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COASTAL FISHERIES AND AQUACULTURE MANAGEMENT IN THE EAST COAST OF INDIA*

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I COASTAL FISHERIES MANAGEMENT

The east coast of India has s shore line of 2,581 km and has an EEZ area of 5,61,388 sq. km. in the Bay of Bengal. The continental shelf is 1,18,950 sq. km (Table 1). The inshore area (upto 50 m depth). which forms 56% of the continental shelf, is being intensively exploited using different types of crafts and gears. During the past one decade the marine fish production from the east coast has increased from 0.41 million tonnes (1985) to 0.69 million tonnes (1994) (Fig.2). In 1994, Tamil Nadu and Pondicherry, Andhra Pradesh, Orissa and West Bengal contributed 59.9, 24.3, 6.9 and 8.9% respectively to the total marine fish production along the east coast.

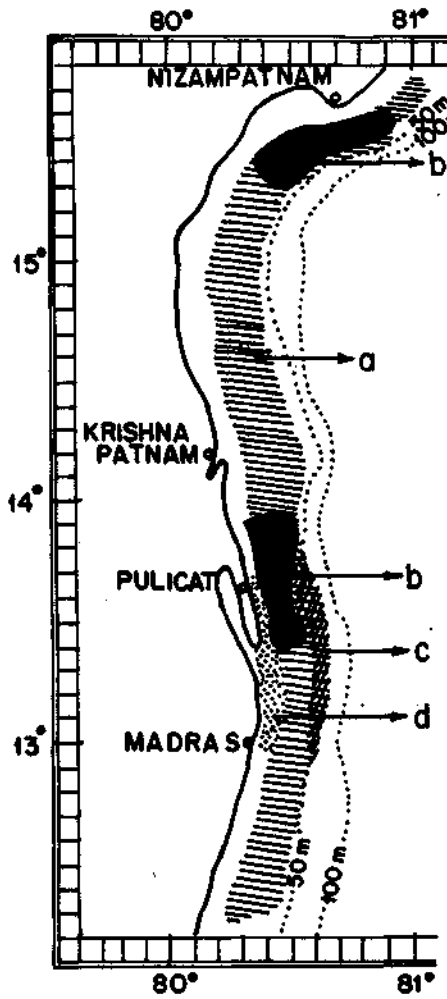

Fig. 1. Fishing areas of Madras based vessels. a. Area under trawling (4,650 sq. km). b. Areas under instensive trawling (1,250 sq. km) by small and large trawers, c. Area under mechanised gill net fishing (270 sq. km) and d. Area under artisanal fishing (40 sq.km).

TABLE 1. *Geographical profile of the east coast of India*

Parameters	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu & Pondicherry	Total
Length of coast (km)	157	480	974	970	2,581
Area (x000ha)					
upto 50m	994	1,707	1,661	2,326	6,688
51-200m	1,292	656	1,443	1,816	5,207
Total	2286	2363	3104	4142	11895

Growth of fishing activity

i. *Fisherfolk population and availability of potential fishing area*

During the past 3 decades the fishing activity has increased throughout the east coast. The population of active fisherfolk increased by 3.5 times in 1991 compared to that of 1961. The substantial increase was in West Bengal (24 times) and Orissa (13 times). The increase was only 35% in Tamil Nadu and Pondicherry. Due to the increase in the population of active fisherfolk the potential fishing area per active fisherman has considerably decreased. For

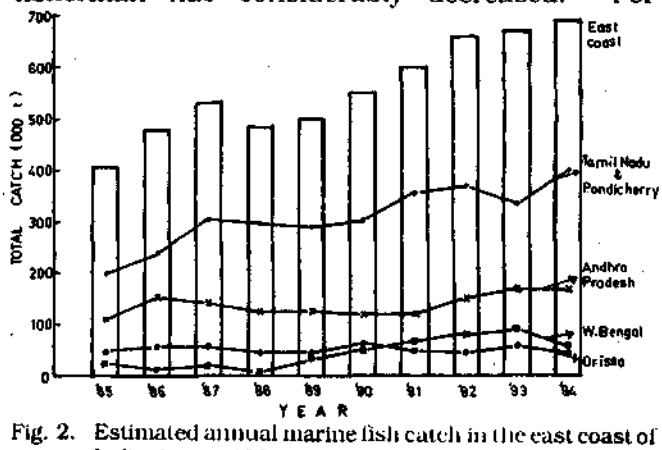

Fig. 2. Estimated annual marine fish catch in the east coast of India during 1985-'94.

* Based on document prepared for III phase of Bay of Bengal Programme (FAO).

TABLE 2. *Comparison of active fisherfolk population and number of fishing craft during 1961 and 1991.*

Parameters	West Bengal		Orissa		Andhra Pradesh		Tamil Nadu & Pondicherry		Total	
	1961	1991	1961	1991	1961	1991	1961	1991	1961	1991
Number of fishing villages	127	652	156	329	321	453	362	375	966	1,809
Fisherfolk population	3,340	81,223	8,828	1,13,242	48,571	1,45,495	56,586	76,366	1,17,325	4,16,326
Number of crafts:										
Mechanised	15	1,880	50	2,179	350	4,082	813	4,082	1,228	12,223
Motorised	0	250	0	529	0	1,688	0	3,298	0	5,765
Non-motorised	783	4,361	2,786	13,791	19,772	50,333	29,661	39,969	53,002	1,08,454
Potential fishing area (ha/fisherfolk):										
Inshore	298	12	193	15	34	11	41	30	57	16
Offshore	387	16	75	6	30	10	32	24	44	13
Total	685	28	268	21	64	21	73	54	101	29
Potential fishing area (ha/boat) :										
Inshore	1,245	158	602	105	83	30	76	50	123	53
Offshore*	No effort	6,872	No effort	3,009	No effort	3,537	No effort	4,451	No effort	4,261
Total	2,865	352	833	143	154	55	136	87	219	87

* 10% of mechanised effort expended in the offshore area

instance the potential fishing area off West Bengal decreased from 685 ha/fisherman in 1961 to 28 ha in 1991 (Table 2). As the increase in the fisherfolk population was the lowest in Tamil Nadu and Pondicherry, the area availability did not decrease substantially and was the highest (54 ha/fisherman) among the east coast states in the 1990s.

ii. Mechanization

There was large scale mechanization of fishing fleets during the past three decades in the east coast. The number of mechanised vessels increased by about 10 times, from 1,228 in 1961 to 12,223 in 1991. In addition, 5,765 motorised vessels were introduced in the 1990s. However, the number of non-mechanised vessels increased by only two times. The large scale expansion and mechanization of fishing fleets was in West Bengal, Orissa and Andhra Pradesh whereas in Tamil Nadu and Pondicherry, the expansion was limited (Table 2).

Barring the 180 Mexican trawlers based in Visakhapatnam, the mechanised vessels in the east coast are of 32'-45' overall length. These vessels restrict the fishing activities mostly to the inshore areas and only about 10% of the total effort of the mechanised vessels is spent in areas beyond 50m depth. Hence, large potential area is available for fishing in the offshore area. The potential fishing area for the east coast is estimated as 53 ha/boat in the inshore and 4,261 ha/boat in the offshore areas.

iii. Production

The marine fish production in the east coast

TABLE 3. *Comparison of annual average catch for 1960-'64 and 1990-'94 in the east coast of India*

Catch	West Bengal		Orissa		Andhra Pradesh		Tamil Nadu and Pondicherry		Total	
	1960-'64	1990-'94	1960-'64	1990-'94	1960-'64	1990-'94	1960-'64	1990-'94	1960-'64	1990-'94
catch (t):										
Inshore	6,000	59,364	6,000	45,375	62,000	1,23,131	11,700	3,11,244	1,87,000	5,39,114
Offshore*	0	10,476	0	8,007	0	21,729	0	54,926	0	95,138
Total	6,000	69,840	6,000	53,382	65,000	1,44,860	1,10,000	3,66,170	1,87,000	6,34,252
Catch/ha (kg):										
Inshore	6.0	59.7	3.5	26.6	39.1	74.1	47.3	133.8	28.0	80.6
Offshore	0.0	8.1	0.0	12.2	0.0	15.1	0.0	30.3	0.0	18.3
Total	2.6	30.6	2.5	22.6	20.9	46.7	26.6	88.4	15.7	53.3
Catch/fisher folk (t)	1.8	0.9	0.7	0.5	1.3	1.0	1.9	4.8	1.6	1.5

* 15% of total catch

increased by 3.4 times in 30 years. The annual average landings increased from 1,87,000 t in 1960-'64 to 6,34,252 t in 1990-'94 (Table 3). The landings increased in all the maritime states. The contribution of West Bengal and Orissa alone to the total east coast landings increased from 3.2 to 11.0% for the former and 8.4% for the latter. The contribution of Andhra Pradesh decreased from 34.8 to 22.8%. Though there was only limited increase in the population of active fisherfolk and in the number of vessels, the percentage contribution of Tamil Nadu and Pondicherry to the landings did not decrease and it remained almost constant at 58% in 1960-'64 and 1990-'94. The catch/fisherman in Tamil Nadu and Pondicherry substantially increased from 1.9 t/fisherman in 1960-'64 to 4.8 t/fisherman in 1990-'94 whereas the catch per fisherman decreased in the other states over the years (Table 3).

TABLE 4. *Potential yield and annual average catch for the years 1990-'94 in the east coast*

State	Potential yield (t)	Catch (t)	Production gap (t)	(%)
West Bengal				
Inshore	2,66,000	59,364	2,06,636	77.7
Offshore	98,000	10,476	87,524	89.3
Total	3,64,000	69,840	2,94,160	80.8
Orissa				
Inshore	3,00,000	45,375	2,54,625	84.9
Offshore	1,55,000	8,007	1,46,993	94.8
Total	4,55,000	53,382	4,01,618	88.3
Andhra Pradesh				
Inshore	2,00,000	1,23,131	76,869	38.4
Offshore	90,000	21,729	68,271	75.9
Total	2,90,000	1,44,860	1,45,140	50.1
Tamil Nadu & Pondicherry				
Inshore	2,80,000	3,11,244	-31,244	
Offshore	1,10,000	54,926	55,074	50.1
Total	3,90,000	3,66,170	23,830	6.1
Total				
Inshore	10,46,000	5,39,114	5,06,886	48.5
Offshore	4,53,000	95,138	3,57,862	79.1
Grand total	14,99,000	6,34,252	8,64,748	57.7

iv. Potential yield and catch

It has been estimated that the potential yield in the continental shelf of the east coast is 1.5 million tonnes. The annual average yield during 1990-'94 (6,34,252 t) was 42.3% of the potential yield and there is a production gap of 57.7% (Table 4). Hence, there is good scope for increasing the catch especially in the offshore areas of West Bengal, Orissa and Andhra Pradesh. In Tamil Nadu and Pondicherry, however, there is only a limited scope of increasing the catch. The catch from the inshore waters indicates an excess of 31,244 t above the potential accounted for mainly by the Madras based trawlers which fish in the contiguous Andhra Pradesh waters and land the catch in Madras.

The trawl factor

The east coast fishery is dominated by lesser sardine, silverbelly, sciaenid, mackerel, anchovy, ribbonfish, threadfin bream and penaeid prawn. The resources are exploited by a multigear system: trawl net, drift gill net and bottom set gill net operated from mechanised crafts while bag net, boat seine, gill net, trammel net and hooks and line operated from motorised and non-motorised boats. In recent years more number of trawlers are being added on to the fleet. In 1994, it is estimated that 48.8% of the total catch in the east coast was by the trawlers (Fig. 3) compared to 38.3% in 1985 and 11.6% in 1969.

To understand the effect of intensification of trawl effort on the fishery, the data on catch and CPUE of trawlers for the period 1985-'94 were analysed and plotted as relative yield and absolute yield against trawl effort (boat days) (Fig. 4-8). The relative yield of the east coast has almost reached a peak beyond 7.4 lakh boat days (Fig.4a) whereas the absolute yield has linearly increased (Fig. 4b). It is clear from the following analysis that the trawling pattern has changed in all the states either in 1990 or in 1991.

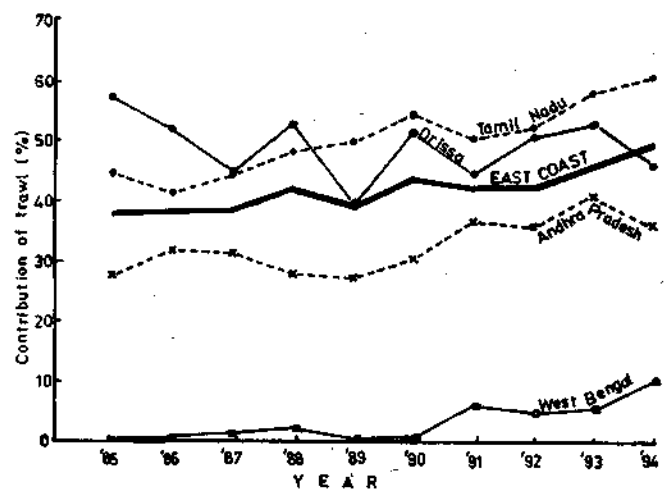

Fig. 3. Contribution of trawl to the total landings during 1985-'94.

i. In Tamil Nadu and Pondicherry, the stagnation observed in the relative (293-321 kg/boat day) and absolute (1.4 lakh t) yields during 1987-'89 changed and the yields increased (377 kg/boat day; 1.7 lakh t) in 1990 (Fig. 5a,b). For an almost equal annual effort of 4.5 lakh boat days during 1987, 1988, 1989 and 1990, the absolute yield was higher by about 20% in 1990 than during 1987-'89.

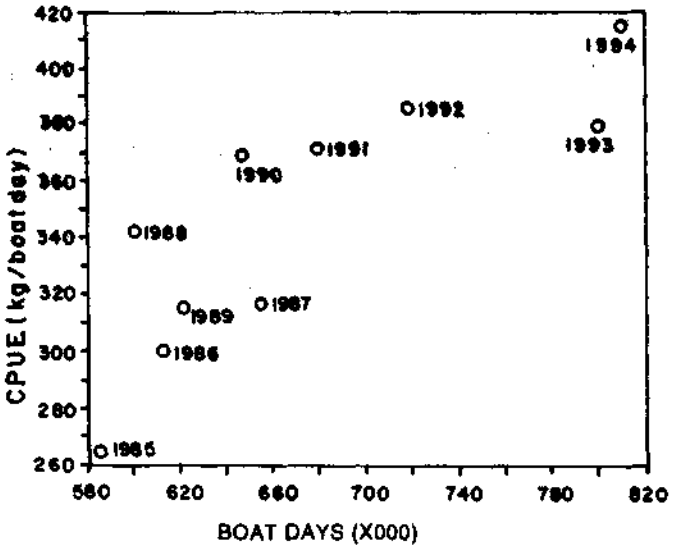

Fig. 4a. Relative yields of trawlers as a function of effort in the east coast during 1985-'94.

ii. In Andhra Pradesh the increase in yield was from 1991. For an equal annual effort of 99,000 boat days in 1990 and 1991, the relative and absolute yields were higher (Fig. 6a,b), by about 25% in 1991.

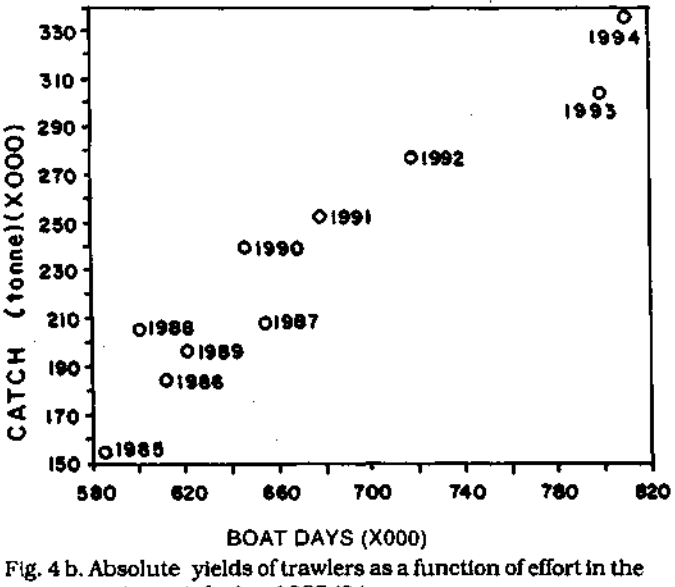

Fig. 4 b. Absolute yields of trawlers as a function of effort in the east coast during 1985-'94.

iii. Orissa was an exception to the above trend. The annual trawl effort and absolute yield fluctuated widely over the decade (Fig. 7b). However, there was a clear decreasing pattern in relative yield with increasing effort (Fig. 7a).

iv. In West Bengal, the difference in yields between 1985-'90 and 1991-'94 was significant. The effort (<900 boat days) and the absolute yield (<4000 t) were very low and the relative yield fluctuated between 321-704 kg/boat day during 1985-'90 (Fig. 8a,b). The effort and absolute yield increased substantially to 6,772 boat days and 3,823 t, respectively in 1991.

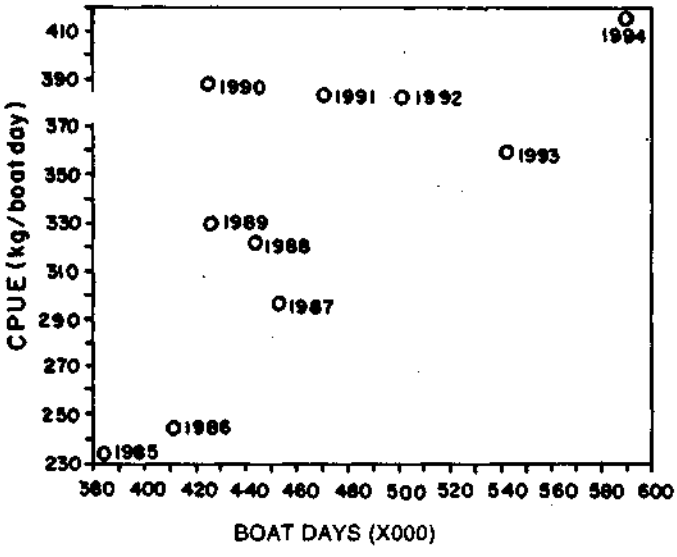

Fig. 5a. Relative yields of trawlers as a function of effort in Tamil Nadu & Pondicherry.

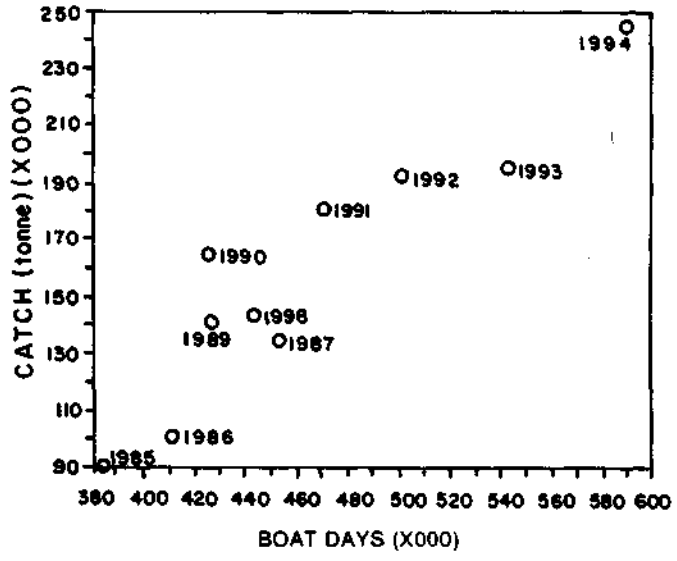

Fig. 5b. Absolute yields of trawlers as a function of effort in Tamil Nadu & Pondicherry.

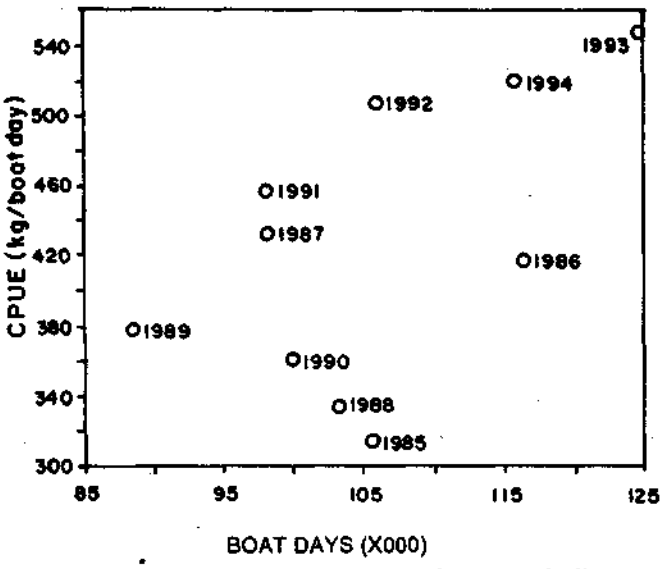

Fig. 6a. Relative yields of trawlers as a function of effort in Andhra Pradesh.

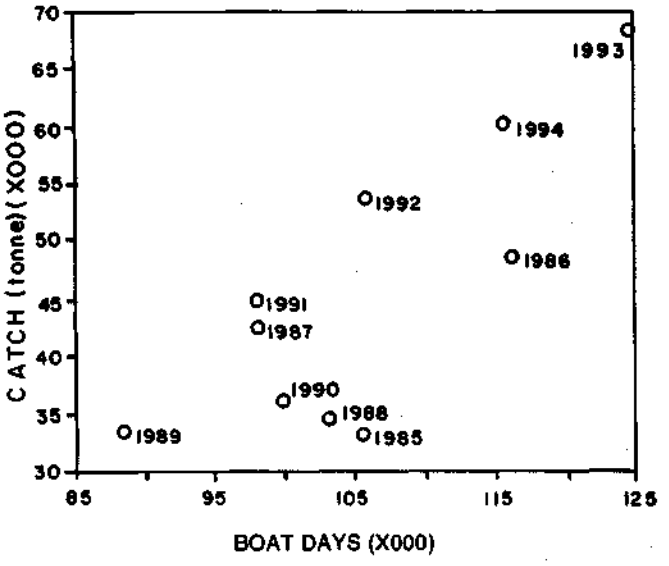

Fig. 6b. Absolute yields of trawlers as a function of effort in Andhra Pradesh.

The increase in effort and relative and absolute yields in Tamil Nadu, Pondicherry, Andhra Pradesh and West Bengal since 1990-'91 were due to the increase in the fishing efficiency of the trawlers. In the 1990s larger trawlers (above 42' overall length) have been added on to the fleet all along the east coast. The higher fish hold capacity of these larger vessels has increased the sea endurance and enabled fishing off the contiguous maritime states. For instance, the tralwers based at Madras conduct fishing off Nizampatnam in Andhra Pradesh, which is about 300 km away. The trawlers of Visakhapatnam and Paradip fish off Sandheads and land the catch in the respective base ports. Intensification of fishing in hitherto underexploited areas has increased the relative and absolute yields in 1990/1991.

Considering the induction of larger trawlers and resultant fishing off the contiguous maritime states, the estimation of effort and yields individually for each maritime state may no longer be relevant. Moreover, the open access to the resource has resulted in frequent clashes in sharing the stock especially between the fishermen of Tamil Nadu and Andhra Pradesh. The conflict of sharing the stock is likely to be a major problem in the years to come. A comprehensive fishery management policy for the trawl fishery of the entire east coast rather than for each maritime state/Union Territory is necessary.

Economics of trawlers

The economic assessment of the trawlers during 1993-'94 (Table 5) has indicated fairly high

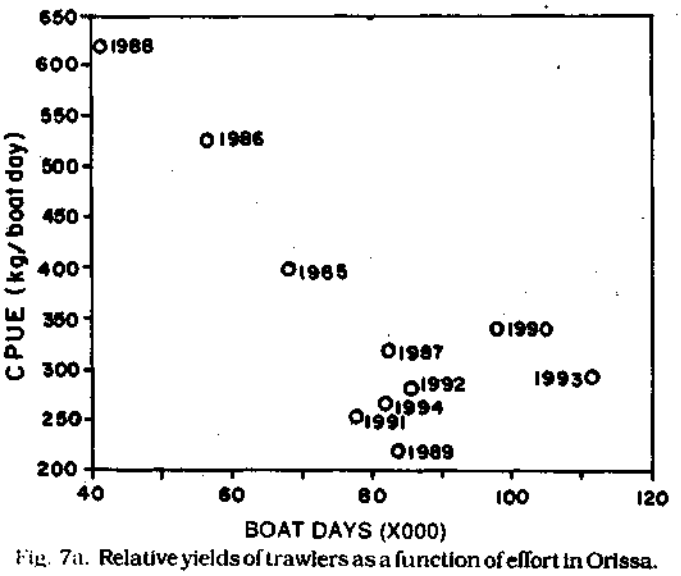

Fig. 7a. Relative yields of trawlers as a function of effort in Orissa.

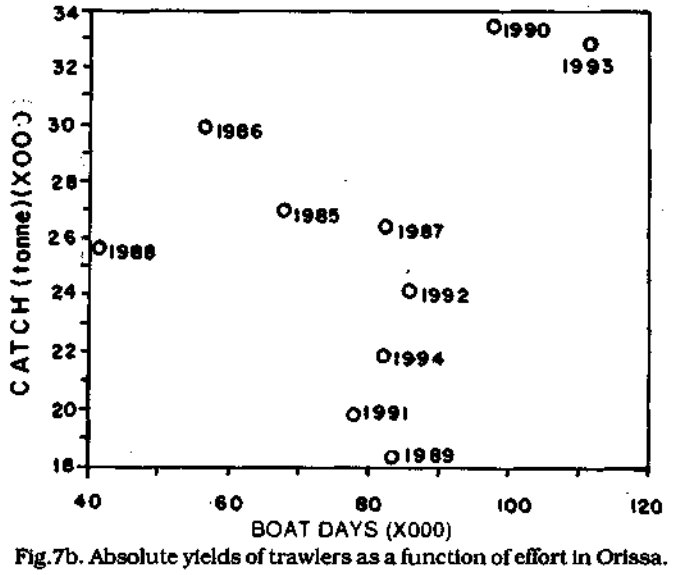

Fig.7b. Absolute yields of trawlers as a function of effort in Orissa.

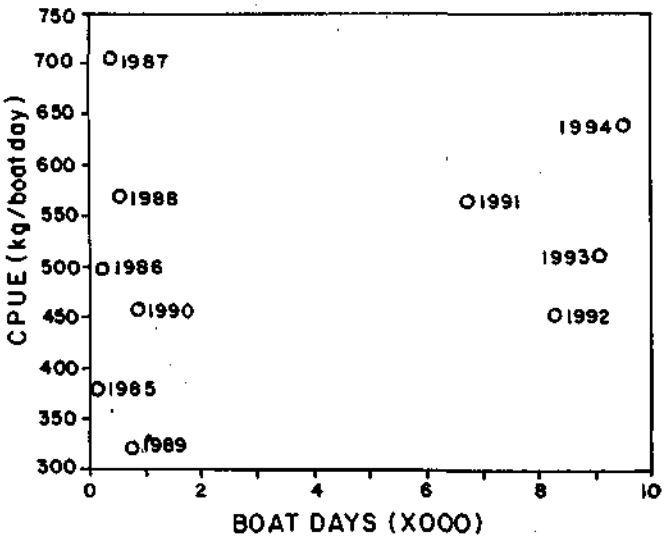

Fig. 8a. Relative yields of trawlers as a function of effort in West Bengal.

annual return (32.6-38.2%) of the capital investment. The high annual return is one of the major factors for increase in effort in the inshore areas.

Suggested management measures

It is clear from the vital statistics of the east coast fisheries that the inshore area (< 50m depth) is intensively exploited and there is considerable scope for intensifying the effort in the offshore area (>50m depth). The following fishery management measures are suggested for all the maritime states/UT in the east coast.

i. As the present trawl effort is limited to a depth below 70m, larger trawlers (>50' OAL) may be introduced to fish in the 70-200m depth zone. The fish hold capacity in these vessels should be large enough (>10 t) to store all the bycatches.

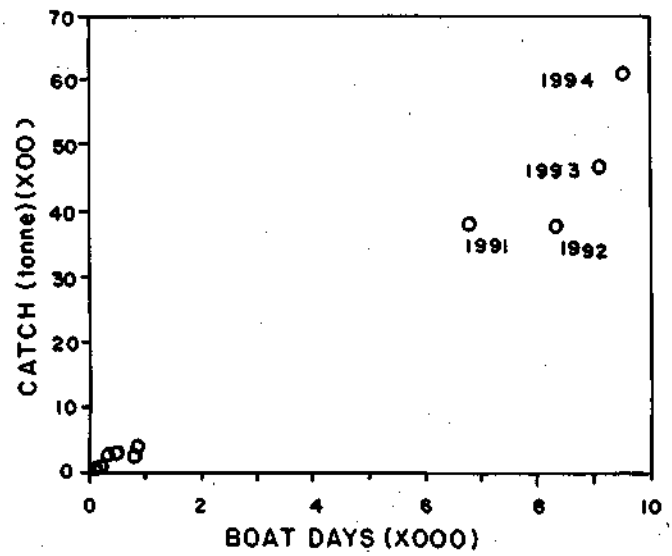

Fig. 8b. Absolute yields of trawlers as a function of effort in West Bengal.

TABLE 5. *Economics of trawlers operated along the east coast during 1993'94; the values are in terms of Rs in lakhs*

Parameters	Tamil Nadu	Andhra Pradesh		Orissa		West Bengal
	*	*	**	*	**	*
Capital investment	5.20	4.85	7.70	4.85	11.00	4.20
Operating cost/year	8.29	6.75		4.57	15.00	3.90
Fixed cost	1.56	1.46		1.35	2.75	1.26
Annual catch (tonnes/unit)	99.60	51.00		40.00	22.00	34.00
Value of catch	10.71	9.10		6.78	20.00	6.01
Annual net profit/year	0.76	0.89	1.79	0.86	2.25	0.85
Net operating income	2.32	2.35		2.21	5.00	2.10
Return (%)	32.60	36.40	23.30	37.10	35.00	38.20
Cost/kg fish (Rs)	9.98	16.10		14.80	80.70	15.15
Operating cost/ kg fish (Rs)	8.43	13.20		11.40	68.20	11.47
Value/kg fish (Rs)	10.75	17.84		16.80	90.90	17.70

* Economics of 32-36' trawlers; ** economics of 42' trawlers

ii. The coast is rich in shark resource. Shark lining using SLR XV type vessels (32' with 26 hp Yanmar engine) should be introduced. These vessels could undertake about 3 days fishing per voyage.

iii. Operation of more number of gill nets like trammel net from motorised crafts should be encouraged throughout the coastline.

iv. Operation of hand squid jigging from motorised and mechanised boats has proved to be very successful in the Gulf of Mannar. This may be popularised in other areas by training the fishermen.

v. The concerned State Governments should promote the establishment of processing plants by extending incentives and by developing the core infrastructure like power, communication and transport.

vi. To enhance the productivity of the intensively exploited inshore areas, artificial reefs may be installed by involving the fishermen co-operative societies in selected coastal fishing villages. The expertise of the CMFRI and the NGOs already engaged in fabrication and

installation of the artificial reefs may be availed.

vii. The fisherfolks could be guided to take up small scale coastal aquaculture and mariculture as an additional/alternative employment (as suggested in Section II).

viii. The fishermen require awareness on the need for fishery management, ill effects of large scale exploitation of juveniles, mesh size regulation, fishing diversification and benefits of installation of artificial reefs. Due to the low literacy rate prevailing among the fisherfolk, mass communication may be made through TV, video, films, radio etc. The services of National Literacy Mission may be utilized.

In addition to the above measures, each state may have to consider individual issues and take up appropriate steps.

Tamil Nadu & Pondicherry

i. As there is no scope for increasing the effort in the inshore waters, restriction and management of trawling effort in depths below 50m is vital.

ii. At present there is no fishing regualtion in the northern part of Tamil Nadu and Pondicherry. The existing long voyage trawlers in Madras, Pondicherry and Cuddalore should be persuaded to undertake only one 5 day cruise in a period of 10 days. The daily fishing trawlers may be permitted to fish only on 3 fixed days in a week.

Andhra pradesh

As there is a production gap of 38.4% in the inshore and 75.9% in the offshore areas, there is scope for augmenting marine fish landings. The following measures are suggested.

i. Motorisation of Kakinada *Navas* and other indigenous fishing crafts.

ii. Introduction of mini trawlers (26' OAL) by converting and improvising the suitable artisanal crafts, as in Kerala.

iii. Introduction of high opening bottom trawling and midwater trawling.

iv. Deployment of the state owned 30' boats in Kakinada for experimental trawling/gill netting, squid jigging etc.

v. Deployment of sona boats of Visakhapatnam Fisheries Harbour currently fishing in the Sandheads to exploit the offshore grounds of the Andhra coast.

vi. Several thousand tonnes of bycatches are discarded in the Sandheads area by the fishing vessels from Andhra Pradesh due to various constraints. The following measures would facilitate the landing of the bycatches:

- By restricting the fishing operation to 3 days per voyage of sona boats and motivating the fishermen to land at Diamond Harbour, Roy Chowk and Paradeep, which are nearer to the Sandheads.
- By suitably increasing the storage capacity of the vessels in accordance with their length to accommodate the entire bycatch.
- By salt curing the bycatches on board and landing it by carrier boats at regular intervals together with iced bycatches.
- By processing the bycatches to produce value added products and development of market for these products.
- By processing the bycatches to produce quality fish meal and fish oil.
- By setting up bycatch processing plants at the major fishing ports by availing experitse from the IFP, CIFT and MPEDA.

Orissa

i. As the relative yield of the trawlers has significantly reduced with increasing effort, trawling in the inshore areas could not be further increased. However, offshore fishing in the 100-200m depth zone could be encouraged by inducting larger trawlers (>50' OAL) for operation from Paradeep and Puri fisheries harbours.

ii. Diversified fishing like gill netting and long lining vital for Orissa.

iii. The codend mesh size of the trawl net may be increased to 25mm by invoking the Marine Fisheries Regulation Act, 1992. This would reduce exploitation of juveniles.

iv. The bycatch discard has to be reduced following the measures suggested for Andhra Pradesh.

West Bengal

The marine fishing activity of West Bengal has increased many times and there is further scope for expansion. The production gap is 77.7% in the inshore and 89.3% in the offshore areas. The suggestions for further development are:

i. The state should induct more small and large mechanised vessels at Diamond Harbour and Roy Chowk.

ii. Berthing facilities should be provided at Diamond Harbour and Roy Chowk for a fixed number of fishing vessels from Andhra Pradesh.

iii. Motorisation of the existing non-mechanised boats in 24 Parganas and Midnapore districts.

iv. Infrastructure facilities such as approach roads, freezing plants, dry fish platforms, market outlets etc. should be provided in the major fish landing centres and fishing harbours.

II COASTAL AQUACULTURE MANAGEMENT

The east coast of India is endowed with an extensive area of coastal fallow lands, sheltered bays, lagoons, estuaries and backwaters and a large variety of cultivable marine organisms of nutritional, therapeutic, ornamental and industrial values. Despite the rich biodiversity and aquaculture potential at present, only shrimp farming has taken roots in the states bordering the east coast of India. Most of the existing aquafarms are owned by non-fishermen communities. A host of social and environmental issues have recently been raised against shrimp farming. These issues could well be overcome by adoption of eco-friendly culture practices, by the introduction of biculture and polyculture techniques with compatible species of finfishes, crustaceans, molluscs and seaweeds and by the active involvement of the coastal fishermen. Empowering the coastal fishermen communities in small scale aquaculture by providing training and technical and financial support would enable them to develop alternate avenues of livelihood, as the limited coastal capture fisheries resources of the Indian east coast cannot sustain the fast growing fisherfolk population. As the literacy rate among the fishing communities is very low, a massive awareness building campaign has to be launched to educate them on the socio-economic benefits of small scale coastal aquaculture and mariculture.

Survey to identify areas suitable for coastal aquaculture

The total area surveyed and identified as potential for coastal aquaculture in the Bay of Bengal coastal zone is about 6,43,000 ha. This does not include the suitable sites in the nearshore areas of the sea, as well as onshore areas contiguous to the coast, backwaters, lagoons and estuaries. Thus the potential would be far greater than the areas already surveyed and identified. Therefore, there is a need for reassessment of the coastal areas to identify suitable sites for coastal farming of cultivable marine species in various coastal ecosystems.

Remote sensing data and satellite imageries available with the National Remote Sensing Agency should be utilised for identification of sites in all the four states.

Detailed macro- and micro-level survey should be conducted in the states to gather information on the geophysical, hydrobiological and meteorological conditions. Information on the land use pattern and land based activities should be generated for the identified sites. Based on the above information, specific technologies suitable for the area would be suggested by the CMFRI.

Technologies for immediate application

There are several economically viable small scale technological packages readily available with the ICAR institutions. Depending upon the suitablility of the sites, these technological packages can be effectively translated for the benefit of the coastal fishermen communities by utilising the coastal water and the land resources. Some of the proven technologies are:

1. Pearl culture (sea and onshore) **2.** mussel culture (sea and onshore, along with shrimp/fish), **3.** shrimp culture, **4.** shrimp broodstock bank, **5.** shrimp backyard hatchery, **6.** shrimp seed bank, **7.** fresh water prawn backyard hatchery, **8.** polyculture of shrimp with other compatible species such as seaweeds, clams, mussels, finfish etc. depending on the suitability of the sites, **9.** cottage shrimp feed industry, **10.** crab fattening, **11.** lobster fattening, **12.** seaweed culture, **13.** raft and line culture of pearl oyster integrated with artificial reefs and **14.** raft and line culture of mussel integrated with artificial reefs. Depending on the demand for seed, hatcheries could also be set up for mussels, clams and pearl oysters. The ICAR Institutes (CMFRI, CIBA and CIFE) would provide the expertise for setting up such small scale units by individual fisherman or by fishermen co-operative units.

As a pilot programme, the grant of Rs 5 lakhs provided by the Union Agriculture Ministry to three of the four states (excluding West Bengal) may be utilized to establish model culture units for mussel, clam, edible oyster, pearl oyster and seaweeds and to train the fishermen.

Alternatively, the above grant of Rs 5 lakhs may be utilised for raft culture of mussels and pearl oysters integrated with the artificial reef programme suggested for each of the states under

the earlier section on coastal fisheries management.

Model farms and facilities

At present shrimp is the only group preferred for farming as there is little awareness among the farming communities about the culture potential of other species. Shrimp farming witnessed spectacular growth during the past five years. But the outbreak of disease and certain social and environmental issues during the past two years, by and large, have decreased the pace of growth. Hence there is a need for diversification of culture techniques by introducing biculture and polyculture techniques and using marine species compatible with shrimp farming. Mussels, clams, oysters, seaweed and certain finfish could be the candidate species. These species have the potential to substantially reduce the nutrient load and plankton density from aquaculture wastes and yield additional biomass from the culture systems. Besides, sustainable aquafarming depends on optimum utilisation of inputs such as seed, feed, fertilizers, chemicals and water, and treatment of wastewater through the application of ecofriendly techniques. Therefore, there is an urgent need to create model farms with adequate facilities for aquafarm waste treatment systems in each of the maritime districts of the east coast states to demonstrate sustainable monoculture and polyculture techniques.

Disease management in aquafarms requires immediate attention. A network of disease diagnosis laboratories has to be set up along the coast. Initially the existing facilities of CMFRI at Madras, Tuticorin, Mandapam and Visakhapatnam, CIBA at Madras, Puri and Kakdwip and the CIFE at Kakinada may be strengthened for intensification of research and training.

Common irrigation, drainage and other essential infrastructure facilities must be made available by the state governments for undertaking small scale mariculture by the fisherfolk.

Research needs

In order to circumvent the socio-economic and environmental issues relating to aquaculture, time-bound research programmes may be taken up on the following priority areas.

- Studies on the carrying capacity for optimum utilization of coastal land and water resources for aquaculture;
- Impact of aquafarm wastes on the nursery grounds and inshore waters;
- Economic performance of farms adopting different culture (extensive, improved extensive and semi-intensive) practices;
- Economic performance of monoculture and polyculture techniques;
- Impact of shrimp culture on shrimp nursery grounds and shrimp fishery in the inshore waters;
- Sea ranching of crustaceans and assessment of its impact in the inshore waters. Management strategies for onfarm waste reduction;
- Diseases in the culture systems, nursery grounds and inshore waters and evolving disease management strategies;
- Socio-economic analysis of integration of artificial reefs with raft or line culture of mussels and pearl oysters.

Training needs

Lack of adequately trained personnel in sustainable culture techniques and diversification of culture practices are one of the major constraints for coastal aquaculture development. A massive training programme has to be launched by designing appropriate curriculum and training strategies to effectively implement the small-scale coastal aquaculture in all the states in the east coast with the following objectives:

- Training the fisherfolk to take up alternative employment like small scale mariculture;
- Training the farmers, trainers, extension and development personnel on sustainable coastal aquafarming techniques including disease diagnosis, prevention and control;
- Development of training aids including video films and manuals.

Awareness building needs

A massive awareness building campaign is essential through mass media on the benefits of sustainable coastal aquaculture highlighting the following aspects;

- Shrimp seed bycatch conservation;
- Management of inputs (water, seed, feed, fertilizers) and disease in farms;
- Ecofriendly coastal aquaculture involving shrimp, seaweed fish and bivalves considering the suitability of the site;
- Socio-economic benefits of small scale coastal aquaculture as an alternative or part time avocation for the coastal fishermen communities.