Uttar Pradesh J. Zool. 30(1) : 65-70, 2010 ISSN 0256-971X

MANAGEMENT TECHNIQUES OF AQUACULTURE AND HARVESTING IN CONTEXT OF CARRYING CAPACITY OF FRESH WATER PONDS

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India's food production has increased considerably due to improved scientific technology and blue revolution. Indian's on an average consume only 4.5 kg fish per person per annum. The per capita food grains availability to population compared to other developed countries is appreciably low. Compared to other states, Bihar has the increased demand for fish production. In order to improve their nutritional status, it is necessary to improve the availability of fish in substantial quantities. In view of management technique of aquaculture some steps are required to be taken like nursery ponds management, estimation of carrying capacity of fresh water ponds, manipulation of the species ratio and supplementary feeding of fish. The carrying capacity also depends on the conversion rate of fodder, richer feeds supporting larger fish crops. Above management techniques are very much required for fisheries in Bihar.

Key words : Carrying capacity, standing crop, aquaculture, Nursery pond management, Stocked species, mortality, fingerlings, inherent fertility.

INTRODUCTION

The first step requisite for the preparation of stock ponds of the size stated above is clear them of aquatic weeds and remove predatory and weed fishes, the methods being the same as those already described for Nursery ponds management.

In larger and deeper stocking ponds, it may not be practicable to poisons for eradication of unwanted fishes and there is no known method to remove them completely. Old tanks and ponds with excess of bottom silt should be desilted before stocking as far as practicable.

In order to more production of natural fish food organisms in small stocking ponds, it is necessary to manure them in suitable instalments with organic manure (cowdung 20,000 to 25,000 kg / ha / yr) and inorganic fertilizers (mixture of ammonium sulphate, single superphosphate and calcium ammonium nitrate in 11 : 5 : 1 ratio at 1,000 to 1,500 kg / ha / yr) which may be suitably varied depending on the water and soil quality.

Carrying Capacity : Some of the more important considerations for attaining high fish production in stocking ponds are species combination, their ratio and rate of stocking. Every pond, irrespective of it what manner it is managed, can support a fish biomass only up to certain weight limit. This limit is callled the Carrying capacity or the Maximum standing crop.

The carrying capacity of ponds is intimately related to their natural productivity and management practices adopted including Fertilization. Articial feeding, the species Stocked and their Stocking rate.

Certain waters are naturally more productive than others. In general, waters in tropic are biologically more productive than those in the temperate regions. This is partly due to

higher temperature in the tropics and prolonged growing season virtually covering the whole year. Even within the same region productivity of water varies considerably due to pond locations on soils of diverse fertility and natural enrichment by minerals brought from the catchment areas. Organic environment is through the agency of human beings and domestic animals.

Fertilization, artificial feeding and aeration increase the carrying capacity of ponds : The carrying capacity also depends on the conservation rate of fodder, richer feeds supporting larger fish crops. The conclusion is due to Hepher & Chervinski (1965) who obtained a significant interaction between the population density and effect of protein rich diet. They reported that carrying capacity of pond in which fish were fed on protein-rich pellets was higher (over 2,600 kg / ha) than those in which the feed was sorghum (1,900 kg / ha).

The maximum standing crop varies with the species of fish stocked, the fast growing one which attain large maximum size yielding more than others. This is due to the fact that slow growing species have natural check in their growth rate, which may come to a halt before the carrying capacity is reached, some extent the yield can be compensated by the manipulation of numbers and repeated harvesting. The maximum standing crop is much higher with herbivorous fish than either zooplankton feeder or carnivores since as stated before, the former subsist more towards the base of the food chain.

An increase in the carrying capacity of a pond is obtained by culturing different species of fish with supplementary feeding habits or different weight classes of the same species. In this system of culture, an enhancement in carrying capacity is obtained not by increasing fish resources but rather by better utilization of the existing fish food. Yashow (1967) showed that stocking of *Tilapia aurea* (3,00/ha) in a pond with carp population (5,500/ha) did not reduce the carp production as compared with single species culture of carp. The overall production in mixed culture was 13 to 35% higher than in monoculture.

When different weight classes of common carp are cultured in the same pond, some competition is no doubt noticed between them which is dependent to a large extent on the average individual weight of the classes concerned. However, the overall production of different-weight classes is generally higher that of a single class cultured alone.

The depth of pond also influences the carrying capacity. A deeper pond will support more fish than a shallow one, simply because the former has more living space. In temperate waters, where the growing period is short, the maximum standing crop may never be attained in the time available (Hicking, 1962).

MATERIALS AND METHODS

The determination of the carrying capacity of a pond is a tedious exercise in biology, the best course being experimental. To start with stocking rates are based on common sense and empirical experience. The number of fish to be stocked may be commuted by adopting the following formula :

Number of fishes to be stocked per unit area

= Total Expected Increase in weight + mortality (not expected increase of weight of individual fish more than 10%)

Thus if in a pond (1 ha area), a total production of 2,270 kg is target and only single species of either Catla or Rohu or Mrigal is to be stocked whose normal growth rate in the first year is 906, 681g and 454 g respective, then the number of fingerlings of any one species, say *Catla*, to be stocked is given by

Catla : 2,500, Ruhu : 3,335 and Mrigal : 5,900. These stocking rates do not take into account the mortality, which necessitates the resultant number to be stepped up by 10% giving 2,750 for Catla 3,668 for Rohu 5,500 for Mrigal.

It is sought to stock a 30 : 30 : 40 combination of Catla, Rohu and Mrigal, the proportional number of fingerlings is given by

$$\frac{2.279 \times 1{,}000}{908} = 2{,}500$$

$$Catla = \frac{2.270 \text{ kg} \times 30}{65.83 \text{ kg}} = 1{,}035 + 10\%$$

$$Rohu = \frac{2.270 \text{ kg} \times 30}{65.83 \text{ kg}} = 1{,}035 + 10\%$$

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Estimating carrying capacity **:** There are many ways estimating the carrying capacity of a Fish pond. All are based on the metabolic requirements of the fish and the effect the wastes released by the fish have on the water. The easiest method of estimating maximum fish density for a pond to keep maximum fish weight within a level of 0.5 to 1 times the fishes' length in pounds per cubic foot. For example, maximum densities for 2-inch fish would be 1 to 2 pounds per cubic foot; 4-inch fish could be kept at up to 2 to 4 pounds per cubic foot. The multiplying factor is referred to as a density index.

Although the density index used for fishes can exceed 1, production efficiency and growth rates may decline without a significant increase in management effort and water flow. Many trout farmers simply maintain all sizes of fish on grow out facilities at 4.5 pounds per cubic foot as an upper limit for fish density, although with proper management and oxygenation the density can be much higher.

When planning the quantities of fish to stock, estimated the total weight of fish the tank can support at harvest, then divided the total weight by the average size of the fish at harvest to determine the appropriate number. Allowed approximately 10 percent loss for mortalities, depending upon the fish size, the length of the culture period, and the past history of fish survival on pond.

The density index estimates only the appropriate density of fish without regard to water flow through the system. Water flow rate will determine how quickly other water quality factors become limiting in each production unit. The loading rate of a tank must also be considered when planning production. An estimate of the appropriate carrying capacity of ponds relative to water flow is to keep tank loadings within a level of 0.5 to 1 times the fishes' length in inches, in pounds per gallon per minute (gpm) of water flow. For example, 2-inch fish at 1 to 2 pounds per gpm, 4-inch fish at 2 to 4 pounds per gpm.

These indeices should be used as a guide for planning production and stocking on a traditional race-way-based pond in the South. Factors such as oxygenation or aeration capacity, extreme temperatures, or very high or very low water exchange rates will influence the carrying capacity of an individual farm. In a properly designed raceway facility with water exchange between 10 and 15 minutes per tank, the estimates of carrying capacity obtained from the flow index and density index will be nearly equal, and only one estimate of carrying capacity will be needed. Accurate production records can be the best tool for predicting the capacities of ponds.

RESULTS AND DISCUSSION

From the view point of fish culture it is should technique to stock fish ponds at a rate well below the carrying capacity and allow the fish to grow upto near the carrying capacity and allow the fish to grow upto on near the carrying in the shortest possible time. The other important factors for deciding the stocking rate are marketable fish size decided by public demand and the length of the growing period. In order to obtain larger fish, the pond should be stocked at lower rate, but this may cause a decrease in fish production per unit area. A sustained production of fish throughout the year can be obtained by maintaining a gap between the carrying capacity and the standing crop at a point of time by periodical fishing. This removal of a part of the fish crop a point of time by periodical fishing. This removal of a part of the fish crop again brings down the biomass well below the carrying capacity and the remaining fish grow faster till the latter is approached.

Manipulation of the species ratio : Investigation in fish culture has also established that mixed culture of a few differed species can yield better fish production than monoculture. In good management the density of each species and the species combination have great significance. Highest production per hectare per year have been recorded when the three Indian major carps (*Catla*, *Rohu*, and *Mrigal*) are cultivated together with three exotic species (Silver carp, grass carp and common carp) in proper combination and densities.

If the water inflow is below saturation, then it decreases the carrying capacity in proportion to the reduction in oxygen saturation. For example, a tank with 100 gpm inflow at 100 percent oxygen saturation could maintain a maximum of 1,000 pounds of 10-inch pound (at 55 to 65^0F) with normal feeding rates. The same 100 gpm inflow at 85 percent oxygen saturation should support up to approximately 850 pounds of pond.

The carrying capacity of an earthen pond can be estimated in a way similar to a tank system if the water exchange rate is approximately 30 minutes or less. If turnover rate is longer than 30 minutes, the capacity is a function of the ratio of surface area to water

Table I : Carrying capacity of ponds under different management methods.

	Unfertilized ponds	Fertilized ponds	Artificially fed ponds	Fertilized & artificialized fed ponds
Capacity	160	350	600	2,680
	848	2,486	=	6,215

volume, inflow rate and oxygen demand of the sediments. The carrying capacities of earthen ponds are best determined by measuring the dissolved oxygen concentration of the pond and outflow waters.

Table II : Sample Count example [Sample Count (137/15.6) = 8.8 fish per pound].

Sample	Weight (lbs.)	Number of Fish
1	**3.5**	**28**
2	**4.1**	**37**
3	**3.1**	**28**
4	**4.9**	**44**
Totals	**15.6**	**137**

Table III : Bar grader dimensions for fish production. The accuracy of this cart depends on the Condition Factor and strain of the fish.

Bar spacing	Fish weight		Fish No.	Condition factor*	
(inches)	Ounces	Grams	Per lbs.	C=0.0004	C=0.00045
3/16	0.05	1.5	312.00	2.0	1.9
1/4	0.10	2.8	160.00	2.5	2.4
3/8	0.17	4.9	93.00	3.0	2.9
1/2	1.0	28.4	16.00	5.4	5.2
9/16	1.5	42.6	10.67	6.2	5.0
5/8	2.0	56.8	8.00	6.8	6.5
3/4	4.0	113.5	4.00	8.5	8.2
7/8	8.0	227.0	2.00	10.8	10.4
1	10.0	283.8	1.60	11.6	11.2
11/16	12.0	340.5	1.33	12.3	1.9

Supplementary feeding of fish : The various practices to enrich the pond water and soil, will stimulate the biological productivity of natural food organisms, but it is rather slow process and their growth does not fast with the increasing food demand of a total fish population under intensive fish culture. The deficiency in natural food is usually made good with the supply of cheap and efficient balanced fish feed items such as oilcakes, rice bran etc. The quality and quantity of fish feed and the method of feeding the various species having different feeding habits are important factors to be considered for successful pond management.

Rate of production of fish, however may differ depending on the level of management besides the inherent fertility status of the region, results obtained in various experimental and commercial ponds have indicated the soundness of the management measure so far evolved as evidenced from the high yield of fish and the attractive economic returns.

ACKNOWLEDGEMENT

I deem my most pleasant duty to record my deep sense of indebtedness to all those who were kind enough to extend their cooperation and help directly or indirectly for the completion of the present study. At the very outset, I take the privilege to express my sincere and deep sense of gratitude to Dr. Y.K.P. Sinha, Professor & Head Department of Zoology, B.R.A. Bihar University, Muzaffarpur for his valuable guidance, untiring help, keen attention and constant stimulation extended to me all along during the preparation of the work. I would like to record my deep sense of indebtedness to Dr. S. Ehteshamuddin. Professor & Head, Dr. A. P. Mishra, Professor, both Department of Zoology, B.R.A. Bihar University, Muzaffarpur and Dr. R.C. Das, Principal, College of Fisheries, I.C.A.R., Kolkata for their encouragement and developing in me an insight for undertaking my present work. I would like to record my deep sense of indebtedness to Capt. (IN) M. Sarangapani, Principal, Sainik School, Nalanda, Rajgir for providing the Lab. facilities for above works. I also received full Library and Technical Assistance from the Librarians as well as staff members of CIFA (Central Institute of Freshwater Aquaculture), ICAR, Bhuvneshwar and CIFF (Central Institute of Fisheries Education), 7 Bunglow Versova, Mumbai, Librarian Sainik School, Nalanda, Rajgir, Bihar for which I am extremely grateful to all of them.

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