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38 Marine catfish resources of India

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ABSTRACT

The marine catfish production showed a continuously declining trend all along the Indian Coast, from 67,666 t (1982) to 37,518 t (1995), while the situation is alarming along the SW and SE coast. This group is one of the most vulnerable resources for irrational harvest during their migratory and breeding phase. With the advent of mass harvesting gear like purse seine and trawlers, there has been a continuous onslaught on this resource during the periods of south bound or north bound migrations parallel to the coast. The damage is further aggravated when their spawning shoals are exploited from the surface often causing large scale destruction of parents and egg / embryos, leading to overfishing affecting the recruitment to the population. The paper gives the possible migratory route, seasons of vulnerability and impact of fishing gear on the resources. It is attempted to corelate the surface drift with the seasonal migrations. Various management practices are proposed to conserve the threatened species and suggested possible lines of exploitation preferably on the non-migratory species from distant waters in the middle shelf.

Introduction

The marine catfish is a commercially important ground fish distributed widely in the coastal waters and formed a substantial fishery resource of the country till eighties. In view of its importance in the marine fish production and the future potential, the CMFRI has initiated a research project in seventies and regularly monitored the fishery, biology and stock characteristics for evolving management strategies. The all India catfish production showed a continuously declining trend with the peak in 1982 (67,666 t) and the dip in 1992 (36,165 t). The annual average catfish

catch in the pre-mechanised era was less than 20,000 t. The large scale mechanisation in 1971- 1980 witnessed a hike in the landings to the tune of 51,271 t followed by the purse seine fishing in Karnataka and Kerala which has further pushed the landings to 57,860 t in 1981-1985 period. Thereafter the production slowly declined to 40,008 t in 1991-1995. But the revalidated potential is around 123,000 t from the EEZ, of which less than 50 m depth zone holds 60,000 t and above 50 m 63,000 t (Anon., 1991). Menon *et al.*, (1996) estimated the potential from the zone between 50 and-100 m as around 40,000 t and 57,000 t from 0-50 m depth, based on data from the experimental bottom trawling (1985-1994) of , *FORV sagar sampada*. On the contrary, the earlier estimate of potential yield of catfishes was 310,000 t (George *et al.*, 1977). The highly varying potential estimate made during different periods of time together with declining landing trends necessitate the implementation of suitable management strategies all along the coast, for sustaining the catfish fishery for the future.

The last 4 decades catfish fishery has been critically analysed and evaluated to study whole gamut of the over exploitation problem for developing management options to protect and conserve the threatened species from further degradation. Considerable research input has gone into this group and the work of Mojumdar (1969, 1978); Dan (1977, 1980); Krishnamoorthi (1978); Menon (1979), Silas *et al* (1980); Mojumder and Dan (1981); Dhulkhed *et al.* (1982 a, b); Rao *et al.* (1977); Anon. (1987) Menon *et. al* (1989,1992 a, b, 1996); James *et al.* (1989) are worth mentioning in this context.

Data base

Regionwise, Statewise and gearwise catfish landings and effort data collected by the NMLRDC (Anon, 1969; FRAD, 1979, 1981, 1986,1995) and species composition as well as biology, behaviour and population characteristics data of dominant species from selected centres are utilised for the present study. Standard management tools have been made use of in suggesting conservation and management measures along the whole range of its distribution.

Fishery

All India catch: Till the beginning of mechanisation the resource was exploited by various artisanal gears from shallow grounds during

fair weather. The annual average (1956-66) catfish catch of 21,139 t (2.8 % of the total marine fish landings of the country), was realised by gillnets, hooks & line, boat seines, shore seines and other artisanal gears. Several species constituted the fishery, with the peak landings in post and premonsoon months, and the production showed steady increase over the years. When mechanised fishing (trawlers) gained strength in 1966-1975, the catfish landings also made concurrent progress with annual average of 29,527 t (1966-1970) and 57,776 t (1971-1975). The introduction of purse seine in 1976-1980 period and its popularisation in 1980 - 1985, along the southwest coast has helped to progress the annual average landings to the tune of 57,860 t (1980-85). The harvest was at its peak during 1971 - 1985 by a multitude of competing users, which include artisanal fishers, mechanised and motorised small scale fishers and the industrial sector. The period of abundance of catfish is January- June off Maharashtra Coast, April- September off Karnataka and Kerala, July - September in the Gulf of Mannar and March - June and December - January off the Andhra Coast. The resource is chiefly exploited by mechanised trawlers (33 %) followed by mechanised gill netters (21 %), non-mechanised gear (14 %), purse seine (11%) hooks & line (10%) and dol net (5%). Indiscriminate exploitation of juvenile and sub-adult populations by bottom trawlers and brooders / spawners by purse seiners has resulted in poor recruitment, spawning stock decline and infrequent shoreward migrations. Ultimately the production gradually declined in 1986-1990, though several innovative gears contributed towards the coastal fisheries in this period, with an annual average catch of 51,244 t. The landings further declined to 40,008 t in 1991-1995 inspite of extended fishing to deeper ground upto 80 -100 m depth and species replacements.

The west coast landed 69.7 % of the total catfish catch and the east coast 30.3 %. Until 1980 the southwest coast was the dominant catfish producing region (56.2 % of the total catfish landing of the west coast); whereas during 1981 -1985 period, the northwest coast produced 72.5 % and in 1991-95 more than 95 % of the catfish catch of west coast (Fig.1). Thus, the depletion of the catfish stock is well manifested in the southwest region, comprising Karnataka and Kerala, where the landings declined from 24,702 t (1971-75) to 1212 t (1991-95). The landing in the northwest region (Goa, Maharashtra and Gujarat) registered a continuously increasing trend from an annual average of 7360 t (1956-1966) to 26,269 t (1986-1990). In the

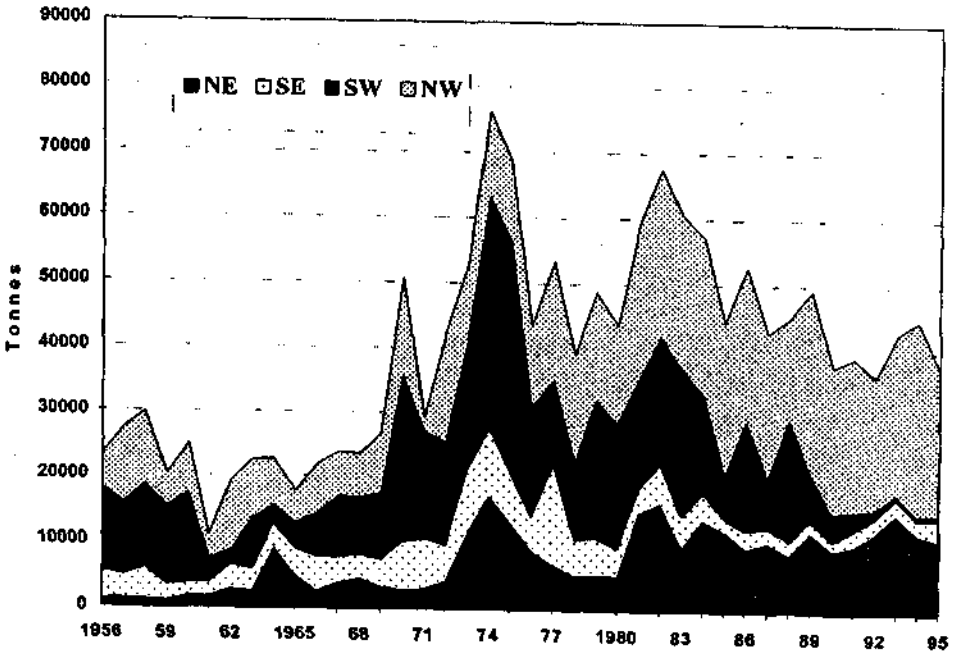

Figure 1 **Regionwise annual catfish production trend.**

northwest region the trawl net landed 38 % of the total catfish catch, followed by gill net (25 %), purse seine (16%), dol net (8%), hooks & line (7%) and non mechanised gear (7%). The trawlers contributed 37% of the total catfish catch of southwest region, gill netters landed 23 %, purse seine 19 %, hooks & line 12 % and non-mechanised gear 6%.

The catfish landings in Gujarat showed a progressive increase from 1843 t (1967) to 14,541 t in 1994 (Fig.2) *Tachysurus dussumieri* (45 %), *T. tenuispinis* (16%), *T. caelatus* (12%), *T. thalassinus* (12 %) and *Osteogeneiosus militaris* (8%) were the most common species. Stock assessment studies of *T. tenuispinis* and *T. thalassinus* revealed that the present level of their exploitation is slightly high for the MSY and hence proposed a 25% reduction in fishing pressure, especially by non selective gears. The production of Maharashtra showed a steady and progressive increase with the peak in 1988 (21,086 t) and there after the landings fluctuated between 7461 t (1995) and 15,279 t (1994) (Fig.3). Of the several species occurring in the fishery the dominant were *T. dussumieri* (25 %), *O. militaris* (22%), *T. thalassinus* (19%) and *T. tenuispinis* (14%). At Goa till 1989 the production increased

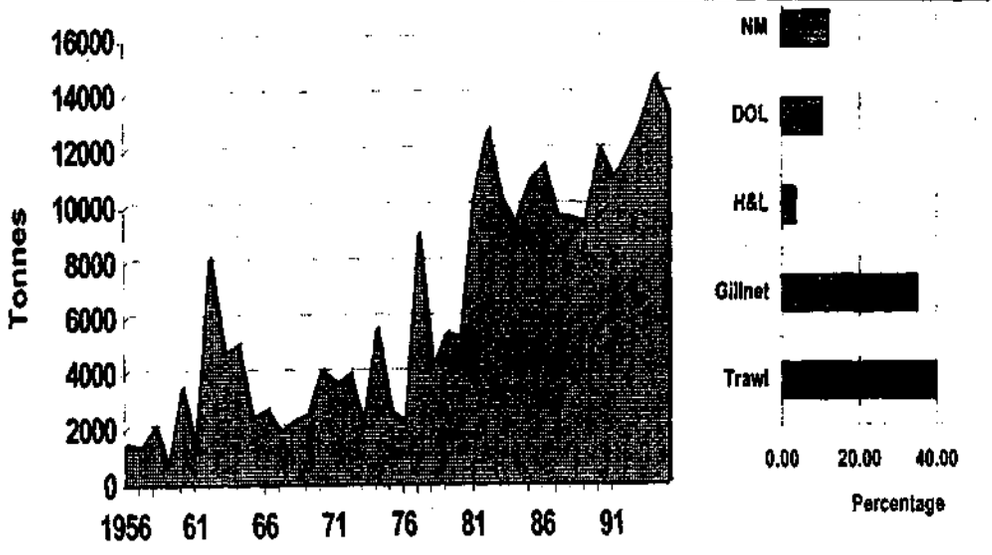

Fig. 2 **Annual production trend of catfish in Gujarat and their gearwise production.**

gradually and reached 5317 t and thereafter declined to 82 t in 1994 (Fig.4). The rise in landings is linked directly to purse-seine impact (1976-1990) and exploitation of shoaling species of *T. tenuispinis*, *T. dussumieri* and *T. serratus*.

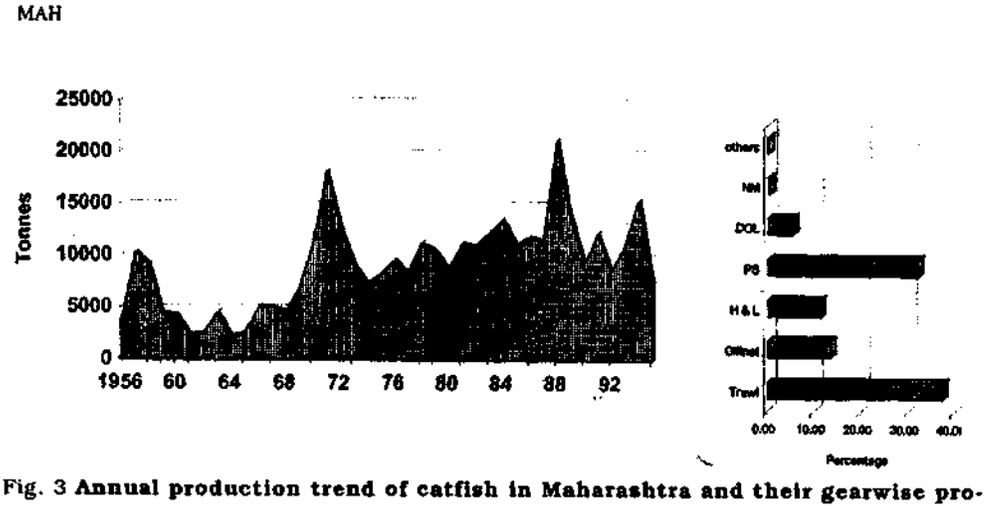

Fig. 3 **Annual production trend of catfish in Maharashtra and their gearwise production.**

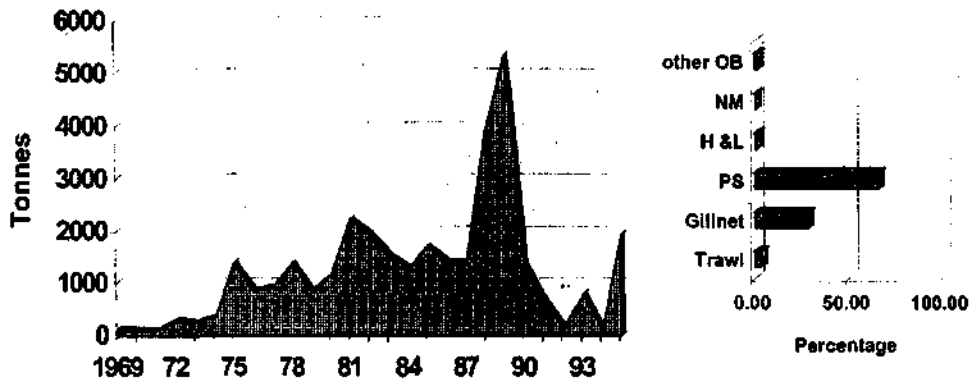

Fig. 4 **Annual production trend of catfish in Goa and their gearwise production.**

The annual landing of 3193 t (1956) has increased progressively and reached a peak of 10,253 t (1982) in Karnataka (Fig .5). The landing declined thereafter until 1988 and recorded a steep fall to 49 t in 1993. The catch chiefly composed of *T. tenuispinis*, (53 %), *T. dussumieri*, (31%), *T. serratus*, (10%) and *T. thalassinus* (6%) during 1979 - 1988. Thereafter (1992-1994) the former 2 species declined (*T.dussumieri* 11% and *T. serratus*, 5 %), while the, *T. thalassinus* continued to contribute to the fishery with 65 % of the total catfish catch. In Kerala the landings showed a fluctuating progress with the peak of 33,528 t in 1974 and this trend continued

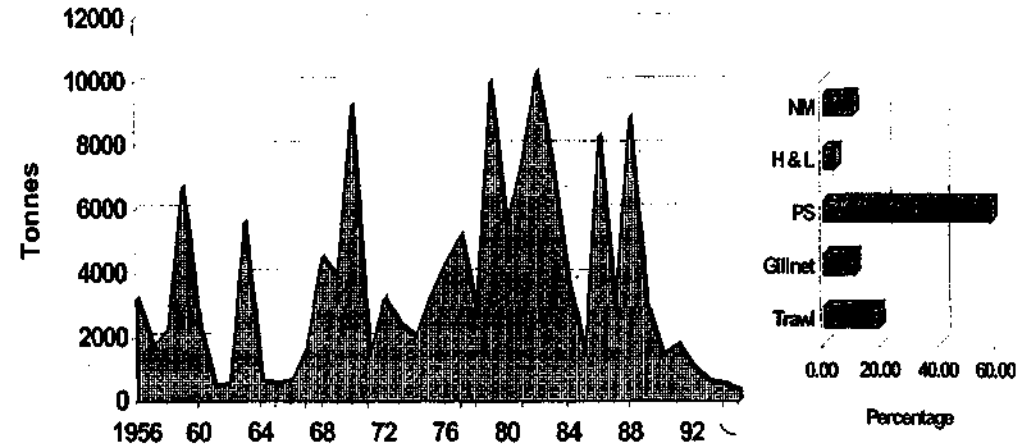

Fig. 5 **Annual production trend of catfish in Karnataka and their gearwise production.**

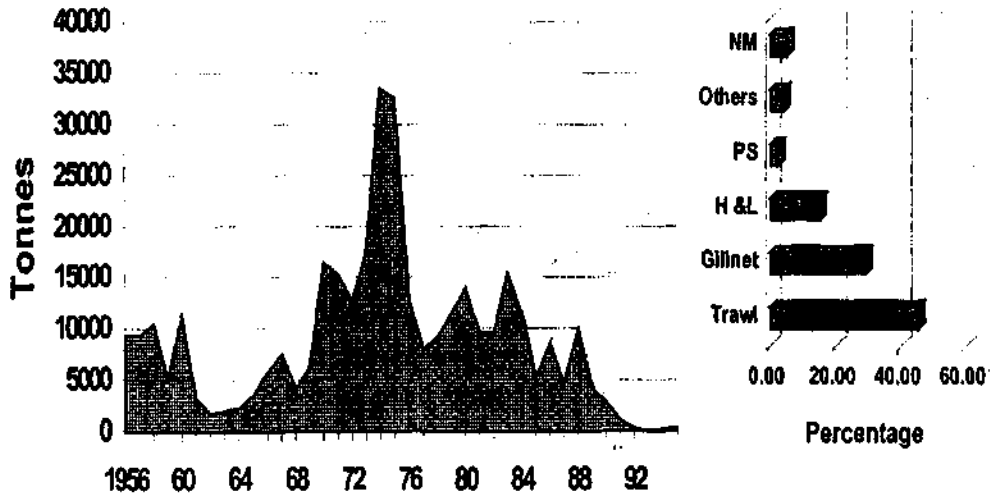

Fig. 6 **Annual production trend of catfish in Kerala and their gearwise production.**

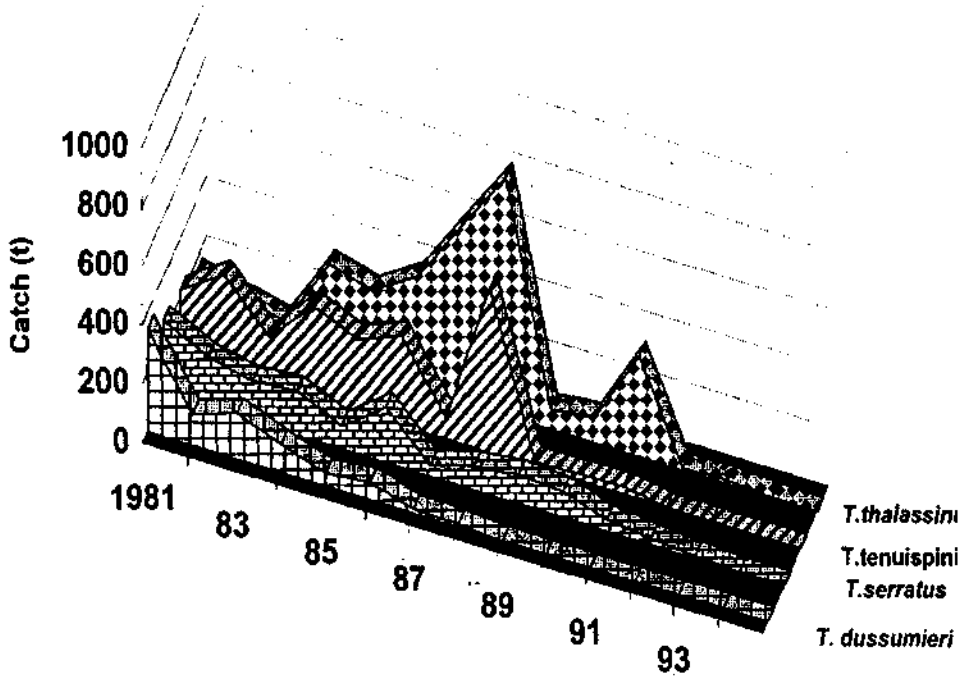

Fig. 7 **Specieswise catfish production at Cochin.**

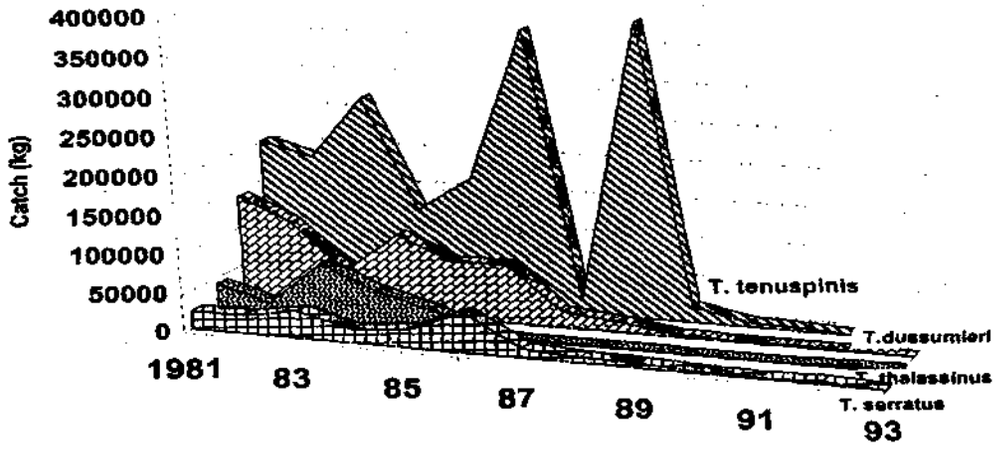

Fig. 8. Specieswise catfish production at Calicut.

until 1983 (15,344 t) and thereafter declined with wide fluctuation upto 1988 (Fig.6). The catch diminished steeply from 1989 and reached a meagre 308 t in 1995. The species composition here during 1984-1988 was *T. thalassinus* (40%), *T. tenuispinis* (30%), *T. serratus*, (18%) and *T. dussumieri*, (12%); whereas in 1991-1995 the composition showed the dominance of, *T. thalassinus* (65%) and *T. serratus*, (19%). The specieswise landings from Cochin and Calicut clearly illustrate the stock depletion of *T. tenuispinis*, and *T. dussumieri* (Figs. 7 and 8).

Along the southeast region the landings progressively increased upto 1975 (8,190 t) and thereafter declined to 2129 t in 1986-1990; whereas in the northeast region the production increased steadily and reached a peak in 1981-1985 (13,283 t) and thereafter maintained steady landings. In 1981-95 period the NE region contributed about 81 % of the total catfish catch of east coast. During 1991-1995 the bulk of the catch (38 %) from the NE was landed by gill-netters followed by non-mechanised gear (24 %), trawl net (20 %), and hooks & line (17 %). Whereas in the southeast region the mechanised trawlers landed 47 % of the total catch; the non-mechanised gear caught 38 % followed by gill-netters 12%.

Catfish production from Tamil Nadu registered a general increase until 1982, 3396 t in 1956-65 to 8055 t in 1971-75, with fluctuation and declined thereafter (7031 t in 1976-80 to 1907 t in 1986-90, (Fig.9).Although many species are available in this part of the coast, the dominant species are

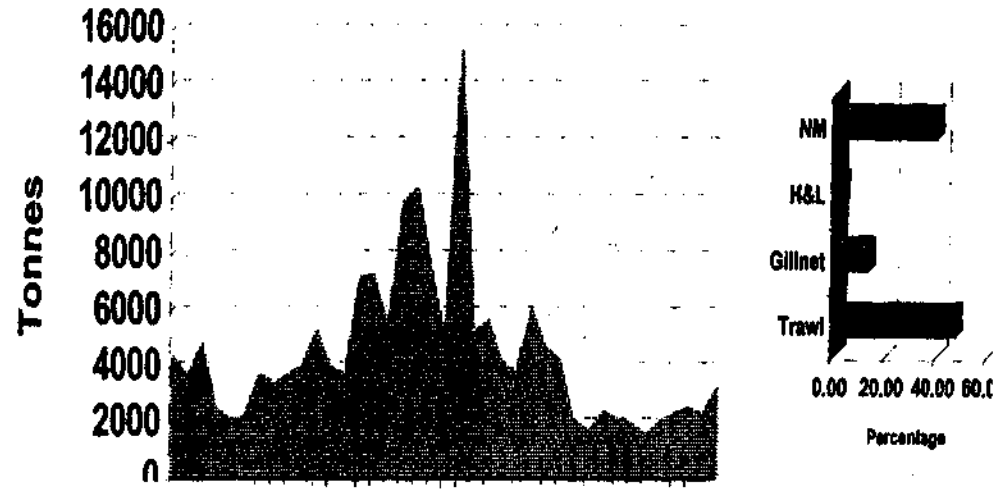

Fig. 9. **Annual production trend of catfish in TamilNadu and their gearwise production.**

T. thalassinus (30 %), *T. caelatus*, (18 %), *T. dussumieri* (4 %), *T. serratus* (3 %) and *O. militaris* (2 %). Catfish catch at Pondicherry showed a declining trend 184 t (1965-75) to 81 t (1976-85) and it further declined thereafter (except a sudden hike in 1986 - 1043 t). (Fig. 10). . The landing showed a general increasing trend 2542 t (1956-65) to 8574 t (1971-75), till 1981-1985 and thereafter slowly declined with minor fluctuations along Andhra Coast (Fig. 11). The major species contributed to the fishery were, *T.*

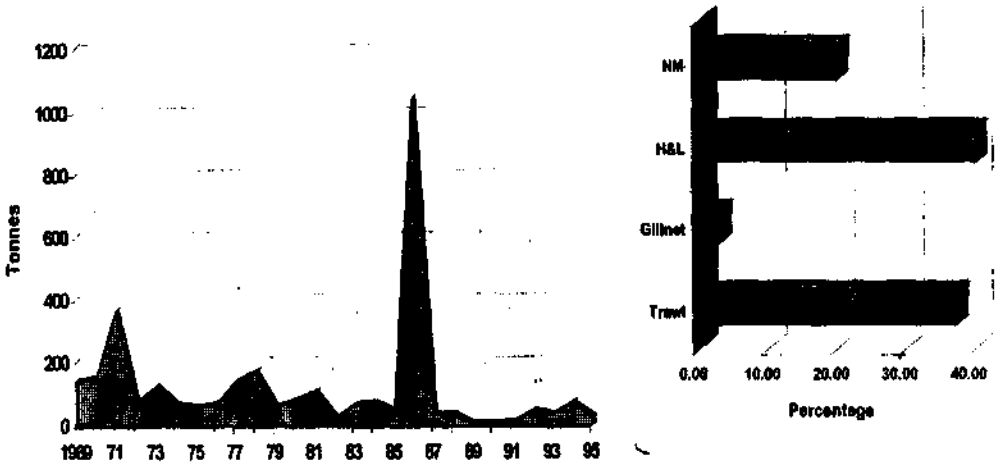

Fig. 10. **Annual production trend of catfish in Pondicherry and their gearwise production.**

thalassinus (67 %) and T. *tenuispinis* (32%) during 1960-1975 period; whereas the latter species declined to less than 10 % of the total catfish catch in 1990-1995 period. Stock assessment study (Menon *et al.*, 1992) revealed that the effort should be reduced considerably to achieve sustainable yield of *T. thalassinus* and *T. tenuispinis*. The landings in Orissa registered a fluctuating trend with general increase (Fig. 12.); the

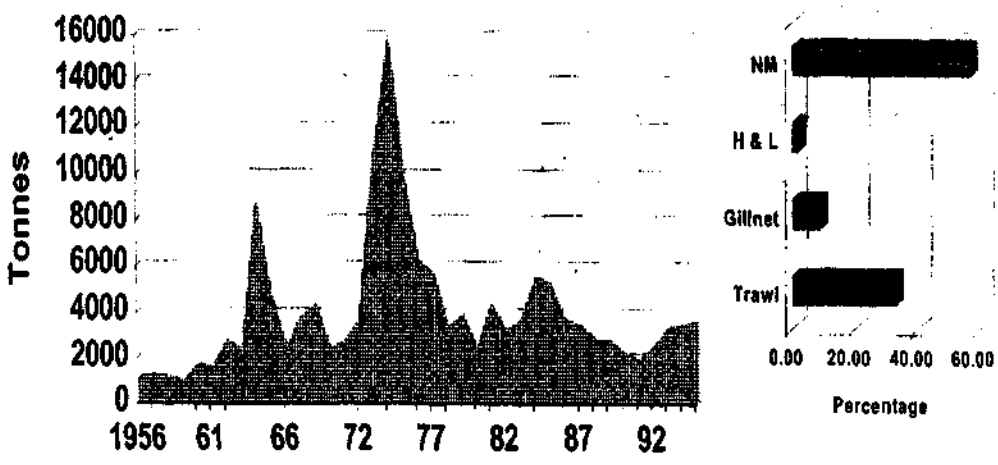

Fig. 11 **Annual production trend of catfish in Andhra Pradesh and their gearwise production.**

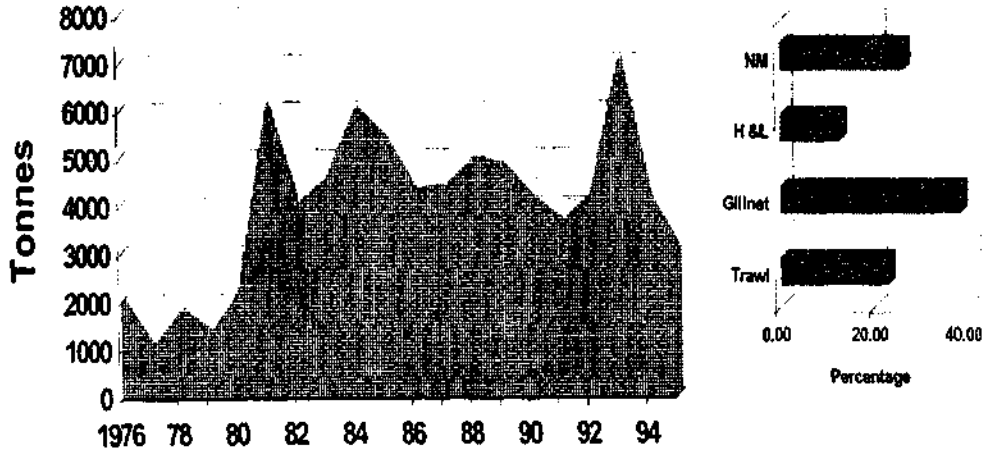

Fig. 12 **Annual production trend of catfish in Orissa and their gearwise production.**

peak landing was in 1981 (6084 t) and it formed 12.5 % of the total marine fish catch of the state in 1981-1985. Of the several species occurring *T. thalassinus*, *T. dussumieri*, *T. tenuispinis*, *T. sona* , *T. caelatus*, and *O. militaris* are the major species contributing to the fishery. In West Bengal the catch showed a peak of 9075 t in 1982 and thereafter it was stable and formed about 17 % of the total marine fish catch of the state in 1986-1990 (Fig. 13.). The dominant species are, *T. thalassinus*, *T. jella*, *T. caelatus* and *O. militaris*. Large quantities of *T. jella* young fish landing was reported from the bagnet operation in the Hoogly- Matlah area.

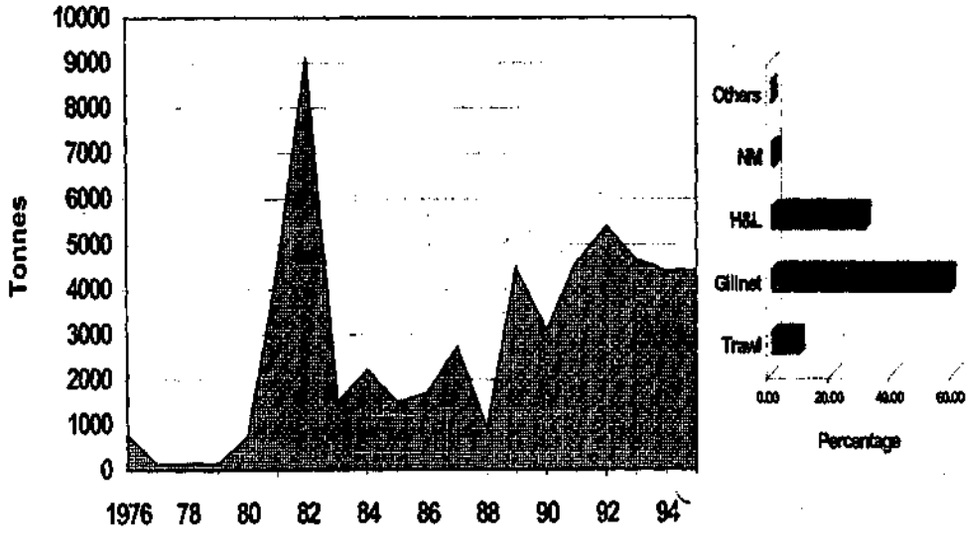

Fig.13 **Annual production trend of catfish in West Bengal and their gearwise production.**

Depthwise production

Catfish landing data of trawl for the year 1997 and 1998 were utilised to synthesise the distribution / abundance pattern in bathymetric realms of 0-10, 10-20, 20-30, 30-40, 40 -50 and above 50 m in various maritime states and all along the Indian Coast. In all India mechanised trawl yield of catfishes, about 39 % was from above 50 m depth, 37 % from 30 -50 m and the rest from the inshore realm upto 30 m. In the NE region, the depth zone 30 -

50 m landed 58 % and the inshore 10-20 m produced 47 % of the total catfish catch; whereas the NW yielded more than 50 % from above 50 m depth zone and about 25 % from 40 -50 m (Fig. 14).

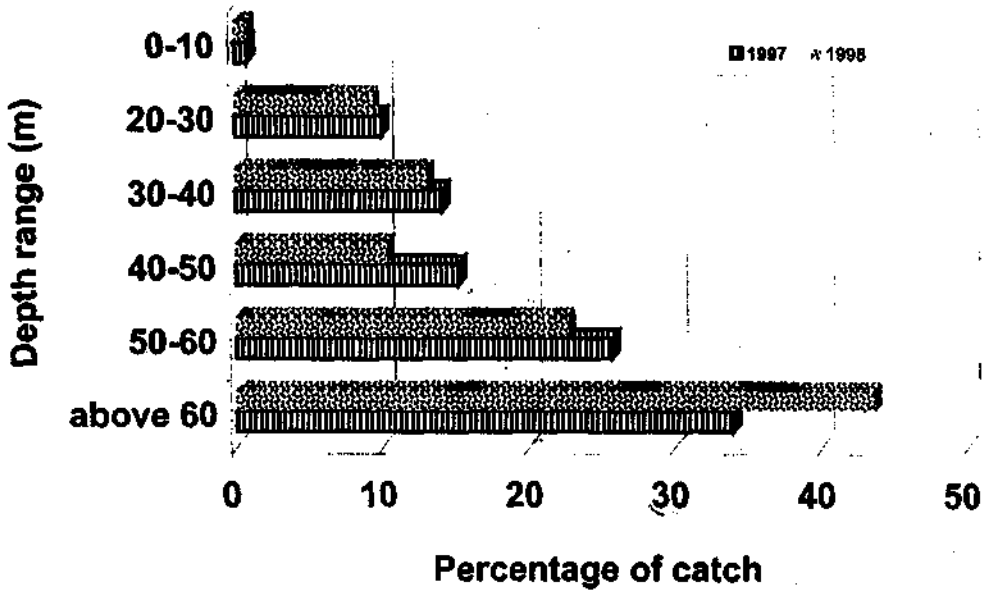

Fig. 14 **Bathymetric production (trawl) of catfish (percentage).**

Fishing impact assessment

Trawl Net: During the pre-mechanised period the catfish fishery was sustained by indigenous crafts and non-mechanised gears such as hook & line, gill net and boat seine and the production showed a gradual and steady improvement, with many species contributing to the fishery. The introduction of trawl net in fifties and large-scale popularisation in subsequent decades altogether changed the fishing pattern and production trends in many of the maritime States. This shrimp targeted but non-selective gear landed many species of demersal fishes in large quantities and catfish was one of the important items among the by catch. Invariably the bottom trawls catch composed of bottom living juvenile and sub-adult, and medium size column moving 1-2 year old fish. Often the juvenile and sub-adults of 7-20 cm formed the bulk (numerical) of the landing at most of the centres along southwest and southeast coasts. The impact of this bottom sweeping has caused damage not only to the ground fishes sustainability,

but also to the bottom habitat and the biota (epi- and in fauna) which form the prey for demersal fishery resources (Lakshmi and Rao, 1992;Menon ,1996). The landings of, *T. thalassinus*, by trawlnet consisted of less than one year old and immature (7-20 cm) fish to the tune of 80% at Mangalore (1988-1991) and 83 % at Visakhapatnam (1986-1993). Similarly about 70 % of the trawl catch of *T. tenuispinis* , consisted of juveniles/ sub-adults (13.5 - 23 cm) at Mandapam (1988-91) and 88 % at Mangalore (1983-89) often from a trawling depth within 30 m. This type of juvenile fishery from the nursery grounds has caused both recruitment and growth overfishing, preferably of *T. thalassinus* and *T. tenuispinis*.The coastal trawling along Mangalore during 1983-93 clearly showed almost complete disappearance of *T. tenuispinis* , from the fishery (Fig. 15). The destructive, overfishing of *T. tenuispinis*, by bottom trawling along Andhra Coast has been reported earlier by Krishnamoorthi (1978), Dan (1980), Anon., (1987), Menon *et al.*, (1992 a and b) and Lakshmi and Rao (1992).

Purse seine: The introduction of purse seine into the commercial fish-

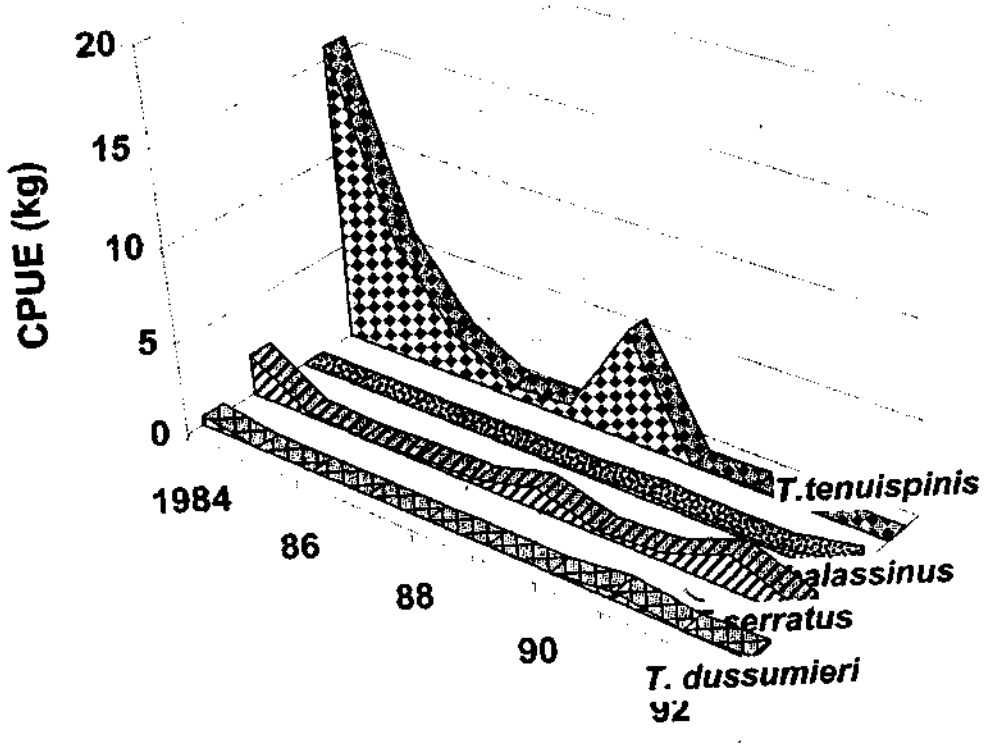

Fig.15 **Specieswise catfish catch by trawl net at Mangalore**

ing in 1979 and its intensification in 1980s has accelerated the growth of coastal pelagics and few shoaling demersals production along Goa, Karnataka and later in Kerala. This has paved the way for rapid proliferation of the gear and the effort has reached around 400 units in Mangalore alone with a concurrent high production of 4286 t of catfish in 1982. Invariably the purse seine catch consisted of gestating males/ female shoaling spawners of *T. tenuispinis*, *T. dussumieri*, and *T. serratus*, during the periods September-November , December - March and July - September respectively (Table 1). In 1979- 87 period the gestating males (*T. tenuispinis and T. dussumieri*) alone formed 64 % of the catfish catch by purse seine. The estimate of annual destruction of egg / embryos / larvae of *T. tenuispinis*

TABLE 1: **Purseseine landing of catfish brooders / eggs / embryo**

Year	Month	Area	Catch of Brooders (t)	Egg/ Larvae	References
T. tenuispinis					
1980	September	Mangalore	204.9	16.0 t	Silas *et al.*, 1980
1980	October.		241.5	14.0 t	Silas *et al.*, 1980
1980	October	Gangoli	82.0	7.6 t	Silas *et al.*, 1980
1981		Mangalore	No data		Dhulkhed *et al.*,
1982					
1982	September.	Karwar	136.1	3.9 t	Dhulkhed *et al.*,
1982					
1982	October.	Karwar		2.3 t	Dhulkhed *et al.*,
1982					
1982	September	Mangalore	10.2	0.13 million	
1982	October.	Mangalore	475.6	5.9 million	
1983	October.	Mangalore	331.0	1.7 million	
1984	September	Mangalore	9.0	0.05 million	
1986	September	Gangoli	1094.0	2.5 million	

T. dussumieri					
1983	March	Mangalore	21.0	1.65 lakhs	Muthiah & Rao
1985					1985
1984	January.	Mangalore	68.7		
1986	Feb.-Mar.	Mangalore	849.0	5.7 million	
1987	February.	Malpe	25.4	0.38 million	
T. serratus					
1996	October	Cochin	4.5	280 Kg.	

during the above period is about 8.2 million (13.4 t) by purse seine. If allowed to grow and contribute to the fishery (by age 2 years and above) it would have yielded 2768 t per year (assuming 10 % natural mortality). Similarly the estimated annual fishing mortality of eggs / embryos / larvae of, *T. dussumieri*, by purse seine in the above period is 1.6 million (5 t). The loss by way of this fishing mortality of egg / larvae is equivalent to 3320

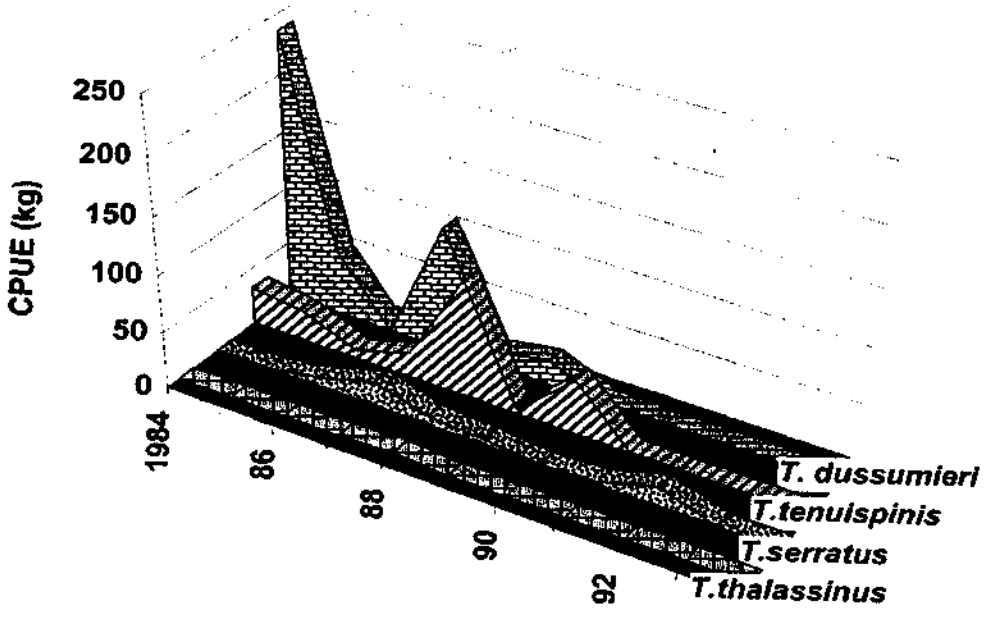

Fig. 16 **Specieswise catfish catch by purse seine at Mangalore.**

t of exploitable fish (4 -5 years old and above) after allowing a 10 % natural mortality. The wanton destruction of catfish brooders with eggs / embryo by purse seine has been reported from Karnataka since 1980 and the vulnerable species were *T. tenuispinis*, T. dussumieri and *T. serratus* (Silas *et al*, 1980; Dhulkhed *et al.*, 1982 a and b ; Muthiah and Rao, 1985). The purse seine catch per unit effort data of Mangalore during 1982-92 shown in Fig. 16 clearly indicates the total disappearance of both *T. tenuispinis* and *T. dussumieri* from this part of the coast since 1989 and 1991 respectively as a consequence of mass destruction of egg/ embryos by purse seine.

Biology and behaviour

The characteristic reproduction, shoaling behaviour and migration of many species of marine catfishes made them easy target for over-exploitation. Species such as *T. tenuispinis*, *T. dussumieri* and *T. serratus* although demersal denizens of coastal habitats, exhibit shoaling behaviour and vertical and horizontal migration especially during their adult / breeding / spawning phases of life history. All these species have low fecundity ranging from 25 - 190 ova and with a single spawning in a year. The breeding period lasts around 5 months with peak in 1-2 months (September - November for *T. tenuispinis*, December - January for *T. dussumieri*, and July - August for *T. serratus*). They are easily vulnerable to purse seines in this period. All species exhibit parental care with the male carrying the brood (25 - 120 eggs) in the oro-buccal cavity for 1 to 2 months time until the juveniles (4 - 7 cm) are released. After spawning the brooding males segregate into shoals and move along the surface and prefer shallow water. The newly released juveniles of all species of tachysurids live in the shallow muddy grounds feeding on the bottom epi- and in- fauna. (Mojumder and Dan, 1981; Mojumder, 1969; Menon, 1979; Anon., 1987; Lakshmi and Rao, 1992). The incessant bottom trawling in these grounds frequently harvested large quantities of both the prey, benthic fauna and the predator catfishes and immature demersal fish juveniles/ sub- adults. The characteristic shoreward breeding migration, the low fecundity, oral incubation and the shallow nursery grounds are the biological and behavioural characteristics detrimental to their survival when threatened by fishing mortality.

Migration

The predominantly demersal marine catfishes exhibit diurnal vertical migration (*Rao et al.*., 1977) and horizontal migration towards the coast and parallel to the coast during monsoon (James *et al.*,1989). The seasonal yield trends, bumper landings at various fish landing centers from Ratnagiri to Madras (Chidambaram, 1987; Srinivasarengan, 1988; Nammalwar *et al.*,, 1989; Sunilkumar *et .al.*,1993; Sawant, 1994 and Kemparaju *et al.*, 1995) throw considerable light on the probable season and course of migration of the major shoaling species *T. tenuispinis*, *T. dussumieri* and *T. serratus*. Analyses of data revealed a south bound coastal migration starting from Ratnagiri during Southwest monsoon, concurrent with the surface drift pattern in the Arabian Sea and north bound migration in the Bay of Bengal upto 15 ° N in August- September and thereafter the reversal trend in Northeast monsoon (November -January) (Figs.17 and 18). The shoreward migration of shoals is mostly evident during breeding season and the

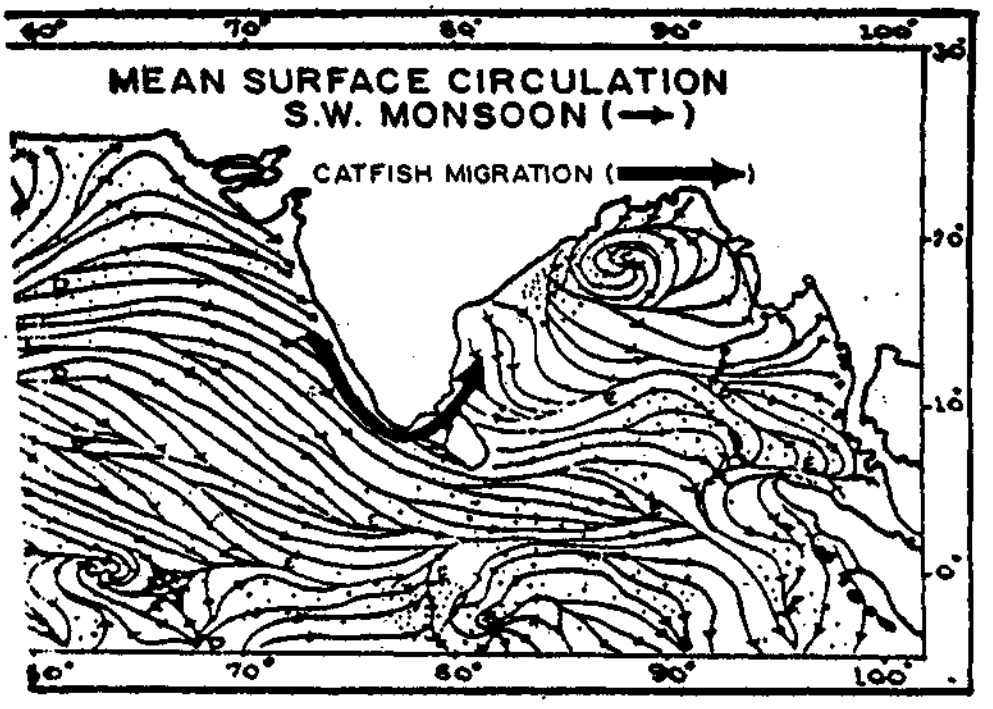

Fig. 17 **Seasonal surface drifts and the migration pattern of catfishes during SW Monsoon**

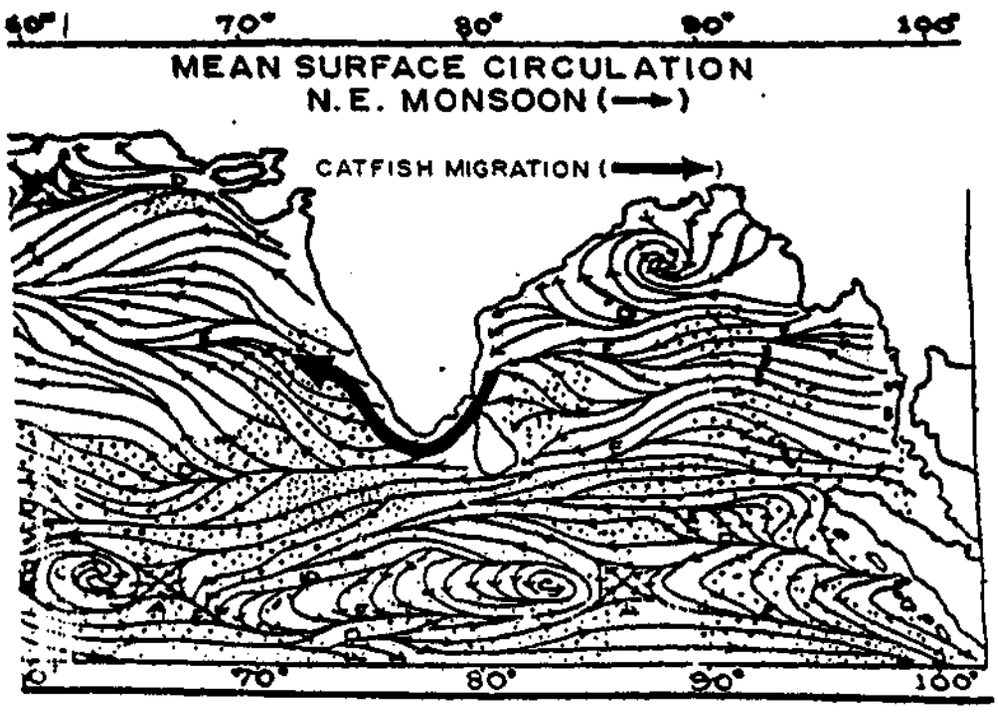

Fig. 18 **Seasonal surface drifts and the migration pattern of catfishes during NE Monsoon**

migration parallel to the coast is reported from below 17° N at west and 15° N at" east coast. The mass harvest of brooders / spawners has, therefore, often takes place from this part of the coast. This has resulted in recruitment overfishing and depletion of stocks of *T tenuispinis* and *T. dussumieri*, in southwest and southeast sectors as evidenced by a continuously declining production trend since late eighties and nineties. Whereas the stocks of the northern sectors (Northwest and Northeast) remain isolated, and the breeding stocks are not threatened by mass exploitation and hence continue to contribute to the fishery. The south bound drift and concurrent movement of catfish, bull's eye and ribbonfish shoals are reported to approach the coast around 17 ° N and move down (James *et al.*,. 1983; Vijayakumarn and Naik, 1988). The movement could be traced upto Madras in the east and a reverse movement in Northeast monsoon. The circulation pattern during the Southwest and Northeast monsoon (Varadachari and Sharma, 1967; James *et.al.*, 1983) clearly shows that

the monsoon current flow is strong from 17° N downwards during SW monsoon and in the north bound Northeast monsoon (November - January) the drift weakens and partly moves away from the coast at around 17° N in the west coast. The movement of the above resource also follows the same pattern. However, to prove this hypothesis, further investigation is needed by conducting tagging recovery, drift bottle and racial studies of migratory species.

Management

A critical analyses of the data on the fishery, biology and behaviour of tachysurid catfishes in the last 4 decades provide valuable research inputs for assessing and evaluating the stock characteristics and for developing suitable management strategies. The earlier assessment of its potential (George *et al*, 1977; Anon., 1987; Menon et *al*, 1992 b, 1996) together with stock assessment studies give a dismay picture of continuously declining potential for this resource.

The dwindling production and poor recruitment along the southwest and southeast region now demand implementation of regulations such as banning coastal bottom trawling, controlling purse seining of gestating / spawning stocks, etc. All such measures are detrimental to the economic objective of the industry and therefore liable to resist. Therefore, it should first be decided that whether the short term economic gains should take preference over the affirmed policy of achieving a sustainable yield whereby protecting the resource from over exploitation. In the interest of both, it is therefore, necessary to formulate suitable management strategies for each region / maritime State depending on the magnitude of the problem.

The problem of fishery management regulations are severe and complex in tropical country like India where the marine capture fisheries is multispecies and the resource users belong to multisectors and not easy to implement and enforce owing to political or socio-economic reasons. Here the fisheries management is viewed as a cost, whereas due to lack of management, often there is over crowding, over investment and over capitalisation in the fishing industry. This excess cost is invariably born by Government and the consumers. In such a context fisheries management has become a benefit and therefore should be considered as a priority

for future development. With the present state of scientific knowledge on fish stocks, biotic and abiotic data base, past experience on resource behaviour, additional research input, together with skilled and rationale fisherfolk's participation, it would be possible to achieve sustainable fisheries resources management and conservation.

The impact of trawling and purse seining on the collapse of North Sea herring fishery, with the longest record of sustainable exploitation, prosecuted with drift nets, is a historic example in this context. Similarly the vulnerability of Capelin (*Mallotus villosus)* to over exploitation due to its peculiar reproductive and shoreward migrational behaviour and the collapse of its fishery has a close resemblance with the present situation of catfish brooder devastation in our country. The collapsing herring fishery and inshore capelin fishery were subjected to severe restriction on fishing effort or banned their fishing for period of 2 - 5 years following a crash of their fishery. These restrictions have helped the stocks to recover and increase the spawning stock biomass (FAO, 1992).

The regionwise production data clearly show that the input of mechanisation (trawling and purse seining) was responsible for sudden increase in landings in 1970 - 1985 periods. Simultaneously this fishing has also caused damages to shoaling species like, *T. tenuispinis*, and *T. dussumieri*, by way of growth overfishing (trawlnet impact) and recruitment overfishing (purse seine impact). As the spawning stock migrations are pronounced in the southwest region, the effect of overfishing is felt at an alarming magnitude in this region. Earlier studies revealed that many commercially important species are under heavy fishing pressure (Krishnamoorthi, 1978; Dan, 1977 , 1980; Anon., 1987 ; Menon, 1979; Menon *et al.*1992 a and b; Bensam and Menon, 1994).Accordingly they suggested regulatory measures (species specific / gear specific / region specific) for implementation by the concerned maritime States. But, often the regulatory measures were not implemented due to several socio-economic / political reasons.

Because of the oceanographic isolation of northern stocks from southern stocks it would be worthwhile to propose different management strategies for the northern and southern regions. The non- mechanised / motorised sector fishing by drift / gill nets and hooks & line should be encour-

aged and promoted all along the distributional range of this resource (Menon *et al.*, 1989). This socially equitable proposition will help to sustain the resource harvest. Mechanised bottom trawling should be controlled or banned in the coastal sector upto 30-m depth all along the coast and the unbridled entry of OB mini trawlers should be regulated. These regulations will reduce growth overfishing and therefore, gradually help to enhance the stock. The control or ban on this bottom trawling operation will also reduce benthic fauna devastation and the exploitable resource's feeding habitat degradation (Lakahmi and Rao, 1992; Bensam and Menon, 1994; Menon, 1996).

The catch and landing of spawning stock and gestating males by purse seine should be banned totally all along the distributional range; this could be easily achieved since the skilled fishermen can detect the catfish shoals and avoid fishing them during breeding season. The implementation of this regulation, of course with the beneficiary fisher societies participation, will reduced the egg/ larval destruction and hence improve and strengthen recruitment (James *et al*, 1989; Menon, 1996). As the spawning of *T. tenuispinis*, *T. dussumieri* and *T. serratus* mostly takes place in the coastal habitat of Kerala - Karnataka, this regulation should be effectively implemented in the southern sector, where this shoreward migrations are intense.

It is often reported that stocks of catfishes occur in areas beyond 50 m depth for exploitable concentration (Joseph and John, 1987; James *et al*, 1989; James and Pillai, 1990; Menon, 1996). But the existence of such stock in deeper grounds is restricted to certain seasons / periods of time, depending on the feeding biology and behaviour of the species and the prevailing oceanographic conditions (Rao *et al.*, 1987). However, the present commercial catch data (1992-1994) revealed that more than 90 % of the total catfish catch is realised from less then 50-m depth zone inspite of the extension of fishing into deeper grounds upto 100 m. Therefore, to make fishing regulations more economical, it would be worthwhile to harvest them during the shoreward migration phase by selective gears without causing recruitment or growth overfishing, rather than to resort to a more costly fishing in the deep. However, the resource could be judiciously harvested from the fishing grounds beyond 30 m depth by High Speed Demersal Trawl (HSDT) or midwater trawl net along the regions where shoreward migration are scanty or infrequent.

Current production of about 36,000 t from the northern region (NW and NE) could be further improved by responsible fishing by non-selective gears (Hooks & line, gill nets) and by midwater trawling in 30 - 100 m, for a sustainable yield, from the potential available in this part (more than 80% of the current total catfish potential from the Indian EEZ). It is generally agreed that unbridled open access to any easily vulnerable resource is the major obstacle to sustainable and responsible fisheries management (Gordon, 1954). Therefore it is imperative that the entry should be restricted through input controls or output controls, of course through persuasive societal participation, to achieve the MSY.

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