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Fishery of sciaenids with some observations on the biology and stock assessment of *Johnieops sina* (Cuvier, 1830) exploited along the Malabar coast

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Abstract

Sciaenids form an important demersal finfish resource exploited off Malabar coast. They are caught by trawls, gillnets and ringseines and are landed throughout the year. The average annual catch was 2452 t during 2001-2008. The landings fluctuated but showed a decline. Though several species supported the sciaenid fishery, *Johnieops sina* was the dominant species contributing more than 58% to the catch. In the fishery, the length of *J. sina* ranged from 62 to 229 mm. The length at first maturity was 114 mm for males and 122 mm for females. The spawning period is prolonged with two peaks, one in September-November and another in February-April. The male – female sex ratio was almost equal in the catch. The length-weight relationship was estimated as $W=0.000046658\ L^{2.8313}$. The estimated asymptotic length ($L\infty$) and annual growth coefficient (K) of *J. sina* were 268 mm and 0.45, respectively. The respective annual total, natural and fishing mortalities were 3.63, 1.10 and 2.31. The spawning stock biomass is more than 30% of the stock at its unexploited level.

Keywords: Sciaenids, *Johnieops sina*, growth, mortality, spawning, population parameters

Introduction

Sciaenids are one of the important demersal finfish resources exploited along the Malabar coast and contribute 1.1% to the total marine landings of this area. They are exploited by trawls, gillnets and ringseines. Information on the occurrence, fishery and biology of sciaenids are available from Indian waters. Studies on the sciaenids exploited along the Malabar coast are those of Nair (1977, 1980), Rao *et al.* (1992), Chakraborty *et al.* (2000) and Mohanraj *et al.* (2003). An attempt was made to study the fishery of sciaenids and biology and stock assessment of the dominant species *J. sina* from Malabar region.

Material and Methods

The data on the landings of sciaenids by trawlers, gillnetters, ringseines and other gears at Malappuram, Kozhikode, Kannur and Kasaragod districts collected by CMFRI for the period 2001-2008 were used for this study. The length frequency data of *Johnieops sina* collected from trawl landings at weekly intervals from 2005 to 2008 were used for estimation of growth and population parameters. A total of 5503 specimens in the length range of 62-229 mm formed the base data for the study. The data on length was grouped into 10 mm class intervals and the raised monthly frequency distribution was used for growth studies following Sekharan (1962). The length-weight relationship was studied following Le Cren (1951). The growth and mortality parameters were estimated using FiSAT programme (Gayanilo Jr. *et al*., 1996) after pooling the annual data for the period 2005-2008. Natural mortality (M) was estimated from the empirical formula suggested by Pauly (1980) by taking the mean seawater temperature as 28^0C and the total mortality (Z) from the catch curve method by Pauly (1983). The exploitation ratio (E) was estimated as the ratio of fishing mortality to total mortality. The exploitation rate (U) was estimated by the formula $U = F/Z^* (1-e^{-Z})$. Fecundity was estimated by examining 114 female specimens in stages V and VI of maturity by the formula $F= W/W_1$ x No. of ova in the sample, where F is fecundity and W and W_1 are total weight and sample weight of

the ovary, respectively. The total length and maturity stage of the fish were recorded and the stomach contents were analysed using the Index of Relative Importance (IRI) (Pinkas *et al.*, 1971). The intensity of feeding was determined based on the degree of distension of stomach due to feeding and the amount of food items contained in it. The stomachs were classified as gorged, full, ¾ full, ½ full, ¼ full, trace and empty and the data for the study period were pooled and classified as poorly fed (empty and trace), moderately fed (1/4 full and 1/2 full) and heavily fed (¾ full, full and gorged). Since no difference in the food and feeding habits of male and female was noticed, the data on both the sexes were pooled.

Results

***Fishery*:** Sciaenids are caught along the Malabar coast by commercial trawlers of overall length (OAL) 32 - 68′ operating in 5-120 m depth range at a distance of 5-50 km from the shore depending upon the season and availability of fish. Few boats return on the same day but most of the boats conduct fishing continuously for 5-6 days. They operate trawls with cod end mesh size of 16-18 mm. Sciaenids are also caught by gillnets operated from FRP boats fitted with or without outboard engines. The size of gillnetters ranged from 21 to 70′. Ringseines are also used for exploitation of sciaenids.

The estimated landings of sciaenids in the Malabar region ranged between 1833 t (2005) and 3181 t (2001) with an annual average of 2452 t (Table1). They formed 1.0% of the marine landings. Trawlers contributed 81.7% of the sciaenid landings followed by ringseiners (8.1%), gillnetters (4.7%) and others (5.5%). The catch has fluctuated but has shown a declining trend. The gearwise trend showed that trawl catches showed declining trend but landings from gillnet and ringseine showed increase.

Monthly average landings of sciaenids in trawl showed that peak landings were in October - November (Fig. 1). The catch rate of sciaenids in trawl ranged from 0.7 kg/hr (2008) to 1.4 kg/hr (2001). Sciaenids were not a regular resource caught by the ringseine but the catch rate was high whenever they were caught in that gear.

***Species composition*:** Eleven species of sciaenids, dominated by *J. sina* (58.8 %), were observed in the fishery (Table 2). The other important species in the fishery were *Otolithes ruber* (17.3%) and *O. cuvieri* (7.8%). *J. sina* was the dominant species in all the gears.

Table 1. Gearwise landings (t) of sciaenids along the Malabar coast

Year	Trawl (t)	%	C/ hr (kg)	Gill net (t)	%	C/U (kg)	Ring seine (t)	%	C/U (kg)	Others (t)	%	C/U (kg)	Total (t)
2001	3009	94.5	1.4	79	2.4	0.2	64	2.0	0.6	29	0.9	2.8	3181
2002	2104	96.6	1.0	49	2.2	0.2	0	0.0	0.0	25	1.1	4.5	2178
2003	2135	70.1	1.0	106	3.4	0.5	46	1.5	0.3	756	24.8	13.6	3043
2004	2172	89.3	1.1	162	6.6	0.6	0	0.0	0.0	98	4.0	21.2	2432
2005	1698	92.6	0.9	58	3.1	0.2	77	4.2	0.9	0	0.0	0.0	1833
2006	1591	65.9	0.8	161	6.6	0.9	659	27.3	8.1	0	0.0	0.0	2411
2007	1856	89.9	0.8	152	7.3	0.6	54	2.6	0.5	2	0.0	0.9	2064
2008	1458	58.9	0.7	161	6.5	0.5	692	27.9	7.5	163	6.5	20.6	2474
Average	2003	81.7	1.0	116	4.7	0.5	199	8.1	2.0	134	5.5	9.9	2452

Table 2. Species composition (%) of sciaenids in different gears during 2001-2008

Gear	*J. sina*	*J. dussumieri*	*J. macropterus*	*J. belangerii*	*J. vogleri*	*O. ruber*	*O. cuvieri*	*J. glaucus*	*J. carutta*	*J. elongatus*	*J. aneus*
Trawl	65.3	2.7	6.5	1.6	3.1	9.1	4.6	3.2	0.4	0.4	3.0
Gillnet	35.7	2.6	3.3	0.8	3.9	32.4	20.4	0.8	0.0	0.0	0.0
Ringseine	73.3	2.5	3.1	3.4	2.5	7.5	3.1	4.7	0.0	0.0	0.0
Others	61.5	8.3	2.7	0.0	0.0	20.3	3.1	4.1	0.0	0.0	0.0
All gears	58.8	4.0	3.9	1.6	2.4	17.3	7.8	3.2	0.1	0.1	0.8

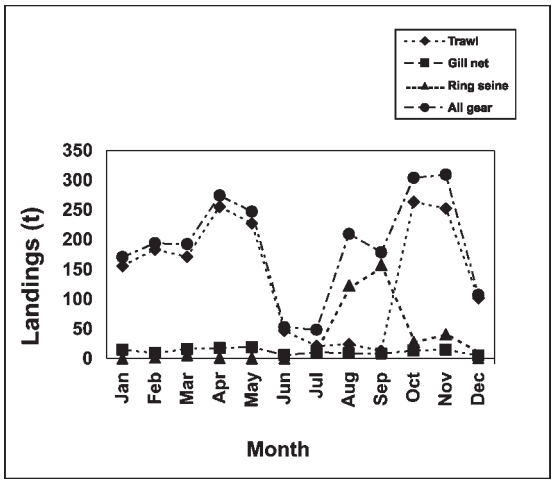

Fig.1. Monthly average landings of sciaenids along the Malabar coast during 2005-08

Gut content analysis: The occurrence of fishes with empty stomach was recorded during most of the months. The occurrence of fishes with heavily fed stomachs in higher numbers during February-April indicates that the intensity of feeding is higher during these months. In general, poor feeding was observed in *J. sina* throughout the period of observation (Fig. 2). The relative importance of food items in *J. sina* in terms of IRI and their percentage for different years is shown in Table 3. The most important food item was fishes (43.70%). The highest IRI values for fishes were noticed during December-May. Fishes such as *Stolephorus* spp. (34.65%), flat fishes (5.19%) and *Trypauchen* spp. were dominant in the stomach.

Crustaceans were the second important food item forming 39.49%. Among crustaceans the penaeid prawns formed 25.32%. They were present for 10 months and the highest IRI of this item was noticed in May (45.86%). Penaeid prawns such as *Penaeus indicus*, *Parapenaeopsis stylifera* and *Metapenaeus affinis* were found in the stomach. Crabs formed 2.45% of the food item and the highest occurrence was observed in July (5.11%).

Spawning period: To determine the spawning period of *J. sina*, only females were taken into account. An arbitrary classification of gonads into four stages, namely, immature, maturing, mature and spent was made. In the examination of gonads for different years, it was seen that there was not much difference in the monthwise occurrence of different stages of maturity for different years, hence, the data were pooled and presented in Table 4. Mature and spent fishes were present in the fishery throughout the year, which indicates that the spawning is prolonged with two peaks, the first peak in September-November and the second in February-April. Relative condition factor is high during September-November and February-April, which varied within the range of 0.94 to 0.98, confirming that *J. sina* has a prolonged spawning season (Fig. 3). It may be concluded that *J. sina* is a continuous breeder having two peak spawning

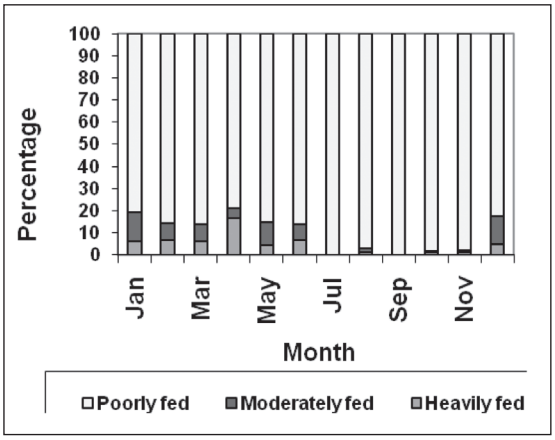

Fig. 2. Monthly feeding condition of *J. sina* during 2005-08

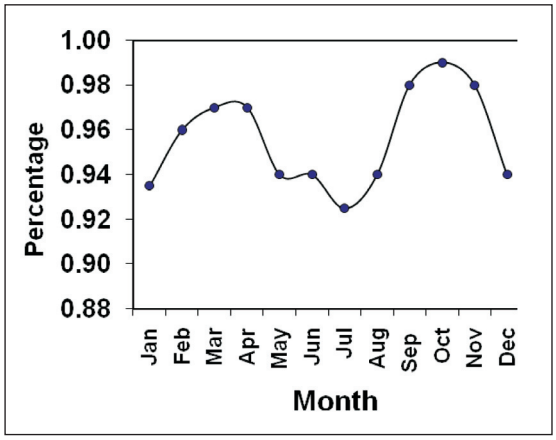

Fig. 3. Average Kn values of female *J. sina* during different months

Table 3. Index of relative importance of food items in *J. sina* along the Malabar coast during 2005-08

Prey	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Fishes													
Ambassis	-	-	-	1.69	0.17	-	-	0.29	3.59	-	-	-	0.48
Flatfishes	-	2.83	0.23	0.71	0.34	2.61	3.24	20.30	2.48	12.97	2.53	13.92	5.19
Eels	-	0.08	-	-	-	-	-	-	-	-	-	-	0.01
Bregmaceros spp.	0.31	-	-	-	-	-	-	-	-	-	-	0.28	0.05
Platycephalus spp.	0.00	-	-	-	-	-	-	-	-	-	-	0.28	0.02
Decapterus spp.	2.53	0.12	-	-	0.40	0.60	-	2.90	0.29	0.47	-	-	0.61
Nemipterus spp.	-	-	-	0.35	-	-	-	-	0.93	-	0.31	-	0.13
Silverbellies	-	-	-	-	1.22	-	-	-	-	-	-	-	0.10
Stolephorus spp.	72.64	42.36	52.48	35.66	45.62	23.17	30.32	10.83	18.52	19.10	22.38	42.72	34.65
Saurida spp	-	-	-	1.38	-	-	-	-	6.62	-	-	-	0.67
Trypauchen spp	-	-	-	-	-	3.62	2.39	-	1.48	-	14.07	-	1.80
Fishes total	**75.48**	**45.40**	**52.71**	**39.78**	**47.74**	**30.00**	**35.95**	**34.32**	**33.91**	**32.54**	**39.30**	**57.19**	**43.70**
Crustaceans													
Copepods	2.89	1.20	-	2.59	0.51	-	14.26	1.49	3.67	5.57	12.82	0.51	3.79
Crab	2.31	3.46	0.39	-	2.83	0.71	5.11	3.93	3.02	4.38	3.32	-	2.45
Deep sea prawns	0.47	0.12	-	-	-	-	-	-	-	-	-	0.20	0.07
Acetes spp.	-	-	-	-	-	-	-	-	1.12	3.61	-	8.12	1.07
Mysids	1.48	2.37	2.17	0.18	0.43	12.69	5.49	14.10	7.06	3.06	16.98	0.56	5.55
Penaeid prawns	8.92	33.73	24.07	18.43	45.86	31.60	31.23	8.16	33.61	29.43	18.60	20.18	25.32
Squilla	7.68	-	-	-	0.47	-	1.04	-	1.16	-	4.11	0.41	1.24
Crustaceans total	**23.75**	**40.88**	**26.62**	**21.19**	**50.10**	**45.01**	**57.14**	**27.68**	**49.64**	**46.04**	**55.83**	**29.98**	**39.49**
Molluscs													
Cuttlefish	0.02	0.30	-	-	1.02	-	2.39	1.48	-	-	-	11.06	1.36
Squids	-	10.26	17.85	-	0.74	22.42	1.51	28.56	16.45	7.91	2.96	1.26	9.16
Octopus	0.02	3.00	2.82	-	-	1.95	1.51	-	-	4.06	1.73	0.00	1.26
Molluscs total	**0.04**	**13.56**	**20.67**	**0.00**	**1.76**	**24.37**	**5.41**	**30.04**	**16.45**	**11.97**	**4.69**	**12.32**	**11.77**
Other items													
Jellyfish	0.58	0.17	-	-	-	-	-	-	-	0.79	-	0.08	0.13
Polychaetes	0.03	-	-	9.64	0.39	0.62	1.51	6.24	-	1.82	0.17	-	1.70
Salpa	-	-	-	29.38	-	-	-	1.71	-	6.84	-	0.43	3.20

seasons one during September - November and another during February – April.

Sex ratio: The sex ratio (n = 5503) between male and female was found to be 1:0.96 showing a marginal domination of male in the fishery (Table 5). The chi-square test showed that the difference is not significant at 5% level.

Fecundity: The fecundity of 114 females with stage V and VI ovaries, ranging from 114 to 229 mm in length and between 25 and 24 g in weight was estimated. The fecundity ranged from 9,253 to 50,925 ova. The number of ova per gram ovary ranged from 1,895 to 9,218 (average: 7,210). The fecundity increased with increase in length of the fish (Fig. 4).

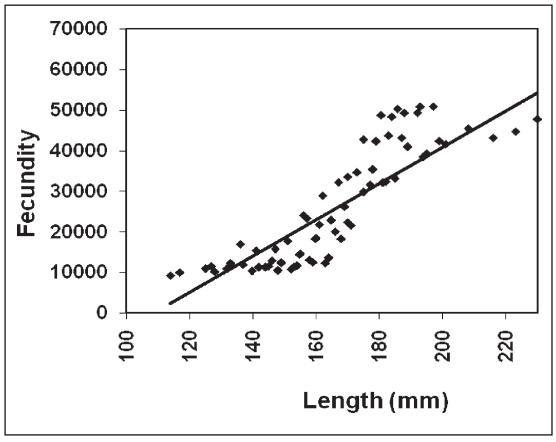

Fig. 4. Fecundity of *J. sina*

Table 4. Stages of maturity in *J. sina* during 2005-2008

Month	No. of specimen observed	Female	Immature (%)	Mature (%)	Spent (%)
January	410	220	11.2	82.8	5.9
February	369	161	12.9	57.8	29.1
March	406	226	10.7	44.4	44.8
April	371	142	15.9	45.2	38.8
May	393	176	13.6	80.7	5.6
June	356	158	29.3	63.5	7.1
July	361	111	57.4	38.1	4.5
August	435	225	25.5	67.1	7.2
September	490	258	2.1	60.1	37.8
October	776	284	13.5	55.3	31.1
November	573	235	38.1	41.4	20.4
December	563	207	38.5	54.8	6.6
Total	5503	2403	20.3	54.3	25.2

Table 5. Sex ratio of *J. sina* during 2005-2008

Month	No. of specimen observed	M	F	F: M ratio
January	410	190	220	1: 1.16
February	369	178	161	1: 0.90
March	406	180	226	1: 1.26
April	371	180	142	1: 0.79
May	393	166	176	1: 1.06
June	356	142	158	1: 1.11
July	361	68	111	1: 1.63
August	435	208	225	1: 1.08
September	490	232	258	1: 1.11
October	776	394	284	1: 0.72
November	573	283	235	1: 0.83
December	563	276	207	1: 0.75
Total	5503	2497	2403	1:0.96*

Chi-square value = 1.80
* Not significant at 5% level

Size at first maturity: With a view to find the size at first maturity, the percentage composition of different stages of maturity was calculated for each 10 mm class interval separately for the sexes. The smallest mature specimen recorded was 98 mm for males and 102 mm female. The size at first maturity of male and female was 114 mm and 122 mm, respectively (Fig. 5).

Length - weight relationship: A total of 1151 males in the size range of 66-208 mm (2-28 g weight) and 1100 females in the size range of 62-218 mm (2-26 g weight) were used for determining the length-weight relationship. The relationship was estimated by the least square method and the regression equation for the sexes was:

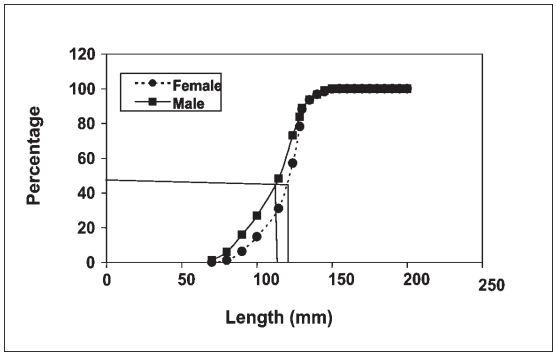

Fig. 5. Length at first maturity of *J. sina* along the Malabar coast

Female: $W = 0.000047472\ L^{2.8514}$ ($r = 0.9512$)

Male: $W = 0.000045005\ L^{2.8215}$ ($r = 0.9465$)

The analysis of covariance showed that there was no significant difference at 5% level between sexes and a common equation was derived as:

$W = 0.000046658L^{2.8313}$ ($r = 0.9494$)

***Stock assessment*:** The growth parameters $L\infty$ and K were estimated as 268 mm and 0.45 y^{-1} respectively. The growth is expressed by von Bertlanffy's equation as

$Lt = 268\ (1-e^{-(0.45)\ t-t_0})$

According to the above equation, it is estimated that *J. sina* attains a length of 90 mm and 147 mm at the end of 1st and 2nd year of its life. The fishery mainly composed of 0 and 1 year classes.

The estimated annual natural, fishing and total mortality, spawning stock biomass and standing stock biomass for *J. sina* for different years are given in Table 6. The natural mortality was estimated as 1.1. The fishing mortality varied from 2.19 (2006) to 2.55 (2007) with an average of 2.31. The total mortality rates varied from 3.29 in 2006 to 3.96 in 2007 with an average of 3.63. Exploitation ratio (E) ranged from 0.56 (2007) to 0.70 (2008) with an average of 0.64. The standing stock biomass ranged from 843 t (2008)

Table 6. Estimates of annual total mortality (Z), fishing mortality (F), natural mortality (M), exploitaion rate (U), exploitation ratio (E), SSB, St.SB and yield of *J. sina*

Year	Z	F	M	U	E	SSB (t)	St.SB (t)	Yield (t)
2006	3.29	2.19	1.1	0.64	0.67	1799	4091	3219
2007	3.96	2.19	1.1	0.54	0.56	830	1803	1143
2008	3.65	2.55	1.1	0.71	0.70	603	843	1345
Average	3.63	2.31	1.10	0.63	0.64	1077	2246	1902

to 4097 t (2006) and average of 2246 t. The spawning stock biomass (SSB) varied from 603 t (2008) to 1799 t (2006) and the average was 1077 t. However, it was seen that SSB formed more than 30% of the annual stock at its unexploited level.

Discussion

Sciaenid landings along the Malabar region increased considerably since the inception of trawling in the 1970s. Considerable changes have taken place in the area, depth and duration of fishing. In general, it was observed that along the Malabar coast the sciaenid landings during the past few years showed a declining trend. The sciaenid fishery of the Malabar region is sustained by 11 species under three genera. The fishery is dominated by *J. sina*, which contributes up to 58.6% of trawl and 35.7 % of gillnet landings. Mohanraj *et al.* (2003), also observed *J. sina* as the major species of sciaenids along the Malabar coast.

J. sina is a carnivore feeding mainly on fishes, crustaceans and molluscs. Among crustaceans, prawns and crabs formed the major diet. Nair (1980) reported that the juveniles feed mainly on zooplankton, especially copepods and amphipods in addition to prawn. Chakraborty (2000) also reported that prawns and fishes were the chief food items of *J. sina*.

Nair (1977) observed that female *J. sina* mature when it attains 115 mm. In the present study, the size at maturity is found as 114 mm for males and 122 mm for females. The condition factor had the minimum value at a length of 114 mm for females and 125 mm for males. The sexes appeared in equal proportion in most of the months. The fecundity of individual fish of the same length varied considerably but it generally increased with the increase in size of the fish. The results of the present investigation were close to the observations made by the earlier authors from this region.

Nair (1977) reported that mature and ripe females were seen during most of the months with the occurrence of ripe specimen in the fishery in greater proportion during November-February and May. The prolonged spawning was evidenced by continuous recruitment of juveniles. Mohanraj *et al.* (2003) reported prolonged spawning period for *J. sina* from Calicut extending from February to November with peak during September-November and May. In the present investigation, it was found that *J. sina* was a continuous breeder with two peaks during September-November and February - April. The increasing trend in the appearance of juveniles from November to April with an increase in the spent ones during the same period suggests that the peak spawning is during September-November and February-April.

Nair (1974) recorded the length of *J. sina* as 135 mm and 175 mm at the end of 1st and 2nd year of its life at Calicut. At Bombay, Chakraborty (1994) observed the growth of this species as 143 and 224 mm at the end of the first and second year. The von Bertlanfy's growth parameters $L\infty$ and K estimated by him were 239 mm and $0.77y^{-1}$and the average Z and E values for 1987-90 were 4.34 y^{-1} and 0.58, respectively. In the present study the estimated $L\infty$ was 268 mm and the K value was 0.45 $y^{-1.}$ The $L\infty$ obtained in this study was slightly higher, while the 'K' values obtained in this study is lower than the earlier reports.

The natural mortality obtained in the present analysis was $1.1y^{-1}$. According to Beverton and Holt (1959), K is associated with the lifespan of fishes. Beverton and Holt (1959) also found that the M/K values would normally range from 1.5 to 2.5. Sparre and Venema (1993) reported that since most of biological process is faster at high temperature within a limit, natural mortality could be related to

environmental temperature. Chakraborty (1994) estimated the instantaneous annual rates of total, natural and fishing mortalities as 4.35, 1.76 and 2.59, respectively. The exploitation rate and ratio were the same. Rao *et al.* (1992) reported the average Z and E values for 1987-1990 as 4.34 and 0.58, respectively. In the present study Z : 3.63, M : 1.1 and F = 2. 31 y^{-1} were estimated. Higher fishing mortality rates indicate that resource is heavily exploited. The current exploitation ratio is more than the optimum rate estimated by Beverton and Holts method. The exploitation ratio estimated for *J. sina* is high showing the intensity of fishing pressure. Hence, further increase in fishing effort is not advisable. However, the spawning stock biomass is more than 30% of the stock at its unexploited level which shows higher regeneration capacity of *J. sina*.

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