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CMFRI MARINE FISHERIES POLICY SERIES NO. 9

POLICY GUIDANCE ON SUSTAINING THE MARINE FISHERIES OF ANDHRA PRADESH

ICAR- CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

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Policy guidance on sustaining the marine fisheries of Andhra Pradesh

CMFRI Marine Fisheries Policy Series No. 9

Muktha Menon, Shubhadeep Ghosh, Mini KG, Indira Divipala, Pralaya Ranjan Behera, Loveson Edward, Jasmin F, A. Gopalakrishnan and S S Raju

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FOREWORD

ICAR-Central Marine Fisheries Research Institute (CMFRI) has been entrusted with conducting research on sustaining the marine fish and shellfish resources of the Indian seas. The sustainable management of these marine resources, on the other hand, lies with the respective State governments. ICAR-CMFRI regularly brings out marine fisheries policy advisories towards fulfilling the institute's mandate and as guidance for management agencies to sustainably manage their marine resources, to ensure the food security of the nation and livelihood for various stakeholders depending on the marine resources. This policy guidance document has been brought out as a guide for developing suitable policies by the State of Andhra Pradesh to manage its marine resources sustainably.

Andhra Pradesh is in the forefront of shrimp culture and its export from the country. However the marine harvest fishery resources of the State are currently in distress with the marine capture fisheries sector progressively becoming economically unviable. This document addresses many of the challenges faced by the marine capture fisheries sector of Andhra Pradesh and wherever, possible has provided solutions for addressing these challenges.

The document is an output of the Visakhapatnam Regional Centre of ICAR-CMFRI. The team of scientists at the Centre have used their experience in the field as well as the experience and inputs of fishermen for the preparation of this document. I hope that this document will facilitate the State government and relevant management authorities, policy makers and planners to frame suitable policies for sustainable management of the marine fisheries resources of Andhra Pradesh.

Kochi
2018

A. Gopalakrishnan
Director, ICAR-CMFRI

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Executive Summary

Andhra Pradesh is one of the leading producers of aquatic resources in the country with the highest production and export of shrimps and the fifth largest marine landings of the country. The state is also home to more than 1 million fishermen who depend on fishing and allied activities for their livelihood. It is estimated that in 2015-2016 the first hand sales of marine finfish and shellfish in the state were to the tune of ₹ 2381 crores. The fisheries sector as a whole contributed 6.4% of the GDP of the state during 2016-2017. Recognizing the importance of fisheries to the state, the state government has accorded the sector a special place in its development plans.

Andhra Pradesh landed an average 2.04 lakh tonnes of marine finfish and shellfish during 1990-2016. The marine landings of the state have been increasing and reached an all time high of 3.42 lakh tonnes in 2014. Pelagic fish contributed the maximum to the state's landing forming 60% of all fish landed in the state. The major resource groups of the state were lesser sardines, penaeid prawns, Indian mackerel, ribbonfish and croakers. The mechanized fishing fleet lands 60% of the marine catch of the state. Mechanized trawlers lead the way contributing to most of the catch from the mechanized sector. However the catch rates of trawlers showed a decrease from 32 kg/h in 2004 to 20.1 kg/h in 2016 indicating that the trawlers are facing issues of sustainability. On the other hand the ring seine units have shown a rapid increase in their numbers as well as catch rates in the state.

Life Cycle Analysis (LCA) indicated that the marine fisheries of Andhra Pradesh are more environment friendly emitting less CO_2 per kg of fish as compared to the global average. Emission intensity per kg of marine fish was 0.34 kg C and 1.26 kg CO_2 in Visakhapatnam, 0.31 kg C and 1.16 kg CO_2 in Kakinada, 0.41 kg C and 1.50 kg CO_2 at Nizamapatnam and 0.37 kg C and 1.37 kg CO_2 at Machilipatnam, much lower than the global average of 1.7 t CO_2 per t of fish.

The marine environment along Andhra Pradesh is steadily warming with an overall 0.4°C increase in mean SST from 1960-2012. There have been concurrent changes in fish populations along the coast of Andhra Pradesh as well with horizontal range extension of species distribution, vertical range extension of species distribution, changes in the timing of phenological events like spawning season and earlier maturation of species. In northern Andhra Pradesh, the urban areas along Visakhapatnam coast was found to be the most polluted because of release of domestic effluents and untreated sewage into the sea at multiple locations. The major fishing harbours at Visakhapatnam and Kakinada were moderately polluted. The highest marine litter to the tune of 84.3 g/100 sq. m. was recorded in the beaches of Visakhapatnam, followed by East Godavari (73 g/100 sq. m.) and Srikakulam (65.2 g/100 sq. m.) along north Andhra Pradesh. A Vulnerability Index calculated for each of the coastal districts of Andhra Pradesh indicated that Krishna district was the most vulnerable and Vizianagaram the least.

Based on the studies of ICAR-CMFRI several recommendations have been made to sustain the marine fisheries of Andhra Pradesh, the major ones being listed below:

- Review, updating and stricter implementation of Marine Fishing Regulation Act
- Regulation of fishing effort with Optimum Fleet Size of mechanized trawlers to be restricted to 1300 for entire Andhra Pradesh
- Diversification of fishing effort through conversion of trawlers to longliners and gillnetters
- Minimum Legal Size (MLS) to be implemented for major commercial marine species
- Shark Management Program for Andhra Pradesh
- Improved Monitoring, Control and Surveillance (MCS) System with a Vessel Monitoring System and logbooks
- Control of coastal pollution
- Marine habitat restoration through Artificial Reefs
- Expansion of mariculture and cage culture technologies in Andhra Pradesh

The marine fisheries sector of Andhra Pradesh is vulnerable to overexploitation of marine resources, environmental degradation and climate change. Thus this sector deserves to be nurtured and managed effectively keeping in mind the challenges faced by the sector. This document has been prepared as a snapshot of the marine fisheries sector of the state, including the challenges that the sector faces and suggests some management measures for holistic development of the sector. It is hoped that the recommendations made in this policy brief, when implemented, will help in sustainable management of the state's marine resources thereby assuring the fishermen of Andhra Pradesh of a secure future.

1. Introduction

The state of Andhra Pradesh with a coastline of 974 km covering 9 coastal districts (Fig. 1) has a long history of fishing. Starting with traditional fishing in ancient times to the modern, technology-intensive fishing, the marine fisheries sector of the state has grown tremendously reaching record landings of 3.42 lakh tonnes in 2014 (CMFRI, 2015). The state is also the largest producer and exporter of farmed shrimps in the country contributing to nearly 50% of forex earnings through marine exports (AP Socio-economic Survey, 2015). With 1,50,868 active fishermen and 31,741 fishing crafts (CMFRI, 2010), the marine fisheries sector is an important source of employment and income generation in the state. The major fishing grounds of the State are found within the narrow continental shelf area, which has an average width of 32-43 km only, with an area ranging from 31000-39000 square km (FAO, 1983; Rao, 1986). The marine fisheries of the State is vulnerable to external influences namely, overexploitation of marine resources, environmental degradation and climate change. Thus this sector deserves to be nurtured and managed effectively keeping in mind the challenges faced by the sector. This document has been prepared as a snapshot of the marine fisheries sector of the State, including the challenges that the sector faces and suggests some management measures for holistic development of the sector. It is hoped that the recommendations made in this policy guidance document, when implemented, will help in sustainable management of the State's marine resources thereby assuring the fishermen of Andhra Pradesh a secure future.

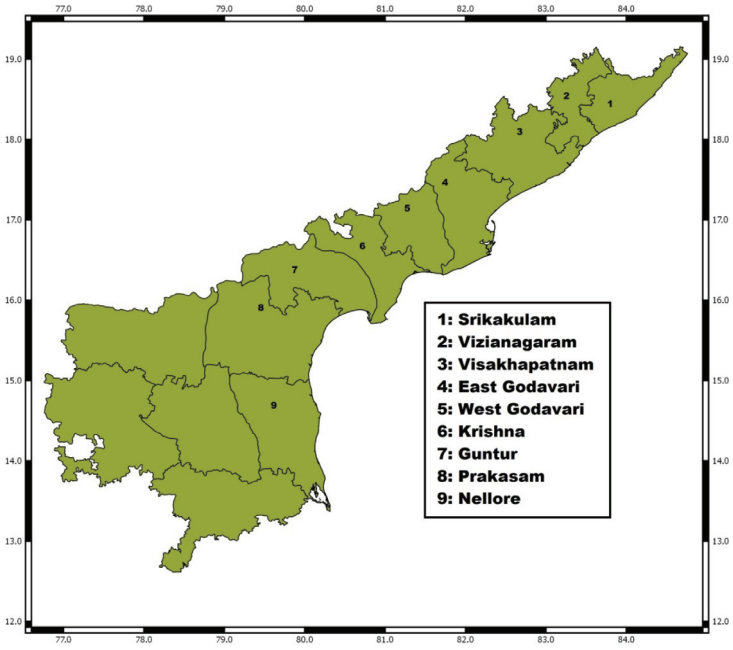


Fig 1: Coastal districts of Andhra Pradesh

2. Marine Fisheries Profile of Andhra Pradesh

2.1 Marine fishing villages

Andhra Pradesh has 555 marine fishing villages with a maximum of 128 villages in Srikakulam district and a minimum of 7 in West Godavari district (CMFRI, 2010). There are 353 marine fish landing centres, with maximum number in Nellore district and the minimum number in West Godavari district (Table 1, Fig. 2). There are two major fishing harbors at Visakhapatnam and Kakinada where bulk of total trawl catch (nearly 70%) is landed and three other fishing harbors at Bhairavapalem, Machilipatnam and Nizamapatnam (Fig. 2).

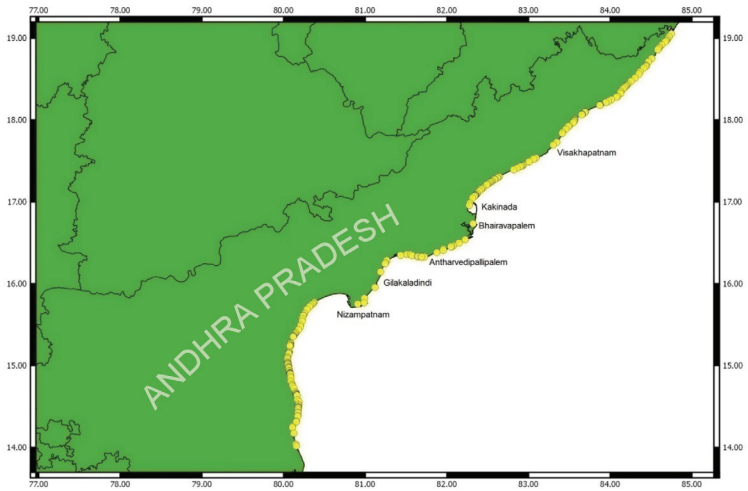


Fig 2: The 353 fish landing centres of Andhra Pradesh with the major harbours indicated in text (Courtesy: GIS project, CMFRI)

Table 1: District-wise details of fish landing centres and fishing villages of Andhra Pradesh

District	Number of landing centres	Number of fishing villages
Srikakulam	55	128
Vizianagaram	12	20
Visakhapatnam	66	63
East Godavari	29	97
West Godavari	7	7
Krishna	37	43
Guntur	8	36
Prakasam	39	67
Nellore	100	94
Total	353	555

Source: GoI 2012 - Marine Fisheries Census

2.2 Marine fishermen

The marine fishermen population of the state was 6,05,428 in 2010 (Table 2). This showed a rapid increase in growth rate in marine fishermen population by 19% from 2005 to 2010. Among 1,63,427 fishermen families reported in 2010, 98.5% belonged to traditional fishermen. The maximum numbers of families were in East Godavari (44,476) and Visakhapatnam districts (28,779) (Table 3). This is an increase of 26% when compared to 2005 (1,29,246 families) that are dependent on marine fishing in Andhra. However, the average family size has fallen from 3.95 in 2005 to 3.7 in 2010, with maximum of 4.05 in Vizianagaram district and a minimum 3.29 in Krishna district. The sex ratio (female to male) among marine fishermen families in Andhra Pradesh showed a declining trend with a decrease of 2%. The sex ratio in 2005 was 962 females per 1000 males whereas in 2010 it was 943 females per 1000 males. Women formed 48.5 % of the total population and the female to male ratio was maximum in East Godavari district (970 females/1000 males) and minimum in Nellore district (910 females/1000 males). The active fisher folk population involved in marine fisheries activities of Andhra Pradesh has increased by 8% from 1,38,614 in 2005 to 1,50,868 in 2010 (Table 4). The full time and part time fishermen recorded during 2010 are 1,27,837 and 19,373 respectively. The part time fisher folk population showed a decline of 30% from 29,109 in 2005 to 19,373 in 2010. There was an increase in activities like marketing of fish and labour activities over the five year period from 2005 to 2010. The other associated activities like net mending, curing /processing and peeling recorded downward trend.

Fishermen pulling a motorized *theppa* onshore

Table 2: Demographic details of fishermen and their families of Andhra Pradesh

S.No.	Particulars	Numbers
1	No. of fisher folk families	1,63,427
2	Fisher folk population	6,05,428
	a. Adult male	1,91,136
	b. Adult female	1,90,888
	c. Children	2,23,404
3	Average population per village	1091
4	Average family Size	3.7
5	Literacy (%)	
	a. Primary Education	18
	b. Secondary Education	13
	c. Higher Education	3
	d. No formal education	66
6	Active Fishermen	1,50,868
	a. Full time	1,27,837
	b. Part time	19,373
7	Per capita income per annum	₹ 72,000/-
8	Fishermen population members of fisheries co-operative societies	37,875
9	Marine resources available per sq. km. of continental shelf area	9 t
10	Marine fish resources available per active fishermen per annum	1.98 t

Source: GoI 2012 - Marine Fisheries Census

Table 3: District-wise details of the fishermen population of Andhra Pradesh

District	Fisher folk population	Average family size	Sex ratio (No. of females per 1000 males)
Srikakulam	98450	3.9	949
Vizianagaram	20812	4.1	938
Visakhapatnam	113632	4.0	923
East Godavari	165208	3.7	970
West Godavari	9188	3.8	952
Krishna	43005	3.3	955
Guntur	39333	3.3	949
Prakasam	51511	3.4	924
Nellore	64289	3.8	910
Total	605428	3.7	943

Source: GoI 2012 - Marine Fisheries Census

Table 4: District-wise details of fishing activities of the fishermen of Andhra Pradesh

Districts	Active Fishermen	Fishing Allied Activities	Other than fishing	Total fishermen occupied
Srikakulam	23559	30644	1011	55214
Vizianagaram	5407	6143	65	11615
Visakhapatnam	26351	24427	1416	52194
East Godavari	45137	23501	2916	71554
West Godavari	2479	1837	1	4317
Krishna	12932	10102	2607	25641
Guntur	10305	13479	56	23840
Prakasam	13134	9875	2804	25813
Nellore	11564	20081	123	31768
Total	150868	140089	10999	301956

Source: GoI 2012 - Marine Fisheries Census

About 97% of 1,63,427 total fishermen families come under the BPL category in Andhra Pradesh in 2010. Majority of fishermen families were below poverty line in Srikakulam, Vizianagaram, Krishna, Guntur and Nellore districts. Infrastructure development in fishing villages of Andhra Pradesh were improved due to conversion of kutchha houses to pucca houses. Percentage of pucca houses is around 70% in fishermen villages and there is an increase of 17% of pucca houses over the year 2005. The other infrastructure up-gradation like electrification of fishing villages increased from 95% to 99% in Andhra Pradesh from 2005 to 2010. However the standard of living of fishermen of the state has not shown much improvement. A study by CMFRI revealed that in Andhra Pradesh, Engels Coefficient of standard of living was 73.25. The higher Engels coefficient of Andhra Pradesh indicates low level of standard of living, indicating that income is enough to meet only the food needs of fishermen, leaving little amount for their welfare.

Andhra Pradesh had the highest illiteracy among fishermen in India; approximately 66% of the fishermen of the State are unschooled (CMFRI, 2010). The national average was 42%; with Goa having the least illiteracy among fishermen at only 14%.

2.3 Marine fish resources

The average annual marine fish landing of Andhra Pradesh during 1990-2016 was 2.04 lakh tonnes. The annual average catch showed an increasing trend over the years (Fig. 3). During nineties, total marine fish landings of Andhra Pradesh was around 1 lakh tonnes, which increased gradually and reached an all-time peak of 3.42 lakh tonnes in 2014 and since then has shown a decrease (Fig. 3).

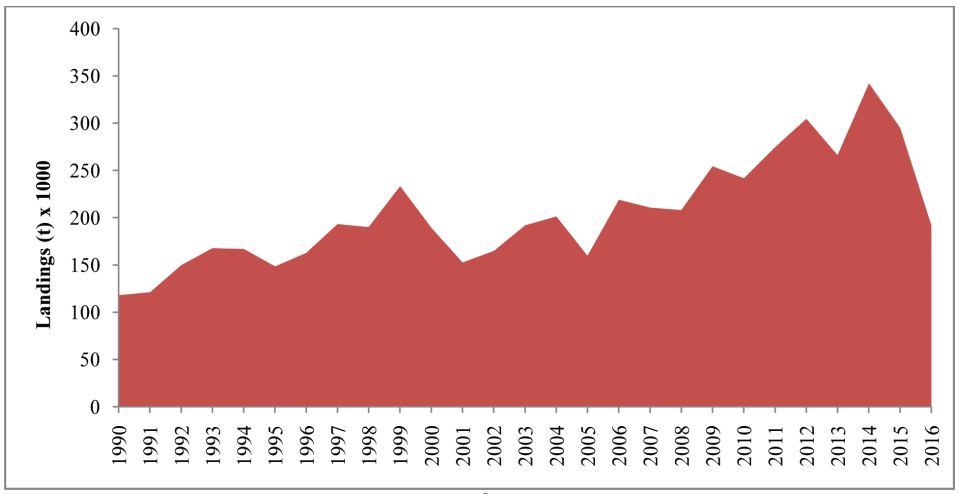


Fig 3: Total marine landings of Andhra Pradesh (1990-2016)

Yellowfin tuna landed at Kakinada Fishing Harbour

Pelagic finfish contributed 60% to the total marine catch, followed by demersal finfish (23%), crustaceans (13%) and molluscs (1%) (Fig.4). The major groups that contributed to the fishery were clupeids, prawns, Indian mackerel, ribbon fishes, carangids, croakers, elasmobranchs, threadfin breams, tunas and cephalopods. The top 5 landed groups in Andhra Pradesh during 2000-2016 were sardines (excluding Indian oil sardine), penaeid prawns, Indian mackerel, ribbonfish and croakers (Fig. 5).

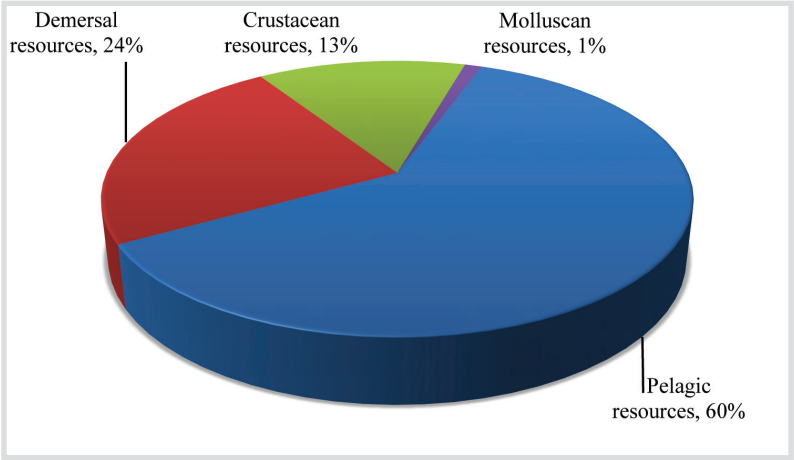


Fig 4: Major groups in the marine landings of Andhra Pradesh

The potential yield estimate in 2010 for the marine fishery resources of Andhra Pradesh was 2.574 lakh tonnes. Post 2010, every year, the marine landings have exceeded the potential yield estimate with several resources having exceeded their potential yield levels and have fallen below it (Table 5). The reason being intense exploitation of fish stocks. Hence, there is an urgent need to reduce the exploitation and to harvest the resources at an optimal level close to the potential yield estimate.

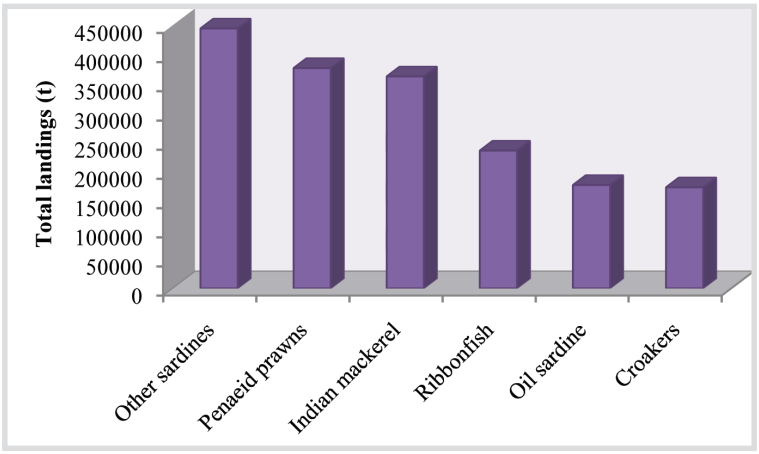


Fig 5: Top six landed (cumulative landings) marine resource groups in Andhra Pradesh (2000-2016)

Table 5: Potential yield estimate (2010) for various groups in the marine fisheries of Andhra Pradesh

Species/Group	Estimated Potential Yield (t)[1]	Current Yield (2016, t)[2]	Long-term average Yield (2007-2016)[2]
Elasmobranchs	9,110	2,670	6,057
Eels	2,346	1,398	2,162
Catfishes	5,536	3,240	5,172
Clupeids	76,825	55,745	70,106
Bombayduck	1,785	466	914
Lizardfishes	2,491	2,089	3,687
Half beaks and full beaks	507	208	405
Flying fishes	74	362	295
Perches	9,910	8,166	11,900
Goatfishes	5,343	3,650	6,014
Threadfins	1,184	909	1,165
Croakers	10,594	7,933	11,591
Ribbonfishes	19,838.7	14,993	14,781
Carangids	12,901	11,047	15,843
Silverbellies	6,965	5,230	6,517
Big-jawed jumper	346	196	341
Pomfrets	13,523	3,248	8,846
Mackerel	18,998	22,880	25,594
Seerfishes	7,732	3,839	6,625
Tunnies	6,056	6,384	12,936
Billfishes	2,010	1,474	2,249
Barracudas	1,880	1,597	2,538
Mullets	2,021	103	607
Flatfishes	4,563	2,060	2,103
Crustaceans	29,424	27,188	33,527
Molluscs	2,140	2,950	3,067

Source: 1 - GoI (2011); 2 - CMFRI, Kochi

Of the pelagic resources, oil sardine landings fluctuated between a maximum of 31,978 t in 1997 and a minimum of 975 t in 1990. Mackerel landings fluctuated between a maximum of 55,631 t in 2014 and a minimum of 3,867 t in 1990. Carangids and yellowfin tuna registered continuous increase in catch over the years; the former from 3,616 t in 1991 to 20,665 t in 2013 and the latter from near to zero landings in 1990 to a peak of 14,477 t in 2014. Around one third of the tuna landing was contributed by the yellow fin tuna, *Thunnus albacares,* caught mainly by hooks and lines. Their landing increased on an average at Visakhapatnam from a meager 183 t during 1990-2001 to 3,221 t during 2002-2016.

Landings of the major demersal resources namely, threadfin breams, croakers, lizard fishes and goatfishes have increased substantially. Threadfin breams increased from a low of 1,078 t in 1990 to a high of 6,884 t in 2014; croakers from 5,596 t in 2002 to 14,276 t in 2012; lizard fishes from 539 t in 2000 to 5,672 t in 2014 and goatfishes from 937 t in 1996 to 7,822 t in 2014. However, post 2014 most demersal resources have shown fall in landings. Among crustacean resources, crabs showed the highest increase in landings from a low of 2,063 t in 1990 to a high of 7,036 t in 2012. The landings of penaeid prawns increased from 8,743 t in 1990 to 29,757 t in 2012 and of non-penaeid prawns from 906 t in 1999 to 2,819 t in 2012. Similar to demersal resources, post 2012, crustacean resources also have shown decreased landings. Cephalopod resources have shown a substantial increase from 446 t in 1991 to 4,222 t in 2012 after which they too have shown reduced landings.

Fish consumption

Marine fish per capita consumption in the state was 2.36 kg, slightly less than the national figure of 3.45 kg. The per capita fish consumption for only the fish eating population of Andhra Pradesh was 7.87 kg. Only less than half of the fish consumed in the state is marine; majority is from non-marine sources. However, both Andhra Pradesh and India are far behind the global per capita fish availability of 20.1 kg (FAO, 2016).

The fisheries sector as a whole contributed 6.4% to the state's GSDP during 2016-2017 (Govt. of Andhra Pradesh, 2018). The marine fisheries sector contributed approximately about ₹ 4000 crores (first hand sales) worth of agricultural output for the financial year 2014-2015 which decreased to nearly ₹ 2381 crores during 2015-2016. In 2016, marine shrimps contributed about ₹ 669 crores, followed by clupeids and mackerel. Among clupeids, lesser sardines, oil sardines, anchovies and rainbow sardines are the chief contributors which are mainly caught by the motorized and artisanal sector with total worth of ₹ 279 crores. Most of the catch is consumed locally fresh and excess landings are marketed as dry fish and trash fish for use in poultry, fish and shrimp meal plants across the country. Mackerel generated about ₹ 229 crores. The high revenue was mainly due to high demand from other states of the country like Kerala, Tamil Nadu and Karnataka. Cephalopods, ribbonfish, seerfishes, pomfrets, tunas, sharks, perches, lobsters and crabs which have high export value contribute about ₹ 1197 crores to the State. Threadfin breams which form an important resource for surimi production plants had a value worth ₹ 24 crores.

Table 6: Volume and value of major marine resource groups landed in Andhra Pradesh (2016)

Rank	Groups	Landings (t)	Average price per kg	Value in crores (₹)
1	Shrimp	22,291	300	668.73
2	Clupeids	55,745	50	278.725
3	Mackerel	22,880	100	228.8
4	Ribbon fish	14,993	150	224.895
5	Carangids	11,047	150	165.705
6	Seerfishes	3,839	300	115.17
7	Perches	5,202	200	104.04
8	Pomfrets	3,248	300	97.44
9	Cephalopods	2,950	300	88.5
10	Elasmobranchs	2,670	300	80.1
11	Croakers	7,933	100	79.33
12	Tunas	6,384	80	51.072
13	Crabs	4,571	100	45.71
14	Catfishes	3,240	100	32.4
15	Barracudas	1,597	200	31.94
16	Threadfin breams	2,964	80	23.712
17	Flatfishes	2,060	100	20.6
18	Goatfishes	3,650	50	18.25
19	Silverbellies	5,230	30	15.69
20	Lizardfishes	2,089	60	12.534
21	Billfishes	1,474	70	10.318
22	Lobsters	39	1000	3.9

2.4 Fishing crafts and gears

The marine fishery of Andhra Pradesh is contributed by mechanized, motorized and traditional sectors with the motorized and mechanized sectors slowly and steadily replacing the traditional sector. There were 31,741 crafts engaged in the fishery of Andhra Pradesh in 2010 (CMFRI, 2010) of which 3,167 were mechanized, 10,737 motorized and 17,837 crafts in non-motorized sector (Table 7). The mechanized sector contributes about 10% of the total marine fishing fleet followed by motorized sector (34%) and non- motorized sector (56%). However the maximum marine fish landings were obtained from the mechanized sector (60%), followed by the motorized sector (30%) and the artisanal sector (10%). Details of the major fishing crafts and gears of the state are shown in Tables 7, 8 and 9.

Trawlers at Visakhapatnam Fishing Harbour

***Theppas* and catamarans at Lawson's Bay, Visakhapatnam**

Table 7: Number of marine fishing crafts in Andhra Pradesh (2005 vs 2010)

Sector	Number of crafts (2005)	Number of crafts (2010)
Mechanized Sector	2,541	3,167
a. Trawlers	1,802	1,341
b. Gill netters	424	1,644
c. Ring seiners	-	182
Motorized Sector	14,112	10,737
Non-motorized Sector	24,386	17,837

Source: GoI 2012 - Marine Fisheries Census

Table 8: Details of marine fishing crafts used in Andhra Pradesh

Mechanized Trawlers	OAL	11 - 15 m
	Engine HP	90 - 250 hp
	Gear carried on board	Semi pelagic fish trawl nets, shrimp trawl nets
Mechanized Gill Netters/ Ring Seiners / Hooks & Lines	OAL	14-16 m
	Engine HP	100-180 hp
	Gear carried on board	Gillnets, Ring seines, Hooks & lines
Motorized (OBM) ***theppa***	OAL	7-10 m
	Engine HP	8- 10 hp
	Gear carried on board	Ring seines, Hooks & lines and Gillnets
Motorized (IBM) ***theppa***	OAL	9-12 m
	Engine HP	20 hp
	Gear carried on board	Ring seines, Hooks & lines and Gillnets

Table 9: Details of marine fishing gears used in Andhra Pradesh

Shrimp trawl net	Top end mesh size	100 - 250 mm
	Cod end mesh size	15 - 20 mm
	Targeted species	Penaeid Shrimp
	Bycatch	Crab, Squilla, Anchovy, Ribbonfish, Silverbellies, Lizardfish, Sciaenid, Nemipterid, Goatfish, Squid, etc.
	Depth of operation	30 - 70 m
	Recommended cod end mesh size	**40 mm square mesh**
Fish trawl net	Cod end mesh size	20 - 30 mm
	Top end mesh size	200 - 1000 mm
	Targeted species	Finfishes
	Depth of operation	30 - 100 m
	Recommended cod end mesh size	**40 mm square mesh**
Gillnet *(Kavalavala)*	Mesh size	10-18 mm
	Targeted species	Sardine, Mackerel
	Net length	100-450 m
	Net depth	5 m
	Recommended minimum mesh size	**30 mm diamond**
Gillnet *(Naravavala)*	Mesh size	15-32 mm
	Targeted species	Mackerel, miscellaneous small fish
	Net length	100-450 m
	Net depth	5 m
	Recommended minimum mesh size	**30 mm diamond**
Gillnet *(Jogavala)*	Mesh size	45-55 mm
	Targeted species	Mackerel, Seerfish
	Net length	100-450 m
	Net depth	5 m

Gillnet *(Teluvala)*	**Recommended minimum mesh size**	**50 mm diamond**
	Mesh size	45-55 mm
	Targeted species	Pomfrets, Seerfish
	Net length	100-450 m
	Net depth	5 m
Ring net	**Recommended minimum mesh size**	**45 mm diamond**
	Mesh size	5-120 mm
	Targeted species	Sardine, Mackerel, Carangid, Shads, Pomfret, Seerfish, Tuna, Rainbow sardine, Anchovy
	Depth of operation	20 - 50 m
	Net length	250 m
	Net depth	15-20 m
Hook & Lines/ Troll lines	**Recommended minimum mesh size**	**50 mm diamond**
	Hook size	0, 8 and 9 No's.
	Targeted species	Yellowfin tuna, Skipjack tuna, Little tuna, Sharks, Rays, Dolphinfish, Marlin, Seerfish, Snapper, Pomadasys, Catfish, Grouper, Barracuda, Cobia, Carangid and Eel
	Line length (main line)	250-300 m
	Branch line length	2 m
	Number of hooks	**Single hooks; up to 150 hooks (long lines)**
Shore seine	Mesh size	10-15 mm
	Targeted species	Sardine, Anchovy, Mackerel, Carangid, Mullet
	Depth of operation	10-25m
	Net length(Ht)	40-60 m
Trammel Net (3 layered)	**Recommended minimum mesh size**	**35 mm diamond**
	Mesh size	100/120-35/50-100/120 mm
	Targeted species	Penaeid Prawn and Non Penaeid prawn
	Depth of operation	20-45 m
	Net length	100-150 m
	Net depth	5 m
	Recommended minimum mesh size	**110/45/110 mm diamond**

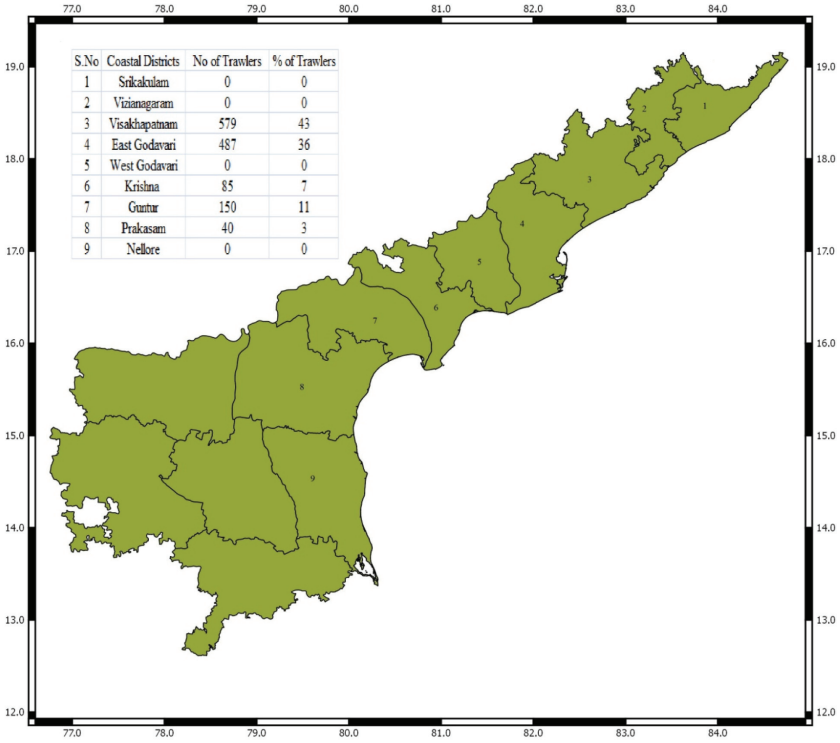
*- Source: Fishery Technology Division, ICAR-CIFT

2.4.1 Mechanized crafts and gears

In the mechanized sector, gillnetters, trawlers and ring seiners constitute 52%, 42% and 6% of the total mechanized crafts. The mechanized sector showed an overall increase in number of crafts by 25 % in 2010 from 2005. However, the number of trawlers showed a declining trend whereas the number of mechanized gillnetters increased from 424 in 2005 to 1,644 in 2010.

2.4.1.1 Mechanized trawlers

The number of mechanized trawlers decreased from 1,802 to 1,341 during 2005 to 2010 resulting in a 26% decline in trawlers of the state. Visakhapatnam district contributes 43% of the total trawlers of Andhra Pradesh with 579 trawlers, 36% in East Godavari district with 487 trawlers, 11% in Guntur district with 150 trawlers, 10% combined in Krishna and Prakasam districts with 85 and 40 trawlers respectively in 2010 (Fig. 6 & 7). Trawlers contributed substantially to the catch of penaeid and non penaeid prawns, ribbonfishes, Indian mackerel, croakers, threadfin breams, carangids and cephalopods. The landings and catch rate of mechanized trawlers in the state showed an overall increasing trend from 2000 to 2012 and then a sharp fall in landings (Fig. 8). The catch rate on the other hand showed an increasing trend during 2000-2014 but since then has fallen to reach 20.1 kg/h in 2016 (Fig. 8). Though the number of trawler units has shown a steady decrease, the corresponding fishing hours increased from 41.4 lakh hours (2010) to 52.1 lakh hours (2013) and since then have decreased (Fig. 9). Since 2012, the number of active trawlers, their fishing hours, total landings and catch rates in the state has fallen pointing towards increasing economic and ecological unsustainability of trawl fisheries in Andhra Pradesh.



S.No	Coastal Districts	No of Trawlers	% of Trawlers
1	Srikakulam	0	0
2	Vizianagaram	0	0
3	Visakhapatnam	579	43
4	East Godavari	487	36
5	West Godavari	0	0
6	Krishna	85	7
7	Guntur	150	11
8	Prakasam	40	3
9	Nellore	0	0

Fig 6: District-wise details of trawlers in Andhra Pradesh

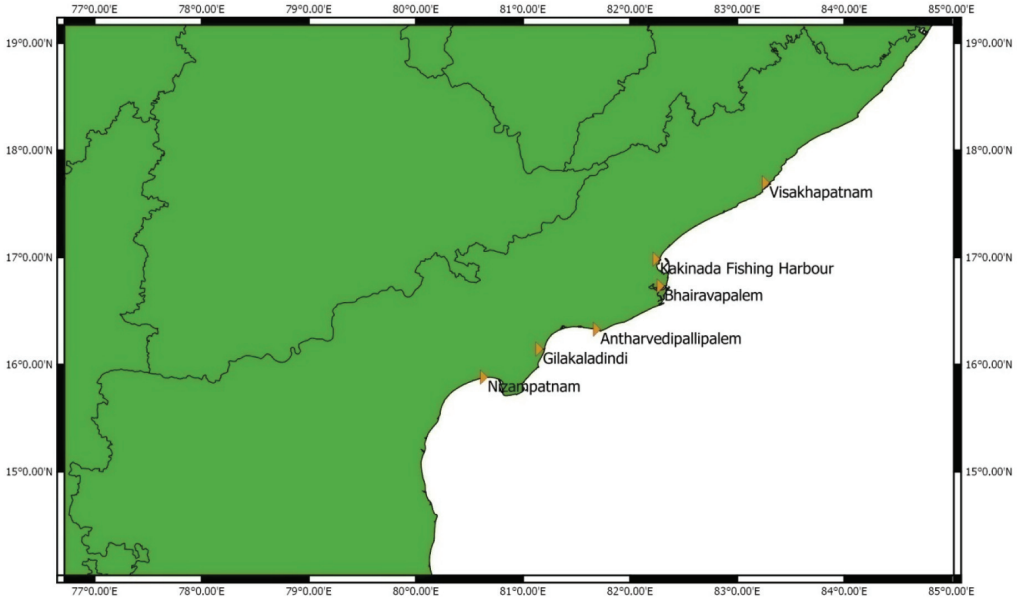


Fig 7: Major mechanized fish landings centres of Andhra Pradesh

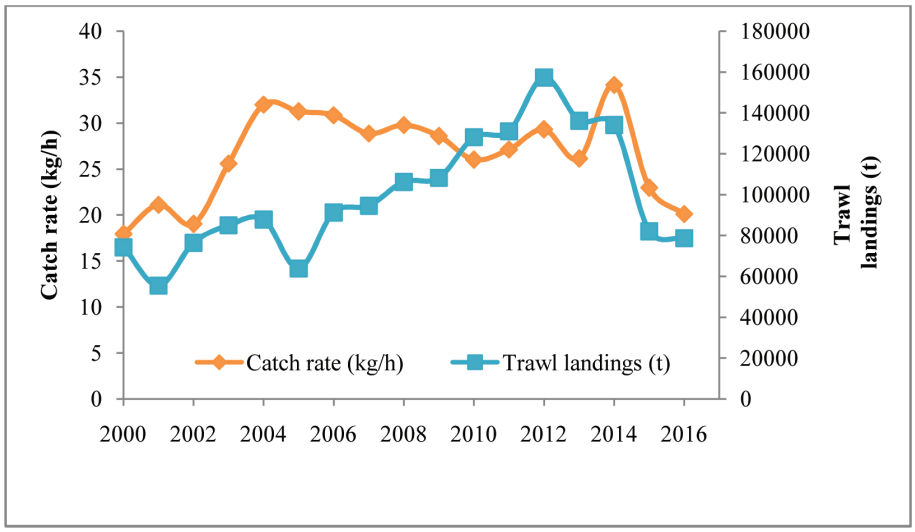


Fig 8: Total landings (t) and catch rate (kg/h) of mechanized trawlers in Andhra Pradesh (2000-2016)

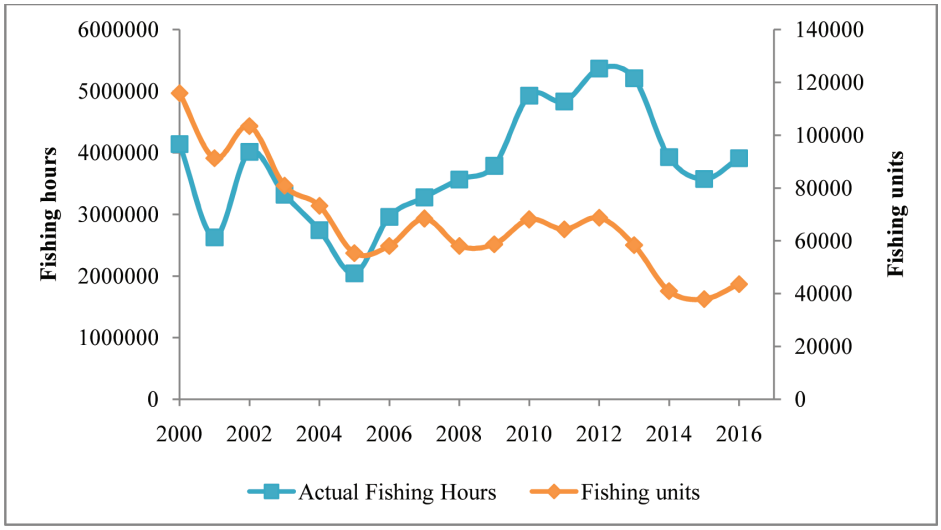


Fig 9: Total units and fishing hours of mechanized trawlers in Andhra Pradesh (2000-2016)

Bycatch in trawls

Trawl bycatch affects ecosystem function and diversity causing physical damage and habitat loss. Bycatch form 41.1% of the total trawl catch in Visakhapatnam. Juveniles of various species are captured in large quantities by trawl nets and contribute 63.6% to the total trawl catch. Bycatch reduction in the trawl fishery can only be achieved by reducing the effort, by increasing the cod end mesh size and by increasing the seasonal closure of the fishery. This, in turn, will preserve the ecosystem structure and function and maintain biodiversity. ICAR-Central Institute of Fisheries Technology (CIFT) has developed a juvenile fish excluder-cum-shrimp sorting device that helps to reduce bycatch from shrimp trawls and protect juvenile fish. Training required to fishermen for fabrication, installation and operations has already been imparted. Bycatch Reduction Device reduces the impact of trawling on the marine community including vulnerable and endangered species and economically benefits the fishers from higher catch values, shorter sorting time, lower fuel costs and longer tow times.

Table 10: Occurrence and mean catch rates of trawl bycatch species from Visakhapatnam waters

Bycatch group	Species	Family	Mean catch rate (kg/h) ± (S.E)	Mean number (n/h) ± (S.E)
Teleosts	*Pennahia anea*	Sciaenidae	5.200±0.350	50.302±8.179
	Johnius carutta	Sciaenidae	3.136±0.122	114.615±.635
	Nibea maculata	Sciaenidae	4.652±0.244	72.543±2.582
	Kathalla axillaris	Sciaenidae	3.811±0.878	111.446±46.195
	Johnius spp.	Sciaenidae	1.408±0.385	29.263±6.140
	Decapterus russelli	Carangidae	65.253±7.040	1642.642±589.4
	Selar boops	Carangidae	2.830±0.329	29.473±4.353
	Alepes spp.	Carangidae	2.259±1.044	41.077±12.864
	Thryssa hamiltoni	Clupeidae	3.347±0.245	108.145±2.935
	Thryssa mystax	Clupeidae	1.966±0.114	157.336±12.126
	Stolephorus indicus	Clupeidae	13.174±1.961	3052.153±550.033
	Dussumieria acuta	Clupeidae	4.355±0.503	116.820±6.607
	Ilisha megaloptera	Clupeidae	1.205±0.010	40.367±1.846
	Upeneus sulphureus	Mullidae	7.941±0.189	382.057±36.844
	Upeneus mollucensis	Mullidae	8.236±0.285	201.688±21.148
	Upeneus spp.	Mullidae	105.190±5.023	4186.052±29.49
	Saurida undosquamis	Synodontidae	13.119±0.131	1200.921±29.28
	Saurida tumbil	Synodontidae	11.206±0.115	609.790±42.33
	Nemipterus randalli	Nemipteridae	19.722±0.401	1605.836±44.37
	Nemipterus japonicus	Nemipteridae	2.530±0.128	429.523±20.69
	Priacanthus hamrur	Priacanthidae	29.393±0.833	903.475±53.24
	Priacanthus tayenus	Priacanthidae	3.090±0.123	67.642±2.57
	Rastrelliger kanagurta	Scombridae	371.055±121.055	4651.784±2290.78
	Rastrelliger faughni	Scombridae	2.321±0.801	19.280±7.07
	Secutor insidiator	Leiognathidae	208.044±12.831	8004.363±454.24
	Photopectoralis bindus	Leiognathidae	118.220±3.007	10757.207±521.08
	Leiognathus elongatus	Leiognathidae	4.757±0.307	1590.198±19.98
	Pentaprion longimanus	Leiognathidae	14.151±0.645	1088.802±65.682
	Gazza minuta	Leiognathidae	11.887±0.674	332.277±43.064
	Leiognathus equulus	Leiognathidae	8.788±0.575	134.132±28.919
	Eubleekeria splendens	Leiognathidae	3.213±0.192	186.080±20.87
	Trichiurus lepturus	Trichiuridae	20.920±0.203	476.076±50.04
	Lepturacanthus savala	Trichiuridae	38.213±39.467	2255.442±125.31

Bycatch group	Species	Family	Mean catch rate (kg/h) ± (S.E)	Mean number (n/h) ± (S.E)
	Apogon poecilopterus	Apogonidae	1.0360.286	420.637±95.63
	Apogonichthyoides taeniatus	Apogonidae	1.523±0.227	500.575±9.638
	Apogon spp.	Apogonidae	1.331±0.136	466.251±14.07
	Ostorhinchus fasciatus	Apogonidae	1.334±0.116	224.352±7.768
	Lagocephalus lunaris	Tetraodontidae	10.21±17.806	199.825±49.702
	Lagocephalus inermis	Tetraodontidae	5.727±1.469	210.463±87.463
	Pseudotriacanthus strigilifer	Triacanthidae	1.676±0.218	79.516±4.303
	Platycephalus indicus	Platycephalidae	5.893±0.329	310.579±45.456
	Cynoglossus spp.	Cynoglossidae	2.876±0.290	25.773±.919
	Fistularia petimba	Fistulariidae	0.930±0.280	55.294±13.294
	Sphyraena spp.	Sphyraenidae	7.254±0.267	59.987±5.226
	Eel		3.089±0.432	42.372±2.838
	Valenciennea sexguttata	Gobiidae	2.942±0.379	30.301±5.178
	Pomadasys maculata	Haemulidae	2.504±0.381	59.867±6.135
Invertebrates				
	Uroteuthis duvaucelii	Loliginidae	6.946±0.304	599.194±10.929
	Sepia aculeata	Sepiidae	1.782±0.204	58.209±6.913
	Sepiella inermis	Sepiidae	3.797±0.062	159.248±5.965
	Sepia prashadi	Sepiidae	6.895±0.228	177.782±17.341
	Sepia spp.	Sepiidae	2.043±0.278	20.505±2.618
	Charybdis natator	Portunidae	1.681±1.560	307.901±2.211
	Portunus sanguinolentus	Portunidae	5.846±0.071	638.791±13.221
	Metapenaeus monoceros	Penaeidae	1.216±0.107	60.601±6.004
	Oratosquillina pentadactyla	Squillidae	1.731±0.133	169.578±2.553
Elasmobranchs				
	Brevitrygon imbricata	Dasyatidae	2.021±0.321	15.123±6.231
	Torpedo panthera	Torpedinidae	1.230±0.125	23.023±8.213
	Torpedo sinuspersici	Torpedinidae	1.120±0.102	15.213±6.314
	Narke dipterygia	Narkidae	1.021±0.103	16.213±6.781
	Narcine brunnea	Narkidae	1.001±0.36	10.213±5.213

A snapshot of trawl catch off Visakhapatnam

2.4.2 Motorized and artisanal crafts and gears

The motorized sector and artisanal sector were showing rapid decline in number of crafts operating in Andhra Pradesh by 27% and 24% respectively in 2010 in comparison to 2005. However a recent development in the motorized sector has been the rise of ring seines operated from motorized theppas (Fig.10). Ring seines began to make their substantial appearance in the marine fleet of Andhra Pradesh from 2010 onwards and since then the number of fishing units has increased nearly 2.5 times by 2014 and then decreased in 2015 and 2016 (Fig. 11). Their catch rate in kg/unit has also increased by 1.2 times from 2010 to 2014 after which it has decreased (Fig. 12). The major fish groups landed by ring seines are Indian mackerel (27%), *Sardinella* spp. (20%) and the Indian oil sardine (15%).

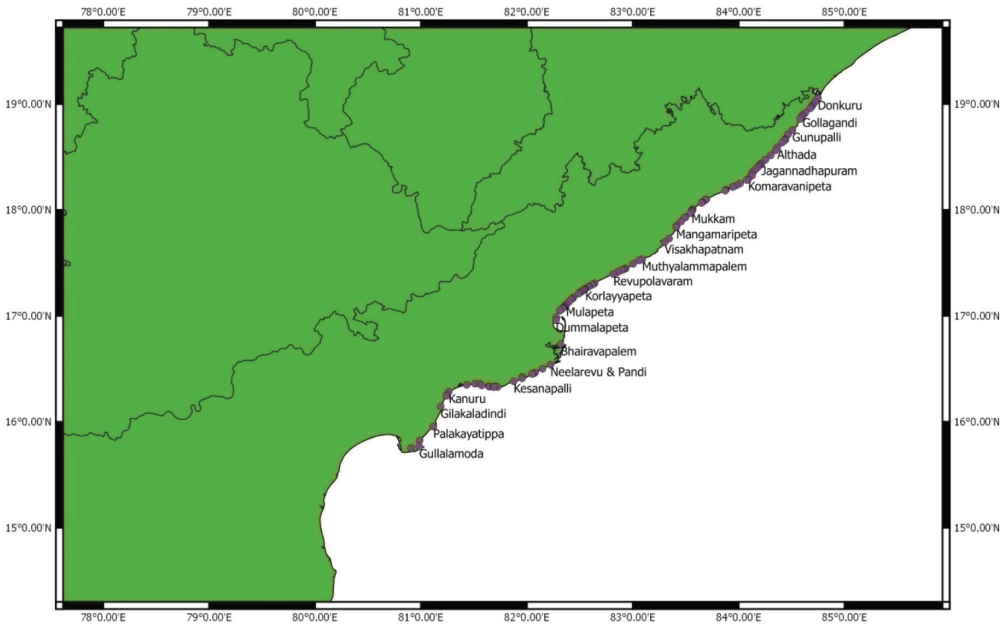


Fig 10: Major ring seine centres of Andhra Pradesh

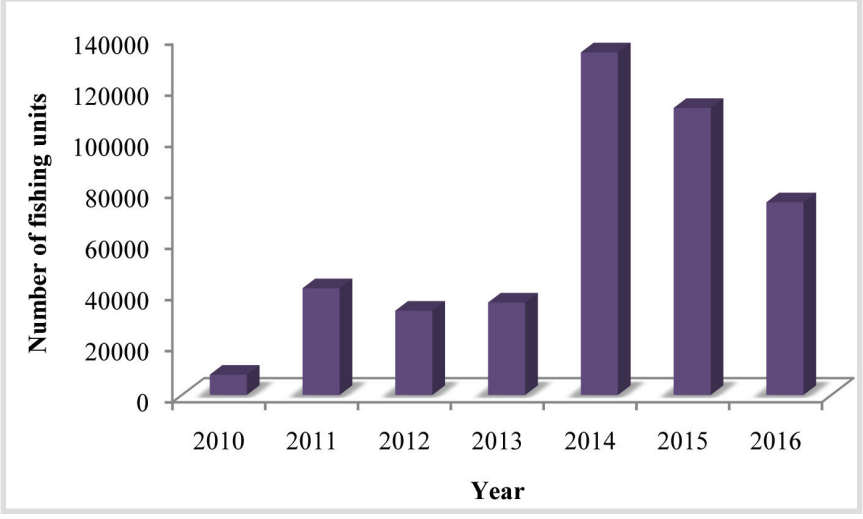


Fig 11: Number of ring seine fishing units in Andhra Pradesh (2010-2016)

A ring seine being offloaded from a fishing boat

Impacts of ring seine fishery

Ring seine fishing units are increasing at an alarming pace in coastal districts of northern Andhra Pradesh. Ring seine with very small meshes are operated in the inshore waters of these districts and as a result, their catch is composed almost entirely of juveniles and sub-adults of oil sardine, mackerel and lesser sardines. Growth overfishing is the consequence of this irrational removal of juveniles from the fishery. These forage fishes play a critical role in the ecosystem by transferring energy from low to upper trophic levels. Trophic interactions necessitate that large predatory fish prey upon this forage fish. The value of the predator fishes supported by the forage fishes is much higher than the value of the forage fishes themselves. Ring seine operations, by virtue of indirectly impacting the abundance of high value predator fishes, have to be controlled. Restrictions need to be put in place on their ever increasing number and on their depth of operation. Spatio-temporal ban on ring seining, especially during the monsoon fishing ban has to enforced. Ring seiners possess the expertise to distinguish between juvenile and adult shoals of small pelagic fishes and hence, they should be educated to desist from fishing juvenile shoals.

Fig 12: Catch-per-unit of ring seine in Andhra Pradesh (2010-2016)

Gillnet units (mainly in the motorized sector) in Andhra Pradesh showed a fluctuating trend during 2000-2016 with a peak in 2006 and a steady decline since then. In 2016 the number of gillnet units (3,52,318) had fallen below the numbers seen in 2000 (6,03,968). However the catch rates of gillnetters have shown a steady increase (catch-per-unit) (Fig. 13).

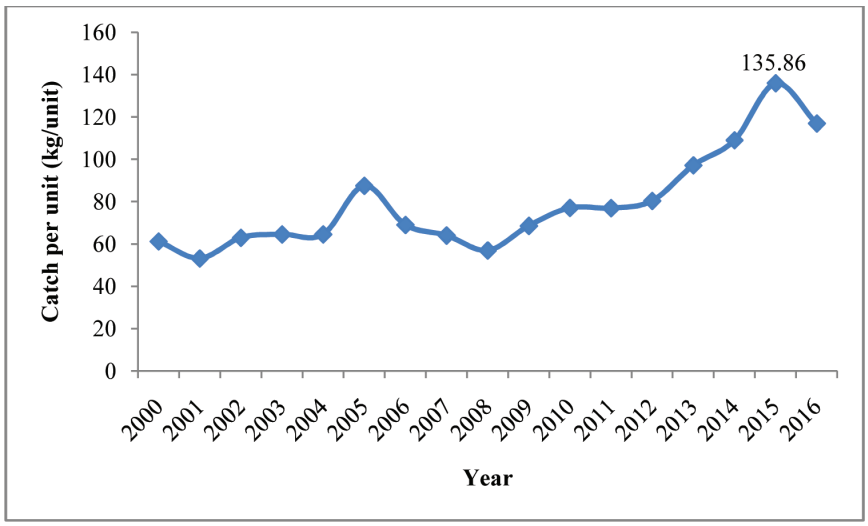


Fig 13: Catch-per-unit of gillnets in Andhra Pradesh (2000-2016)

2.5 Economic efficiency of fishing gears

The economic performance of various fishing units for Andhra Pradesh is given below. Total Factor Productivity growth was positive with a value of 5.80. This was because of increased landings of high value resources like shrimps and tunas and increased efficiency of fishing operations in the state.

Table 11: Economics of mechanized and motorized fishing units

Fishing method	Total Operating Cost (₹)	Gross Revenue (₹)	Net Operating Income (₹)	Capital Productivity	Average share of fuel to the Total Operating Cost (%)	Average share of crew wages to the Total Operating Cost (%)
Multiday trawling (< 6 days)	28,598 - 33,511	39,818 - 1,10,352	11,220 - 78,274	0.29 - 0.72	-	-
Multiday trawling (> 6 days)	16,403 - 57,156	27,638 - 1,74,519	11,235 - 1,17,363	0.33 - 0.59	55	27.5
Singleday trawling	5,594 - 11,039	17,189 - 35,893	11,595 - 24,854	0.25 - 0.33	57	26
Motorized Gillnet	4,586 - 7,032	5,946 - 12,329	1,360 - 6,806	0.52 - 0.77	33	59

Source: ICAR - CMFRI Annual Reports

Table 12: Economics of non-mechanized fishing units

Fishing method	Total Operating Cost (₹)	Gross Revenue (₹)	Net Operating Income (₹)	Capital Productivity
Gillnet	377 - 1,292	753 - 2,171	377 - 1,000	0.50 - 0.66

Source: ICAR - CMFRI Annual Reports

3. Status of marine fish stocks of Andhra Pradesh

The Rapid Stock Assessment (RSA) indicated that most marine fish and shellfish stocks of Andhra Pradesh are slowly moving into an unhealthy state. Approximately 68% of the 60 groups for which data is available are either in the "Less abundant" or "Slow declining" category (Fig.14). Eight percent are in the "Rapid declining" category, 2% in "Depleted" and 8% in "Collapsed" categories respectively (Table 14). Only 13% of the stocks were in the "Abundant" category. The stocks in the "Declining" and "Depleted" categories may be treated as vulnerable stocks which warrant specific measures for their management and conservation.

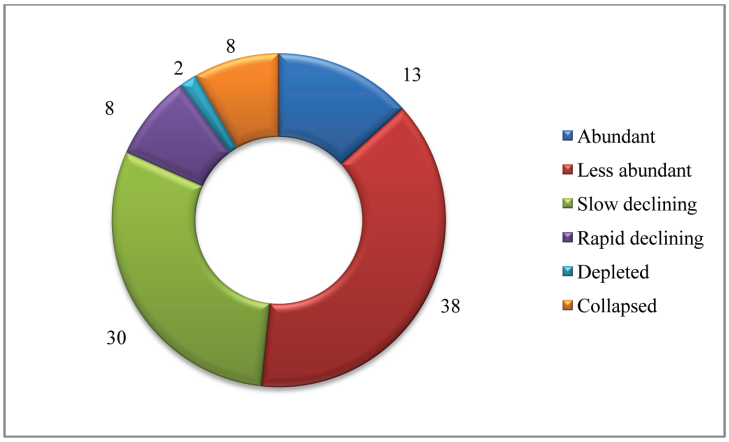


Fig 14: Status of fish stocks of Andhra Pradesh (% composition)

Unsorted catch from a trawler

Fished taxa diversity of Andhra Pradesh

Around 616 species of marine fauna are distributed in the waters of Andhra Pradesh of which 476 are finfishes species belonging to 248 genera and 101 families, 33 species of shrimps belonging to 11 genera and 5 families, 4 species of crabs of 3 genera and 1 families, 3 species of lobsters of 2 genera and 2 families, 16 species of gastropods of 16 genera and 12 families, 23 species of bivalves of 16 genera and 10 families, 10 species of cephalopods of 5 genera and 2 families, 35 species of stomatopods of 11 orders and 6 families, 6 species of echinoderms of 4 genera and 4 families, 1 species of sponge of 1 family, 1 species of soft coral of 1 family, 2 species of turtle of 2 genera and 1 family and 4 species of mammals of 3 genera and 2 family.

Table 14: Details of stocks in each category of RSA

Abundant	Less abundant	Slow declining	Rapid declining	Depleted	Collapsed
Anchovies (*Thryssa* spp.)	Eels	Guitarfish	Sharks	Mullets	Hilsa shad
Goatfish	Catfish	Rays	Bombayduck		Anchovies (*Setipinna* spp.)
Croakers	Oil sardine	Wolf herring	Big-jawed jumper		Pig face breams
Other Carangids	Lesser sardines	Other hilsa	Lobsters		Wahoo
Halibut	Lizardfish	Golden spotted anchovy	Stomatopods		
Soles	Flyingfish	Anchovies (*Stolephorus* spp.)			
Penaeid prawns	Threadfin breams	Other clupeids			
Crabs	Other perches	Half beaks and full beaks			
	Ribbonfish	Rock cods			
	Threadfin (Polynemids)	Snappers			
	Horse mackerel	Scads			
	Leather jackets	Black pomfret			
	Silverbellies	Silver pomfrets			
	Indian mackerel	Chinese pomfret			
	Spotted seer	Other mackerel			
	Skipjack tuna	Streaked seer			
	Little tuna	Billfishes			
	Frigate tuna	Non-penaeid prawns			
	Yellowfin tuna	King seer			
	Barracudas				
	Flounders				
	Squid				
	Cuttlefish				

The top five landed marine groups, as mentioned earlier are *Sardinella* spp. (lesser sardines), croakers, penaeid prawns, Indian mackerel and ribbonfish. All these groups except penaied prawns and croakers fall in the "Less abundant" category with the exceptions falling in the "Abundant" category. A plot of the landings and catch rates (Catch per hour-CPH) in trawls for penaeid prawns and croakers (Figs. 15 & 16) showed an increasing trend initially with a decline since 2014 (for penaeid prawns) and 2009 (for croakers). Lesser sardines showed highly variable landings and catch rates, with very high landings in 2015 (Fig. 17). Ribbonfish showed highly variable landings and catch rates (Fig. 18). Indian mackerel was landed mainly by gillnets in the early 2000s; then by trawl till 2010 and since then the species is landed mainly by ring seines in Andhra Pradesh. The landings and catch rate of mackerel in ring seines show an increasing trend till 2014 and a decreasing trend since then (Fig. 19).

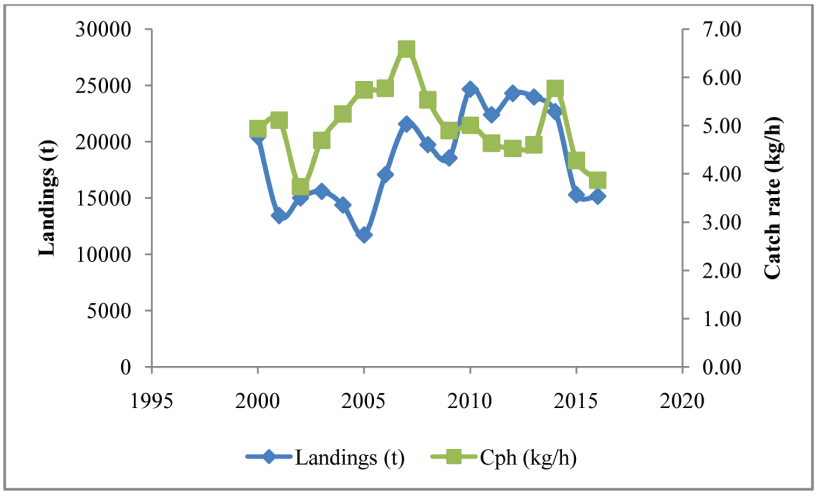


Fig 15: Landings and catch rate (kg/h) of penaeid prawns in trawls in Andhra Pradesh

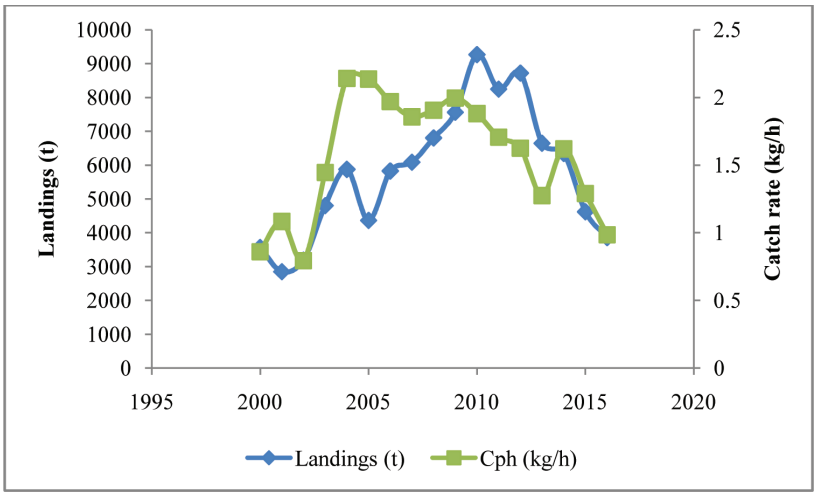


Fig 16: Landings and catch rate (kg/h) of croakers in trawls in Andhra Pradesh

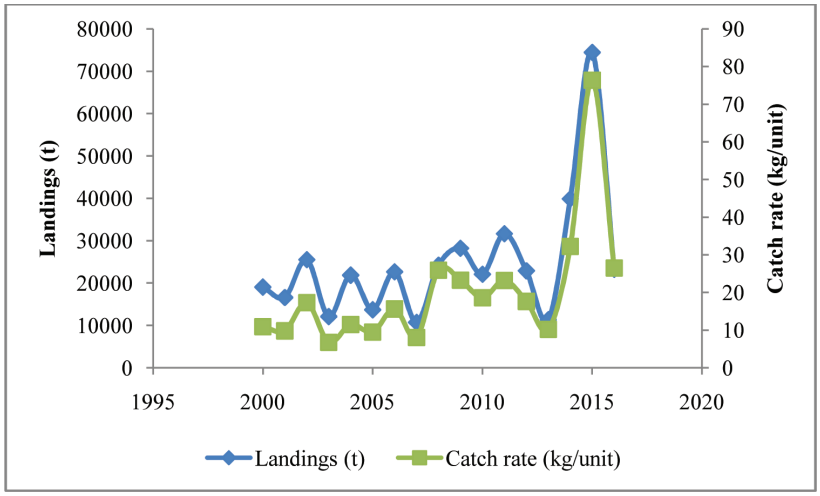


Fig 17: Landings and catch rate (kg/unit) of lesser sardines in gillnets and seine nets in Andhra Pradesh

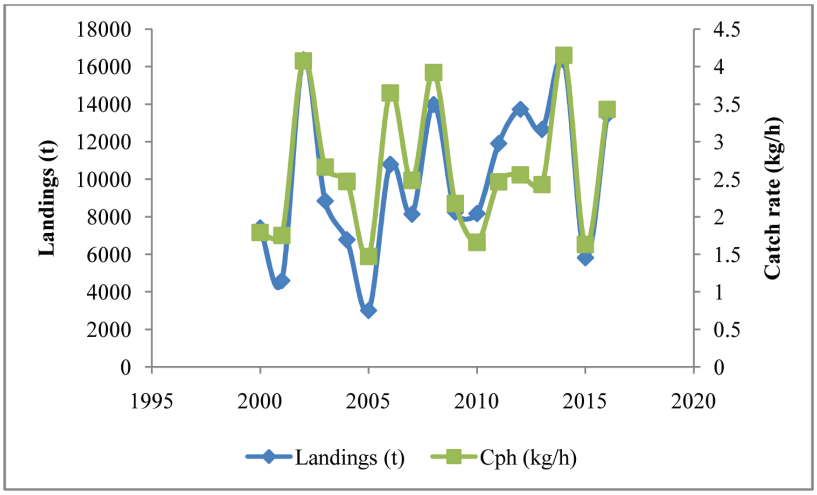


Fig 18: Landings and catch rate (kg/h) of ribbonfish in trawls in Andhra Pradesh

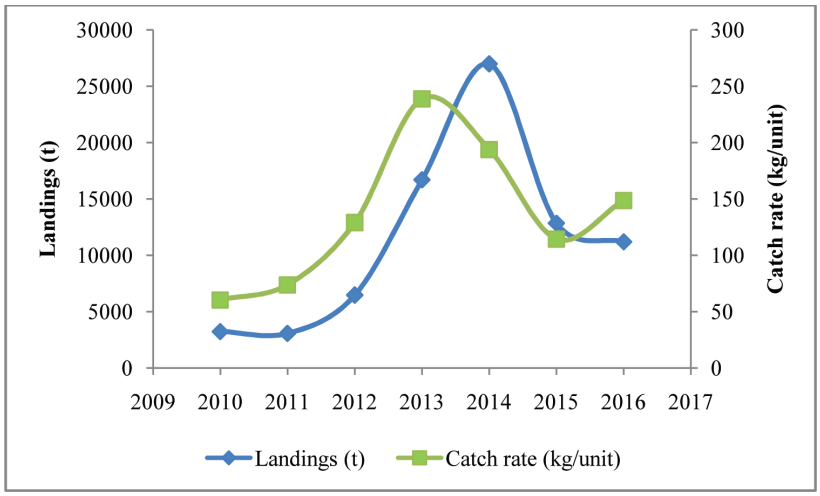


Fig 19: Landings and catch rate (kg/unit) of Indian mackerel in ring seines in Andhra Pradesh

Mackerel landed at Visakhapatnam Fishing Harbour

Stock assessments were carried out for individual species within a group and for a particular gear. Stock assessments (2012-2017) of major pelagic resources namely Indian mackerel, ribbonfish, yellowfin tuna, king seer and spotted seerfish indicated that these resources are optimally fished. On the other hand Indian oil sardine and skipjack tuna were under exploited (Table 15). Among demersal resources, one species of threadfin bream and one croaker was optimally exploited; other species studied were under exploited. Of the crustacean resources studied, one each was under-exploited, optimally exploited and over exploited. Of the molluscan resources studied, one was over exploited, the others were optimally exploited.

Table 15: Maximum Sustainable Yield (MSY) and stock status of major species in Andhra Pradesh

Species	Common name	Average Yield (t) (Years in parenthesis)	MSY(t)	Maximum yield-per-recruit (YPR_{max}) (g)	F multiplier to reach YPR_{max}	Status
Pelagic species						
Rastrelliger kanagurta	Indian mackerel	31,203 (2012-2017)	31,368	14.93	1.2	Optimally exploited
Sardinella longiceps	Indian oil sardine	14,039 (2012-2017)	15,126	10.79	2.4	Under exploited
Trichiurus lepturus	Ribbonfish	15,957 (2012-2017)	15,957	48.8	1.0	Optimally exploited
Katsuwonus pelamis	Skipjack tuna	3,285 (2012-2017)	3,489	957.4	1.8	Under exploited
Thunnus albacares	Yellowfin tuna	4,898 (2012-2017)	5,026	12,688.2	0.8	Optimally exploited
Scomberomorus guttatus	Spotted seerfish	2,401 (2012-2017)	2,421	92.8	1.2	Optimally exploited
Scomberomorus commerson	King seer	2,762 (2012-2017)	2,848	1,045.2	1.4	Optimally exploited
Demersal species						
Nemipterus randalli	Threadfin bream	573 (2013-2014)	1,258	11.644	3.0	Under exploited
Nemipterus japonicus	Threadfin bream	4,967 (2012-2015)	5,102	7.754	1.4	Optimally exploited
Nibea maculata	Croaker	641 (2013-2014)	744	27.592	3.0	Under exploited
Pennahia anea	Croaker	877 (2007-2011)	1,043	41.9	1.2	Optimally exploited

Species	Common name	Average Yield (t) (Years in parenthesis)	MSY(t)	Maximum yield-per-recruit (YPR_{max}) (g)	F multiplier to reach YPR_{max}	Status
Psettodes erumei	Indian halibut	481 (2013-2015)	1,527	216.427	2.2	Under exploited
Saurida undosquamis	Lizardfish	2,012 (2012-2016)	7,060	22.913	3.0	Under exploited
Crustacean species						
Metapenaeus monoceros	Brown shrimp	5,588 (2012-2016)	6,622	7.762	0.2	Over exploited
Metapenaeus dobsoni	Flowertail shrimp	2,266 (2012-2016)	2,354	1.125	1.8	Under exploited
Portunus sanguinolentus	Three spot crab	1,912 (2012-2016)	1,912	40.796	1.0	Optimally exploited
Molluscan species						
Uroteuthis duvaucelii	Squid	3,722 (2012-2016)	4,468	11.88	0.4	Over exploited
Sepia aculeata	Cuttlefish	7,359 (2012-2016)	7,405	145.191	0.6	Optimally exploited
Sepia pharaonis	Cuttlefish	5,638 (2012-2016)	5,638	187.32	1.0	Optimally exploited

Landings of seerfish

An analysis of size at first maturity of major species over time has shown that most species mature at smaller sizes recent years (Fig. 20). The major demersal species namely, *Nemipterus japonicus, Upeneus vittatus, Saurida undosquamis, Otolithes ruber* and pelagic species namely, *Rastrelliger kanagurta, Sardinella longiceps* and the major cephalopod resource, namely *Uroteuthis duvaucelli* are maturing at sizes smaller than before. This could be the result of either increased fishing pressure on the species or environmental changes or a combination of both. Fixing a Minimum Legal Size (MLS) can to a large extent restrict the downslide of maturity sizes.

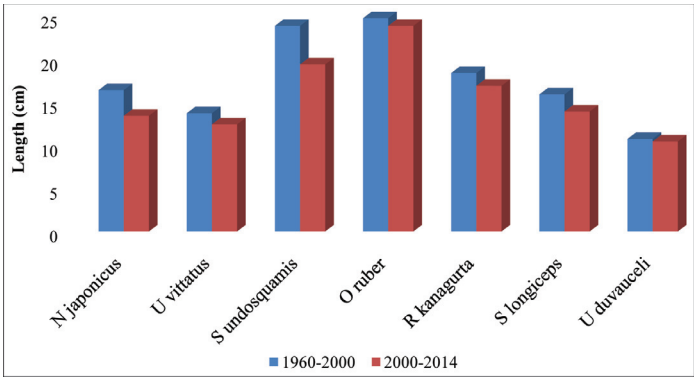
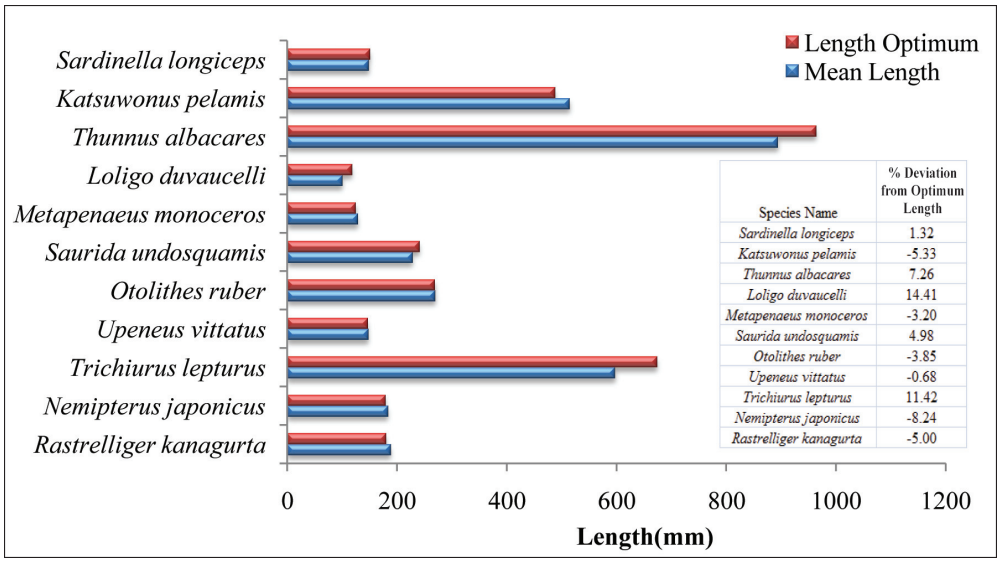


Fig 20: A comparison of length at first maturity (published vs present values) of major species in Andhra Pradesh

An analysis of mean lengths of major species and optimum length indicated that for most species mean length was in close association with the optimum length indicating that the present sizes are giving maximum sustainable yield from the stocks (Fig. 21). Trend of mean lengths (2011-2015) indicated that it has been steady for most major species in Andhra Pradesh (Figs. 22 & 23).

Influence of aquaculture industry on marine fisheries: White Pacific shrimp saves the black tiger shrimp

During the peak culture periods of black tiger shrimp (1995-2005), targeted fishing for gravid broodstock of black tiger shrimp existed when a single brooder of *Penaeus monodon* would fetch anywhere from ₹ 2000 to 30,000. This led to concerns that rampant broodstock collection from the wild would have deleterious effects on wild populations of black tiger shrimp. Today however black tiger shrimp has taken the back seat in the culture scenario of Andhra Pradesh with the advent of the Pacific white shrimp, *Litopenaeus vannamei*. At Visakhapatnam, where earlier the demand for broodstock for tiger shrimp was nearly 1.5 lakh pieces per year, today it has come down to only 5,000 pieces per year with a brooder fetching only ₹1,500 to 3,000. It is expected that reduced fishing of black tiger shrimp brooders should have a beneficial impact on wild populations of the species. An analysis of black tiger shrimp catch rates (non-brooders) indicated that during the peak culture periods of 2000-2008 the average catch rate was 0.06 kg/h. However, since the culture of Pacific white shrimp started, the catch rate of black tiger shrimp has increased to 0.315 kg/h in 2014.



Species Name	% Deviation from Optimum Length
Sardinella longiceps	1.32
Katsuwonus pelamis	-5.33
Thunnus albacares	7.26
Loligo duvaucelli	14.41
Metapenaeus monoceros	-3.20
Saurida undosquamis	4.98
Otolithes ruber	-3.85
Upeneus vittatus	-0.68
Trichiurus lepturus	11.42
Nemipterus japonicus	-8.24
Rastrelliger kanagurta	-5.00

Fig 21: Comparison of mean length and optimum length of major commercial species of Andhra Pradesh

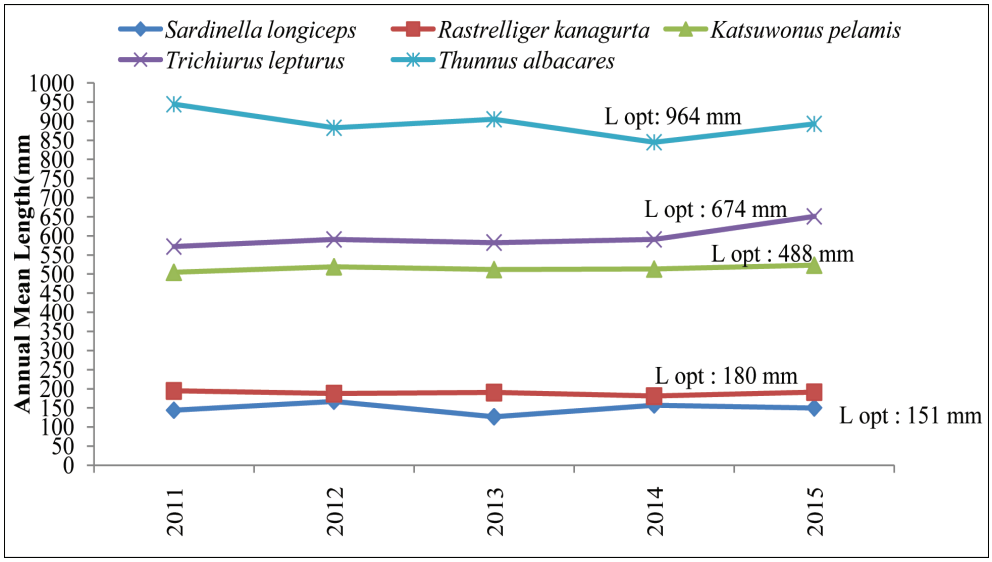


Fig 22: Trend of mean lengths and optimum length of major pelagic species of Andhra Pradesh

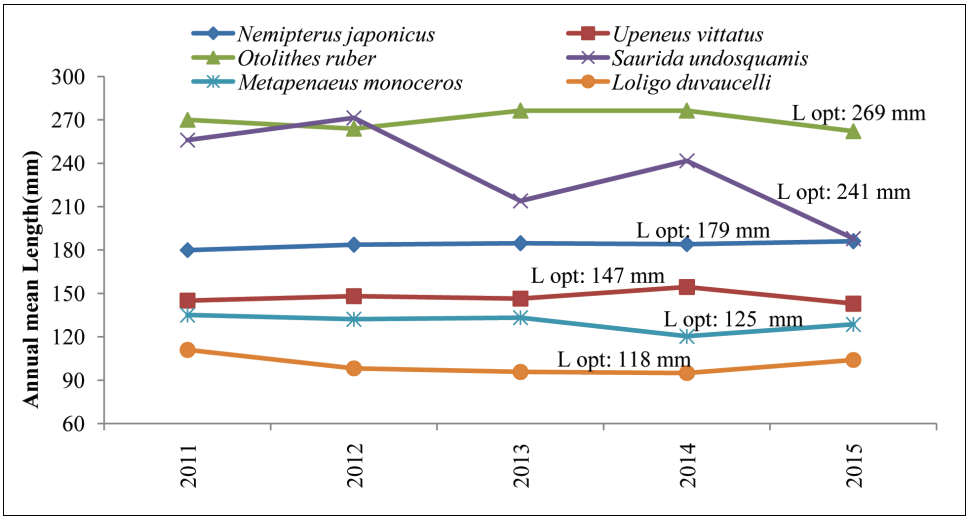


Fig 23: Trend of mean lengths and optimum length of major demersal, crustacean and cephalopod species of Andhra Pradesh

The groups in the "Declining" category of the RSA can be considered as vulnerable stocks. Of these the two elasmobranch groups, namely, sharks and guitarfish are particularly vulnerable due to their life history features of slow growth, late maturation and few pups. The third elasmobranch group namely "rays" are in the "Less abundant" category. The contribution of elasmobranchs to total landings of Andhra Pradesh has showed a steady decline from 1985 to 2014 (Fig. 24). The composition of elasmobranch landed in the state has also changed drastically. Sharks which dominated in the 1980s have given way to rays which became the dominant group in the 2000s (Fig. 25). Globally, sharks are considered as a highly vulnerable group and need focused management approach for sustainable growth in Andhra Pradesh as well. Formulating and implementing a management program for sharks in Andhra Pradesh as suggested by CMFRI in the Guidance to NPOA on Sharks in India (Kizhakudan *et al.*, 2015) would be an effective conservation strategy for the state.

Elasmobranchs landed at Visakhapatnam

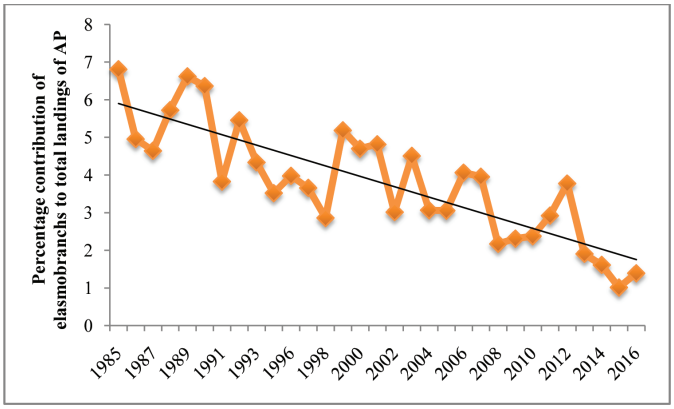


Fig 24: Percentage contribution of elasmobranchs to the total landings of Andhra Pradesh

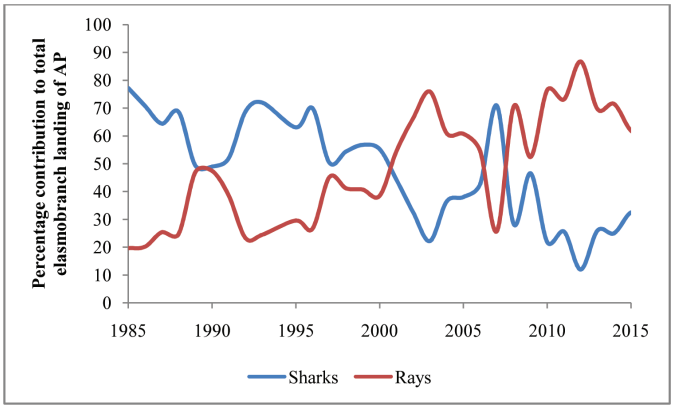


Fig 25: Contribution of sharks and rays to elasmobranch landings of Andhra Pradesh

Whale shark landings in Andhra Pradesh

The landing of the whale shark *Rhincodon typus* Smith 1828 has been banned by the Govt. of India since 2001. However observations in the field indicate that whale sharks are caught and landed quite often in East Godavari district of Andhra Pradesh. The whale sharks get entangled in gillnets used for tuna fishing. The price for a whale shark ranges from ₹ 6,000-25,000 depending on the size and quality of the shark.

A 3m long whale shark landed at Kakinada in 2014

4. The marine environment along Andhra Pradesh

During 1960-2012, sea surface temperature (SST) along the coast of Andhra Pradesh has shown an increasing trend with warming of 0.4^{0}C (Fig. 26). Increased warming of the seas is mainly attributed to increased carbon dioxide in the atmosphere due to anthropogenic reasons. In addition to increasing SST, the ocean is also getting progressively more acidic. These changes in the ocean have led to a number of consequences including sea level increase, changes in ocean circulation, increased stratification of the ocean and subsequent changes to ocean biota.

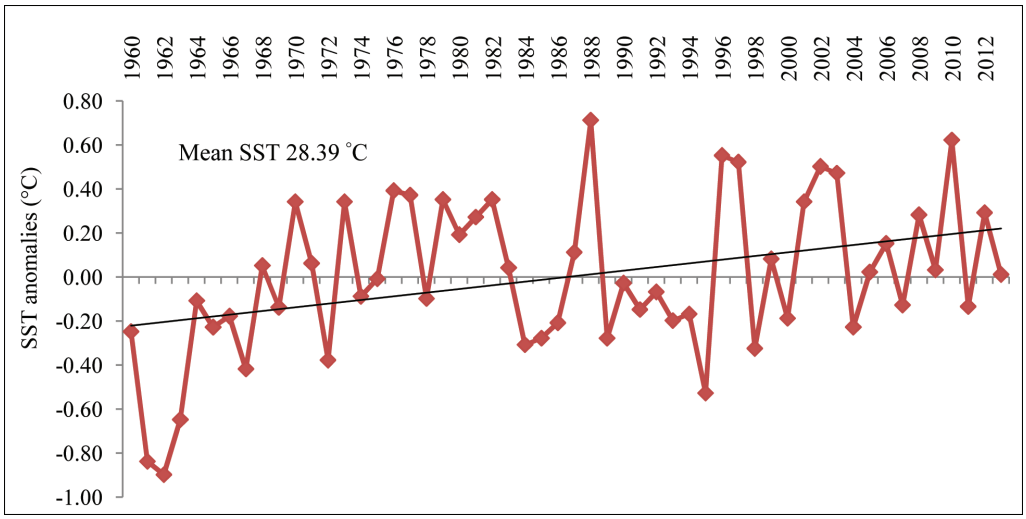


Fig 26: SST anomalies along Andhra Pradesh (1960-2012) (Source: ICOADS, Woodruff *et al.*, 2011)

Effects of warming of seas along Andhra Pradesh coast are visible in the marine resources along the state's coastline. There is horizontal range extension of species distribution, vertical range extension of species distribution, changes in the timing of phenological events like spawning season and earlier maturation of species. The northward range extension of the Indian oil sardine is well documented in literature (Vivekanandan, 2011). Studies have shown that concurrently there is increased predation on sardines by other fishes. Thus the range extension and increased abundance possibly occurring as a result of environmental signals has affected the trophic structure of coastal ecosystems along Andhra Pradesh. The depth of surface gillnets was four fathoms in the 1980s in the state but now that has increased to nine fathoms indicating the deepening of shallow-water species. The fishermen during surveys have also opined that small pelagic species due to variation in surface-water temperature have descended to the lower layers from the surface. The Indian mackerel and the Indian oil sardine are found to descend to deeper waters in the last two decades (Figs. 27 & 28). In Andhra Pradesh, shift of spawning season for threadfin breams was observed from relatively warmer to cooler months (Fig. 29). During 1990 - 1999, peak spawning season was from August - October, however in recent years (2002 - 2010), peak spawning has shifted to the cooler months of November - January.

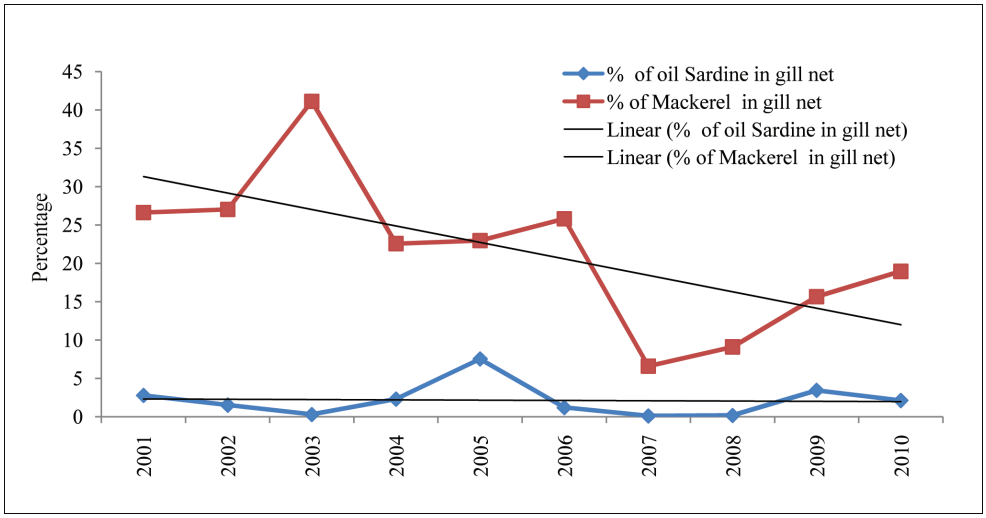


Fig 27: Percentage of oil sardine and Indian mackerel landed by gillnets

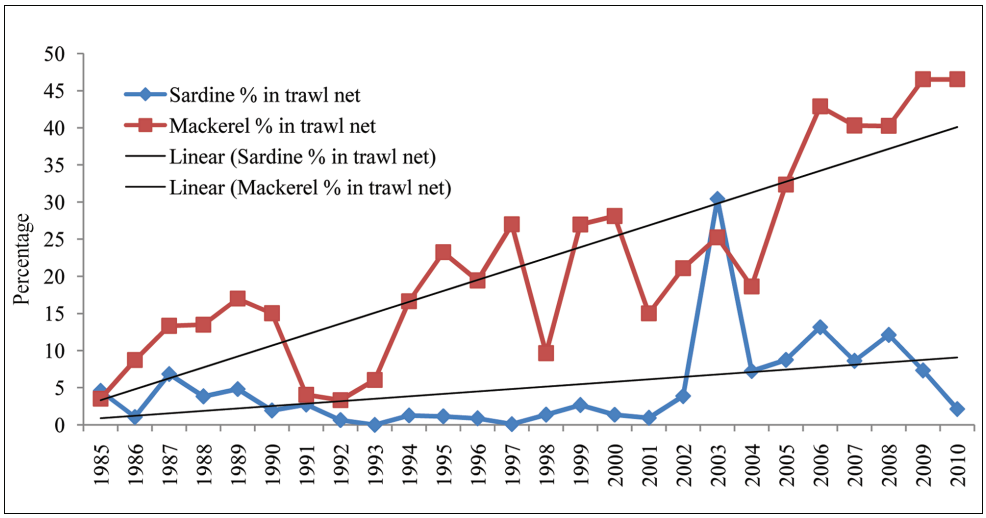


Fig 28: Percentage of oil sardine and Indian mackerel landed by trawlers in Andhra Pradesh

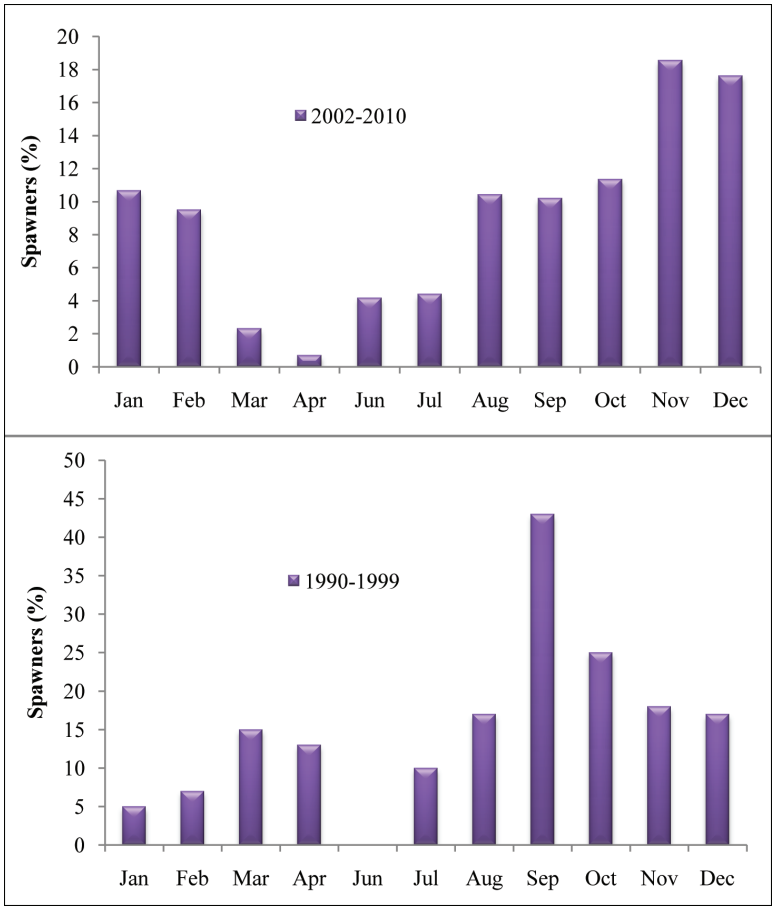


Fig 29: Monthly percentage of spawners of *Nemipterus japonicus* in Andhra Pradesh (1990-1999 vs 2002-2010)

Life Cycle Analysis (LCA) indicated that the marine fisheries of Andhra Pradesh are more environment friendly emitting less CO_2 per kg of fish landed as compared to the global average. Mechanized catches contributed 80 - 85 % of the total fuel burnt and 79 - 90 % of the total electricity consumed. The harvest phase (88 - 93 %) burnt the most fuel, while the post harvest phase (51 - 62 %) contributed the most to the electricity consumption. Emission intensity per kg of marine fish was 0.34 kg C and 1.26 kg CO_2 in Visakhapatnam, 0.31 kg C and 1.16 kg CO_2 in Kakinada, 0.41 kg C and 1.50 kg CO_2 at Nizamapatnam and 0.37 kg C and 1.37 kg CO_2 at Machilipatnam, much lower than the global average of 1.7 t CO_2 per t of fish. Fuel and electricity consumption and emission intensity was high for mechanized landings and low for motorized landings. The highest emissions were recorded in the harvest phase at all the places. By increasing the fuel efficiency of marine diesel engines, by controlling craft speed, by using large propeller with lower revolutions and by reducing the craft drag, reduction in energy consumption and subsequent emissions is possible.

Table 16: Carbon footprints for craft gear combinations

Fishing units	Kg C emitted per kg of fish	Kg CO_2 emitted per kg of fish
Mechanized trawlers	0.466	1.713
Out-board motorized gillnetters and hooks and liners	0.186	0.685
Out-board ring seiners	0.247	0.906
Non mechanized units	0.154	0.566

A ring seine being dried on the beach

5. The coastal environment along Andhra Pradesh

Andhra Pradesh has a coastline of 974 km with a continental shelf area of 31000-39000 sq km. A number of industries are situated along the coastline of the state, which together with increased coastal urbanization have resulted in degradation of coastal water quality. Water quality has been impacted by land run-offs, agricultural run-offs, untreated sewage and industrial effluents. Increased solid waste in terms of plastic waste has been increasing along north coastal Andhra Pradesh. A part of this invariably gets washed into the sea where it inadvertently enters fish through ingestion leading to increased mortality. Coastal pollution exacerbates the pressure faced by fish stocks as polluted water harms brooders, fish eggs, larvae and their food, the plankton. Thus the coastal environment should also be managed effectively for sustainable fish populations.

There are a number of ports and industries along the coast of Andhra Pradesh which release effluents in addition to the sewage generated by human settlements. All these eventually find their way into the sea along the state. As per 2014-2015 data from coastal waters of Andhra Pradesh, the parameters being monitored are all within permissible range for fisheries purposes (APPCB, 2015). However, of the 1580 MLD of sewage generated in the state 1295.5 MLD (8.2%) is untreated. Untreated sewage entering coastal waters and being retained there by local oceanographic features can lead to localized ambient water quality degradation for marine fish. A direct impact of such untreated sewage entering marine waters is the increasing ingestion of plastic by fish. In the northern coastal districts of Andhra Pradesh viz., Srikakulam, Vizianagaram, Visakhapatnam and East Godavari; urban areas along Visakhapatnam coast was found to be the most polluted because of release of domestic effluents and untreated sewage into the sea at multiple locations. The major fishing harbours at Visakhapatnam and Kakinada were moderately polluted. Water quality was pristine in other coastal areas of northern Andhra Pradesh.

Plastics and other debris off Visakhapatnam Fishing Harbour

Marine litter in beaches was studied in a CMFRI project in 100 sq. m. quadrants. Again because of urbanization, highest marine litter to the tune of 84.3 g/100 sq. m. was recorded in the beaches of Visakhapatnam, followed by East Godavari (73 g/100 sq. m.) and Srikakulam (65.2 g/100 sq. m.). The intense use of beaches for recreation, tourism, and religious activities has increased the potential for litter contamination in the urban beaches of Visakhapatnam. Litter in beaches at Visakhapatnam was contributed by glass and plastic, whereas in East Godavari and Srikakulam it was because of glass and footwears (CMFRI unpublished report).

The water from the rivers of Andhra Pradesh has been continuously diverted for use in irrigation and other industrial and urban uses. This had led to the rivers being dry with complete absence of freshwater in their lower stretches and estuaries creating a stumbling block in the migration route of fish, in particular hilsa. The Godavari estuary, known to be the traditional hilsa breeding and nursery ground, is increasingly getting shallower with less water volume and hypersaline due to low runoff from catchment areas and seawater intrusion. The disconnection of creeks of adjoining brackish water bodies with sea because of reduced flow of fresh water into sea has also proved detrimental for mullets. The reduced flow from the major rivers of Andhra Pradesh has in turn affected their deltaic areas and mangroves.

Vulnerable districts of Andhra Pradesh

A Vulnerability Index (VI) was created in a council funded project for each of the 9 coastal districts of Andhra Pradesh based on five parameters namely, geographical, environmental, industrial, socioeconomic and recreational to assess the most vulnerable districts in the state. The results indicated that Krishna district was the most vulnerable and Vizianagaram the least (CMFRI unpublished report).

Coastal Districts	Vulnerability Index	Rank
Krishna	0.76	I
Visakhapatnam	0.66	II
East Godavari	0.65	III
Nellore	0.63	IV
Guntur	0.57	V
Prakasam	0.56	VI
Srikakulam	0.38	VII
West Godavari	0.31	VIII
Vizianagaram	0.21	IX

Mangrove forests in Andhra Pradesh are located in the estuaries of the Godavari and Krishna rivers. They are also found in small patches along the coast of Visakhapatnam, West Godavari, Guntur and Prakasam districts, encompassing an area of about 582 sq. km in Andhra Pradesh. Mangrove forests perform multiple ecological and biological functions, most important of which with respect to fisheries are providing habitat, food, and spawning grounds for finfishes and shellfishes and protection of coastlines. There was a decline of 143 sq. km in Andhra Pradesh in mangrove area during the period 1987-2013 (Sahu *et al.,* 2015). The major threats to mangrove area destruction in Andhra Pradesh reported was agriculture, grazing, developmental activities, invasion of alien species and aquaculture (Swain *et al.,* 2013,Tarakanadha *et al.,* 2013, Shaik *et al.,* 2013). The loss of mangrove vegetation across the coastal region reduces the coastal shield against natural coastal disasters. Moreover, it will lead to enhanced loss of biodiversity due to degrading coastal habitats and nursery grounds of various marine fauna. It requires immediate attention for its governance, planning and creating awareness for its restoration of lost mangrove vegetation and for active participation of stakeholders/local communities.

6. Management objectives of the State

The Government of Andhra Pradesh promotes the rational exploitation and utilization of the state's fishery resources in a manner consistent with the overall goal of sustainable development (AP Fisheries Policy). Presently the marine fisheries of the State are managed under the Andhra Pradesh Marine Fishing Regulation Act of 1995. The Act directs the Government to have regard for the following matters, namely:

1) Protecting the needs of fishermen , particularly those using traditional crafts
2) Conservation of fish and scientific regulation of fishing
3) Maintenance of law and order in the sea
4) Any other matter

The Act aims towards managed marine fisheries in the State with the following regulations:

1) Registration of fishing vessel - All mechanized fishing boats, other mechanized vessels, traditional country crafts and motorized beach landings crafts which is to be used for fishing has to be registered with the Govt. of Andhra Pradesh under this Act or under the MPEDA Act, 1972. Failure to do so would lead to penalties or eventual seizure by the concerned authorities.
2) License for fishing within territorial waters - Owners of registered fishing crafts need to obtain a license for using the fishing craft for the purpose of fishing in a specified area falling in the territorial waters of the state.
3) License for fishing beyond territorial waters - From 2015, the Dept. of Fisheries, Govt. of Andhra Pradesh has started issuing licenses for fishing vessels to fish beyond territorial waters.
4) Mesh size regulation - Traditional crafts are prohibited from fishing using nets less than 12.7 mm (half inch) mesh size. Trawl nets with cod end mesh size of less than 12.7 mm (half inch) are also prohibited from fishing along the state.
5) Area restriction - Mechanized fishing vessels are prohibited from fishing within 8 km from the shore. This zone is reserved for traditional crafts only and any mechanized vessel fishing in the reserved zone would be penalized. Mechanized crafts below 15 m OAL can fish beyond 8 km and mechanized crafts of twenty five gross tonnes and or above 15 m OAL can fish only beyond 23 km from shore.
6) Closed season - Fishing by mechanized vessels and motorized crafts is banned from April 15-June 15 (from 2015 onwards) in territorial waters for conservation of fish brooders.
7) Juvenile fishing prohibition - The Act clearly mentions that no fishing vessel registered and licensed under this Act be used for catching shrimp juveniles or any other fish requiring conservation.

Though the Act aims at efficient management and conservation of resources, the implementation of the Act with respect to conservation remains very poor. Mesh sizes as small as 5 mm are common in trawl net cod ends as is fishing by trawlers within the reserved zone of 8 km.

7. Recommendations for sustainable management and conservation of marine fish resources of Andhra Pradesh

We hereby propose several recommendations for sustainable management and conservation of the marine fish resources of Andhra Pradesh. These recommendations are based on several studies conducted by CMFRI for other coastal states as well as published scientific information. These recommendations are also based on the National Policy on Marine Fisheries 2017 (GoI, 2017) of the Government of India. The NPMF 2017 is aimed at ensuring "the health and ecological integrity of the marine living resources of India through sustainable harvests for the benefit of current and future generations of the nation".

1) **Review, updating and stricter implementation of Marine Fishing Regulation Act** - The MFRA 1995 of Andhra Pradesh has provisions for conservation of marine resources of the state. However now the Act is more than 20 years old and needs updating with the latest changes happening in the marine fisheries sector of the state. One of the biggest lacuna in the present scenario is poor implementation of the provisions of the Act. However with the current strength of the State Fisheries Department it is not an easy task to implement and monitor implementation of the provisions of the MFRA. Hence a separate Enforcement Wing is mooted for the State Fisheries Department which can happen only if the Act is updated. The stakeholders (i.e. fishermen) too are of the opinion that the Department should form enforcement teams which includes fishermen as members for better enforcement of management and conservation measures.

   a. **Establishment of Marine Fisheries Surveillance Units** - Establishing a Marine Fisheries Surveillance Unit at each district headquarter which should have as its members a representative of the State Fisheries Department and the fishing industry (fishermen, traders and processing industry) for effective implementation of MFRA.

   b. **Stock assessments of major marine resources** - Periodic stock assessments of major marine resources of the state should be a requirement under the MFRA of the state. ICAR-CMFRI is already carrying out regular stock assessment of major resources which could be used for management by the State Fisheries Dept.

2) **Input controls:**

   a. **Regulation of fishing effort** -There has been an uncontrolled increase in fishing effort in Andhra Pradesh over the last decade. In an effort to maximize their returns and suit specific situations, fishermen have adopted new designs in fishing crafts and gears. Trawlers and gillnetters became larger in length; trawl nets with suitable modifications targeting specific resources came into existence viz., shrimp trawl net, ribbonfish trawl net and cephalopod trawl net; increase in horsepower of engine and number of boats with outboard

motor and introduction of in-board motor fitted large vessels operating large nets, winches and other deck equipments are some of the important changes that have taken place in the last few years. Ring seine units, with no regulations on length, depth and mesh size, have multiplied in recent times. As a result the fish stocks are under high fishing pressure. Thus regulation of fishing effort is the need of the hour. Some recommendations to regulate the fishing effort of AP are:

- **Optimal Fleet Size** - CMFRI has estimated that a total of 1,300 mechanized fishing boats are optimal for fishing the marine resources of Andhra Pradesh. As per Real Craft figures, there are 1,569 mechanized crafts in Andhra Pradesh currently (Govt. of AP, 2018). Thus the state currently has 62% excess fishing capacity. The state along with the stakeholders should make serious efforts to bring down excess fishing capacity to the optimal level of 1,300. The State govt. can initiate buy-back measures or diversification of fishing crafts to new fishing/non-fishing sectors to bring about fleet size reduction.

- **Replacement of all mechanized fishing vessels older than 15 years** - Use of old fishing boats is both economically inefficient and a hazard to the life of fishermen. Hence all mechanized boats which are beyond 15 years in age should be replaced with new boats.

- **Total prohibition on construction of new mechanized boats in Andhra Pradesh** - No new mechanized boats should be constructed in the state other than for the purpose of replacement of old boats as mentioned above. If the replacement boat is in the same length as the old boat, subsidies should be maintained as such. However if the new boat is of a length higher than the old boat, subsidies should be cut, the percentage of which should be decided by the State Fisheries Department. Boat building yards also should be monitored and regulated by the State Fisheries Department with new fishing boats built only after being granted permission by the State Fisheries Department.

- **Re-registration of new fishing crafts** - All newly replaced mechanized fishing crafts should be given a new registration number and the craft should be re-certified by relevant authorities (State Fisheries Dept. or other govt. agencies) for its seaworthiness. In all such cases, length of craft should be taken at point of maximum distance from bow to stern and not the length of the keel. Renewal of license should be carried out periodically with a check on the engine power also, which can be carried out by the State Fisheries Department and a third party agency, which has been recognized by the Marine Mercantile Department.

- **Classification of crafts based on use of engine for propulsion and fishing** - Confusion exists within stakeholders on classification of crafts and their terminology. A clearer classification of crafts based on the different engine powers, use of engine for propulsion and/or fishing, etc. should be made.

- **Engine power - craft size limits** - There should be limits placed on the power of engines used in crafts of different sizes. The optimal combination of engine power and size of craft as estimated for Kerala and applicable for Andhra Pradesh is presented here.

Table 17: Fishing vessel length and Engine Horse Power combinations

S. No.	Length(m)	Breadth(m)	Depth(m)	Maximum allowable main engine horsepower	Present engine horsepower used
1	Up to 15.00	Up to 4.70	2.4	140	108-110
2	15.00-17.50	4.70-5.20	2.4-3.0	200	240
3	17.50-20.00	5.20-5.50	2.65-3.1	250	240-285
4	> 20.00	> 5.25	> 3.0	> 250	240-360

Source: Mohamed *et al.*, 2013

- **Restriction of high powered crafts from trawl fishing** - There are reports of high horsepower engines of 300 hp and more being used for trawling in certain places of Andhra Pradesh. Such practices should be prohibited immediately and such crafts should be allowed to use only longlines or gillnets in areas beyond the 200 m contour line.

b. **Diversification of fishing effort** -Diversification of fishing effort should also be given priority. There is ample opportunity to increase the production of unexploited deep sea pelagic resources especially the oceanic tunas and billfishes along with oceanic cephalopods by increasing the distance and depth of fishing. This will ease out considerably the fishing pressure in the inshore waters.

- **Conversion of trawlers** - Conversion of shrimp trawlers to tuna liners is already being advocated in the state. Further conversion of bottom trawls to mid-water fish trawls should be encouraged. A number of trawl operators are also switching over to ring seines. CMFRI is conducting a study on the impact of ring seines on the state's marine resources. The results of the study can form inputs for setting guidelines for ring seine operation in the state. As mentioned above, trawlers which use high powered engines should be diverted from trawling to deep sea longlining and/or gillnetting.

c. **Mesh size regulations** -Mesh size regulations in the trawl cod ends (40 mm, square mesh) should be strictly implemented and followed to reduce fishing of juvenile fish. Use of Bycatch Reduction Devices (BRDs) should be advocated vigorously. Mesh sizes for other fishing gears may be regulated as recommended in Table 9 of this document.

d. **Registration of fishing gears** - All fishing gears used in the marine sector should be registered with the State Fisheries Department with codes for each type of gear. Eventually this can lead the way for restrictions on maximum size of gear and number of gear carried by each craft.

e. **Restriction on number of ring seines** - Though ring seines are thought to be an efficient gear for capturing shoaling pelagic fish, the current fishing technique using this gear is to drag the net over the bottom of the sea, thereby disturbing the benthos and substrate. The mesh sizes are too small to allow escapement of juvenile fish. Hence the number of ring seines should be restricted in the state with mesh size restrictions in place.

f. **Seasonal closure of fishing** - Closed fishing season of 60 days is already in place; however, stricter implementation of the reserved zone for traditional fishers (up to 8 km from shore) should be carried out. This will prevent indiscriminate exploitation of brooders and juvenile fish which inhabit the coastal, nutrient-rich waters. Fishermen can provide inputs on season closures for vulnerable groups which can then be incorporated into fishery management plans.

g. **Area closures for fishing/Marine Protected Areas** - The estuaries of Godavari and Gosthani at Bhairavapalem, the Krishna estuary at Machilipatnam, the Kandaleru estuary at Krishnapattinam, the Vamsadhara estuary at Kalingapatnam, the Vasishta - Godavari estuary at Antarvedipalem and the estuaries of Pennar, Swarnamukhi and Sarada are home to brooders and juveniles of a vast array of fin and shellfishes and should be closed for fishing during certain months of the year. Recently CMFRI has conducted an in-depth study on the availability of fish seed resources in different seasons along the coastal waters of Andhra Pradesh. Seeds of mullets, milkfishes, seabass and snappers are available in plenty in the river mouths and creeks during the monsoon season and such areas should be closed for fishing during these months when occurrence of brooders and fingerlings are high. Similarly nursery areas of sharks can be protected. Voluntary area closures by fishermen would go a long way in sustaining fishery resources of the state.

h. **Increasing use of economic efficient gears and fishing techniques** - Fishing units with high factor productivity growth targeting high value resources increases the efficiency of fishing operations and needs encouragement. Tuna long liners targeting tuna and other large pelagics have to be promoted for higher economic returns to the fisherfolk and to make fishing operations more lucrative and profitable.

i. **Minimization of inter-sectoral conflicts** - The stagnating landings of marine resources has resulted in gillnetters extending their vertical range of operations into deeper waters (bottom set gill nets) and trawlers venturing into mid-columnar waters (mid-water or pelagic trawls). This has created conflicts between trawlers and gillnetters. Similarly, small pelagics occurring in near shore surface waters are heavily exploited by surface drift gillnets and ring seines, leading to potential conflicts between them. For resolving these conflicts, a Vessel Monitoring System (VMS) should be in place and the operational area for each sector as indicated in MFRA has to be strictly implemented.

j. **Council Based Management System** - A council based management system is advised for efficient management and governance of the marine fisheries of Andhra Pradesh. This will be in accordance to the details as laid out in Mohamed *et al.* (2017) which envisages a national level council as an apex national co-management body under which there will be councils at the state, district and village level.

3) Output controls:

a. **Minimum Legal Size (MLS)** - As of now no state in India has any restriction on the amount of fish (quota) that can be caught by a fisherman. However a restriction on the size of fish landed is possible. The Minimum Legal Size (MLS) is one such control measure which if implemented, would enable most fish to spawn at least once before being caught. The MLS is the minimum size of a fish that can be landed by a particular gear at harbours in a state. If more than 50% of a vessel's landings are found to be at sizes less than MLS, the particular vessel owner/operator should be penalized. MLS is estimated on the basis of Minimum Size at Maturity and also the Size at First Maturity with the latter being a more conservative measure and is generally used for more vulnerable species. The MLS for major commercial species recommended for Andhra Pradesh (based on MLS estimated for Kerala and Tamil Nadu) is presented in Annexure I.

b. **Prohibition on catch of Endangered Threatened & Protected (ETP) species** - As mentioned earlier, whale sharks are being landed in Andhra Pradesh, despite a ban (WPA, 1972) on their catch and landings. Fishermen need to be made aware of which species are Endangered, Threatened and Protected as per national and international laws, so that they do not accidentally or otherwise, catch and land such protected species. Increasing awareness through prominent display boards at major harbours and fish landing centres and strict penalties if ETP species are landed will go a long way in the protection of these vulnerable species.

c. **Protection of vulnerable species** - Specific, short-term, rapid research programs aimed at studying the distribution grounds, reproductive biology and trophodynamics of the vulnerable species should be carried out. With the results obtained, suitable management and conservation measures should be promulgated.

d. **Shark management program** - As suggested by the Guidance to NPOA on Sharks a shark management program for Andhra Pradesh is necessary for conservation of shark resources of the State. The major themes of the management program should be:

- ✦ Strengthen the database on fishery, abundance and biology of sharks; market and trade and socio-economics of primary stakeholders from Andhra Pradesh
- ✦ Undertake specific research based on species and issues pertaining to elasmobranch resources of Andhra Pradesh
- ✦ Education programs to sensitize stakeholders and to equip them with skills to allow for participatory management
- ✦ Establish conservation and management measures specific for elasmobranch resources of Andhra Pradesh

4) **Improved Monitoring, Control and Surveillance (MCS) System** - - Currently there is a very limited system of monitoring, control and surveillance of marine fishing vessels and their operation in Andhra Pradesh. The MCS system should be improved with the following key aspects:

a. **Vessel Monitoring System (VMS)** - All fishing vessels (mechanized and motorized) should be fitted with a VMS for monitoring and surveillance of the fishing fleets in Andhra Pradesh. VMS should be made mandatory and may be linked with availability of subsidies for large scale implementation.

b. **Logbook system** - A logbook system with information on fishing operation and fish catch should be made mandatory for marine fishing vessels in Andhra Pradesh. The logbook details should be made available to management agencies and research institutions both for management purposes as well as research. This too maybe linked with availability of subsidies for efficient implementation.

c. **Trip registration** - Each fishing voyage should be registered with the relevant port/ harbour authorities for improved information on how many fishermen are in the sea, which becomes critical in the case of extreme weather conditions like cyclones.

5) **Control of coastal pollution** - CMFRI has carried out detailed studies on the effluents released by existing coastal industries and the magnitude of their effects on coastal fish populations. The recommendations emanating out of these studies has to be enforced by the fisheries department. Prior to according permission for setting up of industry in the coastal areas, EIA studies by a team of researchers and all associated stakeholders, has to be made mandatory with special emphasis on its impact on coastal fisheries. Littering on beaches and sea shore should be made punishable by law and persons found violating should be taken to task with strict penalties.

6) **Regulation on river water abstraction** - It is the need of the hour to ensure a minimum volume of freshwater discharge from all the rivers of Andhra Pradesh to the sea, which in turn will facilitate the productivity and spawning and feeding migrations. Bunding the river banks is an absolute necessity and the State Fisheries Department should impress upon the state irrigation department to undertake the work in all major rivers in the state. However, prior study has to be made by the State Fisheries Department on the area and the time of bunding.

7) **Restoration of mangrove habitats** - Restoration of degraded mangrove vegetation therefore assumes paramount importance and is the need for the hour. Restoration will enhance the breeding success and improve the recruitment strength for commercially important coastal finfishes and shellfishes. It will form a barrier and protect the coastline and the coastal communities from the adverse impacts of catastrophic natural calamities.

Cleaning the oceans through fishermen's participation

Marine fishermen of Visakhapatnam have evinced interest in retaining and bringing back all plastic debris caught during their fishing operations in an effort to clean the oceans. This initiative in combination with good plastic waste management systems in coastal towns can go a long way in cleaning the coastal seas of Andhra Pradesh.

Plastics caught during trawling off Visakhapatnam

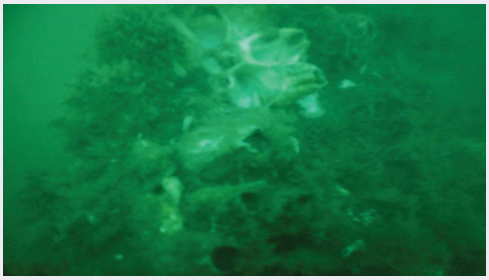
8) **Marine leasing policy** - In Andhra Pradesh, there is no uniform, fixed, comprehensive, transparent and fisherfolk-friendly policy of leasing of marine areas. Fixation of property rights to the stakeholders is the fundamental criterion for ensuring sustainability of fisheries. It makes owners/leasers responsible for minimizing the extent of possible externalities generated out of his/her enterprise. Policy measures should include and define property rights over the marine capture fisheries resources. Coastal aquaculture/mariculture activities like cage farming, pen farming, and capture based aquaculture are an economic boon for coastal fishermen. These activities not only add to marine fish production but also provide additional income to coastal fishermen and generate foreign exchange. As in Andhra Pradesh there is no policy for mariculture, government should immediately initiate collaboration with research institutions in identifying the areas suited for mariculture and the area specific candidate species.

9) **Marine habitat restoration** - Detailed survey was performed by CMFRI in the coastal waters of northern Andhra Pradesh and suitable areas for reef installation were identified at multiple locations in the districts of Srikakulam (Manchineelapeta) and Visakhapatnam (Muthyalammapalem, Pudimadaka and Bheemunipatnam). Artificial reefs are known to aggregate fishes (see box) and are deployed for the benefit of small coastal fisher communities displaced by the motorized/mechanized sector, who alone has the rights to fish in these areas.

Artificial Reefs to the rescue

Introduction of artificial reef modules to restore marine habitats is gaining popularity in inshore waters. Fishes get attracted to the artificial reefs for various reasons like shelter, food or even for breeding purposes. Artificial reefs offer substrate for growth of smaller organisms and thereby promoting the growth of smaller and bigger fishes in and around. Artificial reefs, therefore, enhances the biological productivity and fishery resources by serving as sanctuaries and nurseries or breeding grounds. With aggregation of fish, the scouting time is reduced, saving fuel and labour charges. Visakhapatnam Regional Centre of CMFRI has recently deployed 210 numbers of reef structures belonging to 3 modules at Muthyalammapalem and initial results on reef maturation and fish catch are encouraging.

Installation of artificial reefs at Muthyalammapalem village, Visakhapatnam, Andhra Pradesh



A colonized artificial reef with growth of algae, barnacles, etc. (Muthyalammapalem village, Visakhapatnam, Andhra Pradesh)

10) **Infrastructure upgradation** - The quality of life of a fisherman will only improve when he gets better returns for his produce. To ensure better returns, the quality of fish should be good. Fish being a quick spoiling produce needs to be stored and handled hygienically. For this the fish hold in boats, the fish landing centres and harbours, the ice and freshwater used, etc. should be clean and hygienic. The concerned authorities should ensure that each of these aspects of post-harvest phase of marine fisheries meets with domestic and international standards, thereby ensuring better returns to the fisherman. The State Fisheries Department along with CIFT and other central research institutes should carry out collaborative programs for infrastructure upgradation in the marine post-harvest sector of the state.

11) **Improved on-board handling** - Marine fishermen of the state are yet to fully realize the benefits accrued from export of marine products from the country. The biggest challenge to that is the quality of resources landed by marine fishermen which precludes purchase of these raw materials by the seafood processing industry. Improvement in post-harvest handling on-board is needed urgently in the marine capture fisheries sector. ICAR-CIFT is already providing training on this which may further be upscaled with the assistance of the State Fisheries Dept.

12) **Fisheries Development/Marketing Cooperatives** - Unlike other states, Andhra Pradesh does not have a State level Fisheries Development/Marketing Cooperative which can take a lead in the marketing and allied activities of the fisheries sector. Such an organization would also play a major role in export promotion, better marketing infrastructure for the sector, etc. which would ensure better returns for the fishermen of the state.

13) **Alternate livelihood options** - Fishing being a highly volatile occupation, fishermen need alternative sources of income which can ensure their livelihood security. Value addition of catch, sport fishing ventures, etc. can be explored as alternate livelihood options for fishermen.

14) **Mainstreaming marine fisheries in development programs** - Marine fisheries form only a part of the multiple aspects of coastal waters. Even though it supports a large population of fisher folk, marine fisheries is still not viewed at par with other major coastal users like ports, defence establishments, coastal industries, etc. For enhanced growth of the marine fisheries sector of the state, it should be viewed at par with other sectors and given comparative financial support. This is especially important for Andhra Pradesh where a number of ports and industries are set to be developed by the State Govt. Carrying out studies on how this would affect coastal fish populations would be the first step towards mainstreaming marine fisheries in the state.

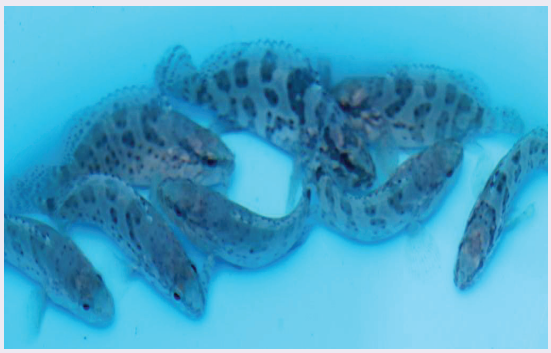
15) **Need-based research efforts** - Research Institutes and Universities should carry out need based research programs for sustainable fisheries of Andhra Pradesh. ICAR-CMFRI must come out with annual stock status advisories for major commercial fish species as guidelines for the State Govt. to manage the state's fish resources. Currently these advisories are brought out only every 5 years; however, use of new methods like Stock Status Plots or Rapid Stock Assessment can be advocated which would enable annual advisories.

16) **Mariculture** - Live broodstock of commercially important marine fish caught by various gears can be maintained in floating cages in near shore areas of the sea which will facilitate their hatchery seed production. Visakhapatnam Regional Centre of CMFRI has demonstrated cage farming of various species in various parts of Andhra Pradesh. For boosting cage farming, cages need to be supplied at subsidized cost by the National Fisheries Development Board through the State Fisheries Department to the fishermen's co-operatives. Species diversification for mariculture/cage culture is to be adopted for ensuring and promoting sustainable and eco-friendly mariculture.

17) **Fishermen awareness and capacity building** - Though fishermen inherently know the value of conservation measures their hard way of life and volatile profession inhibits practical application of these values. Hence it is up to the management and research authorities to increase the awareness of fishermen towards conservation and management of fish resources. Efforts are particularly needed towards increasing awareness for reducing juvenile fishing and bycatch. Fishermen, especially the younger generation, should be sensitized about the benefits of conservation. NGOs can play a big role in increasing

Mariculture

The first open sea floating cage farming of seabass was successfully demonstrated by Visakhapatnam Regional Centre of Central Marine Fishery Research Institute (CMFRI) at Visakhapatnam and Balasore. This initial success with cage culture has resulted in establishment of cage farming in all the maritime states of our country under the technical supervision of CMFRI. At present, in the coastal waters of our country, more than 1,500 cages have been installed. Cage culture of marine fish is a boon to the landless fishfarmer. Breeding and seed production of commercially important marine finfishes and shellfishes was perceived to be a necessity for mariculture, keeping in view the scarcity and irregularity of wild available seeds. CMFRI has perfected the technology for breeding and seed production of cobia, pompano and groupers and supply of seed is being made to various state governments and fish farmers at nominal cost for mariculture in cages and coastal ponds. With CMFRI's initiative and efforts, it is expected that mariculture will reach new heights in near future and will contribute for bringing about a blue revolution in the country.



Orange-spotted grouper fingerlings reared at Visakhapatnam RC of CMFRI

awareness among fishermen, especially with regard to ETP species. Open access, wide spatial distribution and high economic value, the fishery resources in high seas are receiving an increasing attention. Traditional fisherfolk need to be given necessary support for gradually extending their fishing ranges and such support should include advance dissemination of information about possible location of fish shoals and empowering them for longer duration voyages in the sea. Installation of communication and navigational facilities and capacity building of the community through awareness and training on harvest and post-harvest skills is required for exploitation of oceanic tunas and deep sea resources, enabling them to improve their socioeconomic status. Capacity building programs should enable them to exploit the resources in economically and ecologically sustainable manner. They should be educated on PFZ advisories and adaptation and mitigation measures of climate change at the community level. Awareness on the role that women can play in marine fisheries sector also needs to be improved. Women are currently involved in auctioning, sales and processing of fish catch. Imparting further skills in value addition, etc. to these women and providing them with better facilities in harbours can improve their livelihood means and act as an extra source of income to the family.

18) **Futuristic initiatives** - Andhra Pradesh prides itself in being the "Sunrise State". The marine fisheries sector of the state also affords new and innovative opportunities which can be transformed into sectoral-level initiatives. Two such initiatives are listed below:

a. **Certification of marine fisheries** - International certification like the Marine Stewardship Council (MSC) certification can be carried out for selected fisheries of the state. For e.g. the yellowfin tuna fisheries of Pudimadaka is a good candidate for MSC certification. Certification by international and/or national organizations will pave the way for wider acceptance of produce among international customers, better returns to the fishermen and sustainable growth of the fishery. CMFRI along with WWF can provide technical help to fishermen for certification of fisheries as was done for the short neck clam fishery of Ashtamudi Lake of Kerala.

b. **Carbon credits** - The use of Carbon Credits is one such initiative which could reap benefits for small-scale and traditional fishermen in the future. Small-scale, traditional fishermen use green methods for fishing like use of sails for propulsion, etc. They are also the ones who bear the brunt of dwindling catches and catch rates. If carbon credits can be allotted to such fishermen who use green, non-polluting methods of fishing which they can then use for either benefits from the Govt. or other purposes, it will go a long way in ensuring better lives along with a better environment.

c. **Need for incorporating Fish Genetic Stock Identification (GSI) information for sustainable management of marine fishery resources of Andhra Pradesh** - Assessment of genetic variability is important for the management of wild genetic resources of fish. Most fish species are composed of populations, also called 'genetic stocks', or 'genetic breeding units', between which limited gene flow occurs. These dynamic

units capable of coping with environmental changes maintain their genetic make up or characteristics distinct from other populations of the same species as a result of genetic variation within them. This differentiation depends upon forces such as migration, reproductive pattern, dispersal, mutation, selection, genetic drift and so on, which act on the species/population during its evolution. If such units are overfished, it is unlikely that population sizes will recover which may lead to collapse of the fishery. Genetic stock identification (GSI), using molecular tools is an essential component of modern fisheries stock assessments, traceability studies, management and policy decisions. GSI is generally carried out with a thorough understanding of the details of the life history of the target species and physical processes in the marine ecosystem. Advanced molecular markers [such as polymorphic microsatellites, Single Nucleotide Polymorphism (SNPs)] from nuclear and mitochondrial (mt) DNA sources are presently employed worldwide in assessment of variations directly at DNA level for identification and quantification of the level of genetic variability and for delineating genetic stock structure within a species.

In Andhra Pradesh, few marine fish stocks are over-exploited and a bulk of the remaining optimally exploited. It is the need of the hour to study genetic stock identification and life history patterns of these species at the national level including Andhra coast. If distinct genetic stocks of any of these species are identified along the Andhra coast, such unique stocks are to be treated distinctly for sustainable harvest management strategies. Scientists (fish biologists, geneticists, quantitative fishery biologists and statisticians), fishery managers and policy makers would work together more effectively to foster productive dialogue so as to incorporate information on genetic stock structure in fish stock assessments and policy decisions for sustainably managing the marine fishery resources of Andhra Pradesh.

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ANNEXURE I

Recommended Minimum Legal Size (MLS) for 61 marine fish/shellfish species of Andhra Pradesh

S. No.	Species/Group	Recommended MLS (cm)	Decision Logic
		Pelagic species	
1.	*Amblygaster sirm*	11 TL	MSM
2.	*Escualosa thoracata*	9 TL	MSM
3.	*Sardinella albella*	10 TL	MSM
4.	*Sardinella fimbriata*	11 TL	MSM
5.	*Sardinella gibbosa*	10 TL	MSM
6.	*Sardinella longiceps*	10 TL	SSD
7.	*Stolephorus indicus*	10 TL	MSM
8.	*Rastrelliger faughni*	22 TL	MSM
9.	*Rastrelliger kanagurta*	19 TL	MSM
10.	*Trichiurus lepturus*	46 TL	SSD
11.	*Auxis thazard*	25 FL	MSM
12.	*Euthynnus affinis*	31 FL	MSM
13.	*Katsuwonus pelamis*	35 FL	MSM
14.	*Thunnus albacares*	50 FL	MSM
15.	*Scomberomorus commerson*	50 FL	MSM
16.	*Scomberomorus guttatus*	40 FL	SFM
17.	*Coryphaena hippurus*	38 FL	MSM
18.	*Megalaspis cordyla*	19 TL	SSD
19.	*Selar crumenophthalmus*	16 TL	MSM
20.	*Decapterus russelli*	11 TL	MSM
21.	*Sphyraena jello*	30 FL	MSM
22.	*Aluterus monoceros*	30 TL	MSM
23.	*Parastromateus niger*	17 TL	MSM
24.	*Trachinotus mookalee*	55 TL	MSM
25.	*Caranx ignobilis*	55 TL	MSM
		Demersal species	
1.	*Nemipterus japonicus*	12 TL	MSM
2.	*Nemipterus randalli*	10 TL	MSM
3.	*Saurida undosquamis*	10 TL	MSM
4.	*Priacanthus hamrur*	15 TL	MSM
5.	*Pampus argenteus*	13 TL	MSM
6.	*Pampus chinensis*	30 TL	SFM

7.	*Otolithes ruber*	17 TL	MSM
8.	*Johnius carutta*	16 TL	MSM
9.	*Nibea maculata*	15 TL	MSM
10.	*Pennahia anea*	13 TL	MSM
11.	*Psettodes erumei*	20 TL	MSM
12.	*Lutjanus johnii*	55 TL	MSM
13.	*Lutjanus argentimaculatus*	50 TL	MSM
14.	*Platycephalus indicus*	30 TL	MSM
15.	*Cynoglossus macrostomus*	9 TL	MSM
16.	*Carcharhinus falciformis*	180 TL	MSM
17.	*Gymnura poecilura*	50 DW	SFM
18.	*Neotrygon indica*	33 DW	SFM
		Crustacean species	
1.	*Charybdis feriatus*	5 CW	MSM
2.	*Charybdis natator*	5 CW	MSM
3.	*Portunus pelagicus*	9 CW	MSM
4.	*Portunus sanguinolentus*	7 CW	MSM
5.	*Metapenaeus dobsoni*	6 TL	MSM
6.	*Metapenaeus monoceros*	11 TL	MSM
7.	*Metapenaeus affinis*	9 TL	MSM
8.	*Parapenaeopsis stylifera*	7 TL	MSM
9.	*Penaeus indicus*	11 TL	MSM
10.	*Peneaeus monodon*	13 TL	MSM
11.	*Peneaeus japonicus*	13 TL	MSM
12.	*Panulirus homarus*	200 g	WFM
13.	*Panulirus polyphagus*	300 g	WFM
14.	*Panulirus ornatus*	500 g	WFM
15.	*Thenus unimaculatus*	150 g	WFM
		Molluscan species	
1.	*Uroteuthis duvaucelii*	8 DML	MSM
2.	*Sepia pharaonis*	11 DML	MSM
3.	*Sepia aculeata*	9 DML	MSM

TL - Total Length, FL - Fork Length, DW - Disc Width, CW - Carapace Width, DML - Dorsal Mantle Length; MSM - Minimum Size at Maturity, SFM - Size at First Maturity, SSD - Size at Sexual Differentiation, WFM - Weight at First Maturity

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