Current World Environment Vol. **11**(2), 531-536 (2016)

An Assessment on Economic Impact of Growth Over Fishing of Commercially Important Marine Ariids Along Mumbai, Northwest Coast of India.

RAMKUMAR SUGUMAR[1]*, A.K. JAISWAR[2], RANJITH LAKSHMANAN[3], SUSHANT K CHAKRABORTY[2], G.B. PURUSHOTTAMA[1], VINAY DESHMUKH[1], VINOD KAVUNGAL[4] and RANI MARY GEORGE[5]

[1]CMFRI Research Centre, Mumbai, India.
[2]Central Institute of Fisheries Education, Mumbai, India.
[3]CMFRI Research Centre, Tuticorin, India.
[4]CMFRI Research Centre, Calicut, India.
[5]CMFRI Research Centre, Vizhinjam, India.

http://dx.doi.org/10.12944/CWE.11.2.22

(Received: May 29, 2016; Accepted: June 24, 2016)

ABSTRACT

The economic assessment on juvenile landings of four dominant marine catfishes at New Ferry Wharf (NFW) landing centre, Mumbai, Northwest coast of India was carried out during January to December, 2013. The dominant catfishes *viz. Nemapteryx caelata* (19.7 %), *Plicofollis dussumieri* (21.5 %), *P. tenuispinis* (24.8 %) and *Osteogeneiosus militaris* (27.5 %) together contributing 93% of total marine catfish landings of the state. Among four species, the juvenile landings of *N. caelata* contribute maximum (93.17 %) followed by *P. dussumieri* (57.14 %), *O. militaris* (36.11 %) and *P. tenuispinis* (21.43 %) with the maximum landing during November to March . The bioeconomic model reveals that if juveniles are allowed to grow up to length at first maturity (L_m); an estimated total annual economic gain will be Rs. 13.15 crores with an estimated biomass gain of 1222 t per annum. The estimated total annual biomass is increased by 2.07 times with an increase in additional revenue by 3.7 times would have been realised. The results of present study suggest that sustainable harvest of these resources would have been yielded maximum economic return to the fishers. With the help of stakeholders participatory approach, management measures such as strict mesh size regulation, effort restriction on bottom trawl up to 50 m depth and awareness campign on catching juveniles and adult in particular to the oral incubated male ariids, would have been implemented during November to March to avoid growth overfishing.

Keywords: “Marine catfish”, “Trawl bycatch”, “Juvenile fishing”, “Economic loss”, “Growth overfishing”.

INTRODUCTION

In Indian waters, marine catfishes were represented by 23 species, of which 11 species forms commercial fishery.[17] The distribution of ariids all along the Indian coast between 30 and 80 m depths with maximum abundance over inshore muddy bottom habitats[16, 19, 21]. In India, the average annual landings of marine catfish was 11,779 tonnes (1950) which are mainly exploited by artisanal sectors.[19] Catfish fishery in Maharashtra is supported by 10 species of which *Plicofollis dussumieri, P. tenuispinis, Nemapteryx caelata* and *Osteogeneiosus militaris* forms 93 % of the total catch of the Maharashtra state[7, 8]. Anintroduction of mechanised trawlers (1966-75) and purse seiners (1976-80) in Maharashtra coast resulted increase in catfish catch, with the maximum landings of 67,666 tonnes was noticed in 1982, thereafter the landing decreased gradually to 45,335 t in 2005 with the

recorded minimum landing in 1995 (37, 518 t).[1, 10, 18, 24] The possible reasons coule be attributed to low fecundity and exhibitionof oral incubation and shoreward breeding migration. Preference in movement of shoals of brooding male to shallow coastal waters is vulnerable to fishing mortality by bottom trawling and by purse seine[3, 4, 5, 18, 22, 27]. Mean length at exploitation was found lower than L_m resulted in heavy fishing pressure on juveniles and sub adults of these resources in Mumbai waters[24]. .New Ferry Wharf (NFW) is one of the major fish landing centre in India representing 33 % of the trawl catch of Maharashtra state[2, 6]. No recent information on juvenile landings of the marine catfishes and its economic loss to the fishers are available along Maharashtra coast. Hence, the present paper aims to quantify the juvenile landings in shrimp trawlers in New Ferry Wharf (NFW) landing centre of Mumbai waters and its economic evaluation due to juvenile fishing.

MATERIALS AND METHODS

The samples were collected during January to December 2013 from multiday trawlers of NFW operated along south of Saurashtra coast to Ratnagiri coast (17^0-21^0 N and 71^0-73^0 E) with depth range from 10 - 60 m (Figure 1). The total catch, length frequency data on the landings of juveniles and adults and also their price of all four species were made at NFW landing centre on weekly basis. The catch data was not available from 1st June to 15th August due to trawl ban imposed by the Maharashtra government. The total length was measured using digital vernier calliper to the nearest mm. The total number of boats landed and the total catch landings of four species were obtained from the database at Mumbai Research Centre of Central Marine Fisheries Research Institute.

The catch recorded from the observed number of boats on the day of observation was raised to total number of boats landed on that day, and then raised to the month. The monthly estimates were used to arrive at annual estimates by taking into consideration the number of fishing days and monthly estimated number of boats by following the method of Alagaraja and Srinath (1980)[2]. The quantity of adults and juveniles of each species landed during the study period was estimated based on length at first maturity collected from published papers for each species. The proportion of juveniles and adults from observed length frequency data was determined for all the four species.

Species-wise total juvenile and adult weight corresponding to length data was calculated based on length-weight relationship method.[15] Adult biomass corresponding to 1 kg of juveniles was obtained from bioeconomic model and economic loss due to juvenile fishing were estimated following the method of Najmudeen *et al* (2008).[23] The mortality rate was calculated as the proportion of total and natural mortality.[14] The economic loss due to juvenile landings of each species was estimated by assuming that the weight gained if they were allowed to grow up to length at first maturity. The concept is that length of most animals in the population would have an opportunity to become mature and spawn and contribute to the future generation sustainably. The annual average landing centre price of juvenile and adult of each species were used to estimate the economic loss.

Table 1: Length at first maturity, Lmean and average annual landing prices of four dominant marine ariids during January to Decemeber 2013

S. No.	Species	Lm (mm)	Lmean (mm)	Average annual landing price	
				Juveniles in Rs/kg.	Adults in Rs/kg.
1	*Nemapteryx caelata*	408	268	45	80
2	*Plicofollis dussumieri*	351	298	50	80
3	*Osteogeneiosus militaris*	392	291	50	90
4	*Plicofollis tenuispinis*	416	290	40	80

RESULTS AND DISCUSSION

The length range, length at first maturity (L_m), average annual mean length (L_{mean}) and average annual landing price structure of juveniles and adults during study period of all the four species are shown in Table 1. The percentage distribution of juveniles size ranges of different species landed are as shown in Figure 2.

The estimated annual juvenile landings of *Nemapteryx caelata* formed 93.17 % of total catch with peak during October to January (Table 2) and minimum size range recorded was 130-139 mm. In *N. caelata,* L_{mean} was 268 mm and L_m was 408 mm, if juveniles are not caught and allowed to grow up to L_m, an additional revenue of Rs. 9.99 crores (Table 2) would have been realized and biomass added was found to be 1,250 tonnes per annum. It was evident from the present study that notable reduction in L_{mean} from 300 mm in 1990's to present 268 mm and the reason may be due to growth overfishing of the stock by bottom trawlers in Northwest coast.[5, 7] The present results showed that annual biomass is increased by 2.96 times with 5.26 times increase in revenue, if juveniles are caught beyond L_m. Diet composition studies by Raje (2006) showed that 56.62 % of the *N. caelata* diet is crustacean and during spawning seasons (February to June & July to January) no mature fish was observed which coincide with the juvenile abundance of present study period. [9, 25]

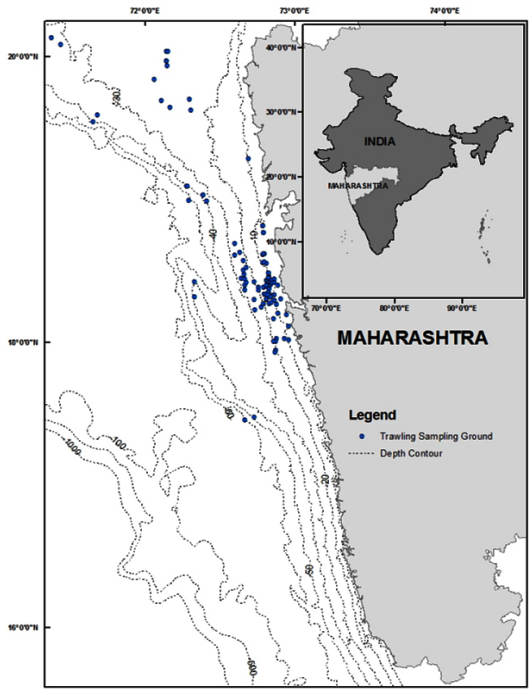

Fig. 1: Shows trawl sampling ground with depth contour during January to Decemeber 2013

The estimated annual juvenile landings of *Plicofollis dussumieri* formed 57.14 % of total catch with peak landing is from November to January (Table 2) and minimum landed size range was 180-189 mm. In *P. dussumieri,* L_{mean} was 298 mm and L_m was 351 mm, if juveniles are not caught and allowed to grow up to L_m, an additional revenue of Rs. 3.48 crores (Table 2) would have been realized and biomass added was found to be 434 tonnes per annum. The present results showed that annual biomass is increased by 1.97 times with 3.16 times increase in revenue, if juveniles are caught beyond L_m.

The estimated annual juvenile landings of *Osteogeneiosus militaris* formed 36.11 % of total catch with peak landing is from January to March (Table 2) and minimum landed size range was 120-129 mm. In *O. militaris* L_{mean} was 291 mm and L_m was 392 mm, if juveniles are not caught and allowed to grow up to L_m, an additional revenue of Rs. 2.7 crores (Table 2) would have been realized and biomass added was found to be 300 tonnes per annum. The decadal decline in L_{mean} from 300 mm in 1990's to present 291 mm and $L_{mean} < L_m$ evidenced due to growth over fishing of the stock was observed during the present study period.[5, 7, 9] The present results showed that annual biomass is increased by 2.96 times with 5.26 times increase in revenue, if juveniles are caught beyond L_m. Studies on index of preponderance showed high value from February to June which coincide with the juvenile abundance of our study period. Diet composition mainly consists of polycheates, penaeid prawns, crabs, molluscs and brittle stars proven to be a voracious bottom feeder and are more vulnerability to bottom trawl fishery.[25] Moreover, occurrence of juveniles landings of *O. militaris* throughout the year is furthur supported by their fractional spawning behaviour from August to April.[7, 8]

The estimated annual juvenile landings of *Plicofollis tenuispinis* formed 21.43 % of total catch with peak landings in January, March, May and October (Table 2) and minimum landed size range was 190-199 mm. In *P. tenuispinis,* L_{mean} was 290 mm and L_m was 416 mm, if juveniles are not caught and allowed to grow up to L_m, an additional revenue of Rs. 1.25 crores (Table 2) would have been realized and biomass added was found to be 434 tonnes per annum. The present results showed that annual biomass is increased by 1.68 times with 3.35 times increase in revenue, if juveniles are caught beyond L_m. Diet composition is dominated by squilla, crabs, prawns and bivalves indicates its preference on bottom dwelling organisms[7]. The spawning season from September to November, March and May coincided with juvenile abundance indicating theses species are more vulnerable to bottom trawl.[7, 9, 13, 19]

The utilization of low value bycatch (LVB) over the period in Indian coast increased from 14% in 2008 to 25% in 2011, this increasing trend was due to increase in price and demand for LVB for the production of fish meal and fertilizer.[11, 12] In India, the literature reveales that very few

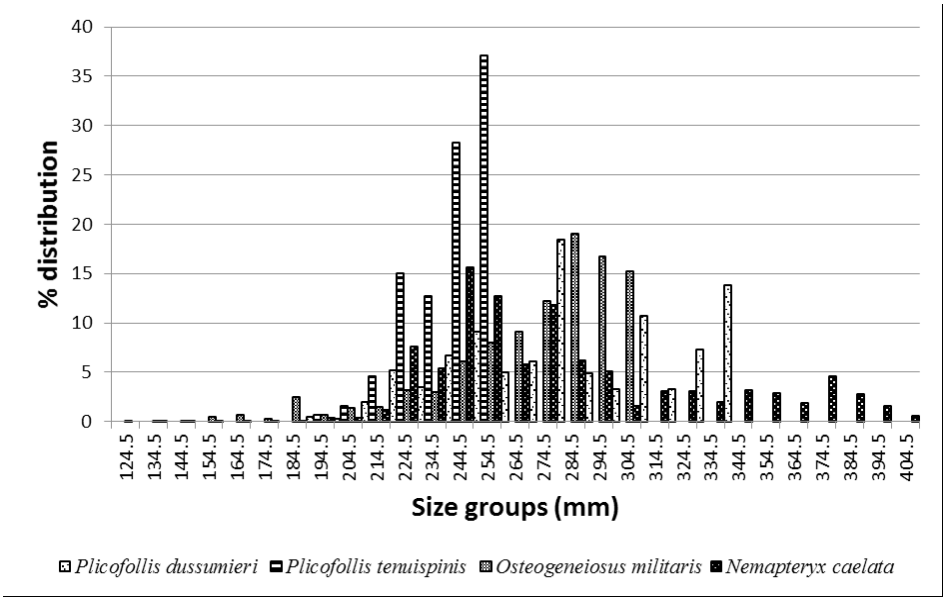

Fig. 2: Percentage distribution of juveniles in various size groups of marine ariids during January to Decemeber 2013

Table 2: Economic evaluation of juveniles of four dominant marine ariids during January to Decemeber 2013

S. No.	Species	Estimated juvenile landing (tonnes)	Price realized for juveniles (Rs in crores)	Estimated biomass Gain (tonnes)	Fold increase in biomass per year	Estimated price realised for biomass (Rs. in crores)	Fold increase in total revenue per year	Month of Maximum juveniles landing	Month of Minimum juveniles landing
1	*Nemapteryx caelata*	423	1.9	1250	2.96	9.99	5.26	November	September
2	*Plicofollis dussumieri*	220	1.1	434	1.97	3.48	3.16	November	April
3	*Osteogeneiosus militaris*	182	0.9	300	1.65	2.7	3.00	November	December
4	*Plicofollis tenuispinis*	93	0.4	156	1.68	1.25	3.35	March	December

researchers had estimated the economic loss of bycatch from trawl net. Najmudeen and Sathiadas (2008)[23] estimated the economic loss due to juvenile fishing from trawlers of India was 15,686 million US dollars per annum. Salim (2014)[26] estimated economic deficit of juvenile landings in trawl net of Ernakulum district, Kerala with loss of Rs.1350 per trip per trawl. Dineshbabu (2013, 2014)[11, 12] estimated economic loss due to landing of low value finfish as bycatch in trawl net along Mangalore coast, Karnataka during 2011 and the loss was found to be Rs. 280 million and Mohammed *et al*[20] found that estimated economic deficit on juvenile landings for *Uroteuthis (P) duvaucelii*, *Sepia pharaonis* and *Octopus membranaceous* along east and west coast of India was about 425 crores. Kamei *et al* (2013)[14] estimated the economic loss of juvenile landings of six dominant species of sciaenids at New Ferry Wharf was at about 68 crores. Recently, Sugumar *et al*[28] estimated economic loss of five dominant species of cephalopods in Mumbai waters and the loss was found to be 33.22 crores.

It is evident from this study that juveniles are found abundant during the period between November to March which agrees with the findings by Kamei *et* al (2013)[14] and Sugumar *et al* (2015).[28] The inshore and coastal waters from southern Saurashtra to Ratnagiri may act as feeding ground for most of the dominant commercial important species during these months. Several authors[16,19,21] observed the prevalence of marine catfish ranged between 30 and 80 m depth and it coincided with the present study wherein depth range was found to be 10 – 60 m for these species. The operation of trawlers in the traditional fishing area brings alarming situation on these resources so strict ban should be enforced on mechanised trawlers in coastal waters of Maharashtra. Maximum economic again will be realized only through stakeholders participatory approach of management measures, such as effort restriction in combination with strict mesh size regulation for sustainable harvest of these resources .

ACKNOWLEDGEMENT

The authors thankful to the Directors of CMFRI, Kochi and CIFE, Mumbai for providing us with all the facilities and logistic support.

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