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Fishery and population characteristics of mackerel landed by trawlers along the Dakshina Kannada coast

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ABSTRACT

The Indian mackerel, *Rastrelliger kanagurta* forms 5-40 % of the marine fish landings along the Dakshina Kannada coast. The paper deals with the fishery, biology and stock assessment of mackerel landed by trawlers along this coast. The mackerel landed were in size 145-275 mm and the length-weight relation was $W = 0.00000138481\ L^{3.3805}$. Growth parameters estimated were L = 281.67 mm and K = 1.233. Based on these estimates and mean values of M 1.696, F 2.9226 and Z 4.6186 with current effort, yield is 452 t per annum at E 0.63. The MSY has been calculated as 530 t for an effort factor of 6.0 indicating that further increase in effort can bring in more mackerel.

Introduction

The Indian mackerel, *Rastrelliger kanagurta* is one of the most important pelagic fish resources along the Dakshina Kannada coast and it forms 5-40 % of the total marine fish landings here. Since early 70's purse seine has been the most efficient gear in landing the mackerel during September-March. The indigenous gear operating during the monsoon months land mackerel in small quantities. Stray specimens of mackerel have been observed occasionally in the trawl nets operated off Mangalore (Rao *et al.*, 1962). Of late, trawlers have started landing marckerel in considerable quantities. As a large number of trawlers operate here almost throughout the year and the effort is increasing every year, contribution by trawlers to the mackerel fishery of this region is becoming significant (Fig. 1). It is therefore felt appropriate that a study

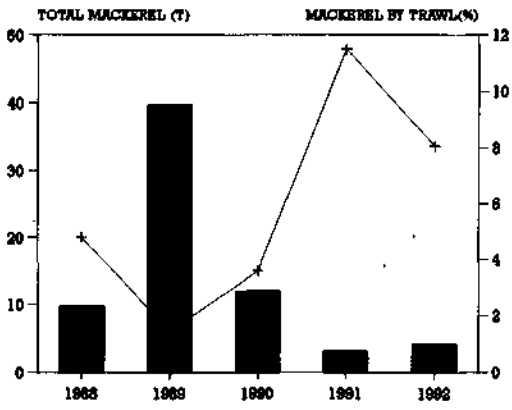

Fig. 1. Contribution of trawl net to the total mackerel catch.

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on the fishery and population of the mackerel landed by trawlers should be condueted utilising the data collected during 1988-'92.

Material and methods

Data on the effort and catch were collected from the commercial trawlers at Mangalore and Malpe for 18 days and the data on length, weight and other biological aspects were collected for 8 to 10 days in a month. Total length in mm from tip of snout to the tip of the upper caudal lobe and wet weight in grams were taken at the field itself. The data on catch and length of mackerel landed by purse seines were also collected and used for comparison. Random samples were analysed for sex in the laboratory. For population studies, monthly length – frequency data during 1989-'91 were pooled and analysed using LFSA programme (Sparre, 1987). Natural mortality was estimated by using Pauly's empirical formula (Pauly, 1980) taking the mean temperature of the trawling grounds as 29°C. The average total number of mackerel landed per year by length group, the estimated growth parameters and the natural mortality were used as inputs for Jone's Length–based Cohort Analysis (Jones, 1984). The combined estimates of 'F' (Cohort Analysis) and 'M' (Pauly's formula) were compared to the value of 'Z' estimated by Length Converted Catch Curve Analysis (Pauly, 1983; 1984 a, b). The stock and potentials were assessed by the Length–based Thompson and Bell Model (Thompson and Bell, 1934) using the fishing mortalities and average recruitment estimated by Length Converted Cohort Analysis.

Results

The trawlers operating along the Dakshina Kannada are mainly 36-42 footer wooden boats with 2-6 days endurance at sea. Trawl nets with 20 - 35 mm cod end mesh operating mainly for prawns and squids get mackerel as by-catch usually from 20-40 m depths almost in all months. But, peak landings occur generally during May. The monthwise effort, catch and catch per unit effort for the period 1988-'92 are given in Table 1.

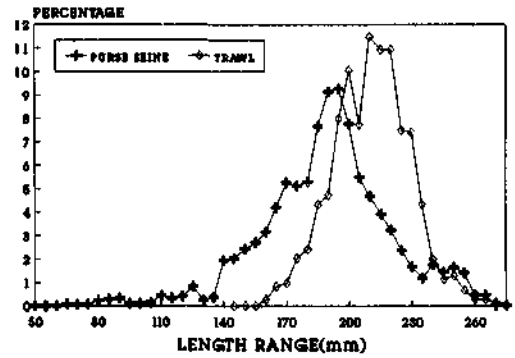

Fig. 2. Length-frequency distribution of mackerel caught in the trawl net and the purse seine.

The mackerel caught in trawl net ranged in size from 145 to 275 mm with mode at 210 mm (Fig. 2). The length-weight relationship was computed as $W = 0.00000138481\ L^{3.3805}$. The fishes landed by the trawl net were bigger than those landed by purse seine, with adults comprising 87.9 % (Fig. 2). The males outnumbered the females during most of the months with significant values in February–May. The x^2 test (Table 2) shows significant dominance of males at 5 % level.

Assuming the growth of mackerel to follow the von Bertalanffy's growth formula L and K have been estimated as 281.67 mm and 1.233 respectively. Computational details of the estimation

Table 1. Monthwise effort (trawl units), catch (kg) and catch per unit effort (kg) of mackerel landed at Mangalore and Malpe harbours (South Kanara coast)

Year	1988			1989			1990			1991			1992		
Month	Effort	Catch	C/E	Effort	Catch	C/E	Effort	Catch	C/E	Effort	Catch	C/E	Effort	Catch	C/E
Jan.	12,565	13,115	1.04	10,887	28,525	2.62	9,969	38,123	3.28	8,947	91,206	10.19	9,461	14,399	1.52
Feb.	11,347	8,333	0.73	11,131	81,433	7.32	8,625	31,206	3.62	7,756	28,459	3.67	7,823	16,324	2.09
Mar.	11,561	24,607	2.13	10,232	67,058	6.55	9,351	62,437	6.78	8,638	67,066	7.76	7,355	22,891	3.11
Apri.	9,579	1,19,376	12.46	9,693	69,632	7.18	7,453	1,09,168	14.65	7,686	27,076	3.52	8,291	12,802	1.54
May	8,870	1,49,185	16.82	7,639	2,18,405	28.59	6,533	1,36,711	20.93	9,232	1,08,962	11.8	8,730	24,058	2.76
Jun.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jul.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Aug.	–	–	–	–	–	–	–	–	–	456	0	0	805	31,101	38.63
Sep.	869	0	0	1,375	1,950	1.42	718	4,093	5.7	3,556	0	0	5,447	1,59,972	29.37
Oct.	443	0	0	419	156	0.37	310	0	0	2,981	292	0.1	8,181	9,066	1.11
Nov.	9,889	80,657	8.16	2,856	63,986	22.4	7,116	2,290	0.32	10,114	8,099	0.8	5,145	17,504	3.4
Dec.	10,701	76,198	7.12	7,285	38,705	5.31	9,414	43,886	4.66	10,701	28,077	2.63	7,424	36,222	4.88
Total	75,824	4,71,471	6.22	61,517	5,69,850	9.26	59,492	4,27,914	7.19	70,067	3,59,237	5.13	68,662	3,44,339	5.01

of fishing mortality (F) by Jone's Length Converted Cohort Analysis are presented in Table 3. The terminal exploitation rate (F/Z) was chosen when mortality/exploitation rate for the last few length groups become approximately equal. The mean value of F was calculated in order to compare the results of the Cohort Analysis with the results of the Length Converted Catch Curve Analysis (Fig. 3). The total instantaneous mortality (Z) was directly estimated by analysis of Length Converted Catch Curve. The mean values of the mortality parameters estimated by the above methods were as follows :

M = 1.696

F = 2.9226

M + F = 4.6186 (Cohort Analysis)

The Z according to Length Converted Catch Curve had a very close value of 4.7. Using the results of Cohort Analysis (Table 3) in the Thompson and Bell Model, estimates on current size of stock biomass and potential yield were made. Table 4 gives the values of yield and biomass at different levels of fishing effort. It is seen that at the current level

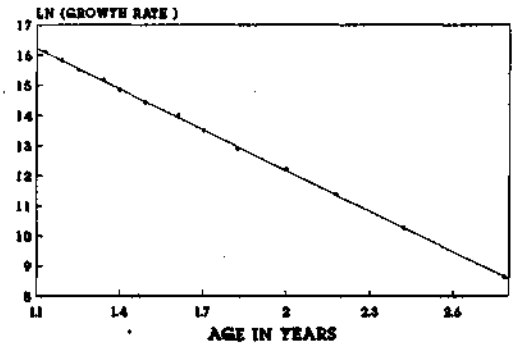

Fig. 3. Length converted catch curve for mackerel landed by trawlers.

TABLE 2. *Sex distribution along with the results of the chi-square test of mackerel landed by trawlers during the period 1989-'91*

Month	Males	Females	Total	Chi-square
Jan.	124	103	227	1.942
Feb.	179	120	299	11.640
Mar.	200	146	346	8.428
Apr.	61	28	89	12.240
May	165	55	220	.000
Jun.	0	0	0	-
Jul.	0	0	0	-
Aug.	0	0	0	-
Sep.	0	0	0	-
Oct.	11	9	20	0.200
Nov.	13	22	35	2.310
Dec.	106	82	188	3.060
Total	859	565	1,424	60.700

of effort (X = 1.00) the yield is about 452 t per annum and the exploitation rate E = (F/Z) = 0.63. The maximum sustainable yield of 530 t is achieved when the level of fishing is increased to 6.

Discussion

Compared to the purse seiners, the contribution by trawlers to the present mackerel fishery of Dakshina Kannade is small, but with the introduction of more multiple day/night fishing units, the landings of mackerel by these units are becoming significant. A positive aspect observed in the mackerel fishery by trawl is that only large size fishes are landed and as majority of the fishes are either in the partially or fully spent stages of gonad development, the fishes are provided with at least one chance to spawn before they are captured.

The Thompson and Bell Analysis (Table 4) indicates that the present catch of 452 t can be increased to 530 t (MSY) by increasing the present level of fishing from 1 to 6. However, in this case an increase in effort to achieve the MSY cannot be recommended as the fishing operation will not be economical. As mentioned earlier the trawlers do not target on fishing mackerel, so an increase or decreas in the trawl effort will have to be suggested based on the studies carried out on the target species. However, it may be suggested that any further increase in effort expended by trawlers will result in substantial increase in mackerel catch.

The L value of 281.67 mm obtained in the present study seems to be a realistic figure as fishes having a size of 275 mm are available in the regular trawl catches. Yohannan (1979) studied the growth pattern of mackerel caught by nonselective traditional gear along the Mangalore coast and estimated the L of mackerel in the mature phase as 271.82 mm. This value is comparable to the results obtained in the present study where the sample consisted mostly of mature fishes. Earlier, Rao *et al.* (1962) based on samples collected from *rampan* estimated the L of mackerel as 316 mm and Devaraj *et al.* (1994) using the same data estimated the L of mackerel of the Mangalore region as 228 mm. The L estimated by Rao *et al.* (1962) is on the higher side as mackerel measuring more than 280 mm were not observed in the catch. The higher value could have resulted due to pooling of small and large size fishes and not taking into consideration the phenomenon of growth compensation as observed by Yohannan (1979). Devaraj *et al.* (1994) estimated different L values ranging from 227 to 285 mm for mackerel samples collected from various centres along the southwest coast of India. Preliminary genetic studies by Verma *et al.* (1994) on mackerel did not reveal the existence of different stocks along the Manglore coast. Therefore the

TABLE 3. *Jones Length Converted Cohort Analysis for mackerel from trawl net (Average for 1988-'91)*

L.L	U.L	M.L	Catch	X*	N	F/Z	Z	F	W	Mean N	Mean N*W	C*W
145	150	147	0.294	1.025964	13235.40000	0.000444	1.696753	0.000753	29.59744	389.986100	11.542590	0.0087010
150	155	152	0.587	1.026982	12573.69000	0.000899	1.697526	0.001526	33.14225	384.450000	12.741540	0.019454
155	160	157	0.532	1.028084	11921.08000	0.000827	1.697404	0.001404	36.97597	378.774700	14.005560	0.019671
160	165	162	12.380	1.029280	11278.14000	0.019206	1.729211	0.033211	41.11183	372.756900	15.324720	0.508964
165	170	167	31.610	1.030582	10633.57000	0.048450	1.782356	0.086356	45.56319	366.041400	16.678010	1.440252
170	175	172	36.096	1.032006	9981.15500	0.056008	1.796625	0.796625	50.34359	358.716300	18.059070	1.817202
175	180	177	72.630	1.033568	9336.67600	0.108906	1.903279	0.207279	55.46674	350.395700	19.435300	4.028549
180	185	182	129.727	1.035291	8669.77500	0.183669	2.077590	0.381590	60.94646	339.963600	20.719580	7.906401
185	190	187	220.010	1.037200	7963.46900	0.284576	2.370624	0.674624	66.79675	326.122000	21.783890	14.695950
190	195	192	209.184	1.039327	7190.35600	0.284551	2.370541	0.674541	73.03176	310.112900	22.648090	15.277070
195	200	197	364.251	1.041713	6455.22100	0.425382	2.951529	1.255529	79.66578	290.117400	23.112430	29.018340
200	205	202	425.279	1.044407	5598.93000	0.487035	3.306273	1.610273	86.71323	264.103600	22.901280	36.877310
205	210	207	316.618	1.047473	4725.73200	0.439187	3.024182	1.328182	94.18869	238.384300	22.453110	29.821830
210	215	212	524.743	1.050993	4004.81400	0.597330	4.211893	2.515893	102.10680	208.571200	21.296550	53.579860
215	220	217	491.579	1.055078	3126.33400	0.627167	4.548957	2.852957	110.48250	172.305000	19.036700	54.310920
220	225	222	505.046	1.059875	2342.52600	0.688345	5.441918	3.745918	119.33080	134.825600	16.088860	60.267570
225	230	227	306.500	1.065587	1608.81500	0.639092	4.699263	3.003263	128.66680	102.055600	13.131170	39.436370
230	235	232	300.778	1.072504	1129.22900	0.702814	5.706866	4.010866	138.50560	74.990760	10.386640	41.659440
235	240	237	173.509	1.081053	701.26700	0.662969	5.032183	3.336183	148.86270	52.008230	7.742087	25.829020
240	245	242	78.950	1.091890	439.55200	0.551421	3.780830	2.855447	159.75350	37.868780	6.049674	12.612540
245	250	247	40.302	1.106074	296.37660	0.445044	3.056102	1.360102	171.19380	29.631580	5.072744	6.899454
250	255	252	27.516	1.125443	205.81940	0.405997	2.855207	1.159207	183.19920	23.736890	4.348582	5.040910
255	260	257	24.097	1.153481	138.04560	0.436673	3.010686	1.314686	195.78560	18.329080	3.588572	4.717847
260	265	262	11.480	1.197708	82.86254	0.330991	2.535094	0.839094	208.96900	13.681410	2.858991	2.398964
265	270	267	10.562	1.277934	48.17886	0.392018	2.789559	1.093559	222.76560	9.658371	2.151553	2.352850
270	275	272	5.284	1.469217	21.23627	0.352389	2.618858	0.922858	237.19140	5.725685	1.358083	1.253319
275	280	277	2.431	2.591917	6.241508	–	–	–	252.26300	–	–	0.613251
Total					133714.500000				3132.62000			452.412000

Mean (FL > =210); 2.9226 (weighted by stock number).

These results were obtained using the parameters: L = 281.61, K = 1.233.

M = 1.696, M/2K = 0.687, Terminal exploitation rate = 0.3894892, q in W = qL^b (grams, cm) = +1.38481E-06, b in W = qL^b = 3.382.

TABLE 4. *Thompson and Bell long term forecast for mackerel landed by trawlers*

X	Yield	Mean biomass
0.2	189.79	608.95
0.4	304.53	506.09
0.6	376.03	437.28
0.8	421.86	389.54
1.0	452.03	355.22
1.2	472.42	329.69
1.4	486.54	310.08
1.6	496.57	294.56
1.8	503.86	281.94
2.0	509.27	271.43
2.2	513.38	262.51
2.4	516.54	254.78
2.6	519.03	248.11
2.8	521.01	241.97
3.0	522.61	236.55
3.2	523.91	231.64
3.4	524.96	227.15
3.6	525.83	223.02
3.8	526.55	219.21
4.0	527.14	215.66
4.2	527.64	212.35
4.4	528.04	209.25
4.6	528.38	206.34
4.8	528.65	203.61
5.0	528.86	201.01
5.2	529.03	198.55
5.4	529.16	196.22
5.6	529.26	194.01
5.8	529.32	191.91
6.0	529.36	189.89
6.2	529.37	187.96
6.4	529.37	186.12
6.6	529.34	184.36
6.8	529.31	182.66
7.0	529.24	181.03
7.2	529.18	179.47
7.4	529.09	177.96
7.6	529.01	176.51

MSY = 529.37 t, X = 6.2, Biom. msy = 187.696 t

different values of L estimated by Devaraj *et al.* (1994) could be, as opined by the authors themselves, due to certain degree of spatial and annual variations in the growth of the fish. Length measurements of mackerel caught by different gear showed difference in thier size range. Analysis of data collected from gears also could affect the estimation of growth parameters. However, from the studies carried out and from actual field observations along the Mangalore coast, it can be stated that mackerel grows to a maximum length of 280 to 285 mm. The trawlers land mainly large sized mackerel and any further increase in trawl effort shall only result in enhanced mackerel catch.

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