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Tuna Fishery and Stock Assessment of Component Species off Chennai Coast

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Abstract

All India tuna production continued to increase with fluctuations from 848 t in 1951 to 64,006 t in 2006, with a peak production of 64,006 t in 2006. During 1985-2006 it varied from 27,148 t in 1985 to 64,006 t in 2006 with annual average landings of 39,937 t. Annual average tuna production by different maritime states was 17,041 t (42.7%) by Kerala, 5,615 t (14.1%) by Gujarat, 5,000 t (12.5%) by Tamilnadu, 2,741 t (6.9%) by Lakshadweep, 2,812 (7.0%) Karnataka, 2,716 t (6.8%) by Maharashtra, 2,009 t (5.9%) by Andhrapradesh, 1,095 t (2.7%) by Goa, 444 t (1.1%) by Andaman & Nicobar Islands, 262 t (0.7%) by Pondicherry, 134 t (0.3%) by Orissa, 68 t (0.2%) by West Bengal. Tamilnadu catch varied from 1,336 t in 1985 to 10,912 t in 2006 with an average of 5,000 t forming 1.4% of total marine fish production during 1985-2006. Species composition of all India tuna catch was *Euthynnus affinis* (51.2%), *Katsuwonus pelamis* (4.1%), *Thunnus tonggol* (10.4%), *Auxis spp*. (20.7%) and other tunnies (13.6%) and the species composition of Tamilnadu was *E. affinis* (59.7%), *K. pelamis* (11.5), *Auxis* spp. (12.5%), *T. tonggol* (5.5%) and other tunas (10.8%).

Tuna landings at Chennai Fisheries Harbour varied from 150 t in 2001 to 1005 t in 2003 with an average annual production of 595 t during 1999-2006. The annual average catch rate increased from 131.7 kg/unit in 1999 to 730.0kg/unit in 2006 and the overall average catch rate was 400.9 kg/unit during 1999-2006. The species composition of tuna at Chennai Fisheries Harbour was *E. affinis* 25.2% followed by *K. pelamis* 35.8%, *T. albacares* 22.3, *A. thazard* 16.3% and *T. tonggol* 0.3%. The growth parameters and mortality rates of *Euthynnus affinis* are estimated to be L∞75 cm, K 1.42/yr, M 1.77, Z 4.86, F 3.09 and exploitation rate U 0.631, that of *K. pelamis* are L∞ 79 cm, K 1.65/yr, M 1.92, Z 4.7, F 2.78, and U 0.587 and that of *T. albacares* are L μ 149.6 cm, K 0.75/yr, M 0.96, Z 2.37, F 1.41, and U 0.539. All the three species presently studied are exposed to marginally higher fishing pressure by the mechanized drift gillnets of Chennai coast. Based on the all India production the standing stock of *E. affinis* is estimated to be 6618 t and average annual stock is 32409 t.

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Introduction

Tunas formed one of the major marine pelagic fishery resources of Indian seas and their exploitation is limited to the shallow inshore waters. All previous observations and other published reports indicate that a considerable magnitude of untapped tuna resource is available, especially in deeper waters, for exploitation (Sivaprakasam, 1995; Mitra, 1999; Pillai and Ganga, 2002). They further pointed out that there is no organised tuna fishing in the high seas of Indian Ocean except in certain pockets. Many developing countries have expanded their fishing activities with an aim to intensify the exploitation of tuna resource from their EEZ (Silas, 1985; James and Pillai, 1991). Of late, attempts are being made to diversify the fishing effort for targeted exploitation of tuna resources by the fishing industry in India. Such a diversification requires sound knowledge on resource characteristics, their abundance over space and time and interrelationship of the fishery with the environment of sea. Status of exploitation and stock assessment of coastal tunas in the Indian seas were dealt in detail by Pillai et al (2002a & b). Along the east coast Siraimeetan (1985) provided valuable information on the fishery, species diversity and bionomics of different species from the Gulf of Mannar and Kasim (2002) on the fishery, growth, mortality rates and stock assessment of *Auxis thazard* along the Tuticorin coast in the Gulf of Mannar. During the present study attempts are made to update the scientific knowledge on the fishery and population characteristics of coastal tunas exploited along the east coast with special reference to the Chennai coast. Management issues are also discussed to a limited extent.

Materials and methods

Weekly data on catch, effort and species composition of tunas exploited by different gears and size frequency data for *Euthynnus affinis, Katsuwonus pelamis and Thunnus albacares* for the period 1985-‘06 were collected from the Kasimedu Fishing Harbour at Chennai and were raised to the month with the respective raising factors. Growth parameters and mortality rates were estimated from monthly length frequency data. $L\infty$ and K were estimated by using ELEFAN routine in FiSAT (Gayanilo *et al*. 1995). Probability of capture and size at first capture (Lc_{50}) were estimated as per Pauly (1984).

Results

Fishery

Tunas were exploited by drift gillnets and hook and lines. Gillnets with 6.0-13.0 cm mesh and hook and lines of varying specifications were operating in the 10-150 m depth zone and landed tunas along with other pelagic fishes. All India tuna production

continued to increase with fluctuations from a mere 848 t in 1951 to 64,006 t in 2006, with a peak production of 64,006 t in 2006. As seen from Table I during 1985-2006 it varied from 27,148 t in 1985 to 64,006 t in 2006 with annual average landings of 39,937 t. Annual average tuna production by different maritime states was 17,041 t (42.7%) by Kerala, 5,615 t (14.1%) by Gujarat, 5,000 t (12.5%) by Tamilnadu, 2,741 t (6.9%) by Lakshadweep, 2,812 (7.0%) Karnataka, 2,716 t (6.8%) by Maharashtra, 2,009 t (5.9%) by Andhrapradesh, 1,095 t (2.7%) by Goa, 444 t (1.1%) by Andaman & Nicobar Islands, 262 t (0.7%) by Pondicherry, 134 t (0.3%) by Orissa, 68 t (0.2%) by West Bengal. Tamilnadu catch varied from 1,336 t in 1985 to 10,912 t in 2006 with an average of 5,000 t forming 1.4% of total marine fish production during 1985-2006. Annual average tuna landings in tons during 1985-2006 by different maritime states in India are given in Fig.1, which indicates that Kerala lands the highest tuna catch, which is 3 times that of Gujarat, occupying the 2nd place and Tamilnadu the 3rd place.

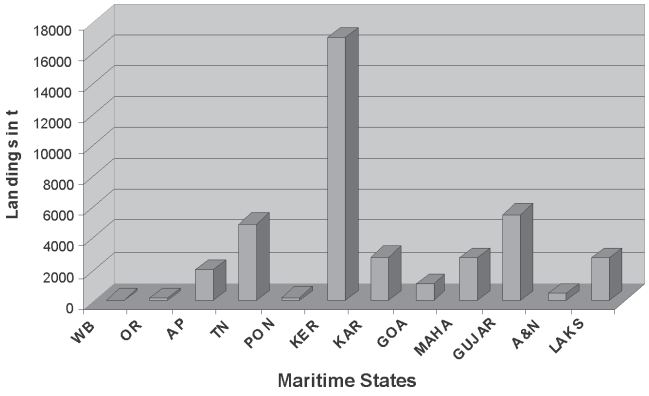

Figure 1. Annual average tuna landings in different maritime states during 1985-2006

Catch composition

The coastal tuna fishery was supported by several species such as *Euthynnus affinis, Auxis thazard, A. rochie, Katsuwonus pelamis, Thunnus tonggol, T. albacares,* and *Sarda orientalis* and the species composition of tuna landings in India during 1985-2006 is given in Table 1. Tuna landings in Tamilnadu during 1985-2006 was constituted by *E. affinis, Auxis* spp., *T. tonggol, K.pelamis* and other tunnies (Table 2). Percentage composition of different species of tunas landed during 1985-2006 is shown in Fig.2, where it is seen that among different species, *E. affinis* formed 51.2%, followed by *Auxis spp*. 20.7%, *T. tonggol* 10.4%, *K. pelamis* 4.1% and other tunnies 13.6%. The species composition of Tamilnadu given in Fig.3 shows that *E. affinis* formed 59.7% followed by *K. pelamis* 11.5, *Auxis* spp. 12.5%, *T. tonggol* 5.5% and other tunas 10.8%.

Table 1 All India landings (tonnes) of different species of tuna during 1985 - 2006

SPECIES	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
E.affinis	16582	18145	13850	13629	26324	32765	17565	23400	16256	12888
Auxis	3076	8455	4456	5992	7462	6995	5407	7896	3365	10228
K.pelamis	85	186	288	170	780	179	133	448	7075	891
Other tunnies	6369	1642	5820	586	2981	5016	2227	1955	6495	2596
T.tongal	1036	109	428	1291	860	880	3633	2384	3556	4065
Tuna Total	27148	28537	24842	21668	38407	45835	28965	36083	36747	30668
%	2.52	3.30	3.02	4.39	3.73	4.59	2.53	3.06	2.30	1.30

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average
15347	19968	19494	18609	22811	23514	21171	24421	21793	18568	22186	30607	20450
4867	11119	8791	9249	8256	9090	11202	11833	15131	7468	5786	16175	8286
796	1225	1571	1249	1840	4387	2672	3117	2393	1397	1615	3330	1629
10892	2824	12181	4855	6521	7081	3827	4401	9176	8395	5825	7779	5429
5787	4263	4429	5722	9098	9935	9040	6350	3861	3903	4515	6115	4148
37689	39399	46466	39684	48526	54007	47912	50122	52354	39731	39927	64006	39942
1.67	1.63	1.46	1.49	2.15	2.24	2.06	1.91	2.00	1.59	1.75	2.36	2.41

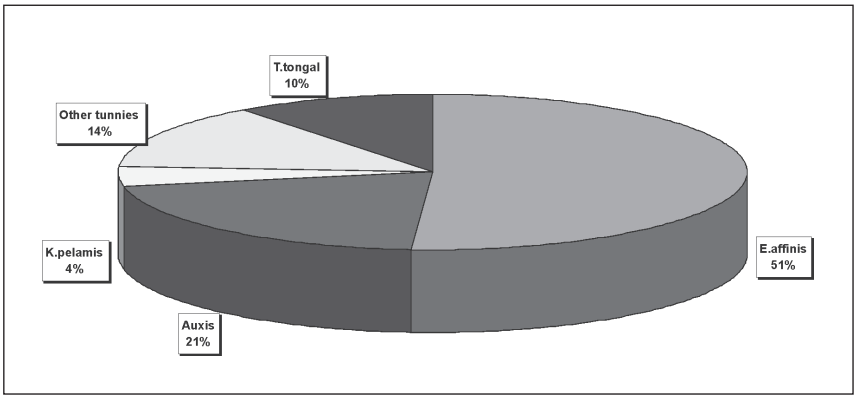

Figure 2. Percentage composition of different species of tuna during 1985 -2006

Table 2. Species composition of tuna landings (tonnes) at Tamilnadu during 1985-2006

Group/Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
E.affinis	783	1275	3073	2612	2145	2308	3195	2905	1597	2399
Auxis	47	481	208	328	849	331	587	555	136	258
K.pelamis	13			46	1	54	8	302	6954	47
Other tunnies	493	515	195	1	599	829	492	279	84	15
T.tongal			50	274	16		4	74	60	257
Tuna Total	1336	2271	3526	3261	3610	3522	4286	4115	8831	2976
%	1.2	2.1	3.2	3.0	3.3	3.2	3.9	3.7	8.0	2.7

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Average
2259	2353	3584	3387	3736	4110	3422	3611	2498	3667	3273	7483	2985
707	423	646	1319	825	902	505	934	784	472	828	1605	624
22	75	393	49	279	1817	379	342	438	447	469	537	576
153	250	73	97	25	1497	378	425	1753	1714	755	1234	539
762	314	93	81	769	109	534	1161	301	948	200	53	275
3903	3415	4789	4933	5634	8435	5218	6473	5774	7248	5525	10912	5000
3.5	3.1	4.4	4.5	5.1	7.7	4.7	5.9	5.2	6.6	5.0	9.9	1.4

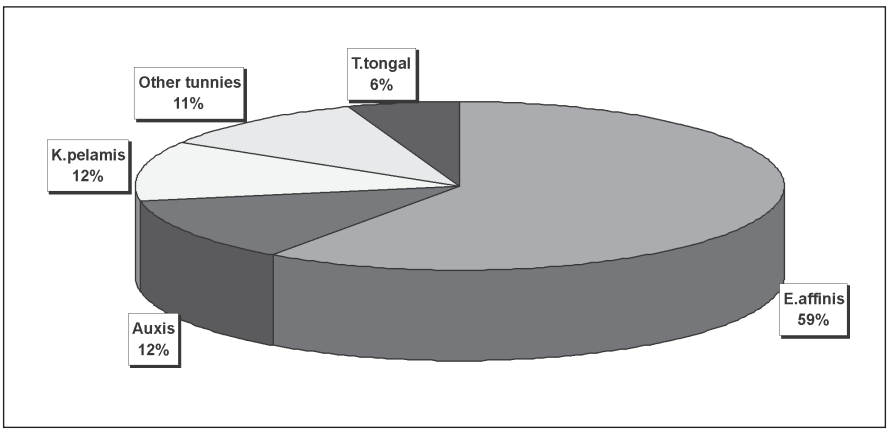

Figure 3. Percentage composition of different species of tuna from Tamil Nadu during 1985 - 2006

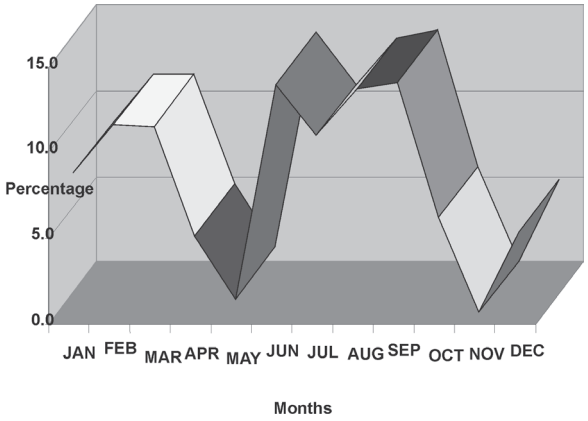

Figure 4. Percentage of Annual Average Catch at Chennai fisheries harbour for 1999-2006

Seasonal Pattern of Fishery

Fishing for tuna was carried out throughout the year along Chennai coast, with peak during June to October and December to April as seen from Table 3 where the monthwise average tuna catch, effort expended and catch per unit effort are given. The percentage annual average catch during different months indicates that there are two peak fishing seasons during February – March and June-September. The species composition of tuna landings at Chennai Fisheries Harbour during 1999-2006 indicates that the landings of *E. affinis* continued to decline whereas, the landings of other three species *A. thazard*, *T. tonggol* and *T. albacares* showed an increasing trend (Table 5). Percentage composition of different species of tuna landed at Chennai coast differs from that of east coast and all India landings, as the dominant species was *K. pelamis* forming 35.8% followed by *E. affinis* (25.2%), *T. albacares* (22.3%), *A. thazard* (16.3%) and *T. tonggol* (0.3%) (Fig.5). Monthwise average catch of different species of tunas landed at Chennai Fisheries Harbour given in Table 4 indicates that except *T. tonggol* the other three species occur throughout the year and for a good fishery.

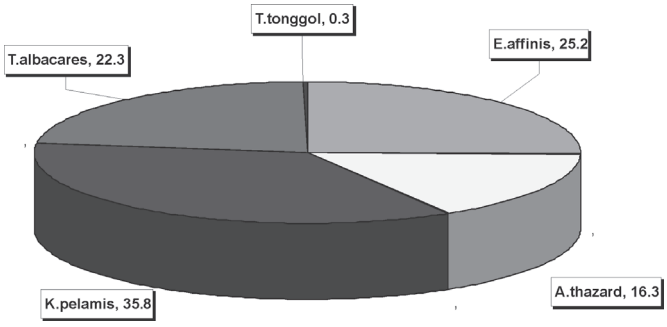

Figure 5. Percentage composition of different species of tuna landed at Chennai during 1999-2006

Table 3. Estimated average fishing effort and catch of tuna by driftgillnet at Chennai fisheries harbour during 1999-2006

Month	E (units)	Catch (kg)	C/E
JAN	135	50453	374.1
FEB	141	67277	475.9
MAR	271	66757	246.2
APR	76	28936	382.6
MAY	86	6851	80.1
JUN	158	81497	515.0
JUL	143	63535	443.5
AUG	161	79747	496.5
SEP	141	82129	580.9
OCT	73	35142	482.2
NOV	16	2289	145.3
DEC	84	30324	363.2
Total	1484	594937	400.9

Table 4. Average month wise species composition of tuna landings at Chennai Fisheries Harbour during 1999-2006

Month	*E.affinis*		*A.thazard*		*K.pelamis*		*T.albacares*		*T.tonggol*		Total
	C (kg)	%	C (kg)	%	C (kg)	%	C (kg)	%	C (kg)	%	
Jan	131607	32.6	47486	11.8	128682	31.9	86847	21.5	9000	2.2	403622
Feb	119624	22.2	75130	14.0	180043	33.5	158409	29.4	5000	0.9	538216
Mar	135807	25.4	63726	11.9	201458	37.7	132788	24.9	0	0.0	533779
Apr	35668	22.4	16209	10.2	83742	52.7	23161	14.6	150	0.1	158930
May	15041	49.2	1516	5.0	5748	18.8	8176	26.7	88	0.3	30569
Jun	128321	27.4	93196	19.9	172937	37.0	72288	15.5	875	0.2	467617
Jul	138799	37.2	65781	17.6	106075	28.5	62099	16.7	0	0.0	372755
Aug	125083	24.8	94392	18.7	170190	33.7	115290	22.8	0	0.0	504959
Sep	153344	26.7	103111	17.9	181234	31.5	136629	23.8	507	0.1	574824
Oct	56187	21.5	62609	24.0	85897	32.9	56078	21.5	0	0.0	260771
Nov	6084	3.7	4456	2.7	3774	2.3	4000	2.4	0	0.0	164167
Dec	80141	33.0	37623	15.5	73404	30.3	51424	21.2	0	0.0	242592
Total	93809	26.5	55436	15.6	116099	32.8	75599	21.3	1302	0.4	354400

Table 5. Species composition of tuna landings at Chennai Fisheries Harbour during 1999-2006

Year	*E.affinis*		*A.thazard*		*K.pelamis*		*T.albacares*		*T.tonggol*		Total (Kg)	Total (t)
	C	%	C	%	C	%	C	%	C	%		
1999	162219	76.8	15309	7.2	4432	2.1	29058	13.8	150	0.1	211168	211
2000	154760	56.3	6117	2.2	48949	17.8	64853	23.6	348	0.1	275027	275
2001	56177	37.4	29871	19.9	38234	25.5	25716	17.1		0.0	150008	150
2002	290959	32.8	171253	19.3	234938	26.5	189980	21.4		0.0	887130	887
2003	244518	24.3	172785	17.2	340500	33.9	232436	23.1	15122	1.5	1005365	1005
2004	68186	13.8	65085	13.1	247482	50.0	114444	23.1		0.0	495197	495
2005	84882	13.2	134278	16.5	371911	50.8	186070	19.5			777141	777
2006	136005	14.2	182812	19.0	419445	43.8	220200	23.0			958462	958
Average	149713		97189		213236		132845		1953		594936	595
%	25.2		16.4		35.8		22.3		0.3			

Stock assessment of component species

Growth parameters, L∞ and K of *E. affinis* were estimated to be 75.0 cm and 1.42/year respectively. The L∞ and K are estimated to be 79.0cm and 1.65/year for the skipjack and 149.6 cm 0.75/year for the yellowfin. The natural mortality rate M is estimated to be 1.77, the total mortality rate Z 4.86, the average fishing mortality F is estimated to be 3.09, and the exploitation rate U is 0.631 for *E. affinis* (Table 6). For the skipjack the M is 1.92, Z is 4.7, F is 2.78 and the U is 0.587 and for yellowfin the M is 0.96, Z is 2.37, F is 1.41and the U is 0.539. Estimates of annual average catch, standing stock and average annual stock for *E. affinis* for Chennai, Tamil Nadu and All India are given in Table 7.

Table 6. Estimates of L∞, K, M, Z, F and U for *E. affinis, K. pelamis* and *T. albacares* along the Chennai coast

Species	L∞ (cm)	K	Natural Mortality M	Total Mortalty (Z)	Fishing Mortality (F)	Exploitation rate (U)
E. affinis	75.0	1.42	1.77	4.86	3.09	0.631
K. pelamis	79.0	1.65	1.92	4.70	2.78	0.587
T. albacares	149.6	0.75	0.96	2.37	1.41	0.539

Table 7. Stock assessment of *E. affinis* at Chennai, Tamilnadu and all India during 1985-2006

	Chennai		Tamilnadu		All India	
Species	Catch (t)	Average annual Stock (Y/U)	Catch (t)	Average annual Stock (Y/U)	Catch (t)	Average annual Stock (Y/U)
E. affinis	150	238	2981	4724	20450	32409

Discussion

The all India tuna landings continued to increase from 1985 and reached the peak in 2006 with an annual average production of 39,937 t. Kerala contributed 42.7% followed by Gujarat 14.1%), Tamilnadu 12.5%, Karnataka 7.0%, Lakshadweep 6.9%, Maharashtra 6.8%, Andhrapradesh 5.9%, Goa 2.7%, Andaman & Nicobar Islands 1.1%, Pondicherry

0.7%, Orissa 0.3%, and West Bengal 0.2%. Tamilnadu catch varied from 1,336 t in 1985 to 10,912 t in 2006 with an average of 5,000 t forming 1.4% of total marine fish production during 1985-2006. Both in all India and east coast landings the little tuna *E. affinis* was dominant followed by *Auxis spp* in all India catch and *K. pelamis* in east coast catch. However in Chennai coast *K. pelamis* was the dominant species followed by *E. affinis*, *T. albacares*, *A. thazard* and *T. tonggol*. This shows that the deepwater species have started emerging in the fishery along the Chennai coast. *E. affinis* is currently exposed to higher fishing pressure and the other two species *K. pelamis* and *T. albacares* are exposed to marginally higher fishing pressure. It is suggested that the gillnet effort may be either reduced by about 10% or the fishery for tuna may be diversified by extending the exploitation to deep waters by deploying subsurface gillnets and hooks & line with appropriate baits targeting the adults of *T. albacares*. Deployment of surface floating FAD may be taken up for exploiting oceanic tunas. The coramandal coast is suitable for establishing fish aggregating devises (FAD's) as seen from the recent experience of Nagapattinam fishermen and the ventures of SIFFS and State Fisheries Department along the Nagapattinam coast. But, as suggested by Silas and Pillai (1985), this may lead to size overfishing, not only of tunas but other fishes also. So deployment of such systems necessitated strict monitoring and enforcement of exploitation of adult fishes through hook size regulation.

Tunas being highly migratory and distributed widely over several oceans, stock abundance depends on the conditions prevailing elsewhere also. So information gained from stock assessment studies may have its own limitations. But, it may give basic information necessary for formulating management guidelines.

Tunas and related groups have very distinct behaviour pattern and they congregate in areas, where favourable conditions prevail. Information on their ecology and influence of various oceanographic parameters on the resource is essential to predict abundance and to locate productive fishing grounds and season. There is an urgent need to look into such information collected by earlier researchers. With increase in global warming there are chances for considerable changes on the profile of several meteorological and oceanographic parameters. So, dependence entirely on earlier data may not provide a realistic picture. However it will be useful for interpreting changes occurring in the fishery over the period. Detailed studies on the pelagic food supply, surface and subsurface temperature, illumination, current pattern *etc.* of tuna fishing grounds round the year need to be undertaken. Such information can be acquired through advanced technologies like remote sensing using satellites or by training and entrusting young dynamic and enthusiastic fishermen with adequate remuneration.

Emergence of longline fishing for yellowfin and other pelagics along both the coast of India especially along Visakhapatnam (Prathiba, 2007) and Nagapattinam by

the traditional sector and at Chennai by the Registered Company-owned large vessels indicate better scope for the expansion of the tuna fishery in the deep waters. Diverting large surplus trawlers and surplus small mechanized wooden trawlers with due modifications for longlining in the present fishing grounds and in still deeper waters seems much promising. Such an attempt at Chennai and Visakhapatnam is already yielding encouraging results, as it enables year round operation and better catches. By considering the socioeconomic implications large factory vessels may be restricted to beyond our EEZ, as it may overexploit the stock and also obstruct their immigration in to the present fishing grounds.

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