1. INTRODUCTION

Fishing is an age old occupation. It has been regarded as a supplementary enterprise of the fishermen community on the subsistence level with little external input. Fisheries sector, however, has an important role in food security, international trade and employment generation. With the changing consumption pattern, emerging market forces and technological developments, it has assumed added importance in India and is undergoing a fast transformation.

Fisheries sector is a principal source of livelihood for a large section of economically underprivileged population of the country, especially in the coastal areas. The importance of fisheries lies in its contribution to nutrition and export including the generation of employment. The contribution of fisheries sector to the GDP has gone up from 0.46 per cent in 1950-51 to 1.47 per cent in 2000-01. The share of fisheries in agricultural GDP has impressively increased during this period from a mere 0.84 per cent to 4.01 per cent. In fact, the fisheries sector is booming and contributing increasingly to the economic growth of the country.

India is the fourth largest fish producer in the world. Fisheries sector is a foreign exchange generator, besides providing nutritious food to the people. It is endowed with an Exclusive Economic Zone (EEZ) of 2.02 million square kilometers, a continental shelf of 0.5 million square kilometers and a coast line of 8119 kilometers. The main inland fishery resources include about 1.20 million ha and brackish water area, 2.38 million ha of fresh water pond and tanks, 3.15 million ha of reservoirs, and about 1,91,000 kms of rivers and canals.

Fisheries activities of the inland sector of India are traditional in nature and fishermen generally carry out the fishing operations without any consideration to sustainability of the resources, which is leading to dwindling catches and poor returns. Reduction in landings can be further attributed to habitat degradation, land reclamation, sand mining and aquatic pollution. The optimise fish yield from inland fisheries sector, recent research has been directed towards reservoirs, the man-made
impoundments with assemblage of both lacustrine and fluviatile characters with huge, untapped potentials and are said to be called “Fish Mines”.

According to the National Sample Survey, the annual per capita consumption of fish in India was 2.45 kg in 1983, which increased to 3.45 kg in 1999-2000. Only about 35 per cent of Indian population was estimated to be fish consumer. However, wide regional variations do exist in fish consumption across regions, states and income classes.

Reservoirs are man-made lakes created by impounding river water for the purpose of irrigation, power generation, flood control, and industrial water needs. A large number of river valley projects have been commissioned since independence as a part of our development activities, resulting in a chain of such artificial impoundments. These water sheets, by virtue of their sheer magnitude and due to their high biogenic production potential, constitute one of the most important resources for inland fisheries development in the country.

Reservoirs in India are prime resources for capture fisheries and extensive aquaculture. They cover a total area of 3.15 million ha, out of which small reservoirs occupy 1.49 million ha followed by large (1.14 million ha) and medium (0.52 million ha) ones. Among variously sized reservoirs, maximum annual production is reported from small reservoirs (50 kg/ha/yr) followed by medium (12.5 kg/ha/yr) and large (11.4 kg/ha/yr) with an average of 20.13 kg/ha/yr, although potential exists for manifold increase as demonstrated in some small, medium and large reservoirs in the country. The low fish yield from reservoirs is mainly due to unscientific management practices resulting from the inadequate knowledge of the ecology and production functions of this biotope.

There are various estimates on the total area under reservoirs in India. The total water spread area of reservoirs in India is about 3 million hectares, which forms about 50 per cent of the total reservoir area in South East Asia (Shetty, 1990). Indian Institute of Management, Ahemadabad (Srivastava, et al 1985) listed 975 reservoirs in India. According to Sugunan (1995), the present total area under the reservoirs in India is 3.1 million hectares.
According to Dixitulu (1999) there are 19370 reservoirs in the country with an extent of 3,153,366 ha (consisting of 19,134 nos. of small ones with an extent of 1,485,557 ha; 180 nos. of medium ones with 575,541 ha and 56 nos. of large ones with an extent of 1,140,268 ha). Kaur and Dhawan (1997) mentions total number of 550 reservoirs with a total water spread area of about 2 million hectares.

A reservoir is having its own special features as it differs from a natural lake or a parent river. Construction of a dam brings about many ecological changes both in upstream and downstream. In the upstream due to change from lotic to lentic conditions, riverine planktons are replaced by lacustrine forms, the benthic riverine fauna is replaced by lacustrine one and the migratory fishes disappear. Among the resident fish species, the running water forms become fewer or completely eliminated and slow water fish species predominate. These changes which have occurred in the new ecosystem give an advantage to predatory fishes. The turbidity level also falls as the reservoir acts as settling basin. The floating macro vegetation may come up particularly in the reservoirs situated in the tropical areas. The excessive macro vegetation becomes a source of many ecological problems as it creates deoxygenation of the water.

In the lower reaches of the river, periodic discharges of sediments from the reservoir may cause mud and silting up of vast stretches with serious consequences on the fauna. Plankton increase in lower reaches due to drift from the reservoir and reduction in turbidity. Thus, the reservoir acts as a fertility trap, reducing amount of dissolved plant nutrients, which would otherwise freely reaching in the lower reaches.

There is usually an initial spurt of plankton and benthic communities etc. This is followed by rapid establishment of aquatic vegetation due to availability of increased nutrients which are released from the decaying submerged organic matter. This results in ideal conditions for the establishment of planktophagus species. This trophic bursts is also an account of the vacant niches created by disappearance of riverine species. The wave action affects soils at different levels enhancing mineral enrichment as the water level rises. Nutrients thus released stimulate great photosynthetic activity. This initial phase of fertility lasts for two to three years. As the effect of trophic burst is over, the reservoir passes through a trophic depression.
phase which is caused by gradual decrease of nutrient release due to continuous sedimentation of the reservoir bed as well as increase in volume of impounded water and using up of available nutrients by aquatic vegetation. Further the nutrients arising from decomposition of vegetation become unavailable to water column because of thermal stratification. Once held up in the deeper water, the nutrients get lost from the reservoir through drawdown from penstock and tunnels. Regular withdrawal of water from reservoir deprives it continuously of nutrients brought in by inflowing water. This phase of trophic depression is characterized by low fish food reserves. Its duration is variable and it lasts for as long as 25-30 years. After trophic depression, the final fertility phase is reached which is at much low level than that is obtained at the stages of initial fertility. The fertility, however, regains itself depending upon the accumulation of organic substances in the bottom soil. Monitoring of species spectrum is during these phases is very important from effective management point of view. The monitoring of population in the changed context of community succession is the essence of reservoir management.

Reservoirs are often referred as a ‘Sleeping giants’ of Indian fisheries (Dixitulu, 2010). Reservoir fisheries development has some interesting economic and social dimensions producing 1 million tonnes of fish from aquaculture entails high investment in the form of pond preparation, feed, seed, medicines, labour and other inputs, apart from heavy demands on water a resource which is becoming increasingly scare day by day. Developing fish production in 1 ha of fish pond will cost Rs. 2 to 3 lakh, in addition to other inputs. At an average yield of 2 tonnes/ha producing 1 million tonnes of fish from aquaculture ponds will cost a formidable Rs. 10,000 crore only for pond digging, leave alone other inputs. In contrast, increasing fish yield from resources cost virtually nothing. The only expenditure involved is stocking, which is very negligible, as opposed to the heavy capital investment required in aquaculture. There is also a social dimension of reservoir fisheries development. The profit obtained in aquaculture ventures accrues to an entrepreneur, investor or a group of individuals as ‘return on investment’. In contrast, the benefits due to increased fish production obtained in the reservoir under a good governance regime, are shared by a large number of fishers the key stakeholders. That meant this
is a large care and each stakeholder gets a slice, albeit small. Thus the reservoirs provide opportunities for inclusive growth, which is economically sound and socially justifiable. Thus, reservoirs are the ‘Sleeping giants’ of Indian fisheries (Dixitulu, 2010).

Unfortunately, majority of Indian reservoirs are not being scientifically managed for fisheries. Only a handful of than have so far has been harassed along scientific lines, while the others are either half-heartedly managed or not managed at all. Lot of progress has been made in several developed countries in deep water fishing in reservoirs and management of their fisheries. As compared to several developed countries, the per hectar fish production in Indian reservoirs is very poor, being only about 29.70 kg/yr as against 88 kg/yr in Russia, 100 kg/yr in Sri Lanka and 65 kg/yr in large reservoirs of Thailand (Dehadri,2002).

Since the reservoirs are primarily constructed for hydel power generation and irrigation purposes, the fish production from them is treated as of bye-product importance. This relegation is one of the reasons of poor fish yield from reservoirs. So much so, the reservoir fish industry could not make any remarkable progress as yet. Because of the country’s growing demand for irrigation and power, new reservoirs have been coming up and thus this potential is expected to grow further giving ample opportunities of culture based capture fishing practices, provided these water bodies are managed scientifically for development of fisheries at an optimally sustainable level.

Reservoirs are generally classified as small (<1000 ha), medium (1000-5000 ha) and large (>5000 ha), especially in the records of the Government of India.

The work of reservoir fisheries development in India was done much earlier in erstwhile Madras state in 1934. Thus the erstwhile Madras fisheries development was the front-runner of reservoir fisheries development in India now inherited by Tamil Nadu fisheries department.

Actually, the systematic reservoir fishery investigations were initiated by Central Inland Fisheries Research Institute (CIFRI), Barrackpore in 1963. The institute took up a detailed study of fisheries of Tungabhadra reservoir in Karnataka and Damodar Valley Corporation reservoirs (Konar, Tilaiya and Panchet) in Bihar.
Later, an All India Coordinated Research Project on Ecology and Fisheries of fresh water reservoirs was launched by ICAR through CIFRI. This project was carried out on five reservoirs located one each in five states (Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Bihar and Himachal Pradesh) in different eco-climatic conditions.

The survey conducted by the CIFRI (1997, 1998) for reservoirs in Maharashtra, Andhra Pradesh and Tamil Nadu states gave encouraging results in the sense that fish production potentiality of some of the reservoirs could be assessed to suggest measures for development of their fisheries. Accordingly, many of the reservoirs were found productive, facilitating the taking of necessary steps in this direction.

Most of the reservoirs are administratively controlled by irrigation, revenue, forestry or electricity departments. These departments do not pay required attention towards development of fisheries. Naturally, department of fisheries is not in a position to interfere in reservoir management. Therefore, the fishing ownership at all reservoirs should be transferred to respective state fisheries departments in all states.

National Fisheries Development Board (NFDB) has been set-up in year 2006 at Hyderabad. The impediments in integrated efforts towards stepping up fish production from reservoirs and ongoing inadequacies in management practices have motivated NFDB to intervene in reservoir fisheries development. NFDB has thus teamed up with CIFRI, the focal organization for national reservoir fisheries development to optimize overall national reservoir fisheries production, in association with state fisheries departments, to play their role as partners. It is expected that the proposed partnerships, supported by infrastructural facilities at individual reservoirs would certainly ensure the sustainable production from reservoirs. NFDB would also provide funds to the states concerned that may join hands with it to achieve the targeted goal. Since the new reservoir projects too are to be implemented taking into confidence the fishermen exploiting the fish from reservoirs, such community-based projects would certainly be beneficial to fishermen too.

After a latest report on the total reservoir area of India (3.15 million ha), many reservoirs have been formed in different states of the country. Accordingly, the total reservoir area of India must have gone up now. Regarding the existence of stagnancy
in country’s overall reservoir fish yield (29.70kg/ha), it may be commented that this figure perhaps may be based on the catch statistics of a few reservoirs and the data of many of the reservoirs might not have been accounted for, due to sampling deficiencies. Moreover, many of the reservoirs could not have been exploited to a sustainable level due to improper and defective fishing. In this background, it may not be correct to say that there is stagnancy in reservoir fish yield of the country. In the light of constraints in reservoir fisheries development as discussed above, high yields may not be expected but, at the same time, some increase in fish production from reservoirs because of coverage of more of water area and an increase in fishing may have taken place, calling for a re-estimation of the present status of potential and annual production level.

1.1. Crafts and Gears:

A knowledge on fishing gear and crafts is very essential for scientific and judicious exploitation and management of reservoir fisheries. New type of gears and fishing methods tested in other countries can be introduced in the Indian reservoirs after experiments. Dynamic gears like trawls and purse seines can be introduced in the reservoirs where the reservoir bottom is free from obstacles. Introduction of shore seines for bulk catching at selected areas after clearing the underwater obstacles may result in higher production. Catfishes and minor carps are dominant in many reservoirs resulting in uneconomic yields. Fishing technology could help to eradicate these undesirable species by operating selective fishing gears. Introduction of echo sounders may have greater impact not only on fish production but also to avoid damage to gears due to underwater obstacles.

Gear technology determines the efficiency of capturing fish with a given standing crop in the reservoir. Gear technology appears to be a fairly well developed science but many state fisheries departments do not provide necessary extension assistance. Fishermen have their own indigenous nets which are the result of their long experience. However, there can be various shortcomings in these indigenous nets such as incorrect relationship between mesh size and diameter of twine, incorrect hanging of the webbing to the float line, omission of lead line and breast lines, incorrect and insufficient rigging with floats and sinkers and insufficient height.
Absence or shortage of appropriate fishing craft often leads to the restriction of fishery to a marginal zone in the reservoir.

Traditional building materials for coracles prevalent in many Indian reservoirs have been completely replaced by synthetic materials. Wooden canoes and rafts are being replaced by tin canoes or fibre glass canoes. The floating rafts of fishermen have already been replaced by compact, easy to transport buoy and foam plastic rafts.

1.2. Impact of dams:

Dams alter river ecosystems and subsequently require development of new relationships between humankind and natural resources associated with these ecosystems. From a fishery perspective, dams and their resulting reservoirs can benefit human societies. Dams, however, usually alter traditional riverine fisheries, sometimes positively (i.e., from tail water fisheries), but more commonly negatively. There typically are found shifts from river-adapted species to those more adapted to lentic environments. Species diversity in impoundments usually declines over time as river-adapted species fade from the system. Dams have had negative impact on riverine fisheries in various systems throughout the region. Dams represent a potential obstacle to migratory fish and special provisions have been made at dams in temperate regions to facilitate the movement of salmon (Clay, 1961). If no provisions have been made at a hydroelectric dam to facilitate upstream fish migration, fish are attracted to the base of the spillway and the outflow from the turbine channels. They are unable to proceed any further. The usual solution of this problem involves the construction of a stepped series of pools rising from the level of the river up to the water level behind the dam. This arrangement (fish way or fish ladder) allows the fish to move successfully from one pool to the next until they reach the top of the dam. Provisions for the downstream movement of juvenile fish are designed on a different basis. Dam construction on the Sefid river (Iran) resulted in reduced stream flow, increased water temperature and declines in food items for sturgeon (Vladykov, 1964). Reservoirs constructed on rivers emptying into terminal lakes of Central Asia and Kazakhstan severely reduced stocks of migratory fishes in the rivers, encouraging development of stocks more lacustrine in character, exacerbated precipitation/evaporation deficit ratios and have led to accelerated salination of
groundwater as well as surface waters (Peter and Mitrofanow, 1998). Sandhu and Toor (1984) noted sharp declines of catches of *Hilsa ilisha* as a result of dams, barrages, weirs and anicuts on the Hooghly, Godavari, Krishna and Cauvery rivers (India), and that mahseer, *Tor putitora* and *Tor tor* no longer are found above Nangal and Talwara dams.

Gill (1984) mentioned the effect of dams on fish fauna of Punjab region. Construction of barrages at Ropar, Harike, and Ferozpur has restricted migration of Indian major carps, in spite of fishways. During most of the year, little water is released into the river below the dams from the reservoirs, and fish are concentrated in pools where they are more easily captured by fishes. Fishways designed to promote fish passage past dams are used by fishers to capture fish.

The dams and barrages form physical obstruction to the migratory fishes causing physiological strain and breeding failure. The classic example is *Hilsa ilisha* that has migratory range of 1500 km upstream of the estuary. Construction of Farakka barrage, 476 km from the river mouth has nearly eliminated the lucrative *Hilsa* fishery above the barrage. Gone are the days when up to 303.6t of *Hilsa* were caught at Allahabad (1956-57). The impact of Farakka on *Hilsa* had been very severe. The average *Hilsa* landing after commission of Farakka barrage at Allahabad, Buxar and Bhagalpur get reduced by 94.61, 98.12 and 83.05 per cent respectively (Chandra, 1989). Another bad effect has been found in the case of *Pangasius pangasius* in Ganga, Brahmaputra, Mahanadi, and Godavari rivers. Dams located in the lower and middle reaches of these rivers obstructed the migration of this fish and adversely affected its population. Torrential fishes like *Glyptothorax, Leptognathus* etc cannot survive in reservoirs and there is a chance of disappearance of their races in nature. The Gandak and Kossi valley projects have also adversely affected the fisheries of North Bihar to a very significant degree. They have affected not only the fisheries of rivers, mauns and chaurs, but indirectly culture fisheries as well as the spawn production, on which culture fisheries lean heavily, has been drastically reduced due to loss of breeding grounds. This has adversely affected the fishery as well as the seed resources of these water bodies, as also those of the main rivers.
In China Danjiangkou dam on the Hanjiang river prevents movements of eels (*Anguilla japonica*) (Liu and Yu, 1992). The dam also blocked migration of commercially important carps. Dams have reduced overall fishery yield from some African systems. Such yield reductions can be temporary or long term.

Zhong and Power (1996) reported that the number of fish species decreased from 107 to 83 because the migration was interrupted by the Xinanjiang dam (China). The reduction of biodiversity occurred not only in the flooded section but also in the river below the dam. Quiros (1989) mentions that dam construction in the upper reaches of Latin American rivers appears to lead to the disappearance of potamodromous species stock in reservoirs and in the river upstream of the structure. The same occurs in reaches where a whole series of dams and reservoirs have been constructed.

In Australia, obstructed fish passage has led to many instances of declining populations or extinctions of species in the affected basin (Mallen-Cooper and Harris, 1990). The concept of obstruction to migration is often associated with the height of the dam. However; even low weirs can constitute a major obstruction to upstream migration. Whether an obstacle can be passed or not depends on the hydraulic conditions over and at the foot of the obstacle in relation to the swimming and leaping capacities of the species concerned. The swimming and leaping capacities depend on the species, the size of the individuals, their physiological condition and water quality factors as water temperature and dissolved oxygen. Certain catadromous species have a special ability to clear obstacles during their upstream migration: in addition to speed of swimming, the young eels are able to climb through brush, or over grassy slopes, provided they are kept thoroughly wet; some species like Gobies possess a sucker and enlarged fins with which they can cling to the substrate and climb around the edge of waterfalls and rapids (Mitchell, 1995).

It may become desirable to construct fish ways in case a migrant fish is present in the riverine system on which the reservoir is constructed to enable the migratory fish to negotiate the dam height. A number of fish ways have been built in India, often at large expense. It appears that many of these fish ways have for various reasons proved to be failures (Yadav, 1983). It might be due to lack of knowledge of
fish migration and leaping capacities of migratory fish combined with exorbitant cost of fish passes have prevented the construction of the right type of fish ways. Even outside India, many fish ways have been failures either because of improper design or incorrect placing, or because of adverse currents which prevented fish from finding or being guided to a fish way or because fish could not or did not wish to make use of the fish way.

Dam construction can dramatically affect migratory fish habitat. The consequence of river impoundment is the transformation of lotic environment to lentic habitats. Independently of free passage problems, species which spawn in relatively fast flowing reaches can be eliminated. From a study of the threatened fish of Oklahoma, Hubbs and Pigg (1976) suggested that 55% of the man induced species depletions had been caused by the loss of free flowing river habitat resulting from flooding by reservoirs, and a further 19% of the depletion was caused by the construction of dams, acting as barriers to fish migration.

Dams can modify thermal and chemical characteristics of riverine water which affect fish species and downstream populations. Water temperature changes have been identified as a cause of reduction in native species. Coldwater release from high dams of the Colorado river has resulted in a decline a native fish abundance (Holden and Stalnaker, 1975). Water-chemistry changes can also be significant for fish. Release of anoxic water from the hypolimnion can cause fish mortality below dams (Bradka and Rehackova, 1964).

1.3. Performance of exotic fishes in Indian reservoirs:

The exotic fishes like *Cyprinus carpio*, *Ctenopharyngodon idella*, *Pangasius sutchi*, *Carassius auratus*, *Lebistes reticulates*, *Tinca tinca*, *Hypophthalmichthys molitrix*, *Oreochromis mossambicus*, *Oreochromis niloticus*, *Salmo trutta fario*, *Salmo salar*, *Onchorynchus nerka*, *Onchorhynchus mykiss*, *Aristichthys nobilis*, *Clarias gariepinus* etc were introduced in Indian waters. The transplantation of these fishes into Indian waters has not been a very good experience.

Tilapia is native of Africa and the Middle East. In India, the first consignment of tilapia was brought by the Central Marine Fisheries Research Institute (CMFRI), in August 1952 from Bangkok and the second by the Madras Fisheries Department in
the same year from Ceylon. Tilapia is hardy but display some of the most undesirable characteristics. It bears at a very small size is difficult to grow to a reasonable market size (100 gm+) with huge differences in growth between the sexes. In Indian reservoirs tilapia has adversely affected the indigenous gene pool.

In Powai Lake of Mumbai the major carps have been badly hit with the accidental introduction of *O.mossambicus* with the production sliding down from 33.3 kg/ha to 11.9 kg/ha (Das *et al.*, 1990).

The accidental introduction of tilapia in Lake Jaismand (Rajasthan) has been reported by Fishing Chimes. The catch has registered more than two fold increase in month of fishing and the whole catch was only of tilapia. The size of tilapia was found reduced compared to that of early period. It is probably due to the inadequacy of food in reservoir.

In Periyar Lake of Kerala, tilapia constitutes more than 25% of its catch whereas the region was earlier dominated by the abundant catch of local species *Etroplus suratensis*.

Tilapia has dominated and virtually eliminated all other fishes including the stocked Gangetic carps in a number of reservoirs of Tamil Nadu and Kerala.

Sreenivasan (1967) reported adverse impact of tilapia on the growth rates of *Catla catla, Labeo fimbriatus* and *Cirrhinus mrigala*. He further observed adverse impact on the catch of *Chanos chanos*.

It is observed that introductions of tilapia and common carp has obliterated *Puntius spp* in Krishnarajasagar reservoir of Karnataka (Ramkrishna, 2008). Tilapias has entered the reservoirs of all the river systems of Karnataka state and affected the faunal composition of indigenous fishes in the reservoirs, posing a great challenge for its effective control and management.

Following accidental escape, silver carp (*Hypophthalmichthys molitrix*) formed a breeding population in Govindsagar reservoir in Himachal Pradesh and Kulgarhi reservoir in Madhya Pradesh (Fish base 2004; Singh, 2004). These reservoirs were known for the dominance of catla fishery whereas the invasion of silver carp altered the habitat rendering it unsuitable for sustaining catla. The food analysis of silver carp delineated that dinophyceae formed the main item of intestinal contents
and its occurrence was high during December to May (65-83%) making the environment more conducive for thriving of silver carp growth. Establishment of silver carp in Govindsagar reservoir may be attributed to the presence of massive Ceratium hirudinella (dinoflagellate), which is a major plankton constituent of the reservoir. It is pertinent to mention that production of catla from these reservoirs has significantly declined (Sugunan, 1995; Singh, 2004). The fishery of Catla catla and Tor putitora in Govindsagar reservoir in Himachal Pradesh has been drastically curtailed by the entry of silver carp (Lakra and Singh, 2007).

In North Indian reservoirs establishment of silver carp has already affected the performance of catla and rohu because of overlapping in feeding niches (Devaraj et al., 2008).

According to Karamchandani and Mishra (1980) silver carp and catla share a common niche and compete with each other for food in a reservoir ecosystem. Percentage composition of phytoplankton in the guts of both the fishes caught during the same time from Kulgarhi reservoir was more or less the same. Zooplankton, the favourite menu of catla, formed 21 per cent of the gut contents of silver carp. The authors concluded that silver carp hampered the growth of catla in the reservoir and advocated caution before its stocking in Indian reservoirs.

Common carp (Cyprinus carpio) has been transplanted into many countries. In India, it was introduced in 1939. There are three varieties of Cyprinus carpio i.e., Scale carp (Cyprinus carpio var. communis), Mirror carp (Cyprinus carpio var. specularis) and Leather carp (Cyprinus carpio var. nudus).

Common carp is not suitable for stocking in Indian reservoirs, especially the larger ones, for diverse reasons. Being a sluggish fish, its chances of survival in a predator-dominated reservoir are very poor. Due to its slow movement and bottom dwelling habit, they are not frequently caught in a passive fishing gear like gill net. It is no wonder, despite a regular stocking for 13 years, not a single common carp was ever caught from Nagarjunasagar reservoir of Andhra Pradesh. The stocked fishes failed to survive among the predators. A more important disqualification is its propensities to compete with some economically important indigenous carps like Cirrhus mrigala, Cirrhus cirrhosa and Cirrhus reba with which common carp
shares food niche. The presence of common carp has resulted in the decline of *Cirrhinus species* in Girna reservoir (Maharashtra) and Krishnarajsagar reservoir (Karnataka).

Introduction of *Cyprinus carpio* var.*specularis* in to Dal Lake has been reported to affect the population of indigenous *Schizothorax sp*. The benthophagus feeding habit of the fish fully utilized the Dal Lake benthos. The induction of the common carp significantly destabilized the native community balance of the Dal Lake and altered the energy flow system (Das, 2008).

The mirror carp has jeopardized the survival of a number of native fish species, after its introduction in the upland lakes of Kumaon Himalayas and some reservoirs of the northeast. Das (1989) observed that introduction of common carp has brought about a sharp drastic decline in the native population of *Osteobrama belangiri* in Loktak Lake of Manipur.

The introduction of *Clarias gariepinus* is very recent by a private trader during 2000. The introduction of this fish has brought about significant loss to the indigenous fish biodiversity. The fish is highly carnivorous and can thrive in extreme environmental conditions. This can certainly be a potential threat to the fish community if established in natural water bodies. The government of India has banned this fish and the people need to know this because it can cause great damage to the environment and the biodiversity.

*Aristichthys nobilis* has been introduced in India without official sanction. Ministry of agriculture, Government of India, Department of Animal Husbandry and Dairying, Fisheries Division, through letter No.31016/1/96 and FY (3) dated 19th December 1997 had requested all the states governments to destroy the existing stock of *Clarias gariepinus* and *Aristichthys nobilis*. The reason for the ban is that these may cross breed with the endemic species and cause genetic degradation of our fish fauna. National Committee on Exotic Species had not approved the introduction of *Aristichthys nobilis* in to the country.

Grass carp (*Ctenopharyngodon idella*) is a natural of rivers of China. It has been introduced in India in 1959 for culture purpose. Fish has been introduced in Himachal reservoirs during 1985-86 and appeared in catches of Pong reservoir during
Grass carp still maintaining low profile in reservoirs probably due to negligible water weeds (Sharma, 2008).

1.4. Reservoir Fisheries of India:

1.4.1. Andhra Pradesh:

In Andhra Pradesh there are 102 reservoirs. Surveys of 40 small reservoirs in the state of Andhra Pradesh were conducted by Sugunan and Katiha (2004) between 1994 and 1999. The studies on macro-zoobenthos in Mir-Alam reservoir was carried out by Anitha et al. (2006). The phytoplankton diversity of Mir-Alam reservoir is reported by Siddiqi and Khan (2002). The Osman Sagar reservoir, located at a distance of 25 kms from Hyderabad city categorized as oligotrophic in nature (Siddiqi and Khan, 2002). Shailaja and Johnson (2006) reported the values of chlorides, fluorides, calcium and magnesium in the reservoir water at 483.7, 1.30, 143.6 and 116.3 mg/l respectively. The reservoir water is primarily alkaline (Siddiqi and Khan, 2002). Altogether, 54 species belonging to 3 groups of phytoplankton were reported (Siddiqi and Khan 2002).

Laxmappa and Vijay Babu (2014) highlighted the reservoir fisheries in Mahabubnagar district. Reservoir fisheries in Mahabubnagar district provide livelihood to more than 15,000 fisher families in the district. Except Priyadarshani Jurala Project, other reservoirs are very productive and manageable which have been giving high yields i.e., 150-200 kg/ha/yr. The fish production level was at 244.20 kg/ha/two years in 2011-12 in Koilsagar which is the best managed reservoir in the district. In smaller reservoirs the average fish production rate is about 180 kg/ha/yr. In some reservoirs particularly Koilsagar, Ramanpad and Chandrasagar, the fishermen are also stocking wild freshwater prawn (scampi) seed along with carp fish seed in Mahabubnagar district. The prawn production is encouraging and successfully which is really an additional income generation to the fishermen who depend on the reservoirs for their livelihood. Laxmappa et al. (2013) documented status of freshwater prawn farming in Ramanpad reservoir and reported average prawn production at 47.09 kg/ha with a weight of 40 gm to 110 gm each.

Hussainsagar, although popularly termed as a lake, is a man made reservoir. It is situated between twin cities of Hyderabad and Secunderabad in Andhra Pradesh.
Husainsagar lake once use to harbor 27 species of fishes (Babu Rao and Siva Reddy, 1984). However recent survey has reported loss of sensitive species and existence of only few species of hardy catfishes belonging to the genera *Channa*, *Clarias*, *Mystus* and *Heteropneustes*. The largest and the most important reservoir of the Medak District is the Pocharam reservoir formed by damming the Aleru River. From Pocharam Lake 25 fish species were recorded (Rao et al.2011).

Wyra Lake is located to the north of Wyra Town in Khammam District. Rao et al (2011) recorded 21 species of fishes from Wyra Lake. *Etroplus suratensis*, a shoaling fish, is very common in the lake. Dense vegetation, many water plants, hiding places and open swimming areas are suitable for this species. Another fish which is reported only in Wyra Lake, *Rhinomugil corsula* which thrives well in estuarine waters, is also reported from the Krishna River basin. The mixing of waters of the Krishna-Godavari river basins explains the occurrence of *Rhinomugil corsula* in Wyra.

### 1.4.2. Chattisgarh:

It is estimated that 1.547 lakh ha of water area comprising ponds and reservoir is available for development of fisheries in the state. Among reservoirs, the small sized category of them comprises 99.13% by numbers. Since its birth in November 2000, the state has witnessed an upsurge in production of fish from 83,833 mt in 2000-01 to 1,20,072 in 2004-05. About 92% is contributed by the private sector. Among reservoirs, 0.1% fish production is contributed by large reservoirs, 9.73% by medium ad 89.15% by small reservoirs. The small category comprises about 50% of the reservoir area. Average annual fish yield from small reservoirs is fairly good but that from medium and large reservoirs is not satisfactory. Under stocking, use of smaller size of fish seed and inadequate fishing effort has been identified as some of the reasons for poor yield from reservoirs (Singh and Tuli, 2006).

The Ravishankar reservoir is also known as Gangrel reservoir was constructed in 1978. The reservoir was formed by damming the river Mahanadi in Raipur district of Chattisgarh state. The water-spread area of reservoir is 9540 ha. Based on the total alkalinity (66.8 mg/l) and total hardness (49.5 mg/l), the reservoir is classified as medium productive reservoir (Desai et al.2007). Desai et al (2007) reported 48 species
of fishes. The fish fauna mainly comprises *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Gudusia chapra*, *Mystus aor*, and *Mystus seenghala*. Weedfishes were abundant in the total fishery of the reservoir, contributing 42% in 1989-90. Later its population was reduced to 31% (1990-91) and 17% (1991-92). This may be due to intensive drag net fishing. Among weed fishes, *Gudusia chapra* (56%) was the most dominant.

1.4.3. Gujarat:

The area of major and medium reservoirs available is state is about 2.55 lakh ha. In reservoirs, mainly three species of major carps viz., catla, mrigal and rohu are cultured. Exotic carps like common carp and grass carp have also been introduced. There are 50 large, 38 medium and 1547 small sized reservoirs in the state. Fish production from reservoirs during year 2007-08 was 18,261 mt. The Sardar Sarovar Project is a multipurpose reservoir with scope for massive economic development of the state of Gujarat. It is the largest dam and part of the Narmada Valley Project, a large hydraulic engineering project involving the construction of a series of large irrigation and hydroelectric multi-purpose dams on the Narmada River. The project took form in 1979 as part of a development scheme to increase irrigation and produce hydroelectricity. Singh (1993) reported 84 fish species from Sardar Sarovar dam.

1.4.4. Himachal Pradesh:

Himachal Pradesh is known to be abundant in natural beauty. Due to the abundance of perennial rivers, Himachal also sells hydroelectricity to other states such as Delhi, Punjab and Rajasthan. The economy of the state is highly dependent on three sources: hydroelectric power, tourism and agriculture. Himachal Pradesh has two large reservoirs, namely Gobind Sagar and Maharana Pratap Sagar. There are also three small reservoirs i.e., Chamera I&II and Pandoh. The total water area of these reservoirs is 42,000 ha at FRL. Two more reservoirs Mallana and Koldam are likely to add the reservoir tally of the state, increasing the total area to approximately 3000 ha.

1.4.5. Jammu and Kashmir:

The state of Jammu and Kashmir has three diverse agroclimatic zone viz. Jammu, Kashmir and Ladakh with a tremendous potential for development of
warm water and coldwater fisheries. All these three regions of the state are bestowed with a network of natural water bodies like rivers, streams, lakes, reservoirs, ponds, swamps etc., spread over an area of about 57000 ha; out of which about 34000 ha are in the shape of lakes, marshy areas, ponds and reservoirs. Further another 23,000 ha extent in the shape of river systems. The fish production from the reservoirs is very low varying from 5 kg/ha/yr to 250 kg/ha/yr. By promoting cage culture, production can be stepped up from reservoirs to 25-50 tons/ha/year (Charak and Fayaz, 2006).

The Dal lake of Kashmir situated in the north-east of Srinagar at mean latitude of 3407’ N and longitude of 74052’E at an average altitude of 1583 m. Ahmad (1980) accounted thirty-seven species of fish from Dal lake. The important species which supports good fishery are Schizothorax esocinus, Schizothorax niger, Schizothorax curvifrons, Labeo dero, Crossocheilus sp, Botia birdi, Nemacheilus kashmirensis, Gambussia affinis, Glyptothorax sp. and Glyptosternum. The Salal reservoir, first man made medium reservoir in state was constructed by damming river Chenab (Chandrabhaga in Sanskrit) -an important tributary of Indus drainage system. After completion of project, it was handed over to National Hydroelectirc Power Corporation on ownership basis for operation and maintenance. Charak and Fayaz (2007) studied fisheries of Salal reservoir.

Ranjit Sagar Reservoir is named after Maharaja Ranjit singh, the renowned ruler of Punjab. The reservoir is located in a gorge section near village Thein of Jammu and Kashmir and as such it is also known as Thein reservoir. National Fisheries Development Board, Hyderabad extended financial assistance to Fisheries Department, Government of Punjab for seed stocking of Indian Major Carps of 80-110 mm size in Ranjitsagar reservoir. The office has sanctioned Rs.15 Lakh and released 50% as first installment i.e., Rs.7.50 lakh against Ranjitsagar reservoir for second consecutive year of stocking for the year 2011-12.

1.4.6. Jharkhand:

Jharkhand is a landlocked state endowed with resources such as ponds, lakes, reservoirs, streams and rivers. Jharkhand state has an extensive wealth of lacustrine fishery resources, consisting of 99 reservoirs of various categories covering a water spread area of about 73,727 hectares. Unfortunately, majority of these water bodies
are not being scientifically managed. These reservoirs could be utilized for intensive and semi-intensive fish and giant freshwater prawn, and ornamental fish production, maintaining a capture-culture balance. The reservoir fish production in the state is only 5 kg/ha/yr. This unimpressed and low fish production potential may be due to low retrieval of the fish stocks and also may be due to uncontrolled poaching that takes place in most of the reservoirs (Singh and Ahmad, 2006). The reservoirs in state are somewhat medium-productive and can be developed to produce substantial quantity of fish by resorting to proper stocking and manipulation of the various species of fish population and judicious exploitation through effective crafts and gears. The reservoirs in state, if managed on scientific lines, would surely boost fish production from the state. Breeding of Indian Major Carps has not so far been noticed in the reservoirs of state. This seems to be for the reason that upstream of these reservoirs are having steeper slopes, rocky beds and are prone to flash floods. They do not provide favourable habitat for spawning of the desirable fishes that are economically important. Trash and predatory fishes are most self-generating and prolific breeders. Gill nets fabricated using nylon monofilament/twine are the most common fishing gear used in the reservoirs. The average fish production of Jharkhand reservoirs is in the order of less than 5 kg per hectare. This low fish production may be due to low retrieval of the fish stocks and also may be due to uncontrolled poaching that takes place in most of the reservoirs. For the present an average production of 15 kg/ha/yr can be expected from the reservoirs of state (Singh and Hasib, 2006). On this basis, production for a water spread area of 73,727 ha of reservoirs, comes to only 1100t/year. The reservoirs in the state are somewhat medium productive and can be developed to produce substantial quantity of fish by resorting to proper stocking and manipulation of the various species of fish population and judicious exploitation through effective crafts and gears.

**1.4.7. Karnataka:**

Total of 74 reservoirs comprising 2.27 lakh ha of water spread area are available in the state for systematic and scientific development. Large reservoirs constitute 80% of the total area, followed by the medium (13%) and small (7%) ones. So far stray efforts were being made to stock available fingerlings in reservoirs here
and there but there had been no regular programme to stock the reservoirs with advanced fingerlings on a scientific basis. The traditional fishermen around reservoirs are issued annual licenses to harvest the catch by collecting a nominal license fee.

NFDB-assisted programme on scientific development of fisheries of selected reservoirs has been taken up by stocking advanced fingerlings of prime cultivable species. Selected reservoirs are being developed by following public-private partnership and public-co-operative partnership approach. They are strengthened by providing financial assistance for advance fish fingerling stocking programme. It is proposed to enhance the per hectare fish production from the present 20-35 kg/ha to 150 kg/ha by scientific development of the selected reservoirs on a sustainable basis.

NFDB extended financial assistance to Department of Fisheries for stocking Indian major carps fingerlings of 80-100 size for first year stocking programme for the year 2011-12 in 51 reservoirs of the state. For this, Rs. 74.665 lakh were sanctioned towards the cost of 80-100 mm size @ one rupee per fingerling that includes all costs towards production of fingerlings either in-situ or ex-situ and transportation, for stocking in 51 reservoirs for the year 2011-12.

The Karanja reservoir is a medium reservoir having water spread area of 5,673 ha with gross irrigation potential of 1,62,818 hectares. Kumar et al. (2013) studied ichthyofaunal diversity of Karanja reservoir and reported 64 fish species belonging to 37 genera, 16 families and 5 orders. Due to the illegal supply of seed of *Clarias gariepinus*, it is recorded in very good numbers and continue to start dominating in the reservoir therefore. Immediate measures should be taken to prevent it from further entering into this system (Kumar et al. 2013). Considerable landing of *Oreochromis mossambicus* and *O. niloticus* were also recorded at all the fish landing centres. Ecologically, these fishes have adverse effect on the indigenous fish diversity of the reservoir. Fishing rights, including exploitation, stocking and disposal by licensing of Karanja Reservoir, as a rule, is vested with the Karnataka State fisheries Department. In some areas, variety of fishing gear is employed for fishing. Gill nets, both surface and bottom set, are the most common. A variety of traps are employed for catching prawn, air breathing catfishes and murrels, while rod and line are sometimes employed to catch *Wallago attu*, *Ompak spp.* and *Mastacembelus spp.*
Except the issuing of licenses from the State Fisheries Department and stocking of fish seeds, there is no monitoring and regulation of fishing in the Karanja reservoir due to the inadequate staff and other required facilities (Kumar et al. 2013).

The Tungabhadra reservoir is the only place in India where reservoir-based pen culture is being carried out from year 1982 onwards for the rearing of carp seed. The reservoir has a water-spread area of 37,814 ha. Growth and survival of rohu spawn in pens with varying stocking densities commissioned in the periphery of Tungabhadra reservoir was studied by Gireesha et al. (2003) for 56 days. David et al. (1969) have made certain observations on the available forage food of catfishes and several commercial carps in Tungabhadra reservoir.

Nelligudda reservoir supports fish diversity of 20 species belonging to 6 families. The fishery is significantly dominated by Oreochromis mossambicus, contributing over 80% to the fish catches. The major carnivores were Channa gachua, Channa striatus, Ompak bimaculatus, Mystus cavasius and Mystus vittatus that are known to be important predators of fish fry especially that of Oreochromis mossambicus and may have a regulatory role on the population density of Oreochromis mossambicus.

The Hemavathy reservoir in Hassan district is one of the major reservoirs in the state covering a water spread area of 9,162 hectares. The fishermen operating in the reservoir are supposed to have been migrating from the neighboring states of Maharashtra, Andhra Pradesh and Tamil Nadu. Lack of transport facilities and preservation facilities prevented the fishermen undertaking their own fish sale business. Main reasons for the socio-economic backwardness of fishermen communities are the distribution of the communities in small clusters, inadequate number of nets and lack of proper understanding of the fishery. The gears used in fishing are gill nets, drag nets, cast nets and long lines. The main craft used for fishing is coracle. The fishermen operated gears for about 265 days in year.

The Linganamakki reservoir was constructed across the river Sharavathi in 1964. The reservoir is oligotrophic in nature. Presently about 120 fishermen families are engaged in fishing. All these families are poor, uneducated and the involvement of children in fishing is often noted. The deputy Director of Fisheries regulates the
fishery in Linganamakki reservoir. Obtaining yearly license is compulsory for all the fishermen for fishing in the reservoir. The fee structure for gill net with a length of 500m is Rs.1000/- per year; cast net Rs.300/- per year and hooks Rs.100/- per year. At present about 200 license holders are in the reservoir area. Thus, the fisheries department earns 1.65 lakh rupees of revenue annually from this source. In order to avoid overflow and washing off of the seeds, the seed is stocked after the monsoon season. The quantity of seed stocked depends on availability of the seed.

The Bhadra reservoir is a multipurpose project constructed for power generation and irrigation. The gears commonly used in reservoir are gill net and cast net. The reservoir supports fish diversity of 27 species belonging to 5 orders.

A systematic investigation by CIFRI revealed that African catfish – *Clarias gariepinus* is negatively impacting the commercially important fishes in Kelavarapalli reservoir in Krishnagiri district. This fish fetch higher price than tilapia as there is a market for it in certain parts of this State. They enter the reservoir from culture ponds adjacent to river South Pennar during rain and floods.

**1.4.8. Kerala:**

The state of Kerala is gifted with an enviable array of inland aquatic resources which occupy an area of 3,55,037 ha. It includes 44 rivers, about 30 brackish water estuaries, 30 reservoirs, several freshwater lakes and several ponds, tanks, beels, oxbow lakes and wetlands. Although Kerala is one of the foremost fish producing states in India, the bulk of its production comes from the marine sector. The fisheries department of Kerala has no data base on the inland fisheries, fishing industry, etc. worthwhile to evolve any development on management policies (Nair, 1989).

The major reservoirs of the state are located in Idukki, Palakkad, Kollam, Thiruvananthapuram, Pathanamthitta, Kozhikode and Kannur districts. Malampuzha, Sholayar, Neyyar, Kallada, Idukki and Periyar are some of the important reservoirs of the state. These reservoirs are stocked with the seed of Indian major carps, common carp and varieties of minor carps. Reservoir fishery in state support many varieties of fishes like carps, tilapia and catfishes.

Attempts to develop reservoir fisheries in Kerala started as early as 1960 under the Department of Fisheries. In 1992 the Indo-German Reservoir Fisheries
Development Project (IGRFD) started activities with its head quarters at Malampuzha under an agreement between the Government of India and Government of Germany.

In reservoirs like Chulliar and Meenkara the fish productivity level has been raised to 227 kg/ha/yr, and 76.5 kg/ha/yr (1992-93 to 1995-96). This level of productivity is among the highest ever reported at the national level. This indicates that if given proper technical and financial support, the production from small reservoir can be increased substantially so that the fishermen can undertake reservoir fishing as a viable avocation.

Chulliar reservoir is constructed across Chulliar river in Palakkad district. The regular fishing in the reservoir was started during 1967-68. Since 1989, stocking as well as fishing is carried out exclusively by SC/ST fishermen co-operative society, with the active support from the department and the Indo-German Reservoir Fisheries Development Project under operation from 1992.

The Malampuzha is a multipurpose reservoir constructed across river Bharatapuzha in Palakkad district. The local fishermen were organized into local Self-Helping Group (SHG). The reorganization into SHG has generated better cooperation in participatory management and virtually stopped the once rampant poaching in the reservoir. Revenues from prawn/fish catch for year 2005-06 was Rs.1,475,000/- which was almost equal to overall production value of the last 15 years. Braj Mohan (2002) highlighted economic and social conditions of fishermen of Malampuzha reservoir. The fishermen are the members of Malampuzha SC/ST Reservoir Fisheries Co-operative Society.

1.4.9. Madhya Pradesh:

Madhya Pradesh is a state richly endowed with inland water resources. Impoundments in state form an important source of fresh water production. The major reservoirs of Madhya Pradesh have different fishery management practices that are unique in nature. Gandisagar, Tawa, Bargi, Halali and Barna are the major reservoirs in the state.

The state has 3 lakh ha water spread area in the form of reservoirs, and ponds, out of which 2.50 lakh ha area is in the form of reservoirs, and 0.50 lakh ha is in the form of village ponds. The average fish production from reservoirs of the state is 53
kg/ha. About 75% of the total production from the reservoir fishery of state is marketed outside the state. Within the state the sale of fish is confined to the nearby areas of reservoirs and cities like Bhopal and Jabalpur. The profit margin from local sales is more than that of outstation sales. This is because the marketing of the catch in distant cities like Delhi and Kolkata involves additional packing and transportation charges. Besides the prices in outstation markets are fully controlled by intermediaries like the wholesalers/commission agents over when the producer (MPFDC/Federations) has no control.

The Tawa is a multipurpose man-made reservoir used for irrigation, hydel power generation and for fishing activity. The construction of dam was initiated in 1956 and completed in 1974. It was transferred to Madhya Pradesh State Fisheries Development Corporation, which was continued till 1994. The fishermen of Tawa reservoir mostly use gill net, gol net, hook and lines etc. Some fishermen have learnt new fishing techniques like the shore seine. The mesh size regulation as well as the regulation in the size of the catch is also enforced strictly which reflected in the catch composition also. The common fishes found in the Tawa reservoir are *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Labeo calbasu*, *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella*, and *Mystus seenghala*. Out of these *Catla catla* and *Cirrhinus mrigala* dominate the catch. All the predatory fishes found in the reservoir fetches higher prices in the market, compared to the introduced species in the reservoir. The exotic fishes such as *H. molitrix* and *C. idella* are very rarely caught.

Gandhisagar is the biggest reservoir and it is the second largest reservoir in the country, next only to Hirakud reservoir in Orissa. It is situated in Mandsaur district of Madhya Pradesh. The water spread area of reservoir is 66000 ha. The average fish yield in Gandhisagar reservoir is about 37.3 kg/ha/yr. In Gandhisagar reservoir fishery is well managed. Major carps and local majors constitutes almost 90% of the total landings followed by local minors and minnows. This shows that the major share of the catch comprises quality fish, which fetch good market price. The stocking of the fish seed in Gandhisagar reservoir is under the control of Madhya Pradesh Fisheries Development Corporation.
The Tighra reservoir has water spread area of 2112 hectares. Uchchariya and Saksena (2012) recorded 51 species of zooplankton from Tighra reservoir. Mahor (2011) made survey on fish fauna of the Tighra reservoir and reported fish diversity of 33 species. Mahor (2011) accounted bait and hooks and gill net as the common gears used in fishing of Tighra reservoir.

Sanjay Sagar reservoir is located in the Guna district is a medium reservoir constructed in 1982 with the help of World Bank Funding. Solanki et al. (2011) reported 16 fish species from Sanjay Sagar reservoir.

Indira Sagar Project is a multipurpose newly constructed reservoir across river Narmada with a water spread area of 49,855 hectares. In this reservoir fishing was started from year 2003-2004. In the year 2004-05, the fish production was 71.5 tonnes, it was 104.793 tonnes in the year 2005-2006 and 204.533 tonnes in 2006-2007. Matsya Mahasangh has formed fishermen’s societies for catch improvement of Indira Sagar reservoir. Vyas et al. (2009) studied the spatial and temporal variation of fish fauna in the stretch of Indira Sagar submergence area and recorded 52 species belonging to 7 orders. The study indicates that this region is still a hotspot of fish biodiversity and conservation measures should be followed to sustain fish biodiversity of tributaries.

1.4.10. Maharashtra:

Maharashtra state has vast potential for fish production from reservoirs spread in most of the districts. Fishery in the reservoirs is normally carried out by the members of fishermen co-operatives.

There are only a few reports on the limnology and/or fisheries of reservoirs in Maharashtra. These include the assessment of water quality and fisheries of Yeldari reservoir by Sakhare (2007), Bhatghar reservoir in Pune district by CIFRI (1997), Nathsagar (Jaikwadi) reservoir in Aurangabad district by Desai (1980), Chhatri lake in Amrawati by Deshmukh (2001), reservoirs in Solapur district by Sakhare (2001), reservoirs in Tasgaon tahsil by Sathe et al. (2001), Dahikhuta reservoir by Shastri and Pendse (2001), Bori and Palas – Nilegaon reservoir of Osmanabad district by Sakhare and Joshi (2002), Manjra and Wan reservoirs in Beed district by Sakhare (2005, 2007) and Majalgaon reservoir in Beed district by Ingole et al. (2011).
Ekburjii is one of the water bodies in Washim district. The total water spread area of water body is 218 hectare. The reservoir is stocked with *Catla catla, Labeo rohita, Cirrhinus mrigala* and exotic carps viz., *Hypophthalmichthys molitrix, Ctenopharyngodon idella*, and *Cyprinus carpio*. Sone and Malu (2000) reported eight predatory and four weed fishes from this reservoir. The fish production from this reservoir is 1 ton/ha/yr.

Deshmukh (2001) studied fish fauna of Chhatri Lake of Amaravathi and recorded 32 fish species i.e., 17 species from order cypriniformes, 5 species from order channiformes, 4 species each from orders perciformes and siluriformes and one species each from order osteoglossiformes and mastacembeliformes.

Kalbande *et al.* (2012) reported 29 species of fishes from Rawanwadi lake of Bhandara district, out of which 19 were of order cypriniformes, 2 of perciformes, 1 of clupeiformes, 4 of ophicephaliformes, 2 of siluriformes and 1 of synbranchiformes.

Pentakli is a medium irrigation project constructed on river Painganga near Pentakli village of Buldhana district. Ubharhande and Sonawane (2012) reported 21 fish species belonging to 10 families. They also reported that the water is suitable for fisheries.

The Tulshi reservoir is located at Radhanagari in Kolhapur district. The reservoir covers 348 hecatares area. Koli and Muley (2012) studied zooplankton diversity and seasonal variation with special reference to physico-chemical parameters in Tulshi reservoir.

Pawar and Mushan (2012) recorded rotifers, cladocerans, copepods, ostracods, protozoans and euglenoids from Hotagi lake near Solapur. Hotagi lake is used for fish culture. Acidic pH of lake water is due to mixing of effluents from Siddeshwar cooperative sugar factory.

Sakhare (2005) studied water quality of Hingni (Pangon) reservoir of Solapur district and its significance to fisheries.

The Ujani reservoir was formed when a dam constructed on the Bhima river near the village Ujani in Madha taluka of Solapur district. The Bhima river is a major tributary of the Krishna river in Maharashtra. Sarwade and Khillare (2010) reported the occurrence of 60 fish species belonging to 6 orders, 15 families and 36 genera.
The Bhatghar reservoir was constructed across the river Yelwandi near Bhor village of Pune district. CIFRI (1997) under the All India Coordinated Projects on Ecology and Fisheries of fresh water reservoirs carried out ecological investigations on Bhathghar reservoir. Altogether 48 fish species belonging 12 families were recorded. The present fish yield from the reservoir is about 4.8 kg/ha/yr. The average catch per unit effort was estimated to e 1.092 kg/day.

Muley and Patil (2006) studied physico-chemical parameters of Pauna reservoir in Pune district and confirmed the occurrence of 25 fish species belonging to 3 orders at Ambegaon village, an important fish landing centre on the bank of reservoir.

Dimbhe is a masonry dam across river Ghod near village Dimbhe of Pune district. Shashwat, an NGO started organizing the fisherfolk in 2003. The Divisional Commissioner of Pune district saw the commitment of the locals and Shashwat, and decided to make a development plan for the region. He roped in the State tribal and fisheries departments, as well as CIFE, Mumbai. Today, fishing at Dimbhe dam is community-run and scientific. 203 tribal families run the Dimbhe Tribal Co-operative Fishing Society that harvests up to 27 tons of fish (Rohu, Catla, Mrigala and Chela) per year. Shashwat has been chosen for the 'Equator Prize 2012,' of the United Nations Development Program, for its work on local development solutions for people, nature and resilient communities. Sehgal et al. (2013) studied zooplankton diversity of Dimbhe dam and revealed four groups of zooplankton viz. rotifera, cladocera, copepoda and ostracoda.

Bhalerao (2012) studied the seasonal fluctuations in water quality and fish fauna of Kasar Sai reservoir of Pune district and suggested some measures for the improvement of the fish production to uplift the economic condition of the fishermen.

The Manjara reservoir, a purely irrigation project was constructed on river Manjara, an important tributary of river Godavari in year 1981. Sakhare (2005) reported 28 species of fishes belonging to 4 orders. The fishes commonly occurred in reservoir water are Labeo rohita, Catla catla, Mystus spp and Channa spp. Most of the fishermen are the local farmers and farm laborers who changed their profession in favour of fishing. Average catch per individual fishermen on a normal day is 3 to 6
kg, while during the peak fishing season the catch per individual fishermen is about 10-12 kg. The catch is sold to middleman who carts the fish everyday by road to market. The womenfolk in the fishermen families often hawk fish in local markets and residential areas.

The Majalgaon reservoir is part of the Jaikwadi scheme. The fishery of reservoir is exploited by fishermen who have been organized from different villages into co-operative society. The maximum fish production was recorded at 59066.75 kg during 2010-11.

Borna reservoir in Beed district was constructed in year 1983 across river Borna. Soon after the formation of reservoir, the Maharashtra state fisheries department leased the reservoir for fisheries to Mandwa Fishermen’s Co-operative Society. Prawn seed is also stocked but prawn catch was very low. It may be due to presence of catfishes which feeds on seed of prawn and carps. Stocking done so far has little impact on the fisheries. The small size at stocking time made them an easy prey to the carnivores in the ecosystem. The policy of stocking never had an ecology base or a consideration to the production potential of the reservoir. Neither had it taken care of growth rate nor the feeding habits of the different species in the ecosystem. It was revealed that tilapia was the most dominant species in Borna reservoir and which may be reducing the number of other indigenous fish species. It may be due to its capacity to adjust with any aquatic conditions and rapid productivity. Tilapia destroys the eggs of other fishes and can steadily replace them. It may be one of the reasons in reducing the carp fishery of reservoir. The tremendous disappearance of carps from the ecosystem may be attributed to the invasion of fish, \textit{Tilapia mossambica}. Performance of tilapia in Borna reservoir is discouraging due to its early maturity, continuous breeding, overpopulation and dwarfining. It is found that the growth rate of \textit{Catla catla} has adversely affected by Tilapia. Major component (40%) of the landings is of tilapia. Catfishes form 35% of catch, followed by carps (10%) and other fishes (15%).

The ecology and fisheries of Wan reservoir in Beed district have been studied by Sakhare (2007). He reported 34 species of fishes belonging to 24 genera falling under 7 orders.
Rathod and Khedkar (2011) reported 26 fish species belonging to 5 orders from Gangapur dam of Nashik district. In Gangapur dam order cypriniformes was most dominant constituting 55% followed by order perciformes at 22%, siluriformes at 12%, osteoglossiformes at 8% and synbranchiformes at 3% of the total fish species. Bhadane (2012 a) reported monthly variations in water quality parameters of Gangapur reservoir.

Sakhare and Joshi (2002) studied ecology of Palas-Nilegaon reservoir in Osmanabad district. The Indian major carps forms the major fishery in reservoir. Their production gradually increased with the increasing of stocking density. Exotic fishes though stocked along the carps however, could not survive and grow in the reservoir due to which they contribute very negligible fishery. Phytoplankton belonging to three groups i.e., myxophyceae, chlorophyceae and bacillarophyceae and zooplanktons belonging to rotifera, cladocera, copepoda, and ostracoda were identified. The plankton showed summer peak coinciding with the mean depth, influx and outflow of water. Rotifera, copepoda, ostracoda, myxophyceae and chlorophyceae contributed to the summer peak of planktonic density. The reservoir is leased to fishermen’s cooperative society. Every year co-operative society gives fishing rights to contractor on a fixed amount. The members of the society never fish the reservoir.

Bori reservoir in Osmanabad district is an artificial impoundment constructed across the river Bori. The reservoir has faunistic diversity of 20 fish species; the overall percentage of Indian major carps is low (Sakhare and Joshi, 2002). In Bori reservoir natural recruitment of major carps is either absent or poor due to nonavailability of suitable breeding grounds. The reservoir needs regular stocking support of major carp fingerlings. The preliminary study of planktons indicates three major classes of phytoplankton, which includes chlorophyceae, cyanophyceae, and bacillariophyceae.

Harni (Katgaon) reservoir is situated near Katgaon village in Tuljapur tahsil of Osmanabad district. Jetithor (2011) studied socio-economic status of fishermen of Harni (Katgaon) reservoir and reported per capita annual income from fisheries in the range of Rs.9000 to 37000/-. A total of 37 fish species belonging to 13 families have
been recorded from the reservoir. The fishery is exploited by fishermen who have been organized from village Katgaon into a co-operative society. The maximum fish catch was recorded during year 2007-08 i.e., 83.68 kg/ha/yr. The minimum production was during 2008-09 at 9600 kg i.e., 40.16 kg/ha/yr. During the study period the catch of carps showed the higher catches than those of local fishes.

Pawar and Pawar (2012) reported the occurrence of 50 fish species belonging to 5 orders from the Kanher reservoir of Satara district. They concluded that 10.32% fish species were carnivorous 60.43% omnivorous and 38.02% herbivorous. Pawar and Sonawane (2011) studied water quality of Kanher dam and concluded that the most of the parameters were within normal range which indicates better quality of reservoir water.

The Koyna dam, also known as Shivajisagar is one of the largest dams in Maharashtra. It was constructed on river Koyna. It is located in Koyna Nagar of Satara district, nestled in the Western Ghats on the state highway between Chiplun and Karad. About 65.7 mt of fish is harvested every year (Valsangkar, 1993). The per hectare yield in relation to maximum water spread area is 5.69 kg only.

Situated near Malegaon town of Nashik district, the Girna dam was erected in 1970 across the rivers Girna and Panzan. The gears used in Girna reservoir are mahajal, dori, chaal, disco and gill nets. Khalid and Siddiqui (1990) reported the reservoir fishery potential of Nashik district in Maharashtra with special reference to Girna reservoir fisheries. Girna reservoir harbours a substantial population of catfishes. This could be the reason for having no apparent relationship between stocking and production of fish in Girna reservoir (Khalid and Siddiqui, 1990). A fisherman earns an average income of Rs. 1000 to 1500 per month. Construction of dam attracted many fishermen families to migrate from nearby districts and towns to reservoir site. The commercially important species in the reservoir are Cyprinus carpio, Catla catla, Labeo rohita, Labeo calbasu, Mystus spp, O.bimaculatus, M. armatus, Wallago attu, Channa spp, and Puntius spp. Construction of dam attracted many fishermen families to migrate from nearby districts and towns to reservoir site. There are nearly 35 bheel (tribal) families, totally devoted to fishing.
Fisheries of Powai Lake in Mumbai is supported by 37 species (Kulkarni, 1947 and Amore 1955). Bhagat (1977) has listed 32 species while Singh Kohli (1991) has listed 10 main fish species in the lake. The fish fauna of Powai lake includes *Catla catla, Labeo rohita, Cirrhinus mrigala, Labeo calbasu*, and exotic fishes such as *Tilapia mossambica, Osphronemus goramy, Hypophthalmichthys molitrix, Tor tor, Ctenopharyngodon idella*, and *Cyprinus carpio*. The average per day catch in year 1950 was 22 kg through angling (Annual Report, Department of Fishery, Mumbai). It has gone down to 8 kg per day in 1989 (Singh Kohli, 1991). Salaskar and Yeragi (2004) found that the average per day catch was 6.5539 kg per day in 1995 and 7.079 kg per day in 1996. Thus, there is a drastic depletion in the per day catch of fish. This may be due to the heavy siltation and high discharge of waste waters into the lake.

1.4.11. North – Eastern Region:

The North -Eastern region, comprising the seven states of Arunachal Pradesh, Manipur, Assam, Mizoram, Meghalaya, Nagaland and Tripura. The Gumti reservoir is located in the south Tripura district. Its construction was completed in the year 1976 under Gumti Hydroelectric project. The water-spread area of the reservoir is of 4500 hectares. The reservoir is having some autostocking with fish breeding observed in certain areas. The resident fish species of economic importance are *Catla catla, Labeo calbasu, Labeo rohita, Cirrhinus mrigala, Heteropneustes fossilis, Clarias batrachus*, murrels and few species of weed fishes and minor carps. The fishery in small quantities is supported by *Tor tor, Tor putitora, Anguilla bicolor, Wallago attu, Mystus aor, Mystus seenghala* and *Macrobrachium rosenbergii*. The fish production has shown gradual improvement from 37.5 kg/ha in 1978-79 to 71.55 kg/ha in 1987-88. Indian major carps and exotic carps constitute about 15% of the total catch with minor carps (45%) and weed fishes (33%) forming the bulk. The reservoir contributed 2.3% of state’s fish production during 1987-88. Main fishing gears used in reservoir are gill-net (5 to 20 cm mesh size), baskets, long lines and dragnets.

Rudrasagar Lake is situated at Melaghar in West Tripura district. It is declared as National Lake No.13 and recently, on 8th November 2005, it was declared as an International Lake numbered 1572 as a Ramsar Site. The lake is looked after by a fishermen co-operative society namely ‘Rudrasagar Udbastu Fishermen Co-operative
Society’ which was established during 1951 with 2000 members which continues, as at present. The society takes care of Rudrasagar lake regarding fishing, boating and all other aspects related to the development of the lake and for biodiversity conservation. Roy and Mandal (2011) documented fisheries of Rudrasagar Lake.

Nongmahir reservoir (Meghalaya) was constructed in the year 1979. The reservoir has a total water spread area of 70 ha. The commonly recorded fishes in the *Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Cyprinus carpio, Acrossocheilus hexagonolepis, Tor putitora, Puntius sophore, Danio rerio, Danio acquipinnatus, Danio dangila, Clarias batrachus, and Heteropneustes fossilis.*

The Umiam reservoir lies in the Khasi Hills of Meghalaya. It was constructed in 1965. Of the 29 species, 21 are native fish species, which are originally found at the time Umiam reservoir was formed, and 5 were introduced native fish species. The species *Cyprinus carpio* (var. communis and var. koi) and *Clarias gariepinus* were the exotic fish species introduced in Umiam reservoir. During 2000-2001, the stocked Indian major carp contributed substantially to the total fish catch of Umiam reservoir, which gave a fish yield of 97.87 kg/ha/yr (Vinod *et al.*, 2003 b). During year 2005, average fish production of Umiam reservoir was 65.52 kg/ha/yr, which includes catches from subsistence and sport fishing, in addition to the commercial catches.

Ward’s reservoir is situated in the heart of Shillong (Meghalaya, North East India). Alfred and Thapa (1996) documented limnological investigation on Ward’s reservoir.

Loktak lake is the largest freshwater wetland in North-Eastern India. The lake is situated 38 kms south of Imphal city of Manipur state. The lake is being stocked with fingerlings of carps since 1966. October to March is the season for phum fishing. Fishermen encircle a phum with a net to collect the fish. It is stated that phums yield between 15-40 t of fish annually, besides catches taken through use of hook and lines etc. The fish fauna of lake comprises 64 species. Loktak lake serves as the breeding ground for several species of migratory fishes such as *Labeo dero, L.angra, L.bata, Cirrhinus reba* and *Osteobrama belangeri*. The fisheries of lake is also supported by *Hypophthalmichthys molitrix, Ctenopharyngodon idella, Cyprinus carpio, Cirrhinus mrigala, Labeo rohita, L.calbasu, L.gonius, Catla catla, Puntius spp, Esomus*
danricus, Heteropneustes fossilis, Ambassissp, Osteobrama cotio, Channa spp, Glossogobius spp, Notopterus spp, Amblypharyngodon mola, Anabus testudineus, Lepidocephalus spp, Clarias batrachus and Tilapia sp. The fish catch is dominated by exotic carps (33%), followed by Indian major carps (21%), minnows (14%) and rest by other forms. The fish production of the lake is 78 kg/ha/yr.

The Doyang Reservoir in Nagaland is one of the largest reservoirs in the north-east region of the country. It is important in view of its rich ichthyofaunal diversity. The fish fauna of Doyang Reservoir is comprised of 90 species belonging to 19 families. The fish production of reservoir is 80 kg/ha/yr.

1.4.12. Orissa:

Orissa is one of the important maritime states of India. It is bestowed with ample inland resources in the form of tanks, ponds, reservoirs, rivers and also a vast stretch of land suitable for coastal aquaculture due to its long coastline of 480 km. The freshwater aquaculture resources of Orissa comprise 1,21,010 ha of ponds and tanks out of which 50,310 ha are panchyat tanks, 35,933 ha are revenue tanks, 34,767 ha are under private ownership, with corresponding average pond size being 0.79 ha, 2.69 ha and 0.23 ha respectively.

Hirakud was the first post-independence major multipurpose river valley project in India and also the largest reservoir in Asia with the longest dam in the world and is situated in undivided Sambalpur district (Sambalpur, Jharsugudu and Bargarh). Construction of dam was completed in the year 1951 and the reservoir was filled in the year 1957. It was formed by damming the confluence of rivers Mahanadi and Ib. Before construction of the dam, the fish fauna of the Mahanadi river system was surveyed by many workers. They reported the fish fauna of economically important species like Notopterus notopterus, Barbus sarana, Catla catla, Labeo boggut, Labeo fimbriatus, Labeo calbasu and Mystus aor. After the formation of the reservoir in the year 1956, the fish fauna of the Mahanadi river underwent a significant change. Most of the species have dwindled due to change of eco-environmental conditions and lack of conditions congenial for migration. The actual fish catch in the reservoir is difficult to know as a good quantity of fish is illegally fished and smuggled out. The production figures, however, shows decreasing trend
year to year. It is due to indiscriminate fishing using small meshed shore seines. The fish production of Hirakud reservoir was estimated to about 15 kg/ha/yr (Khan et al. 1992). Gill nets, drag nets, cast nets, stake nets and long lines comprise the major fishing tackles operated in Hirakud. The crafts used in Hirakud reservoir are mostly wooden boats. Single boat bottom trawling was also carried out in Hirakud reservoir. It was mainly for weeding out predatory and trash fishes. The high opening trawl operated in reservoir landed a total of 2705 kg of fish with an average catch rate of 48.35 kg/ha. The occurrence of bottom and off bottom fishes like scienids, *Notopterus notopterus*, *Rita chrysea*, *Mystus spp*, *Rohite cotio*, *Wallago attu* etc., indicate that bottom trawling is effective for the removal of these fishes (Dawson, 2002).

**1.4.13. Punjab:**

The state has made great strides in aquaculture during the last four decades. The areas under fish farming and also capture fish production have gone up by about 30 times. Around 70% of the total fish production of the state comes from aquaculture and 30% from capture sector. There is a vast network of natural water resources including 17543 km of rivers and canals and 23000 ha of reservoirs/lakes/wetlands. These water resources have immense potential for fishery development. The reservoir productivity (50 kg/ha/yr) though higher than the national productivity (20 kg/ha/yr), the actual potential is much higher, being 100 kg/ha/yr (Dhawan, 2010).

Harike wetland covering 4100 ha area is included in the list of Ramsar sites in 1990. The wetland has assumed international importance as it is a breeding ground and habitat for a large variety of migratory as well as domiciled birds. It is one of the largest wetlands in North India and is very important source of water supply for the state of Punjab. The wetland area is spread over in about 41 sq.km. Of this, 2269 acres are upland ad 6904 acres are under water. Dua and Prakash (2009) reported 61 species of fishes belonging to 17 families. Moza and Mishra (2008) studied ecology and fishery of Harike wetland. The fish catch was all time high, 286.7 t/yr during 1999-2000 with an average of 28.67 t/m, when the sanctuary area too was used for fishing activity to some extent. The catch decreased sharply thereafter, culminating in
an average decrease of 57%. Fish composition of Harike indicate that the area holds maximum commercial fishery where in Indian major carps is dominant, present in the range of 26.63 to 51.48%, followed by common carp 8.96 to 33.54% and large size catfishes, 4.32 to 23.65%.

Ropar wetland covers 1365 ha area. Wetland came into formation in the year 1952 with the construction of head works. Since this wetland is located right by the side of badly damaged and absolutely eroded Shivalik foothills, a large amount of silt and nutrients gets transported into the wetland every year. The excessive siltation is reducing the water holding capacity of the lake. 55 species of fish have been reported from this wetland (Tiwana et al. 2008).

1.4.14. Rajasthan:

Rajasthan, located in the northwest of India has been the house of royalty in India. Hemawas dam is the second largest reservoir of Pali district of Rajasthan. Sharma and Mohan (2010) recorded 14 fish species belonging to 4 orders and 5 families.

Bisalpur reservoir is one of the largest reservoirs in state covering catchment area of 8655 km². The reservoir is situated near village Bisalpur of Tonk district. Matur and Summarwar (2007) conducted preliminary survey of fisheries of Bisalpur reservoir and recorded 44 species of fishes. They also reported fastest growth rate of *Catla catla* (1.5 to 2 kg/year) followed by *Labeo rohita* (about 800-900 gms/year) and *Cirrhinus mrigala* (600-700 gm/year). The exotic fishes such as *Cyprinus carpio var. communis* and *Ctenopharyngodon idella* are stocked in reservoir with seed of Indian major carps.

Sharma and Bharadhwaj (1980) reported 45 fish species belonging to 7 orders, 12 families and 28 genera from Gudha reservoir of Bundi district. The fishing is mainly done by gill-nets, drag nets, cast nets and hook and lines.

Sharma et al. (2011) studied limnological characteristics, plankton diversity and fish fauna of Pichhola Lake of Udaipur. They reported 15 species of fishes.

Jaismand Lake is the Asia’s first manmade lake in Udaipur district. The fishery of the lake has been managed by Rajasthan Tribal Area Development Cooperative Federation Limited. A total of 44 species of fish have been recorded from the lake.
(Anon, 1984). The major gears used were surface gill nets, tapa nets, hook and lines and drag nets.


**1.4.15. Tamil Nadu:**

Tamil Nadu is gifted with rich fishery potential. The inland fisheries sector has about 3.7 lakhs ha of water spread area comprising reservoirs, tanks, ponds, estuaries and backwaters which are suitable for both capture and culture fisheries.

Bhavanisagar reservoir has an area of 7,720 ha at full reservoir level and 3,695 ha at mean reservoir level. In spite of high phytoplankton productivity, *Catla catla* has fairly established itself into a viable stock, and therefore, it is necessary to stock this reservoir with the fingerlings (8 to 10 cm long) of this species at a rate of about 750 fingerlings per hectare every year and reduce predatory fishes like *Wallago attu* by selective fishing using hook and lines (Devaraj *et al.*., 1990). Food and feeding habits of *Notopterus notopterus* from Bhavanisagar reservoir were studied by Jesu Arockia Raj *et al.* (2004).

Mettur reservoir (Stanley Reservoir) is the only large reservoir in the state of Tamil Nadu. *Catla catla* was introduced in 1928, while the other major carps like *Labeo rohita, Cirrhinus mrigala* and *Labeo calbasu* were introduced from 1948 onwards. *Etroplus suratensis* and *Chanos chanos* were also stocked (Sreenivasan, 1998).

Sathnur reservoir has an area of 1,635. A self-sustaining population of catla was established and this continued for decades. About 90% of the catches were carps, of which over 80% were catla. The fishery of reservoir is mainly supported by the fishes such as *Catla catla, Labeo rohita, L.calbasu, L.fimbriatus, Cirrhinus mrigala, C.cirrhosa, Cyprinus carpio, Tilapia mossambica, Mystus aor, Mystus seenghala, Heteropneustes fossilis, Clarias batrachus* and *Wallago attu*.

The Amaravathy reservoir (907 ha) is a medium sized reservoir. The fishery of reservoir is predominantly of Tilapia (*Oreochromis mossambicus*). Other fishes found
in Amaravathy reservoir are *Catla catla, Cirrhinus mrigala, Hypophthalmichthys molitrix, Cyprinus carpio, Labeo rohita, L. bata, L. fimbriatus, L. calbasu, L. bata, Puntius spp Mystus aor, Mystus seenghala, Ompak bimaculatus, Tor tor* and *Wallago attu.*

Present fish yield in Aliyar reservoir is one of the highest in the country. The fishing in Aliyar reservoir was done both by Department of Fisheries and private fishing units, on a royalty basis, without any restriction on mesh size. This resulted in indiscriminate exploitation of stocked fishes much below the desirable size. The cumulative effect of a number of irrational reservoir management practices resulted in a very low yields, ranging from 2.67 to 54.7 kg/ha/yr with an average of 26.21 kg/ha/yr.

Raj and Lawrence (2012) reported water quality of Perumchani reservoir. Raj (2010) studied sediment profile in Perumchani reservoir and found higher silt accumulation during summer and winter months at the reservoir outlet. High level of sediment organic carbon was noticed during premonsoon. The summer months had high nitrogen content in the sediments and lowest during winter months and month after rains. Rate of siltation is fast while all other parameters are within the permissible limit.

Krishnagiri reservoir is constructed across the Ponnaiyar river basin near Periyamuttur village of Krishnagiri district. The common fishes recorded in the catches are *Labeo kontius, L.fimbriatus, Puntius sarana, Cirrhinus reba, C.mrigala, Notopterus notopterus, Ompak sp, Mystus aor, Wallago attu, Glossogobius giuris, Mastacembelus armatus, Chela sp., Cyprinus carpio, Tilapia mossambica,* and *Rhinomugil corsula.* From 1965-66 till 1979-80 the catches varied from 14132 kg/yr to 17400 kg/yr. Construction of dams on three tributaries Vaniar, Pamban and Sulagiri Chinnar (all less than 200 ha in area) reduced the silt turbidity in Krishnagiri reservoir, resulting in higher fish yields. Krishnagiri has a high MorphoEdaphic Index (MEI) of 67.3, ranking second among all Tamil Nadu reservoirs.

Santhi (2012) studied the water quality of Kodumudiar reservoir and concluded that the concentrations of all the water quality parameters are within the prescribed limit.
Thirumoorthy reservoir with water spread area of 388 ha at full reservoir level. Earlier the fish yield was very low i.e., 56.33 kg/ha/yr. Later on following the scientific management the reservoir was stocked (Selvaraj et al. 1997). There had been a conspicuous improvement in the yield right from 1991-92 (87.3 kg/ha/yr) and a record yield of 182.1 kg/ha/yr was achieved during 1995-96. The contribution by major carps also improved (88.5-96.4%) simultaneously, resulting in substantial increase in the revenue.

1.4.16. Uttarakhand:

Uttarakhand is a place with great diversity of the region where snow-clad mountains, green hills, fertile valleys, flowing rivers and thriving lakes add to the natural beauty. In Uttarakhand dams were constructed for hydel power generation. Storage of water for irrigation and flood control were secondary. None of the dams in state can therefore be described as multi-purpose projects. The fine sediments and debris filling the reservoirs formed behind the dams are losing their water holding capacity. Thus, the economically useful life of the reservoirs is diminishing rapidly. There are more than 200 hydroelectric projects. Most of these hydel power projects are constructed in the upper and middle reaches of rivers. The important reservoirs in state are Sharadasagar, Nanaksagar, Baigul, Dhaura, Baur, Kishau, Lata tapovan, Chibro, Ramganga, Khodri, Tamak lata, Chungar chal, Dhauliganga, Rishiganga, Karmali, Devsari, Tumaria and Tehri. The Sharadasagar has about 43% area in India and remaining in Nepal. The total area of reservoirs in Uttarakhand is 20,353 ha (Kathia et al., 2009).

Dhaura reservoir is located in the Tarai region of Udham Singh Nagar. It was constructed in 1961 across the river Dhaura which receives a number of rivulets in the course of their flow. Mishra et al. (2010) recorded 30 species of phytoplankton. Deorari (1993) reported 33 species of phytoplankton from Dhaura reservoir.

1.4.17. Uttar Pradesh:

Uttar Pradesh is endowed with natural wealth in abundance. This wealth lies hidden below a variety of rocks of different ages found in lofty mountain ranges of the Himalayas in the North and Vindhyan ranges in the South.
Nanaksagar reservoir covers an area of 4,662 ha. It was constructed across the rivers Deoha and Kamin in 1962. The common fishes recorded in the reservoir are *Gudusia chapra*, *Labeo rohita*, *L. calbasu*, *Cirrhinus reba*, *Channa punctatus*, *Mastacembelus armatus*, *Puntius sarana*, *P. sophore*, *Mystus seenghala*, *Mystus teengra*, *Wallago attu*, *Notopterus chitala* and *Ompak bimaculatus*. Joshi and Khanna (1980) studied the relative fecundity of *Labeo gonius* from Nanaksagar reservoir. The fecundity was 286111 eggs/kg of body weight.

The Keetham reservoir in Agra was constructed in 1925 with a maximum water spread area of about 306 ha. The fish fauna of reservoir comprises fish species like *Catla catla*, *Labeo rohita*, *Labeo calbasu*, *Labeo gonius*, *Cirrhinus mrigala* and *Gudusia chapra*. The major carps and *Labeo gonius* together contribute 51% of the total catch of which the later alone being 39%, from the main carp fauna of the reservoir. The next important fish is the *Gudusia chapra*. It forms of about 30% of the total catch, followed by other species 11%, Catfish 8% and Murrel 1%. Drag net, scoop net, drift net, gill net and hooks and lines are common gears used for fishing. The dragnet fishing is most effective for catching bigger sized fishes including the carps and catfishes. Scoop nets generally used for catching the *Gudusia chapra*.

Bacchra reservoir (140 ha) is located in the Allahabad district. Khan *et al.* (1990) reported stocking of the Bacchra reservoir in detail. Bacchra reservoir once harboured mostly catfishes and weed fishes up to 90% and the rest being major carps as revealed by the catches of 1981. Selective fishing for catfishes and stocking with Indian major carp seed was initiated in Bacchra reservoir in 1983. The major carps firmly established in the reservoir within two years of planting as was evident from experimental fishing. The natural breeding and auto stocking of major carp also helped augmenting the population of primary consumers in the ecosystem. This was corroborated when breeding of major carps for the first time was observed on 16th July 1986 in the reservoir. An iron screen of 6 mm mesh was fixed in the irrigation canal in order to check the escapement of fingerlings. In year 1988 fish production in reservoir was 139 kg/ha/yr.

Pili reservoir is an earthen dam with area of 1440 hectares. It is located in Bijnore district. The fishes commonly recorded in Pili reservoir are *Catla catla,*
Labeo rohita, L. calbasu, L. bata, L. dicolus, Cirrhinus mrigala, C. reba, Puntius spp, Tor tor, Barilius bola, Ambassis sp., Amblyparyngodon mola, Channa spp., Notopterus notopterus, Wallago attu and Ompak pabda. The gears used in fishery are gill net, cast net, drag net, hooks and mahajal.

1.4.18. West Bengal:

The important reservoirs of West Bengal are Maithon (6680 ha), Panchet (7880 ha) and Kangsbati and Kumari (7400 ha). The main aim of forming Kangsbati reservoir was storage of water and its utilization for agriculture purpose. State Fisheries Department has taken up several steps to stock fingerlings of Indian major carps in the Kangsbati reservoir. During year 2007-08 fingerlings of Indian major carps, Pungas, Tilapia and freshwater prawn was liberated in the reservoir through the financial assistance from NFDB to increase diversity of the stocks. The cage culture was done with the financial assistance from a centrally sponsored scheme. The fry of carps like Puntius japonicus, Catla catla and Labeo rohita recorded almost 90% survivality in the cages. Among other species Pangasius species, Tilapia species, Anabus species, Clarias species and Macrobrachium species have been shown economic survival value during entire culture period. The fingerlings of Clarias and Anabas gained good weight within three months of culture period. Almost 20 times of weight gain was recorded in Pangasius, Tilapia, Lates and Anabus species. The growth of Clarias was found very much encouraging. The seedling that was 12 gm at the time of liberation, in case of Clarias fingerlings, increased to 37 gm weight after three months of farming period.