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940 ESTIMATES OF OPTIMUM FLEET SIZE FOR THE EXPLOITED INDIAN SHELF FISHERIES

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Introduction

A characteristic feature of marine fish production in India is its annual fluctuations, as vividly shown by the statistics of production for the past four decades. This phenomenon has led to considerable uncertainties about investment in the production process. Marine fisheries still remain open access and suffer from overcapitalization. The nearshore region within the 40 to 80 m depth range, covering an area of 0.45 million sq. km, is subjected to heavy fishing pressure. About 2,43,000 fishing vessels (1,82,096 artisanal craft, 26,171 motorised craft and 34,571 mechanised craft) exploit this area, where the estimated annual potential is 2.2 million tonnes. A conservative estimate of investment on fishing implements (craft as well as gear), at current prices is about Rs. 33.4 billion, but the return per unit investment seems hardly viable. Unhealthy competition and unregulated fishing may decimate the exploited stocks and therefore, the question of deciding the optimum size of fishing fleets which would allow sustainable yields becomes very relevant. An exercise to answer the question requires large amount of information on the physical parameters of the vessels, economic indicators of fishing operations and the vital statistics of fish populations. The integration of these parameters into a succinct mathematical model is time consuming, especially in view of the multiplicity of fishing operations and the consequent complexities of computation. Nevertheless a macrolevel exercise was attempted and the results described here.

Method

In a multispecies, multigear dispensation, it is often observed that the catch per unit effort of a given type of fishing unit does not reliably indicate stock abundance nor the efficiency of that unit. The competition for the same resource by many gear of varying characteristics and dimensions does not facilitate a reliable index of abundance of any fish. Nevertheless, more than anything else, catch, effort and catch per unit effort (CPUE) set the prameters for fishery regulations. Whatever be the factors studied, so long as effort is the one parameter which is amenable to physical control, the results accruing from any study should be capable of being translated to details of catch and effort. Hence, any study making use of historic data on catch and effort will receive positive premium.

Logically, the gearwise catch and effort data form the base of the present study. On a macrolevel, the data in Table 1 form the broad base of the study. At the microlevel, the data utilised consist of the statewise, gearwise catch, effort and CPUE, which are further split between the pelagics and demersals. Trawlers, purseseiners, gillnetters, bagnetters, dolnetters, other mechanised units (mainly hooks & line), motorised craft operating boatseines, ringseines, gillnets, dolnets and others and finally the traditional nonmechanised craft are separately considered in the first phase.

In the second phase the weighted CPUEs for the pelagic and demersal groups have been arrived at separately as indicated below.

The weighted CPUE (pelagic) =

$$\frac{(134497 \times 83 + 117341 \times 2170 + \ldots + 306666 \times 35)}{134497 + 15188 + \ldots\ldots + 97779} = 403$$

and the weighted CPUE (demersal) =

$$\frac{(509384 \times 313 + 15188 \times 281 + \ldots\ldots + 97779 \times 11)}{509384 + 15188 + \ldots\ldots + 97779} = 248$$

TABLE 1. *Trend in catch and effort of major fishing units in India during 1985-'96 (catch in tonnes, effort in boatdays and CPUE in kg)*

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
MTN	Catch	556571	643881	752386	763673	729718	850125	952422	1056964	1080664	1251278	1129395	1226030
	Effort	1444604	1629098	1980971	2112104	1655701	1715211	1827405	1858717	2019665	2190596	2004995	1853567
	CPUE	385	395	380	362	441	496	521	569	535	571	563	661
Relative	Catch		15.69	16.85	1.50	—4.45	16.50	12.03	10.98	2.24	15.79	—9.74	8.56
growth (%)	Effort		12.77	21.60	6.62	—21.61	3.59	6.54	1.71	8.66	8.46	—8.47	—7.55
	CPUE		2.59	—3.90	—4.80	21.89	12.46	5.15	9.11	—5.91	6.75	—1.39	17.42
MPS	Catch	103098	132529	135836	178200	286616	183100	163559	163236	194955	115879	117705	149126
	Effort	56121	54086	74514	81719	125972	102559	101213	92607	95733	67804	71467	100655
	CPUE	1837	2450	1823	2181	2275	1785	1616	1763	2036	1709	1647	1482
Relative	Catch		28.55	2.50	31.19	60.84	—36.12	—10.67	—0.20	19.43	—40.56	1.58	26.69
growth (%)	Effort		—3.63	37.77	9.67	54.15	—18.59	—1.31	—8.50	3.38	—29.17	5.40	40.84
	CPUE		33.38	—25.60	19.62	4.34	—21.53	—9.48	9.08	15.53	—16.08	—3.63	—10.04
MGN	Catch	107891	103539	125783	124396	129174	93523	140547	98904	100508	96982	152652	115558
	Effort	774835	1005109	1221912	1422817	898419	674023	961592	682884	573141	659675	1672996	946643
	CPUE	139	103	103	87	144	139	146	145	175	147	91	122
Relative	Catch		—4.03	21.48	—1.10	3.84	—27.60	50.28	—29.63	1.62	—3.51	57.40	—24.30
growth (%)	Effort		29.72	21.57	16.44	—36.86	—24.98	42.66	—28.98	—16.07	15.10	153.61	—43.42
	CPUE		—26.02	—0.07	—15.07	64.45	—3.50	5.34	—0.91	21.08	—16.17	—37.94	33.78
MBN	Catch	234095	199367	137782	116107	183099	203814	220427	145869	128949	140504	93720	149018
	Effort	508838	326810	302849	314784	405145	376974	362896	199879	216280	211833	158433	333244
	CPUE	460	610	455	369	452	541	607	730	596	663	592	447
Relative	Catch		—14.84	—30.89	—15.73	57.70	11.31	8.15	—33.82	—11.60	9.96	—33.30	59.00
growth (%)	Effort		—35.77	—7.33	3.94	28.71	—6.95	—3.73	—44.92	8.21	—2.06	—25.21	110.34
	CPUE		32.60	—25.42	—18.93	22.53	19.63	12.35	20.15	—18.30	11.25	—10.82	—24.41

OBBS	Catch	92002	1188433	48416	87800	51705	42176	24973	19187	15002	13856	14021	38918
	Effort	203640	329713	170680	196178	97678	69036	53439	37485	61560	52534	48519	99641
	CPUE	452	359	284	448	529	611	467	512	244	264	289	391
Relative	Catch		28.73	—59.12	81.35	—41.11	—18.43	—40.79	—23.17	—21.81	—7.64	1.19	177.57
growth (%)	Effort		61.91	—48.23	14.94	—50.21	—29.32	—22.59	—29.85	64.23	—14.66	—7.64	105.36
	CPUE		—20.49	—21.03	57.77	18.27	15.41	—23.51	9.53	—52.39	8.23	9.56	35.16
OBGN	Catch	23504	34263	21074	36794	72421	88481	89512	98622	133004	159053	96703	171271
	Effort	352098	467281	318073	510626	926496	1012930	1090464	1105604	1705992	2065080	1202484	2776394
	CPUE	67	73	66	72	78	87	82	89	78	77	80	62
Relative	Catch		45.78	—38.49	74.59	96.83	22.18	1.17	10.18	34.86	19.58	—39.20	77.11
growth (%)	Effort		32.71	—31.93	60.54	81.44	9.33	7.65	1.39	54.30	21.05	—41.77	130.89
	CPUE		9.84	—9.64	8.76	8.48	11.75	—6.03	8.67	—12.60	—1.21	4.41	—23.29
OBRS	Catch	0	22498	31558	85146	279980	269941	227834	201616	162710	160133	219041	183882
	Effort	0	29106	80364	137038	340209	251103	281943	262855	281850	229170	204049	240277
	CPUE	0	773	393	621	823	1075	808	767	577	699	1073	765
Relative	Catch			40.27	169.81	228.82	—3.59	—15.60	—11.51	—19.30	—1.58	36.79	—16.05
growth (%)	Effort			176.11	70.52	148.26	—26.19	12.28	—6.77	7.23	—18.69	—10.96	17.75
	CPUE		0	—49.20	58.23	32.45	30.63	—24.83	—5.08	—24.74	21.04	53.63	—28.71
NM	Catch	389165	404445	373303	351348	407535	361801	364793	359751	315098	314497	274657	279980
	Effort	1021695	8801921	9065681	1085207	8053393	7752961	7420431	6950056	6553056	5813378	5390018	4678579
	CPUE	38	46	41	32	51	47	49	52	48	54	51	60
Relative	Catch		3.93	—7.70	—5.88	15.99	—11.22	0.83	—1.38	—12.41	-0.19	—12.67	1.94
growth (%)	Effort		—13.85	3.00	19.70	—25.79	—3.73	—4.29	—6.34	—5.71	—11.29	—7.28	—13.20
	CPUE		20.63	—10.39	—21.37	56.30	—7.78	5.35	5.29	—7.11	12.51	—5.81	17.44

(MTN = mechanised trawler; MPS = mechanised purse seiner; MGN = mechanised gillnetter; MBN = mechanised bagnetter; OBBS = outboard motorised boatseiner; OBGN = outboard motorised gillnetter; OBRS = outboard motorised ring seiner; NM = nonmechanised units).

TABLE 2. *The total catch and CPUE for the 1986 pelagic fisheries by fishing tackles*

Gear	Catch (t)		CPUE (kg)	
	Pelagic	Demersal	Pelagic	Demersal
Trawler (mechanised)	1,34,497	509,384	83	313
Purseseiner (mechanised)	1,17,341	15,188	2,170	281
Gillnetter (mechanised)	78,419	25,120	78	25
Bagnetter (mechanised)	953	379	243	97
Dolnetter (mechanised)	1,10,300	87,735	342	272
Others (mechanised)	6,541	2,789	64	27
Boatseine (motorised)	92,651	25,782	281	78
Gillnet (motorised)	31,350	2,913	67	6
Ringseine (motorised)	21,623	875	743	30
Dolnet (motorised)	0	0	0	0
Others (motorised)	5,352	5,736	48	52
Nonmechanised	3,06,666	97,779	35	11
Total	9,05,693	7,73,680	4,154	1,192

The weighted CPUEs for the pelagic and demersal groups have thus been arrived at for the years 1986 to 1996 (Table 3).

The standardised effort (SF) has been obtained as follows:

SF=Landings / weighted CPUE x 1000 (since unit of CPUE is kg)

Thus, for 1986,

SF(P) = 905693 / 403 x 1000 = 2245667

SF(D) = 773680 / 248 x 1000 = 3124724

where 9,05,693 and 7,73,680 are the total landings of pelagic and demersal groups in tonnes separately. The standard efforts so obtained are given in Table 3. A response curve, fitted to the total catch against the standard effort, of the form $y = af - bf^2$, forcing through the origin, gives the following estimates of maximum sustainable yield (MSY).

MSY (P) = 1215899

MSY (D) = 961485

The data on the average landings (pelagics and demersal) in the various maritime states during 1992-'96 are provided in Tables 4 & 5. The expected MSY values for the different fishing fleets in different states have been obtained by projecting the current average to the MSY. Thus in Table 6 the MSY of 3,858 for the trawl fleet in West Bengal has been derived as follows.

3,858=3,807 x 12,15,899 / 11,99,877, where the figure 1,19,987 denotes the average annual pelagic landings in tonnes.

Similarly the expected MSY values for all the fleets (gear) for all the states in respect of both pelagic and demersal resources have been obtained. The results are given in Tables 6 and 7.

TABLE 3. *Weighted CPUEs and standard effort*

Year	Total		Weighted CPUE		Standard effort	
	Pelagic	Demersal	Pelagic	Demersal	Pelagic	Demersal
1986	9,05,693	7,73,680	403	248	22,45,667	31,24,724
1987	8,44,310	8,04,855	364	247	23,22,644	32,57,798
1988	9,83,766	8,01,783	480	219	20,49,957	36,60,770
1989	13,93,617	8,14,981	649	251	21,46,999	32,52,139
1990	12,48,570	8,94,143	557	298	22,41,188	30,02,895
1991	12,45,611	9,76,500	431	322	28,89,532	30,32,933
1992	12,42,081	10,70,144	386	349	31,68,576	30,15,729
1993	12,09,430	10,61,922	450	331	26,59,161	31,68,073
1994	11,32,008	12,09,013	312	353	36,01,011	34,05,318
1995	11,46,718	10,27,369	356	312	33,00,821	33,67,231
1996	12,47,476	10,74,891	344	337	37,26,407	32,81,097

TABLE 4. *Estimated landings during 1992-'96 (pelagic)*

State/Gear	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	Total
West Bengal	3,807	0	911	15,008	1,442	0	29,098	0	0	0	6,948	57,213
Orissa	6,612	0	2,799	0	8,845	0	178	0	0	674	6,305	25,413
Andhra Pradesh	21,465	0	6,088	0	338	111	8,107	0	0	8,935	57,637	1,02,681
Tamil Nadu	67,181	0	14,564	299	4,605	1,912	26,704	0	0	9,850	78,514	2,03,630
Pondicherry	345	0	474	751	20	0	1,506	0	0	1,093	6,391	10,579
Kerala	70,615	6,390	1,442	0	303	14,151	34,653	1,71,915	0	11,958	21,031	3,32,457
Karnataka	17,785	61,886	308	0	1	0	6,718	1,072	0	2,723	3,889	94,384
Goa	3,042	40,951	360	0	126	0	2,391	0	0	220	800	47,890
Maharashtra	61,202	36,653	10,578	18,552	1,086	0	3,669	0	13	794	2,033	1,34,578
Gujarat	65,163	0	12,963	70,377	3,886	0	33,421	0	712	0	4,529	1,91,051

TABLE 5. *Average landings during 1992-'96 (demersal)*

State/Gear	MTN	MPS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	Total
West Bengal	6,849	0	604	3930	258	0	5,176	0	0	0	3,613	20,430
Orissa	19,861	0	855	0	2989	0	31	0	0	474	1,801	26,011
Andhra Pradesh	38,667	0	1297	0	102	20	1,057	0	0	1,847	16,109	59,099
Tamil Nadu	1,61,874	0	2459	14	1577	65	7,390	0	0	2,031	20,503	1,95,913
Pondicherry	2,587	0	19	0	1	0	142	0	0	56	1,027	3,832
Kerala	2,00,019	96	66	0	546	3223	2,753	13,863	0	15,542	5,158	2,41,267
Karnataka	58,379	1224	118	0	5	31	198	771	0	1,226	1,943	63,895
Goa	24,167	1204	42	0	62	0	311	0	0	39	391	26,216
Maharashtra	1,58,981	4199	2825	26135	797	0	441	0	4	1,818	1,395	1,96,594
Gujarat	2,02,987	0	7387	28249	3423	0	10,846	0	221	0	5,855	2,58,967

(MOTHS = other motorised boats; OBDOL = outboard motorised dol netter; OBOTHS = other outboard motorised boats; MTN= mechanised trawler; MPS = mechanised purse seiner; MGN = mechanised gill netter; MBN = mechanised bag netter; OBBS = outboard motorised boat seiner; OBGN = outboard motorised gill netter; OBRS = outboard motorised ring seiner; NM = nonmechanised units).

TABLE 6. *Estimated maximum sustainable yield (pelagic)*

State/Gear	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	Total
West Bengal	3,858	0	923	15,208	1,461	0	29,487	0	0	0	7,041	57,977
Orissa	6,701	0	2,836	0	8,963	0	180	0	0	683	6,389	25,752
Andhra Pradesh	21,751	0	6,169	0	343	112	8,215	0	0	9,055	58,407	1,04,052
Tamil Nadu	68,079	0	14,759	303	4,667	1,937	27,061	0	0	9,981	79,563	2,06,349
Pondicherry	349	0	480	761	20	0	1,527	0	0	1,107	6,476	10,720
Kerala	71,558	6,475	1,461	0	307	14,340	35,116	1,74,211	0	12,118	21,312	3,36,897
Karnataka	18,023	62,713	312	0	1	0	6,808	10,86	0	2,759	3,941	95,644
Goa	3,083	41,498	365	0	127	0	2,423	0	0	223	810	48,530
Maharashtra	62,019	37,143	10,719	18,799	1,101	0	3,718	0	13	804	2,060	1,36,375
Gujarat	66,034	0	13,136	71,316	3,938	0	33,867	0	722	0	4,590	1,93,602
Total	3,21,454	1,47,828	51,161	1,06,388	20,929	16,389	1,48,401	1,75,297	734	36,730	1,90,588	12,15,899

TABLE 7. *Estimated maximum sustainable yield (demersal)*

State/Gear	MTN	PN	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	Total
West Bengal	6,029	0	532	3,459	227	0	4,556	0	0	0	3,181	17,984
Orissa	17,484	0	752	0	2,631	0	28	0	0	417	1,586	22,898
Andhra Pradesh	34,039	0	1,142	0	90	17	930	0	0	1,626	14,181	52,025
Tamil Nadu	1,42,498	0	2,165	12	1,388	57	6,506	0	0	1,788	18,048	1,72,462
Pondicherry	2,277	0	17	0	1	0	125	0	0	50	904	3,373
Kerala	1,76,077	84	58	0	481	2,838	2,424	12,203	0	13,682	4,541	2,12,387
Karnataka	51,391	1,078	104	0	5	27	175	679	0	1,079	1,711	56,247
Goa	21,275	1,060	37	0	54	0	273	0	0	34	344	23,078
Maharashtra	1,39,951	3,696	2,487	23,007	702	0	388	0	3	1,600	1,228	1,73,062
Gujarat	1,78,689	0	6,503	24,867	3,013	0	9,548	0	195	0	5,154	2,27,968
Total	7,69,709	5,918	13,795	51,346	8,592	2,939	24,953	12,882	198	20,277	50,877	9,61,485

(MOTHS = other motorised boats; OBDOL = outboard motorised dol netter; OBOTHS = other outboard motorised boats; MTN = mechanised trawler; MPS = mechanised purse seiner; MGN = mechanised gill netter; MBN = mechanised bag netter; OBBS = outboard motorised boat seiner; OBGN = outboard motorised gill netter; OBRS = outboard motorised ring seiner; NM nonmechanised units).

TABLE 8. *Average catch per unit effort during 1992-'96 (pelagic)*

State/Gear	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM
West Bengal	266	0	541	551	132	0	417	0	0	0	92
Orissa	92	0	54	0	91	0	29	0	0	33	21
Andhra Pradesh	202	0	79	0	135	135	67	0	0	284	36
Tamil Nadu	118	0	57	295	43	105	46	0	0	56	33
Pondicherry	30	0	49	349	24	0	32	0	0	133	28
Kerala	121	1,952	134	0	94	343	57	733	0	30	22
Karnataka	95	1,465	156	0	13	1	120	124	0	163	60
Goa	62	1,259	75	0	504	0	52	0	0	56	57
Maharashtra	209	2,349	126	145	68	0	43	0	12	30	26
Gujarat	234	0	203	488	552	0	95	0	26	0	36

TABLE 9. *Average catch per unit effort during 1992-'96 (demersal)*

State/Gear	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM
West Bengal	428	0	391	143	24	0	74	0	0	0	50
Orissa	251	0	13	0	26	0	3	0	0	20	6
Andhra Pradesh	371	0	18	0	39	37	10	0	0	39	10
Tamil Nadu	293	0	11	4	19	4	10	0	0	16	9
Pondicherry	193	0	2	0	1	0	3	0	0	24	4
Kerala	347	28	6	0	197	72	5	58	0	41	5
Karnataka	312	30	39	0	51	102	4	92	0	83	34
Goa	474	45	6	0	78	0	5	0	0	8	28
Maharashtra	559	284	37	199	72	0	5	0	4	75	19
Gujarat	689	0	94	152	519	0	24	0	7	0	38

(MOTHS = other motorised boats; OBDOL = outboard motorised dol netter; OBOTHS = other outboard motorised boats; MTN = mechanised trawler; MPS = mechanised purse seiner; MGN = mechanised gill netter; MBN = mechanised bag netter; OBBS = outboard motorised boat seiner; OBGN = outboard motorised gill netter; OBRS = outboard motorised ring seiner; NM nonmechanised units).

TABLE 10. *Estimated MSY effort (pelagic)*

State/Gear	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	Total
West Bengal	14,486	0	1,706	27,611	11,070	0	70,711	0	0	0	76,697	0
Orissa	72,498	0	52,086	0	98,652	0	6,300	0	0	20,588	2,98,358	0
Andhra Pradesh	1,07,651	0	78,503	0	2,532	834	1,23,033	0	0	31,836	16,32,604	1,10,956
Tamil Nadu	5,75,280	0	2,59,267	1,027	1,09,679	18,432	5,88,282	0	0	1,79,410	24,40,826	58,996
Pondicherry	11,696	0	9,750	2,180	848	0	47,815	0	0	8,334	2,29,492	0
Kerala	5,90,841	3,317	10,873	0	3,265	41,855	6,17,966	2,37,623	0	4,06,876	9,83,569	0
Karnataka	1,89,672	42,801	2,002	0	110	311	56,630	8,732	0	16,969	65,978	11,78,791
Goa	49,327	32,951	4,886	0	253	0	46,586	0	0	3,989	14,181	0
Maharashtra	2,96,967	15,814	85,259	1,29,337	16,088	0	85,897	0	1,082	26,783	77,747	0
Gujarat	2,82,195	0	64,709	1,46,157	7,134	0	356,496	0	28,247	0	127,492	0
Total	21,90,613	94,883	569,041	3,06,313	2,49,631	61,432	19,99,718	2,46,355	29,329	6,94,786	59,46,942	13,48,744

TABLE 11. *Estimated MSY effort (demersal)*

State/Gear	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	Total
West Bengal	14098	0	1361	24274	9463	0	61573	0	0	0	63599	0
Orissa	69700	0	58419	0	101963	0	8445	0	0	20998	277828	0
Andhra Pradesh	91864	0	61956	0	2297	470	90296	0	0	41985	1375762	99250
Tamil Nadu	486764	0	196858	2881	71608	15532	650578	0	0	115001	2056834	349828
Pondicherry	11785	0	9623	0	822	0	40306	0	0	2068	225956	0
Kerala	507720	2987	9451	0	2437	39250	513311	211194	0	335855	860379	0
Karnataka	164710	36441	2648	0	93	263	43789	7374	0	13018	50693	1153192
Goa	44849	23382	6539	0	691	0	52974	0	0	4198	12391	0
Maharashtra	250506	13021	66527	115826	9775	0	70696	0	912	21308	65223	0
Gujarat	259346	0	69176	163930	5806	0	398416	0	28855	0	135630	0
Total	1901341	75831	482559	306912	204957	55515	1930385	218569	29767	554431	5124294	1602270

(MOTHS = other motorised boats; OBDOL = outboard motorised dol netter; OBOTHS = other outboard motorised boats; MTN = mechanised trawler; MPS = mechanised purse seiner; MGN = mechanised gill netter; MBN = mechanised bag netter; OBBS = outboard motorised boat seiner; OBGN = outboard motorised gill netter; OBRS = outboard motorised ring seiner; NM nonmechanised units).

TABLE 12. *Estimated effort (in boatdays)*

State/Gear	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTH	NM	Total
West Bengal	14,247	0	1,562	2,6925	10,823	0	69,334	0	0	0	72,078	0
Orissa	70,453	0	53,297	0	99,385	0	6,521	0	0	20,742	2,94,038	0
Andhra Pradesh	97,435	0	75,359	0	2,479	756	1,18,657	0	0	33,052	15,75,155	1,06,759
Tamil Nadu	5,12,245	0	2,49,164	1,054	97,761	18,334	5,99,406	0	0	1,65,342	23,59,381	94,925
Pondicherry	11,773	0	9,746	2,180	847	0	47,150	0	0	7,375	2,29,053	0
Kerala	5,29,235	3,312	10,811	0	2,705	41,401	6,09,937	2,35,693	0	3,65,849	9,59,441	0
Karnataka	1,70,537	42,675	2,131	0	97	263	56,218	8,155	0	15,635	60,460	11,69,180
Goa	45,371	32,619	5,003	0	312	0	47,163	0	0	4,016	13,596	0
Maharashtra	2,63,148	15,513	80,966	1,21,535	12,855	0	84,187	0	1,042	22,872	72,543	0
Gujarat	2,65,139	0	66,123	1,50,372	6,490	0	3,64,940	0	28,374	0	1,31,671	0
Total	19,79,582	94,119	5,54,162	3,02,067	2,33,753	60,754	20,03,512	2,43,847	29,416	6,34,882	57,67,415	13,70,864

TABLE 13. *Estimated optimum fleet (in boats or units)*

State/Gear	MTN	PN	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	Total
West Bengal	79	0	10	179	72	0	347	0	0	0	360	1,048
Orissa	391	0	355	0	663	0	33	0	0	104	1,470	3,016
Andhra Pradesh	541	0	502	0	17	4	593	0	0	165	7,876	9,698
Tamil Nnadu	2,846	0	1,661	7	652	92	2,997	0	0	827	11,797	20,878
Pondicherry	65	0	65	15	6	0	236	0	0	37	1,145	1,568
Kerala	2,940	28	72	0	18	207	3,050	1,178	0	1,829	4,797	14,119
Karnataka	947	356	14	0	1	1	281	41	0	78	302	2,022
Goa	252	272	33	0	2	0	236	0	0	20	68	883
Maharashtra	1,462	129	540	810	86	0	421	0	5	114	363	3,930
Gujarat	1,473	0	441	1,002	43	0	1,825	0	142	0	658	5,584
Total	10,998	784	3,694	2,014	1,558	304	10,018	1,219	147	3,174	28,837	62,748

(MOTHS = other motorised boats; OBDOL = outboard motorised dol netter; OBOTHS = other outboard motorised boats; MTN = mechanised trawler; MPS = mechanised purse seiner; MGN = mechanised gill netter; MBN = mechanised bag netter; OBBS = outboard motorised boat seiner; OBGN = outboard motorised gill netter; OBRS = outboard motorised ring seiner; NM nonmechanised units).

Table 8 and 9 give the average CPUEs (average for 1992 to 1996) for the pelagics and demersals separately.

The expected efforts corresponding to the MSY estimates have been derived by dividing the MSY by the current CPUE. Thus the MSY effort for MTN for West Bengal for the pelagic fish has been found to be 3,858/266 x 1000 = 14,486 boatdays.

Similarly the MSY effort in respect of all the states have been arrived at and are shown in Tables 10 and 11.

Thus two estimates of MSY efforts have been obtained from which the weighted MSY effort has been arrived at by obtaining a weighted average of these estimates. Thus the final estimate of MSY effort for the trawl fleet in West Bengal has been obtained as:

Effort (MSY) = (14,486 x 266 + 14,098 x 428) / (266 + 428)

Similar effort (MSY) values have been the fleets obtained for all (gears) statewise as given in Table 12.

The optimum fleet size (in number of boats or units) has been obtained by dividing the effort (MSY) by the expected number of operations (fishing days) in a year (Table 13).

Limitations

- No estimates have been possible for the island territories of the Andamans and the Lakshadweep as the Institute has no detailed information on gearwise production in these areas.
- In the absence of required economic indicators it is not possible to make a realistic assessment of the actual fleet size that the fishery can sustain. The estimates presented here, to that extent, would mean the fleet required to be operated per day of fishing. However, the effort given in Table 12 can be taken as a reference point for managing the fisheries.
- Estimates are subject to the assumption that the present dispensation would continue for some more time. However, experience shows that changes do occur very fast. For example, purse seine was not in operation in Maharashtra some six years ago. In Kerala, boat seine which was the main tackle in the traditional sector is getting replaced fast by ringseines. The operational efficiency of ringseine is increasing day by day. Long voyages and multiday operations are quite popular with the trawlers in some parts of the country. Perhaps, this phenomenon may change the entire structure of trawling operations in the country.
- A sizable proportion of production from the artisanal sector comes from Tamil Nadu and Andhra Pradesh. Hence it was felt that the estimates in respect of the nonmechanised units in these two states needed further investigation. However, the difference of such estimates from the estimates in Table 13 is negligible.

As mentioned above, the determination of the optimum fleet size is beset with the problem of changes in fishing practices. This is more conspicuous in view of the rapid motorization of the traditional fishing craft. Motorization of traditional craft has led to, in many maritime states, fabrication of nets that are more efficient than the erstwhile ones. Table 14 gives the replacement ratios for the purse seine and ring seine fleets in Kerala and Karnataka in terms of the major traditional gear.

TABLE 14. *Replacement ratios*

State	Gear	OBBS	OBGN	OBRS	NM
Kerala	Purse seine	4.8	32.2	2.5	73.5
	Ring seine	1.9	12.9	-	29.4
Karnataka	Purse seine	14.5	12.0	6.9	16.0
	Ring seine	2.1	1.7	-	2.3

This would mean that a purse seine in Kerala effectively replaces 4.8 OBBS, 32.2 OBGN, 2.5 OBRS and 73.5 NM units, and so on. The socioeconomic implication of such replacement schedule, as has been happening in the southwest coast of India, is quite formidable and alarming.