Management Plans for the Marine Fisheries of

Tamil Nadu

Indian Council of Agricultural Research
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Foreword

From time immemorial, marine fishing has been an important or sole occupation for the coastal communities in India. Starting from a subsistence level, the marine fisheries have evolved into a significant commercial enterprise contributing to food and nutritional security, employment generation, and foreign exchange earnings. With a view to increase the marine fish production, the fisheries sector has undergone tremendous changes with respect to the craft and gear, pattern of fishing and fishing ground. The growing demand for fish and fishery product results in continuous increase in exploitation and thereby exerting high pressure on the resources leading to their over exploitation and depletion. This warrants a continuous monitoring of the fishery and necessary interventions to protect the fishery from undesirable consequences. Thus the main aim of a fishery policy is to keep the exploitation at sustainable level for the benefit of fisher livelihoods, food security and economic gain besides conservation of biodiversity. However, the multi-species and multi-gear fisheries present several problems to management.

Marine fisheries in Tamil Nadu have undergone tremendous change in terms of fishing pattern, fishing method, extension of fishing grounds, composition of fish catch and consequent increase in the total fish catch in recent years. In 2016, Tamil Nadu ranked second among the maritime states in India in the marine fish production. The increase in production has both negative and positive impacts. This will be visible after a detailed study of the status of past and present fishery. The policy brief of Tamil Nadu marine fisheries is the result of various aspects of the fishery including the catch, effort, biology, stock assessment, economics of operation etc. The present document brings out management options that would aid decision makers to implement effective management measures to keep the fishery at sustainable level.

Dr. A. Gopalakrishnan
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Executive summary

Marine fisheries are dynamic and always prone to change in tune with the changing demands, challenges, advancement of technologies etc, as is evident in modification of fishing crafts and fishing gear, extension of fishing ground, emergence of new resources, collapse and disappearance of certain resources and new forms of market demands. The overall results of such changes have both positive and negative impacts on the fishery and this necessitates continuous monitoring and interventions to ensure sustainability of the fishery as well as conservation of the resources. This policy guidance gives an overall picture of the present status of marine fisheries of Tamil Nadu, various changes in the crafts, gears, trends in landing of major resources over the years, their distributional range, status of stocks, social structure of the fishing community, economics of the fishing operations, main drivers for fishing and the need for improved management of the exploited stocks for overall sustained growth of the marine capture fisheries sector of Tamil Nadu. The recommendations given in the document are based on scientific studies and analysis carried out by the scientists associated with the Tamil Nadu Fishery Management Plans project, interactions with various stakeholders during official meetings as well as personal meetings at different landing centres.

Important observations and recommendations emerged from the study are:

- There exists over capacity in the fishery. In order to keep the effort at sustainable level, the maximum number of mechanized trawlers may be limited to 1698 (79.4% of the existing) in Coromandel Coast (CC), 685 (75.4% of the existing) in Gulf of Mannar (GM) and 610 (23% of the exiting) in Palk Bay (PB). The trawlers in PB are for operating within the Indian side of PB. The Mechanized hook and liners and mechanized gillnetters may be limited to 226 and 153 respectively in GM. The number of outboard motor operated gillnetters (OBGN) may be reduced to 5996 and 8880 in GM and CC respectively. Mechanized ring seine (MRS) in CC may be restricted to 88.
- The engine power of the boat is found to be above requirement which may be regulated depending on the mode of fishing. Only those vessels which conform to the specifications of the government may be registered and permitted for fishing.
- There is urgent need to control the indiscriminate harvest of juveniles and uncontrolled exploitation of non-edible resources. Introducing square mesh of 35 mm mesh size instead of the existing diamond mesh in the cod end

of trawlers will be effective as proven in other places. Minimum legal size for the commercially important resources implemented in Karnataka and Kerala to be strictly enforced along Tamil Nadu. Suitable monetary fine to the merchants who purchase the juveniles may also be introduced. A local agreement by the boat owners not to bring the non-edible by-catch to the harbour is very effective.

- It is clear that ring seine is mainly targeting oil sardine and no other traditional gear targets oil sardine though this resource form part of the catch in some other gears. However, the present study indicates that the number of mechanized ring seine available at present is 117% more than the maximum sustainable fleet size (MSFS). Complete banning of the operations of ring seine is not a practical option; instead the number can be limited to the optimal level for harvesting oil sardine at sustainable level.
- In PB, the excess trawlers as found out from the present study need to be phased out completely. The initial phasing out should be targeted to those who are willing to opt out from fishing and secondly to the boats from areas which are constrained to or are likely to do cross border fishing mainly because of their proximity to the International Maritime Boundary Line (IMBL) and other positional disadvantages. The government should also ensure that the boats thus phased out are not used in PB for the same purpose by a third party. The trawlers from Rameswaram have to be completely phased out. The remaining trawlers may be allowed to trawl in the traditional ground found within our waters in PB, GM or Bay of Bengal limiting their number within MSFS.
- There is scope for further increasing the traditional gillnetters by 29% more than the existing vessels in PB. The government should encourage the adoption of traditional fishing methods. For this, besides the willing mechanized boat owners, the government can introduce a scheme to provide traditional craft and gears to fishermen of mechanized trawlers on subsidy as an alternate source of employment and income generation.
- Before venturing into deep sea fishing as part of diversification and as analternate for trawlers in PB, deep sea fishing to catch tunas is advocated after assessing the area available for fishing, number of units required, the man power requirements, their training besides proper and sustained market avenues which will fetch a decent price to the catches. This is inevitable since the fishermen practicing other modes of fishing cannot immediately switch over to deep sea fishing. Moreover, proper landing centres have to be made available in GM and Bay of Bengal for smooth operation of these boats.
- At present, fishing for oceanic tunas using longline is in its nascent stage and limited boats are engaged in it. In order to popularize this method, there is a need to show the viability of this fishing operation among the fishermen and proper training has to be imparted. Moreover some incentives should be given to those who really initiate this fishing method. A good market avenue is to be arranged prior to the introduction of this fishing method.

- In order to control the exploitation of juvenile fishes by trawlers, the cod end mesh size of trawl gear may be fixed at 35 mm square mesh in Tamil Nadu similar to the recommendations by the committee to evaluate fish wealth and impact of trawl ban along Kerala coast.
- The token system existing in PB and GM is an excellent system which can be extended to CC as well. Similarly the same system can be implemented for traditional gears also. This would enable accounting of the actual number of units going for fishing from each centre and help to find the fate of vessels in case of natural calamities.
- Participatory mode of fisheries management will be more effective. So the government under the fisheries department should form village level, district level and state level management councils involving the fishermen/fishermen leaders in addition to other stake holders such as representatives from fishing industry, merchants, NGOs and scientists from research institutes for the effective implementation and management.

Introduction

From time immemorial, marine fishing has been the single important occupation for the coastal communities in India. Starting from a subsistence level, it has evolved into a significant commercial enterprise contributing to food and nutritional security, employment generation and foreign exchange earnings. It is well known that marine fisheries is dynamic and is prone to changes in tune with the changing demands, challenges, advancement of technologies etc as is evident in modification of fishing crafts and gears, extension of fishing ground, emergence of new resources, collapse and disappearance of certain resources and changes in market demands. The overall results of such changes have both positive and negative impacts on the fishery and this necessitates continuous monitoring and interventions to ensure the sustainability of the fishery as well as conservation of the resources. The type of intervention is decided through appropriate policies. Tamil Nadu is one of the important coastal states on the east coast of India with a coast line of 1076 km extending partly to west coast and has 41412 km^2 continental shelf areas, 1.9 lakh km^2 exclusive economic zone and 19000 km^2 of territorial waters. The width of the continental shelf varies from 40 to 60 km, the average being 43 km. There are 13 coastal districts. Present salient features of Tamil Nadu marine fisheries are given in table -1.

Table 1. Salient features of Tamil Nadu marine fisheries

No. of coastal districts	13
No. of fishing villages	608
Marine fisher folk population	10.07 lakh
Fishing craft registered as on 20.5.2018(on line) Mechanized fishing boats	5893
Traditional crafts(motorized & Non-motorized)	38,779(32,879+5900)
Major harbours	6
	Chennai, Thoothukudi, Nagapattinam, Chinnamuttom, Colachel, Muttom(PPP)
Major habours under construction	3
	Thengapattinam, Pompuhar, Mookaiyur
Medium fishing harbours	3
	Pazhayar, Mallipatnam, Cuddalore
Fish landing jetties	36

Source: Tamil Nadu State Fisheries Policy Note 2017-18.

Considering the characteristics of the regions, it can be broadly classified into three ecosystems mainly as Coromandel Coast (CC), Palk Bay (PB), and Gulf of Mannar (GM). The fishing ground, fishing pattern and fishing days are unique in each region.

The comparison of important demographic status in Tamil Nadu over the years is given in table 2. It shows an increase of nearly 38% in fishing villages during 2005 when compared to those in 1980. However this showed a decrease of 27% in 2010 when compared to those in 2005. This decrease may be partly due to destruction of certain areas due to sea erosion. There was an increase of landing centres from 352 to 407 in 2010. The number of fisher families showed a remarkable increase of 154% in 2005 over those in 1980. However there was only slight increase (0.3%) from 2005 to 2010. The fisher population also showed an increase of 99.5% in 2005 when compared to those in 1980 whereas the increase was only around 1.6% from 2005 to 2010. The active fishermen population also showed an increase of 107% over those in 1980 whereas the increase in 2010 was only 7% when compared to those in 2005. Nevertheless, the percentage of active fishermen to the total fisher population remained almost same being 24.4, 25.3 and 26.7 respectively during 1980, 2005 and 2010. The average family size was 5.2 in 1980 but it remained 4.1 during 2005 and 2010. The percentage of literacy was 19 in 1980 which increase to 67% in 2005. But in 2010, it was reduced to 63%.

Table 2. Comparison of important demographic status in Tamil Nadu over the years

Year	1980	2005	2010
Fishing villages	422	581	573
Landing centers	352	352	407
Fisher families	75721	192152	192697
Fisher population	396000	790000	802912
Active fishermen	96500	200000	214064
Average family size	5.2	4.1	4.1
Average literacy rate (%)	19.15	66.8	63
Active fishermen (%)	24.37	25.3	26.7

Source: Census by CMFRI in 1980, 2005& 2010.

The Coromandel Coast (CC) of Tamil Nadu which is surf beaten, extends from Pulicat to Point Calimere with a total length of 357. The CC is inclusive of Thiruvallur, Chennai, Kanchiuram, Villupuram, Cuddalore and Nagapattinam districts. Palk Bay (PB) extends from Point Calimere to Dhanushkodi with a length of 294 km. It is relatively shallow and is characterized by calm waters. The near shore water is characterized by luxuriant growth of sea grasses up to about 4 m depth. The bottom of the ground is generally muddy. The maximum depth is 16 m. Tiruvarur, Thanjavur, Pudukkottai and Ramanathuram come under this. Gulf of Mannar (GM) extends from Dhanushkodi to

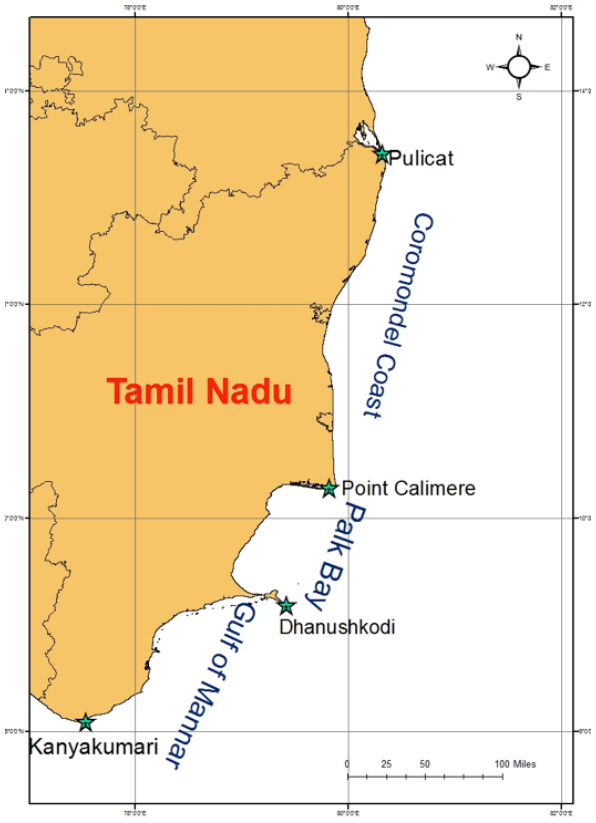
Kanyakumari totalling 365 km. It is relatively deep and is rich in biodiversity. Part of Ramanathapuram district; Tuticorin, Tirunelveli and Kanyakumari are included. SW coast extending from Kanyakumari to Nagercoil covering a distance of 60 km is also put under GM considering the fact that Chinnamuttom which is a major harbour in Kanyakumari is in GM. Moreover many of the vessels from west coast of Kanyakumari do come and fish from or near GM. In CC and in GM, the continental gradient is high and in PB, it is low where the depth does not exceed 16 m.

The craft and gears existing in the fishery in CC are mechanized trawlers engaged in single day and multiday fishing, multiday drift gillnetters targeting oceanic tunas and other large pelagics, traditional pelagic and bottom set gillnets operated from motorized boats targeting small and medium sized pelagic and demersal fin fishes, crabs and cephalopods, motorized bag nets targeting small and medium fishes mainly pelagic fishes, ring seines operated from mechanized boats, hooks of various sizes operated as troll and long lines from motorized boats and indigenous trawls operated from motorized boats. Mechanized multiday day trawlers' voyage vary from 4 to 15 days and that of drift gillnetters targeting oceanic tunas and other large pelagics vary from 6 to 20 days. There is no weekly breaks and the fishing is suspended during the 60 day state-wide mechanized fishing ban during April-June besides voluntary suspension of fishing during October-December by the multiday drift gillnetters and mechanized ring seiners on account of inclement weather.

In GM, the mechanized trawlers operating from Tuticorin and Chinnamuttom are permitted to undertake one day trawling through a token system. The boats are to leave by 5 A. M and return by 9 P. M. This is implemented to avoid clash between traditional fishermen and mechanized trawlers. However, the trawlers operating from Colachel are allowed to undertake multiday voyage. Moreover each village has a landing centre and the boats belonging to people of that village are permitted to base their boat there and mostly they will have their own traditional rules and regulation for the operation of the type of crafts and gears and their disposal. The other craft and gears are: mechanized drift gillnetters engaged in multiday voyages targeting oceanic tunas and other large pelagic resources, gillnets of different mesh sizes operated from out board motor fitted fibre glass boats targeting small and medium pelagic and demersal fin fish and shell fish resources, hooks of various sizes targeting demersal and pelagic resources besides cephalopods, ring seines operated from outboard motor operated fiberglass boats, indigenous trawls operated from country crafts, shore seines etc. Unlike other areas, here Sunday is invariably a fishing holiday. In some centres, Saturday is also included in the weekly holiday

In PB, the crafts and gears are mechanized trawlers, indigenous trawlers operated from motorized boats, gillnets of various mesh sizes targeting pelagic and demersal fin fishes and also shell fishes besides outboard motor operated

ring seines. Here, in order to avoid clash between mechanized and traditional fishermen, mechanized trawlers are permitted to fish for three days in a week and rest of the days are allotted to the traditional fishermen. Moreover, on fishing days, the mechanized trawlers are permitted to go for fishing only after getting tokens from the fisheries department. So fishing of mechanized trawlers is restricted to 24 hours trip. Generally the vessels go in the morning of allotted day and return next day morning.



Studies on the diversity of fished taxa (Table 3) showed that maximum diversity was in CC followed by GM and PB (Sathianandan *et al*, 2011).

Table 3 Taxonomic details in the fished taxa in the three marine systems along Tamil Nadu coast.

System	Phylum	Class	Order	Family	Genus	Species
Coromandel	3	8	46	163	338	750
Palk Bay	3	8	40	127	245	462
Gulf of Mannar	3	7	48	154	321	657

Chapter 1

Developments in marine fishing practices over the years

In marine fisheries sector, we can see progressive changes in craft and gear in tune with various demands; these changes may be in the size of the boat, engine capacity, provision of additional equipment to ease the fishing operations, replacement of existing gear with more efficient gear or addition of new gears. The developments can in general be categorized into those in a. Craft and gears b. Infrastructure development c. Governance and d. Welfare measures

Period	Important developments in Tami Nadu Marine Fisheries
Craft and gear	
Till 1950s	The development of craft and gear was not uniform throughout Tamil Nadu. Sometimes a development took place in a district which reached other districts after a reasonable gap even in the same coast. The fishing was carried out fully by indigenous craft and gears throughout the coast. Nets were made of cotton and hemp. Hand lining also prevalent.
1960-1980	Replacement of net materials: The cotton and hemp were replaced with nylon and HDPs. Motorization of country craft: Motorization of Catamarans started during 1966 in Kanyakumari. By 1979, there was wide spread introduction of mechanized country craft in this region. Motorization of traditional craft started in Tuticorin in 1986. The indigenous trawl locally known as '*thallumadi*' introduced during 1970s. Introduction of three walled gillnet, trammel net in 1980s for targeting prawns and fishes. Mechanized boats for gillnetting were commissioned by the government in 1960. The operation was within coastal areas. One day fishing targeting neritic tunas and seer fishes. Gillnetting from motorized and mechanized boats was single day operation. The total length of a gillnet unit was around 160 m and its breadth around 4 m during 1980s. The catch was comprised by neritic tunas, seerfish etc.

	Start of India's first indigenous deep sea fleet which targets sharks all over the south west coast using mechanized hook and line by fishermen from Thoothur (Kanyakumari) in 1987. **Stern trawling:** Commercial trawling became more common during 1970s targeting prawns. Singe day fishing limited to day time. Size of the boat varied from 7.5-9.0 m OAL. Length of the net was 30 to 35 m. The catch was comprised of prawns and demersal finfishes. High opening bottom trawling:
	High opening bottom trawling method for demersal fish and prawns was introduced by Bay of Bengal Programme (BoBP) in 1982 in Palk Bay and Gulf of Mannar. **Multiday trawling:** It started during 1980s itself in Chennai by vessels of 10 to 14 m OAL with engines of up to 120 hp, initially 2- 3 days per trip for prawns. **Pair trawling:** Bay of Bengal Programme (BOBP) introduced two-boat high opening bottom trawl for pair trawling. Palk Bay with Mandapam, Rameswaram and Pamban as bases was chosen for experimental fishing in 1980-1981. By 1982, commercial scale operation started. Size of the boat was 9.14 to 9.75 m OAL with engines of 45-70 hp. The nets had a length of 51 m with cod end mesh size of 25 mm. Target of trawling for shrimp shift to fishes, especially untapped resources like sardine, pomfrets etc. Hand jigging for cephalopods gained momentum during 1980s in Kanyakumari
1990-2000	By 1992, all plank-built traditional boats were motorized in Gulf of Mannar. In Coromandel Coast, catamarans fitted with outboard motors were tried in 1991. B y 1992, it became more common. Introduction of fibre reinforced plastic (FRP) boats with outboard engines in 1990s. Duration of multiday trawling increased to 7 days per trip during 1995-98 in Chennai. It spreads to other parts of Coromandel Coast and Kanyakumari during late 1990s. Size of boats increased to 13-15 m with engines of 120 hp. Area of operation also extended. In places other than Chennai, in Gulf of Mannar and in Palk Bay, the size of boat increased to more than 20 m with engine power more than 200. Size of trawl more than 60 m. The boats were provided with GPS, VHF and echosounder. Trawling covers more water column instead of bottom or near bottom areas resulting in increase in the magnitude and diversity of catch. Hand jigging for cephalopods initiated in Tuticorin during early 1990s

2000-2004	Ring seines operated from out board motor operated FRP boats prevalent in certain areas of Gulf of Mannar, Palk Bay and Coromandel coast. Size of ring seine is 250 to 400 m. Targeted fishing for oil sardine results in increase in its landing. Thoothoor shark fleet start yellowfin tuna fishing with support from export companies. Conversion of trawlers into drift gillnetters for tuna and other large pelagic fishing in Tuticorin. Multiday drift gillnetting of 2 to 3 days per trip in Chennai started. Size of net was of 1 Nm (nautical mile) only. Catch was dominated by oceanic tunas. Multi-day trawling expands to all the Coromandel Coast. Size of boat and size of trawl net increased. Pair trawling activity prevalent in Palk Bay and in certain area of Coromandel coast. Size of boat more than 20 m and net size also increased 80 m. Deep sea trawling beyond 100 m for prawns started in 2004 at Chennai.
After 2004	Drastic reduction in the number of catamarans. The size of trawlers increased to more than 24 m. The engine power also enhanced to more than 400 hp. Now in places like Tuticorin, Chinnamuttom, Cuddalore, Nagapattinam etc, the engine power is around 600hp. The size of trawl net increased along with the increase in engine power and now the gear is more than 90 m. Pelagic resources form substantial contribution in trawl catch. The size of gillnet targeting oceanic tunas increased to more than 5 Nm. The fish hold capacity increased to 20 t. The duration of fishing trip also increased to 20 days. Hydraulic winch installed in the deep sea drift gillnetters in 2012. This considerably reduced the hauling time of net. In Tuticorin also, the size of fishhold capacity increased to 20 t and the net size also increased to more than 5 Nm since 2016. Mechanized ringseiners start operation in Cuddalore and Nagapattinam since 2009. The size of the boat is more than 25 m with inboard engines of >500 hp. The size of the net is also increased to 1000 m. It is provided with GPS, echosounder. Carrier boats to transfer the catch from the ringseiners to the harbour, jetties. Substantial improvement in oil sardine landing. Multiday ring seine fishing of 3 to 4 days per trip for oceanic tunas started in 2017 at Cuddalore. The craft remain unchanged but a new gear with mesh size of 110 mm with a size of 2000 to 2100 m fabricated for this. The fishing is far away from the territorial waters.

Infrastructure development

Since 1960s the government with the support of central government started construction of jetties and fishing harbors at important marine fish landing centers along with opening of mechanical workshop, dry dock facility, fuel stations, ice plants, processing plants, cod storage, road connectivity etc. Construction of new harbours, jetties and expansion of existing harbours are being continued. The first harbour in Muttom, Kanyakumari under BOOT (Build, Own, Operate and Transfer) mode became functional in 2015.

Governance

1970s

Conflicts arose between the traditional fishermen and mechanized trawlers along Pudukotai-Thanjavur area in Palk Bay.

A regulated fishing with 3 days night fishing in a week for mechanized trawlers and the rest 4 days for traditional gears was implemented in 1978 along Pudukottai and Thanjavur districts to avoid clashes between fishermen of mechanized trawlers and traditional gears. The boats were given token before departure on the allotted days.

The Tamilnadu fisheries development corporation limited (TNFDC) was established in 1974 as a state owned undertaking through which sale of fuel to the fishing crafts and sale of outboard motors and inboard motors to the fishermen are done.

In 1974, Sri Lanka settled the maritime boundary issue with India in historic waters by concluding an agreement, known as, the Agreement between India

and Sri Lanka on the Boundary in Historic Waters in Palk Bay between the two countries and related Matters.

During 1976, the India and Srilanka concluded another agreement on themaritime boundary between the two Countries in the Gulf of Mannar and the Bay of Bengal and related matters–for the purpose of extending the maritime boundary line to cover the Gulf of Mannar and the Bay of Bengal.

1980s

The Tamil Nadu Marine Fisheries Regulation Act (TMFRA) was adopted in 1983.

This is an act to provide regulation, restriction and prohibition for fishing by fishing vessels in the sea along the whole or part of the coast line of the state.

Registration of all fishing vessels and license for fishing.

Mechanized fishing vessel to fish beyond 3 Nm from the coast in the territorial waters.

Mechanized fishing vessel shall leave for fishing only after 5 a.m and shall report back not later than 9 p.m.

Mechanized fishing vessel: vessel not less than 8 m OAL and not more than 15 m OAL with engines of not less than 15 hp and not more than 120 hp.
Deep sea fishing vessel: vessel not less than 15 m OAL with engines of not less than 120 hp.

Regulated fishing in PB and GM: In order to resolve the conflict between mechanized vessels and traditional boats, a three-four day rule was implemented in the PB and GM region of Ramanathapuram district in 1993. It allows mechanized vessels to fish for three days a week and the remaining four days by the traditional gears just as the 1978 agreement in Pudukottai-Thanjavur region

2000s

The Tamil Nadu Marine Fisheries Regulation (Amendment) Act, 2000.

Under this, no fishing vessel shall be registered unless such vessels carry buoy, first aid box, equipment for communication and such life-saving and fire fighting appliances as may be prescribed.

Ban of gears: Operation of pair trawl and purse seine was banned from 2000 onwards.

Mechanized fishing ban: Uniform fishing ban for 45 days from April 15-May 31 along the east coast and from June 15-July 31 along the west coast was implemented from 2001 but it was extended to 60 days from 2017.

The Tamil Nadu Marine Fisheries Regulation (Amendment) Act, 2011. The definition for mechanized and deep sea vessel amended.

Mechanized fishing vessel: vessel not less than 10 m OAL and not more than 24 m OAL with engines of not less than 20 hp and not more than 150 hp.

Deep sea fishing vessel: vessel not less than 24 m OAL with engines of more than 150 hp

The Tamil Nadu Marine Fisheries Regulation (Amendment) Act, 2016. Under this, the following main amendments were made in respect of craft and gears:

Mechanized fishing vessel:

Vessel not less than 10 m OAL and not more than 24 m OAL with engines of not less than 28 hp and not more than 240 hp.

Deep sea fishing vessel: vessel not less than 24 m OAL with engines of not less than 240 hp.

Motorized country craft: A wooden or fibreglass reinforced plastic (FRP) catamaran, vallam or canoe of not more than 12 m OAL fitted with OBM or IBE having an engine capacity of less than 28 hp.

Mechanized fishing vessels to fish beyond 5 Nm from the coast in the territorial waters.

Motorized country craft having motorized means of propulsion either from single engine or multiple engines having capacity of 8 hp and above shall not fish within 3 Nm from the coast in the territorial waters.

Providing 50% subsidy to the fishermen for procurement of tuna longliner cum drift gillnetter. To diversify the fishing operation from inshore fishery to the under exploited offshore fishery, government introduced a scheme for providing 25% subsidy for conversion of mechanized fishing boats and replacement /upgradation of motorized fishing crafts into tuna long liners in 2010-2011 and this was increased to 50% in 2012. In 2013-14, the maximum subsidy amount was fixed at ₹30 lakh based on the estimation of the unit cost as ₹60 lakh.

To mitigate the conflict in the Palk Bay, 60% of the subsidy was earmarked for Palk Bay districts.

Issue of biometric card to the fishermen after Mumbai attack in 2008.

On line registration of boats

Installation of artificial reef in the inshore waters for stock enhancement in 2007-2008.

Sea ranching of resources especially prawns to counter the depletion of stocks as a result of over exploitation.

Welfare schemes

The government on its own and with the support of central government carries out various schemes to uplift or fortify the life and livelihood.

Motorization of traditional craft by giving subsidy to traditional fishermen for the purchase inboard and outboard engines.

Reimbursement of 100% central excise on high speed diesel from 1991-92.

The Tamil Nadu government give 100% sales tax exempted diesel to the mechanized and traditional boat owners from 2004 onwards.

Subsidized and sale tax exempted industrial kerosene to the traditional fishermen of Kanyakumari, Tirunelveli and Tuticorin.

Financial assistance to the marine fishermen families during lean fishing season started since 2011.

Financial assistance to the marine fishermen families during the fishing ban period since 2001.

National Fishermen Savings -cum- Relief Scheme, National Savings -cum- Relief Scheme for marine fisherwomen since 2006-07 and group accident insurance scheme.

Free housing scheme for fishermen is being implemented since 1994.

Other relief schemes such as relief assistance to the released Tamil Nadu fishermen who were languished in Iranian jail, daily relief to the marine fishermen apprehended in other countries, daily relief to the families of missing fishermen, relief to the families of deceased/injured fishermen due to shooting by Sri Lankan Navy and others.

Source: (Pillai&Sathiadhas, 1982; Balakrishnan and Alagaraja,1984; BoBP, 1987; Marichamy et al., 1992; Rao and Pillai,1992; Sambennet and Arumugham,1993; Maheswaradu et al., 1994; Thirumulu et al.,1994; Jayasankar, 1995; Vivekanandan and Meiyyappan, 1999; Pillai et al.,2000; Bavinck and Karunaharan,2006; FIMSUL,2011; Mohanraj et al.,2012; Surya et al, 2016. Shajeeva, 2016; Tamil Nadu Fisheries Policy notes for different years, Discussion with the survey staff & our own observation and interaction with the stakeholders)

Table 4. Details of important craft, gears in each region and major resources landed by the gears.

Region	Craft	Gear	Resource targeted
CC	Mechanized boat	Trawl	Fish, prawn,crab,lobsters,cephalopods
	Mechanized boat	Trawl	Deepsea prawns
	Mechanized boat	Deep sea drift gillnet	Tuna, billfishes, Mobulid rays
	Motorized boat	Drift gillnet(large mesh)	Tuna, seerfish, barracuda, carangid, billfish
	Motorized boat	Drift gillnet(medium mesh)	Tuna, seerfish, barracuda, carangid, mackerel
	Motorized boat	Drift gillnet(small meshed)	Sardines
	Motorized boat	Bag net	Sardines, mackerel, carangids
	Motorized boat	Bottomset gillnet	Lutjanids,lethrinids,rays, crab, prawns, lobsters
	Motorized boat	Longline	Serrfish, barracudas, dolphinfish
	Mechanized boat	Hook and line	Groupers, Lethrinids, Lutjanids
	Motorized boat	Ring seine	sardines, carangids
	Mechanized boat	Ring seine	sardines, carangids,tunas
	Non-motorized boat	Shore-seine	Fishes, cephalopods
GM	Mechanized boat	Trawl	Fish, prawn,crab,lobsters,cephalopods
	Mechanized boat	Trawl	Deepsea prawns
	Motorized boat	Indigenous trawl	Prawns, cephaloods, fishes
	Mechanized boat	Deep sea drift gillnet	Tuna, billfishes, Mobulid rays
	Motorized boat	Drift gillnet(large mesh)	Tuna, seerfish, barracuda, Carangid, billfish
	Motorized boat	Drift gillnet(medium mesh)	Tuna, seerfish, barracuda, Carangid, mackerel
	Motorized boat	Drift gillnet(small meshed)	Sardines
	Motorized boat	Bottomset gillnet	Lutjanids,lethrinids,rays, crab, prawns, lobsters
	Motorized boat	Longline	Seerfish, barracudas, dolphinfish
	Mechanized boat	Hook and line	Groupers, lethrinids, lutjanids,cephalopod

	Motorized boat	Ring seine	sardines, carangids
	Motorized boat	Traps	Lobsters
	Non-motorized boat	Shore-seine	Fishes, cephalopods
PB	Mechanized boat	Trawl	Fish, prawn, crab, lobsters, cephalopods
	Motorized boat/ NM	Indigenous trawl	Prawns, cephalopods, fishes
	Motorized boat	Drift gillnet(large mesh)	Seerfish, barracuda, Carangid, billfish
	Motorized boat	Drift gillnet(medium mesh)	Tuna, seerfish, barracuda, Carangid, mackerel
	Motorized boat	Drift gillnet(small meshed)	Sardines
	Motorized boat	Bottomset gillnet	Lutjanids,lethrinids,rays, crab, prawns, lobsters
	Motorized boat	Ring seine	sardines, carangids
	Motorized boat	Traps	Fishes

Chapter 2

Trends in marine fish production

The total landing in TN remained above 6 lakh tonne since 2012.

The trend of production from the three regions (CC, GM and PB) is not always in consonance with the trend of overall production from TN.

When the landing in 2012 increased to 7.3 lakh t from 6.7 lakh t in 2011, the landing in CC only showed substantial increase whereas the landing in other two regions showed a decrease compared to previous year suggesting the need to study region wise production also.

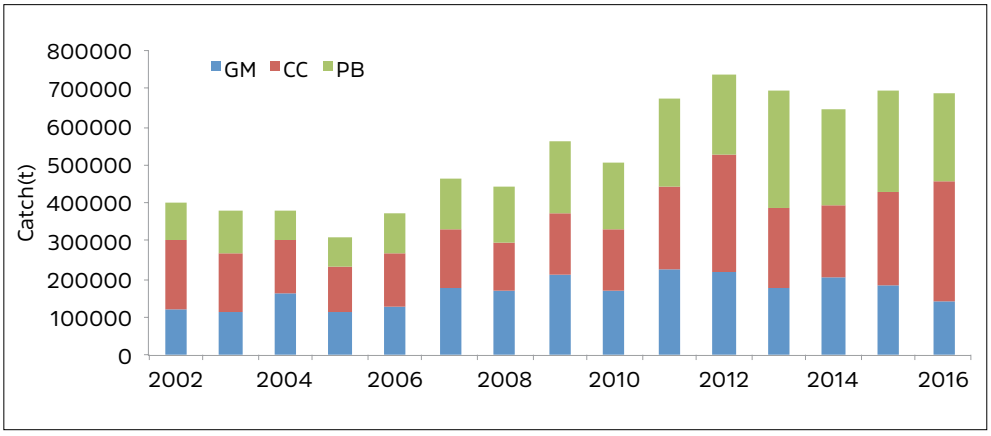


Fig.1. Total fish production and region-wise contribution

2.1 Percentage contribution of landings from the three regions to the total catch

- During 2002 and 2003, CC dominated, thereafter till 2009, GM dominated.
- But from 2013 to 2015, contribution of PB was highest and CC dominated next year.
- Increase in the landing of oil sardine played a major role in the increase of overall production

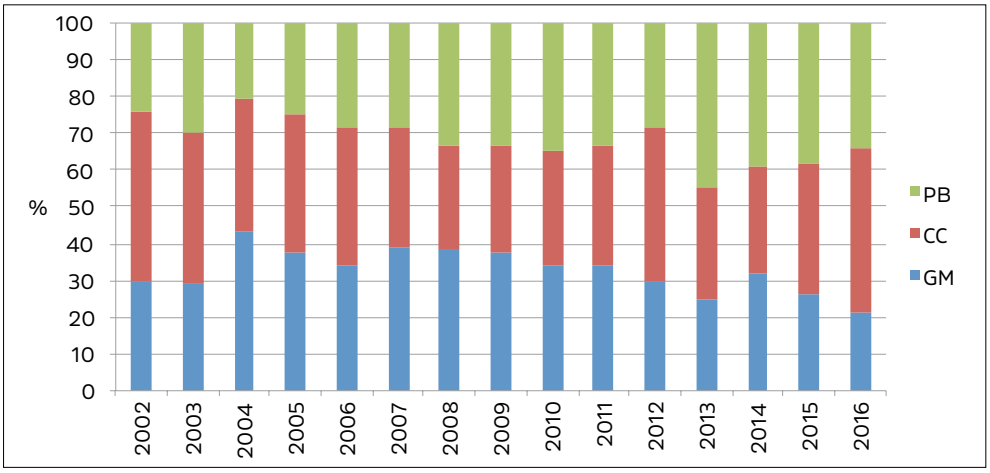


Fig. 2. Percentage contribution of landing from the three regions to the total catch.

2.2 Contribution of landings by different sectors

In TN, mechanized sector contributed more than 50% of the total landing.

- Mechanized trawlers remained as the main contributor in mechanized group.
- The percentage contribution by non-mechanized sector became almost negligible after 2007.

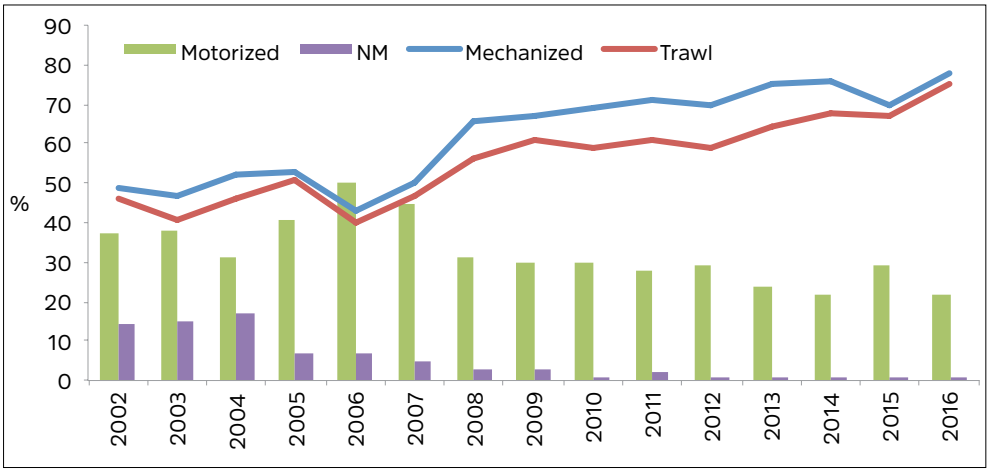


Fig.3 Percentage contribution of landing by different sectors

- In CC, motorized sector had pivotal role in the total production. From 2005 to 2007, it remained the major contributor relegating mechanized sector to the second position.

- But from 2008 onwards, mechanized sector remained as the main contributor with more than 60% of the total production.
- Non-mechanized sector became insignificant from 2007 onwards.

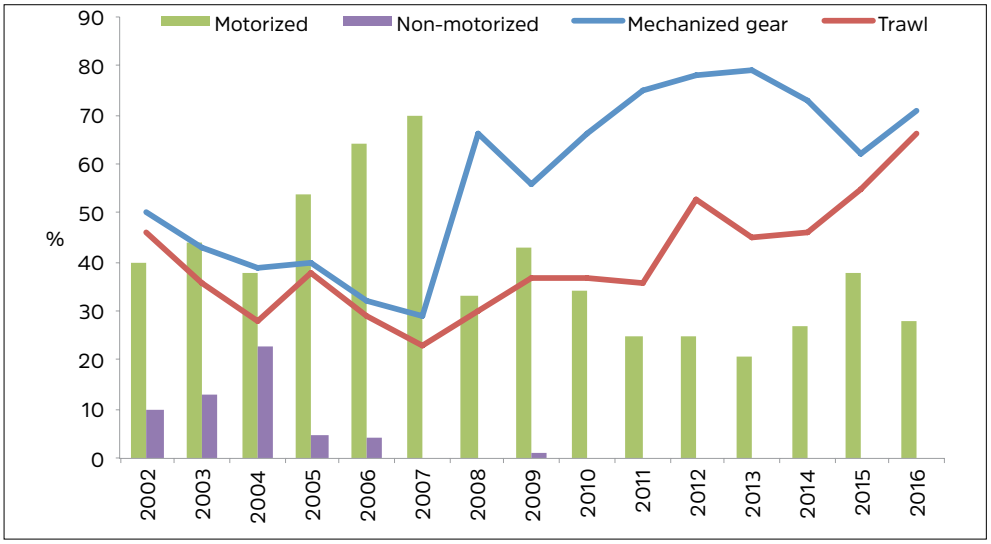


Fig.4 Percentage contribution of landing by different sectors in Coromandel Coast

In GM, the mechanized sector is almost fully contributed by mechanized trawl net which formed the dominant contributor after 2006.

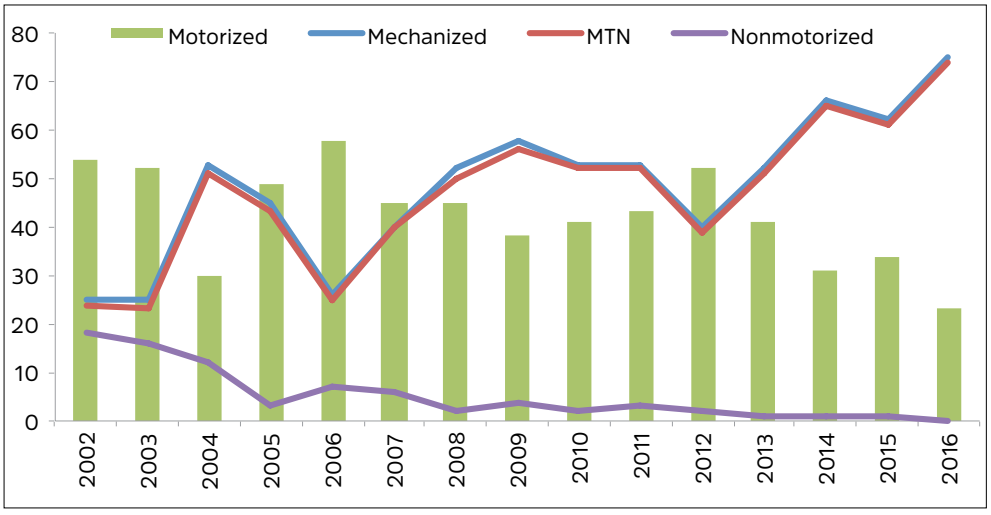


Fig.5 Percentage contribution of landing by different sectors in Gulf of Mannar

In PB, the mechanized sector comprised by mechanized trawl net contributed more than 70% of the total catch in all the years.

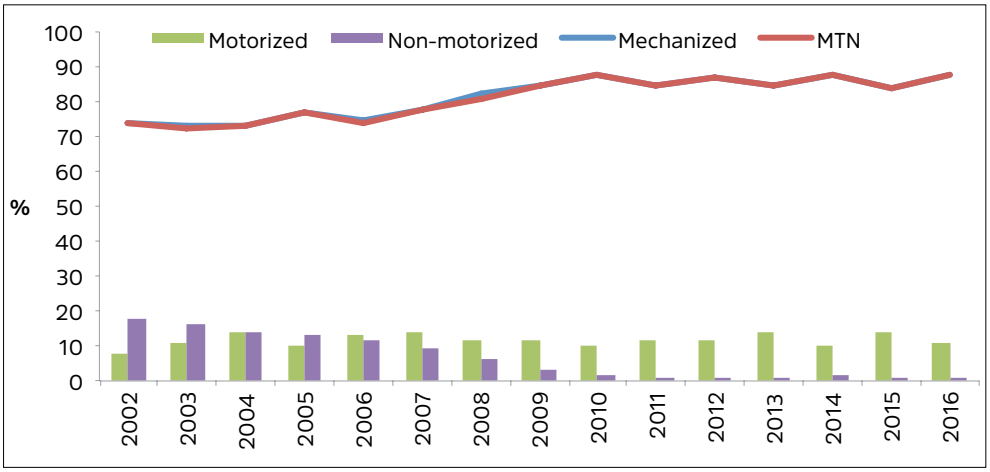
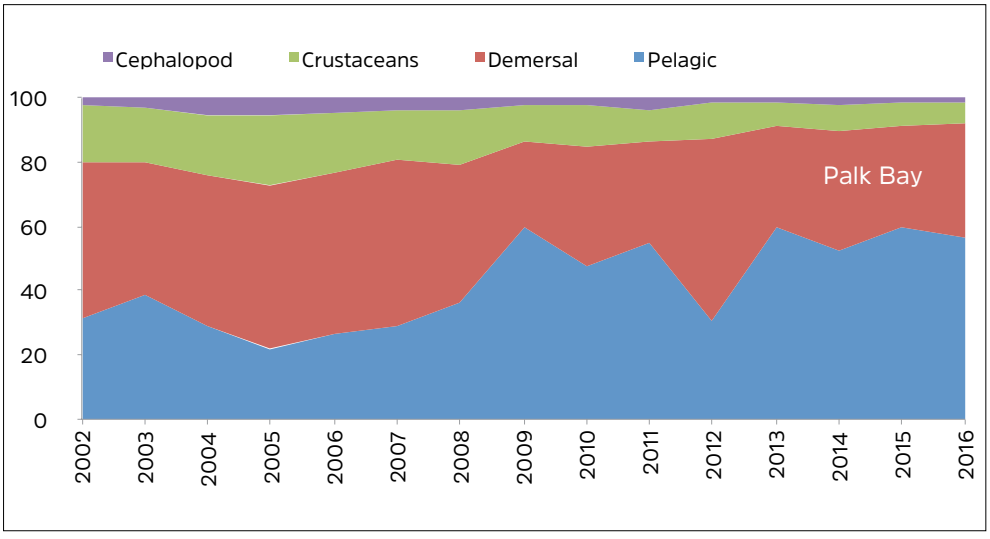


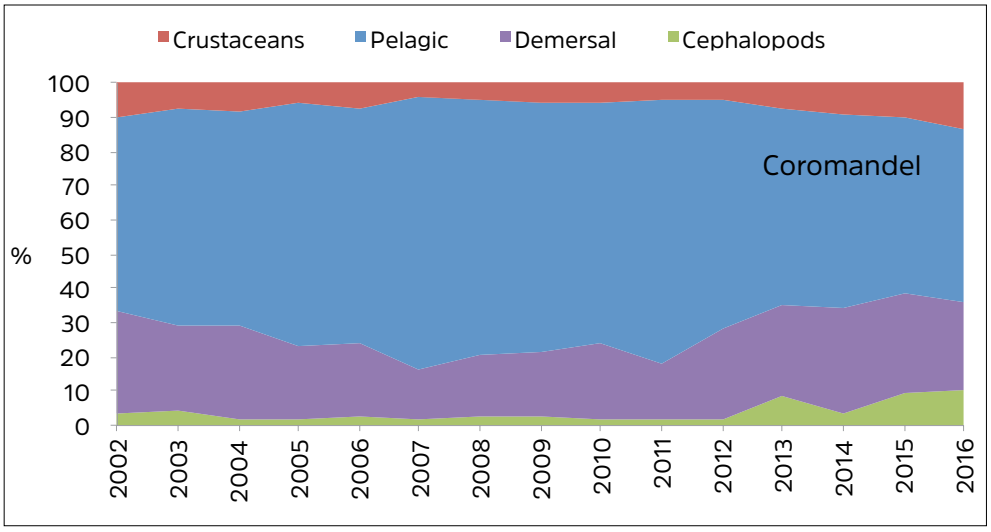
Fig.6 Percentage contribution of landing by different sectors in Palk Bay

2.3 Resource wise contribution (See the appendix 1 for different resources coming under pelagic, demersal, crustacean and cephalopod group)

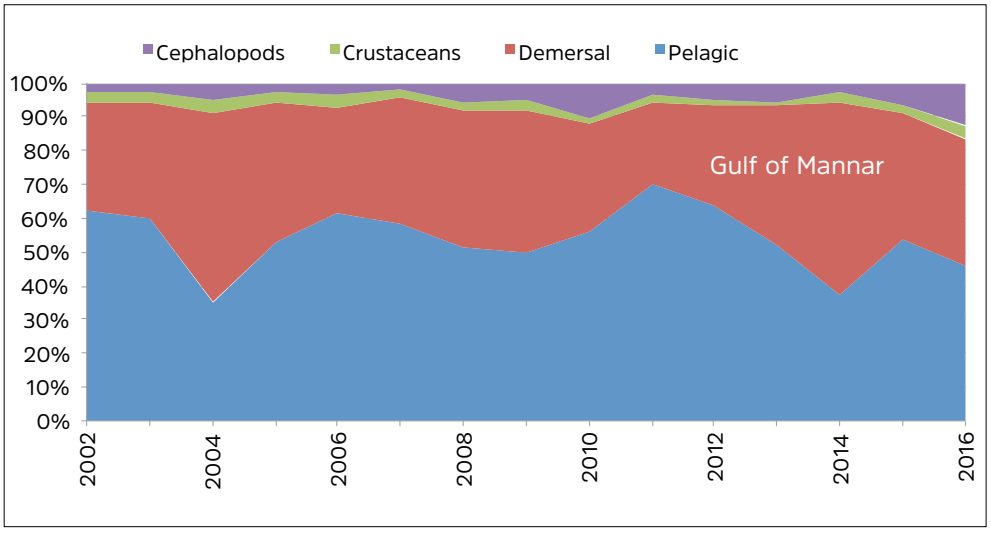
Initially in PB, demersal group dominated till 2008 but after that pelagic group showed clear domination except in 2012. Moreover, there was gradual decrease in percentage contribution of crustacean from 2010 onwards.



In CC, it was pelagic resources, domination in all the years. The percentage contribution of crustacean showed marked improvement from 2013.

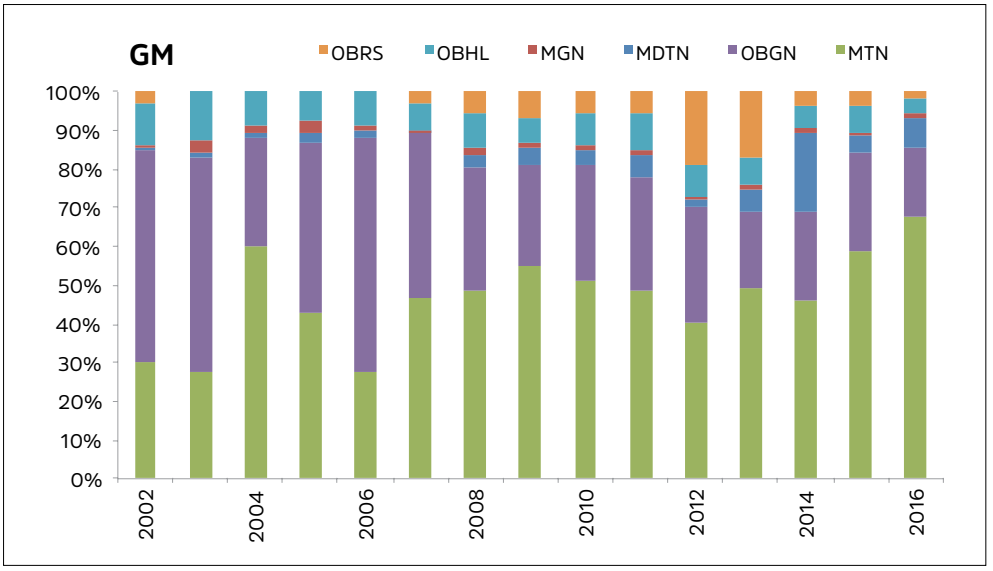


In GM, though the general trend was pelagic group domination, there was demersal domination in certain years.



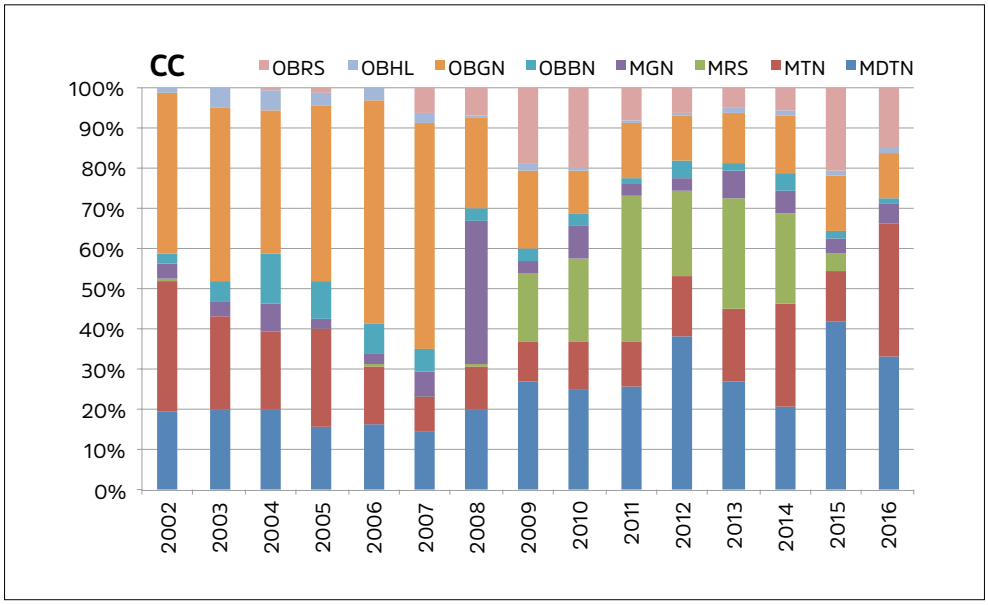
2.4 Percentage contribution by different gears to the landing

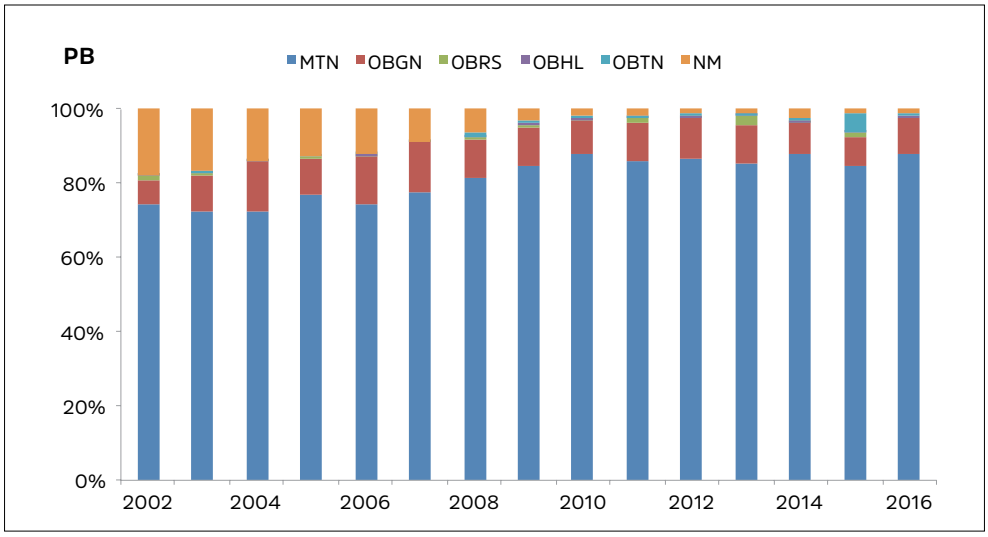
The percentage contribution by different gears in GM showed domination of OBGN (outboard motor operated gillnetter) till 2006. But after that, the contribution by MTN (mechanized single day trawlers) showed continuous increased contribution in the subsequent years. Along with this, there was the contribution of OBRS (outboard motor operated ringseiner) from 2007 onwards. From an initial 2.3%, it increased to 15.7% during 2013. Another significant contributor is OBHL (outboard motor operated hook and liner) and its contribution varied from 5.3% in 2012 to 9.7 in 2003. On an average, MTN contributed 42%, OBGN 31%, OBHL 7.4% and OBRS 6.8%. The other major contributors were NM (non-mechanized gears) 5.9%, MDTN (Mechanized multiday trawlers) 3.9%, MGN (Mechanized gillnetter) 1.2% and MHL (mechanized hook and liner) 1.1%.



Percentage contribution by different gears in CC showed a clear domination of OBGN in contribution till 2007 but afterwards multiday trawlers (MDTN) became the highest contributor. The average contribution by MDTN, MTN and OBGN was 21, 16 and 26 respectively. They together on average accounted 63% of the total catch. But from 2007onwards, ring seine became vogue. Both OBRS and MRS (mechanized ring seiners) contributed on an average of 6%. From 2012 to 2014, MRS contribution was higher and varied from 13 to 27%.

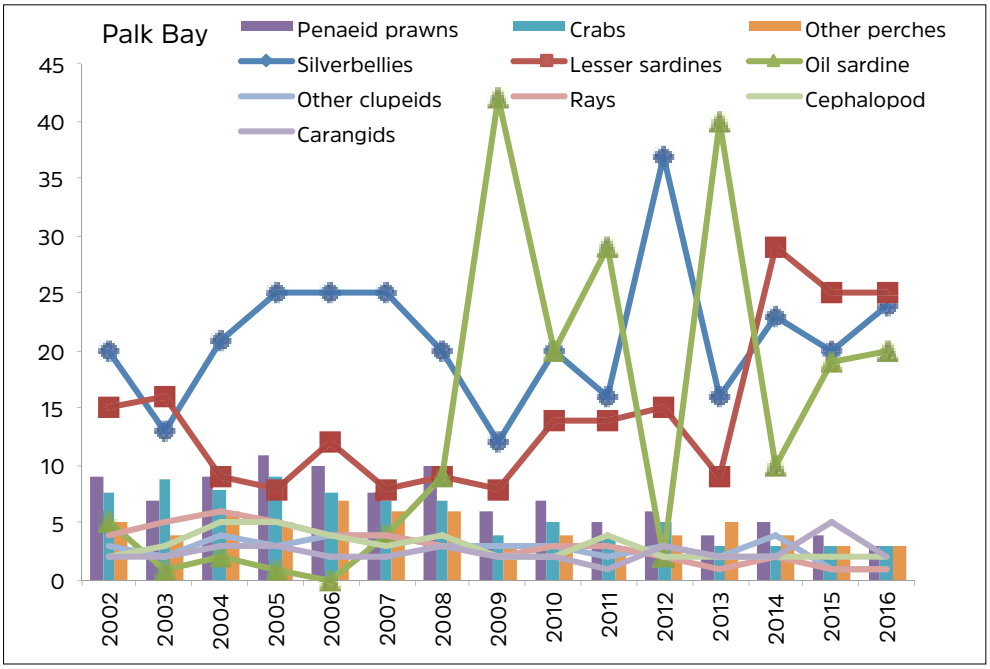
In PB, the mechanized trawl net was the most important gear throughout the period contributing more than 80% of the total landing.

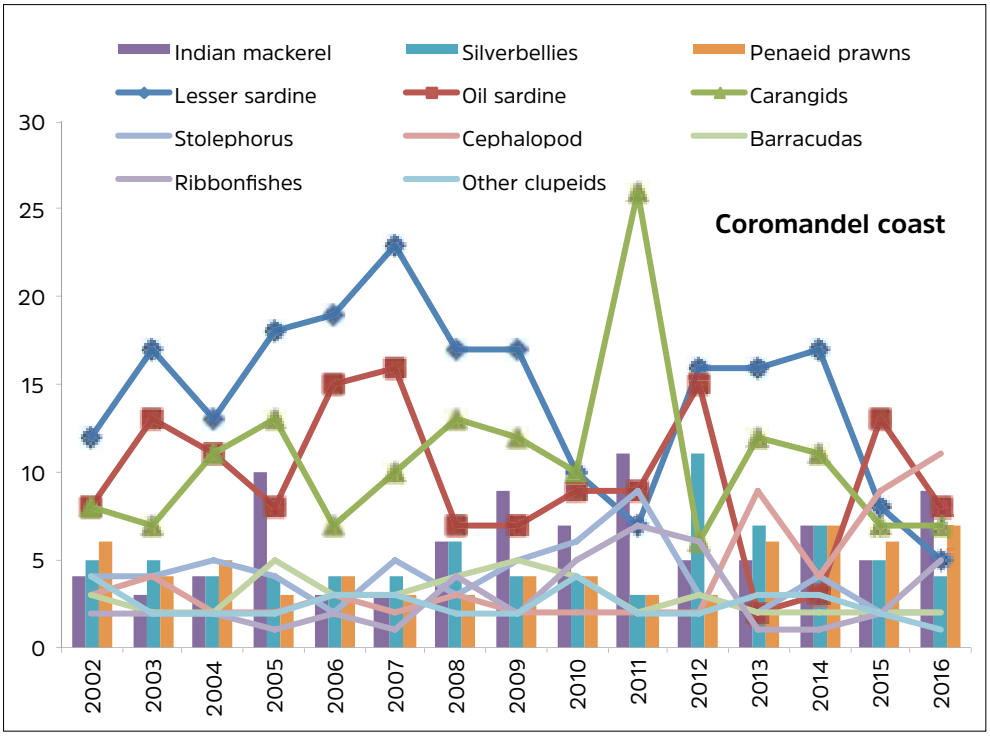




2.5 Dominant 10 resources (formed 5 or more than 5%) in percentage contribution to the total landing in any of the study period in different regions

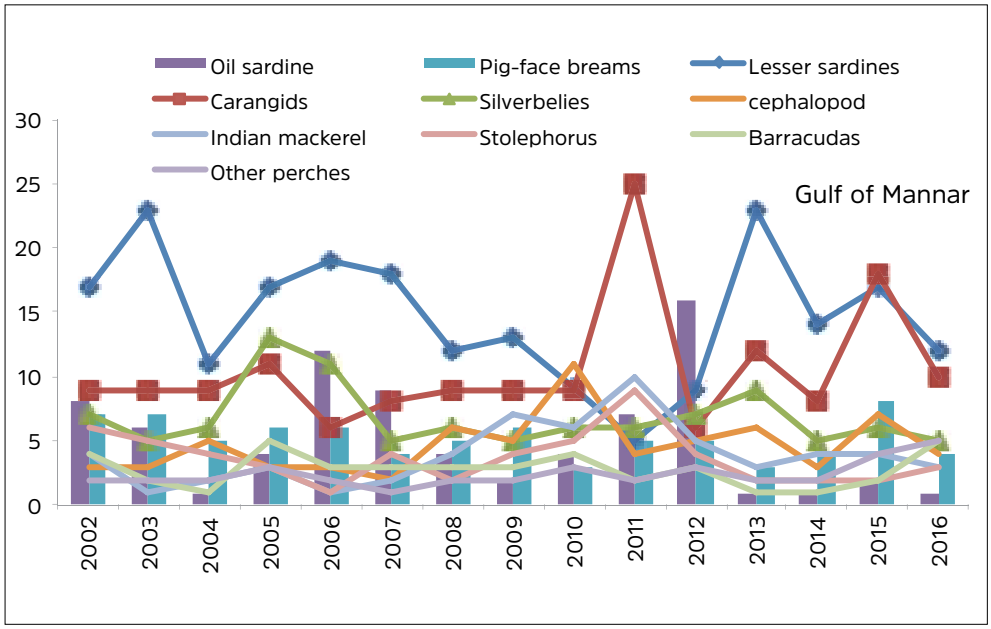
In PB, though lesser sardines have been a dominant resource, oil sardine became dominant since 2008.


Palk Bay
Penaeid prawns
Crabs
Other perches
Silverbellies
Lesser sardines
Oil sardine
Other clupeids
Rays
Cephalopod
Carangids
45
40
35
30
25
20
15
10
5
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016


Indian mackerel
Silverbellies
Penaeid prawns
Lesser sardine
Oil sardine
Carangids
Stolephorus
Cephalopod
Barracudas
Ribbonfishes
Other clupeids
Coromandel coast
30
25
20
15
10
5
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

In CC, it was small pelagic resources that were more predominant. From demersal resources, silverbellies alone dominated.

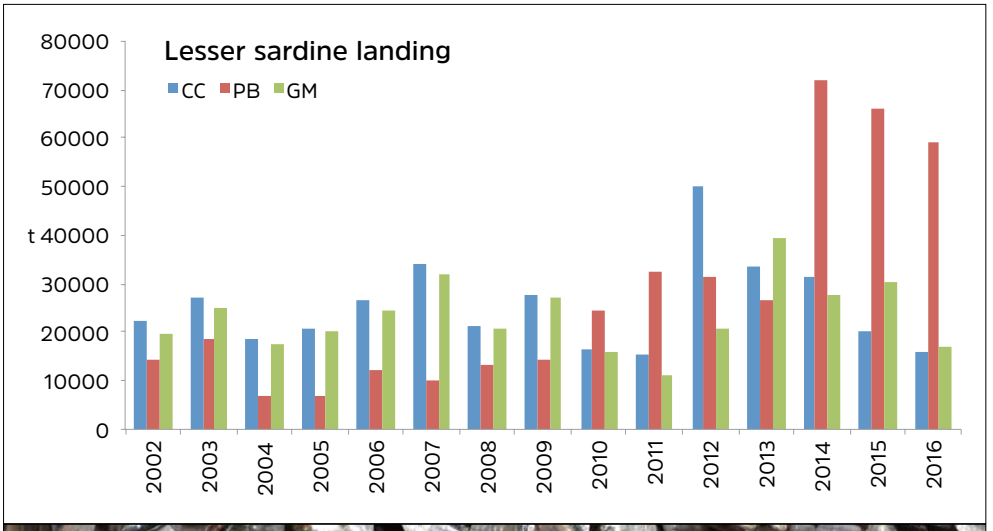
Oil sardine, lesser sardines, carangids, Indian mackerel and whitebaits from small pelagic, pigfacebreams and silverbellies from demersal resources and cephalopods constituted the dominant ones in GM.



2.6 Production trend of major resources/species

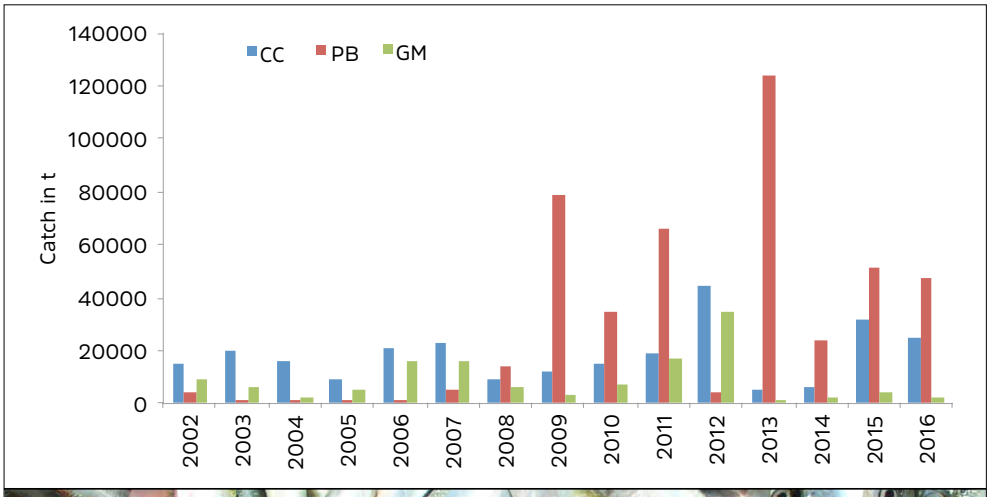
Lesser sardine

Lesser sardine landing remained around 59700 t during 2002 to 2011 whereas the average catch increased to more than 1 lakh t during 2010 to 2016. Till 2010, the major contribution was from CC with its percentage contribution varied from 20 to 45%. But after 2011, the contribution from PB increased and in 2016, its contribution was 64% and more than 80% of the catch was landed by trawlers.



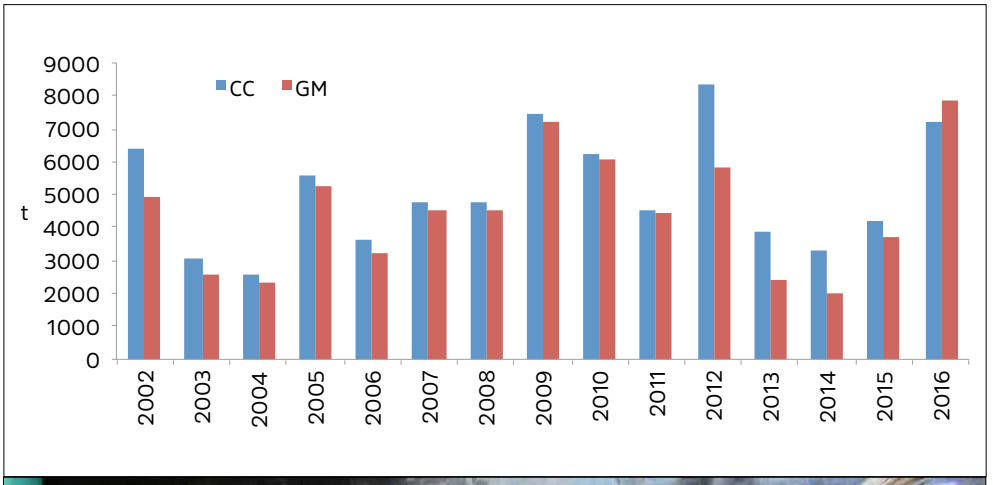
Oil Sardine

The oil sardine landing fluctuated between 15000 t and 44000 t during 2002 to 2008. But in 2009, the landing showed substantial improvement registering more than 100% increase compared to the maximum catch of 44000 t recorded prior to 2009. Thereafter the catch showed substantial increase reaching to 130761 t in 2013 followed by fluctuation in landing and recorded 73864 t in 2016. Till 2007, the major contributor of oil sardine was from Coromandel Coast followed by Gulf of Mannar. Thereafter, the catch was fully shared between CC & PB. Whenever the contribution by CC was more, it was less in PB and vice versa. In CC, the major gear was either edavala (Outboard motor operated bagnet) or *kavalavala* (OBGN). But after 2009, it was ringseine. In PB, the major gear was pair trawl.



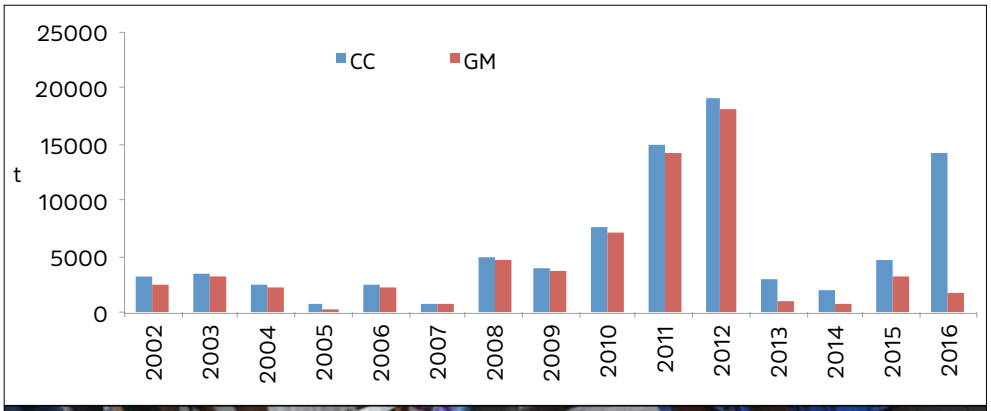
Barracuda

The landing showed heavy fluctuation. Targeted fishing is by hook and lines only and its operation is mostly seasonal from October to March-April. But it is mainly landed by trawlers, the peak being June to September when the catch is dominated by juveniles. The landing was almost equally shared between GM and CC. In PB, the catch was nominal.



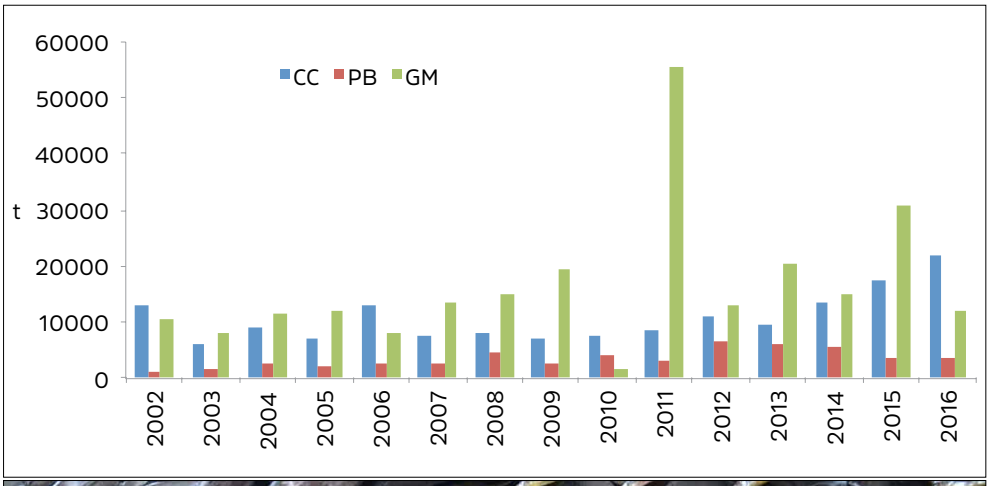
Ribbonfishes

Here also the landing was very less in PB. Between CC and PB, the former was the major contributor with trawlers contributing more than 90% of the landing.



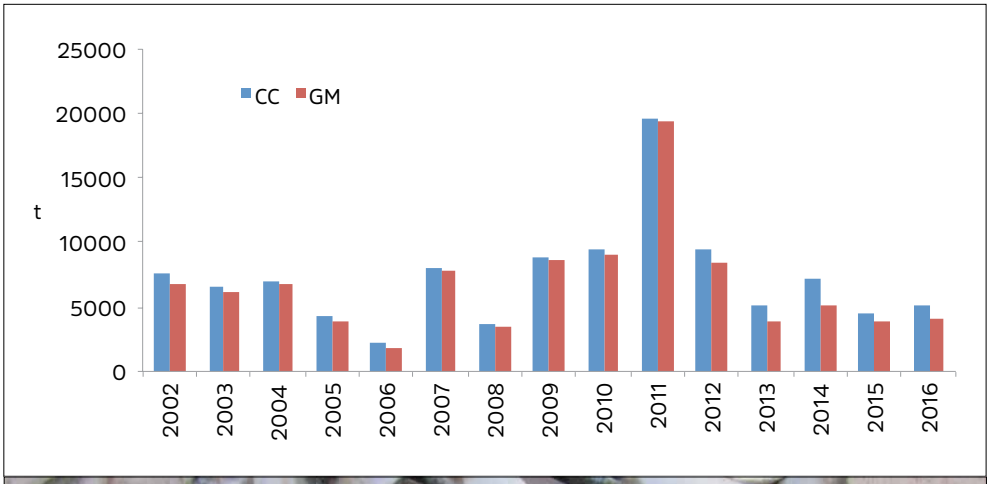
Carangids

Carangid landing was almost steady till 2009 with catch hovering around 25000 t but in 2010, it decreased to 13313 t. In the following year it increased to 67417 t which was the maximum catch recorded during 2002 -2016. The major contributors of carangidae are GM and CC. In both regions trawl was the major gear. The carangidae are comprised by a wide variety of species though *Decapterus* sp and *Selar crumenophthalmus* formed the dominant ones.



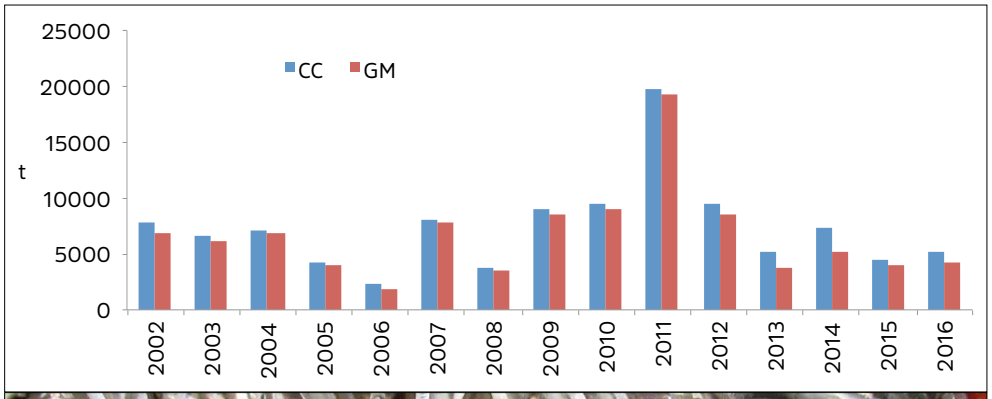
Indian mackerel

The catch varied from 6314 t in 2003 to 47384 t in 2011 with an average of 20251 t. From 2009 onwards, the catch was above average in all the years except in 2013. In general, more than 50% of catch was landed in CC but in 2016 more than 92% of the catch was accounted for by CC. In CC, 67% of the catch was contributed by OBGN and 18% by trawlers. In PB and GM, trawlers accounted for much of the catch, the percentage being 92% and 68% respectively. When the overall contribution by different gears was taken, OBRS accounted for 57%, followed by trawlers 27 (%) and OBGN (15%).



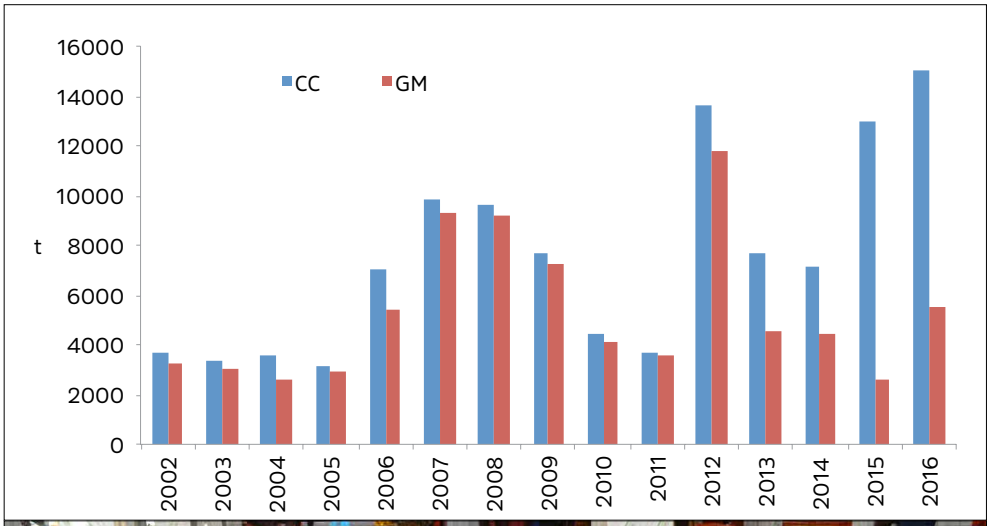
Whitebaits

The landing showed wide fluctuation. From 14530 t in 2002, it plummeted to 4047 t in 2006. Thereafter it increased and reached 38984 t in 2011 followed by a gradual reduction and recorded 272 t in 2016. Almost the entire catch was caught from CC and GM with slightly increased contribution from CC. Trawlers was the main contributor.



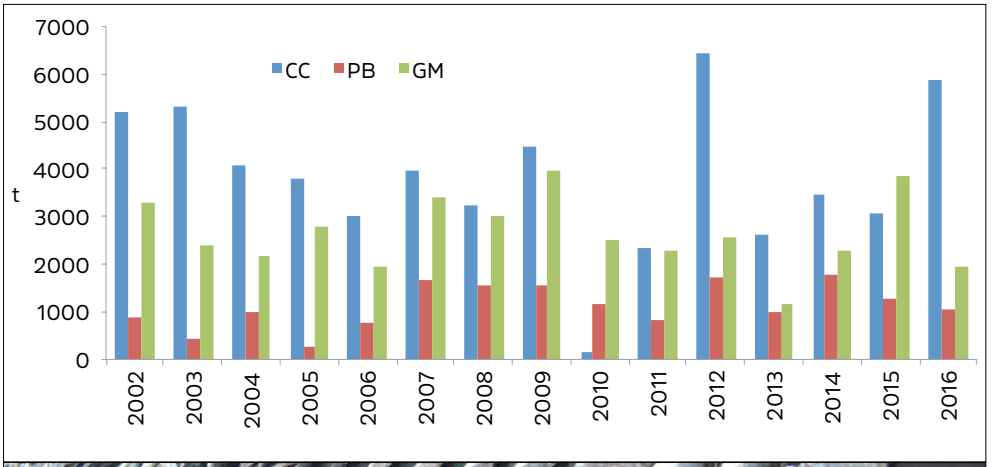
Tunas

Tunas were mainly landed in CC and GM and out of these two, CC was more important contributing more than 50% of the catch. Drift gillnet was the most important gear. Tunas being highly migratory, the catch showed wide fluctuation.



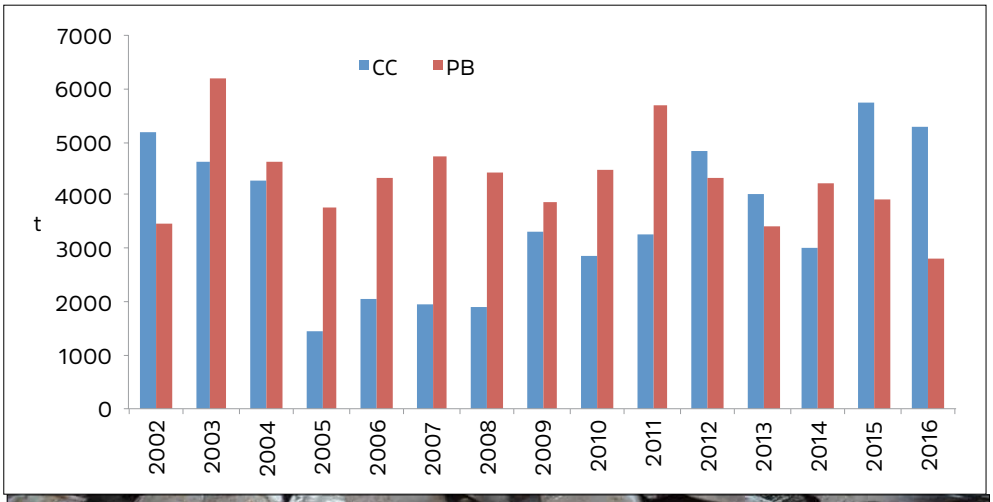
Seerfish

The catch varied from 3835 t in 2010 to 10799 t in 2012 with an average of 7577 t showing wide fluctuation. Among the three regions, the highest contribution was from CC and lowest contribution from PB. In general trawlers accounted for 36% of the catch followed by OBHL (29%) and OBGN (11%).



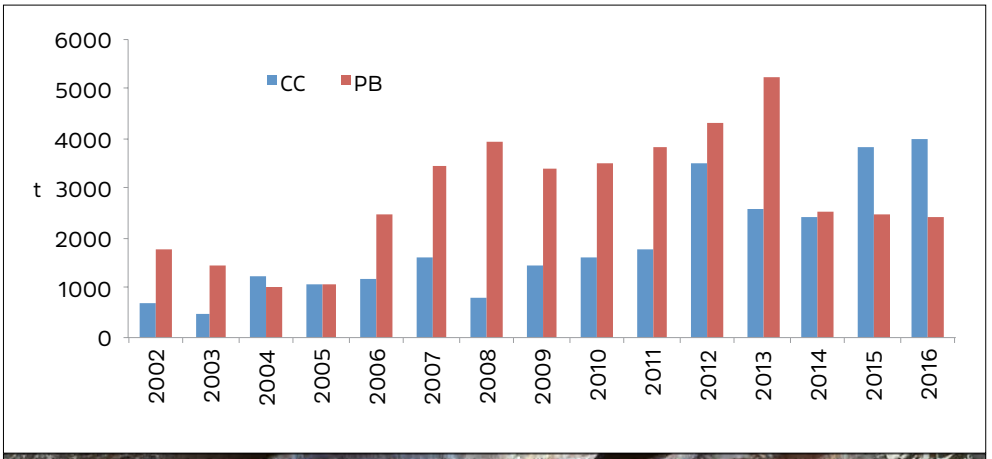
Rays

During 2002 to 2016, the catch varied from 5243 t to 10838 t with an average catch of 7875 t. The landing was mainly due to incidental catch by trawl.



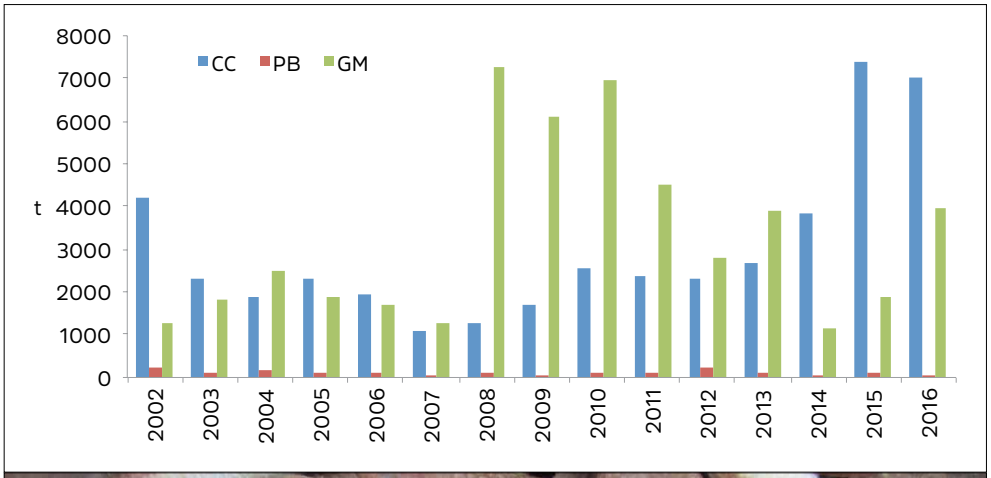
Catfishes

This resource formed a by-catch in trawl, drift gillnet and hook and lines. The landing varied from 1929 t in 2003 to 7854 t in 2012 with an average landing of 4750 t. The catch from 2007 was above this average.



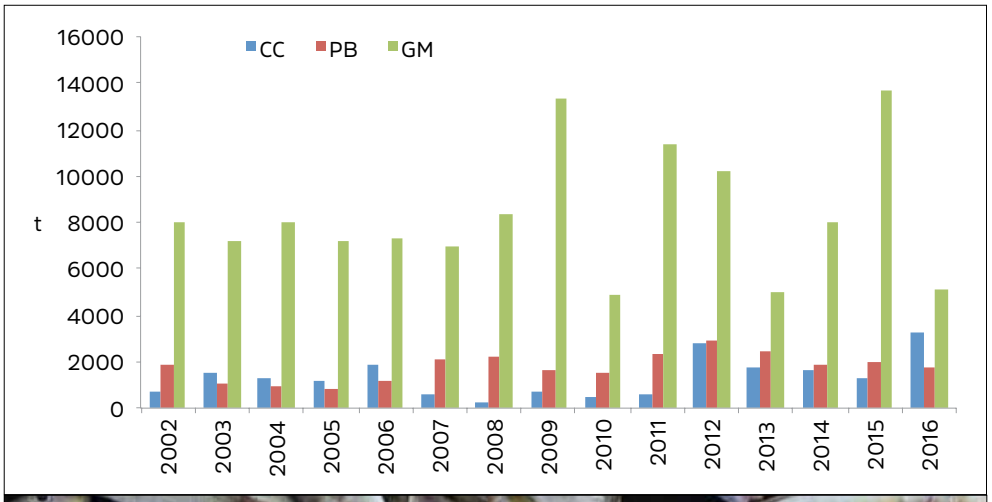
Lizardfish

The landing ranged from 2456 t in 2007 to 11019 t in 2016 with an average of 6376 t. After 2007, the catch was either near or above average catch and it was almost fully caught by trawlers as a bycatch.



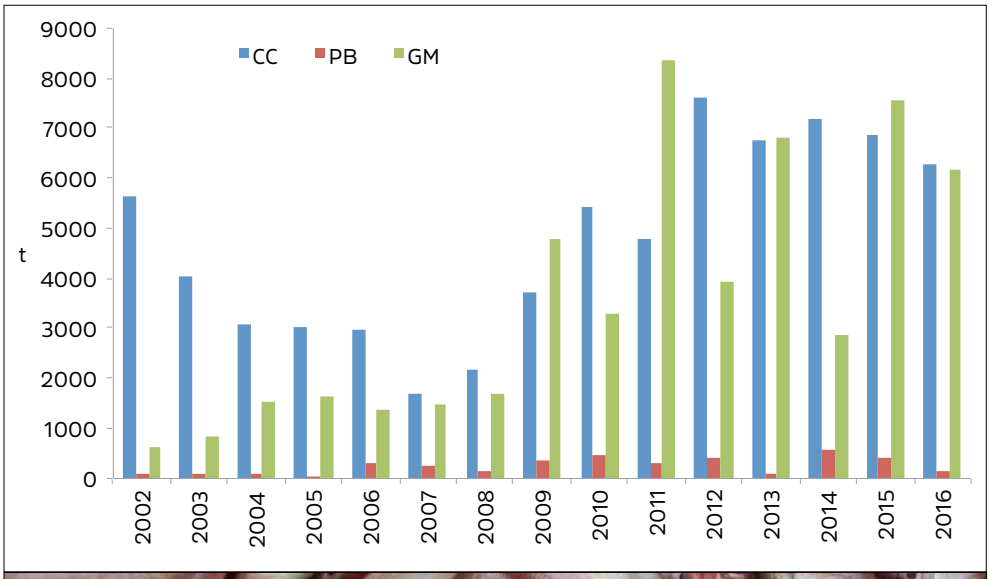
Pigfacebream

Pigfacebream is a targeted fish especially in GM. The catch in TN varied from 6913 t in 2010 to 17050 t in 2015 with an average of 11418 t. In most of the years, more than 70% of the landing was reported from GM.



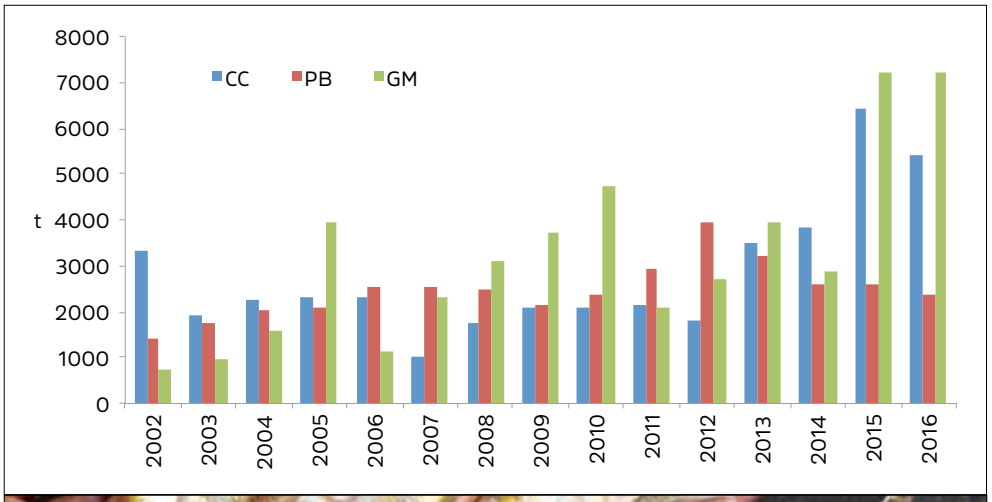
Threadfinbream

The landing varied from 3408 t in 2007 to 14858 t in 2015 with an average of 8532 t. From 2008, the catch was well above average landing. CC and GM together accounted for more than 90% of the landing and trawlers contributed more than 90% of the catch.



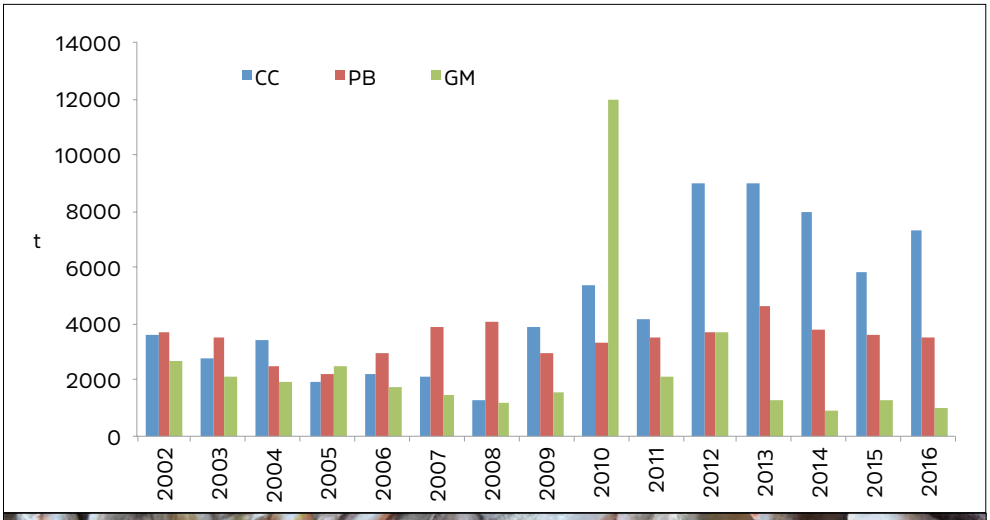
Goatfish

The landing fluctuated between 4610 t in 2003 and 16217 t in 2015 with an average catch of 8499 t. From 2012 onwards, the catch was above the average landing. This was mainly caught by trawlers.



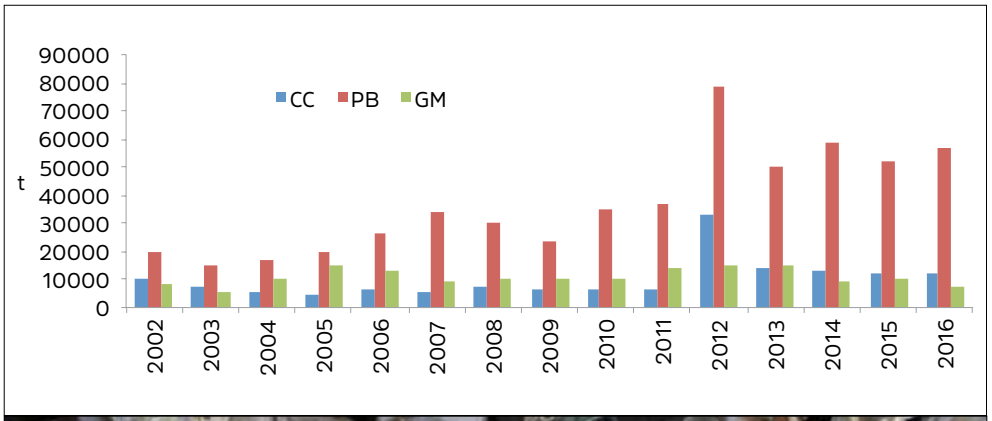
Croakers

The minimum landing (6507 t) was recorded in 2007 and the maximum (20580 t) in 2010 with an average of 10612 t. The catch was either near or more than the average catch since 2010. It was mainly contributed by trawlers



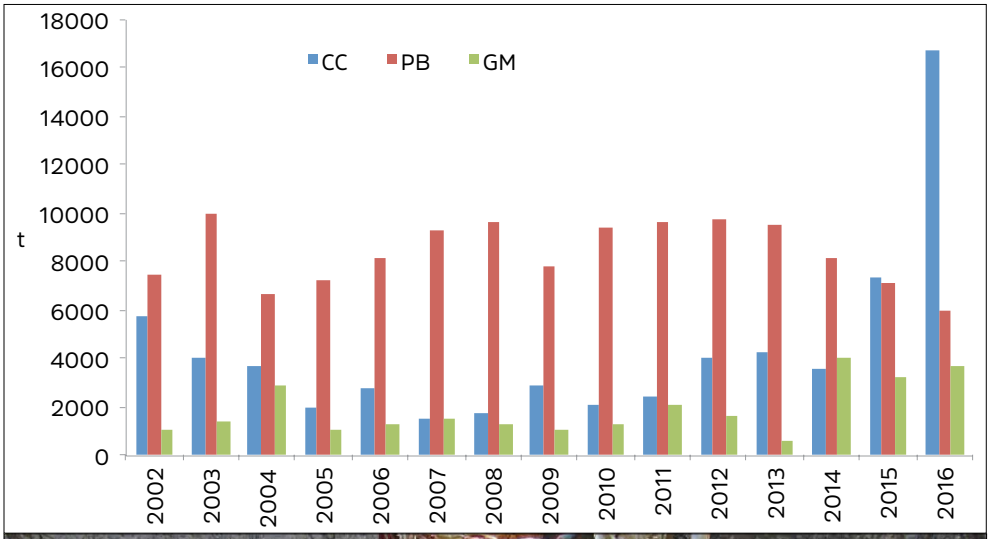
Silverbellies

Though this was a dominant resource, there was hardly any fishing as was done earlier in PB. The catch varied from 26911 t in 2003 to 126591 t in 2012 with an average of 57602 t. From 2011, the landing was above average and was mostly contributed by trawlers with PB remaining the major region.



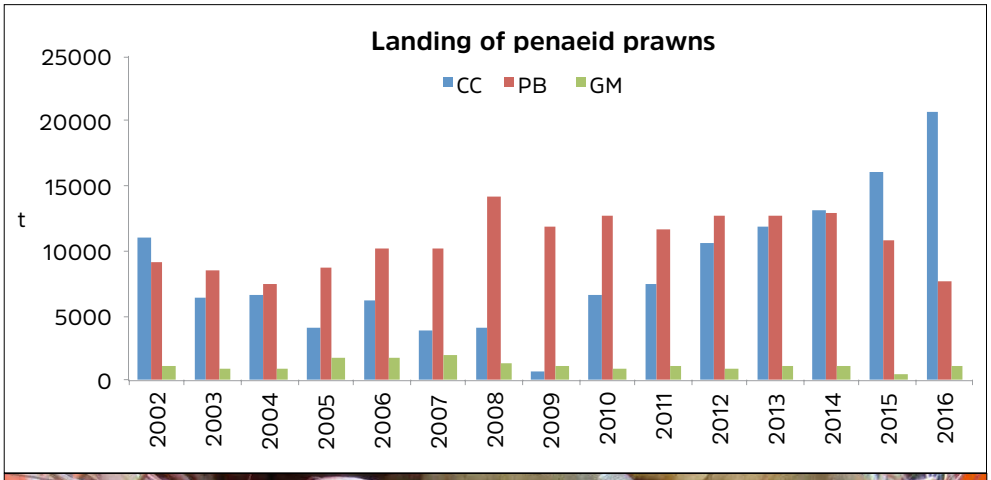
Crabs

Crab landing in general showed a steady increase. From 10261 t in 2005, it increased to 26438 t 2016 with an average of 14635 t. PB was the most important contributor and was targeted fishery by gillnets.



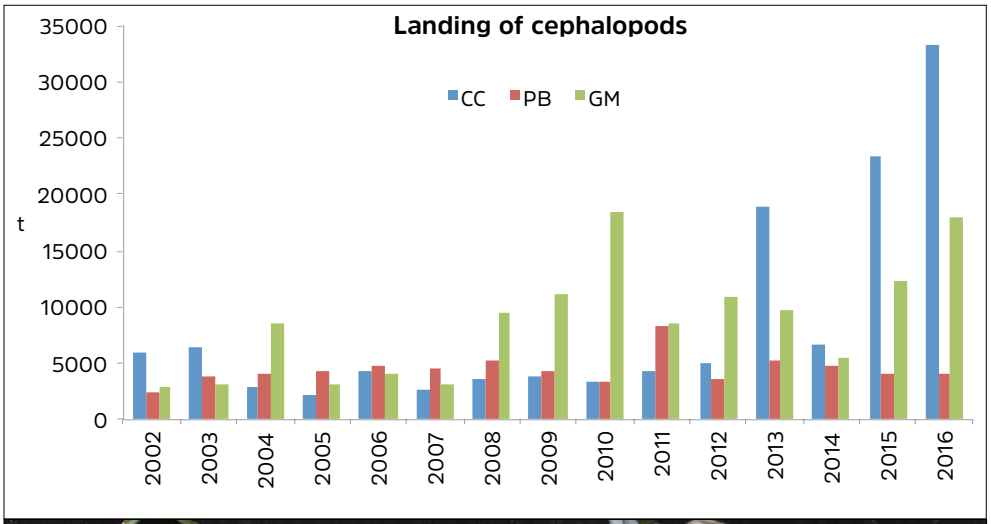
Penaeid prawn

The penaeid prawn landing ranged from 13592 t in 2009 to 29465 t in 2016 with an average landing of 20518 t. The catch from 2010 onwards was more than 20000 t. Major share of the catch was from CC and PB from where the trawlers targeted prawns. In GM, the trawlers mainly targeted cephalopod and fishes. Here prawns were mainly targeted by OBGN.



Cephalopod

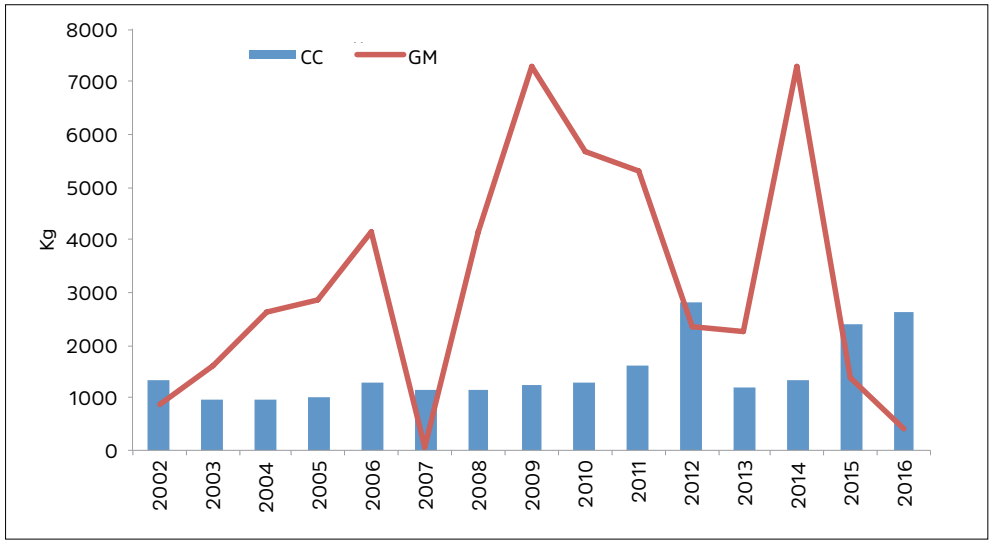
The catch witnessed marked increase from 9563 t in 2005 to 55337 t in 2016 with an average of 21480 t. Cephalopod is now a targeted resource and is mostly landed by trawlers though there is seasonal targeted fishery by OBHL.



2.7 Trends in catch rates for different fishing fleets

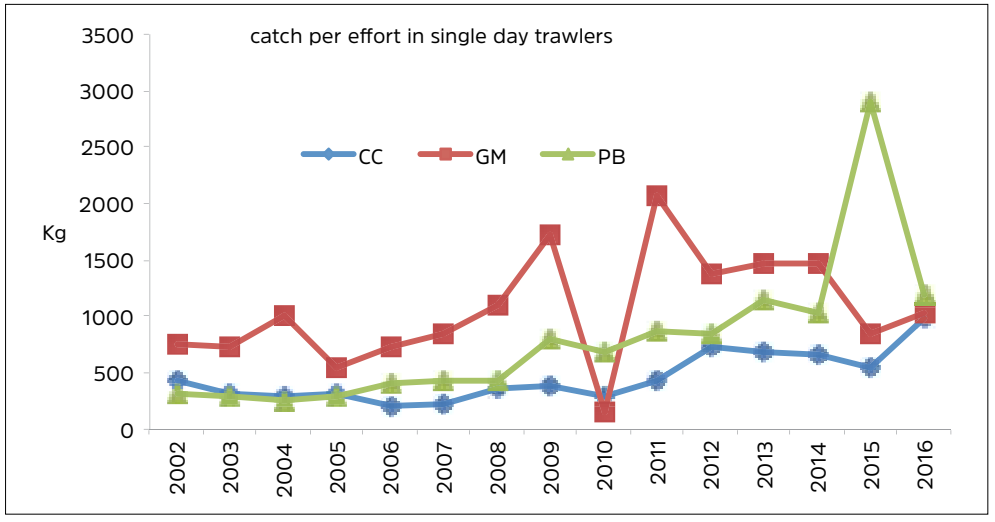
2.7.1 Mechanised multiday trawlers

The CPUE in GM though showed wide variation, it was very much higher compared to that in CC. It varied from 60 kg in 2007 to 7246 kg in 2009 after which it came down to 421 kg in 2016. In CC, it varied from 978 kg in 2002 to 2817 kg in 2012



2.7.2 Mechanized single day trawlers

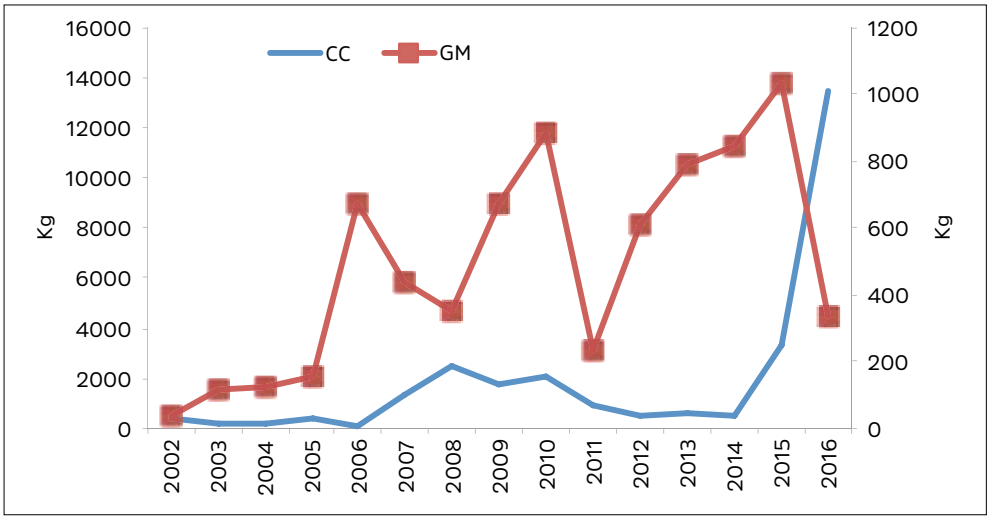
There is wide fluctuation in the CPUE. In CC, the minimum CPUE was 207 kg in



2006 and maximum in 2016 being 979 kg. In GM, the CPUE ranged from 142 kg in 2010 to 2067 kg in 2011 where as in PB, it varied from 256 kg in 2004 to 2901kg in 2013

2.7.3 Multiday drift gillnet

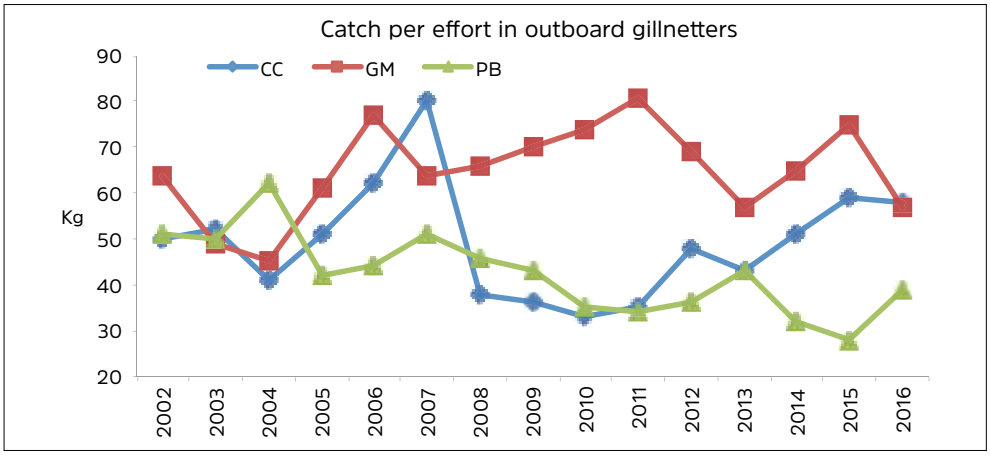
Here also wide fluctuation is seen pointing to the fluctuation in the availability of the resource as well as capacity of the unit. In GM, the target is 1 t whereas



in CC, the target is 20 t per voyage. In CC, the CPUE varied from 86 kg in 2006 to 13409 kg in 2016. In GM, it ranged from 35 kg in 2002 to 1029 kg in 2015.

2.7.4 Motorized gillnet

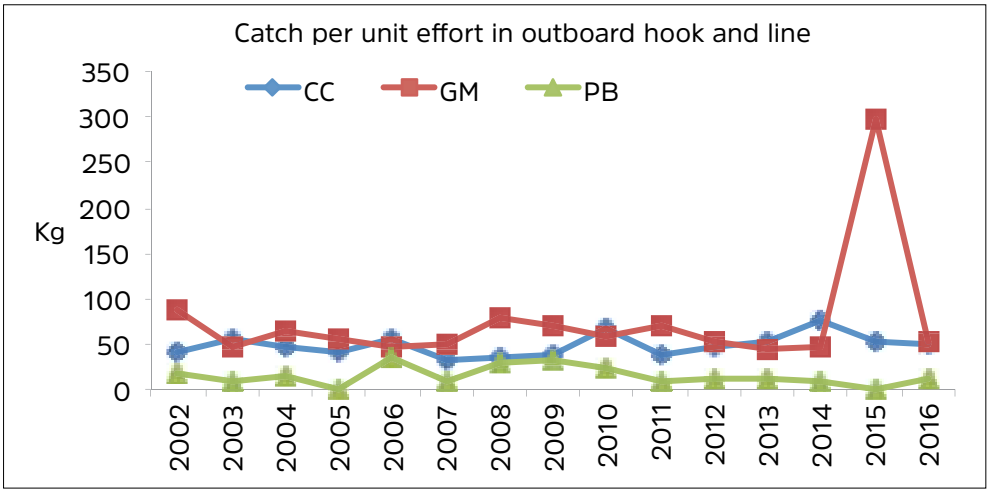
In CC, from an initial CPUE of 40 to 50 kg, it reached over 80 kg in 2007 and then drastic decrease. It hovered around 40 kg till 2011 and then started increasing



and recorded 60 kg in 2015. In GM, the CPUE was around 60 to 80 kg in most of the years. In PB, the maximum CPUE recorded was 62 kg in 2004. From 2010 onwards, it was below 40 kg except in 2013.

2.7.5 Motorized hook and line

In CC, the CPUE varied from 32 kg in 2007 to 76 kg in 2014 where as in GM, it ranged from 45 kg in 2013 to 2 kg in 2015. In PB, the CPUE was generally very low and it varied from 2 kg in 2015 to 36 kg 2006



2.7.6 Comparisons of trawlers and ringseiners

Even though pair trawling and ring net are banned, their operation is rampant. At present, pair trawling is limited to certain areas in CC and PB. In PB, the operation is seasonal and is prevalent especially during the abundance of shoaling fishes like oil sardine. Here this resource is not targeted by the traditional gears. In Nagapattinam, but for the size of the gear and proportional increase in the magnitude of catch, catch composition in pair trawl is same as that in the trawlers operated from there. Moreover, operation of pair trawling is unabated even after the imposition of ban. The operation of mechanized ring-seine is prevalent in Cuddalore and some areas of Nagapattinam since its introduction and this gear is also operated from outboard motor operated FRP boats in other districts like Tuticorin, Tirunelveli, Tiruvallur, Villupuram, Ramanathapuram etc. The percentage cotribution of ring net catch in total catch is less than 20% whereas that of trawl net is above 60%. The traditional pelagic gillnetters mainly target lesser sardines and mackerel. If the percentage contribution of oil sardine, lesser sardine and mackerel by trawl and ring seines are considered, the percentage contribution by trawlers in respect of lesser sardine and mackerel landings is higher than that by ringnet as is visible from the table 5.

Table 5. Comparisions of landings in percentage of oil sardine, lesser sardine and Indian mackerel by trawlers and ringseiners

	Oil sardine		Lesser sardine		Indian mackerel	
	Trawl	Ringnet	Trawl	Ringnet	Trawl	Ringnet
2010	29.6	51.5	59.1	4.4	38.8	25.3
2011	43.1	48.0	58.5	10.8	31.2	6.2
2012	4.9	82.2	65.4	9.2	24.5	13.5
2013	65.8	30.2	41.9	33.6	21.8	13.0
2014	30.7	56.2	68.7	8.2	19.7	14.1
2015	53.6	33.4	66.1	11.0	24.2	40.8
2016	76.2	13.4	67.3	8.5	26.3	57.2

Moreover the ring net catch is dominated by oil sardine and the percentage of lesser sardines and mackerel are below 20% only (Fig.). Thus it is clear that ring net is mainly targeting oil sardine and no other traditional gear targets oil sardine though this resource form part of the catch in some gears. In fact, its percentage contribution in the landing of lesser sardine and mackerel is much lower than that by trawl net. However, it is found that the number of mechanized ring seine available at present is 117% more than the MSFS in CC. Hence there is an urgent need to reduce the number but not ban it completely.

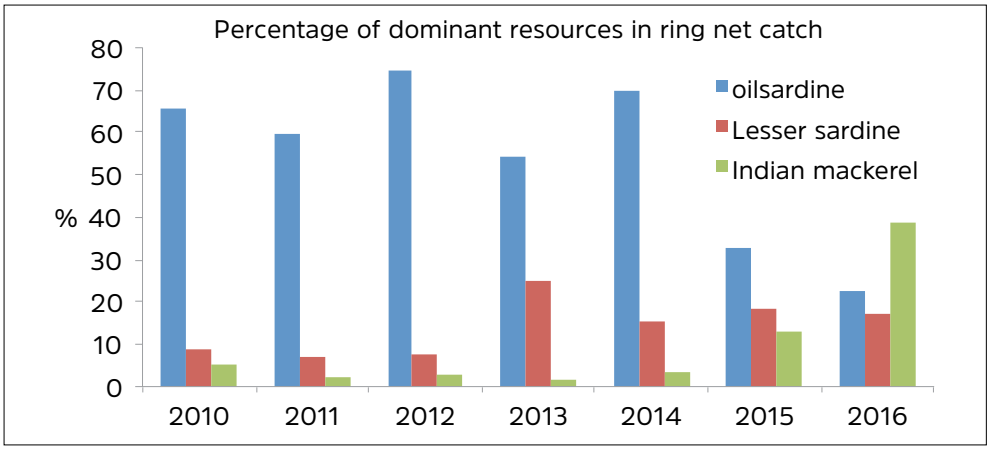


Fig.6. Percentage of dominant resources in ringseine landing.

In trawl, out of the more than 450 species landed, nearly 70% were either bottom living or near bottom living ones. But in ring seine out of around100 species landed, around 80% were either surface dwelling or near surface dwelling ones. Moreover in ring seine, the percentage contribution of resources other than oil sardine, mackerel and lesser sardines was very low being below 10 to 20% indicating its overall impacts on the fauna and ecosystem much lower that by trawl

Chapter 3

Economics of fishing

The economic return from the fishing operations is an important component in the marine fishing sector that decides the scale of operations. The profitability ranges across the seasons just like prices as also the operating costs of fishing per trip. Costs of fuel and crew wages are the most significant components of the operating costs of fishing, which jointly shares about 70 to 80 percent of the total operating cost per trip and these two inputs decides the profitability of the fishing trip.

In Tamil Nadu, 76% of the marine fish landings are contributed by mechanized crafts, 23 percent by the motorized crafts and one percent by the non-mechanized crafts (CMFRI, 2018). Out of the mechanized crafts' landings, trawlers share for about 80 percent of the landings followed by gillnets. The economic performance of the mechanized fishing methods in Tamil Nadu (Table 6) is given below (average of 2012-17)

Table 6. Economic performance of mechanized fishing units

Sl. No	Economic indicators	SDF (Trawl)		MDF Trawl	MDF GN
		Fish	Shrimp	6-10 days	(>7days)
1	Gross revenue (₹)	48,764	38,241	51,853	33,965
2	Total Operating cost (₹)	28,896	24,936	36,203	19,042
3	Net operating income (₹)	19,868	13,305	15,650	14,923
4	Operating ratio (Capital productivity)	0.59	0.64	0.7	0.56
5	Labour productivity (kg/crew/trip)	240	81	65	39

It is seen that the capital productivity is very efficient in single day fish trawl (with a lowest operating ratio of 0.59) against the 0.7 in the case of multi-day trawlers (6-10 days). The labour productivity was also higher in single day trawl compared to multiday trawl. However, the operating ratio in all fishing methods is on an average above 55 percent which is to be regularized. The operating ratio also indicates that the share of gross revenue that is absorbed by the operating expense leaving the balance to meet other requirements. This again emphasis the need for optimizing use of the two critical resources namely fuel costs and crew wages. Out of these two, regularizing fuel costs is more possible than the crew wages.

Chapter 4

Stock status and optimum fishing

4.1 Rapid stock Status Assessment

This is a simple and rapid way of assessing the health of a stock. Under this method, the catch is assumed to be proportional to abundance and the historical maximum catch is taken as the base line catch and is compared with the recent average catch. Historical maximum catch from the past 12 year period (2002-2013) was taken and compared with the average catch during 2014-2016. The criterion used for stock classification is given below (Mohamed *et al*., 2010):

Stock classification	Recent average catches as percentage of historical maximum
Abundant	> 70
Less abundant	50-69
Declining	11 to 49
Depleted	6 to 10
Collapsed	< 5

In PB, the most important resources in terms of the quantity of landings are silverbellies, oilsardine, lesser sardine, penaeid prawns, crabs and cephalopods in the order of abundance. These resources together constitute more than 85% of the total landing. All these resources except oil sardine are in a healthy state. Oil sardine being highly fluctuating, its fishery here depends on its seasonal migration and its harvest by pair trawlers. Almost 90% of oil sardine catch is contributed by pair trawlers. In trawlers, besides prawns, cephalopods have also become a targeted resource. The less abundant status of cephalopod may be a sign of decrease in abundance due to increased exploitation (Table 7).

Table 7. Results of rapid stock assessment of Palk Bay resources

Sl. No.	Species/stock	Historical maximum catch	Recent 3-year average catch	% to the maximum catch	Stock status
Pelagic resources					
1	Wolf herring	2122	1621	76	Abundant
2	Thryssa	14942	2151	14	Declining
3	Oil sardine	124276	40766	33	Declining
4	Lesser sardines	32491	65694	202	Abundant
5	Other clupeids	5985	5176	86	Abundant
6	Other shads	6545	8397	128	Abundant
7	Barracudas	3389	1865	55	Less abundant
8	Half beaks&Fullbeaks	922	567	61	Less abundant
9	Ribbonfishes	688	270	39	Declining
10	Horse mackerel	416	422	101	Abundant
11	Scads	261	107	41	Declining
12	Indian mackerel	2889	1183	41	Declining
13	Stolephorus	669	812	121	Abundant
14	Bill fishes	37	136	368	Abundant
15	King fish	1745	1375	79	Abundant
16	Leatherjackets	2026	461	23	Declining
Demersal resources					
17	Sharks	389	205.0	53.0	Less abundant
18	Skates	824	11.0	1.3	Collapsed
19	Rays	6197	3671.0	59.0	Less abundant
20	Eels	2299	308.0	13.0	Declining
21	Catfishes	5258	2484.0	47.0	Declining
22	Lizard fishes	260	59.0	23.0	Declining
23	Rock cods	237	77.0	33.0	Declining
24	Snappers	1083	751.0	69.0	Less abundant
25	Pig-face breams	2921	1888.0	65.0	Less abundant
26	Threadfin breams	449	374.0	83.0	Abundant
27	Other perches	14292	7902.0	55.0	Less abundant
28	Goatfishes	3974	2516.0	63.0	Less abundant
29	Threadfins	1641	672.0	41.0	Declining

Sl. No.	Species/stock	Historical maximum catch	Recent 3-year average catch	% to the maximum catch	Stock status
30	Croakers	4609	3642.0	79.0	Abundant
31	Silverbellies	78458	56138.0	72.0	Abundant
32	Black pomfret	92	54.0	59.0	Less abundant
33	Silver pomfret	1520	695.0	46.0	Declining
34	Soles	741	343.0	46.0	Declining
Crustacean resources					
35	Crabs	10011	7084	71	Abundant
36	Lobsters	299	37	12	Declining
37	Penaeid prawns	14117	10435	74	Abundant
	Cephalopod resources				
38	Cephalopod	8378	4349	52	Less abundant

In CC, the most of the important exploited resources are in a healthy state. The lesser sardine especially *Sardinella gibbosa* is in great demand as a comparatively cheap source of nutrition and food. So there is a targeted fishery for this. Increased exploitation coupled with inherent natural fluctuation might be a cause for its dwindling. The major gear for oil sardine fishery is ringseine but its operation in many areas is stopped because of stiff opposition from other fishers and also from the government. Wahoo is solitary in nature and is landed as a by-catch in deep sea drift gillnet and hook and lines. Most of the sharks caught from Tamil Nadu waters especially large sized commercially valuable sharks are commonly landed at Cochin Fisheries Harbour (Table 8).

Table 8. Results of rapid stock assessment of CC resources

Sl. No.	Species/stock	Historical maximum catch(t)	Recent 3-year average catch	% of maximum catch	Stock status
	Pelagic resources				
1	Wolf herring	4124	1258	31	Declining
2	Thryssa	7524	5485	73	Abundant
3	Oil sardine	44750	20926	47	Declining
4	Other sardines	50153	22518	45	Declining
5	Other clupeids	6753	3515	52	Less Abundant

Sl. No.	Species/stock	Historical maximum catch(t)	Recent 3-year average catch	% of maximum catch	Stock status
6	Other shads	396	147	37	Declining
7	Barracudas	8389	4883	58	Less Abundant
8	Half beaks & Full beaks	3374	1125	33	Declining
9	Ribbon fishes	19142	7024	37	Declining
10	Mullets	645	255	40	Declining
11	Horse Mackerel	477	847	178	Abundant
12	Scads	3453	6912	200	Abundant
13	Other carangids	9919	9545	96	Abundant
14	Indian mackerel	23316	17984	77	Abundant
15	Stolephorus	19635	5653	29	Declining
16	Bill fishes	2605	2118	81	Abundant
17	Kawakawa	5788	3636	63	Less Abundant
18	Skipjacktuna	660	3836	581	Abundant
19	Auxisspp.	1708	741	43	Declining
20	Other tunnies	8894	3489	39	Declining
21	King seer	6411	3280	51	Less Abundant
22	Spotted seer	113	843	746	Abundant
23	Wahoo	86	9	10	Depleted
24	Flying fish	5355	11880	222	Abundant
25	Leatherjackets	718	464	65	Less Abundant
	Demersal resources				
26	Sharks	1356	498	37	Declining
27	Skates	647	72	11	Declining
28	Rays	5194	4673	0	Abundant
29	Eels	690	423	61	Less abundant
30	Catfishes	3514	3431	98	Abundant
31	Lizard fishes	4181	6099	146	Abundant
32	Rock cods	1247	927	74	Abundant
33	Snappers	983	1648	168	Abundant
34	Pig-face breams	2751	2099	76	Abundant
35	Threadfin breams	7625	6765	89	Abundant
36	Other perches	5737	6375	111	Abundant

Sl. No.	Species/stock	Historical maximum catch(t)	Recent 3-year average catch	% of maximum catch	Stock status
37	Goat fishes	3504	5216	149	Abundant
38	Threadfins	3065	689	22	Declining
39	Croakers	9020	7050	78	Abundant
40	Silverbellies	33091	12364	37	Less abundant
41	Black pomfret	1081	1021	94	Abundant
42	Silver pomfret	3004	16899	563	Abundant
43	Chinese pomfret	90	32	36	Declining
44	Halibut	587	320	55	Less abundant
45	Soles	947	1823	193	Abundant
	Crustacean resources				
46	Crabs	5713	9240	162	Abundant
47	Lobsters	195	246	126	Abundant
48	Non-penaeid prawns	1565	1942	124	Abundant
49	Penaeid prawns	11762	16602	141	Abundant
	Cephalopod resources				
50	Cephalopod	18953	21113	111	Abundant

In GM, out of the 41 resources /resource groups, 19 are in a healthy state. The major gear for oil sardine fishery is ringseine but its operation in many areas is stopped because of stiff opposition from other fishers and also from the government. In Tuticorin area, the gillnetters targeting lesser sardine avoid oilsardine shoals because of lack of local demand. These reasons could be attributed to the dwindling in landing of oil sardine along with the fishery independent factors. The reduction in shark landings perhaps may be due to the protection of several species under the Indian Wild Life Protection Act 1972 and banning of shark fin trade. The trawlers are now targeting cephalopod and fishes, therefore the data on the landing of prawns now may not be an index of its actual availability and abundance. The change in pattern of fishing could also be a reason for the declining status of penaeid prawns. In the case of non-penaeid prawns, the fishery is only seasonal lasting for four months. Thus collapsed status of non-penaeid. prawns might be an indication of over exploitation or it could also be due to shift in fishing pattern. Whenever there was a drop in price, the fishermen would suspend deep sea prawn fishing and resume targeting other resources like cephalopod or fishes (Table 9).

Table 9. Results of rapid stock assessment of GM resources

Sl. No.	Species/stock	Historical maximum catch(t)	Recent 3-year average catch	% of maximum catch	Stock status
	Pelagic resources				
1	Wolf herring	3377	1394	41	Declining
2	Oil sardine	34559	2776	8	Depleted
3	Lesser sardines	39449	24941	63	Less abundant
4	Other clupeids	4883	1812	37	Declining
5	Barracudas	6112	4519	74	Abundant
6	Halfbeaks &Fullbeaks	3374	2128	63	Less abundant
7	Ribbon fishes	18234	1995	11	Declining
8	Horse Mackerel	687	133	19	Declining
9	Scads	48057	10962	23	Declining
10	Other carangids	11896	8236	69	Less abundant
11	Indian mackerel	22864	6406	28	Declining
12	Whitefish	19349	4401	23	Declining
13	Billfishes	2605	1244	48	Declining
14	Kawakawa	4829	1430	30	Declining
15	Skipjacktuna	660	604	91	Abundant
16	*Auxis*spp	1577	801	51	Less abundant
17	Other tunnies	7263	1344	19	Declining
18	King seer	3962	2701	68	Less abundant
19	Flyingfishes	387	115	30	Declining
20	Leatherjackets	2524	1557	62	Less abundant
Demersal resources					
21	Sharks	8366	352	4	Collapsed
22	Skates	1497	342	23	Declining
23	Rays	2556	2019	79	Abundant
24	Catfishes	1561	547	35	Declining
25	Lizardfishes	6975	2310	33	Declining
26	Rock cods	2509	2079	83	Abundant
27	Snappers	3947	2865	73	Abundant
28	Pig-face breams	13390	8966	67	Less abundant
29	Threadfin breams	8385	5549	66	Less abundant

Sl. No.	Species/stock	Historical maximum catch(t)	Recent 3-year average catch	% of maximum catch	Stock status
30	Other perches	5515	6466	117	Abundant
31	Goatfishes	4722	5772	122	Abundant
32	Croakers	11913	1062	9	Depleted
33	Silverbellies	15042	9193	61	Less abundant
34	Silver pomfret	499	101	20	Declining
35	Soles	2077	335	16	Declining
36	Big jawed jumper	568	49	9	Depleted
Crustacean resources					
37	crab	2938	3685	125	Abundant
38	Non-penaeid prawns	4248	226	5.0	Collapsed
39	Penaeid prawns	2034	924	45	Declining
40	Lobster	111	66	59	Less abundant
Cephalopod resources					
41	Cephalopod	18307	11986	65	Less abundant

4.1.1 Mean lengths and optimum lengths (L_{opt}) of important resources

Optimum length (L_{opt}) is defined as the length at maximum biomass in the unfished population (Froese *et al.*2018). In an exploited population**,** if the mean length is close to L_{opt}, it indicates that the population has a size and age distribution similar to an unexploited healthy population.

Table 10. L_{opt} and Mean length of different resources from TN.

Species	Lopt	Mean size(cm)	Lmean/Lopt
Sardinella gibbosa	12	13	1.1
Sardinella fimbriata	13	14	1.1
Sardinella longiceps	15	17	1.1
Amblygaster sirm	16	18	1.1
Stolephorus indicus	13	12	0.9
Rastrelliger kanagurta	19	22	1.2
Trichiurus lepturus	57	52	0.9
Thunnus albacares	90	69	0.8

Species	Lopt	Mean size(cm)	Lmean/Lopt
Katsuwonus pelamis	46	50	1.1
Euthynnus affinis	47	38	0.8
Sarda orientalis	45	42	0.9
Auxis rochei	25	26	1.0
Auxis thazard	31	31	1.0
Gymnosarda unicolor	76	52	0.7
Scomberomorous commerson	60	36	0.6
Scomberomorous guttatus	43	38	0.9
Acanthocybium solandri	114	110	1.0
Coryphaena hippiurus	52	69	1.3
Xiphias gladius	189	113	0.6
Istiophorus platypterus	202	133	0.7
Istiompax indica	226	235	1.0
Tylosurus acus melanota	58	66	1.1
Caranx ignobilis	65	85	1.3
Caranx heberi	54	75	1.4
Sphyraena jello	39	45	1.2
Nemipterus bipunctatus	13	16	1.2
Nemipterus japonicus	13	15	1.2
Nemipterus randalli	12	14	1.2
Parupeneus indicus	28	25	0.9
Lethrinus lentjan	20	24	1.2
Gazza minuta	9	11	1.2
Equulites lineolatus	12	11	0.9
Karalla dussumieri	8	10	1.3
Nibea maculata	15	15	1.0
Otolithes ruber	18	19	1.1
Johnius carutta	16	16	1.0
Psettodes erumei	35	23	0.7
Parastromateus niger	20	20	1.0
Saurida micropectoralis	23	30	1.3
Saurida tumbil	29	28	1.0
Saurida undosquamis	24	19	0.8
Synodus myops	18	20	1.1
Uroteuthis (Photololigo) duvaucelii	11	10	0.9

Species	Lopt	Mean size(cm)	Lmean/Lopt
Uroteuthis(P). singhalensis	12	12	1.0
Sepia pharaonis	12	8	0.7
Sepia prabahari	8	9	1.1
Sepia aculeata	10	8	0.9
Penaeus semisulcatus	14	15	1.1
Penaeus indicus	13	14	1.1
Penaeus latisulcatus	11	16	1.5
Penaeus merguiensis	16	20	1.3
Penaeus monodon	13	20	1.5
Metapenaeus dobsoni	8	9	1.1
Metapenaeus monoceros	9	11	1.2
Metapenaeus affinis	12	10	0.8
Parapenaeopsis maxillipedo	8	7	0.9
Parapenaeopsis stylifera	7	7	1.0
Metapenaeopsis stridulans	8	6	0.8
Metapenaeopsis mogiensis	7	6	0.9
Metapenaeopsis toloensis	7	7	1.0
Metapenaeopsis andamanensis	8	8	1.0
Metapenaeopsis coniger	8	7	0.9
Plesionika quasigrandis	9	8	0.9
Heterocarpus gibbosus	8	9	1.1
Solonocera hextii	10	10	1.0
Solonocera crassicornis	5	7	1.4
Charybdis feriatus	5	9	1.8
Charybdis natator	5	8	1.6
Charydis smithii	4	6	1.5
Portunus sanguinolentus	7	10	1.4
Portunus pelagicus	9	8	0.9
Portunus gladiator	5	8	1.6

Of 72 analysed resources, 61(85%) had mean lengths close to L_{opt} with L_{mean}/L_{opt}> 0.9 and thus a size and age structure indicative of a healthy condition.

4.1.2 Minimum Legal Size (MLS) of important species

Minimum legal size (MLS) is the size above which a particular species can be legally caught and retained, if caught. The advantage of MLS is that it aids in control of two major problems in the fisheries management, growth overfishing

and recruitment overfishing either by increasing the size of harvest or by increasing or maintaining the spawning stock. The decision logic to arrive at the MLS of different species (Mohamed *et al.* 2014) is given below

Criteria	Explanation	Logic
SSD	Size at sexual differentiation in to male and female	This metric can be used to prevent juvenile exploitation and growth overfishing in those stocks which are very abundant, have high reproductive potential and whose biomasses are not affected by high fishing pressure
MSM	Minimum size at maturity or the smallest mature fish	This metric can be used to prevent growth overfishing in stocks which are moderately resilient to fishing pressure
SFM	Size at maturity or Size at 50% maturity	Conventionally used as a metric to prevent growth overfishing completely and recruitment overfishing partially. Can be used in situations where the stock is depleted or rebuilding

Extension of fishing ground beyond territorial waters and often into the waters of other states necessitates more or less similar MLS all along India. Otherwise there are chances that the sizes that are illegal in one state can be legal in the adjacent state resulting in clandestine deals. More over the growth and maturity of many resources are found to be almost same from different areas. Considering these reasons, the legal sizes found out for Kerala and Karnataka are retained for Tamil Nadu along with other resources studied from here.

Table 11. Minimum legal size (MLS) of 113 commercially important resources from TN.

Species name	MLS(cm)	
Sardinella gibbosa	10TL	MSM
Sardinella albella	10TL	MSM
Sardinella fimbriata	11TL	MSM
Sardinella longiceps	10TL	SSD
Amblygaster sirm	11TL	MSM
Escualosa thoracata	.9TL	MSM
Stolephorus indicus	10TL	MSM
Stolephorus waitei	7TL	MSM
Encrasicholina devisi	6.7TL	MSM
Rastrelliger kanagurta	14 TL	MSM
Trichiurus lepturus	46TL	SSD
Thunnus albacares	50FL	MSM
Thunnus tonggol	44FL	MSM

Species name	MLS(cm)	
Katsuwonus pelamis	35FL	MSM
Euthynnus affinis	31 FL	MSM
Sarda orientalis	35FL	MSM
Auxis rochei	18 FL	MSM
Auxis thazard	25 FL	MSM
Gymnosarda unicolor	50FL	MSM
Scomberomorous commerson	50FL	MSM
Scombermorous guttatus	37FL	SFM
Coryphaena hippiurus	38FL	MSM
Decapterus macrosoma	14TL	MSM
Decapterus russelli	11TL	MSM
Megalaspis cordyla	19TL	SSD
Selar crumenophthalmus	16TL	MSM
Scomberoides tala	30FL	MSM
Scomberoides tol	22.5FL	MSM
Scomberoides commersonianus	31.5FL	MSM
Sphyraena putnamae	27FL	MSM
Sphyraena obtusata	17.5 FL	MSM
Sphyraena barracuda	76FL	MSM
Rachycentron canadum	61FL	SFM
Nemipterus bipunctatus	12.8	MSM
Nemipterus japonicus	12TL	MSM
Nemipterus randalli	10TL	MSM
Parascolopsis aspinosa	10.1TL	MSM
Arius arius	7.9TL	MSM
Nibea maculata	14TL	MSM
Otolithes ruber	17TL	MSM
Otolithes cuvieri	16TL	MSM
Johnius carutta	15TL	MSM
Johnius dussumieri(J.sina)	11 TL	MSM
Johnius glaucus	15TL	MSM
Johnius belangerii	14TL	MSM
Kathala axillaris	13.5TL	MSM
Pennahia anea	13TL	MSM
Lactarius lactarius	10TL	MSM

Species name	MLS(cm)	
Parastromateus niger	17TL	MSM
Pampus argenteus	13TL	MSM
Saurida undosquamis	10TL	MSM
Suarida tumbil	17TL	MSM
Saurida micropectoralis	11TL	MSM
Synodus myops	10.5TL	MSM
Upeneus sulphureus	10.9TL	MSM
Upeneus taeniopterus	12.4TL	MSM
Upeneus supravittatus	12.7TL	MSM
Parupeneus indicus	19.8TL	MSM
Parupeneus heptacanthus	12.6TL	MSM
Sillago sihama	11.3TL	MSM
Photopectoralis bindus	7.1TL	MSM
Gazza minuta	6.7TL	MSM
Eubleekeria splendens	8.9TL	MSM
Equuilites lineolatus	8.7	MSM
Leiognatus dussumieri	7.7TL	MSM
Secutor insidiator	6.2TL	MSM
Priacanthus hamrur	14TL	MSM
Lutjanus lutjanus	13.5TL	MSM
Lethrinus lentjan	14.5TL	MSM
Epinephelus diacanthus	18TL	MSM
Cephalopholis miniata	21.1TL	MSM
Psettodes erumei	20TL	MSM
Cynoglossus macrostomus	9TL	MSM
Carcharhinus limbatus	98TL	MSM
Carcharhinus falciformis	180TL	MSM
Scoliodon laticaudus	28.99TL	MSM
Rhizoprionodon acutus	57.5TL	MSM
Rhizoprionodon oligolinx	53TL	MSM
Brevitrygon imbricata	14DW	MSM
Pateobatis jenskinsii	61DW	MSM
Gymnura poecilura	29DW	MSM
Uroteuthis (Photololigo) duvaucelii	8DML	MSM
U (P). Singhalensis	8.5DML	MSM

Species name	MLS(cm)	
Sepia pharaonis	11DML	MSM
S. prabahari	7.1DML	MSM
Amphioctopus neglectus	5DML	MSM
Charybdis feriatus	5CW	MSM
Charybdis natator	5.3CW	MSM
Charydis smithii	4.3CW	MSM
Portunus sanguinolentus	7CW	MSM
Portunus pelagicus	9CW	MSM
Portunus gladiator	5.3CW	MSM
Penaeus semisulcatus	11.3TL	MSM
Penaeus indicus	11.3TL	MSM
Penaeus latisulcatus	11.3TL	MSM
Metapenaeus dobsoni	6TL	MSM
Metapenaeus monoceros	11TL	MSM
Metapenaeus affinis	9TL	MSM
Metapenaeus moyebi	6.3TL	MSM
Parapenaeopsis maxillipedo	6.3TL	MSM
Parapenaeopsi stylifera	7TL	MSM
Metapenaeopsis stridulans	6.3TL	MSM
Metapenaeopsis hilarula	6.3TL	MSM
Metapenaeopsis andamanensis	7.3TL	MSM
Plesionika quasigrandis	8TL	MSM
Heterocarpus gibbosus	7.3TL	MSM
Solonocera hextii	7.3TL	MSM
Solonocera choprai	6.2TL	MSM
Aristeus alcocki	13TL	MSM
Panulirus homarus	200g	WFM
Panuirus ornatus	500g	WFM
Panulirus polyphagus	300g	WFM
Thenus unimaculatus	150g	WFM

SSD-Size at sex differentiation, MSM- Minimum size at maturity, SFM-Size at 50% maturity WFM-Weight at 50% maturity, TL-Total length, FL-Fork length, DW-Disc width DML-Dorsal mantle length, CW-Carapace width,

The catch can be considered violation if only more than 50% of the size composition of catch is below the MLS. Inspection of the catch can be done at sea or at landing centre taking an unsorted catch.

4.1.3 Potential yield

Potential yield here is the maximum sustainable yield (MSY). For the potential yield estimate (Sathianandan *et al*., 2008), the catch data for the period 2002-2015 were used. These data were first grouped into three categories of CC, GM Coast and PB and then a five point moving average was calculated for each of the resources or resource group and the maximum of the moving average of each resource or resource groups were taken. Then these were added together after classifying them into small pelagic, large pelagic, demersal, crustacean and cephalopod. Potential yield for each of these five categories was estimated by adding the maximum of the moving average of the resources/ resource group identified for that category. The potential yield estimated for each category was distributed proportionately to the average catch of the fleet for the period 2013-2015. Using catch per hour (CPH) for trawlers and catch per unit effort (CPUE) for other fleets, the total number of hours and units of operation required for each type of fleet to catch their proportion of potential yield was calculated. These hours of operation and number of units by each fleet for the potential yield was divided by the average trip per year to get the maximum sustainable fleet size.

Table 12. Potential yield and average catch of different groups from different regions of TN.

Coromandel				Palk Bay			Gulf of Mannar		
Group	Potential Yield(t)	Average Catch(t)	% of potential catch	potential Yield(t)	Average Catch(t)	% of potential Yield	Potential Yield(t)	average	% of potential
								Catch(t)	Yield
Demersal	103407	58400	56.5	92010	63720	69.3	75014	64846	86.4
Small pelagic	134234	100857	75.1	139316	74522	53.5	112392	79426	70.7
Large pelagic	20795	15376	73.9	4604	3224	70	18319	12697	69.3
Crustacean	16601	12297	74.1	23461	20528	87.5	6053	4378	72.3
Cephalopod	11675	6674	57.2	5255	4480	85.3	11726	7907	67.4
Total	286712	193604	67.5	264646	166474	62.9	223504	169254	75.7

4.1.4 Optimum fleet size

Table 13. Optimum fleet size from different regions of TN.

Different crafts	Existing fleet size	Maximum sustainable fleet size	% in excess or deficient
Palk Bay			
Mechanized trawl	2650	1220	117
(If 50% do cross border fishing)		610	334
Out board gillnet	2571	3626	29(less)
Other OBM	N. A	250	N.A
Outboard hook & line	N.A	595	N.A
Outboard ring net	57	35	63
Outboard trawl net	N.A	648	N.A
Coromandal coast			
Mechanized trawl	2139	1698	26
Mechanized ring seine	249	88	183
Mechanized drift gillnet	284	420	32(less)
Out board gillnet	12807	8880	44
OBHL	N.A	279	N.A
OBRS	N.A	87	N.A
OBTN	N.A	59	N.A
Gulf of Mannar			
Mechanized trawl	908	685	33
Mechanized hook & Line	380	226	68
Mechanized drift gillnet	N.A	153	N.A
Out board gillnet	9482	5996	58
Outboard hook & line	N.A	988	N.A
Outboard ring net	N.A	155	N.A
Outboard trawl net	N.A	38	N.A

N.A :Not available.

4.1.5 Level of by-catch and discards

Earlier the non-edible fishes were taken by merchants and sent to the fish meal plants after drying in the sun. It was only an ancillary activity. But with the setting up of fish oil companies which require fresh fish, the demand for by-catch in fresh condition became very high. This high demand coupled with decent

income acted as an impetus to undertake even targeted fishing for by-catch in Gulf of Mannar and in places like Nagapattinam. This resulted in the increase in the magnitude of exploitation of certain resources which otherwise formed only normal by-catch and this in a way masks the decrease in the availability and abundance of quality fishes when the total production alone is considered.

In Tuticorin fishing harbor, the single day trawlers landed 2009 t of low value by-catch in 2010-2011 (Jeyasanta and Patterson, 2017). All the fishes irrespective of their category, condition or size are in great demand because of which they are rarely discarded. This is the case in Chinnamuttom fishing harbor also. In Nagapattinam, there is even targeted fishing for low value fishes. Sometimes even quality fishes like mackerel and oil sardine also find their way into oil extraction purpose. In Chennai Fishing Harbor, the estimated low value by-catch in single day trawl was 13% (3000 t) of the total landing in 2008 which increased to 17% (5000 t) in 2011. The reported discard was only 1% (Dineshbabu *et.al.* 2013). However in multiday trawlers, the low value fishes of only the last haul are brought to the harbor and according to the fishermen, rest is discarded into the sea in Chennai, Cuddalore etc and the quantification of discard is not made mainly for want of reliable data.

4.1.6 Level of subsidy in fisheries

Tamil Nadu government give subsidies to fishermen on fuel and financial assistance during fishing ban and lean season. The states also gave subsidies for purchase of new nets and boats, life-saving jackets and navigation systems, and the development of marine infrastructure. During 2017-18, Tami Nadu government gave a subsidy of 2285.2 million which was the highest among maritime states. Of this amount, centres contribution through MPEDA was 3%.

Sale tax exempted fuel to the boats

The government of Tamil Nadu provides Tax exempted high diesel of 18000 liters per craft per year for mechanized fishing boats and 4000 liters per craft per year for motorised crafts registered in the fisheries department. The government also provides Tax exempted industrial kerosene of 3400 liters per craft per year to the fishermen of Tuticorin, Tirunelveli and Kanniyakumari districts who own motorized traditional crafts fitted with kerosene driven motors.

Subsidy assistance for purchase of outboard motors and inboard motors

The government is providing subsidy assistance towards the purchase of Outboard Motors (OBM)/Inboard Engines (IBE) to be fitted in the traditional

crafts of fishermen. This is coming under Blue Revolution Scheme. The fishermen will be provided with 50% subsidy of the unit cost of the engine or ₹30000/- whichever is less which will be shared equally between the centre and state governments under the scheme.

Subsidy assistance for purchase of tuna long liner cum gillnetter

To diversify the fishing operation from inshore fishery to the under exploited offshore fishery, government introduced a scheme for providing 25% subsidy for conversion of mechanized fishing boats and replacement /upgradation of motorized fishing crafts into tuna long liners in 2010-2011 and this was increased to 50% in 2012. In 2013-14, the maximum subsidy amount was fixed at ₹30 lakh based on the estimation of the unit cost as ₹60 lakh.

Subsidy assistance for diversifying trawl fishing into deep sea fishing in PB.

In order to phase out trawling from Pak Bay and diversify the trawlers into deep sea vessels, the government introduced a scheme. Under this scheme, in 2013-14, the maximum subsidy amount was fixed at ₹30 lakh based on the estimation of the unit cost as ₹60 lakh. In 2017-18, the unit cost per unit was fixed as ₹80 lakh with a subsidy of 50% from government of India,20% from government of Tamil Nadu, 10% from the beneficiary fisherman and the balance 20% shall be met out from Institutional financing. The government has accorded financial sanction for ₹286 crore (₹200 crore by Government of India and ₹86 by state government) for the diversification of 500 boats in first phase.

Chapter 5

Management Issues and Options

5.1 Issues common to Tamil Nadu Marine Fisheries

Fishing days and number of units: In many of the mechanized landing centres, the number of fishing days is highly variable and the actual effort expended may be less than 50% of the available units. Besides, though there is no apparent increase in the number of units, there is a tendency to increase the catchability of a unit by constantly increasing the size of the boat, capacity of engine and size of the net on a competitive basis in open violations of the regulations imposed by the government. The technological advances also contribute to an increase in the real fishing capacity. These point to over capacity and over capitalization.

Absence of a common vessel registry: In all the harbours where there is multiday fishing, it is absolutely difficult to get the exact details on the number of fishing days by a unit, its area of fishing, actual number of units landed a day along with catch particulars as at present these information are known to the concerned owners or the persons associated with them only.

Jurisdictional area: As the vessels including those coming under indigenous units are capable of going to deeper areas, the fishing grounds are mostly beyond the territorial sea. At present there is ambiguity in the regulation of vessels fishing beyond territorial area.

Sectoral conflict- banned gears, encroachment: Certain gears are banned in Tamil Nadu though operation of these gears is rampant. There is a need to relook the ban in the light of wider acceptance of these gears and proportionate opposition. Another point of conflict is the encroachment of trawlers into areas earmarked for fishing by indigenous gears

Storage: There is a demand for storage facilities in the landing centres especially for deep sea fishermen targeting oceanic resources. According to them, the prices considerably drop if there is above normal landing and they are forced to sell it due to lack of facility for storage and its disposal later.

Marketing: Now deep sea fishing is practiced only from limited centres and the

number of units landing per day is also very limited mostly less than 50 in Chennai and less than 20 in Tharuvaikulam. The markets for more than 90% of the catches are in different places of Kerala and Kanyakumari district of Tamil Nadu.

Fishing vs. conservation: Often issues of conservation takes precedence over fishing which ultimately affect the livelihood of even innocent fishermen. This needs to be carefully and scientifically implemented so that the fishing and conservation go hand in hand.

Pollution: One of the serious issues is the pollution of coastal seas both from the effluents released from factories and houses as well as from the factories set up along the coastal areas. Plastic pollution is also an emerging issue.

Management on PPP harbours: The primary objective of a harbour set up on PPP mode is to run it on profit. So they may have to cater to boats even from outside the area and at the same time protect the interest of local boat owners.

Different level players-fisheries, forest, coast guard: The different departments entrusted to oversee different activities often act in isolation putting the fishermen in to untold difficulties.

Scientific data: The ability of the boats to access distant places, increase in the endurance, diversity in the fishing methods and targeted resources make the collection of true data on fisheries very difficult which will also affect the research result. Thus there is a need to make log sheet mandatory for the fishing units.

5.2 Issues particular to an area other than the general

Gulf of Mannar

Increasing magnitude of by-catch exploitation: The newly established fish meal plants and fish oil plants in and around Tuticorin and other plants in Tamil Nadu in addition to demands from places in Karnataka encourage the trawlers to do targeted fishing for bye-catches even when the normal operation is suspended due to poor catch of quality fishes. This is putting an extra pressure on resources which were either not exploited earlier or formed only a part of regular bye-catches.

Coromandel Coast

Increasing magnitude of by-catch exploitation: The demands from fish meal plants and oil plants situated even outside the state encourage the fishermen to bring all the by-catches besides engaging targeted fishing for it in areas

like Nagapattinam. By-catch is mainly comprised by juveniles of sciaenids, threadfinbreams, silverbellies and various species of clupeoid fishes. Even quality fishes like oil sardine and mackerel are in demand by fish oil companies. This is putting an extra pressure on resources.

The Fishing ground: The fishing ground of multiday trawlers from Chennai and Cuddalore extend from Nagapattinam to beyond Nizampatnam of Andhra Pradesh, at times extending beyond that. There is discontent among the counterparts in Andhra Pradesh erupting this into clashes between them at times.

Palk Bay

IUU fishing: According to international criteria, the fishing in the EEZ of another country without their permission is coming under IUU fishing. Now fishing in Palk Bay area is constantly under conflict as the vessels from our side are frequently confiscated by Sri Lanka for trespassing the IMBL and fishing in their EEZ notwithstanding the claim by the Indian fishermen that they are fishing on their traditional ground. So there is an urgent need to settle it. Otherwise the fishing can be labelled as IUU.

Diversification of fishing: The fishing for oceanic resources using hook and line and drift gillnetting in the EEZ of India is advocated as an alternative to trawling in Palk Bay. In this connection, there is an urgent need to assess the area available for fishing, the number of units that can be deployed, the manpower requirement, their training besides proper and sustained marketing avenues which will fetch a decent price to the catches.

5.3 Existing Management Measures

In the fishing communities, many aspects of village life including fishing are governed by the village councils/committees. Religious activities, social life, cultural activities and even civic affairs in the village are under their control. They have powers of taxation and collect revenues from a variety of sources including a percentage of the fish sale value. They can mete out punishment for violation of village decisions. Various kinds of sanction including the ultimate sanction of ostracization from the village community are applied, depending upon the severity of the violation. The relationship with the outside world is often mediated through the village governance system. Even law enforcement authorities cannot easily impose their will in a fishing village without negotiating with the local village committee or parish priest (in the case of the villages dominated by Christians). All fishing villages are part of the modern GramPanchayat System—the third and lowest tier of governance under the Indian constitution. Most Gram Panchayats have boundaries that go beyond the fishing village and include agrarian villages/

hamlets. The fishing village relate to the Gram Panchayat as one single block on most matters. All this means that in most areas, the fisherman's first loyalty or accountability is to his village governance system and then only to other external authorities. As far as fishing is concerned, all aspects of fishing come under the purview of the village self-governance system. Many kinds of rules and regulations govern fishing in each village. These include fishing technology, fishing time, market times, market rules, *etc*. Conflict resolution is very much part of the mandate of the village committees. It is note-worthy that the village self-governance system tends to be all-male. However, a crack in the male bastion is visible with the women becoming members of parish committees of Kanyakumari district and some of them rising to the position of Vice presidents of their parish (FIMSUL 2011).

There are already some management measures which can broadly be classified as:

a. Community based local management

Community based planning processes have advantage in that local stakeholders are given greater control in resource management, are afforded increased legitimacy in decision-making processes, and are able to incorporate place based approaches more reflective of local conditions and community priorities. There are landing centres throughout the coast in Tamil Nadu and one of the characteristic features of these landing centres is their ownership. The landing centre of a village is for the use of that particular village and no intrusion is allowed. This is more prominent along Gulf of Mannar. Because of this, each village has their own rules and regulations for the fishing activities and all the people involved in fishing and allied activities meticulously follow it. These management measures have remarkable agreement with the FAO code of conduct for responsible fisheries which states that the right to fish carries with it an obligation to do so in a responsible manner. Some of these local management measures are highlighted here:

1. Working of Village councils (Ur Panchayats) in Nagapattinam as an example: Informal councils locally known as Ur Panchayat which govern the fishing villages are prevalent in CC (Bavinck and Vivekanandan, 2017). The Ur Panchayat is in charge of fisher affairs in each village. This is a self-governance system. The fishing villages are relatively small (500–5000 persons) and homogenous with single caste system being the norm. The Ur Panchayat here consists of three levels. The Ur panchayat at the first or settlement level is the strongest. The second institutional level coincides with the taluk. There are five such groupings in Nagapattinam-Karaikal area with one village in each grouping playing the role of talaigramam. The fisher population views villages that possess this status as having more power either because of their population count, or because of

their economic wealth and influence. In case of sub-regional issues that need addressing, it is the head village that calls or is requested to call a meeting. The final layer includes the fishing population of the region as a whole, and is known as the Fisher Organization of Nagapattinam. Ur panchayats form the pinnacle of a village society that is made up of various family groupings and residential units (Bavinck, 2001). It is these groupings and units that appoint representatives into the 'Ur panchayat' with various qualities guiding selection level of education, experience in fishing, ability to articulate ideas well, size of following and connection to the outside world. Most 'Ur panchayats' opt for a system of nomination in which past members plays a major role. The role of Ur panchayats relates to the well-being of the village and thus manages all affairs which may be of social, economic and environmental relevance. Fishing and fish trading being the major livelihood option, the 'Ur panchayat' naturally involve themselves in fisheries matter. Dispute resolution is a major activity. If dispute involve parties outside the village, settlement will be arrived at with them. They also regulate gears that they feel harmful to the profession.

One disadvantage with these community based management measures is that their control is limited to their village. So the gear prohibited in one village may be permitted in adjacent village. Ring seining is an example which is prohibited in some villages but is active in other villages.

2. Shore-seine operation at Valinokkam, Ramanathapuram: The area earmarked for shore seine operation will not be encroached upon by others. As the area is limited, they have introduced rotation system for the operation of the units. The units are permitted to operate only on the day of their allocation and no owner can violate this. Moreover in order to tide over manpower shortage, the same manpower is used for the operation of all the units. Because of this, the shore-seine operation is still active here.

3. Tharuvaikulam, Tuticorin district of Tamil Nadu: Tharuvaikulam landing centre is the only place in GM where an year round operation of mechanized multiday drift gillnet targeting oceanic resources especially tunas is being practiced except during the uniform fishing ban period. One of the decisions of the Panchayat is that the boats based at the landing centre should not use trawl net and instead use only selective gears like gillnets and hook and line. Everybody meticulously abide by that. Though there is no restriction on fishing, Sunday is a holiday for the centre and hence no disposal of the fish on that day. Another peculiarity is that all the fishermen here belong to the Nadar community, especially Christian Nadars unlike other centres.

4. Veerapandiapatnam, Tuticorin district of Tamil Nadu: Based on a decision and with full support from the people, the mechanized trawling is suspended

from here during June to October. During other months, these boats are moored at Tuticorin fishing harbour. But the traditional gears are operated throughout year from here.

5. Kombuthurai, Tuticorin district: Actually the forefathers of the present fishermen migrated from Kanyakumari district. The villagers at that time allowed them to fish from there on condition that they should use only hook and line mode of fishing. These migrant fishermen later settled there and the present generations also continue that tradition.

6. Regulation of sea weed harvest in Ramanathapuram district: In order to control over exploitation and thus sustain the sea weed resource, since 2006, seaweed collection (*Gelidiella acerosa*) is banned during the month of October to January in Palk Bay region, whereas in Gulf of Mannar region, seaweed (*Gelidiella acerosa*) collection is banned during the month of March to June. Similarly the seaweed (*Sargassum* spp.) is collected only during the month of July to October in a year. In some villages collection of seaweeds is restricted to 12 days in a month, with Friday designated as no-collection day. Another community initiative is the banning of metal scrapers for collection of seaweed. Traders have been asked not to buy seaweed collected with scrapers. (Johnson, 2013).

b. Co-management measures as a method to avoid clash between mechanized trawlers and indigenous gears

Most of the indigenous gears are operated during the night mostly on the wee hours and each net runs into kilometres when soaked in the water. The fishing grounds or the movement area of the mechanized trawlers are also the same. So in order to avoid a direct hindrance to the safe operation of the indigenous crafts, the government in consultation with the leaders of mechanized boat owners and traditional fishermen, implemented operational guidelines in Palk Bay and Gulf of Mannar.

Palk Bay:

Three days night fishing to mechanized crafts and four days for non-mechanized crafts was implemented in 1977 in Pudukottai and Thanjavore districts as a solution to put an end to the confrontation between mechanized and non-mechanized groups. Later in 1993, this was implemented in Ramanathapuram districts also. Accordingly the mechanized boats are issued tokens on the previous day of their fishing and no boat should go for fishing without the token. The boats usually go in the morning and return in the next day morning.

Gulf of Mannar

The mechanized trawlers operated from Tuticorin fishing harbour in Tuticorin district and from Chinnamuttom harbour in Kanyakumari district are allowed only day fishing. They have to leave by 5 A.M. and return by 9 P.M. and are regulated through token system. However, there are occasional complaints of damage of the traditional gears and then proper compensation is arrived at either through mediation between the affected parties or through government intervention.

c. Management as per the Tamil Nadu Marine Fisheries Regulation Act 1983 and Tamil Nadu Marine Fishing Regulation (Amendment) Act, 2016

There are different management measures with a view to sustain the resources and also to avoid conflict by different sectors. These are:

- Uniform fishing ban for mechanized vessels from 15 April to 29 May now extended to 14 June from 2017.
- Delineation of area for mechanized fishing vessel, i.e. 3 nm away from the shore till 2016 now extended to 5 nm away from the shore in the territorial waters as per the TNMFR (Amendment) Act, 2016.
- Motorized country craft with motors of 8 hp and above not to fish within 3 nm from coast line within territorial waters from 2016 as per TNMFR (Amendment) Act, 2016.
- Cod end mesh size of trawlers
- Size of boat and engine horse power being revised from time to time.
- Banning the fishing by purse seine, ring seine and pair trawlers since 2000.
- Restricting the operation of mechanized trawlers by limiting their time of operation in Gulf of Mannar and Palk Bay.
- Augmentation of coastal fish wealth through installation of artificial reef structures.
- Harbour Management Committees

Level of compliance:

Violations are reported mainly in the mechanized sectors and they are:

- Trawlers quite often operate in areas very close to the shore ignoring area delineation
- Most of the OBM crafts have engines of hp 8 or above and they generally do not adhere to area delineation.
- The size of fishing craft as well as the engine power is increased at their will.
- Mesh size is not as per regulation.

- The operation of ring net and pair trawling is going on in areas where there are no local objections.

Community based regulation of fishing gear and the reasons for their regulation: A few examples from Coromandel Coast (Bavinck and Karunaharan, 2006)

***Vaalaivalai ban*:** The fishermen of Madras region requested the colonial government in 1886 to ban Vaalai valai –a cotton drift net with a two inch mesh size used for catching mackerel and wolfherring. The main gear at that time was bag net.

Protest against synthetic net making materials Fisheries department commenced distribution of synthetic materials at subsidized rate around 1960. Though many accepted it, there was some protest against their use in Kalvinagar, Madras region. This protest lasted only for a year or two ending in 1965

Ban on fishing with bottom nets. In the late 1960s, many of the gillnet types of net which were in use became defunct because of the impact of trawl nets. But bottom set gillnet began to become popular and this was particularly effective in rocky bottoms. In Kalvinagar, the fishermen were using hook and line and so the council prohibited the use of bottom set gillnet. This ban lasted several years until the fishermen from Kavinagar learned how to use it and later became very widespread.

Introduction of trammel net. Private traders introduced the three-walled trammel net (Tamil: *mani*, *disco*, or *eppo valai*) to the Coromandel Coast in the early 1980s. It attained great popularity because of its rich shrimp catching potential. Soon after introduction, some places, especially in Kavinagar, its use was banned. This was mainly out of a fear that those who do not use this gear will not get any catch and this will badly affect the elder fishermen.

Banning of the snail net in 1996: In 1995, the traders introduced small hoopnet called kaachavalai for catching gastropods. But in the following months, the council prohibited its use. The fishers in general had three reasons to ban a newly introduced gear;

>Harm to the fish stock
>Harm to other gear users
>Harm to the community.

5.4 Suggested Input Output Control Measures

5.4.1 Input controls

Compared to output control measures, input control measures are relatively easy to implement and they also require an efficient monitoring system.

5.4.1.1 Registration and licenses for new fishing crafts: Tamil Nadu government made compulsory on line registration of fishing vessel and as on 30.6.2017, a total of 5861 mechanized fishing boats, 30239 motorized fishing vessels and 5427 non-motorized traditional crafts were registered. Even though this was done as a part of coastal security, it would definitely act as a check on the addition of new boats.

Table 14. Different category of registered boats from TN

Sl. No	District	Mechanized boats	Motorized boats	Non-motorized boats	Total
1	Thiruvallur	0	2154	1	2155
2	Chennai	852	1232	64	2148
3	Kancheepuram	11	2153	517	2681
4	Villupuram	23	1074	964	2061
5	Cuddalore	303	2421	1910	4634
6	Nagapattinam	1173	4399	136	5708
7	Thiruvarur	1	174	0	175
8	Thanjavur	271	1008	102	1381
9	Pudukottai	420	1172	238	1830
10	Ramanathapuram	1724	3485	1026	6235
11	Tuticorin	293	4378	38	4709
12	Tirunelveli	0	1079	1	1080
13	Kanyakumari	790	5510	430	6730
	Total	5861	30239	5427	41527

*Source: Tamil Nadu State Fisheries Policy Note 2016-17

5.4.1.2 Reduction of fishing effort: There is over capacity in the fishery. So in order to keep the effort at sustainable level, the maximum numbers of mechanized trawlers needed are 1698 in CC, 685 in GM and 610 in PB. The trawlers in PB are for operating within the Indian side of PB. Already the Tami Nadu Government has decided to phase out the trawlers from Palk Bay region and diversify them into deep sea vessels targeting oceanic resources. The government has to put a cap on the size of mechanized trawlers and no addition of new vessels but

only replacement of old vessels be allowed. The Mechanized hook and liners and mechanized gillnetters may be limited to 226 and 153 respectively in GM. OBGN may be reduced to 5996 and 8880 in GM and CC respectively. Mechanized ring seine (MRS) in CC may be reduced to 88. Mechanized ring seiners are now diversifying the fishing into deep sea for oceanic tunas.

5.4.1.3 Fixing and capping the size and power of boats: In order to get a larger share of the catch, there is a tendency to increase the size of the boat, fixing of more powerful engine and use of more lengthy fishing gear thereby nullifying the impact of effort reduction. The size and engine power may be fixed as per the recommendations by Mohamed *et al.* (2014):

Table 15. Size of mechanized trawlers and maximum allowable engine horsepower

Sl. No.	Length (m)	Breadth (m)	Depth (m)	Maximum allowable main engine horse power (MCR)
1	Up to 15.0	Up to 4.70	2.4	140
2	15.00-17.50	4.60-5.20	2.40-3.0	200
3	17.5-20.00	5.2-5.5	2.65-3.1	250
4	> 20	> 5.25	>3.0	> 250

Source: Mohamed *et al*., 2014.

Table 16. Size of mechanized gillnetters and maximum allowable engine horsepower

Sl. No.	Length (m)	Breadth (m)	Depth (m)	Maximum allowable main engine horse power (MCR)
1	Up to 15.0	Up to 4.6	Up to 2.4	Up to 90
2	15.0-20.0	4.6-5.5	2.4-3.2	140
3	>20.0	>5.25	>3.0	> 140*

Source: Mohamed *et al*., 2014.

Use of right sized engines reduces the initial investment, operational cost and fuel usage which eventually reduce the carbon emission also. High fuel usage, besides polluting the environment, decreases the economic viability of operation.

5.4.1.4 Closed season: The 45 day seasonal fishing ban for mechanized vessels from 15th April to 29th May since 2001 has been increased to 61 days from 2017. Though the primary objective of the fishing ban is protection of the spawning stocks, it also helps in regulating the fishing effort thereby giving a respite to the ecosystem. Therefore there is a need for the continuation of this.

5.4.1.5 Implementation of minimum legal size and regulation of mesh size: As a means of controlling the indiscriminate exploitation of juveniles and thereby preventing the growth overfishing, implementation of minimum legal size and regulation of mesh size is very effective. Moreover, as juveniles form dominant constituent of by-catch, it will also reduce the exploitation of by-catch.

CMFRI recommends to the DoF-GoT to implement the MLS as given in the report through proper ordinance or act. Consider the catch as a violation if more than 50% of the randomly selected fish sample of 25-50 numbers from the catch is composed of juveniles. Inspection can be made at the landing centre or at the sea.

Table 17. The optimum mesh sizes for different gears

Gear	Optimum mesh size(mm)	Specific resources if any
Gill net	33.4	Sardines
(Optimum mesh size determined for different species)	50	Indian mackerel
	152	Narrow barred spanish mackerel
	104	Indo-Pacific king mackerel
	126	Silver pomfret
	38	Indian white prawn
	84	Frigate tuna
	104.2	Little tuna
Ring seine	22	Indian mackerel, Oil sardine
	12	Whitebait
Trawl net cod end	35 mm square mesh size	Will facilitate escapement of juveniles

The recommended cod end mesh size is 35 mm square mesh for trawlers Source: Mohamed *et al*., 2014.

5.4.2 Output Controls

The main output control measures are total allowable catch (TAC) for a fishery and catch quotas. Output control measures are generally more difficult to implement. The catch in non-selective gears like trawl net comprises of several species many of which are of low economic value. Now trawlers account for more than 50% of the total landing. Fixing an upper limit on how much of a species can be caught by a trawler is fraught with so many practical problems. Some of the resources which form a dominant one in the catch may be a targeted resource in a selective gear. In such cases fixing a quota for each type of unit is highly problematic. Moreover, it involves high cost of monitoring besides accurately quantifying the catches. Notwithstanding these bottlenecks, attempts are being made to find a viable method.

5.5 Protection of Sensitive Habitats

5.5.1 Gulf of Mannar Biosphere Reserve

The GOMBR was set up in 1989 jointly by the Government of India and State of Tamil Nadu. The government of Tamil Nadu vide G. O. Ms No.962 dated 10.9.86 notified under section 35 (1) of the Wild life (Protection) Act 1972 the intention to declaring the 21 islands including 3.5 fathom depth on bay side and 5 fathom on the seaway side as Marine National Park for the purpose of protecting marine wild life and its environment along with sustainable use of marine resources and to address the livelihood issues of fisher populations. From 1.1.2013, the reserve is under the control of state government.

5.5.2 Exploitation of Endangered, Threatened and Protected (ETP) species

5.5.2.1. Elasmobranchs: The following 10 species of elasmobranchs (4 sharks, 2 rays, 1 guitarfish and 3 sawfishes) were included under Schedule I of the Indian Wildlife Act, 1972 in the year 2001.

Table 18. Species coming under Elasmbranchs included under Schedule 1 of Indian Wild Life Act,1972.

Scientific name	Common name	Family/Order
SHARKS		
Rhincodon typus	Whale shark	Rhincodontidae/Orectolobiformes
Carcharhinus hemiodon	Pondicherry shark	Carcharhinidae/Carcharhiniformes
Glyphis gangeticus	Ganges river shark	Carcharhinidae/Carcharhiniformes
Glyphis glyphis	Speartooth shark	Carcharhinidae/Carcharhiniformes
RAYS		
Himantura fluviatilis	Ganges sting ray	Dasyatidae/Rajiformes
Urogymnus asperrimus	Porcupine ray	Dasyatidae/Rajiformes
GUITARFISHES		
Rhynchobatus djiddensis	Giant guitarfish	Rhinobatidae/Rajiformes
SAWFISHES		
Anoxypritis cuspidate	Pointed sawfish	Pristidae/Pristiformes
Pristis microdon	Largetooth sawfish	Pristidae/Pristiformes
Pristis zijsron	Longcomb sawfish	Pristidae/Pristiformes

Exploitation and trade of these species are banned and declared as punishable offence.

In August 2013, the Ministry of Environment and Forests (Wildlife Division) prohibited the removal of shark fins on board vessels in the sea, and advocates landing of the whole shark(*vide F. No4-36/2013WL, 21 August 2013*). In February, 2015, the Department of Commerce of the Ministry of Commerce and Industry, Govt of India, through Notification No.110/(RE-2013)/2009-2014 and Notification No.111/(RE-2013)/2009-2014 prohibited the export of shark fins of all species of sharks. India is also a signatory to IOTC Resolution 13/06/ 2013 which states that Oceanic white tips are not to be retained and are to be released unharmed, to the extent practicable, when caught in association to IOTC regulated fisheries

Table 19. Species of sharks and rays included in Appendix II of CITES

Scientific name	Common name	Family/Order	Year of inclusion
SHARKS			
Carcharhinus longimanus	Oceanic white tip	Carcharhinidae/ Carcharhiniformes	2014
Carcharhinus falciformis	Silky shark	Carcharhinidae/ Carcharhiniformes	2016
Sphyrna lewini	Scalloped hammerhead	Sphyrnidae/ Carcharhiniformes	2014
Sphyrna mokarran	Great hammerhead	Sphyrnidae/ Carcharhiniformes	2014
Sphyrna zygaena	Smooth hammerhead	Sphyrnidae/ Carcharhiniformes	2014
Alopias pelagicus	Pelagic thresher	Alopiidae/Lamniformes	2016
Alopias superciliosus	Big-eye thresher	Alopiidae/Lamniformes	2016
RAYS			
Manta birositris	Giant manta ray	Mobulidae/Rajiformes	2014
Manta alfredi	Reef manta ray	Mobulidae/Rajiformes	2014
Mobula spp. (5 species)	Devil rays	Mobulidae/Rajiformes	2016

Further the inclusion of 14 species of sharks and rays in Appendix II of CITES in 2014 and 2016 have helped to tighten the reins on undue exploitation for sharks through targeted fishing. CMFRI's study on Non-Detriment Findings for exploitation of CITES listed species recommends a precautionary approach (Zacharia *et al*., 2017) in fishing of these listed species. Stakeholder meetings conducted by CMFRI at four major centres in Tamil Nadu (Chennai, Thoothukudi, Mandapam and Thoothoor)

in 2016 have helped to generate awareness on the impact of fishing CITES listed species and the need to obtain CITES certification for export of non-fin products (export of fins being banned by the Government of India). The need for CITES certification for export of the listed species in whole or non-fin product form will help control the trade of fins and other parts, particularly of protected species, masked under other names. However, this can also lead to the rejection of several consignments of non-fin (elasmobranch) products of species other than those listed in the WPA or the CITES.

In addition to these specific measures, fishing practices along the Indian coast (or parts of) are also regulated, through Marine Protected Areas declared by the Ministry of Environment, Forests & Climate Change, fixing Minimum Legal Size (MLS) for capture of common species, gear-specific mesh size regulations, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, introduction of by-catch reduction devices and seasonal ban on fishing (particularly trawling) activities from 15 June to 31 July along the west coast and 15 April to 31 May along the east coast, implemented under the State MFRAs. However, there still exists a gap between the fished, the traded and the reported, and the need of the hour is to bridge this gap in order to put in place effective regulatory and management plans for conservation of the protected and endangered resources. The Tamil Nadu Forest Department, in collaboration with the Wildlife Institute of India, under the CAMPA-Dugong Programme of India, is in the process of developing the next management plan of the Gulf of Mannar Marine National Park (GOMMNP) and Biosphere Reserve for the period 2017-18 to 2026-27. CMFRI has recommended a set of action plans to ensure conservation of protected elasmobranchs in the habitat, which can be expanded to the entire Tamil Nadu coast.

In order to ensure region-specific and resource-specific management regimes, the following action plans are suggested for implementation.

Immediate documentation of current fishing grounds on a spatio-temporal basis with respect to shark resources – this can be done on a participatory approach. Data sharing between fishers and government research/implementation agencies can be made mandatory through educating the fishers about the biological vulnerability of shark resources. Such data can be used to identify seasons and grounds of shark aggregations for feeding and breeding and can be more effective in determining closed seasons, closed grounds and gear restrictions.

Defining the availability of ETP resources in Tamil Nadu waters – this can be done either with the help of fishermen or through exploratory surveys. The latter is time consuming and entails utilization of manpower and funds which can prove constraining. Hence,

a participatory approach is called for. Correct information on fishing grounds can be obtained from fishers who operate in the coastal waters of Tamil Nadu.

Occurrences (sightings and incidental catches) of protected species, particularly the whale shark, Pondicherry shark, all sawfishes, giant guitarfish and porcupine ray, and the CITES listed species – hammerhead sharks, oceanic white-tip shark, manta rays, thresher sharks, silky shark and devil rays, must be mandatorily reported to the monitoring agencies. Wherever possible details regarding grounds, gear, weight of catch, numbers caught etc. must be recorded and shared.

Seafaring activities like shark ecotourism can be encouraged in critical habitats such as the Gulf of Mannar, to reduce shark fishing and offer alternate livelihood means for the fishers. Spotting and swimming with the whale shark can be promoted along the lines followed in countries like Australia and South Africa.

There should be a widespread awareness campaign in the region and fishers and locals should be educated about vulnerable shark resources and the need for conservation and management. Posters, pamphlets and handouts can be distributed for generating awareness. Research agencies like CMFRI and NGOs can play a major role in these campaigns.

Continuous monitoring of shark occurrences and landings must be done to establish a strong database that will easily reflect changes in fishing and landing patterns as well as trade and utilization, following the implementation of regular action plans which can be altered according to the status of the resource.

Strong linkage must be made mandatory between different agencies including research bodies, legislative and management implementing authorities, monitoring agencies, NGOs, fishermen associations, trader associations etc. with all the agencies working towards a common goal which protect the habitat, the resource and the interests of the primary stakeholders without affecting their livelihood.

The Government of Tamil Nadu must implement strict monitoring of all elasmobranch consignments at ports of entry/exit, and take necessary steps to control at sea transfers.

5.5.2.2 Sea cucumber: In India, sea cucumbers are mainly distributed in Gulf of Mannar and Palk Bay along main land coast. Of the 39 species of sea cucumbers reported from Gulf of Mannar and Palk Bay (Sastry,1998), the *beche-de-mer* production was mainly from two species, *Holothuria scabra* and *Holothuria spinifera* and occasionally on 4 to 5 additional species based on their availability. Indiscriminate exploitation and insufficient management measures have caused

over exploitation of the species (Asha *et al*., 2017). The ministry imposed a blanket ban in 2001 on the fishery and trade from Indian waters by listing all holothurians under schedule I of the Indian Wild Life (Protection) Act, 1972 which was implemented strictly since 2003. Due to illegal fishing and clandestine trade even during the ban period, the ban could not yield the expected result.

Asha *et al*.(2017) from CMFRI gave the following suggestions for the conservation and sustainable fishery of sea cucumbers:

- Lift the moratorium on selected species of sea cucumbers by the Ministry of Environment, Forests and Climate Change, Government of India, initially for a period of one or two years, on an experimental basis.
- Constitute a National Committee by the government comprising of scientists, officers of the Forest Department and Fisheries Department and fishermen representatives for developing a framework for sea cucumber fishery management.
- Have a totally regulated sea cucumber collection and trade, strictly following all the guidelines and /regulatory measures laid down by the National Committee in the management guidelines.
- Carry out strict monitoring and surveillance of fishery and trade, particularly with regard to the quantity of each species of sea cucumber harvested by individuals or groups, size that is caught and the quantity that is traded.
- Involve the local communities in every stage of planning and decision making process.

5.5.2.3 Sea horse: Gulf of Mannar and Palk Bay are known for rich biodiversity of seahorses (six species) and this region was the main contributor of export trade of sea horse from India. The depletion of sea horse resources from the wild forced the Government to enforce a ban on the export permits of all species of syngnathids from July 2001 and listed them under the Schedule I, Part-IIA of the Indian Wildlife (Protection) Act, 1972. All seahorses (*Hippocampus* spp.) are listed in Appendix II of CITES in 2002, and implemented from 2004 (CoP-12, 2002). Since then, all nations that are signatory to CITES are required to submit export and re-export records for seahorses. Following implementation of ban, there is considerable decrease in fishing of syngnathids. However, the demand in the overseas market for dried seahorses has only resulted in clandestine fishing and trade which may continue and may, if unchecked. The livelihood of fishers who were engaged in the collection and trade of seahorses were severely affected and they have few alternate options of livelihood. The dependency on livelihood has also led to illegal collection and trade of seahorses even after the ban. The studies have shown that a controlled or a regulated capture of seahorses from the wild with proper monitoring appears to be the preferred policy solution (BOBLME, 2015). Some of the regulatory measures suggested in the report are:

i). Seasonal closure: If the Government lifts the moratorium on collection and trade of seahorses, there should be a seasonal closure for six months which have to be reviewed in the subsequent years.

ii). Minimum Legal size: For all the seahorse species found in the Gulf of Mannar and Palk Bay, the recommended minimum legal size of capture is 10 cm.

iii). Rotation of harvest areas: During every fishing season, certain areas can be restricted from fishing and fishing can be done in the subsequent year in these areas. This regular rotation of harvest areas will also help in stock enhancement.

iv). No-take zones: There should be a no-take zone and this 'no-take zone' need to be identified involving the local communities who were involved in seahorse fishing and have a rich knowledge on seahorse habitats and areas of abundance. A community level self-imposed regulation would be far-reaching and successful in restricting targeted fishing for seahorses in the designated no-take areas.

v). Gear limitation: The operation of trawl in the inshore areas, very close to the shore need to be restricted in order to minimize the by-catch of seahorses. Also, the country trawl or the mini trawls which are operated exclusively in the seagrass beds need to be limited or restricted.

vi). Catch quota: The fishermen who were involved in the collection of seahorses should be registered and license need to be issued to each one of them. Also, quotas should be fixed for individual fishers or a fishing group, so that resources are not over-exploited and this also ensures equity in sharing of resource. The registered fishers should maintain log books on catch and sales, which should be made available to the concerned authorities for verification. Deciding upon 'Quota of Harvest' for each fishing unit should be based on the outcome of periodic stock assessment studies conducted by research institutions. Also, there should be strict inspection and monitoring of the harvested catch by the concerned authorities and the renewal of license should be denied for non-compliance of catch quota

vii). Habitat protection: Protect and restore the critical habitats such as sea grass beds and coral reefs for conservation of seahorses

5.5.3 Enhancement of *Penaeus semisulcatus* stock through sea ranching by CMFRI

CMFRI has initiated sea ranching of hatchery produced seeds of *P. semisulcatus* in Palk Bay (~ 3 million PL of 15-20 mm/year) to replenish the stock and is also planning to intensify it and assess the impact of this on the natural stock.

5.6 Migrant workers

In Tamil Nadu both outward migration and inward migration of fishers are prevalent. Outward migration involves intra district, inter district, interstate and foreign country migration. In Tuticorin fishing harbor, though people from nearby areas like Kayalpattinam, Punnakayal etc work in the trawlers, peak migration is during peak fishing months from June to August-September. Thereafter, the percentage of boats going for fishing will be drastically reduced due to lean period. Accordingly the manpower requirement also comes down substantially. In Chennai, people from Tuticorin are employed as captains in majority of the multiday drift gillnetters targeting oceanic tunas. The pull factor is higher income. There are studies from Tamil Nadu indicating migration of agricultural labourers from the districts of Villupuram and both agricultural workers and fishers from Ramanathapuram to Dakshina Kannada (Swathy Lakshmi and Johnson, 2013) and fishers from Kanyakumari to different fishing harbours of Kerala and Malpe in Karnataka (Sathiadhas*et al*., 2008). The fishers from Kanyakumari operate their mechanized boats from these states targeting sharks. But now they are targeting large pelagic like tuna and bill fishes from deep sea using hook and line. In addition, fishers from Kanyakumari district work as captain on most of the trawlers that operate from Kerala because of their exceptional fishing skills coupled with their willingness to undertake deep sea fishing trip. Fisherfolk from Kanyakumari, Cuddalore, Tuticorin and Ramanathapuram districts in Tamil Nadu also work in boats that operate from Kerala coasts. The push factors for migration from Villupuram to Dakshina Kannada in order of rankings were lack of employment, less wages in agriculture sector, incidence of drought and lack of own land for cultivation. The push factors of migrants from Ramanathapuram in order of rank were less employment opportunities, dwindling catches, lesser wages and problems associated with cross border fishing in Palk Bay. The pull factors include more employment opportunities, higher wages and sustained income. The push factors for Kanyakumari for the operation of boats from Kerala are less service facilities including disposal of catch and for labourers, it is less wages and absence of continued labour opportunity.

Gulf countries are the main countries where the fishermen mostly from Kanyakumari and Ramnathapuram districts migrate to work in the fishing vessels there. In addition to this, it is reported that 40% of the fishermen from Arcattuthurai of Vedaranyam Taluk in Nagapattinam migrate to countries like Singapore, Malaysia and Middle East countries in search of employment in sectors other than fishing. Here also the main push factor is poor income from fishing. One of the serious problems for the fishermen who migrate to gulf countries as fishing hands is their insecurity in work place because they are always at the risk of either losing their life or confiscation and jail term in neighboring countries for illegally crossing and fishing in their waters. The affected families seldom get any compensation.

The inward migration is from states like Andhra Pradesh, Telangana and Northeastern states. They are mainly seen in Chennai and Cuddalore fishing harbors. The people from Andhra Pradesh and Telangana are employed in trawlers and gillnetters as fishing hands in Chennai whereas people from north eastern states work mostly in ice factories and at the fish purchasing companies located in the harbour at Chennai and Cuddalore. The people who are employed in fish handling companies are given salaries besides free accommodation and food whereas the migrant fishers normally stay in the boats. Here also the push factors are less opportunities and low wages. The pull factors are reasonable wage and decent living conditions.

The newly constructed JPR fishing harbour at Muttom and another fishing harbour at Thengaipattinam may pave the way for the boats from Kanyakumari operating from ports of other states to return to Kanyakumari. Moreover, as the JPR port is on PPP mode, any boat from any other area can come and sell their catch from there.

5.7 Industries depending on fisheries

The main industries involved in fisheries are boat yards, ice factories, processing plants, fish meal and fish oil companies. These are mostly owned by private parties. A major part of the by-catch as well as oil sardine is going to Karnataka, Andhra Pradesh etc for oil extraction and fish and cattle feed industries.

Table 20. Industries engaged in pre-harvest activities

Industries	CC	GM	PB	Total
Boat yards	38	24	13	75

Table 21. Industries engaged in post-harvest activities

Industries	CC	GM	PB	Total
Ice factories	29	26	33	88
Cold storages	7	3	7	17
Freezing plants	4	7	3	14
Curing yards	81	5	10	96
Peeling sheds	101	4	7	112
Processing plants	4	4	7	15
Extraction plants	1	1	0	2
Fishmeal plants	1	1	0	2

Ice factories are more in PB but curing and peeling sheds are more in CC (Table 25). The fact that extraction plants and fishmeal plants are present in CC and GM area indicates the more conducive opportunities like availability of raw materials, suitable sites *etc.*

Chapter 6

Recommended Management Measures

The study indicates that there is overcapacity in the fishing fleets in Tamil Nadu. Accordingly the existing fleet sizes have to be regulated to the desired level treating each region separately as found out from the present study taking fishermen into confidence. The mechanized trawlers are found 26% in excess of the maximum sustainable feet size in CC, 33% in GM and 334% in PB. The Mechanized hook and liners and mechanized gillnetters are in excess of 68% and 58% respectively of the MSFS in GM. In CC, OBGN is found to be 44% in excess of MSFS. Mechanized ring seine in CC is in excess of 183% of MSFS.

The engine power of the boat has to be regulated depending on the mode of fishing. For this, strict monitoring and suitable punishment to the violators must be introduced.

Indiscriminate harvest of juveniles and uncontrolled exploitation of non-edible resources should be discouraged through proper and effective intervention as the major constituent of the non-edible by-catch is also comprised mainly by juveniles of commercially exploited resources. In order to reduce the juvenile domination, introduce square mesh instead of the existing diamond mesh in the cod end of trawlers. Implement minimum legal size for the commercially important resources. Impose suitable monetary fine to the merchants who purchase the juveniles. Local agreement by the trawl owners not to bring the non-edible by-catch to the harbour is more effective. It is partially successful in centres like Cuddalore and Kasimedu.

Even though pair trawling and ring net are banned, their operation is rampant. At present, pair trawling is limited to certain areas in CC and PB. In PB, the operation is seasonal and is prevalent especially during the abundance of shoaling fishes like oil sardine. Here this resource is not targeted by the traditional gears. In Nagapattinam, but for the size of the gear and proportional increase in the magnitude of catch, catch composition in pair trawl is same as that in the trawlers operated from there. Moreover, operation of pair trawling is unabated even after the imposition of ban. The operation of mechanized ring-seine is prevalent in Cuddalore and some areas of Nagapattinam since its introduction and this gear is also operated from outboard motor operated FRP boats in other districts like Tuticorin, Tirunelveli, Tiruvallur,

Villupuram, Ramanathapuram*etc*. The percentage cotribution of ring net catch in total catch is less than 20% whereas that of trawl net is above 60%. The traditional pelagic gillnetters mainly target lesser sardines and mackerel. If the percentage contribution of oil sardine, lesser sardine and mackerel by trawl and ring nets are considered, the percentage contribution by trawlers in respect of lesser sardine and mackerel landings are very high as is visible from the table.

Moreover the ring net catch is dominated by oil sardine and the percentage of lesser sardines and mackerel are below 20% only. Thus it is clear that ring net is mainly targeting oil sardine and no other traditional gear targets oil sardine though this resource form part of the catch in some gears. So it can be seen that ring net is not a threat to other traditional gears. In fact, its percentage in the landing of lesser sardine and mackerel is much lower than that by trawl net. However, the present study found that the number of mechanized ring seine available at present is 117% more than the maximum sustainable fleet size (MSFS). Hence there is an urgent need to reduce the number but not ban it completely.

In Palk Bay only the excess trawlers as found out from the present study should be completely phased out as it is not possible and also not prudent to completely phase out trawling considering the resultant drastic reduction in the production besides loss of livelihood options to many people. The initial phasing out should be targeted to those who are willing to opt out from fishing and secondly to the boats from areas which are constrained to or are likely to do cross border fishing because of their proximity to the IBML and other positional disadvantages. It is informed that there are many owners who are willing to surrender their boats to the government provided the government gives them a decent buy back value. The government should give top priority to this. The government should also ensure that the boats thus acquired are not used in Palk Bay for the same purpose by a third party. The next target should be boats from Rameswaram. Among the different areas, Rameswaram is more disadvantaged in that they can take their boats toward north only as the entry to the Gulf of Mannar is rendered difficult due to shallow nature of Adam's bridge. As the easy option is to move towards north, there is every likelihood of the boats to cross the IMBL as it is very near. Therefore the trawlers from Rameswaram must be completely phased out. As already mentioned the boats from other areas fishing in Palk Bay have some options to continue to fish from the grounds either in Palk Bay of India or Gulf of Mannar. The boats from Mandapam (GM side) operate 7 to 8 months in Gulf of Mannar and only during the rest of the period, they fish in Palk Bay. The boats from Thondi and Soliarkudi are also mostly fish in the Palk Bay of our side. Moreover, there are already known trawl fishing grounds in Pudukottai and Thanjavur and most of the boats are fishing in an around these grounds from these places. So the remaining trawlers may be allowed to trawl in the traditional ground found within our waters in Palk Bay or Bay of Bengal limiting

their number within MSFS. The existing trawlers should be limited to 610. Moreover the present study shows that there is scope for increasing the traditional gillnetters here. The government may encourage the adoption of traditional fishing methods. For this, besides the willing mechanized boat owners, the government may also introduce a plan to issue traditional craft and gears to fishermen of mechanized trawlers on subsidy as an alternate source of employment and income generation.

Before venturing into deep sea fishing to catch oceanic tunas and other resources as part of diversification and as a replacement for trawlers in Palk Bay, there is an urgent need to assess the area available for fishing, the number of units that can be deployed, the man power requirements, their training besides proper and sustained market avenues which will fetch a decent price to the catches. This is inevitable since the fishermen practicing other modes of fishing cannot immediately start multiday deep sea gillnetting or hook and line. The typical example is Kasimedu, Chennai where more than 80% of the drivers who control the deep sea multiday gillnet fishing operation are from Tharuvaikulam of Tuticorin. Without their participation, this fishery will be almost nominal there. Moreover, proper landing centres have to be made available in Gulf of Mannar and Bay of Bengal for smooth operation of these boats.

At present, the fishing for oceanic tunas using long line is in its nascent stage as only limited boats are engaged in it. The fishing for larger oceanic tunas especially yellow fin tuna using hook and line at present is seasonal and is practiced along areas like Colachel. But here also, the hook and lines are operated as trolls from trawlers as a subsidiary fishing. Even though some boats from Kasimedu, Chennai started using long lines for tuna in 2017, they later shifted to drift gillnetting.

Though the fishermen from Thoothur, Kanyakumari are adept at long line fishing in deep sea, they are highly mobile and are fishing all along the Indian coast. Thus there is complete absence of targeted fishing for larger yellowfin tunas. So there is a need to show the viability of this fishing among the fishermen fishing here through proper training. Moreover some incentives should also be given to those who really initiate this fishing. A good market avenue is also to be arranged prior to the beginning of this fishing.

The cod end mesh size of trawl net may be fixed at 35 mm square mesh as recommended by the committee to evaluate fish wealth and impact of trawl ban along Kerala coast (Mohamed *et al*., 2014). According to them, this will facilitate escapement of juvenile fishes.

The government may introduce token system at each mechanized landing centres in CC just as in GM and PB to account the daily movement of number of vessel out or into

the harbor as at present the owner of a boat or his coterie only know the whereabouts of it. In the case of traditional gears, there is no token system even in PB and GM. As the landing centres are mostly situated in the villages or nearer to them, the issue of token in the traditional landing centres can be entrusted with the concerned village. This would enable accounting of the actual number of units going for fishing from each centre. Moreover this would also facilitate the government to understand the fate of the number of boats in case of some calamities like cyclone, tsunami etc.

As no management measure can be implemented without the full cooperation of the stakeholders especially the fishermen, participatory mode of implementation will be more effective. So the government under the fisheries department should form a three tier system of Fisheries Management Councils: village level, district level and state level management councils involving the fishermen / fishermen leaders in addition to other stake holders such as representatives from fishing industry, merchants, NGOs and researchers for the effective management as done in Kerala. In the case of Fishing Village Management Council, there already exists village panchayat or village church council and harbour based fishing management committees. The village panchayat or village church council functions under the leadership of panchayat president or village church parish. All the fishermen of age 21 or above are members and they are bound to obey the decisions of the head. The harbour based management committee mainly cater to the interests of the owners and fishermen of mechanized boats of the respective harbours. These committees act as dispute resolution forum for the fishing and allied activities of the concerned village or fishing harbour. The structure of the present committees can be retained as such in village management council and harbour management committees. In the district level council, the management of the fishing activities should be resolved by a committee headed by the district collector. This committee should include the fishermen or fishermen leaders of the respective district, village heads,representatives of traders, department of fisheries staff headed by Joint director or Assistant Director of fisheries, members from research institutes, college of fisheries, NGOs etc. The district level committee can look into specific problems of the respective districts or the specific regions such as Coromandel, Gulf of Mannar and Palk Bay. The state level committee should comprise the Commissioner of fisheries, Joint director of state fisheries from all districts, fishermen or fishermen leaders of recognized unions, representatives of traders, representatives from research institutes, college of fisheries, representatives from Forest, Police, NGOs *etc*. The state level committee can decide on matters related to state as a whole. The district committees may meet once in a month as done in Tuticorin and Kanyakumari districts and the state committee may meet once in 6 months or as and when situation demands. At present, in Tuticorin and Kanyakumari districts, grievance meeting of the fishermen are held once in a month at the office of the Collector in the presence of officials from state fisheries department which look into all the problems concerning their life. Here only fishermen leaders/panchayat heads are invited.

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Appendix

Important resources coming under pelagic, demersal, crustacean and cephalopod group.

Pelagic resources	Demersal	Crustaceans	Cephalopod
Wolf herring	Elasmobranchs	Crabs	Squid
Lesser sardines	Eels	Lobsters	Cuttlefish
Oil sardines	Catfishes	Non-penaeid prawns	Octopus
Barracudas	Lizard fish	Penaeid prawns	
Half beak & Fullbeaks	Rockcods	Stomatopods	
Ribbonfishes	Snappers		
Mullets	Pig-face breams		
Carangids	Threadfin breams		
Mackerels	Goatfishes		
Anchovies	Threadfins		
Whitebaits	Croakers		
Tunas	Silverbellies		
Seerfishes	Black pomfret		
Billfishes	Silver pomfret		
Flyingfishes	Chinese pomfret		
	Halibut		
	Soles		
	Big jawed jumper		
	Flounder		

Annexure

Table 26. Salient results of stock status assessment-GM

	M SY	MSE	
Name of Stock	f-Factor	f-Factor	Remarks
Thunnus albacares	0.4	0.4	High fishing effort
Katsuwonus pelamis	1.2	1.1	Scope for increase in effort
Euthynnus affinis	1.3	1.3	Scope for increase in effort
Scomberomorous commerson	0.3	0.4	High fishing effort
Rastrelliger kanagurta	8	3.3	Scope for increase in effort
Sardinella gibbosa	5	2	Scope for increase in effort
Stolephorus indicus	10	4	Scope for increase in effort
Portunus pelagicus from	0.6	0.4	High fishing effort
indigenous trawl			
Portunus pelagicus from	1	0.8	Fishing at optimal level
estuarine gillnet			
Portunus pelagicus from	1.4	0.8	Fishing at optimal level
marine gillnet			
Portunus sanguinolentus from	0.6	0.6	High fishing effort
trawl			
Portunus sanguinolentus from	0.4	0.4	High fishing effort
indigenous trawl			
Portunus sanguinolentus from	1.2	1	Fishing at optimal level
estuarine gillnet			
Charybdis natator from trawl	0.6	0.4	High fishing effort
Charybdis natator from	0.4	0.4	High fishing effort
indigenous trawl			
Charybdis natator from	0.6	0.6	High fishing effort
estuarine gillnet			
Charybdis natator from	0.8	0.6	High fishing effort
marine gillnet			
Portus gladiator from trawl	3	2	Scope for increase in effort
Portus gladiator from estuarine	3.2	1.8	Scope for increase in effort
gillnet			
Portus gladiator from marine	3.2	2	Scope for increase in effort
gillnet			
Penaeus semisulcatus from trawl	1	0.8	Fishing at optimal level
Penaeus semisulcatus from	0.4	0.2	High juvenille exploitation
indigenous trawl			
Penaeus indicus from trawl	1.4	1	Fishing at optimal level

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