ISSN No:-2456-2165

Growth, Survival and Biomass of *Etroplus suratensis* in Shallow Water Cages Installed at Gopalpur Creek, Bay of Bengal, India

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Abstract:- With an intention to integrate artisanal level of capture based aquaculture with the sustainable management practices of small scale fisheries an attempt has been made through this study to collect juveniles and sub adults of Pearl spot *Etroplus suratensis* from Gopalpur creek and to stock in small cages installed in the same waterbody to observe its growth so as to develop a package of practices for local fishers as an option of additional income. Three sets of cages with three replicas of each one were fixed and sub adults of *Etroplus suratensis* were stocked at the rate of 15, 20 and 25 nos per m^2 for a period of 150 days. During the period of experiment temperature fluctuated from 24.6- 31.8°C, water pH from 8.1- 8.5, Water transparency from 14.2 – 32.9 cm, Dissolved oxygen from 5.0- 6.9 ppm, and water salinity from 5.3- 21.3 ppt in the cage installation site. The daily growth rate (DGR) marked a fluctuation from 0.347 to 0.593 g/day while the specific growth rate (SGR) fluctuated from 0.48 to 0.75%. More production was obtained from cages stocked with more stocking density.

Keywords:- *Gopalpur Creek, Etroplus Suratensis, Shallow Water Cage, Daily Growth Rate, Specific Growth Rate, Survival and Biomass.*

I. INTRODUCTION

The capture based aquaculture is a kind of farming technology where fish seeds/ juveniles/sub adults are caught in its early stages from a definite waterbody and is grown to its adult size or marketable size in captive conditions. It generates more profits; ensure employment and marketing. It has the potential to generate profits when compared to other aquaculture activities to a greater extent leading to socio economic development of a region. It would be appropriate to integrate artisanal level of capture based aquaculture or indigenous methods of culture with the sustainable management practices in tune with small scale fisheries (SSF) in India. Small-scale fishing dominates in many countries including India. It needs low investment, indigenous gears, indigenous technical knowledge (ITK) simple skill and an easy approach. In this regard, the shallow waterbody like estuaries, creeks and tidal lagoons etc. offer excellent scope for practice, particularly growing fish, shrimps and crabs in small cages suitable for such shallow waterbody.

The selection of species needs to be based on their abundance, duration and above all the suitability of aquatic system for its growth and survival. On the contrary the adoption of CBA under small scale fisheries in shallow waterbody without appropriate measures may increase the risk of spreading pathogens and water pollution. Authors [1], [4], [.7], [9], [12], reported on various aspects i.e. raising fish in small cages in estuaries, adoption of cage culture, supplementary feeding and growth rates, advantages, dis-advantages and risk of such practices in Indian context whereas [2], [11], [13], reported on production aspects. [3], [5] and [8] reported on failures of management aspects and suggested to make necessary adjustments accommodating the biological, agricultural and socio-economic realities.

II. MATERIALS & METHODS

A. Study Area

Gopalpur Creek lies between 19° 16’ 22” Nand 19 o 15’ 39” N Latitude and between 84 ° 54’ 0.6” E and 84° 55’15” E Longitude is a typical brackish water ecosystem spreading over 8-10 km2. It is influenced by agriculture run-off from one side and tidal ingress from other side through its mouth located in East side. Usually, the mouth, the inlet of the creek varies from 25 to 40 meter in monsoon with a depth of 3 to 4 meters separating two sand dunes. However, this inlet gradually gets filled up in sand due to littoral drifting of water current prevalent in Gopalpur bay and becomes 25-30 meters in width with 0.5 to 1.0mt in depth during summer months. Heavy influx of sea water continues to take place through the inlet into the creek throughout the year in each high tide and discharge into the sea in corresponding low tide. Therefore, varied forms of marine organisms enter to the creek including fish and shrimp juveniles and larval forms. Besides, the sea water and fresh water discharge develop a brackish water environment and serves as estuarine habitat for fish, shrimp, crabs and oysters and bivalves etc.

During monsoon often entry of fish and shrimp larvae takes into the creek water. Many of them goes back to the sea and a few makes its habitat in the creek which serves as the source of capture fisheries to nearly 700 fisher families inhabiting in the bank of creek i.e. Gopalpur fishermen village and Haripur village. The creek is leased out to the fishermen society on annual basis for the purpose of capture fisheries. The excess runoff of freshwater during monsoon and brings down the salinity and provides ample of opportunity for fresh water fishes. Gradually, the water converts to brackish water soon after monsoon ends and further increases to become saline later on. Subsequently, owing to restricted ingress of seawater and excess of evaporation makes the system hypersaline.

B. Species Selection

Realizing the need of promotion of artisanal fisheries in Gopalpur creek, Odisha by way of enhancing fish production, it was thought of to retain fish and shrimp seeds/ juveniles available during monsoon which otherwise go back to the sea, and to grow them in small shallow water cages as a source of additional income. An attempt was made to observe the growth of pearl spot fish *Etroplus sp* in cages, so that a definite programmer can be developed for wise use of its resources. Pearl spot, *is* indigenous to Indian continent and Srilanka. It inhabits in estuarine conditions and has high capacity for acclimatization to freshwaters at all size groups. Filamentous algae and detritus constitute the major food for the fish in its habitat. The species having browsing / 'scraping' behavior keep the cages free from fouling and mesh clogging algae.

C. Fabrication and installation& stocking and monitoring

Three sets of experimental cages (each set having three each) were fixed closure to the inlet so as to take the advantage of water flow during high and low tide. Cages of rectangular size 2.0 m x 1.0 m x 1.2 m made of locally available bamboo splits with 15 mm gaps between bamboo splits were fabricated by the local fishermen. Nylon mosquito nets of 0.5 mm mesh size were tied as an inner layer to protect fish from abrasion and avoid loss of feed pellets. The cages were kept in fixed position by towing it in prefixed bamboo poles interlocking in a line in such a way that the width of cage faces water current so that water can pass through all the three cages thus making it very efficient in water exchange. Bamboo barricade was provided for each location to protect the cage from floating weeds and turbulence due to tidal force. The outer opening of cage is provided with a cover made of same bamboo split wrapped with mosquito cloth to protect against sunlight and birds. Seeds/ juveniles of pearl spots, *Etroplus suratensis*, of size between 45-55 mm / 42-48 gm collected from the same waterbody and were stocked at three different densities of 15, 20 and 25 nos./ m^2 in three different sets of cages. The stocked fishes were fed twice a day with dry pellets at the rate of feeding were adjusted according to biomass 5-7% adjusting to the biomass of the cage.

The weight gain of fish was determined by subtracting initial weight from final weight. This weight gain is divided by number of culture days to ascertain the average daily weight gain and the result was expressed in g. The Specific growth rate was estimated following standard formula = (100 x (LN final weight – LN initial weight) /days)) taking a sample size of 25% from each cage. Critical water quality parameters like temperature and dissolved oxygen (DO) were observed on daily basis using temperature probe and digital DO meter while routine parameters i.e. transparency, pH, and salinity were ascertained at fortnight intervals following sechi disc method and using pH meter and salinometer respectively. The repair of cages and cleaning and replacement of nets etc., were carried out as and when necessary.

III. RESULTS AND DISCUSSION

Out of three treatment cages of set I, the first cage with a stocking density of 15nos/m^3, where fish juveniles of size below 45mm/42g were stocked recorded its body weight gain of 47g, 58g,75g, 100g and 130g during 30 days, 60 days, 90days, 120days and 150 days of culture while in the 2nd cage the body weight enhanced from 45g to 48g, 55g, 70g, 105g and 125g and in third cage fish grew from initial 48g upto 54g, 65g, 78g, 115g and 137g in 30th, 60th ,90th, 120th and 150th days of culture. The daily growth rate (DGR) varied 0.59g, 0.53g and 0.59 with a mean of 0.571 ± 0.03 g./day and specific growth rate (SGR) fluctuated from 0.681% to 0.753% with a mean of 0.711 ± 0.03 %. Similarly, in the 2nd set of experimental cages with a stocking density of 20 no's/m^3 fishes stocked between 45-55mm/42-48g recorded maximum growth up to 122 g in 4th cage followed by 120g in 5th cage and 115g in 6th cage indicating mean DGR of 0.493 ± 0.04 g/day and SGR of 0.649 ± 0.06 % while the 3rd set of cages of stocking density of 25 no's/m^3 where fishes between 45-55mm/ 42-48g recorded maximum growth up to 112g in 7th cage followed by 110g in 8th cage and 100g in 9th cage resulting mean DGR of 0.415 ± 0.06 g/day and SGR of 0.579 ± 0.08 %. Statistical analysis (ANOVA) indicated no significant variation of growth of fish within cages and significant variation of growth within months. Added, survival rate of fishes was relatively high (87-93%) in 1st set followed by 2nd and 3rd set of cages (80-87%). But maximum biomass was obtained from 7th cage (5.00kg) followed by 4th& 8th cage (4.600kg each), 9th cage (4.400 kg), 5th& 6th cage (4.00 kg each), 3rd cage (3.800kg), 1st cage (3.600 kg) and 2nd cage (3.200 kg) indicating higher biomass in cages having more stocking density in spite of relatively low survival rate.

Experiments on cage culture in India indicated yield rates range from of 0.7 to 1.3 kg/m^3/month [7] while, [9] reported total fish production of 16.03 kg/m^3/year. Author [4] recorded an average fish production of 26.76± 9.308kg (range 17.80- 44.40) kg/m^3 in 205.3 ± 60.9 days of culture with a record of 0.50-0.90 g growth per day at a survival rate varying between 45 and 100%. The fish attained maximum size of 350-480 g at harvest (average size of 163.76 ± 40.214g) at a specific growth rate ranged from 0.27 to 0.76% leading to a situation of more the production from higher the stocking density (230 no's/ m3).

Growth performance of pearl spots (*E. suratensis*) to an extent of 0.593 g/day at Gopalpur creek throughout this study appears less than the results obtained by [4] from Venbenad lake of Kerala but certainly better considering its natural growth in open waters of Gopalpur creek. The growth rate of Pearl spot is comparatively much slow than many estuarine fishes, hardly growing to 120-130 g. The attainment of 137g in 150 days in shallow water system encourages its possibilities of cages culture. Fish production increases with increase of stocking size limiting to its maximum growth phase and similarly with stocking density considering its carrying capacity. But in the present investigation such kind of result was not recorded. It could be due to the fact of stocking of oversize fish in cages. This implies that higher stocking density would have fetched more production. The mortality rates were low when stocking size and stocking density was more without much fluctuation. The observed biomass 2.50 kg/m^3 of pearl spot under cage culture is satisfactory for the study. Higher stocking density and frequent feeding results, increased production in cage fish farming particularly for carnivorous fed fishes but not for pearl sopt with browsing feeding habits. The results also confirm that pearl spot adapts well in low to moderate volume cages suitable for shallow waterbody which could be due to its schooling behavior. Therefore, higher stocking stocking density to an extent of 4 to 5 time would be possible.

The net cages stocked with pearl spots were free from clogging of algae and fouling of biofilms due to its algal browsing behavior and algal grazing tendency mostly on filamentous algae and detritus as evidenced from the findings of [6], [10] and [16]. The bamboo sticks and its supported pieces acted as good substrates for the growth of filamentous algae and bio-film that served as an additional source of natural food for the fish.

The values of physic-chemical parameters of water in the cages like temperature, dissolved oxygen, transparency and pH were well within tolerable limits of fish. However, in set I cages (C-1, C-2 & C-3) where fishes were stocked at a density of 15 no's/m3 water temperature fluctuated from 24.6 ºC (Dec) to 31.1 ºC (August) at a mean of 29.0 ± 2.4ºC., dissolved oxygen from 5.2 ppm to 6.9 ppm (6.00 ± 0.70 ppm), transparency 14.2 cm to 32.9 cm (23.5± 7.2cm), water pH from 8.1 to 8.5 (8.3 ± 0.14) and salinity from 10.5 pot (August) to 21.3 pot (16.9± 4.5 pot). Similarly, in set II cages (C-4, C-5 & C-6) temperature fluctuated from 25.2 ºC - 31.8 ºC. (29.1 ± 2.6 ºC.), dissolved oxygen from 5.0 - 6.1 ppm(5.5 ± 0.41), water transparency from 15.4cm- 37.5 cm (23.1 ± 9.06 cm), water pH from 8.2- 8.5 (8.4 ± 0.10) and salinity from 11.3 – 20.8 ppt (16.5± 3.9 ppt) and in set III cages (C-7, C-8 & C-9) water temperature fluctuated from 25.3 ºC - 31.5 ºC (29.3 ± 2.4 ºC), dissolved oxygen from 5.2 ppm- 6.5 ppm (5.9 ± 0.54 ppm), transparency from 15.7 cm – 31.7 cm (22.0 ± 7.3 cm), water pH from 8.2-8.5 (8.4 ± 0.10) and salinity from 5.3 ppt- 21.2 ppt (14.1 ± 6.0 ppt) during the period of study. ANOVA test indicated significant variation within months (P< 0.05) for both water temperature and water salinity and non-significant variation (P>0.05) within experimental site. But for water pH and dissolved oxygen it marked non-significant variation within months and sites. All the water parameters were suitable for growth of fish during the period of experiments.

Usually, unused feeds settle below the cages if not dispersed through water current and such accumulation lead to decomposition and depletion of oxygen level. On the event of prolonged situation, biological oxygen demand (BOD) increases. Author [15] reported very low levels near cages. However, high oxygen levels between5.2 ppm to 6.9 ppm observed at the cage installation site in the present study indicative of stress free situation. Added the water circulation through cages compensated the dissolved oxygen concentration of water in fish cages. So it confirms good exchange of water between cage and open water in the present study and minimal clogging and fouling of nets and cages. The low transparency (below 20 cm) recorded in the months of July, August and September was the effect of sediment transport because of littoral drift phenomenon prevalent in Gopalpur bay coupled with mixing of silt laden rain water flow from the adjacent catchment areas. Added, frequent rains and very low levels of salinity often associated with the risk of disease outbreak in caged fishes. In the present study neither any indication of disease nor its occurrence was noticed.

IV. CONCLUSION

Based on the growth performance of Pearl Spot *E. suratenis* as recorded in the present experiment, it is concluded that there is a possibility to undertake shallow water cage culture in the Goplpur creek by the local fishermen community either at individual or family or through fishermen's' cooperative society. However, considering evidences of failures in cage farming management practices in spite of inclusion of small-scale fish farming in Africa in the late 1950s and early 1960s as a means of improving the quality of life for poor farmers as reported by (Kalinga, 1991) adequate precautions need to be taken and suitable practice of packages need to be followed before adopting such technologies in this waterbody.

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TABLE 1. Water quality in the cage sites during the period of cage culture practice in Gopalpur creek, East coast of India.

Water parameters	**1st day**	**30 days**	**60 days**	**90 days**	**120 days**	**150 days**
Stocking density (15nos/m^3)	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (oC)	30.0	31.1	30.8	29.6	27.9	24.6
Dissolved Oxygen(DO)	5.2	5.6	5.6	5.7	6.8	6.9
Transparency (cm)	17.4	14.2	20.8	26.3	29.5	32.9
Water pH	8.1	8.2	8.4	8.5	8.4	8.3
Salinity (ppt)	12.3	10.5	17.4	19.3	20.7	21.3
Stocking density (20 nos/m^3)						
Temperature (^{o}C)	30.6	31.8	31.2	29.2	26.8	25.2
Dissolved Oxygen(DO)	5.0	5.5	6.1	5.4	5.2	5.9
Transparency (cm)	16.2	15.4	17.3	21.2	37.5	30.8
Water pH	8.3	8.2	8.4	8.5	8.4	8.3
Salinity (ppt)	12.5	11.3	16.4	17.8	20.2	20.8
Stocking density (25 nos/ m^3)						
Temperature (^{o}C)	30.8	31.5	31.2	29.7	27.4	25.3
Dissolved Oxygen(DO)	5.2	6.1	5.9	5.3	6.4	6.5
Transparency (cm)	15.7	16.3	16.8	20.5	31.7	30.8
Water pH	8.3	8.2	8.4	8.5	8.4	8.3
Salinity (ppt)	5.3	9.4	13.4	15.6	19.8	21.2

ISSN No:-2456-2165

TABLE.2. Growth, survival and biomass of *E. suratensis* in experimental cages during 150 days of culture at Gopalpur creek, East cosat of India

Features	**Site –I (set-I)**			**Site-II (set-II)**			**Site III (set-III)**		
	C-1	C-2	C3	C-4	C-5	C6	C-7	C-8	C-9
Cage size (m^3)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Cage stocking volume	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Stocking density (nos/ m^3)	15	15	15	20	20	20	25	25	25
Days of culture (DOC)	150	150	150	150	150	150	150	150	150
Mean stocking size									
Weight (g)	42	45	48	42	45	48	42	45	48
Length (mm)	45	50	55	45	50	55	45	50	55
Max. size at harvest									
Weight (g)	130	125	137	122	120	115	112	115	100
Length (mm)	125	112	130	128	110	105	110	120	105
Survival (%)	93	87	93	87	80	87	87	80	87
Total Biomass (kg/m^3)	1.8	1.6	1.9	2.3	2.0	2.0	2.5	2.3	2.2
DGR (g. fish/day)	0.586	0.533	0.593	0.533	0.500	0.446	0.467	0.433	0.347
SGR(%)	0.753	0.681	0.699	0.710	0.654	0.582	0.654	0.595	0.489