STOCK ASSESSMENT OF SEERFISHES ALONG THE WEST COAST OF INDIA

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ABSTRACT

On an average, about 48,850 t of seerfishes were landed annually in India during 1998-2002. Of this, West coast contributed 29,088 t and East coast 19,759 t. Along the West coast the seerfish fishery is mainly supported by the king seer, *Scomberomorus commerson* (17,622 t) and the spotted seer *S. guttatus* (11,416 t). Gillnet contributed 9,968 t of king seer and 7,394 t of spotted seer and trawl net 3,201 t of king seer and 2,154 t of spotted seer. Analysis of the pooled length frequency data collected from different centres along the West coast gave growth parameters as L∞= 142 cm, K = 0.5 $year^{-1}$ and t_o = -0.0314 $year^{-1}$ for *S.commerson* and as L∞= 69 cm, K = 1.0 $year^{-1}$ and t_o = -0.0116 $year^{-1}$ for *S.guttatus*. Using the length-frequency weighted to the West coast landings, the mortality parameters were estimated to be M = 0.73, Z = 2.43, F = 1.69 and E = 0.70 for *S. commerson* and M = 1.41, Z = 6.17, F = 4.76 and E = 0.77 for *S. guttatus*. Length-cohort analysis indicated higher fishing mortality of young king seer (23-30 cm) by trawl and higher length groups (74-78 and 90-94 cm) by gillnet. In the case of spotted seer, fish above 38-40 cm were exposed to higher fishing pressure.

The standing stock was estimated to be 9,542 t against the present yield of 13,169 t (trawl 3,201 t and gillnet 9,968 t) for king seer and 5,142 t against the present yield of 9,549 t (trawl 2,154 t and gillnet 7,394 t) for spotted seer. Results of Thompson and Bell multifleet yield analysis indicated that for *S. commerson* a maximum yield of 14,382 t (3,017 t in trawl and 11,365 t in gillnet) would be obtained if the gillnet effort is kept constant at the present level while the present trawl effort is reduced by 20%. In the case of *S. guttatus*, an optimum yield of 9,598 t (2,186 t in trawl and 7,412 t in gillnet) would be obtained when the present trawl effort is reduced by 40%.

Introduction

Among marine finfishes, seerfishes are the highly sought after group for their commercial importance owing to their high quality meat content and unit value. Their landings in India, over the years show year to year fluctuations but with an overall increasing trend. The catch varied between 4,505 t in 1953 and

54,871 t in 1998. During 1998-2002 the landing varied between 42,578 t in 2001 and 54,871 t in 1998 with an average of 48,850 t. Of this, the West coast contributed about 65% and East coast 33%. Out of the five species in the fishery, only two species *viz*., the king seer, *Scomberomorus commerson* and the spotted seer *S. guttatus* are of prime importance. These are exploited chiefly by gillnet and trawl. The king seer is more abundant all along the coast of peninsular India whereas, the spotted seer is obtained mostly from the northern parts of both West and East coasts of India. Information on the stock assessment of seerfishes is available in the works of Banerji (1973), Devaraj (1977, 1983), Kasim and Hamsa (1989), Thiagarajan (1989), Yohannan *et al.* (1992), Pillai *et al.*(1994), Devaraj *et al.* (1999) and Kasim *et al.* (2002). This paper presents the results of the stock assessment of the above two most common seerfish species from the West coast of India based on the data collected during 1998-2002.

Database and approach

Gearwise and specieswise catch and effort data from the West coast states of India, *viz.* Gujarat, Maharashtra, Goa, Karnataka and Kerala collected by the Fisheries Resources Assessment Division of Central Marine Fisheries Research Institute, Kochi and length-frequency data collected from different marine fish landing centres at Veraval, Mangalore-Malpe, Calicut and Kochi during 1998-2002 formed the database for this study. Fork-length data collected from the above centres were grouped into 4 cm intervals in the case of *S. commerson* and 2 cm intervals for *S. guttatus*. The monthly pooled length-frequency was raised to total catch of concerned species of West coast for all five years (1998-02) and the annual average figures were obtained. Growth parameters L∞ and K were estimated using ELEFAN I in FiSAT programme (Gayanilo *et al.*1995) and t_o was estimated by the empirical formula. Recruitment pattern was studied using FiSAT (Gayanilo and Pauly, 1997). Length-weight relationship was estimated by the method of least squares on log transforms. The instantaneous rate of natural mortality (M) was estimated as per the empirical formula of Pauly (1980) with a sea surface temperature value of 28°C and the instantaneous rate of total mortality (Z) by length-converted catch curve method (Pauly, 1984). The exploitation ratio was estimated from the relation E=F/Z and the exploitation rate (U) from the equation $U=F/Z\ (1-e^{-z})$. Jones' (1984) length-cohort analysis was carried out to assess the stock and mortality rates of cohorts and the effects from changing the fishing efforts of gillnet and trawl net was studied using Thompson and Bell (1934) yield analysis using Excel spread sheets (Sanders, 1995). The annual total stock (P) was estimated from the equation P=Y/U where Y is yield in t and U is the exploitation rate.

Results

Stock assessment of S. commerson

Length-weight relationship:

Fork length (cm) and weight (gm) measurements of 232 fishes, size ranging from 25 to 100 cm collected from the commercial catches were used to estimate the length –weight relationship of the species as:

$$W = 0.016077\ L^{2.80}$$

Growth parameters:

The growth parameters of *S.commerson* were estimated to be L∞= 142 cm and K = 0.50 year^{-1} and t_0 = -0.0314 year^{-1}. Using these values, the von Bertalanffy growth equation is fitted as:

$$Lt = 142\ (1\text{-exp}^{\ -0.5(t+0.031)})$$

Recruitment:

Recruitment took place in a single pulse, extending from June to January with a peak in October (Fig.1).

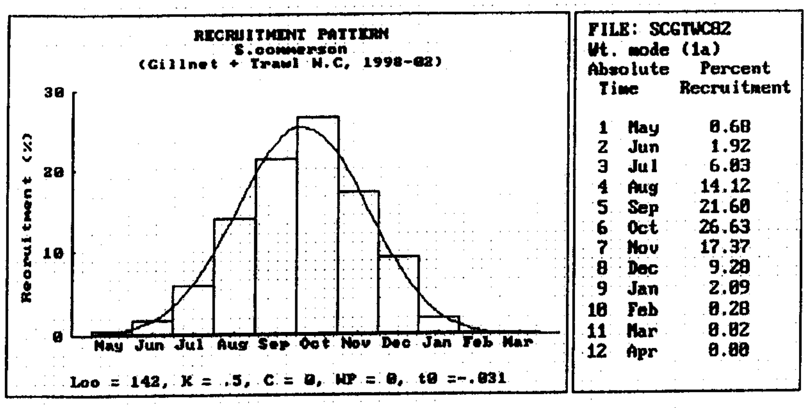

Fig.1 Recruitment pattern of *S. commerson* off West coast of India during 1998-2002

Mortality and standing stock:

The instantaneous rate of natural mortality M was calculated as 0.73 using Pauly's (1980) empirical formula. The length-converted catch curve gave the total mortality rate Z as 2.43 (CI = 2.53 to 2.33) and the fishing mortality rate F as 1.69. Exploitation ratio is worked out to be 0.70. Estimation of stock size (N), instantaneous rate of fishing mortality (F) and total mortalities (Z) was done using Jones' length cohort analysis with inputs L∞=142, M=0.73, M/K = 1.46 and Terminal F =0.5 and the results are given in Table 1. The mean Z was estimated to be 1.69 and mean F at 0.96. Youngfish of 26-30 cm size group suffered high fishing mortalities and among the higher length groups the mortality was higher amongst size group between 74-78 and 90-94 cm. This is because of bulk exploitation of young ones by the bottom trawl and the larger groups by the gillnetters. The standing stock was estimated to be 9,542 t as against the present yield of 13,169 t (trawl net 3,201 t and gillnet 9,968 t).

Yield prediction by Thompson and Bell multi-fleet analysis

Thompson and Bell yield prediction analyses showing the likely effects of different combinations of fishing effort on the yield of king seer by drift gillnet and bottom trawl are shown in Fig.2-7.

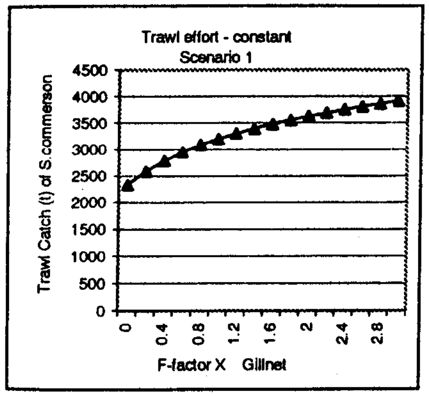

Fig.2 Assessment of trawl catch of *S. commerson* when trawl effort is kept constant while gillnet effort is varied

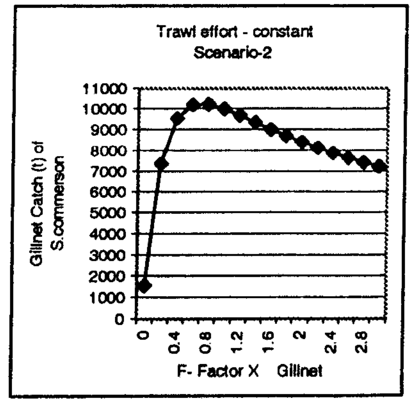

Fig.3 Assessment of gillnet catch of *S. commerson* when trawl effort is kept constant while gillnet effort is varied

Table 1 : Jones' length-cohort analysis for *S. comerson* off West coast of India

Length	Mid-length	Trawl catch (N)	Gillnet catch (N)	Total catch (N)	Trawl proportion	Gillnet proportion	X*	N	F/E	F	Z	Standing Stock (N)	Stan Stoc
10	12	2759	0	2759	1	0	1.02272	22333035	0.0028	0.0021	0.73205	1343948	2
14	16	52312	0	52312	1	0	1.02345	21349194	0.0514	0.0395	0.76954	1323038	5
18	20	453344	0	453344	1	0	1.02423	20331065	0.3254	0.3522	1.08219	1287204	9
22	24	1159266	0	1159266	1	0	1.02506	18938062	0.5667	0.9549	1.68493	1213981	14
26	28	1814649	0	1814649	1	0	1.02595	16892589	0.6946	1.6605	2.39049	1092839	19
30	32	1477192	3904	1481096	0.99736	0.00264	1.02690	14280168	0.6792	1.5453	2.27535	958423	25
34	36	1248372	23383	1271754	0.98161	0.01839	1.02793	12099423	0.6744	1.5118	2.24179	841226	30
38	40	759897	67117	827014	0.91884	0.08116	1.02904	10213574	0.6027	1.1076	1.83758	746684	36
42	44	589427	158513	747940	0.78807	0.21193	1.03025	8841480	0.6044	1.1152	1.84519	670682	43
46	48	346509	284466	630975	0.54916	0.45084	1.03156	7603943	0.5898	1.0497	1.77970	601102	49
50	52	202372	396929	599301	0.33768	0.66232	1.03298	6534163	0.6049	1.1176	1.84758	536249	55
54	56	127061	419260	546321	0.23258	0.76742	1.03454	5543401	0.6124	1.1534	1.88344	473645	59
58	60	73896	431801	505697	0.14613	0.85387	1.03626	4651319	0.6260	1.2219	1.95193	413850	63
62	64	53737	451185	504922	0.10643	0.89357	1.03815	3843511	0.6612	1.4244	2.15444	354470	65
66	68	21355	402642	423998	0.05037	0.94963	1.04026	3079826	0.6611	1.4240	2.15400	297752	64
70	72	16108	366255	382363	0.04213	0.95787	1.04261	2438469	0.6804	1.5541	2.28408	246038	62
74	76	13833	324681	338514	0.04086	0.95914	1.04525	1876499	0.7011	1.7125	2.44252	197671	58
78	80	8360	273821	282180	0.02963	0.97037	1.04824	1393686	0.7153	1.8337	2.56367	153888	52
82	84	8895	209452	218347	0.04074	0.95926	1.05165	999167	0.7197	1.8748	2.60482	116463	45
86	88	4425	144233	148658	0.02977	0.97023	1.05559	695802	0.7006	1.7083	2.43829	87022	38
90	92	4205	107563	111767	0.03762	0.96238	1.06017	483618	0.7040	1.7361	2.46612	64378	32
94	96	358	69534	69892	0.00513	0.99487	1.06558	324854	0.6698	1.4809	2.21089	47196	26
98	100	222	51713	51934	0.00427	0.99573	1.07205	220509	0.6737	1.5072	2.23716	34458	22
102	104	222	34581	34803	0.00637	0.99363	1.07995	143420	0.6607	1.4215	2.15152	24483	17
106	108	0	20635	20635	0	1	1.08979	90745	0.6202	1.1920	1.92203	17311	13
110	112	0	14235	14235	0	1	1.10239	57474	0.6164	1.1731	1.90307	12134	10
114	116	0	9518	9518	0	1	1.11911	34381	0.6167	1.1745	1.90445	8104	7
118	120	0	3991	3991	0	1	1.14236	18947	0.5038	0.7411	1.47111	5385	5
122	124	0	1117	1117	0	1	1.17691	11026	0.2782	0.2814	1.01138	3970	4
126	128	0	380	380	0	1	1.23369	7011	0.1401	0.1190	0.84898	3195	4
130	132	0	315	315	0	1	1.34446	4298	0.146	0.12484	0.85484	2520	3
134	plus	0	1072	1072	0	1	1.65864	2144	0.5	0.73	1.46	1468	22
											Standing stock		954

*. X = (LB-L(i)/LB-L(i+1))) (M/2K)

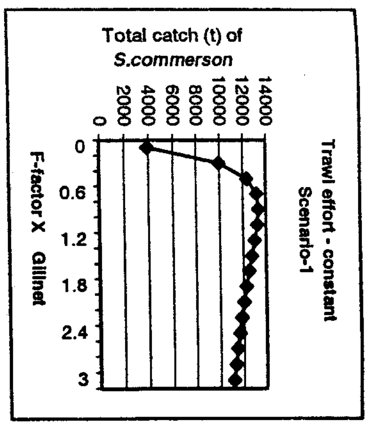

Fig.4 Assessment of total catch of *S. commerson* when trawl effort is kept constant while gillnet effort is varied

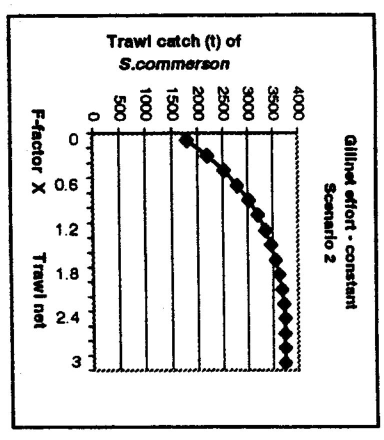

Fig.5 Assessment of trawl catch of *S. commerson* when gillnet effort is kept constant while trawl effort is varied

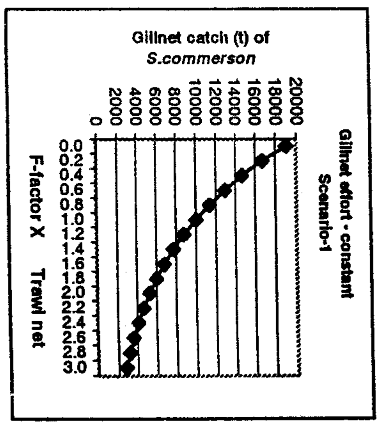

Fig.6 Assessment of gillnet catch of *S. commerson* when gillnet effort is kept constant while trawl effort is varied

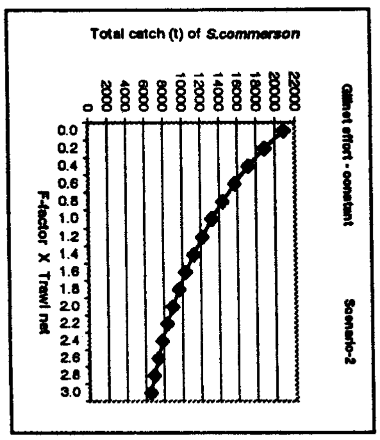

Fig.7 Assessment of total catch of *S. commerson* when gillnet effort is kept constant while trawl effort is varied

Scenario 1:

If the present trawl effort is kept constant and drift gillnet effort is varied, the likely impact on the yield of *S. commerson* by trawl, gillnet and the total yield of *S. commerson* (by both gears combined) is depicted in Figs.2-4. When the gillnet effort is increased further the present catch from trawl would increase (Fig.2) whereas, the catch in gillnet would decline from the present level (Fig.3). A maximum yield of 10,221 t would be obtained in gillnet, when the gillnet effort is brought down by 20% from the present level or in other words 80% of the present gillnet effort along the West coast would result in optimum yield by this gear. In this scenario, the effect on total catch of *S. commerson* would be same as on the gillnet yield of the species and an optimum catch of 13,306 t would be obtained at 80% of the present gillnet effort (Fig.4).

Scenario 2:

If the present gillnet effort is unchanged while the trawl effort is varied, the relative change in the king seer catch by trawl, gillnet and total catch (king seer catch by both gears) along the West coast is given in Figs.5-7. In this situation, the trawl catch would increase from the present level (3,350 t) but then, the increase would be very nominal as the trawl effort increases (Fig.5); while the gillnet catch would come down from the present catch of 9,996 t with increase in trawl effort (Fig.6) and similar trend is expected on the total catch of *S.commerson* along the West coast of India (Fig.7) and the present catch of 12,142 t would slide down with increase in the trawl effort from the present.

Stock assessment of *S.guttatus*

Length-weight relationship:

Total 200 fishes measuring between 32 and 51 cm in length and between 360 and 1500 gm in weight were used to establish the length-weight relationship of the species as:

$$W = 0.022966281\ L^{2.78}$$

Growth parameters:

The growth parameters $L\infty$, K and t_0 were estimated to be 69 cm, 1.0 yr^{-1} and -0.0116 yr^{-1} respectively. The growth of the species along West coast can be described by the von Bertalanffy's growth equation:

$$Lt = 69\ (1\text{-}\exp^{-1(t+0.0116)})$$

The fish attains 43.9, 59.8, 65.6, 67.8, 68.5, 68.8, 68.9 and 69.0 cm at the end of 1- 8 years of its life respectively.

Recruitment:

Recruitment occurred in a single pulse during September-May with a peak in December (Fig.8)

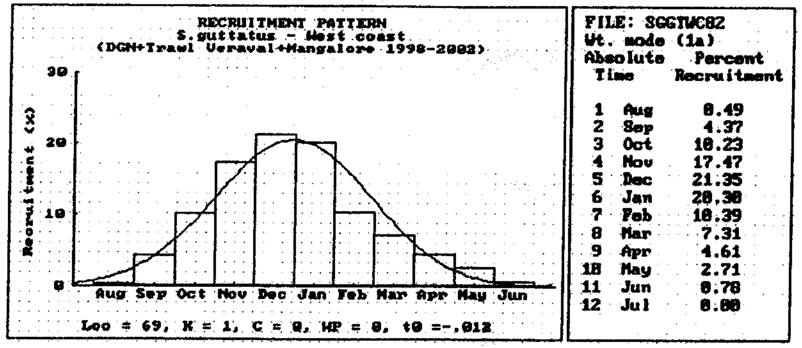

Fig.8 Recruitment pattern of *S. guttatus* off West coast of India during 1998-2002

Mortality and standing stock:

The natural mortality M was calculated using Pauly's empirical formula with input values of $L\infty = 69$, $K = 1$, $T = 28\ °C$ as 1.41. The total mortality Z was estimated from the length-converted catch curve method as 6.17. The fishing mortality F was estimated to be 4.76 and the exploitation ratio as 0.77.

Stock size (N), length-wise fishing mortality rates and total mortality rates estimated employing length-cohort analysis with M/K = 1.41 and Terminal F = 0.5 are given in Table 2. It is seen that fish above 38-40 cm are exposed to higher fishing mortalities. The mean F and mean Z were estimated to be 0.818 and 2.228 respectively. The standing stock was estimated at 5,142 t as against the present average annual yield of 9,549 t (trawl 2,155 t and gillnet 7,394 t).

Results of Thompson and Bell analysis for predicting the effects of different combinations of effort of trawl and gillnet on the stocks of *S.guttatus* are shown in Figs.9-14.

Scenario 1.

If the trawl effort is maintained at the present level while the gillnet effort is varied, further increase in gillnet effort would result in decreased

Table 2 : Jones' length-cohort analysis for *S. gttatus* off West coast of India

Length	Mid-length	Trawl Catch (N)	Gillnet Catch (N)	Total Catch (N)	Trawl proportion	Gillnet proportion	X*	N	F/Z	F	Z	Standing stock (N)	Standing stock (t)
13	14	0	444	444	0	1	1.02597	38849231	0.00023	0.00032	1.41032	1377234	48.566
15	16	0	6113	6113	0	1	1.02696	36906887	0.00319	0.00451	1.41451	1356353	69.329
17	18	2177	11174	13350	0.16304	0.83696	1.02804	34988317	0.00704	0.01000	1.42000	1334754	94.656
19	20	61167	79752	140919	0.43406	0.56594	1.02920	33092963	0.07089	0.10758	1.51758	1309942	124.511
21	22	127267	191072	318339	0.39978	0.60022	1.03046	31105025	0.15012	0.24905	1.65905	1278207	158.353
23	24	100587	122053	222640	0.45179	0.54821	1.03183	28984415	0.11263	0.17897	1.58897	1243990	196.289
25	26	98757	144159	242916	0.40655	0.59345	1.03334	27007749	0.12459	0.20067	1.61067	1210523	238.611
27	28	114738	306196	420934	0.27258	0.72742	1.03500	25057996	0.20310	0.35935	1.76935	1171384	283.720
29	30	166772	432216	598989	0.27842	0.72158	1.03682	22985410	0.27459	0.53372	1.94372	1122285	329.299
31	32	225277	670486	895763	0.25149	0.74851	1.03885	20804000	0.37491	0.84566	2.25566	1059249	371.882
33	34	200979	705330	906309	0.22176	0.77824	1.04112	18414696	0.39467	0.91930	2.32930	985871	409.658
35	36	193600	873794	1067394	0.18138	0.81862	1.04367	16118310	0.45551	1.17958	2.58958	904894	440.767
37	38	262165	1210973	1473138	0.17796	0.82204	1.04655	13775016	0.56533	1.83387	3.24387	803297	454.742
39	40	330459	1289082	1619542	0.20404	0.79596	1.04984	11169229	0.62821	2.38248	3.79248	679770	443.792
41	42	407764	1415337	1823101	0.22366	0.77634	1.05364	8591212	0.70589	3.38411	4.79411	538724	402.800
43	44	359170	1170761	1529931	0.23476	0.76524	1.05805	6008511	0.73299	3.87073	5.28073	395257	336.332
45	46	253922	771021	1024943	0.24774	0.75226	1.06326	3921268	0.72347	3.68891	5.09891	277845	267.522
47	48	170904	737785	908689	0.18808	0.81192	1.06950	2504564	0.78027	5.00697	6.41697	181485	196.690
49	50	110691	403712	514402	0.21518	0.78482	1.07711	1339982	0.77638	4.89543	6.30543	105078	127.567
51	52	82989	238995	321984	0.25774	0.74226	1.08658	677420	0.80499	5.82050	7.23050	55319	74.895
53	54	45734	87071	132805	0.34437	0.65563	1.09871	277436	0.78823	5.24806	6.65806	25306	38.051
55	56	19479	26692	46171	0.42188	0.57812	1.11480	108950	0.73638	3.93862	5.34862	11723	19.502
57	58	6224	25358	31582	0.19708	0.80292	1.13716	46249	0.82553	6.67140	8.08140	4734	8.682
59	60	3996	0	3996	1	0	1.17037	7993	0.5	1.41	2.82	2834	5.712

*, X = (LB-L(i)/(LB-L (i+1))) (M/2K)

Standing stock **5141.9293**

production of the trawl catch of the species from the present yield of 2,174 t (Fig.9). The gillnet catch of *S. guttatus* will be optimum (7,405 t) at present effort level and with further increase in effort, the catch would decrease (Fig.10). In this scenario, the impact on the total catch of *S. guttatus* would be same as on the gillnet production of the species (Fig.11) *i.e.*, the total catch of the species would decline. In fact the maximum sustainable yield of 9,589 t is obtained at 80% of the present gillnet effort or 20% less of the present gillnet effort.

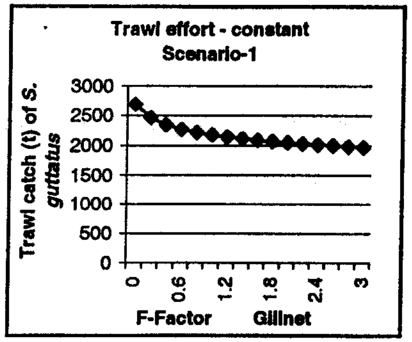

Fig.9 Assessment of trawl catch of *S. guttatus* when trawl effort is kept constant while gillnet effort is varied

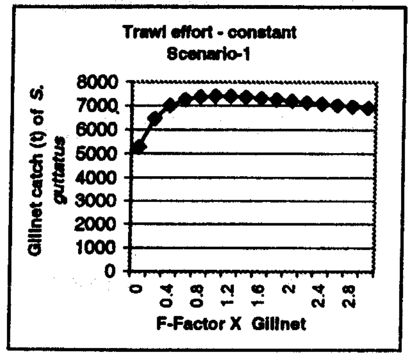

Fig.10 Assessment of gillnet catch of *S. guttatus* when trawl effort is kept constant while gillnet effort is varied

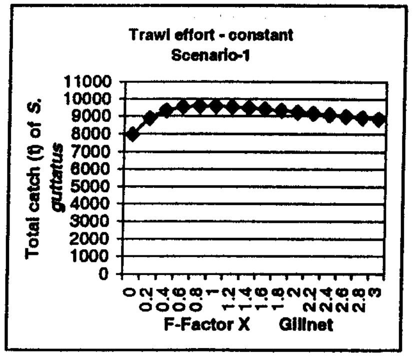

Fig.11 Assessment of total catch of *S. guttatus* when trawl effort is kept constant while gillnet effort is varied

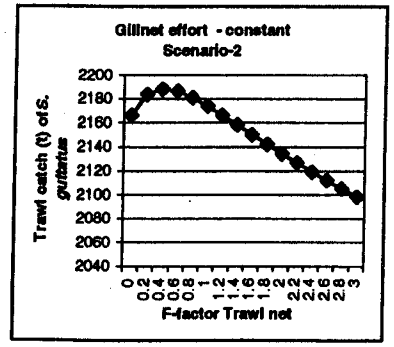

Fig.12 Assessment of trawl catch of *S. guttatus* when gillnet effort is kept constant while trawl effort is varied

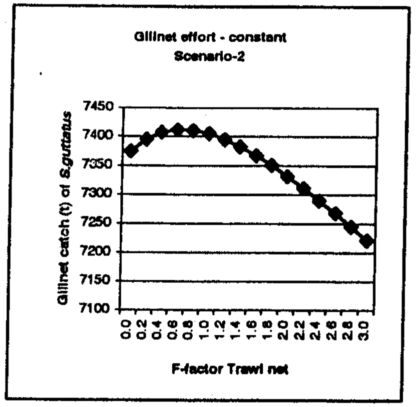

Fig.13 Assessment of gillnet catch of *S. guttatus* when gillnet effort is kept constant while trawl effort is varied

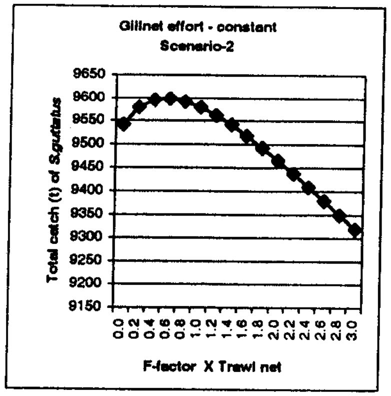

Fig.14 Assessment of total catch of *S. guttatus* when gillnet effort is kept constant while trawl effort is varied

Scenario 2.

If there is no change in the present gillnet effort and the trawl effort is varied, maximum yield (2,188 t) in trawl would be obtained at 40% of the present trawl effort (Fig.12) or in other words 60% of the trawl effort should be reduced. In gillnet, a maximum yield of 7,412 t would be obtained at 60% of the present trawl effort. Any further increase in trawl effort would result in reduction in the present spotted seer catch (7,404 t) by gillnet (Fig.13). In this situation the effect on the total production of *S.guttatus* will be same as on the gillnet production of the species and the total catch will be optimum (9,598 t) at 60% of the present trawl effort with 9,579 t (Fig.14).

Discussion

For king seer, the analysis of pooled length frequency data obtained from different centres along the West coast of India during 1998-2002 has generated the growth parameter estimate of L∞ as 142 cm. This is comparable with the estimate of 146 cm by Yohannan *et al.* (1992) along Kerala coast during 1984-88 and Pillai *et al.* (1994) along the South-west coast of India during 1989-91 and an average of 141.4 cm as estimated by Devaraj *et al.* (1999) based on the values

obtained from different centres like Veraval (146.5 cm), Mangalore (146 cm), Calicut (127 cm) and Cochin (146 cm) along the West coast during 1989-94. Kasim *et al.* (2002) estimated L∞ for the above centres as 124.6, 120, 128 and Kochi 132.5 cm respectively during 1995-99 and the pooled data from all these centres gave L∞ as 137.6 cm. Yohannan *et al.* (1992) and Pillai *et al.* (1994) estimated K as 0.78, Devaraj *et al.* (1999) gave an average estimate of 0.61, whereas the estimate given by Kasim *et al.* (2002) is very high at 1.27. The present estimate of 0.5 is low and is very close to that of the estimate of Devaraj *et al.* (1999).

Yohannan *et al.* (1992) and Pillai *et al.* (1994) estimated the natural mortality rate M for the South-west coast as 0.78, Devaraj *et al.* (1999) as 0.85 as compared to the present estimate of 0.73. The M estimated by Kasim *et al.* (2002) is high (1.37) owing to the high value of K calculated by them for the stocks of West coast during 1995-99.

Based on the data collected from the gillnet fishery Yohannan *et al.* (1992) calculated Z for Kerala waters during 1984-88 as 4.08 and Pillai *et al.* (1994) as 3.3 from South-west coast during 1989-91. Devaraj *et al.* (1999) estimated Z for the gillnet exploitation during 1992-95 from different centres along the West coast ranging from 3.71 to 6.34 with an average value of 4.66. Kasim *et al.* estimated Z as 5.38 for the pooled data from all gears. The present pooled data from both gillnet and trawl catches gave Z estimate as 2.43 through the length-converted catch curve method, whereas the Jones' length cohort analysis gave a mean value of Z as 1.69.

The fishing mortality (F) rates estimated for drift gillnet fishery were 3.30 by Yohannan *et al.* (1992) for Kerala coast, 2.67 by Pillai *et al.* (1994) for South-west coast and 2.87 to 6.29 and 3.15 to 5.1 obtained for different centres along West coast by Devaraj *et al.* (1999) and Kasim *et al.* (2002) respectively. The present data set obtained from gillnet and trawl fisheries along the West coast centres during 1998-2002 gave the F value as 1.69 using length-converted catch curve as against a low mean value of 0.96 generated through the Jones' length-cohort analysis.

Exploitation ratio was estimated as 0.51 for the drift gillnet fishery of West coast during 1969-74 (Devaraj 1983). Yohannan *et al.* (1992), Pillai *et al.* (1994) and Devaraj *et al.* (1999) estimated the E around 0.8 during different periods, 1984-88, 1989-91 and 1995-99 respectively. Kasim *et al.* (2002) while analysing the West coast data during 1995-99 estimated E as 0.73 which is close to the present estimate of 0.70 indicating marginal reduction in the exploitation of *S. commerson* in the recent years along West coast of India.

The stocks of *S. commerson* along West coast was assessed at 22,629 t by Devaraj (1983) during 1967-74 followed by Yohannan *et al.* (1992) at 16,014 t and 18,303 t at M/K = 1 and M/K = 1.5 respectively, Devaraj *et al.* (1999) at 17,468 t and Kasim *et al.* (2002) at 21,920 t. The present estimate of 21,437 t is close to the estimate made by Devaraj (1983) and Kasim *et al.* (2002).

The growth parameters L_∞ = 69 cm and K = 1.0 year $^{-1}$ estimated in the present study for *S. guttatus* are very close to the estimates of 68 and 69 cm and K 0.84 and 0.80 obtained for Mangalore (mid-west coast) and Veraval (North-west coast) waters respectively and L_∞ = 66.3 cm and K = 1.04 year $^{-1}$ for West coast worked out by Kasim *et al.* (2002).

Devaraj *et al.* (1999) estimated M, Z and F for *S. guttatus* for Mangalore waters as 1.29, 6.0 and 4.71 respectively. Kasim *et al.* (2002) reported much higher values for the above parameters during 1995-99 as M = 1.92, Z = 9.28 and F = 7.36 for Mangalore-Malpe area and M = 1.91, Z = 7.53 and F = 7.36 for Veraval waters. The values of M = 1.41, Z = 6.17 and F = 4.76 obtained in the present study are closer to the respective values estimated by Kasim *et al.* (2002) for the exploitation of *S.guttatus* by all gears along the West coast during 1995-99. However, the exploitation ratio of the species during the above three periods i.e., 1989-94, 1995-99 and the present period 1998-2002 are almost at the same level with an E value of 0.77. From this it is evident that this species is continued to be exposed to high fishing pressure.

Devaraj (1977) estimated the annual stock of *S.guttatus* for West coast during 1967-74 at 958 t. Subsequently during 1989-94, Devaraj *et al.* (1999) gave an estimate of 12,184 t. Kasim *et al.* (2002) have worked out the annual stock at 15,230 t. The present estimate of 28,935 t arrived at from the mean Z and mean F values obtained from Jones' cohort analysis is higher than the estimates given by various workers during different earlier periods.

The estimates of growth parameters, mortality, and biomass are based on the data from gillnet. It is well known that estimates of population parameters from gillnet data need to be considered with caution. It goes without saying that the results presented, in the absence of any other alternative, can be taken as indicative.

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