Biological Forum – An International Journal **9**(2): 248-257(2017)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Study on Gross Primary Productivity, Fish Catch, Stocking and Management in Motial Lake Reservoir and Socio-Economic Status of Fishermen

Sarita Kumari*, Jawed Ahmed Khan* and M. S. Thakur**
**Department of Zoology, Saifia Science College, Bhopal, Madhya Pradesh*
***Centre for Environment Studies, Department of Biosciences,*
Himachal Pradesh University, Shimla, (Himachal Pradesh), India.

(Corresponding author: Sarita Kumari)
(Received 21 August, 2017, Accepted 21 November, 2017)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: This study was carried out in Motia Lake Bhopal, Madhya Pradesh, India for two years from 2011 to 2013 on the production and population of fishes. The three major carps such as Catla, Rohu and Mrigal were dominant and constitute about 81.66% (279.72 Kg/ha/yr) and 98.77% (352.49 kg/ha/yr) of total catch during the study period. The total fish productions were found to be 264.65 and 283.00 Kg/ha/yr during 2011-12 and 2012-13, respectively. In the fish catches, rohu (*Labeo rohita*) was the major species followed by catla (*Catla catla*), common carp (*Cyprinus*), mrigal (*Cirrhinus mrigala*) and grass carp (*Ptenopharyngodon idella*). The average stocking rate of major carps was recorded to be 25155.76 numbers each year. Among the stocked species, catla, rohu and common carp were found thriving well in the Motia Lake. The fish production was found to be stocking density dependent. Further, the production of 1 Kg fish, stocking density requirement of 66 was observed in lake. The socio-economic survey of lake showed that the fishery was not only a profitable business but also helpful in improving the nutritional status of fish eating population of Bhopal.

Key Words: Primary productivity, fish catch, stocking, fish yield, Socio-economic status

INTRODUCTION

India's inland water bodies are diverse and important source of food and also provide employment for the people of rural India. India is the second largest producer of Inland fishes. At present, about 80% of inland fish produced in India is derived from aquaculture and 22% from capture fisheries.

Reservoir constitutes a single largest inland fishery resource, in terms of production and size. These made ecosystem offer enough scope for stock manipulation through ecological maneuverings paving the way for production hikes at relatively low capital investment. Majority of reservoirs in our country are no scientifically managed. The area under fresh water aquaculture in the form of lakes was estimated to be about 2.85 million hectare (Piska, 2000). According to report of UNESCO (1978), water reservoir area was found about 6,00,000 Sq. Km. Sugman, (1995) has estimated total of 19,370 reservoirs in India with total area of 3.15 million hectare. It has been reported that the average Indian reservoir fish production was found to be 29.70 Kg/ha/yr (Dahadrai, 2001).

Fish played an important role from ancient times in providing protein rich and less fat diet to the mankind. It is one of the main components of animal protein in diet 11 kg/yr/person (Govt. of India, 1976). The per capita available of fish was found to be 8.00 Kg/yr (Piska, 2000). India was ranked eight at position among the fish producing countries of the world (total production 56,05,136 tones and inland production (27,80,440 tones) Piska and Naik (2002). About 3.57% of the total fish production was observed in about 4.949 million tones.

Aquaculture has been showing a tremendous growth during past decades (FAO, 2004, Pratibha *et al*, 2014). Aquaculture similar to other animal production system generates waste. The amount and quantity of waste depends on production system and feed quality (Piedrahita, 2003, Baliarsingh *et al.,* 2013). Accumulation of these pollutants deteriorates water quality in the water body and also increased the incidences of diseases in the Fishes (Cripps, 1999). In order to maintain the quality in aquaculture system, water has to be discharged after effluent water.

Discharge of aquaculture waste forms a major environmental concern because it caused eutrophication of receiving water such as lakes and ponds (Cripps and Bergheim, 2000).

The productivity of inland water was found good in a slight alkaline nature with pH between7.5 to 8.5. The total alkalinity between 100 and 200 ppm, nitrates 0.06 to 1.0 ppm, phosphates 0.2 to 0.4 ppm and potassium 0.5 to 1.00 ppm were optimal ranges for productive water. To maintain the healthy fish life, a concentration of 5-8 ppm of dissolved oxygen was required. Physical factors like temperature, depth and turbidity also influenced the productivity. The ideal temperature for fish life was found to be 22 - 30°C (Das, 2000). Total alkalinity, hardness, nutrients like nitrates and phosphates, dissolved solids are essential to know the tropic nature of water body.

In natural waters, the primary production entirely depends on photosynthesis. In fresh waters the primary production depends on three types of organisms such as macrophytes, phytoplankton and periphytes. Out of which the phytoplankton accounts for maximum primary production in most water bodies. In some shallow water bodies, macrophytes are more important from fish production. Periphytes occur in almost all water bodies on the margin but only rarely contribute to total production. Primary productivity is mainly of two types such as gross primary productivity (GPP) and net primary productivity (NPP). Gross primary productivity includes the organic matter used up in respiration during the measurement period. Net primary productivity (NPP) contains organic matter in the tissues or cell in excess of the respiratory utilization by plant during the measurement period. The primary productivity has a direct relationship with phytoplankton of the water body. Devi (1997); Kohli *et al*. (1998); Piska (2000), Das (2000); Pulle and Khan (2001) and Das *et al.* (2002) have done extensive work on the GPP and NPP of the various reservoirs of India.

The per hectare fish production in Indian reservoirs was found to be about 29.68 kg/ha/yr against 88 Kg in the USSR (Dehadrai, 2001), 283 Kg/Ha/Yr in Srilanka and 64.5 Kg/Ha/Yr in large and 250 kg/ha/yr in small reservoirs of Thailand. Per hectare yield in China was reported as high to be 150 kg/ha/yr in reservoirs (Sreenivasan, 2001).

Optimum yield and maximum benefits depend upon effective management with scientific approach. This requires study of certain climatic, morphometric and biological parameters. To record and analyses changed the reservoir due to nature and man's interference in order to plan future fishery activity of the reservoir. Fishing and marketing needs to be watched and their data be analysed with an enormous reservoir resources exceeding 3 million hectares in area in India. The average yield from Indian reservoirs increased from 29.69 kg/ha/yr to 50-200 kg/ha/yr when managed scientifically. (Khalid and Siddiqui, 1990; Tuli, 1999).

The management of reservoirs was studied by Fort and Brayshan (1980), Das *et al.* (1984) and Kumar (1990). Socio economics of fishermen was worked out by Sultan (1992); Murugan *et al.* (1994), Siddique, (1996), Rao (2000) and Das (2000). They reported the status, constrains and prospects of inland fisheries extension in India. Productions to marketing were revived by Sreenivasan (1998). Velayudhan and Sidharthan (1998) and Piska (2000) have studied the influence of stocking on fish yield and its impact on rural economy in Chulliar reservoir and minor reservoir in Hyderabad. Ahmed and Sugunan (1998) have revived the status and scope of North Eastern Indian reservoir fisheries. Sukumaran and Rahman (1998) have discussed the prospects of reservoir fisheries development in Karnataka. Khan*et al*. (1999) has revived the present status and future prospects of Jammu and Kashmir fisheries. Velayudhan (1999) has analyzed the issues in fish marketing and scope for intervention by the local bodies. Tuli (1999), Sreenivasan (1999), Sakhare (1999), Das (2000), Piska (2000), Sharma and Kumar (2001), Sreenivasan (2001) and George (2001) have studied the different reservoirs of India and discussed their present status and problems. Velayudhan (2001), Singh (2001), Debasis and Qureshi (2001), Rao *et al*. (2001) and Kumar (1990) have elucidated the socio economic aspects of fisheries of various reservoirs in India. Murthy (2002) has reviewed the fisheries development in Andhra Pradesh.

Hence, the present work has been undertaken to know the status of fisheries and development of a minor reservoir. The main focus was given to understand the key environmental parameters, biotic communities, primary productivity of the reservoir along with the stocking, potential yield, catch structure, fishing efforts and marketing. Finally, the suggestions were also mentioned to enhance the fish production in the reservoirs and discussed the present scenario of the reservoirs.

MATERIALS AND METHODS

The present study was conducted in a minor reservoir Motia Lake in the center of Capital City of Bhopal (23^o 16' N & 77^o 36' E; 550 meters above MSL) spreading over 7 hills. The water spread area is 10.89 hectares. The age of the reservoir is 90 years. The reservoir water is used for many purposes including fishing activities. Bhopal city is called the City of Lakes.

The two main lakes such as upper lake and lower lake provide livelihood and add to scenic beauty to the Bhopal city. This is endowed with a number of eighteen water bodies developed over a period of 900 years. The study was carried during 2011- 2013.

A. Sampling procedure

A plankton net (mesh size 65 µm) was used to filter 50 liter of surface water to obtain 100 ml of the net plankton concentration. All the samples were packed in a cane basket, protected them from intense sunlight and contamination and were transported to the laboratory without any delay.

B. Quantitative analysis

For the estimation of primary production, light and dark bottle method was employed as described by (Wallen Weider (1976). The gross primary productivity (GPP) was calculated with the following formula (Somashankar and Sreenath 1994).The gross primary production was estimated thrice in a month for two years.

$$GP = \frac{LB-DB}{T} \text{ x } 375 \text{ mg c/m}^{-3} \text{ / hr}$$

Where GPP= Gross primary productivity
LB = Dissolved oxygen content of light bottle (mg/lit)
DB = Dissolved oxygen content of dark bottle (mg/lit)
T = Incubation time (hr.)

Fishing was conducted by traditional methods using the following craft and tackle. The traditional catomarian improved with thermacole were used. This box will act as a float with holding the weight of person operating with a load of nets and fish. This is operated in water with the help of wooden oar.

Most of the fishing were done by gill netting and cast netting. After catching, the fishes were brought to the shores and segregated species-wise and sold out to customers or retailers or wholesalers or commission agents. The total catch of each species were weighed and production of particular was calculated. Then the whole month data was calculated species-wise. Finally the catch of the month and then the year were calculated

The stocking of rohu, catla, mrigal common carps and grass carps were done in the month of July and August months. The concept of agri-business model was applied to discuss the management of the reservoir (Desai, 1984). Production potentiality was estimated with the help of Gulland model (Gulland, 1974). He has given a simple model related to the potential yield of fish seed stocked.

$$Y = KMB$$

Where Y = Estimated potential fish yield (Kg/ha/yr)
K = Constant as accidental mortality which is 0.04
M = Mortality co-efficient which is 0.25 for major carps and 0.60 for cat fishes.
B = Number of fish seed stocked.

The fish productivity was calculated with the help of the following formula as described by Agarwal, (1990):

$$P = NS$$

Where P = Fish productivity (kg/ha/yr)
N = Constant including natural motality 0.25 and accidental mortality 0.40, i.e 0.65
S = Number of fish seed stocked per hectare per year

Average catch per day and average catch per fishermen were calculated in the reservoir. Linear regression equation was used to estimate the relationship between fish yields and gross primary productivity as described by Melack, (1976).

$$FY = bGP + a$$

$$\text{Log } FY = b \text{ Log } GP + \text{Log } a$$

$$b = \frac{\Sigma xy - n\bar{x}^2}{(\Sigma x^2 - n\,\bar{x}^2)}$$

$$a = \frac{\Sigma y - b\Sigma x}{n}$$

$$r = \frac{\Sigma xy - n\bar{x}^2}{\Sigma x^2 - n\bar{x}^{-2}) + (\Sigma y^2 - n\bar{y}^{-2}}$$

Where b = regression coefficient
a = intercept
r = correlation coefficient
x = independent variable
y = dependent variable
n = number of observations

In the similar way the relationships between stocking density, fish production and inputs and outputs were calculated.

The marketing of fishes were done immediately after catching. The fish caught during September to December were sold out to customers directly at reservoir site or nearby local market. The fishes caught from January were sold out to consumers or retailer or wholesaler or commission agents. The various channels of marketing and profits of producer (fishermen who caught fish from reservoir), retailers, wholesaler and commission agent were analyzed as per methods described by Agarwal (1990). The price variations of each species were also analyzed for two years. The producers' shares in consumer's rupee were also discussed. Fishes were grouped into five categories based on the prices and economy.

Socio-economic statuses of fishermen who depend on reservoir were discussed.

The aspects such as fishermen population, literacy status, occupation, education, house-hold facilities and their fishing equipment were discussed. The present status of the fishermen's co-operative society, Malkajigiri was also discussed. The socio-economic status of fishermen was studied by preparing questionnaire in a standard proforma.

RESULTS AND DISCUSSION

A. Fish Productivity

The fish productivity of major carp in the reservoir was observed to be 297.72 kg/ha/yr during 2011-2012. An increase in fish productivity was recorded in the second year i.e. 2012-2013 (352.49 kgs/ha/yr). The average production was recorded to be 279.72 kg/ha/yr and 518062 kg/ha/year (Figure 1). However, the productivity was found less than proposed productivity (1300 kg/ha/yr). This may be due to less growth of major carps as well as mortality of fish seed due to the presence of predators.

In this study the fish productivity was found much higher than small reservoirs of India (49.9 kg/ha/yr). Piska, (2000) & Agarwal, (1990) recorded the productivity of fishes in many small and minor reservoirs in Haryana such as Suraj Kund (355.7 kg/ha/yr), Hallipark (227.8 Kg/ha/yr), Karnal (17 kg/ha/yr), Dhoz (160 kg/ha/yr), Tillyar (138 kg/ha/yr), Damdara (63.95 kg/ha/yr) and Mornital (138 kg/ha/yr).

Devi (1997) and Piska (2000) recorded the productivity of 445 kg/ha/yr and 528 kg/ha/yr during 1993-95 in Ibrahimbagh and Shanthamrai reservoirs of Rangareddy district, Andhra Pradesh. The present productivities were found higher than other minor reservoirs like Baghla (106 kg/ha/yr), Bachra (139 kg/ha/yr) and Gularia (100 kg/ha/yr) managed by scientific methods as described by Jhingran and Sugunan (1990).

Bharatiya (1990) studied the fisheries of the reservoirs like Itihadol, Siregaon bandh, Shivani bandh, Ashola mendha, Pandharo budi, Makardho kada, Ukarwai and Kolar and concluded that per hectare the fish production varied from 3.82 - 106.93 kg/ha/yr. The maximum yield of 103 kg/ha/yr was in small reservoir of 33 hectares. He observed that in the reservoir the fish production of 9.96 kg/ha/yr was achieved (Fig. 1). Sinha (1990) reported that the production in the Gomti reservoir was increased from 37.5 kg/ha/yr to 71.55 kg/ha/yr from 1979-79 to 1987-88.

The present productivity of fish was observed higher in Motia Lake than large reservoirs by Srivastava (1985) in Pong dam (4.1 to 25.08 kg/ha/yr), Rihand (3.7 to 14.24 kg/ha/yr), Tenughat (0.53 to 1.471 kg/ha/yr), Kangsabati (0.55 to 1.10 kg/ha/yr), Kodana (6 kg/ha/yr), Gandhisagar (0.52 to 13.3 kg/ha/yr), Hirakud (10.5 kg/ha/yr), Santhamur (3.5 to 11 kg/ha/yr), Tungabhadra 5.54 kg/ha/yr, Pilit (08-35.30 kg/ha/yr) and Shardarsagar (42 to 56 kg/ha/yr). The fish production of 7 kg/ha/yr in Nizamsagar, 107 kg/ha/yr in Kolleru, 8 kg/ha/yr in Bhadha and 6 kg/ha/yr in Panam reservoirs. According to Srivastava (1985) the average reservoir annual fish yield was increased to about 60 kg/ha/yr.

Higher productivity of fish was found in Bidikiyar lake (825 kg/ha/yr) and Ambala muncipal lake (500 kg/ha/yr) in Haryana (Agarwal, 1990), 547.9 kg/ha/yr in Shathamraj (Devi, 1997, Piska, 2001).

Mahapatra (2003) recorded fish production of only 15.6 kg/ha/yr in Hirakud reservoirs and 5-10 kg/ha/yr in other major reservoirs in Orissa. He concluded that the yield rate was increased to 100 kg/ha/yr by proper management.

The present yield of fish from the Motia Lake remained much higher 279.72 kg/ha/hr during 2011-2012 and 353.49 kg/ha/yr during 2012-2013. It has been estimated that the catch rate from large, medium and small reservoirs was found to be low as 11.43, 12.30 and 49.90 kg/ha/yr, respectively with a gross average of 29.70 kg/ha/yr. (Dehadrai, 2001). Data collected by CIFRI suggested that the fish production potential of reservoirs was found much higher ranged from 50-75 kg/ha/yr for medium and large reservoirs to 150 kg/ha/yr for small reservoirs. Low priority given to reservoir fisheries, till recent past and inadequate implementation of management norms are the main cause for the present poor production from Indian reservoirs.

Sreenivasan (2001) estimated the production potential of Indian reservoirs at 100 kg/ha/yr. According to a conservative administrative the estimated potential yield of Indian reservoirs was found to be about 50 kg/ha/year. One of the best managed reservoirs in India is Gobind Sagarwhich has been observed with consistently high yields of 105 kg/ha/yr, seven times higher the national average (Anon, 1977). Bihar holds the record for the lowest fish yield from reservoirs, 0.54 kg/ha/yr. In 1997-98, the TNFDC operated 11,088 ha of reservoirs, producing 426.73 mt of fish (38.5 kg/ha) (Sreenivasan, 2001).

B. Stocking Densities

The stocking of major carps was found to be 2,10,000 in 2011-12 and 2, 95,000 in the year 2012-2013, respectively (Fig. 2). The stocking rate was reported to be 30840.2 fingerlings/ha and 50611.3 fingerling/ha during 2011-2012 and 2012-2013, respectively. The average stocking rate was recorded to be 40725.7 fingerling/ha.

Different authors suggested different stocking densities in India reservoirs. Agarwal (1990) recommended the following stocking rates in reservoirs of Haryana.

1. Large reservoirs (1000 – 5000 ha) – 500 fingerling/ha/year
2. Medium reservoirs (100-1000 ha) – 1000 fingerling/ha/year.
3. Minor reservoirs (10-100 ha) – 2000 fingerling/ha/year
4. Small reservoirs (below 10 ha) – 10000 fingerling/ha/year

In the present study, the reservoir came under minor reservoir category. The stocking rate was found more than 10 times to Agarwal's (1990).

When compared to Srivastava (1985), the present stocking material was at fry stage. As per Government of India the average all the reservoirs in India were under- stocking range of 2-150 fingerlings per hectare against the required density of 500 fingerlings per hectare. In China, the stocking was found very high varying from 1200-3000 fish seed per hectare per year. Mohanty (1984) suggested 1000 seeds/ha in reservoirs of Orissa. Das *et al.* (1984) reported the stocking rate of 200 fingerlings/ha in few reservoirs like Madura, Hadgarh, Talsara etc. In most of the reservoirs, the stocking rate was found low when compared to the proposed stocking rate.

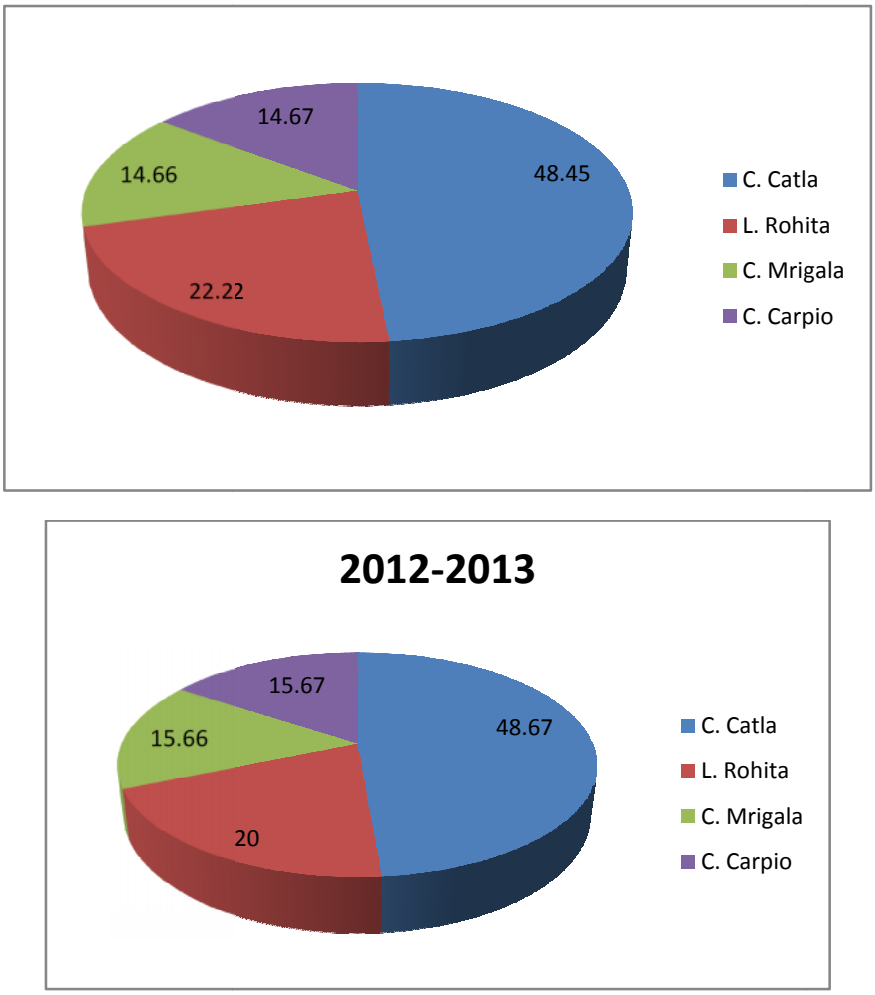

Fig. 1. Stocking densities of major carp in the Motia Lake during 2011-12 & 2012-13.

In the present study the stocking percentage of the surface feeder, catla was found to be 48.76%. The percentage of column feeder, rohu and common carps were recorded to be 15.57% and 14.56% (Table 2). As far as possible, each reservoir were stocked with 30 to 35% silver earn and catla, the surface feeder, rohu, a column feede rwith 15-20% only. Bottom feeders such as mrigal and common carp together were stocked to the extent of 45%.

Availability of aquatic weeds in the water body decides the stocking density of grass carp preferably 5-10% (Piska, 1999, 2000).

Agarwal (1990) reported that stocking of surface column and bottom feeders were 15%, 26.1% and 57.2%, respectively in Karnal lake in Haryana. He also reported that 1.7% of grass carp was stocked along with the above fishes. He also reported that the reservoirs have more than 5 meters depth with less bottom feeders. Less than 5 meters deep reservoirs was stocked with 40% surface feeders, 30% column feeders and 30% bottom feeders.

In practice, the bulk of fingerlings stocked do contain more of rohu even to the extent of 90%. But in the present study the catla seed was stocked around 45% in the reservoir. Rohu stocking was next to catla around 25-30%, followed by mrigal, common carp and grass carp was recorded in the reservior. The demand of catla and common carp fry was heavy in most of the places.

The present study indicated that catla, rohu and common carps get easily established and thrive well in this minor reservoir and produce a fair amount of yield. Grass carp was not much adaptive to this water body, may be due to the presence of few aquatic weeds in the reservoir. Government of India (1976) reported that the reservoirs was stocked with requisite quality fish seed, necessary to establish a fish seed farm of suitable capacity to produce enough fingerlings for stocking in reservoirs.

During the present study rohu is dominated over the other fishes in the reservoir. Catla domination was reported by Yadav (1983) in Hirakund and Devi (1997) in Ibrahimbagh and Shathamraj reservoirs. Agarwal (1990) reported that bottom feeders dominated in Karnal lake. Kumar (1990) reported that silver carp dominated in the fauna of Gobindsagar reservoir by vanishing Indian major carp. Yadav (1983) reported common carp dominance in Sukhna lake, Pitamahal, Sanamachkandana and Hadgarh reservoirs. Mrigal domination was found in stocking in Mandira reservoir (Das *et al.*,1984).

In present stocking rates, productivity and number of fingerlings for produced 1 kg fish in the present reservoirs during 2011-12 and 2012-13. The number of fingerling for proposed production of 1 kg fish was found to be 1.54 for the reservoir Chary (2005). This was calculated with the help of the stocking rate recommended by Agarwal (1990) for minor reservoirs in Haryana. The number fingerlings for present production of 1 kg fish were very high (62.36).

Impact of Stocking Densities on Fish Production

In present study, the average fish production was found to be 313.78 kg/ha/yr with the average stocking rate of 25155.76 nos/ha. (Fig. 2). According to Sreenivasan (1999) in relation to stocking, recapture of carps was very poor in Kovilar and Periyar reservoirs of Tamilnadu. In Periyar, 46 carp fingerling produced one kg of yield. In Kovilar 53 fingerlings were needed to produce one kg of yield. For catla, 53 fingerlings yielded one kg in Periyar.

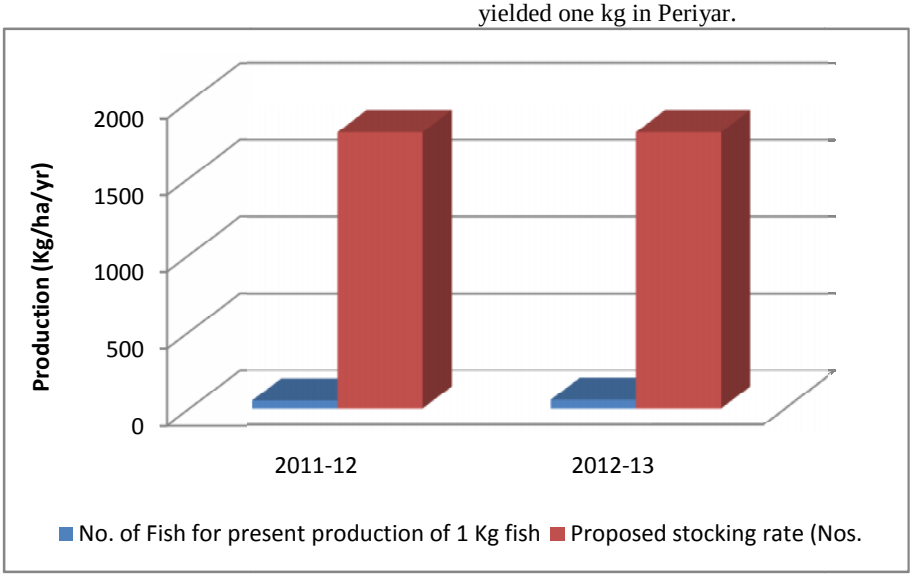

Fig. 2. The relationship between stocking densities and major carps production from the Motia Lake during 2011-12 & 2012-13.

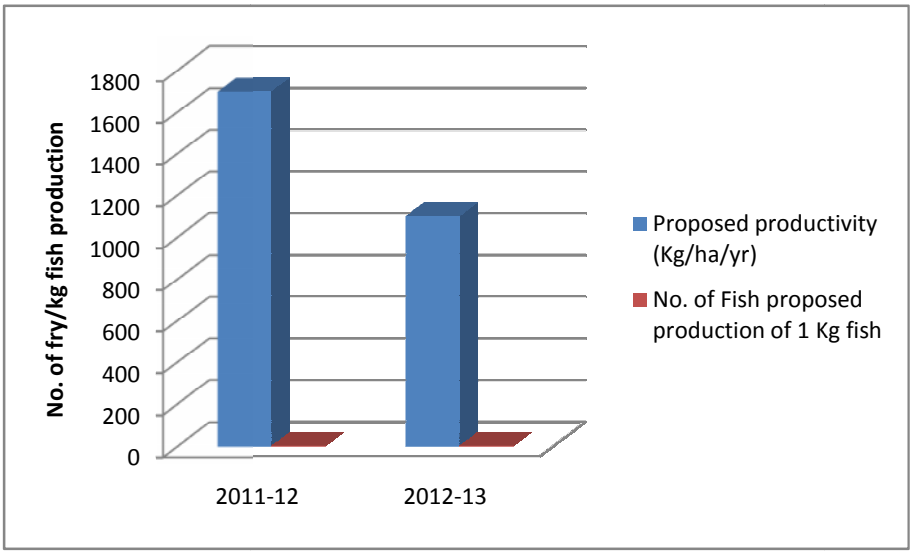

Fig. 3. No. of fry/kg fish production in the Motia Lake during 2011-12 & 2012-13.

The high positive correlation indicated that the high fish yield may be due to high stocking density. The fish yield was increased from first year (280.13 kg/ha/yr) to second year (347.43 kg/ha/yr) due to increased stocking densities (from 21935.82 to 28375.90 fry/ha). This indicated that the stocking densities play a pivotal role to increase the fish yield. That means stock manipulation results in improvement of fish production in the reservoir (Figures 2 & 3). During the present study tilapia (*Oreochromis mosambicus*) population was negligible (6.02), no tilapia dominance was observed in the reservoir. Importance of tilapia on fish production was reported by Rao and Shakuntala (1998) in Nelligudda reservoir, Karnataka. Piska and Rao (2002) in perennial tank, Nalgonda, Piska *et al.* (2002) in Pochampally and Piska and Rao (2003) in a perennial tank in Nalgonda investigated the fish production. They reported inverse relationship between major carps and tilapia production and direct relationship between tilapia production and other fish production. They also reported that tilapia competes with major carps for natural food and space.

Management

The following macro and micro systems were used for the management of minor reservoir.

(i) Fishery input

It was observed that the fishing craft and gear used by local fishermen were in good condition to catch the fish. On an average, fishermen spent Rs 1200/- per year towards fishery equipment. There is no good source of supply through approved source for fishing crafts and various types of gears used.

It has been also observed that though fish seed stocked is more in the reservoir but fish seed supply was not in sufficient quantities. The fish seed supplies of major carp have increased There was no natural collection of fish seed. The fish seed was obtained from private hatcheries.

Due to the stocking fingerlings, the mortality rate was high. The predation of fingerlings by predator fishes found in reservoirs was another reason for high mortality. This will lessen the stress on the available scanty nursery space and enable the utilization the same for four to five times in a year raising major carp seed. Sreenivasan, (1984), Selvaraj and Murgesan, (1990) Khan *et al.* (1990) and Piska (2001) reported that the mortality rate of carp was high due to predation by carnivores, hence the stocking of carp fingerling should be high for a better yield in reservoirs.

The rate of stocking of small fingerlings may be more than twice the rate as recommended by Agarwal (1990) hence, the fish seed rearing farms should be established near these reservoirs to get advanced fingerlings for stocking the reservoirs. The selection of species in stocking the reservoir was most important for increasing the production in this system. Though, the murrels are highly priced fish in this region, the murrel seed was never stocked, due to the non-availability of the seed and its predatory nature. Murrels were multiplied by auto-stocking in the reservoir. Cat fishes were also not stocked in the reservoir.

(ii) Fishery credit, extension and education

Financial institutions and banks are providing loans for agriculture, dairy, poultry, forestry and fishery projects. NABARD is also providing more than 80% refinance to the banks for agriculture credits.

Government and banks pay attention towards financing the fishermen, fishing workers and fish market intermediaries engaged in capture fisheries for the purchase of crafts and gears. The present fishermen co-operative society was small one and never went for financing from Government or banks. t.

(iii) Fishery habitat

A complete survey of the present reservoir was conducted for utilizing it to maximum capacity. The area of the reservoir was cleared for the efficient exploitation of the fish-stock. The habitat was cleared before impoundment in summer when water spread area was small. The Due to the clearance of obstacles, the brood fish and juveniles may not have places for shading and hiding. The periodical cleaning to the bottom increased the efficiency of gear and production of more fish.

The reservoir was infested with aquatic weeds like water Hyacinth, Hydella, Potamogeton, Vallisneria, Pomea etc. The growth of the aquatic weeds in water impoundment and causes restriction in the movement of fish and adversely affects the fish production. The weeds were controlled by both mechanical and biological methods. The mechanical method was adapted to clear the weeds. The floating weeds like Hyacinth was uprooted with the help of hands and cleared from the surface of water body. The grass carps were also introduced in the reservoir along with other major carp fingerlings. The grass carp cleared the weeds most effectively by feeding on them.

(iv) Fish administration

Generally the fishery wealth of any water body is under the control of Government/Local body with regard to the development, conservation and regulation. Motia Lake were grouped into different categories depending upon the water spread area and seasonality. The

Assistant, Director of fisheries of Madhya Pradesh is assisted by Fisheries Development Officer (FDO) who is authorized to supervise/provide guidance as well as conduct statutory deliberations. Fishing is a co-operative is large responsibility of providing a wide range of services required by the fishermen to support their production, marketing programmes and also to promote their welfare.

Devi (1997) and Piska (2000) reported the activities of fishermen co-operative society of Shathamraj and Ibrahimbagh reservoirs of Andhra Pradesh. Sasmal and Qureshi (2001) have extensively studied the role of fishermen cooperative society of Hoshangabad, Madhya Pradesh in the development of fishery. Chity and Dana (2003) suggested few points to solve the problems of co-operative society of West Bengal. The Karnataka co-operative fisheries federation, Mysore, established 102 retail fresh fish marketing units and sold 256.51 tones of fish worth of 77.19 lakh rupees during 2002-2003. The federation pools up the catches from the landing centers exploited by primary fishermen's co-operative societies. The federation has helped the fishermen in construction of 1176 houses (Chandrasekhar, 2003).

(v) Fish Marketing System

Selling the produce at reasonable price to the consumer should be the aim of the marketing in the interest of the producer. Marketing includes all economic activities such as the process of transferring goods and service from the produce to consumer. It includes while selling and retailing, buying, transport, storage and distribution, collection and accounting. The fish marketing is normally done at the collection centers which are mainly situated in the area of fish landing. Fish has peculiar features at its own and gives a big strain and stress on the method for marketing. Based on the marketing place, production importance and products to the market can be classified as whole sale market terminal market and retail market.

Agarwal (1990) reported that fish commission agent get high profit, followed by fishermen, fish contractor, fish farmers and least by fish retailed in markets of Haryana. Devi (1997) reported four marketing channels in distribution Ibrahimbagh and Shathamraj reservoirs. She also reported that fish farmer/producer get high profits, whereas wholesaler get less profits.

Price

The fish price fluctuations were prominent in the market. The price variation was found from morning to evening in the same market. The prices variation is not only due to the sudden supply and demand of particular variety of fish but also due to other varieties of fishes in the market. The perishability tendency of fish has definitely a role to play in determining the price of fish at the markets. The fish price varied from reservoir site to market. When fresh fish reached early in the morning a high price was quoted, then fish prices fall as the day advanced in the market. There was a great price risk because of high perishable tendency of fresh fish.

The prices of fishes were as influenced due to following reasons:

1. Elasticity of demand: Whenever the demand was more then prices of fishes are high. Mostly the prices of fish in retail markets depend on wholesale markets. During Sundays and other holidays the fish prices were more due to high demand. Especially on festival like Dussehra and Pongal the fish prices was more due to high demand. During March to May the prices of fishes were slightly less due to more production.

2. Type, sex and quality of fish: The demand of murrels was more therefore, the price are high as compared to other groups. Sex never played any role in determination of price. Live and fresh fishes prices were more than that of dead and preserved fishes.

3. Size and weight of fish: Large sized fish fetched good price in the markets. More than 1 kg fish usually fetched more than the smaller fishes of any variety.

4. Distance of procuring centers to market: The distance from the lake to market was not much hence, the distance never played any role in determination of prices.

The survey was also conducted on the minimum facilities of the house hold. It was indicated that 90% houses of fishermen are having minimum facilities like kitchen, bathrooms, and lavatories. The survey showed that all the houses were provided with electricity.

In order to increase the extent of adoption of technologies and to improve the socio-economic conditions of fishermen the following suggestions have been given:

(1) Selection of appropriate fishing technologies

(2) Supply of inputs through fisheries co-operatives and fisheries department

(3) Strengthening of infrastructure facilities

(4) Increasing the number of extension personnel involved in technology transfer. The economic variables were found to have significant positive correlation with the extent of adoption of technological practice. (Balasubramanian and Bihari, 2001, Velayudhan, 1999, Mathew and George, 2001).

CONCLUSION

In the present study the carps such as Catla, Rohu and Mrigal were found in dominance during the study period. The total fish productions were found to be 264.65 and 283.00 Kg/ha/yr. The average stocking rate of carps was found 25155.76 in each year. Among the stocked species, catla, rohu and common carp were found thriving well in the Motia Lake. The fish production was found to be stocking density dependent. The socio-economic survey of lake showed that the fishery is not only a profitable business but also helpful in improving the nutritional status of fish eating population of Bhopal. It was inferred that about 90% houses of fishermen have not minimum facilities such as kitchen, bathrooms and lavatories.

REFRENCES

Agarwal, S.C. (1990). Fishery Management. Ashish Publishing House, New Delhi.

Ahmed, J.W. & Sugunan, V.V. (1998). Status and scope of Resenors Fisheries of the North - Easter India. *Fishing Chimes*. **18**(6): 09-12.

Anon. (1977). Fresh water fisheries and aquaculture in China. FAO Fisheries Technical Paper, NO FIR/T 168 (20&23).

Anon. (1983). Inland fish marketing in India. Case study of selected major reservoirs. IIM, Ahmedabad, Publ., **4**: 1-73.

Apha. (1995). Standard methods for the examination of water, waste and sewage. 14th Edn. New York.

Baliarsingh B.K., Laishram Kosygin S.K. Swain and A.K. Nayak (2013). Species Diversity and Habitat Characteristics of Freshwater Fishes in the Similipal Biosphere Reserve, Odisha with Some New Records. *Biological Forum – An International Journal* , **5**(2): 64-70.

Bandyopadhyay, M.K, Singh, S.K. & Sarkar, B. (2003). Possibility of raising Indian major carp seed in cases for stocking larger water Bodies, CA – 1. *Nat. Sem. Fish and Shellfish Culture.* 37pp.

Banerjee, A. & Chattopadyay, G.N. (2002). Soil quality based approach for increasing productivity of fish ponds - a case study. *Nat. Symp. Fisheries Enhanc. Inland Waters*, 42pp.

Bhartiya, M.T. (1990). Management of Reservoir Fisheries through Fishermen co-operatives in Maharashtra, Constraints and Measures Proc. Nat. *Workshop Reservoir Fish*. 65-70.

Chandrasekhar, S.V.A. (2003). Trophic status of Saroornagar Lake, Hyderabad, Andhra Pradesh. *Nat. Conf. Urban lakes*. 90-91.

Das, A. K. (2000). Role of physical and chemical features of Soil in reservoir productivity. *Fishing Chimes*. **20** (7): 30- 32.

Das, A.K. & Srivastava, N.P. (2001). Proc. Workshop on Lake 'Management in India, 31pp.

Das, R.K., Misra, D.C., Murthy, T.S., Pradhan, N.K. &Mitra, S. (1984). Managing reservoir fisheries, certain case studies.*Proc. Freshwater Fish - Rural Devel. Sec*. **I**: 57-63.

Das, A.K. (2002). Evaluation of production potential in a peninsular reservoir (Yerrakalva). *J. Inland. Fish. Soc. India*, **34**(2).

Das, A.K., Krishna, Rao, D.S., Sukumaran, P.K. & Karthikeyan, M. (2002). Strategies for Management of Karnataka reservoirs. *Fishing Chimes.* **22**(2): 17-21.

Dehadrai.(2001). Reservoir fisheries in India. *Proc. Nat. Sem. Reverine and Reservoir Fishers*. 97– 04.

Desai, V.R., Shrivastava, N.P. & Kumar, D. (2007). Constraints in reservoir fishery development of care study of Ravishankar Sagar reservoir. *Fishing Chimes*. **27**(4): 19-22.

George, N. (2001). Fishery Management practices of the major reservoirs in Madhya Pradesh. *Pro. Nat. Sem. Riverine and Reservoir Fisheries*, 363-370.

Gowda, H.S.V. (2002). Status of Fisheries Development in Karnataka. *Fishing Chimes.* **22** (1): 86-94.

Gulland, J.A. (1974). Guidelines for fishery management. *J.J.O.F.C Dev. Food and Agriculture Organisation*, 74 pp.

Jain, A.K. (1998). Fisheries resource Management in Rajasthan: An overview of present status and future scope. *Fishing Chimes*. **17**(11): 9-15.

Jhingran, A. G. & Sugunan, V.V. (1990). General guidelines and planning criteria for small reservoir fisheries management. *Proc. Nat. Workshop Reservoir Fish*. 1-8.

Khalid, M.A. & Siddiqui, M.S. (1990). Reservoir fishery potential of Nasik District in Maharashtra with special reference to Girna Dam reservoir fisheries. *Proc. Nat. Workshop, Reservoir Fish.* 97-101.

Khan, A. A. (1984). An appraisal fishing gear in relation to the fishery and related problems of reservoirs of Gobindsagar (Punjab) and Hirakud (Orissa). *Proc. Fresh Water Fish, Rural Devel. Sec.* I: 5- 13.

Khan, S. (1990). Present status of the fisheries of Hirakud reservoir in Orissa and strategy of enhancing yield and betterment of fishermen communities. *Proc. Nat. Workshop Reservoir Fish*. 150-154.

Khan, M.A., Dwivedi, R.K.,Mehrotra, S.N., Sfirvastava, K.P., Tyagi, R.K.&Kathia P.K. (1990). Stocking as a management tool in optimizing fish yield from small (Bachhra) in Ganga basin. *Proc. Nat. Workshop Reservoir Fish*.71-76.

Khan, T A., Bhise, M.P. &Angchook, T. (1999). Jammu and Kashmir Fisheries: Present status and Future prospects. *Fishing Chimes*,**18**(10): 23-26.

Kohli, M.P.S. (1998). Manpower requirements in Indian Fisheries Sector. *Fishing Chimes*. **18**(2): 42-46.

Kumar, K. (1990). Management and development of Gobindsagar reservoir- A case study. *Proc. Nat. Workshop Reservoir Fish*. 13-20.

Mahapatra, B.K., Vinod, K.& Mandal, B.K. (2002). Stocking of Indian major carps in Umiam reservoir of Meghalaya – an approach for culture based fisheries. *Pro. Nat. Symp. Fisheries. Enhanc. Inland Waters*. 43-44.

Mahapatra, B.K. (2003). Present status of Fisheries of Hirakud reservoirs, Orissa. *Fishing Chimes*. **22**(10 & 11): 76-79.

Mathew, P.M. & Mohan, M.U. (1990). Reservoir Fisheries in Kerala status and scope for development. *Proc. Nat. Workshop Reservoir Fish*. 111-117.

Mathew, N.P.A. & George, J.P. (2001). Reservoir Fisheries: Post-independent Scenario and Strategies for Development. *Proc. Nat. Sem. Reverine Reservoir Fisheries*.415-420.\

Melack, J.A. (1976). Primary productivity and fish yields in tropical lakes. *Trans. A.M. Fish. Soc*. **105**: 575-580.

Mohan, B. (2001). Economic status of the fishermen of Malarapuzha reservoir. *Proc. Nat. Sem. Reverine and Reservoir Fisheries*.421-425.

Mohanty, S.K. (1984). An approach for the development of reservoir fisheries in Orissa. *Proc. Freshwater Fish. Rural Devel. Soc*. 40-46.

Murthy, D.S. (2000). Fisheries development in Andhra Pradesh. *Fishing Chimes*. **20** (1): 90- 91.

Murthy, D.S. (2002). Highlights of fisheries development in Andhra Pradesh. *Fishing Chimes*. **22** (1): 64-70.

Murugesan, V. K., Ranipalaniswamy &Manoharan, S. (2002). The influence of water quality on the productivity of reservoirs in Tamilnadu. *Proc. Nat. Symp. Fish. Enhanc. in Inland Waters*. 37 A.

Murugesan, V. K., Ranipalaniswamy & Manoharan, S. (2002). Fish production potential, actual yield and scope for enhancement of four medium reservoirs in Tamilnadu. *Proc. Nat. Symp. Fish. Enhance in Inland Waters*: 56pp.

Natarajan, A.V. (1974). Planning strategies for development of reservoir fisheries in India CICFRI, Barrackpore.

Piska, R.S. (1999). Fisheries and Aquaculture. Lahari Publications, Hyderabad.

Piska, R.S. (2000). Concepts of Aquaculture. Lahari Publications, Hyderabad.

Piska, R.S. (2000). Impact of stocking Densities of Major can seed on fish production in a minor Reservoir.*Fishing Chimes*.**20**(9): 39-41.

Piska, R.S. (2001). Fisheries of minor reservoir, Shathamraj, Hyderabad. *Ind. J. Fish*.**48** (2): 119-122.

Piska, R.S. (2003). Carp seed productions scansions in Andhra Pradesh.*Fishing Chimes*.**23**(1): 122-123.

Piska, R.S. & Naik, S.J.K. (2002). Marine Fisheries IVC, BIE, Hyderabad.

Piska, R.S. & Rao, A.M. (2002). Phenominat fish production in the Tilapia-dominated tank. *Aquacult*. **3**(2): 171-176.

Piska, R.S.; Chary, K.D. & Muralikrishna. (2004). Fish production in a Tilapia-dominated perennial tank. *Nat. Symp. Fisheries Enhanced Inland Waters*. 34pp.

Piska, R.S., Devi, B.S. & Chary, K.D. (2000). The present status of fisheries of Ibrahimbagh, a minor reservation of Hyderabad. *Fishing Chimes*. **20** (2): 41-43.

Pratibha Chourey, Durga Meena, Alok Varma and Geeta Saxena (2014). Fish Marketing System in Bhopal (M.P.) *Biological Forum – An International Journal* **6**(1): 19-21.

Pulle, J.S. & Khan, A. M. (2001). Seasonal variations in primary production in Isapur Dam, Maharashtra. *J. Aqua. Project.***16**(2): 19-33.

Rao, D.S. (2000). Poor growth performance of Rohu and Mrigal in Turbid tanks of Karnataka analysis.*Fishing Chimes.* **20**(9): 42-44.

Rao, N.P. & Raju, P.B.J. (2001). Limnological investigations and diversity of Plankton in sewage - fed fish culture pond at Nambur near Guntur, Andhra Pradesh, India. *J. Aquat. Biol*. **116**(1 & 2): 11-14.

Rath, R.K. (1993). Fresh water Aquaculture Scientific Publishers, Jodhpur.

Sasmal, D.& Qureshi, T.A. (2001). Inter relationship of the multitudiuous factors influencing the socio-economic status of fisher communities at Hoshangabad. *Fishing Chimes*. **21**(1): 106-107.

Selvaraj, C. &Murugesan, V.K. (1990).Management techniques adopted for achieving a record fish yield from Aliyar reservoir, Tamilnadu.*Proc. Nat. Workshop. Reservoir Fish*. 86-96.

Sharma, M.S. &Durve, V.S. (1985). Tropic status and fishery potential of Rajastan waters. In: Mishra, S.D., Sen, D.N and Ahmed I. Eds. *Pro. Nat. Symp. Evaluation of Environ*. 180-186.

Siddiqui, R. (1996). A study of the fishermen in Tamilnadu and Orissa.*Fishing Chimes.* **16**(8): 35-36.

Sreenivasan, A. (2001). Stagnating reservoir fish production of India.*Fishing Chimes*. **21**(1): 39-43.

Sreenivasan, A. (1984). Influence of stocking on fish production in reservoirs in India. *FAO fisheries Report*, **312**: 40-52.

Sreenivasan, A. (1999). The role of small reservoir in fish production. *Fishing Chimes*.**18**(10): 29-31.

Sreenivasan, A. (1999a). Fish production in some small reservoirs of Tamilnadu. *Fishing Chimes*.**19**(7): 32-34.

Srivastava, A. & Tamot, P. (2002). Liminified status of Kernian Reservoir with special reference to Socio-economic survey of threatened fish Mahseer Ac - 9, The Sixth Indian Fisheries forum, CIFE Murnbai, India, 90pp.

Srivastava, A. (1985). Inland Fish Marketing in India Indian Institute of Management, Ahmedabad.

Srivastava, V.K. & Reddy, M.D. (1983). Fishery development in India. Concept publishing company, New Delhi.

Sukumaran, P. K. &Rahman, M. F. (1998). Prospects of reservoir fisheries development in Karnataka. *Fishing Chimes*. **18**(8): 19-20.

Sultan, S. (1992). Status of Fisheries co-operatives in Bundelikhand (UP).*Fishing Chimes*.

Velayudhan, T. D. (1999). Issues in fish marketing and scope for interceptor by the local bodies. *Fishing Chimes.* **18**(11): 19-25.

Wani, F. & Dana, S.S. (2003). Problems and prospectors of fisheries in J & K state CA - 26. *Nat. Sem. Fish and Shellfish Cult. North-East. India*, 67pp.

Yadav, P. K. (1983). A comment on reservoir fish system. *Proc. Nat. Workshop. onDevel. Inland Fish Resources*. 269 - 275.

Zihwen, S. (1980). Manual of small scale reservoir fishery culture. FAO Pub. Rome.