Productivity Index Scale- New Tool for Fish Stocking in Natural Water Bodies

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Abstract

Productivity Index Scale (PIS) which can estimate production potential of given waterbody and supports decision making about the stocking density. The parameters considered are color, Secchi disc reading, water spread area, mean depth, pH, level of weed infestation and Water Retention period. Different parameters are scored on different scale range. At any given situation the PI value will not be more than 21.0. Since the depth does not have negative impact on PI, higher value is given for > 5 feet. However, in more than 5-6 feet there will be less photosynthetic activity and hence it is not considered with increasing depth. By stocking natural lentic waterbodies using this broad based tool, 20.3% higher production can be harvested. Productivity can still be affected by presence of food fishes, weed fishes, inflow and out flow of water, natural calamities, catchment, source of water, domestic utilization pattern etc. the scopes and limitations of PIS are discussed in this paper.

Key words: Productivity index, Natural water bodies, stocking density.

Introduction

The quantum of natural food produced in a pond is the result of interplay of various factors viz., climate and fertility status of pond soil and water. Phytoplankton being the primary producers in aquatic environment depends upon all these factors. Increase in primary production means an increase in pond productivity. With the adoption of suitable management measures through fertilization, the fertility status of pond soil and water could be maintained which will help in an increased primary production. Satomi (1967) observed that the composition of C:N:P in phytoplankton is approximately 50:7:1 by weight. Seymour (1980) from his data indicated that 1:4 ratio of P:N was advantageous to phytoplankton production in pond. It is obvious that lack of these elements in the environment would affect the productivity to a great extent. Various workers have observed that addition of these elements in the form of fertilizers or manures resulted in an increase in natural food and also fish production (Rabanal, 1967, Saha & Chatterjee, 1975 and Dobie, 1967).

The freshwater resources of many states are a critical component of their economic and social well being. Most of the resources are underexploited or mismanaged, some are degraded or destroyed and needless to say they are not managed scientifically.

It is usual practice that ponds/tanks are stocked based on the water spread area (WSA). It is often mistaken that more WSA brings more fish production. In many parts of the country farmers have taken larger tanks on lease for higher bids and stocked the tanks based on WSA, eventually ended up with greater financial losses. Stocking the tanks or ponds based on the water spread area may no longer be valid since fishes don't feed on water. WSA is less significant than productivity of a given tank to decide the stocking density and production potential of the tank. Stocking any water body based on availability of food, water quality and other parameters is wise management strategy. In similar lines of Leaf Color Chart (LCC) which is used as rapid tool to estimate nitrogen requirement in paddy, PIS is designed with easily measurable parameters on site.

Material and Method

The experiment was conducted in 18 selected natural tanks of size 1-2 ha in Mandya district of Karnataka. Eight tanks were stocked with conventional stocking density and other eight were with as per the proposed Productivity Index Scale (PIS). The fish species used were catla, rohu and common carp. Control tanks were stocked @ 10,000 No. ha^{-1} in the ratio of 3:3:4 (C:R:CC), where as treatment tanks were stocked with the value by computing with PIS and it was 4300 No. ha^{-1}. The experiments were carried out for eight months. Fish sampling was monthly done using cast net. Fish length and weights were recorded. Water parameters such as total alkalinity, pH, and dissolved oxygen content were recorded on sampling days.

Magada's Productivity Index Scale

Tank/pond located in____________Village_____________Taluk________District having WSA of _____________ ac/ha with effective WSA of _______________ ac/ha____

Secchi Disc Reading (SDR)

0-10	1
11-20	2
21-30	3
31-40	4
41-50	3
51-60	2
61-70	1
71-80	0
> 90	-1

Color of Water

Transparent	0
Pale	1
Grey	2
Light green	3
Olive green	4
Dark green	3
Muddy	2
Black	1

Mean Depth (feet)

<1	0
1-2	1
2-3	2
3-4	3
4-5	4
>5	5

pH of water

3-4	0
4-5	1
5-6	2
6-7	3
7-8	4
8-9	3
9-10	2
>10	0

Weed infestation (irrespective of origin of weed)

Fully covered	0
75% covered	1
50% covered	2
25% covered	3
<10% covered	4
No vegetation	3

Water Retention period (WR) in months

>10	1.0
8-10	0.9
6-8	0.7
4-6	0.5
2-4	0.3
<2	0.0

The stocking density (SD) of a tank can be estimated using the following formula;

$$SD/acre = PI \times WR \times 100$$

$$SD/hectare = PI \times WR \times 100 \times 2.5$$

Where SD = Stocking Density
WR= Water Retention period
PI= Productivity Index (sum of all six parameters)

Signature of the official
(With seal and date)

After evaluating six PI parameters, note down all the corresponding readings and location specific remarks. This is crucial in adopt situation specific management modules to increase production of the tank.

Table 1. Blank table for taking corresponding estimated values at the field

Parameter	Value	Remarks
Secchi disc reading		
Color		
pH		
Mean depth		
Weed infestation		
Water Retention period		
PI value	**Total =**	

The stocking density (SD) of a tank can be estimated using the following formula and the corresponding number of fingerlings (> 5cm)

SD/acre = PI × WR × 100

SD/hectare = PI × WR × 100 × 2.5

Where SD = Stocking Density
WR= Water Retention period
PI= Productivity Index

Some of the attributes and parameters cannot be estimated accurately, only logical and eye estimation is taken into consideration. However, there is no doubt that PI chart will play a significant role in estimating stocking density and production potential of a water body. Before giving tanks/ponds on lease, the Fisheries Department officials can evaluate PI and the lease amount can be fixed based on the PI value. The lease amount can be estimated as follows;

Lease amount/ha/yr (Rs.) = PI × 6

The present lease amount is Rs. 100/ha/year irrespective production potential of the tank. Using Productive Index Scale, we can clearly demark the productive and unproductive tanks, so that fairness in leasing policy can be expected. Moreover, it is useful in identifying less productive tanks and adopting better management techniques to improve them.

Results

Studies reveled that productions will be higher, when the ponds are stocked based on production potential. In the present experiment, the higher yield was obtained in T2 (1152.28 kg ha-1 m^{-8}) followed by control T2 (957.48 kg ha-1 m^{-8}). There was significant increase (20.3%) in the yield in the treatment ponds where it was stocked using Magada's PIS method. Among species in both the treatments, the survival percent and growth rate was better in common carp followed by rohu and catla.

Discussion

It is evident that there is an inverse relation between stocking density and growth rate. Since, there was no manurig in both the treatments, the percent survival was poor. In a natural tanks and ponds, where there is no periodical manuring, stocking less number would a better management strategy for getting better yield. There have been a number of attempts at correlating fish yields with limnological factors influencing the productivity of lakes. The direct approach, which has received greater attention recently, is the correlation of fish yields with primary production (Mc Connel et al., 1977; Noriega-Curtis, 1979; Liang et al., 1981). The comparison of the relation between primary production and fish production in various fish pond ecosystems seems to corroborate the conclusion drawn by Mc Connel et al. (1977). Though statistically we can draw conclusion on relationship between primary production and stocking density; there are real principal differences between different types of ecosystems and a uniform equation cannot be elaborated and applied for all of the water bodies. Even the logistic curve describing the whole range of primary production and fish production relations proposed by Liang et al. (1981) seems to be inadequate to provide a satisfactory explanation of the relation at different management levels.

Color of waterbody varies with season, influx of pollutants, sewage etc. natural color of a tank in most of the period can be taken as reference or plankton density can be observed using plankton net. Among weeds there are different types. For the purpose of PIS, only marginal and floating weeds are taken; but for submerged weeds, different management strategy has to be applied. The tanks are leased to the public. The lessee will not estimate the stock or production potential and stock the tanks with available carps usually 2-3 times more than the requirement. Since, we cannot estimate the present stock easily, estimation based on PIS may not be valid; but for seasonal tanks, it is better reference tool.

However, instead of stocking the natural lentic waterbodies based on thumb rule technique, the PIS would give fair knowledge of a given waterbody and help the farmers to harvest better yields.

Table 2. Details of stocking, initial mean weight (IMW), final mean weight (FMW), survival percent and production of fish (mean values of 8 replications)

Treat.	Spp. Stocked	Stocking density No. ha^{-1}	IMW (g)	FMW (g)	% Survival	Prodn. by spp. Ha^{-1} m^{-8}	Prodn. by spp. Ha^{-1}/day	Total production (kg ha^{-1} m^{-8})
T1	Catla	3000	1.50 ±0.1	254±18.00	22.0	167.64	0.69[a]	957.48
	Rohu	3000	2.0±0.06	280±14.99	34.6	290.64	1.16[b]	
	C. carp	4000	1.8±0.08	312±13.00	40.0	499.20	2.08[c]	
T2	Catla	1290	1.50 ±0.1	290±20.80	46.5	173.95	0.71[a]	1152.28
	Rohu	1290	2.8±0.20	320±22.54	68.0	280.70	1.21[b]	
	C. carp	1720	2.4±0.18	520±26.55	78.0	697.63	2.90[d]	

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