the quality of the soil had a direct bearing on reservoir productivity.

6.1 Potentia hydrogenii (pH):

The pH of the soil is the measure of the H^+ions activity and largely depends upon the relative amounts of adsorbed H^+ and metallic ions. The soil pH was acidic at Parambikulam (5.95), Sandynulla (6.31), Vaigai (5.9), Vembakottai (6.05), Manimuthar (6.04), Pechiparai (5.75), Vidur (6.27) and Willington (6.25) and hence these reservoirs may be classified as low productive ones following Jhingran (1990). Reservoirs with soil pH ranging from 6.5 to 7.5 (circum-neutral pH) are categorized as medium productive ones, which include Thoonakadavu, Amaravathi, Peruvaripallam, Palar-Poranthalar and Pilloor. Reservoirs with alkaline soil having a pH exceeding 7.5 are considered highly productive and this category includes Uppar (7.52), Gunderipallam (7.75), Varattupallam (7.83), Odathurai (7.95) and Orathupalayam (8.18).

6.2 Electrical conductivity:

Conductivity is the measure of the current carrying capacity indicating the presence of soluble salts in the soil. The electrical conductivity of the reservoirs ranged from 0.20 to 0.72 (mmhos/cm). The mean value of electrical conductance of the soil was high in Willington (0.72 mmhos/cm), Manimuthar (0.68 mmhos/cm), Gunderipallam (0.68 mmhos/cm), Odathurai (0.67 mmhos/cm), Vidur (0.67 mmhos/cm) and Orathupalayam (0.65 mmhos/cm) reflecting their higher productivity.

6.3 Macronutrients:

The available nitrogen and phosphorus contents of the bottom soil are considered the most essential macronutrients in influencing the productivity of the reservoir.

6.3.1 Available Nitrogen:

The available nitrogen content of the bottom soil from Thoonakadavu, Peruvaripallam, Amaravathy, Palar-Poranthalar, Uppar, Gunderipallam, Varattupallam and Pechiparai was more than 25 mg, but less than 60 mg per 100g. Hence, these reservoirs belonged to medium productive category (Jhingran, 1990). The other reservoirs had to be included in low productive category, as they contained less than 25 mg available nitrogen/100 g soil.

6.3.2 Available Phosphorus:

Phosphorus tends to get precipitated at higher concentration and it is lost to the sediment. Unlike carbon and nitrogen , phosphorus cycle is a long one and it takes many years for recycling. As such the soil samples from the reservoirs excepting Gunderipallam contained less than 3.0 mg of available phosphorus/100g. Hence, they are considered to be less productive. P was a limiting factor in these reservoirs. Gunderipallam, a medium productive reservoir, recorded available phosphorus content of 3.12 mg/100g.

6.4 Organic carbon:

It is estimated that more than 70 % of organic matter entering into the sediment of the reservoir comes from autochthonous source and that macrophytes are the major source of organic matter, which amounts to 1.5 to 2.5 times than that of phytoplankton. The organic carbon content of Thoonakadavu, Parambikulam, Gunderipallam and Varattupallam was appreciably high (>3%). However, the sediments of Uppar (0.39 %), Manimuthar (0.45 %) and Vidur (0.44 %) contained very low percentage of organic carbon. The rest of the reservoirs recorded 0.51 to 2.85 % of organic carbon in the soil.

7. WATER QUALITY

7.1 Physical features

As the reservoirs surveyed are located in tropical region of the country, the air and water temperatures are in the optimum range, favouring higher biological activities. The various parameters analyzed concerning water quality are given in Table -3.

7.1.1 Water temperature:

Temperature an intensity aspect of heat energy influences the various stages of life activities. Temperature fluctuation of aquatic habitat in peninsular India is not more conspicuous compared to that of North India. The average surface temperature of the reservoirs located in the plain lands ranged from 25.2 to 30.5 ^{0}C. Lower water temperature of 12.1 ^{0}C was recorded at Sandynulla reservoir. Annual difference in epilimnetic water temperature varied from 0.7 ^{0}C (Orathupalayam) to 6.5 ^{0}C (Amaravathy).

7.1.2 Transparency:

The intensity of light penetrating through water media is screened by suspended particles, plankton, silt, clay and colloids. During the period of survey, the secchi disc visibility was only 17 cm at Uppar reservoir. It was due to the combined effect of suspended particles and plankton abundance. The reservoir was dry during part of the year. The transparency of water extended beyond 100cm in Thoonakadavu, Peruvaripallam, Amaravathy, Palar-Poranthalar, Pilloor, Manimuthar and Pechiparai, as their waters were clear and less turbid. Reservoirs with moderate mean depth (Gunderipallam, Varattupallam, Sandynulla, Vaigai, Vembakottai, Krishnagiri, Vidur, Willington, Odathurai and Orathupalayam) exhibited relatively lower value (< 100 cm) of secchi disc reading. Though the mean depth of Sandynulla reservoir was 10.44 m, the visibility was only 79 cm which could be attributed to the turbidity of the water due to algal bloom. The effluents discharged from Protein Product Industry located adjacent to the reservoir supplied nutrients to the algae. Transparency values depend upon the turbidity produced by various elements, which is well illustrated in the data analysis. Transparency is negatively correlated with total alkalinity, silicate and electrical conductivity of the soil. Minimum transparency was recorded during Southwest monsoon period (July–September) in Parambikulam, Thoonakadavu, Peruvaripallam, Palar-Poranthalar, Gunderipallam and Varattupallam which may be ascribed to suspended particles brought in by the runoff rain water combined with profuse growth of plankton.

7.2 Chemical features:

7.2.1 Dissolved oxygen (D.O.):

The oxygen contents of the surface water remained sufficiently high (5.26 to 8.65 ppm) in all the reservoirs surveyed. The turbulence occurring at the top layer of water and direct diffusion of atmospheric air kept the water at higher concentration of oxygen. The seasonal variation in oxygen content in water was minimal (0.4 to 3.3 ppm) in all the reservoirs excepting Parambikulam where it was maximum (4.8 ppm). This vital gas was below the desirable level at the bottom layers in certain reservoirs such as Gunderipallam (1.2 ppm in September), Varattupallam (1.6 ppm in September) and Palar-Poranthalar (2.6 ppm in March). The low content of dissolved oxygen in water is bound to create stress for the biotic communities including fish fauna.

7.2.2 Free carbon dioxide (Free CO_2):

Free carbon dioxide, which is essential for synthesis of carbohydrate through photosynthetic activities, was present in small quantities (1.0 to 5.2 ppm) in Parambikulam, Thoonakadavu, Peruvaripallam, Amaravathy, Palar-Poranthalar and Pechiparai reservoirs throughout the study period. This gas was absent in all the seasons in Uppar, Gunderipallam, Sandynulla, Vembakottai, Krishnagiri, Vidur, Willington, Odathurai and Orathupalayam reservoirs. In the absence of this gas, it was drawn from bicarbonates and carbonates for carbon synthesis. The gas was present in one or two seasons and the value increased with increase in depth in the remaining reservoirs.

7.2.3 Potentia hydrogenii (pH):

The waters of Parambikulam and Thoonakadavu were slightly acidic. The other reservoirs were alkaline in nature with a pH range of 7.15 to 8.27 units. The photosynthetic activity was the most likely process capable of elevating pH. The pH of the surface water was generally higher in all the reservoirs compared to the lower water strata. Statistical analysis indicated a positive correlation between the water pH and the gross primary production (GPP).

7.2.4 Total Alkalinity (T.A.):

Alkalinity in natural water is formed primarily due to the dissolution of carbon dioxide in water forming HCO_3^- and CO_3^{--} ions. Hydrolysis of salts yielding hydroxyl (OH^-) ions also enhanced the alkalinity value. It was further enhanced due to the presence of silicates, phosphates and borates. The higher acid neutralizing capacity (>100 ppm) of the waters of Uppar, Gunderipallam, Varattupallam, Vaigai, Vembakottai, Krishnagiri, Vidur, Willington, Odathurai and Orathupalayam placed them in the category of highly productive reservoirs. The moderate alkalinity values (50 – 100 ppm) were recorded at Parambikulam, Palar-Poranthalar, Pilloor and Sandynulla. Oligotrophic tendency was observed in Thoonakadavu, Peruvaripallam, Amaravathy, Manimuthar and Pechiparai recording very low value of T.A.(<50 ppm). Total alkalinity showed positive correlation with electrical conductivity of the soil at 5 % significant level.

7.2.5 Total dissolved solids (T.D.S.):

T.D.S., T.A. and conductivity are regarded potential indices of reservoir productivity. Standing crops of various communities reflected the effect of edaphic factors as represented by the TDS content of the lakes. However, in the present study, the total dissolved solids content in many reservoirs fell below 52.5 ppm designating them as oligotrophic reservoirs. Nevertheless, the higher content of solids amounting to 289.6 ppm at Odathurai placed it into highly productive reservoir. Orathupalayam reservoir, a highly polluted one with textile effluents containing hazardous salts elevated the TDS value to 2011.2 ppm. However, from the correlation matrix analysis, it was evident that the TDS was positively related to gross primary production at 5% significant level.

7.2.6 Specific conductivity:

Conductivity is a measure to calculate the capacity to conduct the current which depends on number and kinds of ions present and their relative charge. Barring Uppar, Odathurai and Orathupalayam, the other reservoirs recorded less than 100 µmhos/cm. The high value recorded at Odathurai might be due to the fertilizers and pesticides leached from the surrounding lushy green rice fields and other ions released from sewage effluents. The higher conductivity value of 3142.5 µmhos/cm recorded at Orathupalayam may be attributed to the variety of chemicals used in textile industries which discharged the effluents into the

reservoir. It is apparent from the statistical analysis that conductivity is positively related to gross primary production at 5% significant level.

7.2.7 Nutrient status:

Nutrients enter into water system through exogenous and endogenous sources.

Phosphate: Phosphorus is considered an important element limiting algal growth. The actual concentration of phosphorus in the reservoir depends upon a number of morphometric and hydrological factors. Leaching of this nutrient from adjoining agricultural land enriches the reservoirs. Phosphorus input to reservoirs from runoff and atmospheric fallout is a function of the area of the catchment. Heavily polluted water with sewage discharge also supplies plenty of nutrients. The high phosphorous content of the most of the reservoirs listed under polytrophic may be from domestic sewage, detergents, agricultural effluents with fertilizer and industrial wastewater.

Reservoirs with phosphorus concentration between 30 and 100 µ g/l. are categorized under Eu-polytrophic. Accordingly, Parambikulam, Thoonakadavu, Peruvaripallam, Amaravathy, Palar-Poranthalar and Pilloor belonged to this category. The other reservoirs were polytrophic, as they recorded more than 100µg / l of P. Sloping field erosion may also leach phosphorus. The application of phosphorous fertilizers to P deficient soil of rubber estates may be the reason for the increasing phosphorus content of the water in Pechiparai reservoir.

Besides, high concentration of calcium and phosphorus produce amorphous compounds such as octa calcium phosphate. This chemically bound phosphorus may test as orthophosphate. The high content (0.54 ppm) of phosphorus recorded at Krishnagiri was probably due to the stronger binding capacity of the high concentration of calcium present in the water.

Nitrate : Nitrate concentration of water was low (traces) in Manimuthar. The value was (2.9 ppm) in certain seasons at Sandynulla reservoir. Nitrogen gain to the watersheds is due to ground water flow, precipitation and N_2 fixation. However, of late, modern agriculture has been identified as the major source releasing 20 - 25% of N_2 every year. In accordance, the higher nitrate value (2.7 ppm) at Odathurai reservoir coincided the time of fertilizer application in the surrounding agricultural fields.

Silicate: As silicate sources are resistant to chemical weathering, it occurs in meagre quantities in water. Solubility of silica is more at high pH and temperature. A significant relationship at 5% level was observed between the water pH and silicate content. Poor content of silicate (2.77 ppm) was noted in Parambikulam reservoir whereas, 18.9 ppm was estimated in Willington reservoir. In general, reservoirs with clear waters such as Thoonakadavu (6.8 ppm), Peruvaripallam (7.1 ppm), Amaravathy (7.5 ppm), Palar-Poranthalar (5.6 ppm), Pilloor (4.8 ppm) and Pechiparai (6.75 ppm) recorded relatively lower content of silica. Whereas, shallow and highly turbid reservoirs (Sandynulla, Vaigai,

Vembakottai, Krishnagiri, Vidur, Odathurai and Orathupalayam) contained higher content of silica (>10.8ppm). Moderate amounts of silica were recorded in Gunderipallam (8.5ppm), Varattupallam (8.4 ppm) and Manimuthar (9.52 ppm).

7.2.8 Hardness:

Excluding Manimuthar and Pechiparai, the other reservoirs recorded comparatively higher values of hardness (>77.0 ppm). It was due to interference of anthropogenic and industrial activities, sewage, sludge discharge. Parallel to this trend, calcium content was more in all the reservoirs compared to the soft waters of Pechiparai and Manimuthar.

7.2.9 Thermal and Chemical stratification:

In general, Tamil Nadu reservoirs have not exhibited any definite thermal stratification during the survey period. However, gradual and steady decrease in temperature with increase in depth was noted. However, the decrease in temperature was not very distinct. In shallow reservoirs, the temperature difference (between surface and bottom layers) was minimal ranging from 0.2° to 2.8° C. However; the difference was more pronounced (4.0° and 5.5° C) in deeper reservoirs like Pechiparai and Parambikulam during monsoon season. In Sandynulla reservoir, mercury reading increased by 0.1° C with every meter increase in depth during June (summer). Uppar, Varattupallam and Gunderipallam exhibited homothermal conditions.

Strong oxycline conditions were absent in shallow reservoirs owing to the perpetual turbulence incited by wind and wave actions. However, shallow reservoirs such as, Varattupallam, Gunderipallam, Palar-Poranthalar, Pilloor, Peruvaripallam and Krishnagiri exhibited clinograde type of oxygen profile. In these reservoirs, a clear-cut drop in dissolved oxygen was noted during monsoon and post-monsoon seasons dividing the water column into epilimnion and hypolimnion. A marked decline in oxygen content observed in Gunderipallam (Surface: 6.3, Bottom:1.2 ppm) and Varattupallam (Surface:6.4, Bottom: 1.6 ppm) indicated their higher productivity status. This may be attributed to the more oxygen demand by the abundant bottom biota and deposits of detritus. Other shallow reservoirs such as Uppar, Odathurai, Orathupalayam, Vidur and Vaigai exhibited orthograde type of oxycline conditions.

Deep and clear waters of Pechiparai and Manimuthar including Amaravathy have shown narrow difference (0.4- 2.4 ppm) between surface and bottom, reflecting the poor occurrence of photosynthetic activities in their waters. However, anoxic conditions were noted in the bottom layer of Parambikulam reservoir (Fig. 3).

8. BIOTIC COMMUNITIES

Plankton, macrobenthos and fishes are the most important biotic communities of the reservoirs. Highly diverse population of these biotic communities indicated the productivity status of the water bodies.

8.1 Plankton:

Remarkable assembleage of tropical flora and fauna formed a vital resource of food for fish in most of the reservoirs. The plankton population was dominated by phytoplankton (51.6 to 99.9 %) in all the reservoirs, except Varattupallam where it was constituted mainly by zooplankton (89.2%).

8.1.1 Phytoplankton

Quantitative analysis revealed a bloom of phytoplankton (418.1 x 10^3 Nos./l) in Odathurai. Optimum water temperature, exuberant sunshine and high T.D.S. content with adequate essential nutrients might have induced the rapid growth of phytoplankton, leading to the bloom. Sandynulla, a highly eutrophic reservoir, located in high altitude with moderate temperature also supported a rich phytoplankton throughout the study period and the annual average count was 85.3x10^3 Nos./l. The highly polluted Orathupalayam reservoir occupied the third position in the rank of phytoplankton production with an annual average of 40.5 x 10^3 Nos./l. The other productive reservoirs recorded an annual average phytoplankton ranging from 11.5 x 10^3 to 39.4 x 10^3 Nos./l. Among these productive reservoirs, Krishnagiri recorded the maximum flora (39.4 x 10^3), followed by Thoonakadavu (24.6 x 10^3), Amaravathy (23.5 x 10^3), Vembakottai (22.9 x 10^3), Vaigai (21.8 x 10^3), Peruvaripallam (15.6 x 10^3), Parambikulam (11.9 x 10^3) and Manimuthar (11.5 x 10^3). The phytoplankton counts were moderate in Palar-Poranthalar (9608 u/l), Gunderipallam (9328 u/l) and Vidur (7340 u/l), and low in Varattupallam (1463u/l), Pechiparai(2673 u/l) and Pilloor (3162 u/l). The quantitative analysis of plankton and the contribution percentage of different groups in the total plankton are shown in Table-4 and Fig.4.

Organisms belonging to chlorophyceae dominated the phytoplankton in Parambikulam (63.3%), Peruvaripallam (53.1%), Vidur (45.0%), Thoonakadavu (41.3%), Palar-Poranthalar (38.5%), Uppar (38.1%), Gunderipallam (26.2%) and Varattupallam (5.3%). Bacillariophyceae outnumbered the other families in Odathurai (90.8%), Willington (59.7%), Amaravathy (54.2%), Krishnagiri (48.6%), Pilloor (42.9%) and Vaigai (40.5%). While, myxophyceae an indicative species of eutrophication predominated in Sandynulla (57.7%), Orathupalayam (48.0%) and Vembakottai (42.4%), desmidiaceae formed the highest group in Pechiparai (56.2%) and Manimuthar (30.9%) representing oligotrophic tendency of the reservoir.

The phytoplankton concentration was more in the surface layer than in the lower strata. The phytoplankton during summer outnumbered that of during winter (Table - 5). The phytoplankton multiplied fast during monsoon in Amaravathy, Pilloor, Gunderipallam, Sandynulla, Vaigai, Vembakottai and Odathurai. It was probably due to allocthonous inputs brought in by runoff rainwater.

Qualitative analysis of phytoplankton revealed the occurrence of 18 genera in chlorophyceae, 12 genera in bacillariophyceae, 7 in myxophyceae and 2 in desmidiaceae (Table-6).

8.1.2 Zooplankton

The zooplankton count (12037units/l) outnumbered phytoplankton in all the seasons in Varattupallam and the annual average contribution of zooplankton swarms was 89.2% in the total plankton population. The other reservoirs which recorded a sizable quantity of zooplankton were Gunderipallam (8781 u/l), Palar-Poranthalar (6229 u/l) and Thoonakadavu (5866u/l). Peruvaripallam (2155 u/l), Krishnagiri (1800u/l), Vembakottai (1390u/l), Parambikulam (1198u/l) and Amaravathy (1105u/l) recorded moderate quantity of zooplankton. The zooplankters in the other reservoirs were poor (Fig.5).

Copepoda was the dominant group (41.2%) among the zooplankters, followed by rotifera (33.3%) and cladocera (14.7%) in Varattupallam. Copepoda also formed the major group (21.0%) in Gunderipallam reservoir followed by rotifera (16.8%) and cladocera (10.6%). The count of rotifera outnumbered that of the other groups of zooplankton in Palar-Poranthalar and Thoonakadavu (see Table - 4). Qualitative analysis of zooplankton indicated the existence of 2 genera each in protozoa and copepoda, and 6 genera each in rotifera and cladocera (seeTable-6). However, correlation analysis indicated that no water and soil parameters influenced the zooplankton abundance (Table - 7).

8.2 Macrobenthic Organisms

The benthic organisms play an important link in the production process of the reservoirs, as they serve as food for a few bottom-feeding fishes. Krishnagiri recorded the highest macrobenthic population (4290 Nos/m^2) closely followed by Willington (4170 Nos/m^2). Gunderipallam, Varattupallam, Amaravathy, Uppar, Vaigai, Pechiparai and Vidur reservoirs also recorded high quantity of macrobenthos (1926 to 2338 Nos./m^2). Palar-Poranthalar, Pilloor, Vembakottai, Manimuthar and Orathupalayam exhibited a moderate quantity of macrobenthos (952 to 1458 Nos./m^2). A low level of bottom fauna was encountered at Parambikulam (502 Nos./m^2) Thoonakadavu (838 Nos./m^2), Peruvaripallam (329 Nos./m^2), Uppar (411 Nos./m^2) and Odathurai (364 Nos./m^2).

While Chironomus larvae formed the major portion of the macrobenthos (2835Nos./m^2) at Krishnagiri , molluscan forms dominated (3939 Nos./m^2) at Willington reservoir. The two diptherian larvae (*Chaoborus* sp.and *Chironomus* sp.) were invariably present in all the reservoirs. However, the quantity was more in Gunderipallam, Amaravathy, Krishnagiri, Uppar, Vidur and Orathupalayam. The bottom soil of Varattupallam harboured the highest number of Oligochaetes (1818 Nos./m^2), followed by Pilloor (866 Nos./m^2). Generally, Oligochaetes were found in all the reservoirs but the density varied according to the suitability of the bottom substratum. A considerable quantity of molluscs in the form of bivalves (*Lamellidens* and *Corbicula*) or gastropods (*Viviparus, Gyraulus, Pila* and *Lymnaea*) was encountered at Pilloor, Uppar, Vaigai, Vembakottai and Vidur. However, a small quantity of these organisms was recorded at Krishnagiri, Odathurai and Orathupalayam.

Chaoborus sp. were virtually absent in certain quarterly samplings at Peruvaripallam, Pilloor, Uppar, Sandynulla, Vaigai, Manimuthar, Krishnagiri, Vidur, Willington and

Odathurai. Similar conditions with respect to *Chironomus* sp. were observed in certain reservoirs such as Peruvaripallam, Sandynulla, Vaigai, Vidur and Willington. Oligochaetes were not present throughout the study period in certain reservoirs barring Palar-Poranthalar, Pilloor, Gunderipallam, Varattupallam and Amaravathy (Table - 8).

8.3 Macrophytes :

The increase of water level during monsoon and the decrease of the same during summer seasons were common phenomena in the reservoirs surveyed. Terrestrial macrophytes grow in the exposed area of the reservoir and they are submerged during monsoon, adding fertility to the reservoir. Apart from the terrestrial plants, certain submerged aquatic plants (*Hydrilla, Ceratophyllum, Najas* and *Chara*), floating plants (*Pistia, Lemna, Salvinia* and *Azolla*) and rooted plants (*Sagittaria, Aponogeton* and *Polygonium*) occurred in Palar-Poranthalar, Vaigai, Vembakottai, Uppar, Gunderipallam, Varattupallam, Odathurai, Vidur and Willington reservoirs. *Cyperus* spp., *Penicum* spp., and *Scirpus* spp. were often encountered in the margin of shallow reservoirs such as Vidur, Willington, Varattupallam and Vembakottai.

9. PRIMARY PRODUCTION:

Hourly carbon synthesis in reservoirs fluctuated widely from 38.3 mgC/m^3 at Pechiparai to 270.0 mgC/m^3 at Gunderipallam. In general, shallow reservoirs exhibited higher amount of primary production, registering 152.7 at Uppar, 270.0 at Gunderipallam, 228.1 at Varattupallam, 189.1 at Vaigai, 160.1 at Krishnagiri and Odathurai and 222.7 at Orathupalayam. Excluding Pechiparai (38.3) and Sandynulla (48.8), the other reservoirs synthesized medium levels of carbon per hour ranging from 62.5 (Peruvaripallam) to 140.6 (Palar-Poranthalar). Corresponding to gross primary production, net production showed similar trend with the lowest value at Pechiparai (19.1 $mgC/m^3/hr$) and higher value at Gunderipallam (169.3 $mgC/m^3/hr$). Evidently, the clear water of Pechiparai represented the poor respiratory activity at the rate of 23.5 $mgC/m^3/hr$ owing to the scant presence of plankton. A proportionately larger respiratory uptake was due to the consumption of oxygen by biotic and abiotic means at Varattupallam (158.3) Krishnagiri (112.4) and Sandynulla (103.1).

The Net: Gross ratio recorded at Odathurai (0.90) reservoir indicated that the net photosynthetic activity was maximum followed by Amaravathy and Vaigai, each recording 0.78 due to higher abundance of phytoplankton. Parambikulam reservoir recorded the lowest value of net: gross ratio of 0.38, followed by Krishnagiri (0.41) and Varatupallam (0.43). The P:R ratio at Vaigai reservoir was the highest (4.32), followed by Amaravathy (3.86), and Vidur (3.11). These values revealed that community respiration was comparatively lower in the reservoirs, and their contribution to gross photosynthesis was lesser. On the contrary, Sandynulla recorded the lowest value (0.47) showing that more energy was expended on respiratory activities by the phytoplankton (Table. 9).

Annual primary productivity is a variable complex and function of available nutrients and intensity of light. Primary production showed well-defined trend in relation to seasons and abiotic variables. Significant variation is not observed in the gross primary production, while mean depth is looked upon as an influencing factor. Average primary production in Varattupallam (2042.6 mgC/m^2/day), Vaigai (2270.42 mgC/m^2/day), Krishnagiri (2406.15mgC/m^2/day) and Odathurai (2478.5 mgC/m^2/day) was apparently high. Willington reservoir exhibited lower phytoplankton productivity, because major part of the year it was dry. The rest of the reservoirs had shown medium level of carbon synthesis ranging from 709.89 mgC/m^2/day in Pechiparai to 1632.8 mgC/m^2/day in Gunderipallam.

In most of the reservoirs, carbon production during pre-monsoon exceeded that of post-monsoon season. However, in a few reservoirs such as Varattupallam, Vaigai, Vidur and Odathurai, the reverse pattern was the case. From the statistical analysis, it was noted that the gross primary production depicted an overall pattern as a function of catchment area to reservoir gross capacity at FRL. It was also observed that the pH, TDS and conductivity of water at 5% level significantly influenced the organic carbon synthesis (Table-10). The energy flow for each reservoir surveyed is presented in Table-11.

Seasonal variation in primary production:

Normally, all the reservoirs showed higher GPP during summer season (Apr-June), except Gunderipallam, Sandynulla, Krishnagiri and Vidur, which showed their peak production level during Jul-Sep (monsoon). Minimum production was recorded during winter season at Parambikulam, Peruvaripallam, Palar-Poranthalar, Uppar, Gunderipallam, Varattupallam, Sandynulla, Odathurai and Orathupalayam. The rest of the reservoirs showed their minimal activity either during the Jul-Sep or Jan-Mar quarter.

10. FISH AND FISHERIES

10.1 Crafts and Gears in vogue

Crafts: A coracle locally called 'Parusu' or 'Parusel' is the most commonly used craft in the reservoirs excepting in Parambikulam and Vidur. Coracle is a circular basket type of craft consisting of an inter woven frame work made up of bamboo strips and a circular sheet of high density polyethylene (HDPE) or high density polypropylene (HDPP) sack material firmly fastened using coir ropes to the rim of the frame placing it on the convex side. A coating of melted bitumen is applied on the outer side of the woven sack to make it water proof. An animal hide (leather) was used earlier instead of HDPE or HDPP woven sack material.

The tribals at Parambikulam region used a catamaran type of craft, fabricated out of locally available bamboo poles for fishing. Four to six bamboo poles of 3 - 3.5 m length were placed parallel to each other and tied fast. A pair of split bamboo strips, one at the bottom and the other at the surface was placed horizontally to the main frame and fastened. Such strengthening was done in four or five places. A person sat on the craft floated on the

surface of the water and moved up using a small oar while fishing. At Vidur, inflated lorry wheel tubes were used as crafts, with the fishermen sitting on one edge and keeping the net on the opposite side to balance his weight while fishing.

Gears: Mostly, gill nets of entangling type were used in the reservoirs. These passive nets were made up of either nylon twines or monofilaments. The mesh size of the nets varied depending on the size of the fish to be caught. Normally, monofilament knotted nets with mesh size ranging from 40 to 80 mm, locally called 'tilapia valai' was used for capturing tilapia, minor carps and weed fishes. Gill nets made up of nylon twines with mesh size ranging from 110 to 280 mm were used for capturing major carps of different size groups. Rangoon nets are gill nets operated in deeper areas allowing the net to hang freely from the surface using thermocol pieces as the floats. Whereas, 'uduvalai' is a narrow bottom set gill net normally operated in the shallow areas. While smaller meshed nets were meant for capturing minor carps and weed fishes, large meshed nets aimed at major carps. The large meshed nets targetted against catla were also called catla nets in this state. The length of net varied from 30 to 100 m with a width of 2 to 6 m. A fisherman owned 2.5 to 20 kg of nets but operated maximum 7.5 kg of net per day. Besides gillnets, cast nets, long lines and rod and line were also used for selective fishing. The long lines and the rod and line with baits in the hooks were operated for capturing predatory fishes and game fishes.

Fishing efforts: A fishing unit consisted of a coracle operated either by two or one fishermen assisted by his wife/sub-adult engaged for this purpose. The quantity of the gill nets used by the fishing unit varied a lot ranging from 2.5 to 7.5 kg by dry weight depending on the purchasing capacity of the head fisherman of that unit. Normally, the gill nets were suspended day and night in the reservoir and the fish entangled in the nets were collected and brought to the shore the next day morning for marketing. The nets were shifted to other places of the reservoir after 5 or 6 days. Once or twice a month, the nets were brought to the shore, washed and aired. The damage in the nets were repaired and reused for fishing.

10.2 Recruitment of fishes

Among the commercially important fishes, *Oreochromis mossambicus* was the only fish found to breed in all the reservoirs. However, the intensity of spawning and recruitment of the species varied a lot, depending on the local conditions. While thousands of breeding pits of 220 to 750 mm diameter and 100 to 160 mm in depth were found in the marginal areas at Uppar and Palar-Poranthalar, such a large-scale breeding and recruitment of offspring of this species was not noticed in other reservoirs. Schools of advanced fingerlings of mahseer were located at Thoonakadavu reservoir. Sampling helped to capture thousands of fingerlings, confirming large scale spawning and recruitment of this endangered species. In the absence of natural recruitment of Indian and exotic cultivable carps in the reservoirs studied, regular stocking of farm produced fry and fingerlings of fast growing carps was done every year in all the reservoirs except Varattupallam.

10.3 Fishery development in reservoirs :

Parambikulam, Thoonakadavu and Peruvaripallam:

No fishery development activity existed in these reservoirs, as they are located in the 'Indira Gandhi Wildlife Sanctuary' covering an area of 28500 ha in the inter-state border of Kerala and Tamil Nadu. However, the tribals, residing nearby the reservoirs indulged in unauthorized fishing. They used a craft made up of locally available bamboo poles. Nylon gill nets of varying mesh size (20 – 120 mm), width (1 – 4 m) and length (10 – 30 m) were operated from the craft. Besides gill net operation, a few tribals and local residents used rod & line with baits in the hooks for attracting targetted fish, particularly predatory and game fishes. A total of 20 to 50 kg of fish, consisting of *O. mossambicus, P. sarana, P. carnaticus, P. dubius, P. dobsonii, P. curmuca, Tor khudree, Mystus sp.*, and *C. punctatus* is caught per day through the unauthorised fishing. Tilapia, mahseer and *Puntius* sp. dominated in the gillnet fishing. Whereas, cat fishes (*Mystus* sp. *Ompok bimaculatus* and *W. attu*), mahseer (*T. khudree*), *M. armatus* and *Channa* sp. predominated in the rod and line fishing.

Amaravathy:

This reservoir is under the fishery management of T.N.F.D.C.Ltd. The reservoir supported a variety of indigenous ichthyofauna such as *Acrossocheilus hexagonolepsis, Cirrhinus cirrhosa, C. reba, Puntius dubius, P. carnaticus, P. sarana, Labeo fimbriatus, L. calbasu, L. bata, L. kontius, T. khudree* and *T. puttitora* in the initial years of its formation. However, after introduction of *O. mossambicus* in 1957-58, the fish propagated rapidly forming a major fishery (341.6 t) out of the total yield of 427 t (502.3 kg/ha) of the reservoir at the cost of the Cauvery carps. The phenomenal individual growth (1.7 to 4.0 kg) of tilapia recorded in the earlier years gradually reduced in size in the subsequent years, reaching 80 to 300 g. Since, further reduction in individual weight would pose marketing problem, efforts were made to replace tilapia fishery through annual stocking of major carp seeds. The rate of stocking varied from 294 to 966 Nos./ha during 1982-97. The annual average seed stocked during the last six years was 463 Nos./ha. In the species composition, *C. catla* was dominating (39.97 to 56.26 %), followed by *L. rohita* (18.96 to 26.92 %), *C. mrigala* (5.8 to 23.4 %) and *C. carpio* (9.97 to 17.78 %). Small consignments of silver carp were also released into the reservoir during 1991-92.

A group of 15 fishing units locally called share-fishermen was engaged in exploitation of the reservoir. The gross fish yield of the reservoir ranged from 94.8 to 123.6 t during 1990-91 to 1996-97 and the yield rate ranged from 111.6 to 145.5 kg/ha with an annual average value of 129.3 kg/ha. The contribution due to stocked species in the total fish landings fluctuated from 33.65 to 77.42 %. Among the stocked species, the contribution due to catla was maximum (11.45 to 55.78 %), followed by rohu (9.28 to 13.55 %), mrigal (5.92 to 10.08 %) and common carp (0.45 to 3.44 %). Among the non-stocked species, tilapia made a sizeable contribution. However, the contribution due to tilapia steadily declined from 61.96 % in 1991-92 to 9.83 % in 1994-95. Thus, this tilapia-dominated reservoir was converted

into a major carp fishery resource in the recent years. In this reservoir, catla, rohu, mrigal and common carp attained 3.5 to 5.0 kg, 0.75 to 1.25 kg, 1.0 to 1.25 kg and 0.7 to 1.0 kg in a year respectively.

Palar-Poranthalar:

The reservoir, which was under the fisheries management of Tamil Nadu Fisheries Development Corporation Limited, was leased out to a private entrepreneur for an annual consideration of Rs. 560000.00 with effect from 01.04.1995. The private fish farmer stocked the reservoir with fish seed of only 2 species viz. *C. catla* (70.9%) and *L. rohita* (29.1%) at a density of 969 Nos./ha in the first year (1995-96). However, in addition to the above species, *C. mrigala* and *C. carpio* were also included in the stocking material during the second and third year respectively. The average rate of stocking during 1995-99 was 740 Nos./ha with the dominance of catla (73.9%), followed by rohu (18.1%), mrigal (5.4%) and common carp (2.6%).

Nineteen fishing units were employed for exploitation of the reservoir. A high fish yield of 104.1 t was obtained in the first year (1995-96) of private management. The fish yield progressively increased in the subsequent years and reached an all time high of 133.5 t during 1998-99. Thus, a sustained high fish yield ranging from 201.0 to 257.8 kg/ha with an average value of 225.5 kg/ha was achieved in the reservoir. The contribution due to stocked varieties was high (76.0 %) in the first year and the value reached 99.4 % in the fourth year (1998-99). In the species composition, *C. catla* formed the major fishery (69.4%), followed by *L. rohita* (16.0%), *C. mrigala* (7.0%) and *C. carpio* (5.2%). Tilapia and other miscellaneous fishes were reduced to a minor fishery (0.4 to 24.0%). The catch per unit effort raised substantially and the income to the fishermen increased by 200% within 4 years of private management. The growth performance of catla was good in this reservoir. They attained a size ranging from 2.5 to 4.0 kg in the first year and from 5.2 to 12.0 kg in the second year in spite of high stocking rate. However, rohu could reach hardly 0.75 to 1.25 kg in a year. The performance of mrigal and common carp was no way better.

Vaigai:

This medium reservoir with a water area of 2419 ha was stocked with fish seed belonging to catla, rohu and mrigal every year. Seed of *L. fimbriatus* was also stocked during 1993-94 and 1995-96. The stocking rate declined sharply from 249 Nos./ha in 1992-93 to 135 Nos/ha in the subsequent years with a marked reduction (103 Nos./ha) during 1995-96. The average rate of stocking was 162 Nos./ha during 1992 - 99 with the dominance of catla (18.77 – 69.23%), followed by mrigal (16.9 – 71.3%) and rohu (4.46 – 26.1%).

Twenty-eight fishing units (two adults per unit) were engaged for exploitation of the reservoir. The total fish landings increased from a low of 9.68t in 1992-93 to a high of 23.75t in 1997-98, giving 4.0 to 9.4 kg/ha/yr during 1992-99. The heavy stocking of carps followed during 1992-94 resulted in better yields of stocked varieties registering 2418 kg (24.97%) and

4917 kg (28.8%) in the total yield. In the following years, an appreciable growth in the annual yield of stocked varieties were observed till 1998-99 except for a sharp fall of 11.44% in 1995-96. Among the major carps, catla was the dominant species followed by mrigal and rohu. The contribution due to non-stocked varieties of fish was more than the stocked ones. While, tilapia dominated the total fish landings during 1995-96 to 1998-99, the contribution by *P. sarana* was higher (38.6 to 61.6 %) during 1992-93 to 1994-95. There was a sizeable contribution due to *W. attu* during 1992-93 to 1996-97 with peak landings (4.2 t) in 1994-95. The landings of *Chela* sp. were high (0.8 to 2.3 t) during 1994-98. Similarly, *O. bimaculatus* also made substantial contribution (1.08 to 1.48 t) during 1995-97. Though, the population of *R. corsula* and *Glossogobius* sp. in the reservoir was high in certain seasons, they are seldom caught in the nets operated, forming a minor fishery. At the fish landing centre, the fishes were sold first to the consumers and the excess was marketed to the merchants.

Vembakottai:

This small reservoir with an area of 468 ha was stocked regularly with seeds of catla, rohu, mrigal and common carp on annual basis and the rate of stocking during 1994-95 to 1998-99 dwindled between 227 and 513 Nos./ha. Catla dominated among the stocked species during 1994-95, 1996-97 and 1998-99. While mrigal was the dominant species during 1997-98, common carp occupied first place during 1995-96.

Thirteen fishing units (2 adult fishermen/unit) were employed for exploitation. The reservoir yielded 2.35 to 15.15 t of fish during 1994-99, the yield rate being 5.0 to 32.36 kg/ha. The stocked varieties contributed 28.0 to 88.1% in the total landings and the non-stocked varieties formed 11.9 to 72.0%. Among the stocked species, mrigal and catla occupied first and second positions respectively during 1994-95. The landings due to catla were the highest during 1995-99 and common carp occupied the second position during 1996-98. Among the non-stocked varieties, the contribution due to tilapia was more and it was followed by *Puntius* sp., *Channa* sp., *Mystus* sp. and *Glossogobius* sp. While selling the fish, preference was given to the public and the balance was sold to the traders. In addition to gill net fishing, drag nets were also operated to capture stranded murrels in the pools and nullahs when water level was reduced drastically. Children belonging to Ceylon refugees settled at the dam site were unauthorizedly fishing with the help of rod and line using earth worms as baits for capturing tilapia and murrels for their subsistence.

Manimuthar:

Among the small reservoirs, Manimuthar has the maximum area (940 ha) and high gross capacity (156.1 M.cu.m.). It is a perennial reservoir with a mean depth of 16.6 m. It was regularly stocked with seed of Indian major carps. Seeds of *L. fimbriatus* were also stocked in the reservoir upto 1995-96, but discontinued in the subsequent years. Similarly, seeds of *C. carpio* were also stocked in all the years, except three years (1992-93 to 1994-95). The rate of stocking was high (531 to 1085 Nos./ha) during 1985-86 to 1992-93, but it was reduced (133 – 239 Nos./ha) in the subsequent years. Different species dominated in the stocking material in different years.

The fish yield shot up from 5.1 t in 1985-86 to 11.99 t in 1987-88, but declined subsequently and reached a low ebb of 1.7 t in 1991-92 to bounce back to a second peak of 10.1 t in 1993-94. In spite of a reduction in the stocking rate during 1994-95 to 1998-99, fish yield remained at 2.98 t to 9.0 t. The fish yield rate ranged from 1.88 to 12.76 kg/ha with an average value of 5.8 kg/ha during the period from 1985-86 to 1998-99. The contribution due to stocked varieties ranged from 23.6 to 50.38%. The low rate of recovery indicated that there was some basic fault in the fish seed stocking. Among the unstocked varieties, *P. sarana* formed the bulk (64.2%) in the total landings. However, the fishery due to this species declined during 1997-99. There was a sizeable contribution of tilapia to the total landings and an increasing trend was noticed in the landings of this species in the later years. *T. khudree, L. calbasu, H. molitrix, Channa* sp. and *Glossogobius* sp. formed a minor fishery, appearing occasionally in the fish landings.

Pechiparai:

This medium reservoir (1515 ha) was regularly stocked with fish seed belonging to catla, rohu and mrigal. Seed of *C. carpio* were added to the stocking material during 1996-97 to 1998-99. Similarly, seed of *L. fimbriatus* were introduced during 1993-94. The stocking rate varied from 165 to 331 Nos./ha during 1992-99. Different species dominated in the seed stocked in different years. The stocking in *C. catla* was low (6.8%) in 1997-98 and it was high (59.2%) in 1996-97. While *C. catla* dominated in the stocking material in 1993-94 (48.8%) and 1996-97 (59.2%), *L. rohita* was predominant in 1997-98 (40.0%). The contribution due to *C. mrigala* was high in 1994-95 (82.4%), 1992-93 (69.46%) and 1995-96 (59.4%). *C. carpio* was high (73.0%) in the total seed stocked during 1998-99.

The fish landings from the reservoir ranged from 13.0 t to 26.3 t per annum between 1992-93 and 1998-99, giving a yield rate of 8.6 to 17.3 kg/ha. In the species composition, *P. sarana* was dominant one contributing 40.0 to 55.6% in the total landings. It was followed by *C. mrigala* (9.7 to 25.0%), *L. fimbriatus* (5.59 to 18.36%), *C. catla* (3.14 to 15.16%), *O. mossambicus* (3.37 to 8.13%), *L. rohita* (0.84 to 3.99%) and *C. carpio* (0.14 to 3.69%). Murrels and mud carps appeared occasionally in the fish landings and formed a minor fishery. However, the demand for murrels was very high (Rs. 70/- per kg).

Sandynulla:

This upland reservoir with an area of 263 ha at an elevation of 2143 m was stocked with seeds of Indian major carps (catla, rohu and mrigal) during seventies and beginning of eighties. Since, these fishes failed to establish in this reservoir, further stocking was given up. Seeds of common carp, silver carp, grass carp and fimbriatus were stocked in the reservoir at 10 to 79 Nos./ha.

Exploitation was started from 1963-64 and 0.5 t of fish was caught in the same year. The fish catch improved gradually and reached a peak (7.36 t) in 1968-69. Subsequently, the yield declined and fluctuated between 2.0 t and 6.6 t with an average of 4.23 t (16.0 kg/ha/yr).

Among the three varieties of common carp stocked in the reservoir, mirror carp breed profusely and recruit its offspring. Fry and fingerlings were regularly collected from this reservoir and were used for stocking in other suitable water bodies.

Pilloor:

Though Pilloor is the main source of drinking water for Coimbatore and nearby villages and towns, the reservoir was regularly stocked with fish seed. During 1988-89 to 1990-91, seeds of rohu, mrigal and common carp were stocked at the rate ranging from 445 to 500 Nos./ha. No stocking was done during 1991-94 as water from the reservoir was reduced to facilitate civil work carried by the Tamil Nadu Water and Drainage Board. Stocking was resumed during 1994-95 with seeds of catla, rohu, mrigal and common carp @ 375 Nos./ha. In the species composition, common carp with 38% dominated in the total seed stocked, followed by mrigal (26.6%), rohu (20.0%) and catla (15.3%). Only Indian major carps were stocked @ 375 Nos./ha during 1995-96. Catla (53.0%), mrigal (39.0%) and common carp (8.0%) were stocked @ 250 Nos./ha during 1996-97.

The fish catch from the reservoir was 2.0 t (5.0 kg/ha) during 1987-88. The catch improved to 3.5 t (8.75 kg/ha) in 1988-89, but declined during the next two years, reaching a low level of 0.6 t (1.5 kg/ha) in 1990-91. After a gap of three years, the reservoir yielded 2.5 t (6.25 kg/ha) of fish during 1994-95. The highest fish catch of 3.98 t (9.9 kg/ha) was obtained during 1995-96. The fish yield showed a slight reduction to 3.7 t (9.25 kg/ha) during 1996-97. The stocked varieties of fish formed a minor fishery (1.0 to 21.9 %), as bulk of the catch was due to indigenous fishes (78.1 to 99.0 %).

Gunderipallam:

This is the smallest reservoir (61 ha) surveyed and it was stocked with seeds of catla, rohu, mrigal and common carp regularly. Silver carp, grass carp, mirror carp and fimbriatus were also stocked in certain years. The stocking rate was ranging from 1115 to 4098 Nos./ha. During the period of survey, *viz.*, 1995-96 and 1996-97, the reservoir was stocked with seeds of catla, rohu, mrigal and common carp @ 2878 Nos./ha. In the species composition, catla dominated with 47.4 %, followed by mrigal (21.4%), rohu (18.5%) and common carp (12.7%). Ten fishing units were utilized for harvesting the fish from the reservoir on crop sharing basis. 8.4 t (1991-92) to 35.0 t (1994-95) was captured from the reservoir and the yield rate was 138.2 to 574.2 kg/ha. The contribution due to stocked species ranged from 9.8 to 61.3%. In the species composition, mrigal occupied first position during 1985-86 to 1990-91. However, catla captured the first position during 1992-93 to 1996-97. There was a sizeable quantity of mrigal and common carp in the fish landings. During the survey period (1996 - 99), an annual average of 17.5 t (286.9 kg/ha/yr) of fish was harvested from the reservoir with 35.7% of stocked species and 64.3% of non-stocked varieties. Among the stocked species, common carp was the dominant one with 24.1%, followed by catla (5.8%). Tilapia dominated the non-stocked species.

Varattupallam:

No stocking was done in Varattupallam during the period under study. It was due to law and order problem. Unauthorized fishing by the local fishermen was done during the survey period. No agency was recording the fish catch and its composition. Examination of the catch revealed the occurrence of *O. mossambicus, Mystus vitatus, glossogobius* sp., *C. striatus* and *C. punctatus* in the reservoir.

Uppar:

The reservoir (453 ha) was under the private management during the period of survey. The private entrepreneur obtained fish seed from both government and private farms located not only in Tamil Nadu, but also in other states such as West Bengal and Andhra Pradesh. Seeds of *C. catla, L. rohita, C. mrigala* and *H. molitrix* procured and released into the reservoir at the rate of 530 Nos./ ha in the first year (1994-95). Catla and mrigal formed the major portion (83.4 %) of the stocking material. Rohu and silver carp (8.3 % each) equally shared the remaining quantity of seed. It was due to a dispute, fish seed stocking was withheld during 1995-96. However, a higher stocking density (962 Nos./ha) was followed in the next year (1996-97). Among the species composition, *C. mrigala* was the dominant species (43.4 %), followed by *A. nobilis* (27.5 %), *H. molitrix* (17.2. %), *C. catla* (7.7 %) and *L. rohita* (4.1 %). The lessee was instructed by CIFRI not to stock the seed of big head carp in the subsequent years. He was advised to fix a wire-mesh screen in the irrigation canals immediately for preventing downward migration of this exotic species. Seeds of Indian major carps alone were stocked in the reservoir during 1997-98. Silver carp seed were also added along with Gangetic carps during 1998-99. In the species composition, catla was dominant species, followed by mrigal and rohu. Silver carp occupied the fourth place. The stocking rate was ranging from 530 to 962 (x : 605) seeds/ha/yr during 1994-99.

Ten fishing units were engaged for harvesting the reservoir as per the agreement. The fishermen used gill nets with mesh size varying from 50 to 240 mm to capture various groups of fishes. A high fish yield to the tune of 90.27 t (199.2 kg/ha) was achieved in the very first year (1994-95) of private management. However, the bulk of the catch was due to unstocked fish (86.1 %) especially *O. mossambicus* (85.5 %), reducing the contribution due to stocked varieties to a meagre proportion (13.9 %). Though the fish harvested from the reservoir declined to 47.8 t (105.6 kg/ha) in the second year (1995-96), the contribution due to stocked species increased substantially (74.4 %). Only sample fishing could be done for a few days in March 1997 due to the dispute, resulting in a low fish catch of 3.256 t (7.0 kg/ha) during 1996-97. However, full-fledged fishing during 1997-98 resulted in an all time high of 101.8 t (224.8 kg/ha), largely contributed by stocked species (78.3 %). As an individual species, *A. nobilis* contributed the maximum yield (40.76 %). The fish yield declined to 35.2 t (77.7 kg/ha) during 1998-99 with almost equal contribution of stocked and unstocked fishes. The yield rate showed a wide fluctuation from 7.187 to 224.8 kg/ha/yr with a mean value of 122.9 kg/ha/yr.

Krishnagiri:

Fry and fingerlings of Indian major carps were regularly stocked in this medium reservoir (1248 ha). Seeds of common carp, silver carp, tilapia and mullets were also released into the reservoir before 1994-95. The rate of stocking was high (834 Nos./ha) in 1992-93, low (200 Nos./ha) in 1994-95 and medium (320 Nos./ha) during 1996-99. Efforts were made to stock more of catla, followed by rohu and mrigal.

Altogether, twenty-seven units were engaged in exploitation of the reservoir, which yielded 12.1 to 85.7 t of fish per annum, resulting in 10.5 to 72.1 kg/ha/yr. The bulk of the fish captured was due to non-stocked varieties (81.65 to 99.56%) and the contribution of stocked fish was negligible (0.44 to 18.35%). Tilapia formed a major fishery in most of the years, excepting 1992-94 and its contribution ranged from 12.0 to 87.61%. The contribution of *P. sarana* was substantial during 1988-95 with peak landings during 1992-93 (55.47%) and 1993-94 (54.8%). *R. corsula* and *Chela sp.* made sizeable contribution in the total fish catch during 1991-93 and 1991-94 respectively. *Glossogobius* sp. appeared in the fish landing (1.6 t) during 1994-95, reached its peak (6.4 t) in 1995-96 and then declined gradually to 0.66 t in 1998-99.

Vidur:

This seasonal reservoir with considerable water area of 798 ha was stocked with seeds of catla, rohu, mrigal and common carp on yearly basis depending on their availability. Seed of silver carp were also stocked during 1991-92. The rate of stocking varied from 95 to 478 Nos./ha/yr.

Ten to fifteen units were employed for harvesting fish from the reservoir. Active fishing is done during January to June. A total of 1.99 t to 11.47 t of fish was captured annually from the reservoir, resulting in an yield rate of 4.2 to 7.5 kg/ha. The stocked species contributed substantially (35 to 63.7%) to the total fish landings. Among the non-stocked varieties, the contribution of tilapia was the maximum. It is interesting to note that a good number of prawns (*M. rosenbergii* and *M. malcomsonii*) were captured from the reservoir. They were big in size, weighing 150-250 g and the females were berried ones carrying yellowish eggs.

Willington:

This shallow, seasonal and medium reservoir with an area of 1554 ha was stocked with seeds of catla, rohu, mrigal and common carp. The rate of stocking was minimum (49 Nos./ha) in 1995-96 and maximum (167 Nos./ha) in 1994-95.

Fishermen belonging to Fishermen Cooperative Society were engaged on crop sharing basis for exploitation of the reservoir. The total fish caught from the reservoir was maximum (11.47 t) during 1994-95 and it was least (1.99 t) in 1992-93. The fish yield rates ranged

from 1.3 to 7.4 kg/ha with an average value of 3.9 kg/ha. The contribution of stocked species of carps was 6.9 to 45.47% and tilapia formed the bulk among the non-stocked varieties of fish. This was the worst managed water body among the reservoirs operated by the Department of Fisheries, Government of Tamil Nadu.

Odathurai:

It is a small impoundment (75 ha) surrounded by agricultural land and it has been regularly stocked with seeds of catla and rohu during the last 10 years from 1990-1991 to 1999-2000. The seeds of mrigal were also released every year excepting 1996-97. Two varieties of common carp *viz. C. carpio* var. *communis* and *C. carpio* var. *specularis* were also introduced into the water body in certain years during this period. A smaller percentage of silver carp during 1991-92, and grass carp during 1991-92 and 1998-99 were released in combination with other carps. The rate of stocking was ranging from 1353 to 2683 Nos./ha. While catla dominated in the stocking material during 1993-94, 1995-98 and 1999-2000, rohu occupied the first position during 1998-99. The bulk of the seed stocked was due to mrigal during 1990-93 and 1994-95.

This water body yielded an annual fish catches ranging from 12.5 t to 19.6 t during 1990-2000 and the yield varied from 166.3 to 261.9 kg/ha/yr. The contribution of stocked species of fish was low (4.1 to 17.24%) during 1990-97, but it improved substantially (41.35 to 49.2%) during 1997-2000. Catla, rohu and mrigal showed steady increase in their landings during the period: While silver carp did not appear in the fish catch, grass carp showed a phenomenal growth with peak landings (1147 kg) during 1999-2000. Among the non-stocked varieties of fish, tilapia multiplied fast and formed a major fishery (48.1 to 91.68%). *Glossogobius* sp. made sizeable contribution during 1998-2000. *Channa* sp. and *L. fimbriatus* also appeared occasionally in the catches.

Orathupalayam:

The reservoir was stocked with seeds of Indian major carps and common carp @ 82 to 233 Nos./ha during 1995-97. The annual fish catch ranged from 24.2 t to 80.1 t, resulting in a yield rate of 57.0 to 188.5 kg/ha/yr. Tilapia formed a major fishery, pushing the stocked varieties into a minor fishery.

The fish seed stocking and the yield from the reservoirs are drawn in the figures 6 and 7.

STOCKING VS YIELD

Stocking of Cauvery carps such as *P. carnaticus, P. dubius, P. dobsonii, P. kontius, L. fimbriatus, L. calbasu, C. cirrhosa, C. reba, A. hexagonolepsis*, etc. in the reservoirs during the initial years of their formation did not help these fishes to get established. It is an indication that the newly formed lacustrine environmental conditions were not conducive for these fishes. Therefore, the fish yield rates were low. Transplantation of the exotic fish,

O. mossambicus in certain reservoirs changed the scenario of fisheries. The introduced tilapia grew fast, multiplied through their prolific breeding habits and managed to establish in all the water bodies at the cost of Cauvery carps. The yield rates through tilapia per unit water area increased substantially. Since the individual growth of tilapia was high, the fish commanded a good market. However, the individual weight reduced due to over population and stunted growth, loosing its demand in the market in the subsequent years. Hence, the fish has been considered as a pest during the last few years. Efforts have been made to replace the tilapia fishery with those of major carps through systematic stocking. The success in this regard suggests that similar attempts may be made in other reservoirs.

In relation to stocking, the yield rate through stocked varieties of fish was generally low in all the reservoirs. It was highest (201.0 kg/ha) in Palar-Poranthalar, followed by Gunderipallam (99.1 kg/ha), Odathurai (88.5 kg/ha), Amaravathy (82.4 kg/ha) and Uppar (77 kg/ha). Other reservoirs yielded low (1.1 - 10.2 kg/ha) quantity of fish, which was far below their actual potential. The results indicate that high stocking rates alone will not culminate in high yield rates. In fact, over stocking may lead to slow growth of fish, high rate of mortality and reduction in production. This may be the probable reason for low yields with high stocking rates in Gunderipallam and Odathurai. The stocking rate has been decided arbitrarily and the species to be stocked has been fixed according to their availability without taking into consideration the biogenic conditions prevailing in a reservoir. Assessment of the growth rate of commercially important fishes in the ecosystem is a pre-requisite for determining the appropriate stocking density and species mix.

The estimated fish production potential against actual yield and the conversion efficiency of reservoirs under different management is given in Table-12. Among the twelve reservoirs managed by the Department of Fisheries in the state, the smallest Gunderipallam reservoir (61.0 ha at FRL) gave the highest average fish yield of 357.8 kg/ha which is 0.59 % of the gross primary production. Smaller the water body easier is the management. Yet, the annual average yield through stocked varieties (99.1 kg/ha) has not commensurate with the high stocking rate (2878 nos./ha). Analogous to this case, an another small impoundment (Odathurai: 75.0 ha) yielded 195.9 kg/ha accounting 0.219% of the gross primary production, despite the high stocking rate (2111 Nos./ha). Disappointingly, the yield rate through stocked species was only 88.5 kg/ha. Orathupalayam reservoir, receiving enormous amount of effluents indicated high fish production potential of 844.1 kg/ha and gave an average yield of 87.7 kg/ha which works out to 0.1% of gross primary production. Remaining reservoirs gave an annual average fish yield ranging from 3.9 kg/ha in Willington to 33.8 kg/ha in Krishnagiri. The conversion efficiency from the gross primary production to fish yield was very poor, ranging from 0.001 to 0.05%. The yield rate through stocked varieties of fish was pathetically low (1.1 to 10.2 kg/ha) in these reservoirs in spite of a high stocking rate of 140 to 450 seed per ha. Amaravathy reservoir, directly managed by T.N.F.D.C. Ltd. gave an average annual fish yield of 129.0 kg/ha equivalent to 0.41% of gross primary production. This reservoir has been stocked moderately at 463 Nos./ha, leading to a recovery of 82.4 kg/ha. Among the reservoirs taken on lease basis and managed by private fish farmers, Uppar (453 ha) indicated a fish production potential of 569.9 kg/ha based on gross primary

production. However, the reservoir yielded a gross annual average of 122.9 kg/ha which is 0.216 % of gross primary production. This reservoir was stocked at the rate of 605 Nos./ha of carp seeds, resulting in a production of 77.0 kg/ha of stocked varieties. Another privately managed reservoir (Palar-Poranthalar: 518 ha) showed a fish production potential of 518.4 kg/ha at 1% of gross primary production and gave an annual average yield rate of 225.0 kg/ha, equivalent to 0.43% of gross primary production. This reservoir stocked at a fairly high rate of 740 nos./ha of cultivable carps gave high yield of 201.0 kg/ha. Moreover, the fish yield progressively increased from 201.0 kg/ha to 257.8 kg/ha year after year, without showing a declining trend as seen in other reservoirs. This is the best-managed reservoir by the private entrepreneur because it adopted appropriate management strategy recommended by the CIFRI.

11. CLASSIFICATION OF RESERVOIRS

The reservoirs surveyed are man-made ecosystems formed by constructing dams across rivers and streams with engineering skill using concrete masonry, stones, rubbles and earth. There is a wide variation in the morphology, hydrology and biology of these reservoirs. Hence, it is difficult to classify these reservoirs on the basis of an individual parameter. However, an attempt has been made to classify the reservoirs based on certain important parameters (Table-13).

12. GUIDELINES FOR FUTURE MANAGEMENT OF THE RESERVOIRS:

12.1 Guidelines Common to all the Reservoirs

Stocking of fish seed in the reservoirs is one of the important management measures to increase the fish production. Stocking of quality fish seed, optimum stocking rate, correct species combination according to food availability in the water body, appropriate size and health condition of the seed at stocking are some of the important criteria for stocking the seed in the reservoir (Selvaraj *et. al.*, 1997 and 2000).

While selecting the fish seed, it is important to choose fast growing fishes which feed on the first trophic level with short food chain and convert the ingested food efficiently with minimum loss of energy.

Among the Indian carps, catla, rohu and mrigal have the above desired qualities and are found to be suitable for reservoir stocking. Further, common carp the omnivore and silver carp the phytoplankton feeder among the exotic fishes are also found to be suitable for stocking purpose to utilize the respective fish food organisms.

To determine the appropriate stocking density and species mix, it is essential to assess the growth of stocked species. Fin-clipping (or fin removal) as a group marking technique evolved and standardized at Aliyar and Thirumoorthy reservoirs (Murugesan and Selvaraj, 1990 and Murugesan, *et. al.*, 1999) may be followed as the method is simple, cheap, easy and reliable.

The stocking rate may be decided according to the growth rate of individual species in each reservoir. It is advantageous to stock fingerlings of more than 100 mm in length to achieve higher survival.

It is also important to stock healthy fingerlings free from disease and active in movement. On the contrary, the fingerlings which are subjected to long distance transportation under crowded condition become weak, succumb to predation and result in poor survival. For this purpose, it is essential to raise fingerlings in the nearby fish farm.

Wherever rearing facilities in the form of fish farm near the reservoir is not available or inadequate the seed transported from the distant places may be reared in pens and cages for a few days before releasing them into the reservoir.

Efficient exploitation of fish is also an important aspect to be tackled effectively for enhancing the yield. The fishing efficiency may be enhanced by usage of appropriate craft and gears. At present, there is wide variation in the quantity of nets used by the fishing units, ranging from 1.5 to 7.5 kg. The unit, which operates with low quantity of nets, may be encouraged to acquire more nets to increase the efficiency of their fishing.

Periodical repairing of the damaged nets is necessary to maintain the efficiency of the gears.

There is a general complaint that larger tilapias entangled in the mono-filament gill nets escape after damaging the nets. To overcome this problem, it is suggested that the thickness of the mono-filament used for fabricating the gill nets may be increased from the present thickness of 0.25 mm to more than 0.3 mm preferably 0.32 mm to avoid damage of fishing gear.

Coloured nets are efficacious than the presently used white nets as the visibility of the nets is less in the phytoplankton dominated reservoirs.

As the food conversion efficiency and the growth rate of fish reduce after 2-3 years of age, the fish should be harvested within this age group to achieve maximum production per unit area.

A minimum growth period of at least two years be given for major carps to breed once in their life span especially in the medium reservoirs with ideal breeding grounds.

The fishing holidays often recommended for medium and large reservoirs need not be strictly followed in small reservoirs, as there is no evidence of spawning of major carps in the latter. However, regular stocking of quality fish seed of appropriate size and species mix must be followed for obtaining a sustained yield.

Screens of appropriate mesh size may be fixed in the irrigation canals and surplus weirs to prevent escapement of fishes.

Stocking of these reservoirs with seed of cultivable carps (*C. catla, L. rohita, C. mrigala* and *C. carpio*) may be done at the earliest possible after receiving water, as the delay may encourage establishment of tilapia, minor carps and weed fishes.

The reservoirs which are not connected to major river systems can be stocked with silver carp to a limited extent of 2 to 5% of the total fish seed for the utilization of the abundant phytoplankton population. While in the process of promoting fish yield of carps, conservation of indigenous fauna should not be ignored.

A lot of debris brought to the reservoirs by the runoff rain water year after year got settled down reducing the capacity of the reservoir to hold water. The accumulated silt should be removed probably once in five years when the water level in the reservoir was low so that the reservoir would store water to its original capacity for meeting the demand in future.

The poor yield in the reservoirs managed by the Department of Fisheries as well as Fisheries Development Corporation and impressive fish production from reservoirs managed by private entrepreneurs suggest that it would be advantageous to attract private entrepreneurs to invest in the potential sector for enhancement of inland fish production. In this connection, a good leasing policy should be formulated. Leasing out of the fishery rights of water bodies through public auction to the highest bidder for a reasonably long period of 5 to 6 years would attract huge private investment in to fishery sector, encourage entrepreneurs, reduce the government botheration on fishery development, increase the revenue of the government and bring healthy competition among the aquaculturists.

12.2 Guidelines for an individual or group of reservoirs:

12.2.1 Reservoirs without fishery development:

Parambikulam, Thoonakadavu and Peruvaripallam:

i) Detailed studies of the ecology and fisheries of the above reservoirs will help to understand the present status and to formulate future management.

ii) Unauthorized fishing in these reservoirs may affect the population structure and bring imbalance in the icthyofauna. Hence, it is essential to regulate fishing activities of tribal and local residents.

iii) A treasure of various native species consisting of *T. khudree, P. carnaticus, P. dubius, P. sarana, P. curmuca, P. dorsalis* and *P. dobsonii* are becoming endangered species. Hence, appropriate steps are essential to conserve their germplasm to maintain the biodiversity of these reservoirs.

iv) Setting up a fish farm for artificial breeding of threatened species, *T. khudree* would help to develop game fishery activities in this region. Occurrence of spawning of *T. khudree* in these reservoirs indicates the feasibility of breeding and propagation.

12.2.2 Reservoirs under the management of the Department of Fisheries:

In general, the annual average yield in all the reservoirs under the control of Department of Fisheries is far below (3.92 to 357.8 kg/ha) compared to their fish production potential (108.3 to 904.6 kg/ha), warranting improvement in the fishery management.

Pilloor:

i) The low fish yields (1.5 to 9.9 kg/ha) obtained from the reservoir reveals poor management. Improvement in fish seed stocking and harvesting of marketable size fish is required. Stocking of advanced fingerlings of catla, rohu, mrigal and common carp at 3:2:1:1 ratio and 200 nos./ha is recommended.

ii) As the estimated fish production potential of the reservoir is high (469.8 kg/ha), production oriented management measures may be applied to enhance fish yield.

Gunderipallam:

i) This shallow productive reservoir is ideal for the application of 'put and harvest' principles of fishery activity.

ii) Though the fish yield in the reservoir is comparatively higher than those of the other reservoirs of Tamil Nadu, its full production potential is not exploited.

iii) Manuring of this reservoir may augment fish production.

iv) Lack of fish farm facilities nearby the reservoir and stocking of fish seed directly after transporting from distant place led to mortality of the seed. Construction of nursery ponds near the reservoir would alleviate this problem.

v) Unhealthy seeds fall prey to predatory fishes like *Glossogobius giuris*, abundantly present in this reservoir. Hence, healthy fingerlings of more than 100 mm should be stocked in addition to management measures to control predatory fishes. Cage culture technique may be practiced in this reservoir to raise healthy fingerlings of desired size.

vi) Failure to stock cultivable carps before tilapia establishes its progeny in the reservoir makes former species to compete for food and space with the aggressive tilapia.

vii) Fixing screens at appropriate places may prevent large-scale escapement of fingerlings and adult fish from the reservoir through the overflow weirs and irrigation canals during monsoon season.

Varattupallam:

i) This zooplankton rich reservoir may be stocked with surface feeders, preferably *C. catla* to graze upon the feed.

ii) This small highly productive reservoir is also suitable for fertilization and enhancement of fish production.

Vaigai:

i) Vaigai, a medium reservoir with mean depth of 8.1 m offers a tremendous fish production potential, because of its favourable physico-chemical characteristics, rich resources of biotic organisms and macrobenthos. Paradoxically, the yield was showing wide fluctuations registering peak landings of 45.6 t, 41.0 t and 60.2 t in the years 1964-65, 1982-83 and 1988-89 respectively. However, the production nose-dived to a low range of 9.68 to 15.3 t during the recent years. Expansion of existing fish farm and utilization of entire farm would ensure steady supply of seeds for stocking the reservoir, resulting in higher fish production.

ii) Fluctuating trend of fish catch compel the fishermen to opt for other occupation. Factors impeding the fish production in this reservoir should be identified and due measures be taken.

iii) Stocking of *Pangasius pangasius* would utilize the abundant molluscs available in this reservoir.

Vembakottai:

i) Since Vembakottai is a small and seasonal reservoir, culture based fisheries system may be adopted.

ii) *C. mrigala* may be stocked in this myxophyceae dominant reservoir.

iii) Nursery ponds constructed adjacent to the reservoir may be maintained and utilized for round the year seed production.

iv) Bottom feeders (*C. mrigala* and common carp) may be stocked to utilize the rich chironomid larvae available in this reservoir for increasing the fish yield.

Manimuthar:

i) Culture based fisheries can be adopted in this clear calm reservoir.

ii) Further, this less turbulent, weed free and shallow reservoir offers ideal sites for installation of cages and pens for culture purpose.

iii) The national fish seed farm available near the reservoir should be utilized for raising advanced fingerlings and stocked in a phased manner at right species-mix and density throughout the year.

Peechiparai:

i) This reservoir tends to be oligotrophic, but organic content, nitrogen and phosphorous are abundant in the soil, ensuring high return if adequate stocking rate of seeds are maintained.

ii) The reservoirs should be stocked with adequate quantity of detritus feeders for utilizing the rich resource of detritus available in the ecosystem due to decomposition of submerged vegetation.

iii) Submerged trees left during pre-impoundment period obstructs active fishing and provides shelter to fish like common carp, making fishing difficult. Steps may be taken to remove the tree trunks when the reservoir level shrinks to make aquaculture operations easy.

iv) As the transparency of the water exceeds 300 cm, the traditional use of white coloured nets may be substituted for coloured ones to reduce visibility of the nets and to increase the efficacy of the nets to capture fishes.

v) Among the stocked fish, catla was allowed to grow to a size ranging from 5 to 15 kg. As the food conversion efficiency and the growth rates are reduced with the progress of age, the fish should be harvested at minimum marketable size to achieve maximum production per unit area.

Krishnagiri:

i) Nutrients and fertile soil drained from the largest catchment area of (5428.3 sq. km) of this reservoir might have favoured the growth of indigenous fishes in this reservoir. Yet, the yield of stocked varieties was poor. Common carp and silver carp may be included in the stocking material to utilize the rich population of phytoplankton.

Sandynulla:

i) Though auto stocking of mirror carps was recorded during May and June, frequent mortality was recorded due to direct discharge of effluents from protein production industry.

ii) The deleterious effect of this untreated effluents let into the reservoir causing large scale mortality of fish should be brought to the knowledge of Protein Production Industry authorities concerned and the effluents treatment be insisted upon.

Vidur:

i) This shallow, seasonal and less productive reservoir may be upgraded by artificial fertilization.

ii) As the previous fisheries data show that the stocked varieties have performed well, this reservoir may be utilized for intensive farming, adopting 'put and take' culture policy.

iii) Prospects of freshwater prawn may be explored in this reservoir as giant size *M. malcomsonii* and *M. rosenbergii* were encountered in the fish catch.

Willington:

i) This is a water stressed productive reservoir. The presence of essential nutrients and growth of biotic communities during monsoon offer ample scope for short-term culture practices. Though the fish production potential

was 130.0 kg/ha/yr, the return was low, warranting the implementation of better fishery management.

ii) Rapid proliferation of tilapia may hamper the growth of carps. Control measures of tilapia may be advantageous to reduce intra-species competition and stunted growth.

Odathurai:

i) Predatory fishes (*Channa spp., Glossogobius sp., Mastacembelus spp.* and *Mystus spp.*) and other uneconomical varieties of fishes (minor carps, tilapia and weed fishes) occurring in sizeable quantities in the impoundment may be removed before stocking the seeds of cultivated carps.

ii) Healthy fingerlings of fast growing carps *viz.* catla, rohu, mrigal and mirror carp in the ratio of 2:1:1:1 may be stocked at a low density of 750 Nos./ha.

iii) In the absence of fish farm facilities nearby the impoundment, alternative system like pen culture may be adopted for raising fingerlings for stocking the reservoir.

Orathupalayam:

i) The effluent discharged into the reservoir must be treated before hand.

ii) Accumulation of heavy metals in the gills and tissues of fish indicates that the fish is not suitable for consumption. Hence, there is need for bringing the hazardous effect of pollution of untreated effluents to the notice of all concerned and take precautionary measures to keep the environment free from pollution so that fishes suitable for human consumption could be produced in future.

12.2.3 Reservoirs managed by Tamil Nadu Fisheries Development Corporation Limited:

Amaravathy:

i) The annual stocking of the carp seeds in the recent years has helped to increase the contribution of carp fishery (80.3%), reducing tilapia and other non-stocked species to 19.7%. Since, the actual fish yield (202.0 kg/ha) is less than its potential (465.0 kg/ha), appropriate stocking with suitable species and density would enhance the fish production.

ii) Fish farm available near the reservoir should be utilized to its core for the uninterrupted supply of fish seed to the reservoir.

12.4 Reservoirs managed by private fish farmers:

Uppar:

i) Inadvertent stocking of *A. nobilis* offsets the growth of *C. catla* by sharing the common niche with the latter. *A. nobilis* grew fast recording 2.5 to 3.0 kg/yr, but it fetched low price due to lack of consumer's preference. Hence, stocking of *A. nobilis*, should be withheld in future.

ii) Removable type of weld mesh screens fabricated as per the advice of CIFRI scientists be placed near the origin of the canal to prevent downward escapement of fishes before releasing the water for irrigation

iii) This reservoir retains water depth of less than 2m for a period of 5 to 6 months. As the benefit of fertilization could be completely harnessed, this management measure may be tried in this reservoir.

iv) The fish production potential of the reservoir has been estimated as 569.9 kg/ha. The highest yield of 224.8 kg/ha has been achieved in this reservoir. A production rate of >1000 kg/ha can be achieved if judicious stocking and exploitation norms, coupled with fertilization technique are followed.

v) There is a shortage of water supply to the fish farm, hampering the seed-rearing programme. Therefore, assured water supply to the fish farm be made to facilitate uninterrupted seed rearing activities.

vi) Seed of *H. molitrix* and *Pangasius pangasius* be included in the stocking material as the former would consume the abundant phytoplankton and the latter feed on molluscan forms present in the reservoir.

Palar-Poranthalar:

i) Among the reservoirs studied Palar-Poranthalar is the best managed reservoir which yielded a sustained fish catch ranging from 201.0 to 257.8 kg/ha. The fish yield was progressively increasing year after year, giving scope for further improvement. The highest yield rate of 257.8 kg/ha was still less than the fish production potential of 622.13 kg/ha estimated through primary production. The gap between the yield and the potential may be due to some artifacts in stocking and exploitation.

ii) Catla, the dominant species (80.0%) in the fish seed stocked in the reservoir contributed only 61.3 % to the total fish harvested. The species mix and the stocking rate must be so adjusted that the food resources available in the reservoir is utilized at the optimum level.

iii) To consume the phytoplankton (41.9 to 57.7%) available in the reservoir, silver carp may be stocked up to 5% in the total seed stocked.

iv) The fish farm, originally constructed for raising fish seed for stocking the reservoir, should be utilized for the said purpose. Further, the water area of the fish farm may be expanded to meet the increasing demand for seed often deficient compared to the required quantity.

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Table 1. Morphometric features of the reservoirs.

Reservoir	Lati-tude	River	Const. period	Basin	District	Catch-Ment area (ha)	Gross capacity at FRL M.cu.m	Water area at FRL (ha)	Catch-ment/ FRL (C/A)	Morpho-edaphic index (MEI)	Mean depth (m)
Parambikulam	10°23'	Parambikulam	1959-67	Chalakudi	Coimbatore	23050	504.66	2072	11.10	0.43	24.3
Thoonakadavu	10°24'	Thoonakadavu	1963-65	Chalakudi	Coimbatore	4335	15.77	432	10.0	5.11	3.6
Peruvaripallam	10°25'	Peruvaripallam	1965-71	Chalakudi	Coimbatore	1580	17.56	290	5.4	1.93	6.06
Amaravathy	10°11'	Amaravathy	1953-58	Cauvery	Coimbatore	83900	114.61	830	98.7	0.96	13.48
Palar-Poranthalar	10°16'	P.Poranthalar	1971-78	Cauvery	Dindugal	25900	43.19	518	50.0	2.00	8.3
Pilloor	11°16'	Bhavani	1962-66	Cauvery	Coimbatore	119140	44.4	400	332.2	1:60	11.1
Uppar	11°16'	Uppar	1965-68	Cauvery	Erode	90388	16.31	453	199.5	6.73	3.6
Gunderipallam	10°47'	Gunderipallam	1974-78	Cauvery	Erode	7223	3.06	61	118.4	4.9	5.01
Varattupallam	11°32'	Varattupallam	1974-78	Cauvery	Erode	6682	3.94	89	75.0	6.15	4.4
Sandynulla	11°33'	Sandynulla	-	-	Nilgiris	4400	27.47	263	16.8	2.89	10.44
Vaigai	10°37'	Vaigaiyaru	1954-59	Vaigai	Theni	225330	192.57	2419	93.2	3.06	7.96
Vembakottai	9°20'	Vaippar	1980-85	Vaippar	Virudhunagar	2691	11.29	468	5.8	11.26	2.41
Manimuthar	8°40'	Manimuthar	1951-58	Tambarabarani	Tirunelveli	16161	156.07	940	17.2	1.16	16.6
Pechiparai	8°29'	Kodayar	1895-06	Kodayar	Kanyakumari	20179	150.26	1515	13.7	1.20	9.9
Krishnagiri	12°30'	Ponniar	1955-58	Ponniar	Dharmapuri	542843	66.10	1248	434.9	10.10	3.7
Vidur	12°04'	Varahanadhi	1958-59	Varahanadhi	South Arcot	129800	16.93	798	162.7	8.49	2.12
Willington	11°54'	Periyaodai	1913-23	Vellar	South Arcot	12950	73.4	1554	8.3	10.62	4.17
Odathurai	11°26'	Bhavani	1936-37	Cauvery	Erode	5680	1.28	75	69.82	198.72	1.57
Orathupalayam	11°10'	Noyyal	1986-94	Cauvery	Erode	221555	17.44	423	532.7	486.99	4.12

Table 2. Soil quality of the reservoirs

Reservoirs	PH (units)	Ec (mmhos)	N (mg/100g)	P (mg/100g)	Org.C (%)
Parambikulam	5.4 - 6.3 (5.95)	0.2 - 0.3 (0.22)	10.3 - 27.3 (16.7)	2.5 - 2.8 (2.62)	3.6 - 4.5 (4.0)
Thoonakadavu	6.5 - 6.7 (6.57)	0.17 - 0.23 (0.20)	27.3 - 33.9 (30.1)	0.9 - 2.2 (1.57)	2.6 - 5.5 (4.0)
Peruvaripallam	6.5 - 7.1 (6.67)	0.17 - 0.25 (0.21)	26.6 - 40.6 (33.1)	2.8 - 3.2 (2.97)	2.0 - 3.1 (2.42)
Amaravathy	6.8 - 7.3 (7.05)	0.25 - 0.29 (0.26)	24.3 - 27.7 (25.5)	0.3 - 0.5 (0.4)	1.0 - 2.9 (1.82)
Palar-Poranthalar	7.0 - 7.2 (7.07)	0.20 - 0.28 (0.25)	24.8 - 27.7 (25.7)	0.8 - 3.1 (2.32)	1.5 - 2.0 (1.82)
Pilloor	6.8 - 7.1 (6.95)	0.24 - 0.29 (0.26)	8.6 - 27.5 (14.8)	0.2 - 2.1 (1.55)	1.3 - 3.2 (2.85)
Uppar	7.1 - 7.9 (7.52)	0.29 - 0.38 (0.34)	30.0 - 31.6 (30.7)	0.49 - 0.65 (0.55)	0.3 - 0.5 (0.39)
Gunderipallam	7.3 - 7.9 (7.75)	0.63 - 0.83 (0.68)	25.2 - 26 (25.6)	3.0 - 3.2 (3.12)	2.9 - 3.1 (3.0)
Varattupallam	7.7 - 7.9 (7.83)	0.33 - 0.37 (0.35)	26 - 27.7 (27.0)	2.0 - 3.2 (2.73)	1.9 - 4.5 (3.4)
Sandynulla	5.7 - 7.7 (6.31)	0.16 - 0.46 (0.32)	24.8 - 24.99 (24.9)	0.96 - 1.08 (1.03)	1.11 - 1.43 (1.33)
Vaigai	5.7 - 6.0 (5.9)	0.32 - 0.42 (0.37)	15.4 - 18.1 (17.3)	0.75 - 3.04 (2.43)	1.1 - 2.12 (1.36)
Vembakottai	5.8 - 6.6 (6.05)	0.36 - 0.45 (0.40)	20.6 - 21.56 (21.1)	0.75 - 1.85 (1.55)	0.83 - 1.08 (0.98)
Manimuthar	5.9 - 6.3 (6.04)	0.59 - 0.75 (0.68)	2.41 - 12.81 (10.0)	0.75 - 2.77 (2.23)	0.38 - 0.91 (0.45)
Pechiparai	5.5 - 6.0 (5.75)	0.36 - 0.43 (0.39)	40.07 - 41.44 (40.6)	0.62 - 2.78 (1.71)	0.75 - 1.93 (1.61)
Krishnagiri	5.7 - 7.6 (6.23)	0.38 - 0.46 (0.42)	18.13 - 19.6 (18.9)	0.68 - 0.75 (0.71)	1.26 - 1.84 (1.66)
Vidur	5.6 - 7.8 (6.27)	0.63 - 0.73 (0.67)	3.5 - 3.73 (3.6)	0.75 - 2.1 (1.71)	0.3 - 0.79 (0.44)
Willington	5.6 - 7.8 (6.25)	0.62 - 0.81 (0.72)	7.41 - 7.65 (7.5)	0.75 - 2.15 (1.74)	0.83 - 1.14 (1.04)
Odathurai	7.7 - 8.1 (7.95)	0.6 - 0.8 (0.67)	10.87 - 21.48 (18.1)	0.6 - 1.06 (0.87)	1.36 - 1.53 (1.44)
Orathupalayam	8.1 - 8.5 (8.18)	0.1 - 1.0 (0.65)	9.6 - 12.18 (10.50)	0.4 - 0.96 (0.66)	0.36 - 0.62 (0.51)

Table 3. Physico - chemical characteristics of water.

Reservoir	Temp. (°C)	pH (units)	D.O. (ppm)	Trans. (cm)	T.A. (ppm)	T.D.S. (ppm)	Sp.Cond. (µmhos/cm)	PO_4 (ppm)	NO_3 (ppm)	SiO_3 (ppm)	Ca (ppm)	Mg (ppm)	Hard-ness (ppm)
Parambikulam	24.0 - 28.6 (26.65)	6.4 - 7.6 (6.9)	4.0 - 8.8 (6.1)	145 - 352 (257)	24.0 - 176 (63.6)	8.4 - 62.6 (23.37)	16.4 - 136.1 (50.15)	0.05 - 0.16 (0.08)	-	2.4 - 3.3 (2.77)	-	-	-
Thoonakadavu	24.0 - 27.8 (25.20)	6.7 - 7.4 (6.97)	6.2 - 8.2 (7.45)	107 - 207 (164)	22.0 - 26.0 (24.5)	10.3 - 27.2 (18.42)	20.3 - 57.8 (38.8)	0.05 - 0.06 (0.05)	-	6.6 - 7.0 (6.8)	-	-	-
Peruvaripallam	25.0 - 29.8 (26.95)	6.8 - 7.9 (7.2)	5.5 - 8.8 (7.47)	103 - 140 (117)	30.0 - 34.0 (31.5)	10.2 - 13.4 (11.75)	10.2 - 27.3 (17.8)	0.05 - 0.07 (0.06)	-	7.0 - 7.3 (7.1)	-	-	-
Amaravathy	24.0 - 30.5 (27.37)	7.5 - 8.4 (8.0)	8.0 - 9.6 (8.65)	76.5 - 140 (116)	16.0 - 97.0 (48.2)	14.4 - 34.0 (26.6)	28.0 - 71.0 (47.4)	0.06 - 0.07 (0.062)	-	7.3 - 7.9 (7.5)	-	-	-
P.Poranthalar	26.0 - 28.0 (27)	7.1 - 8.7 (7.9)	5.4 - 8.0 (7.05)	100 - 140 (128)	50.0 - 74.0 (65.0)	13.6 - 18.4 (14.9)	26.5 - 34.0 (29.7)	0.04 - 0.06 (0.05)	-	5.2 - 5.9 (5.6)	-	-	-
Pilloor	23 .0- 28.0 (25.75)	7.5 - 8.1 (7.7)	7.6 - 9.2 (8.2)	55 - 200 (133)	34.0 - 76.0 (60.0)	13.5 - 20.1 (16.8)	27.3 - 42.0 (35.2)	0.06 - 0.08 (0.07)	-	4.0 - 6.0 (4.8)	-	-	-
Uppar	27.5 - 30.0 (28.33)	7.6 - 8.4 (7.86)	4.8 - 6.2 (5.26)	15 - 22 (17)	110 - 176 (154)	32.4 - 62.6 (52.5)	65.1 - 136.1 (112.4)	0.12 - 0.16 (0.14)	-	2.9 - 3.3 (3.2)	-	-	-
Gunderipallam	25.0 - 30.0 (28.25)	8.2 - 8.4 (7.27)	6.0 - 8.8 (6.9)	42 - 52 (48.2)	120 - 294 (172.5)	18.0 - 32.0 (24.0)	40.4 - 67.6 (51.7)	0.16 - 0.28 (0.22)	-	8.2 - 9.1 (8.5)	-	-	-
Varattupallam	28.0 - 29.0 (27.33)	8.0 - 8.2 (8.0)	6.4 - 9.0 (7.8)	42 - 55 (50)	140 - 152 (144)	21.2 - 33.0 (28.1)	47.3 - 67.1 (59.2)	0.12 - 1.8 (0.7)	-	7.9 - 9.0 (8.4)	-	-	-
Sandynulla	12.1 - 23.0 (16.5)	7.5 - 8.6 (8.0)	6.2 - 8.2 (6.85)	74 - 86 (79)	40.8 - 94.0 (66.2)	27.1 - 34.4 (30.2)	59.8 - 69.8 (63.5)	0.4 - 0.54 (0.34)	0.024-2. 9 (0.689)	9.7 - 17.8 (12.9)	18.4-23.2 (21.22)	30.4-36.4 (33.40)	72-80 (77)
Vaigai	26.0 - 28.0 (27.35)	7.8 - 8.8 (8.2)	7.2 - 8.4 (7.6)	67 - 83 (76)	55.2-200.4 (117.2)	17.7 - 34.1 (24.4)	39.5 - 73.2 (51.5)	0.15 - 0.46 (0.31)	0.21-1.2 (0.540)	8.7 - 26.6 (15.15)	12.0-20.2 (16.03)	31.2-55.1 (43.15)	64-112 (88)
Vembakottai	27.0 - 30.6 (29.15)	6.2 - 8.9 (7.8)	6.1 - 7.5 (6.6)	20 - 100 (51.5)	114 - 277.2 (181)	29.1 - 36.4 (28.0)	42.0 - 75.8 (58.2)	0.15 - 0.62 (0.31)	0.10-1.6 (0.613)	11.5 -13.9 (12.7)	18.4-21.0 (19.22)	40.8-53.7 (45.45)	90-108 (95)
Manimuthar	25.2 - 27.0 (26.4)	7.0 - 7.3 (7.15)	7.6 - 8.0 (7.8)	30 - 220 (116)	36 - 52 (44.1)	10.5 - 35.1 (19.5)	22.7 - 70.8 (40.6)	0.26 - 0.45 (0.34)	T-1.7 (1.7)	6.2 - 14.0 (9.52)	2.4-5.8 (3.2)	3.8-8.4 (6.0)	12.2-18 (15)
Pechiparai	27.0 - 29.0 (27.6)	7.6 - 8.1 (7.9)	6.7 - 8.0 (7.5)	80 - 300 (149.5)	24 - 32 (27.7)	9.5 - 16.2 (12.12)	10.1 - 27.2 (21.2)	0.19 - 0.47 (0.33)	0.43-1.7 (0.753)	6.0 - 7.8 (6.75)	1.8-3.2 (2.8)	3.3-7.7 (5.5)	8-16 (12)
Krishnagiri	24.0 - 29.0 (27.25)	7.2 - 8.4 (8.0)	6.7 - 9.3 (7.7)	36 - 93 (64)	113 - 176 (147.5)	25.8 - 45.6 (38.3)	56.0 - 92.5 (78.6)	0.21 - 1.1 (0.54)	0.42-2.7 (1.180)	8.9 - 17.4 (14. 42)	19.2-29.6 (20.42)	53.0-74.6 (60.95)	110-146 (122)
Vidur	28.0 - 31.5 (30.5)	8.1 - 8.6 (8.2)	5.6 - 7.8 (7.17)	27 - 95 (56.5)	96 - 181.2 (134)	14.5 - 29.0 (21.9)	37.5 - 42.0 (38.1)	0.32 - 0.44 (0.4)	0.36-0.61 (0.466)	13.3 -17.1 (15.9)	6.9-21.6 (11.85)	56.6-88.2 (74.45)	114-154 (134)
Willington	27.6 - 30.5 (29.4)	7.9 - 8.5 (8.2)	7.0 - 8.2 (7.46)	27 - 120 (63)	96 - 178 (112)	42.0 - 46.1 (33.2)	84.8 - 91.3 (58.8)	0.39 - 0.51 (0.44)	0.84- (0.84)	16.9- 19.9 (18.9)	20.0-21.6 (20.82)	33.8-54.0 (43.9)	78-110 (94)
Odathurai	30.0 - 31.0 (30.1)	7.4 - 8.4 (8.0)	6.8 - 9.4 (8.1)	33 - 82 (66.2)	86 - 163 (139)	256 - 332.8 (289.6)	400 - 520 (452.5)	0.13 -.195 (0.149)	0.025-2.7 (0.828)	4.1 - 19.5 (16.15)	15.2-32.9 (23.53)	22.9-56.6 (39.54)	142-272 (207.2)
Orathupalayam	29.3 - 30.0 (29.77)	7.5 - 8.2 (7.9)	6.4 - 7.6 (7.3)	80 - 124 (98.5)	74 - 240 (178)	1728-2240 (2011.2)	2700 - 3500 (3142.5)	0.18- 0.137 (0.201)	0.026-0.6 (0.40)	8.2 - 12.8 (10.82)	40.1-112.2 (79.15)	48.1-149 (103.9)	30-832 (596)

Table 4. Distribution of plankton (Nos./l) and their contribution (%) in the reservoirs.

Reservoirs	C.phy ceae	B.phy ceae	M.phy ceae	Desmidia ceae	Total phyto Plankton	Protozoa	Rotifera	Cladocera	Copepoda	Total zoo plankton	Total plankton
Parambikulam	8259	3202	392	-	11853	-	540	163	495	1198	13051
(%)	(63.3)	(24.5)	(3.0)		(90.8)		(4.1)	(1.2)	(3.8)	(9.2)	
Thoonakadavu	12593	11600	400	-	24593	-	4808	300	758	5866	30459
(%)	(41.3)	(38.1)	(1.3)		(80.7)		(15.8)	(1.0)	(2.5)	(19.2)	
Peruvaripallam	9419	5533	608	-	15560	-	1167	400	588	2155	17715
(%)	(53.1)	(31.2)	(3.4)		(87.7)		(6.6)	(2.3)	(3.3)	(12.2)	
Amaravathy	2633	13348	7528	-	23509	-	470	180	455	1105	24614
(%)	()10.7)	(54.2)	(30.6)		(95.5)		(1.9)	(0.7)	(1.8)	(4.5)	
Palar-Poranthalar	6103	2435	1070	-	9608	-	2513	1598	2118	6229	15837
(%)	(38.5)	(15.3)	(6.8)		(60.6)		(15.9)	(10.0)	(13.4)	(39.4)	
Pilloor	1083	1699	380	-	3162	-	250	200	348	798	3960
(%)	(27.3)	(42.9)	(9.6)		(79.8)		(6.3)	(5.0)	(8.8)	(20.2)	
Uppar	2183	1480	1143	-	4806	-	423	193	313	929	5735
(%)	(38.1)	(25.8)	(19.9)		(83.8)		(7.4)	(3.4)	(5.4)	(16.2)	
Gunderipallam	4750	3700	878	-	9328	-	3048	1930	3803	8781	18109
(%)	(26.2)	(20.4)	(4.8)		(51.6)		(16.8)	(10.6)	(21.0)	(48.4)	
Varattupallam	723	420	320	-	1463	-	4493	1987	5557	12037	13500
(%)	(5.3)	(3.1)	(2.4)		(10.8)		(33.3)	(14.7)	(41.2)	(89.2)	
Sandynulla	1475	33733	49770	280	85258	40	200	400	340	980	86238
(%)	(1.7)	(39.2)	(57.7)	(0.3)	(98.9)		(0.2)	(0.5)	(0.4)	(1.1)	
Vaigai	6948	9180	5670	-	21798	-	280	100	490	870	22668
(%)	(30.7)	(40.5)	(25.0)		(96.2)		(1.2)	(0.5)	(2.2)	(3.8_	
Vembakottai	4310	7930	10300	360	22900	250	420	190	530	1390	24290
(%)	(17.7)	(32.6)	(42.4)	(1.5)	(94.70	(1.0)	(1.7)	(0.8)	(2.3)	(4.4)	
Manimuthar	3100	2620	2030	3750	11500	-	160	140	340	640	12140
(%)	(25.5)	(21.6)	(16.7)	(30.9)	(94.7)		(1.3)	(1.1)	(2.8)	(5.3)	
Pechiparai	240	453	267	1713	2673	-	53	267	53	373	3046
(%)	(7.9)	(14.9)	(8.8)	(56.2)	(87.8)		(1.7)	(8.8)	(1.7)	(12.2)	
Krishnagiri	11550	20030	7720	130	39430	-	640	410	750	1800	41230
(%)	(28.0)	(48.6)	(18.7)	(0.3)	(95.6)		(1.5)	(0.1)	(1.8)	(4.4)	
Vidur	3620	1890	1620	210	7340	-	330	210	150	690	8030
(%)	(45.0)	(23.5)	(20.2)	(2.6)	(91.3)		(4.1)	(2.6)	(1.9)	(8.6)	
Willington	1690	4870	1070	180	7810	60	-	150	140	350	8160
(%)	(20.7)	(59.7)	(13.1)	(2.2)	(95.7)	(0.7)		(1.8)	(1.7)	(4.2)	
Odathurai	4815	379980	30890	2430	418115	-	50	115	265	430	418545
(%)	(1.1)	(90.8)	(7.4)	(0.6)	(99.9)					(0.1)	
Orathupalayam	2655	9480	19908	8415	40458	60	420	393	110	983	41441
(%)	(6.5)	(22.8)	(48.0)	(20.3)	(97.6)	(1.0)	(1.0)	(0.9)	(0.3)	(2.4)	

Table 5. Seasonal variation in phytoplankton population in the reservoirs (Nos./l).

Reservoirs	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar
Parambikulam	10960	14160	15540	6750
Thoonakadavu	31620	23920	26960	15870
Peruvaripallam	12880	12870	19680	16810
Amaravathy	13750	36420	27720	16140
Palar-Poranthalar	7650	7840	10800	12140
Pilloor	2874	3500	3170	3100
Uppar	4580	DRY	3480	6360
Gunderipallam	6710	12010	10620	7970
Varattupallam	DRY	1760	1660	970
Sandynulla	26880	120840	94710	98760
Vaigai	20520	29240	21910	15520
Vembakottai	15520	25880	5760	45440
Manimuthar	14720	6200	10040	15040
Pechiparai	-	600	2860	4560
Krishnagiri	18600	29240	36360	73520
Vidur	12440	3640	3200	10080
Willington	8200	DRY	7400	8080
Odathurai	128280	1330000	167580	46600
Orathupalayam	23670	45840	72320	20240

Table 6. Plankton diversity in the reservoirs.

Family & genera	PA	TH	PE	AM	PP	PI	UP	GP	VP	SA	VA	VE	MA	PC	KR	VI	WI	OD	OR
CHLOROPHYCEAE																			
Ankistrodesmus sp.	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Staurastrum sp.	P	P	P	P	P	P	P	P	P	P	P	P		P	P	P	P	P	P
Kirchneriella sp.	P		P		P	P	P	P		P	P		P	P	P	P		P	P
Scenedesmus sp.	P	P	P	P	P	P	P	P	P	P	P	P	P		P	P	P	P	
Clostridium sp.		P		P	P	P		P		P		P	P	P			P		P
Pediastrum sp.	P	P	P			P	P	P	P		P	P		P	P	P	P	P	P
Cosmarium sp.		P	P		P		P	P	P	P	P		P		P	P	P	P	P
Zygnema sp.	P		P	P	P	P	P	P	P	P	P	P	P	P		P	P		
Hormidium sp.		P		P	P	P		P	P	P		P		P	P			P	P
Actinastrum sp.	P	P	P				P		P		P	P	P	P	P	P	P	P	P
Spirogyra sp.	P	P	P	P		P	P			P	P		P	P		P	P		P
Tetraspora sp.	P		P	P	P	P		P	P	P		P			P	P		P	P
Coelastrum sp.		P				P	P	P		P	P	P	P	P	P		P	P	
Protococcus sp.	P	P	P	P	P		P	P	P	P	P		P	P	P	P	P		P
Botrycoccus sp.		P	P	P	P	P	P	P	P		P	P	P			P		P	P
Endorina sp.	P	P	P		P	P				P		P		P	P	P	P	P	
Ulothrix sp.			P	P			P	P	P	P	P		P	P	P		P	P	P
Selenastrum sp.		P			P	P	P	P	P	P	P	P	P	P		P			P
	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
BACILLARIOPHYCEAE																			
Tabellaria sp.	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Navicula sp.	P	P	P		P	P	P	P	P	P		P			P	P	P	P	P
Synedra sp.	P			P	P	P	P		P	P	P	P	P	P		P			P
Cyclotella sp.	P	P	P		P		P	P		P	P			P	P		P	P	
Pinnularia sp.				P	P	P	P	P	P	P		P	P		P	P		P	P
Amphora sp.	P	P	P			P	P	P	P			P	P	P		P	P		
Diatoma sp.	P	P	P	P	P					P	P		P	P	P		P	P	P
Fragilaria sp.					P	P	P	P	P	P	P	P				P		P	P
Surirella sp.			P	P		P	P	P			P	P	P		P			P	
Melosira sp.	P	P	P		P	P	P	P		P	P		P	P	P	P	P		P
Cymbella sp.	P				P	P					P	P		P			P	P	P
Nitzhia sp.	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
MYXOPHYCEAE																			
Anabaena sp.		P		P		P			P	P		P	P		P	P	P		P
Nostoc sp.	P	P	P	P	P	P	P	P	P		P			P		P		P	P
Microcystis sp.	P		P	P	P			P		P	P	P	P	P	P		P	P	P
Oscillatoria sp.	P	P	P		P	P	P		P	P	P	P	P	P	P	P	P	P	P
Anacystis sp.		P	P	P	P		P	P				P	P	P		P			
Aphanocapsa sp.					P	P	P	P	P	P	P			P	P		P	P	P
Coelosphaerium sp.	P		P	P	P		P			P		P	P				P		P

Table 6. (contd.) Plankton diversity in the reservoirs.

Family & genera	PA	TH	PE	AM	PP	PI	UP	GP	VP	SA	VA	VE	MA	PC	KR	VI	WI	OD	OR
DESMIDIACEAE																			
Closterium sp.	P	P	P	P	P	P		P		P	P		P	P		P		P	
Camphylodiscus sp.							P			P			P	P		P		P	
PROTOZOA																			
Arcella sp.	P	P	P			P					P	P	P	P	P	P			P
Difflugia sp.				P		P			P	P									
ROTIFERA																			
Keratella sp.		P		P		P		P			P	P	P			P	P		P
Brachionus sp.	P	P	P		P			P	P		P		P		P		P		P
Filinia sp.	P	P	P	P	P	P	P	P	P	P		P	P	P	P	P	P	P	P
Testudinella sp.							P							P		P			
Asplanchna sp.	P	P	P	P	P	P	P	P	P	P	P	P	P		P		P	P	P
Polyarthra sp.				P					P		P			P		P		P	P
CLADOCERA																			
Daphnia sp.	P	P	P	P	P	P	P	P		P			P		P	P			P
Ceriodaphnia sp.						P		P	P	P	P	P		P		P		P	P
Bosmina sp.				P		P			P		P								P
Moina sp.	P											P	P		P	P		P	
Sida sp.		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Diaphanosoma sp.	P	P			P	P		P	P			P		P	P		P		P
COPEPODA																			
Diaptomus sp.	P	P	P	P	P	P	P	P	P	P	P	P		P	P	P	P	P	P
Cyclops sp.				P			P		P	P		P	P	P				P	
Nauplii					P									P	P	P			P

PA - PARAMBIKULAM
TH - THOONAKADAVU
PE - PERUVARIPALLAM
AM - AMARAVATHY
PP - PALAR-PORANTHALAR
PI - PILLOOR
UP - UPPAR
GP - GUNDERIPALLAM
VP - VARATTUPALLAM
SA - SANDYNULLA
VA - VAIGAI
VE - VEMBAKOTTAI
MA - MANIMUTHAR
PC - PECHIPARAI
KR - KRISHNAGIRI
VI - VIDUR
WI - WILLINGTON
OD - ODATHURAI
OR - ORATHUPALAYAM

Table 7. Correlation between abiotic factors and zooplankton abundance.

	Water									Soil					Zoopl.
	Temp.	pH	D.O.	Trans.	T.A.	T.D.S.	Cond.	PO_4	SiO_3	pH	E.C.	N_2	P	Org. C	
Temp	1.0000														
PH	.2985	1.0000													
D.O.	-.0025	.1034	1.0000												
Trans	-.1433	-.3839*	.0428	1.0000											
T.A.	.4022**	.3444*	-.2412	-.4497**	1.0000										
T.D.S.	.3038	.1395	.0850	-.1778	.2617	1.0000									
Cond.	.2973	.1540	.0480	-.1900	.3027	.9963**	1.0000								
PO_4	.0886	.2843	.0419	-.2902	.2821	-.0463	-.0303	1.0000							
SiO_3	.2094	.3561*	.1300	-.3888*	.2919	.3114	.3094	.3497*	1.0000						
pH	.1552	.1013	.0731	-.2077	.2332	.4277**	.4277**	-.1023	-.0666	1.0000					
E.C.	.3851*	.3264*	.0746	-.3864*	.3661*	.3823*	.3823*	.2908	.5376**	.0721	1.0000				
N_2	-2462	-.1341	-.0807	.0565	-.2490	-.1151	-.1180	-.2041	-.4322**	.1292	-.5200**	1.0000			
P	-0316	-.1802	-.0079	.1088	-.0049	-.2921	-.3087	.0456	-.1836	-.1084	.0082	-.0260	1.0000		
Org. C	-3419*	-.2932	.0857	.4097**	-.2113	-.1455	-.1531	-.1355	-.4172**	.1573	-.4325**	.2659	.3838*	1.0000	
Zoopl.	-.0863	.0252	.0729	-.0297	.1112	-.1519	-.1520	-.2173	-.2340	.3521*	-.0541	.2765	.2368	.3738	1.0000

* 5% Significance ** 1% Significance

Table 8. Bottom macrofauna (Nos./m^2) in the reservoirs.

Reservoirs	*Chaoborus* sp.	*Chironomus* sp.	Oligochaetes	Molluscs	Total
Parambikulam	318	149	35	-	502
Thoonakadavu	520	239	79	-	838
Peruvaripallam	87	171	71	-	329
Amaravathy	1052	917	369	-	2338
Palar-Poranthalar	309	440	280	-	1029
Pilloor	44	287	866	109	1306
Uppar	159	1032	743	375	2309
Gunderipallam	1028	526	401	-	1955
Varattupallam	144	310	1818	-	2272
Sandynulla	87	209	115	-	411
Vaigai	152	390	292	1155	1989
Vembakottai	168	406	195	195	964
Manimuthar	206	519	227	-	952
Pechiparai	476	898	552	-	1926
Krishnagiri	903	2835	530	22	4290
Vidur	271	660	541	487	1959
Willington	43	130	58	3939	4170
Odathurai	195	88	48	33	364
Orathupalayam	487	486	423	62	1458

Table 9. Primary production and its related values in reservoirs.

Reservoir	GPP (mgC/m^3/hr)	NPP (mgC/m^3/hr)	Respiration (mgC/m^3/hr)	Av. GPP (mgC/m^2/day)	Net:Gross	P:R
Parambikulam	70.3	26.6	51.9	1032.0	0.38	1.35
Thoonakadavu	78.1	52.1	26.6	1040.9	0.67	2.90
Peruvaripallam	62.5	28.6	39.1	988.9	0.46	1.60
Amaravathy	96.3	75.5	24.9	863.8	0.78	3.86
Palar-Poranthalar	140.6	83.3	52.1	1420.4	0.59	2.70
Pilloor	130.2	96.1	46.8	1287.1	0.73	2.70
Uppar	152.7	110.1	67.3	1561.3	0.72	2.27
Gunderipallam	270.0	169.3	87.4	1632.8	0.67	3.09
Varattupallam	228.1	97.2	158.3	2042.6	0.43	1.44
Sandynulla	48.8	37.1	103.1	1054.7	0.76	0.47
Vaigai	189.1	147.4	43.7	2270.4	0.78	4.32
Vembakottai	138.7	99.6	79.7	1401.5	0.72	1.70
Manimuthar	93.7	52.1	78.1	1254.6	0.56	1.20
Pechiparai	38.3	19.1	23.5	709.9	0.50	1.63
Krishnagiri	160.1	65.9	112.4	2406.1	0.41	1.42
Vidur	109.3	80.2	35.1	1329.8	0.73	3.11
Willington	78.1	39.1	46.9	343.5	0.50	1.67
Odathurai	160.1	144.5	88.5	2478.5	0.90	1.81
Orathupalayam	222.7	144.5	88.6	1665.6	0.64	2.51

Table 10. Correlation between abiotic factors and gross primary production

	Water									Soil					GPP
	Temp.	pH	D.O.	Trans.	T.A.	T.D.S.	Cond.	PO_4	SiO_3	pH	E.C.	Avail.N_2	Avail. P	Org. C	
Temp.	1.0000														
PH	.2985	1.0000													
D.O.	-.0025	.1034	1.0000												
Trans.	-.1433	-.3839*	. 0428	1.0000											
T.A.	.4022**	.3444*	-.2412	-.4497**	1.0000										
T.D.S.	.3038	. 1395	.0850	-.1778	.2617	1.0000									
Cond.	. 2973	.1540	.0480	-.1900	.3027	.9963**	1.0000								
PO_4	.0666	. 2843	.0419	-.2902	.2821	-.0463	-0303	1.0000							
SiO_3	.2034	.3561*	.1300	-.3888*	.2919	.3114	.3094	3497*	1.0000						
PH	. 1552	. 1031	.0731	-.2077	.2332	.4277**	.4277**	-.1023	-.0666	1.0000					
E.C.	.3851*	. 3264*	.0746	-.3864*	.3661*	.3823*	.3823*	. 2908	. 5376**	.0721	1.0000				
Avail.N_2	.2462	-.1341	-.0807	.0565	-2490	-.1151	-.1180	-.2041	-.4322**	. 1292	-5200**	1.0000			
Avail. P	-.0316	-.1802	-.0079	.1088	-0049	-.2921	-.3087	. 0456	-.1836	-1084	. 0082	-.0260	1.0000		
Org. C	-.3419*	-.2932	.0857	.4097**	-2113	-.1455	-.1531	-.1355	-.4172**	.1573	-.4325**	.659	.3838*	1.0000	
GPP	.1573	.3898*	.0224	-.2504	.2431	.3298*	.3418*	. 1128	. 1322	.1045	.1130	-.1555	-.0415	.0005	1.0000

* 5 % Significance ** 1 % Significance

Table 11. Energy flow in the reservoirs

Reservoir	Radiant energy (10^6Kcal/ha)	Primary Production (10^6 K cal/ha)	Photosynthetic efficiency (%)	Fish Prod. Potential (10^6 Kcal/ha)
Parambikulam	9184	37.66	0.41	0.54
Thoonakadavu	9183	37.99	0.41	0.55
Peruvaripallam	9182	36.09	0.39	0.52
Amaravathy	9189	31.52	0.34	0.45
Palar-Poranthalar	9188	51.84	0.56	0.75
Pilloor	9151	46.97	0.51	0.68
Uppar	9151	56.99	0.62	0.82
Gunderipallam	9142	59.60	0.65	0.86
Varattupallam	9141	74.56	0.82	1.28
Sandynulla	9137	38.49	0.42	0.55
Vaigai	9198	82.87	0.90	1.20
Vembakottai	9387	31.82	0.34	0.62
Manimuthar	9393	45.79	0.49	0.61
Pechiparai	9403	25.90	0.28	0.37
Krishnagiri	9139	87.83	0.96	0.88
Vidur	9123	48.53	0.53	0.17
Willington	9146	12.54	0.14	0.18
Odathurai	9160	90.47	0.99	1.30
Orathupalayam	9155	60.80	0.66	1.21

Table 12. Fish production potential versus actual yield in the reservoirs.

S. No.	Reservoirs	Area (ha)	Fish at 1 % GPP (kg/ha)	Av. Fish yield (kg/ha)	Conversion efficiency (%GPP)	Av. Stocking (Nos./ha)	Stocked recovery (kg/ha)
	Dept. of Fisheries						
1	Gunderipallam	61	596.6	357.8	0.599	2878	99.1
2	Odathurai	75	904.6	195.9	0.219	2111	88.5
3	Sandynulla	263	384.9	16.0	0.042	0	16.0
4	Pilloor	400	469.8	8.0	0.017	312	1.1
5	Orathupalayam	423	844.1	87.7	0.100	158	-
6	Vembakottai	468	428.2	19.3	0.045	349	10.2
7	Vidur	798	484.8	5.7	0.010	231	2.7
8	Manimuthar	940	421.4	5.8	0.014	213	2.3
9	Krishnagiri	1248	614.5	33.8	0.050	450	2.5
10	Pechiparai	1515	259.1	10.7	0.041	190	3.4
11	Willington	1554	108.3	3.9	0.040	140	1.2
12	Vaigai	2419	767.3	7.2	0.001	162	2.1
	TNFDC Ltd.						
13	Amaravathy	850	315.3	129.0	0.410	463	82.4
	Private						
14	Uppar	453	569.9	122.9	0.216	605	77.0
15	Palar-Poranthalar	518	518.4	225.0	0.430	740	201.0

Table 13. Classification of the reservoirs.

Classification on the basis of						
Reservoirs	**Area**	**Depth**	**Water retention**	**Water flow**	**Primary production**	**Fish yield**
Parambikulam	Medium	Deep	Perennial	Fluviatile	Medium	-
Thoonakadavu	Small	Deep	Perennial	Fluviatile	Medium	-
Peruvaripallam	Small	Deep	Perennial	Fluviatile	Medium	-
Amaravathy	Small	Deep	Perennial	Fluviatile	Medium	High
Palar-Poranthalar	Small	Deep	Perennial	Fluviatile	Low	High
Uppar	Small	Shallow	Seasonal	Stagnant	High	Medium
Pilloor	Small	Deep	Perennial	Fluviatile	Medium	Low
Gunderipallam	Small	Shallow	Seasonal	Stagnant	High	High
Varattupallam	Small	Shallow	Seasonal	Stagnant	High	-
Sandynulla	Small	Shallow	Seasonal	Stagnant	Low	D.N.A*
Vaigai	Medium	Deep	Perennial	Fluviatile	Low	Low
Vembakottai	Small	Shallow	Seasonal	Stagnant	Low	D.N.A*
Manimuthar	Small	Deep	Perennial	Fluviatile	Low	D.N.A*
Pechiparai	Medium	Deep	Perennial	Fluviatile	Low	Low
Krishnagiri	Medium	Deep	Perennial	Fluviatile	Low	Low
Vidur	Small	Shallow	Seasonal	Fluviatile	Low	Low
Willington	Medium	Shallow	Seasonal	Fluviatile	Medium	Low
Odathurai	Small	Shallow	Seasonal	Stagnant	High	Low
Orathupalayam	Small	Shallow	Seasonal	Stagnant	High	D.N.A*

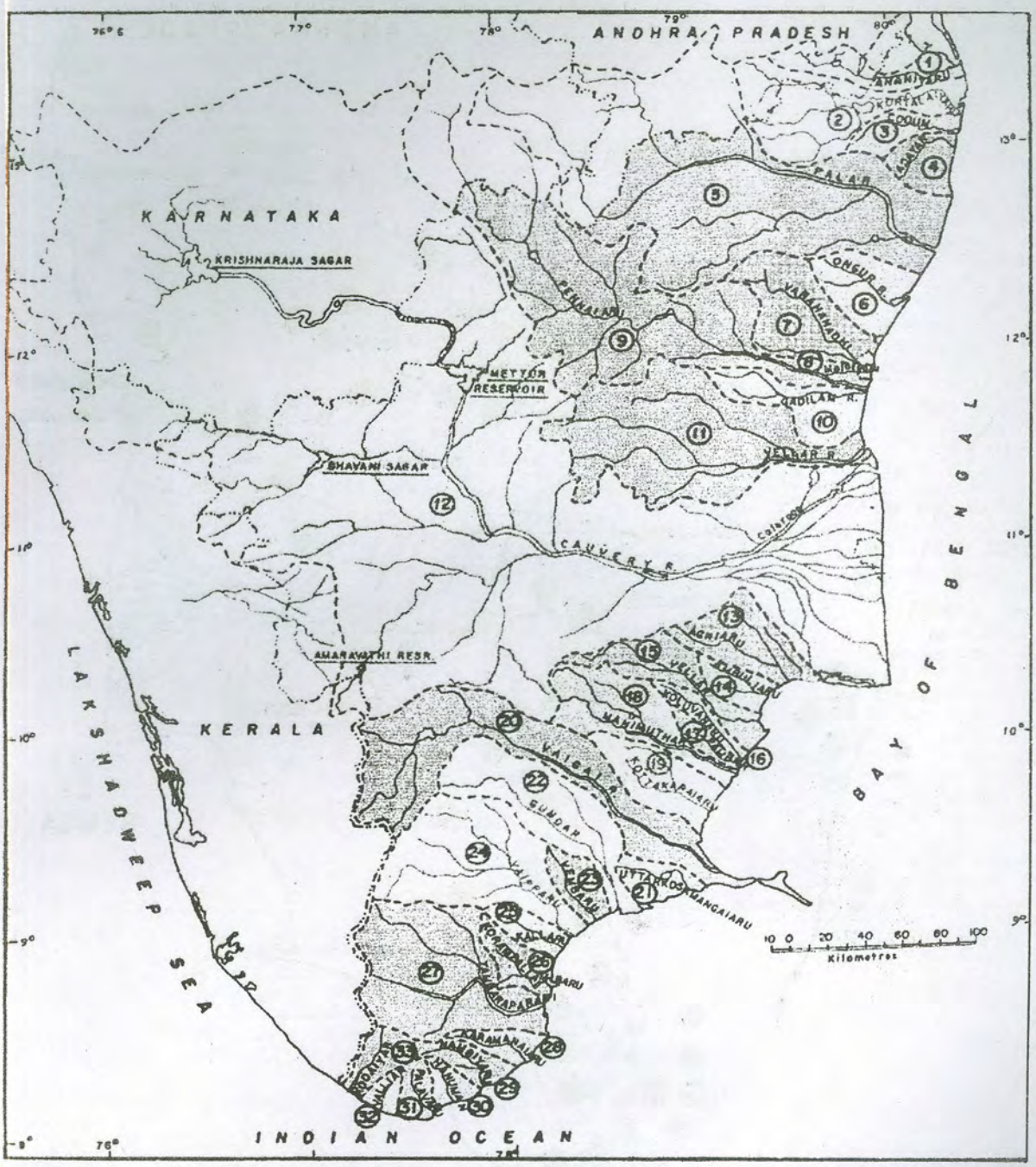


Fig. 1 RIVER BASINS IN TAMIL NADU

1. ARANIYARU
2. KORTALAIYAR
3. COOUM
4. ADAYAR
5. PALAR
6. ONGUR R.
7. VARAHA NADHI
8. MALATTARU
9. PENNAIARU
10. GADILAM
11. VELLAR
12. CAUVERY
13. AGNIARU
14. AMBULAYARU
15. VELLAR
16. KOLUVANARU
17. PAMBAR
18. MANIMUTHAR
19. KOTTAKARAIARU
20. VAIGAI
21. UTTARKOSAMANGAIARU
22. GUNDAR
23. VEMBARU
24. VAIPPARU
25. KALLARU
26. KORAMPALLAMARU
27. TAMBARAPARANI
28. KARAMANAIARU
29. NAMBIYARU
30. HANUMA NADHI
31. PALAVARU
32. VALLIAR
33. KODAIYAR

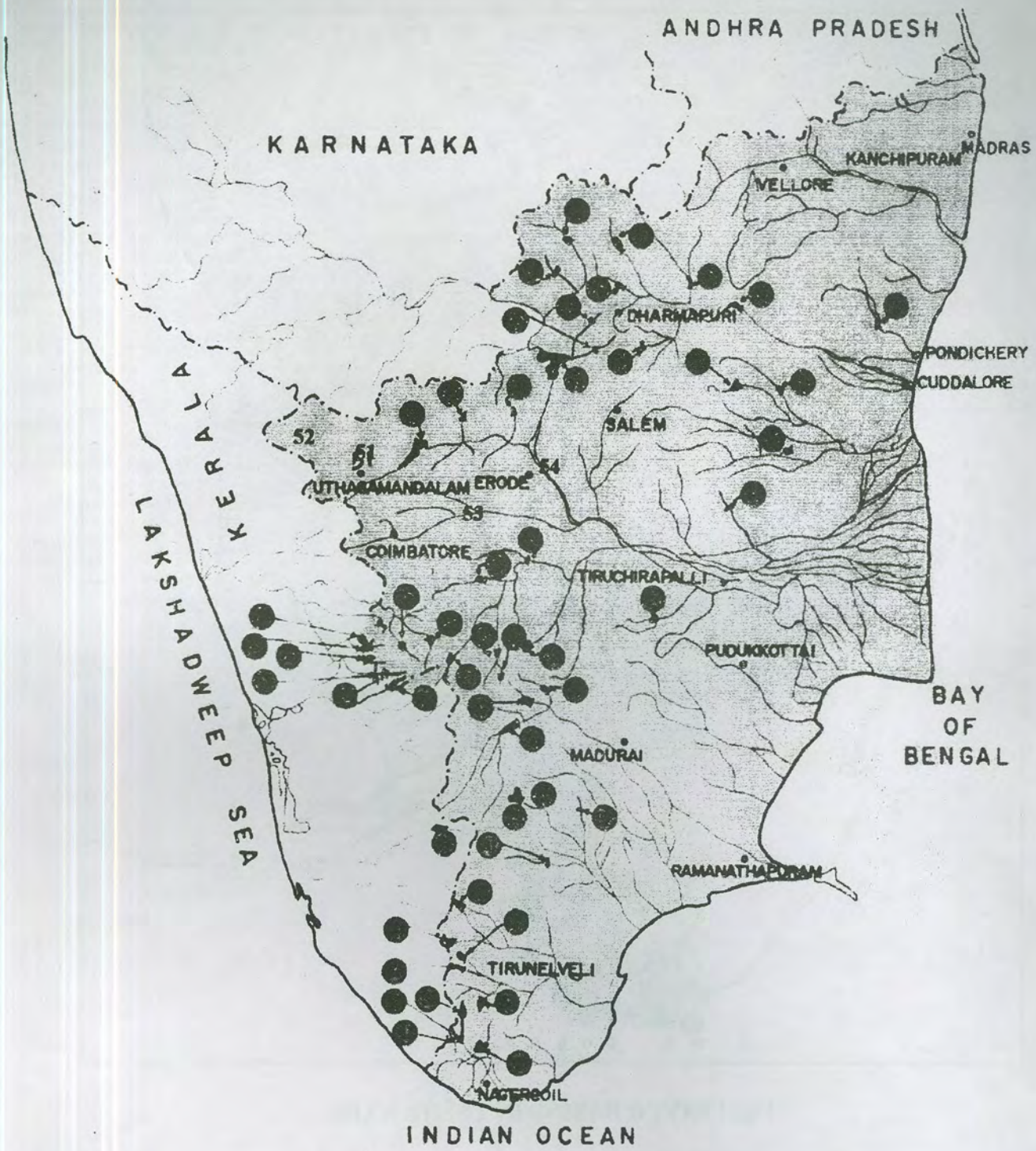


Fig. 2 RESERVOIR LOCATION MAP

46 PARAMBIKULAM
47 THOONAKADAVU
48 PERUVARIPALLAM
18 AMARAVATHY
19 PALAR-PORANTHALAR
51 PILLOOR
21 UPPAR
16 GUNDERIPALLAM
17 VARATTUPALLAM
52 SANDYNULLA
26 VAIGAI
31 VEMBAKOTTAI
33 MANIMUTHAR
38 PECHIPARAI
2 KRISHNAGIRI
1 VIDUR
7 WILLINGTON
54 ODATHURAI
53 ORATHUPALAYAM

Fig.3. Stratification in certain reservoirs of Tamil Nadu

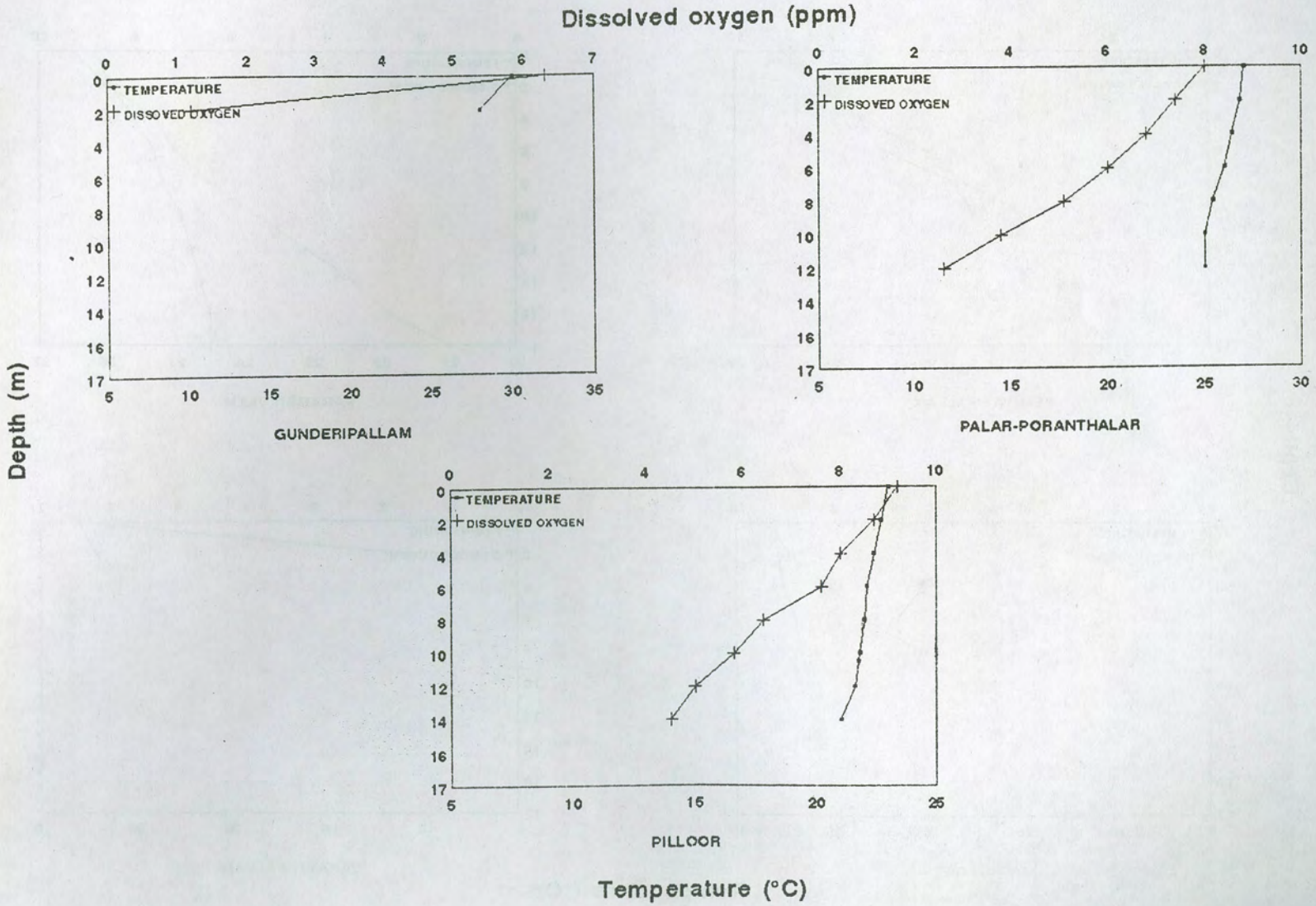


Fig.3. Stratification in certain reservoirs of Tamil Nadu

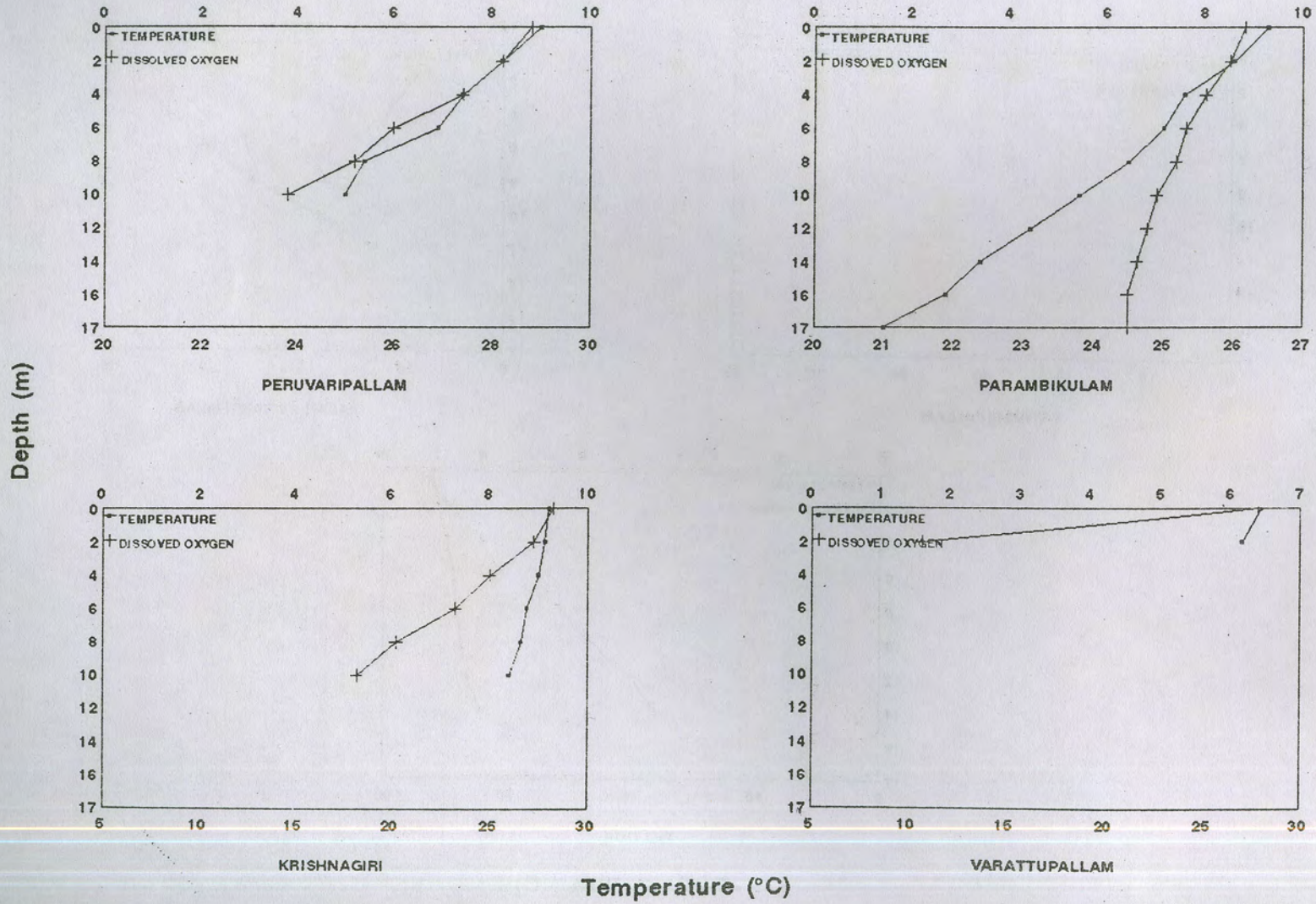


Fig. 4 : Phytoplankton abundance

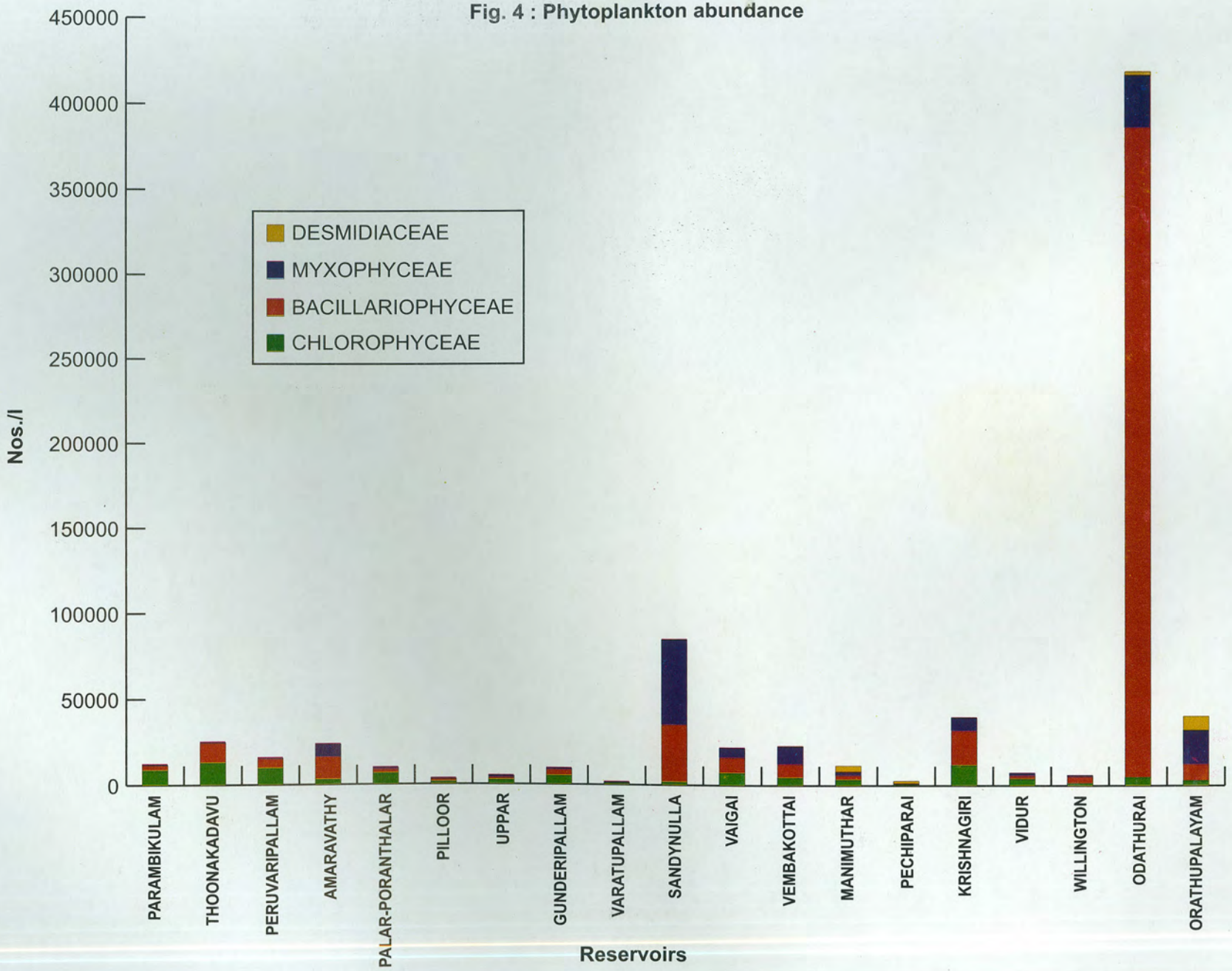


Fig. 5 : Zooplankton abundance

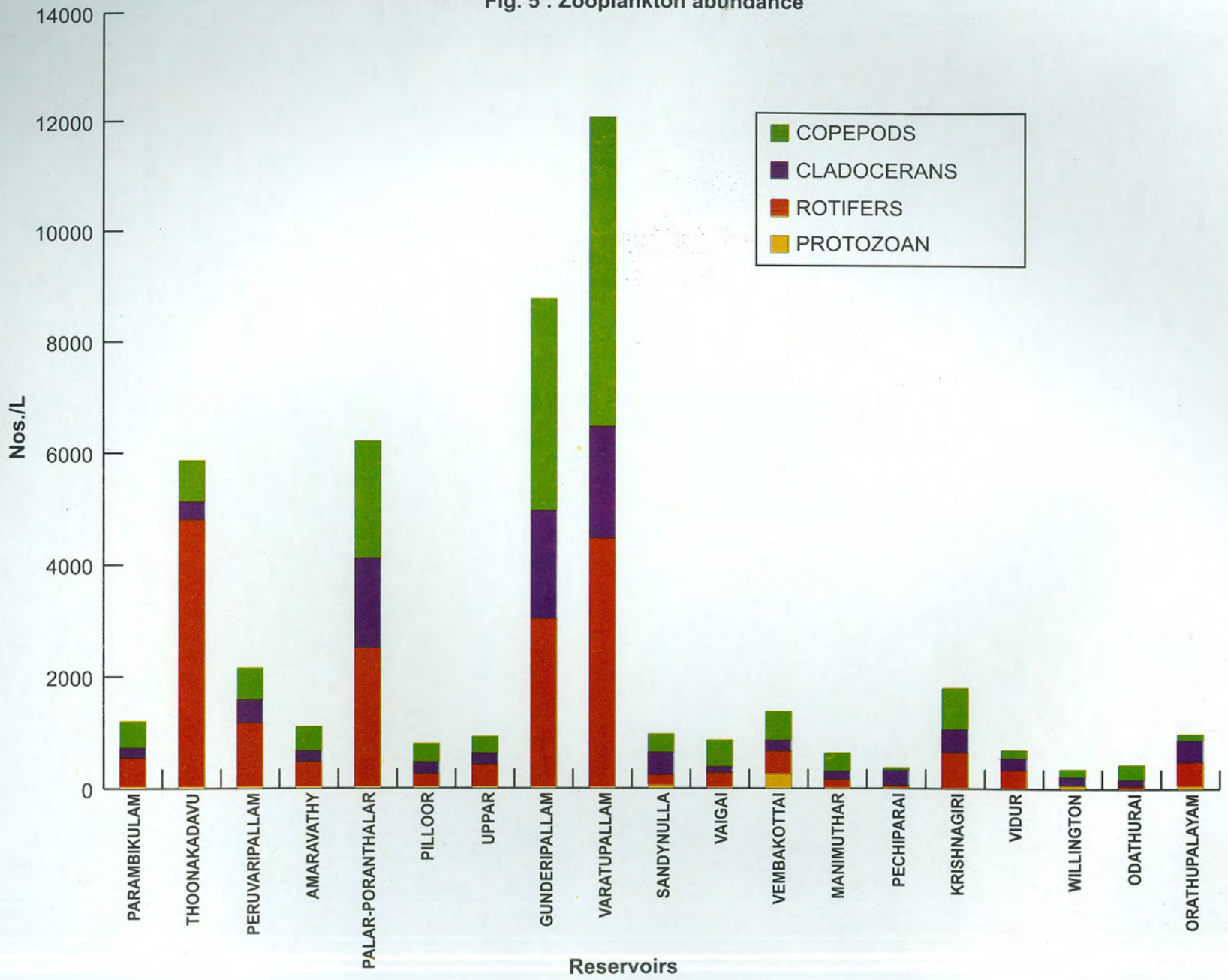


Fig. 6 : Fish seed stocked in the reservoirs

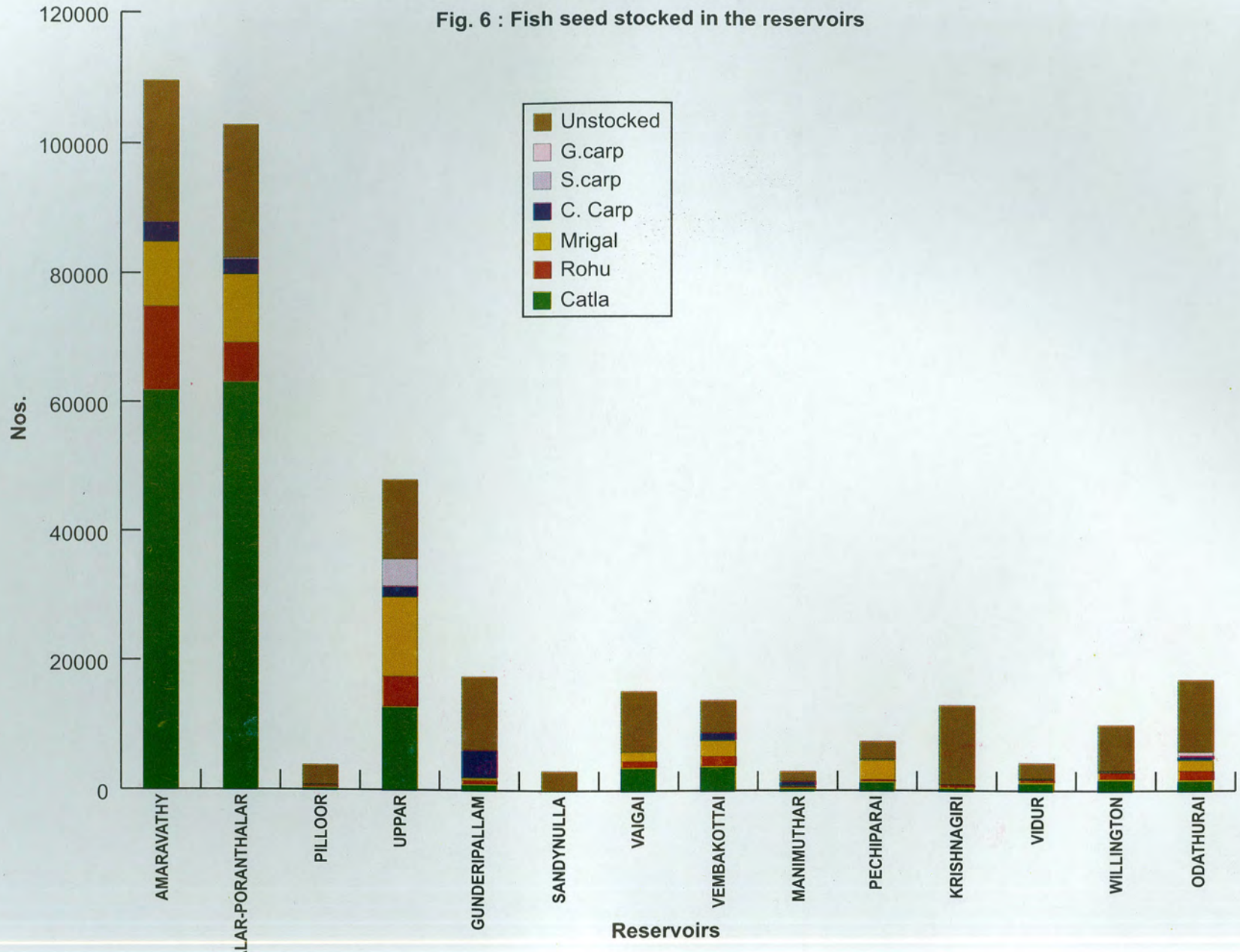
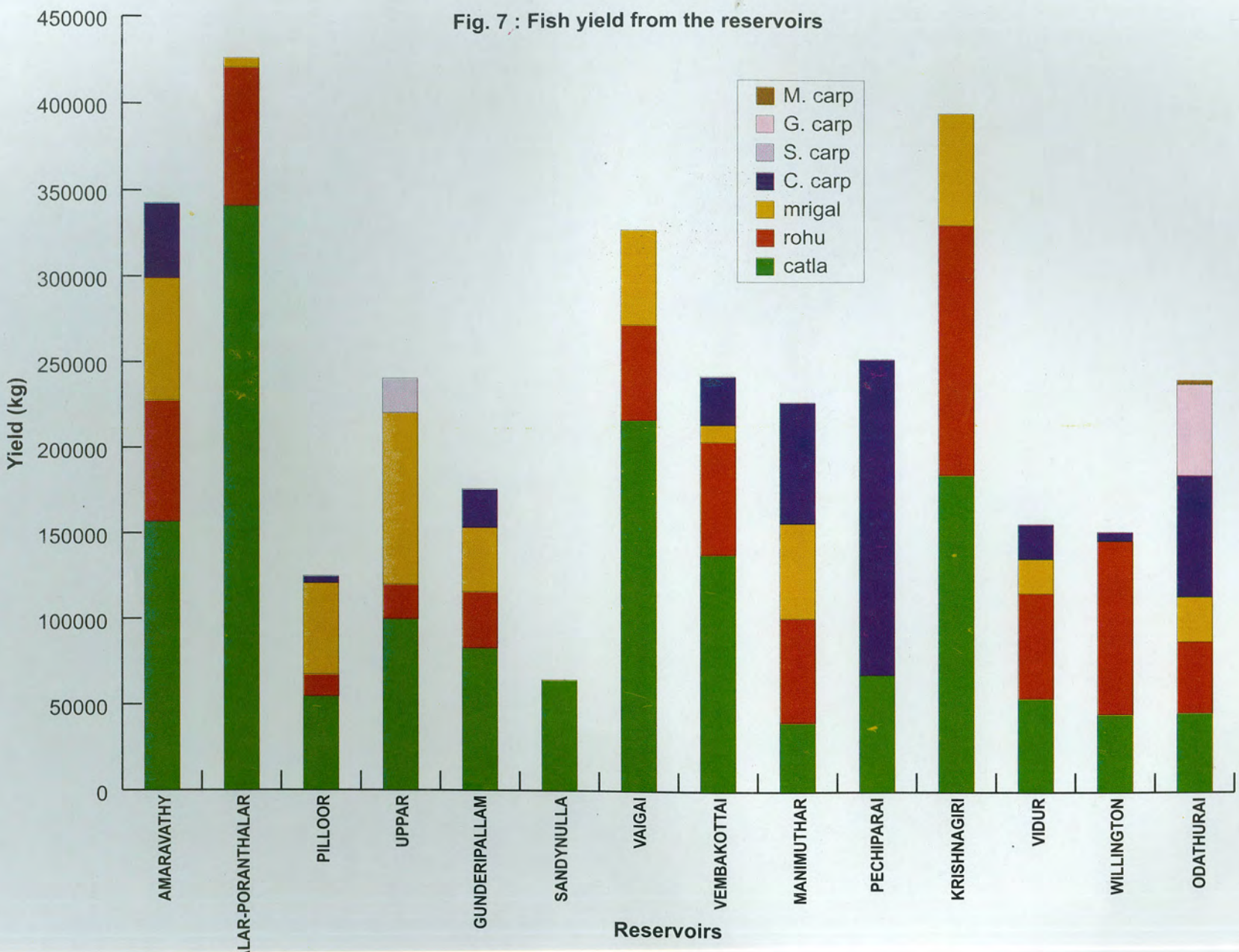


Fig. 7 : Fish yield from the reservoirs



Sediment collection with Peterson crab

Water sample collection

Vaigai dam front view

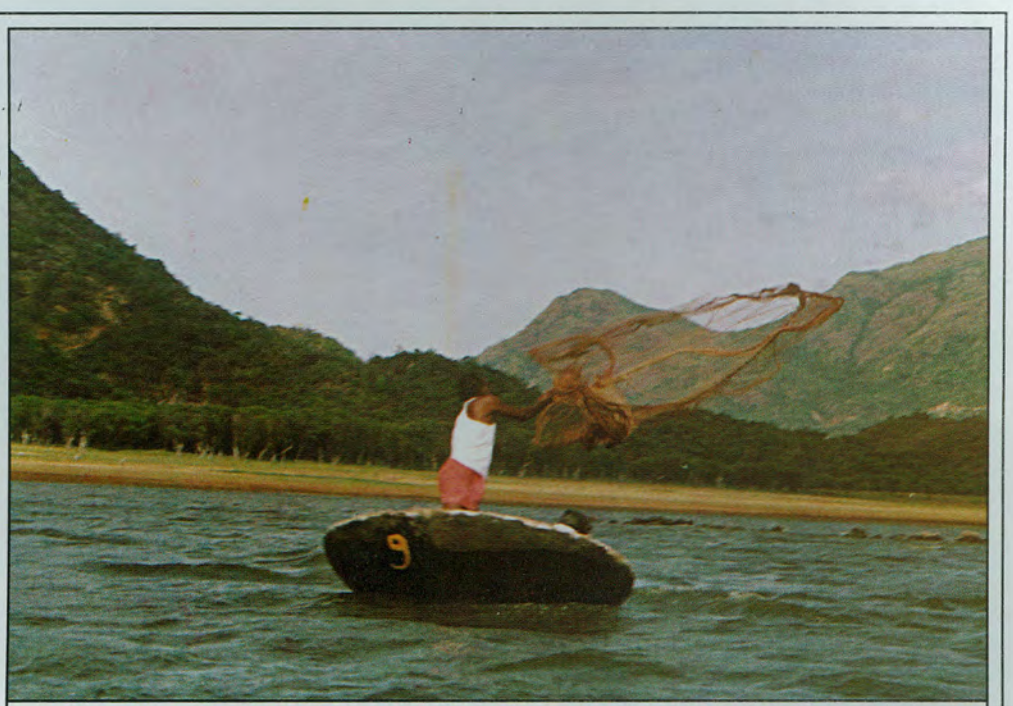
Vaigai reservoir inner view with departmental boat

Poor fish catch at Vaigai reservoir

Palar-Poranthalar reservoir at reduced water level

Bumper crop of major carps and tilapia from Palar-Poranthalar

Synthetic coracle and bamboo framed coracle, as fishing crafts



Cast net operation from bamboo framed coracle

Fish caught in cast net operation

Rod and line fishing

Inflated or air-filled or blown-up lorry wheel tube serving as a fishing craft

Spreading/operating gillnets using lorry wheel tubes as a craft

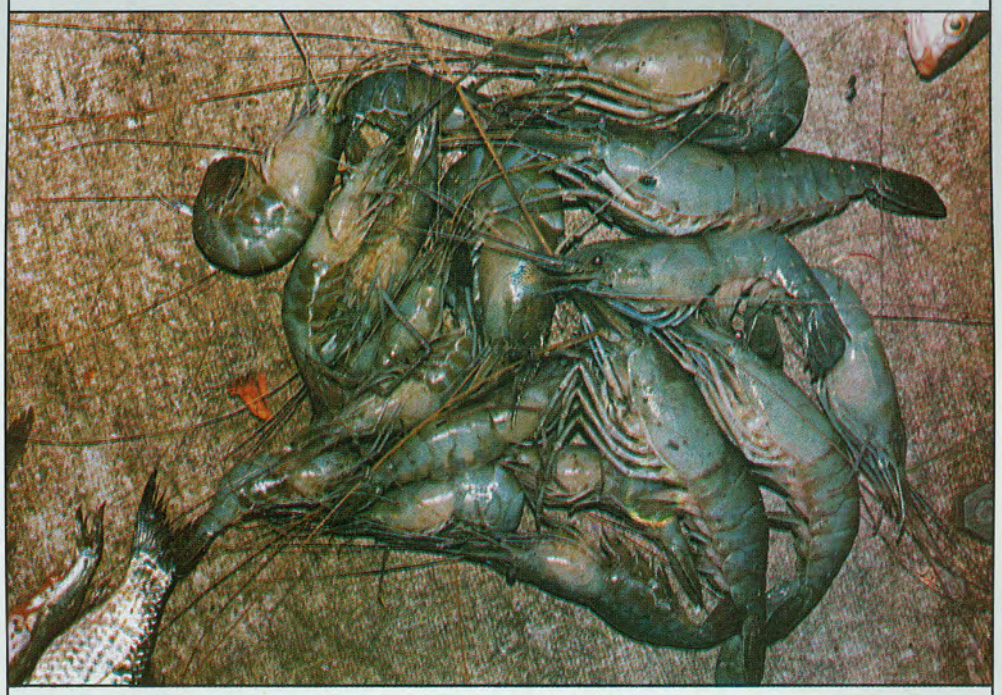
***Channa striatus* catch from Vembakottai reservoir**

Tilapia domination over common carp at Vembakottai

A view of Pechiparai reservoir

A view of highly polluted Orathupalayam reservoir

Fish catch (carps, tilapia and prawns) from Vidur reservoir



Prawn catch from Vidur reservoir

Weld mesh screen placed in the irrigation canal for preventing escapement of fish