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Marine Fisheries of Andhra Pradesh-An Appraisal

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Andhra Pradesh with a long coastline of 974 km and a continental shelf area of 33,227 km^2 is spread over nine districts (Fig.1) and supports a rich fishery constituted by several groups of fishes, crustaceans, molluscs and other marine organisms. In the marine fisheries sector, Andhra Pradesh has always been known for its healthy fishing grounds, diverse resources, variety of crafts and gears, high entrepreneurship and adaptability to new technologies in exploiting the available resources and the sector contributes significantly to the employment generation in the state. The annual total marine fish landing of the state ranged from 1,51,435 t to 2,33,276 t during 1996-2006 and contributed to 7.2 % of the total fish landings of the country. Over the years, marine fisheries sector had witnessed several developmental and technological changes which in turn have resulted in enhanced fish production and utilization. It is envisaged that by 2020, Andhra Pradesh will have a thriving fisheries sector with a targeted annual fish production of over one million tonne (marine and inland fish production), in order to provide nutritional food to the people and to have enough surplus for exports. This paper deals with the marine fishery status in Andhra Pradesh during 2000-2006 and suggests a few options for the optimal management of the fishery.

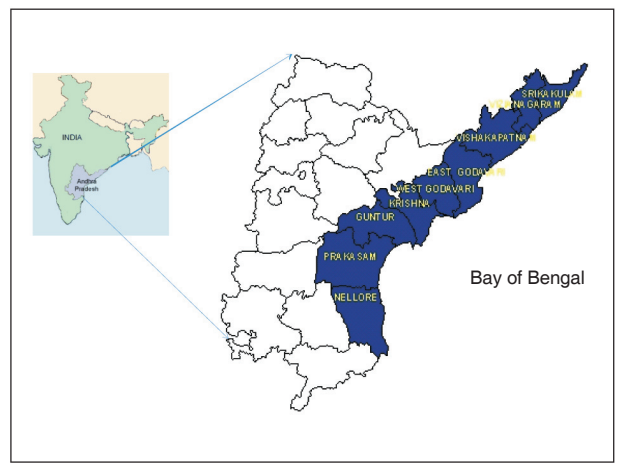

Fig. 1. Coastal districts of Andhra Pradesh

Production trends

The marine fishery production in the state fluctuated over the years, but has registered a gradual increasing trend. The total fish catch in Andhra ranged from 1,51,435 t in 2002 to 2,33,276 t in 1999 with an average annual production of 1,85,948 t (Fig.2).The

present study period (2000-2006) has witnessed the ups and downs of production. The catch fluctuated between 1,51,435 in 2001 to 2,17,461 t in 2006. Andhra Pradesh with an average annual (2000-2006) marine fish production of 1, 80, 833 t stood fifth among the maritime states of the country. The catch in general showed an increasing trend (Fig.3) though a slight decline in total catch was seen during 2001 and 2005. Highest catch of 2,17,461 t was observed in 2006 and lowest of 1,51,748 t in 2001.

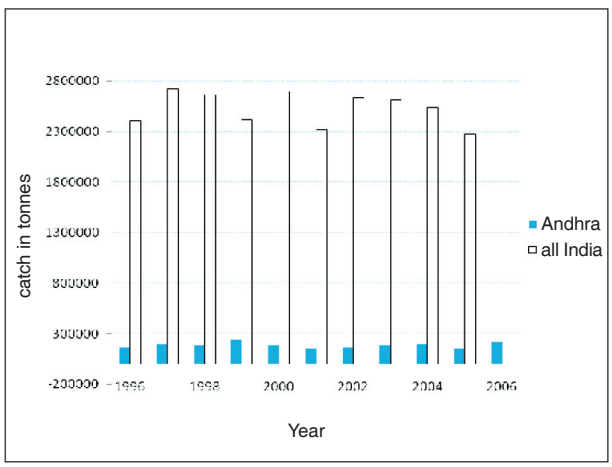

Fig. 2. Annual Marine fish landings in India and Andhra Pradesh

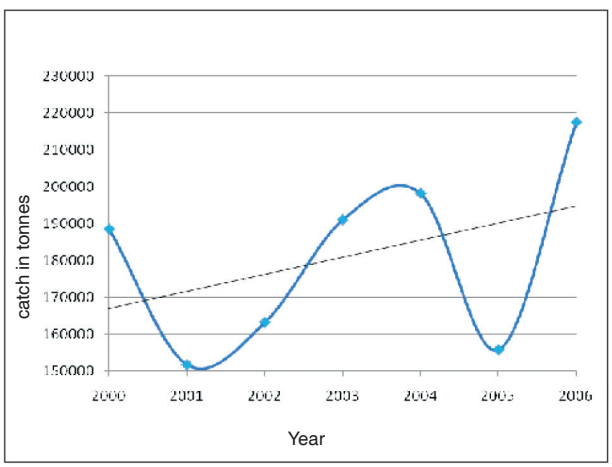

Fig. 3. Marine fish landing with trend line Andhra Pradesh

Finfishes and crustaceans were the major contributors to the fishery. Molluscs and other groups formed a negligible part of the catch. The pelagic finfishes comprising clupeids, scombroids, carangids and ribbonfish formed the bulk of the fishery and contributed more than fifty percent of the total marine fish landings followed by demersal resources (25.5%), crustaceans (14.5%) and others (3.3%) (Fig.4).

Major fish resources

Finfishes (84.5%) and crustaceans (14.5%) were the two major groups contributing to the fishery of the region. The contribution of molluscs, turtles, mammals and other groups to the fishery was negligible (Fig.5).Among finfishes, the pelagic group was dominant and contributed to 56.7% of the total catch followed by demersal finfish (25.5%). Sardines (15.4%) followed by mackerel (8.4%), ribbonfish (7.0%), carangids (5.7%), seerfish (3.6%) and anchovies (3.1%) were the major pelagics landed along the Andhra coast. These resources not only contribute greatly to the state's catch but also form a significant portion of all India catch. Of the several pelagic fishes landed, pomfrets, seerfish and mackerel are commercially important and fetch a good price both in the local as well as other markets outside the state. Of the total all India landings, Andhra Pradesh contributed to 14.8% of pomfret catch, 13.7 % of seerfish catch and 12.7% of the mackerel catch. The tunas are another important emerging fishery resource group from Andhra Pradesh especially off Visakhapatnam coast. Of the different species of tuna contributing to the fishery, yellowfin tuna is the most important. As it is an emerging resource, it is still underfished and at present forms a minor component of the total fish catch of Andhra Pradesh. With targeted fishing already in action for exploiting these oceanic tunas, its contribution to the total fish catch of the region is bound to increase by

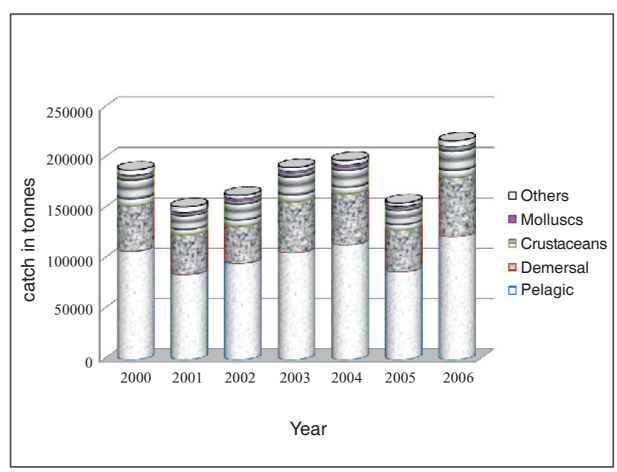

Fig. 4. Contribution of major groups to total fish catch at Andhra Pradesh

several folds in the coming years. In the demersal group, croakers formed the dominant group (4.5%) followed by perches (3.7%), silverbellies, catfish and rays (2.2% each). Crustaceans were dominanted by the penaeid prawns (9.9%) followed by crabs (2.8%) and non-penaeid prawns (1.4%). Prawns have always been the mainstay of the Andhra marine fishery and are the major revenue earner for the state. Of late however, the catch of pelagic fishes like sardine and mackerel have increased but prawns still continue to be major revenue earner in the marine fisheries sector. The contribution of the important resources to the total fish catch (all gears combined) of Andhra Pradesh during 2000 to 2006 is given in Fig.6. Among these, the catch of pelagic fishes viz., sardines, mackerel and ribbonfish exhibited high annual fluctuations compared to the demersal resources.

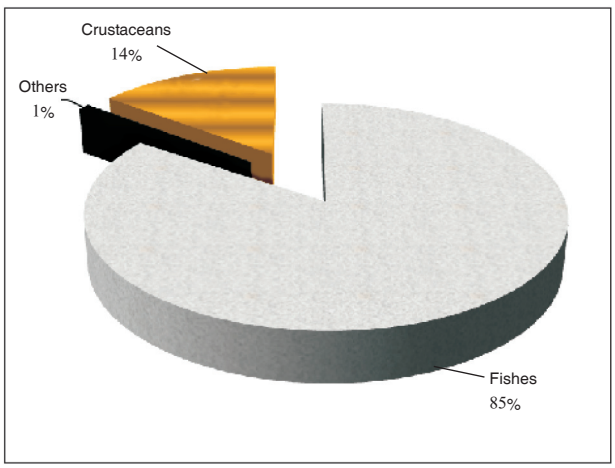

Fig. 5. Contribution of major groups to the marine fishery of Andhra Pradesh

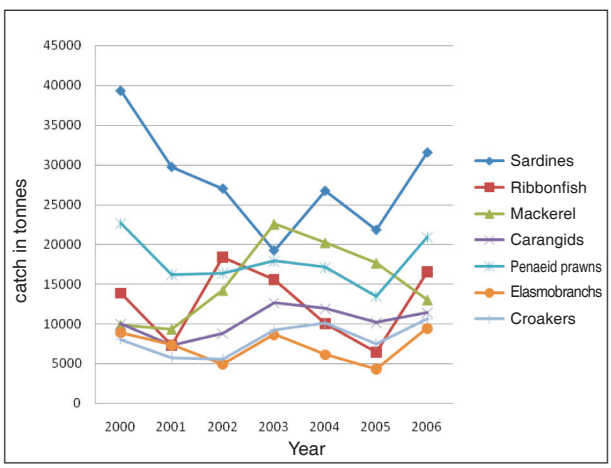

Fig. 6. Major resources contributing to the fishery of Andhra Pradesh

However, the increased landings of all major resources resulted in better annual catch during 2006 (Fig.3).

Mode of exploitation

The crafts used for fishing include the large and medium mechanized trawlers (Plate 1) and a number of traditional crafts *viz. catamaran* (*tepalu*), *masula boat* and the *nava* (Plate 2). Technological advancement in craft construction include the introduction of steel bodies for larger crafts and fibregalss slowly replacing the wood in the smaller traditional crafts. The details of different crafts operating along Andhra Pradesh have been discussed in detail by Sreekrishna (2002). A variety of gears are employed to harvest the rich coastal as well as offshore marine fishery resources of the state. The gears in use range from simple cast nets to large seines and trawls. The line fishing for coastal, offshore and oceanic fishes is very active in Andhra Pradesh. They are operated either from small traditional non-mecahnized crafts, motorized crafts or from medium to large mechanized crafts depending on the area of operation, resource targeted and price of the fish. During 2001-06, the mechanized, motorized and non-mechanized sectors contributed on an average, 42.1, 23.3 and 34.6% respectively to the total marine fish landings of the state (Fig.7). While the mechanized sector showed an increasing trend, non-mechanized sector registered a declining trend. The trend by motorized sector remained more or less the same over the years. Motorization is slowly becoming popular and more and more non-mechanized units

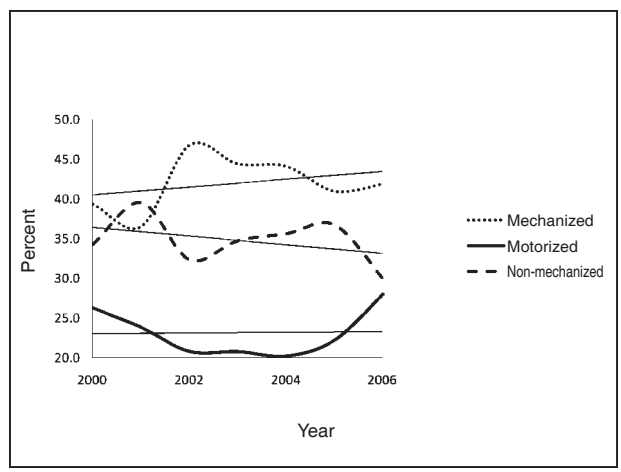

Fig. 7. Contribution of different sectors to the fishery and their trends during 2000-2006

are opting for out-board engines. The availability of highly valued oceanic tunas in the deeper waters off Visakhapatnam is in fact inducing many of the non-mechanized crafts fishing for this resource to go for motorization.

The different resources contributing to the catch by different sectors varied. The pelagic resources formed 35.5, demersal 29.7, crustaceans 28.3, molluscs 1.7 and others 4.8% of the catch from the mechanized sector. Penaeid prawns were the most dominant component of the catch contributing to 20.2% of the total trawl catch. The other major resources that contributed to the trawl catch were ribbonfish (10.8%), croakers (5.7%), mackerel (5.6%) and goat fish (3.9%). The trends in landings of the major resources in the mechanized sector are given in Fig.8. Of the five resources, the prawn fishery indicated negative trend over the years. Other resources except ribbon fish showed a positive trend.

Plate 1. Mechanized trawlers berthed at Visakhapatnam Fishing harbour

Plate 2. Beached traditional wooden and fibre crafts

The Indian mackerel (12.4%) and sardines (11.9%) were the dominant species in the motorized sector. Seerfish, rays and sharks contributed 10.4, 6.3 and 5.1 % respectively to the total catch of motorized sector. Annual landings of the dominant groups contributing to the motorized sector are presented in Fig.9.

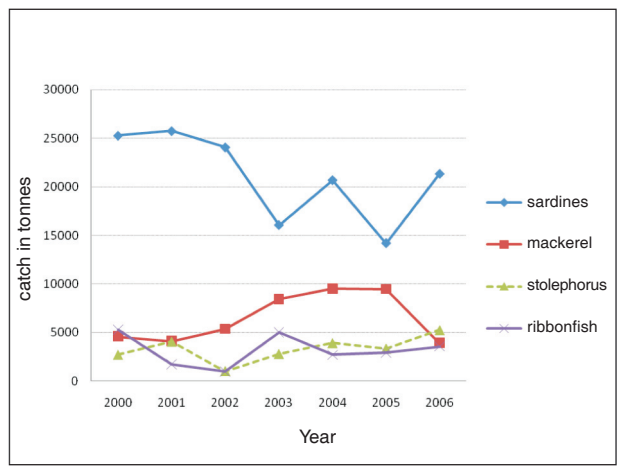

Fig. 8. Major resources contributing to the mechanized sector

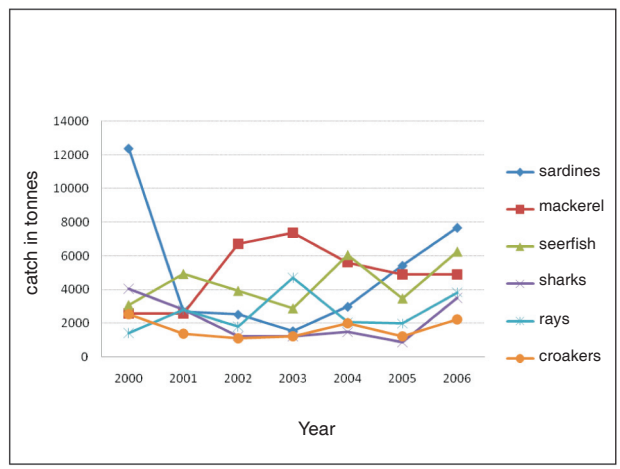

Fig. 9. Dominant groups contributing to the catch of motorized sector

As generally observed in the case of tropical pelagic resources, the catch of major pelagics in Andhra too fluctuated annually. Furthermore the catch of sardines and mackerel showed an inverse relationship (Fig 7.) Mackerel, seerfish, croakers and rays landing showed a positive trend and sardines a negative trend.

Sardines were the dominant resource in non-mechanized sector (Fig. 10.) with a whopping contribution of 33.7% followed by mackerel (10.4%), stolephorus (5.3%) and ribbonfish (5.1%). Other groups which contributed significantly to the catch included tunas, other clupeids, Thryssa, carangids and croakers. The non-mechanized sector uses the seines, gill nets and the hook and lines. Clupeids, croakers and crabs formed the dominant groups in the seines and gill nets. The hooks and line fishery is generally dominated by the tunas, seerfish, flyingfish and carangids. The tunas comprising of several species, however dominates the catch by hooks and lines. A few of these crafts operating specially for oceanic tunas have been motorized. This has been mainly done to facilitate the crafts to reach the fishing grounds in a few hours even when there is not enough wind to drive the usually sail mounted crafts.

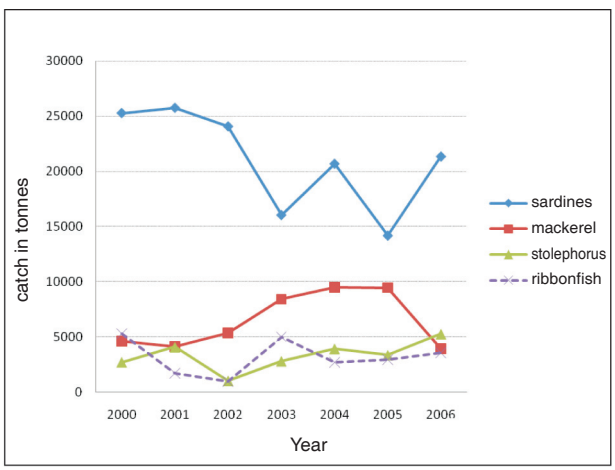

Fig. 10. Major resources contributing to the non-mechanized sector

The gears operated for commercial fishing along Andhra coast can be broadly categorized as trawls, seines, gillnet and the hook and line. The trawls were the major contributors (40.7%) followed by gillnets (31.7%), seines (23.8%) and hook & lines (3.8%) (Fig.11). While the trawls land all groups of fin fishes, crustaceans and molluscs, the seines and gill nets mostly land pelagic fishes and crustaceans. The hooks and line target scombroids (tunas and seerfish), rocky fishes like snappers, carangids and flying fishes.

The trawlers operating along Andhra coast are of two kinds, the smaller trawlers (*sorra* and *royya*) have an OAL of 9.75-10.0 m and the bigger trawlers

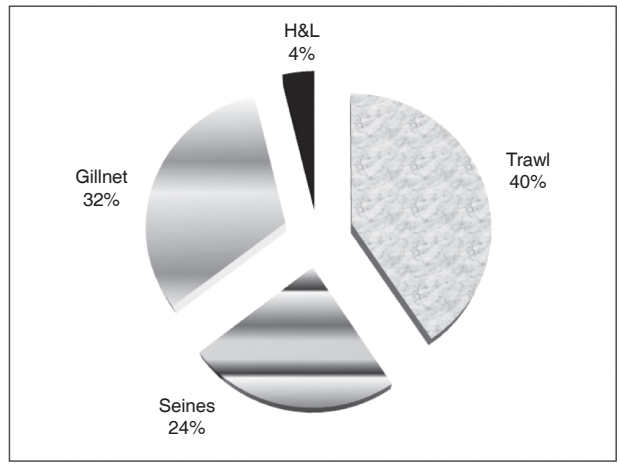

Fig. 11. % Contribution of different gear types to the marine fishery of Andhra Pradesh

(*sona boats*) with an OAL of >13.m. The details of the different types of trawlers operating at Visakhapatnam are given in Table 1. Earlier, the smaller trawlers used to operate only for a day but, of late these small trawlers too stay back at sea for more than 2-4 days and operate at a depth range of 10-70 m. The catch is dominated with prawns (*M. dobsoni*, *P. monodon*, *P. indicus*), crabs and finfishes (croakers, elasmobranchs, mackerel, ribbonfish and carangids). The sona boats generally operate at depths greater than 50 m with an operational depth of 50-150 m. These target the larger size deep water prawns (*M. monoceros*, *P. monodon*, *S. crasicornis*), cephalopods *(Sepia* spp., *Loligo* spp.) and fishes (croakers, goatfish, elasmobranchs, mackerel, ribbonfish). The major groups landed by mechanized trawlers over the years are given in Fig.12. The total fish catch by trawlers fluctuated but

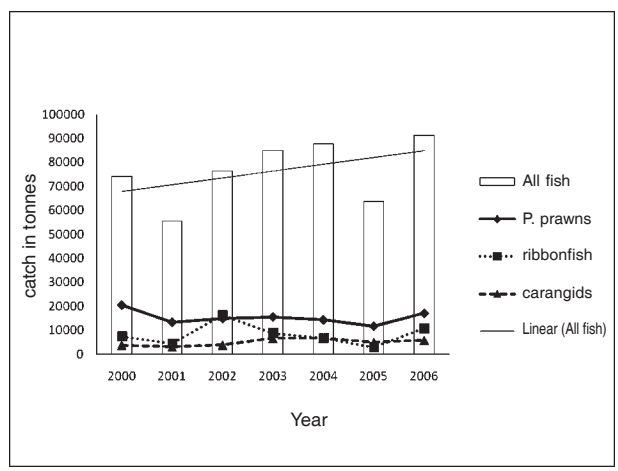

Fig. 12. Major resources contributing to the trawl fishery at Andhra Pradesh

Table1. Details of trawlers and trawl net used along Andhra coast

Details	Small trawlers	Large multi-day trawlers
Length Overall	9.14-11.41 m	>13.1 m
Engine power	65-86 hp	102 hp
Crew strength	6	9
Type of trawl net	Shrimp trawl	Shrimp trawl
Cod end mesh size	10-20 mm	15-25 mm
Depth of operation	10-70 mm	Upto 100 m
Fish hold capacity	2-3 t	5-8 t
Duration of voyage	3-4 days	10-15 days
Major groups caught	Prawns, crabs, clupeids, scombroids, ribbonfish, carangids	Prawns, cephalopods, threadfin breams, goatfishes, ribbonfish, sharks and rays

showed an overall increasing trend (Fig.12). Penaeid prawns were the mainstay of the trawl fishery and their catch fluctuated between 13,433 t in 2001 and 20,446 t in 2006. Ribbonfish was the next dominant resource and the catch varied between 3,005 t in 2005 to an all time high of 16,359 t in 2002. However, the catch of both the resources exhibited negative trend over the years. The ribbonfish, mackerel, croakers and carangids exhibited a positive trend over the years.

Gillnets are very popular gear along this coast and operated mostly by the motorized and the non-mechanized crafts. They are known by several local names depending on the mesh size and fish caught in them. Both the drift as well as the set gillnets are used. These nets target the clupeids (lesser sardines, oil sardine, other clupeids, *Thryssa*), scombroids (mackerel, seerfish, tunas), carangids (scads, trevallies) and prawns (*P. indicus*, *M. dobsoni*). The details of different types of gill nets used in Andhra Pradesh are given in Table 2.

The seines, both the shoreseine (*Pedda vala*, *Aluvi vala*) and the boatseine (*Iragu vala*) target the shoaling clupeids, engraulids, scombroids, trichiurids,

Table 2. Details of gill net used along Andhra coast

Details	Mesh size (mm)	Period of operation	Target species
Polyamide monofilament gillnet	20-130	Throughout the year	Anchovies, sardines, mackerel, seerfish clupeids, thryssa, pomfrets
Polyamide multifilament gillnet	20-30	Throughout the year	Anchovies, sardines, seerfish and ribbonfish
Polyamide multifilament trammel net	20(I)-250(O)	June-December	Shrimps
HDPE gillnet	60	Throughout the year	Seerfish, tunas, sharks

Table 3. Details of seine used along Andhra coast

Details of net (m)	Total length (mm)	Mesh size	Target species
Shoreseine (*Alivi vala*)	1000	10 (bunt) - 30 (wings)	Sardines, anchovies, carangids, mackerel, seerfish, ribbonfish, croakers, silverbellies
Shoreseine (*Pedda vala*)	470	5-10 (bunt) - 1800 (wings)	Sardines, anchovies, carangids, mackerel, seerfish, ribbonfish, croakers, silverbellies
Boatseine (Iraguvala)		3-10 (bunt) - 600 (wings)	Ribbonfish, shrimps, silverbellies, croakers, anchovies, clupeids

and the carangids. Prawns and crabs too are caught by this gear at times. The catch trend here also showed an increasing trend over the years. Details of the shore seines and the boat seines are given in Table 3.

The shoreseines are operated all along the coast seasonally. The operation is labour oriented and fishing is carried out on a community basis in the coastal villages. Shoreseines are operated within 20 m from the shoreline and 25-40 people are involved in the operation of *pedavala* and 80-100 persons in the operation of *alivivala*. The gear mainly targets the near-shore shoaling fishes like mackerel, seerfish, carangids, silverbellies and anchovies. Juveniles are also landed by this gear during March-April (Plate 3). As the gear is operated very close to the shore, most of the fish caught are live when brought out of water. The Visakhapatnam Regional Centre of CMFRI undertook a rapid survey of the shoreseine operation and its catch along a 110 km coastal stretch from Visakhapatnam to Kalingapatnam and estimated the number of juveniles in the catch.

Plate 3. Juveniles seerfish landed by shoreseines at visakhapatnam

Shoreseining was active along this stretch with an estimated 50 units operarting along this stretch. Though the gear can be operated throughout the year whenever conducive weather conditions prevail, the availability of fish shoals in the nearshore area determines the season of operation. It is generally operated from October to April with the peak season being November to March. Operation is mainly carried out from early morning hours (06.00 h) to late afternoon (15.00 h). Each unit gets around 200 kg (*peddavala*) - 1100 kg (*alivivala*) of fish per haul. Generally two or three hauls are made per day by the *peddavala* and one haul by the *alivivala*. Remuneration to the fishermen depends on the quantity of commercially important (seerfish, mackerel and carangids) fishes caught. However the presence of exceptionally large quantities of juveniles, especially of commercially important fishes, in the catch during certain months is alarming. Enquiries during the present rapid survey revealed that this is a common phenomenon along this coast every year. Young fishes were abundant during March-April contributing to nearly 3.5 % of the total catch by weight. Interestingly, the juvenile catch consisted only of seerfish (40%) and mackerel (60%). The total length of seerfish ranged from 60 to 120 mm and that of mackerel from 50 to 100 mm (Fig.13) and weighed 2 to 17 g and 2 to 10 g respectively. The average length and weight of seerfish was estimated at 90 mm and 6 g respectively.

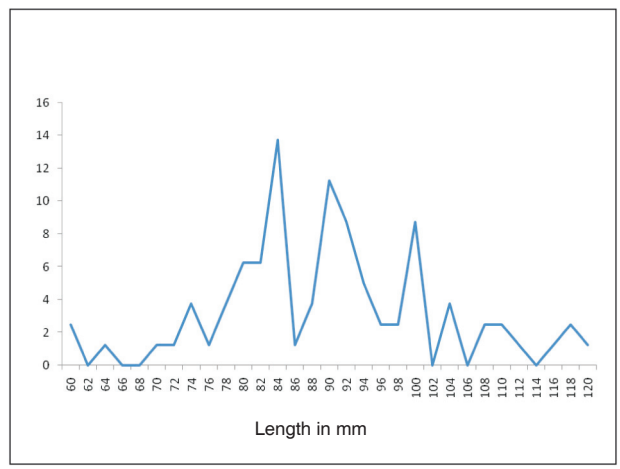

Fig. 13. Length Frequency distribution of seerfish juvenile caught by shoreseine at Visakhapatnam

The quantity (in numbers) of young ones of mackerel and seerfish in the shoreseine catch was estimated. On an average, 1200 numbers of juveniles were landed by a shoreseine unit per haul. These trends wherein juveniles are landed in large quantities are observed for about 25 days from mid March to the second week of April. Over a period of 25 fishing days and an average of two hauls per unit, an estimated 30,00,000 number of juveniles are landed by 50 units along the stretch of coastline surveyed. The number of seerfish in the catch was estimated at 12,00,000 and mackerel comprised the remaining

18,00,000 numbers. Juveniles of other species like silverbellies and croakers are also observed in the catch but their period of occurrence does not coincide with that of mackerel and seerfish. As of now, these young ones do not fetch money and are either discarded at the landing site itself or beach dried and mixed with other ingredients during the process of fish/chicken feed preparation.

Shore seines are operated very close to the shore and unlike in other operations, the fishes caught are alive and active when the net is dragged above the water level. Presently there is no restriction on the season of operation as well as mesh size to be used in the operation of shoreseines, hence operation will continue and huge quantities of young ones will be destroyed annually. An alternate beneficial long term solution to this problem may be to officially recognize these gears as natural seed collectors of these commercially important fish species during the couple of months when juveniles are abundantly available. This will ensure that the young ones get a better price and are beneficially used for culture purposes. The Central Marine Fisheries Research Institute has already demonstrated techniques of cage culture for the large scale rearing of marine finfishes at Visakhapatnam. Cage culture is fast catching up as the most effective method for the rearing of marine fishes. The availability of commercially important seeds in good quantities as indicated in the present survey can be gainfully utilized for this purpose until suitable technology for seed production of such high valued fishes is developed.

Line fishing is used to catch the coastal, offshore and oceanic fishes. These are mostly operated by non-mechanized crafts though motorization is slowly gaining popularity since the last couple of years. The longlines are operated at depths ranging from 30 m to 300 m depending on the type of fish targeted. The lines operated at lower depths generally target coastal tunas, seerfish, snappers, leather jackets and flying fishes. These longlines have a mainline of a total length ranging from 300-1000 m with 100-600 hooks attached to it from branch lines. The hook numbers used here range from 4-12. The units operating for larger oceanic fishes especially yellowfin tunas, sailfishes and kingseer use hook numbers one or two. The number of hooks per line is also limited to 25-30 numbers. Trolling is equally popular for hooking the oceanic large sized fishes. These are operated beyond 200 m and the hook numbers used are one, two or four. Details of hook and lines used along Andhra Pradesh are given in Table 4.

Fishing season

Fishing is carried out throughout the year along the Andhra coast. However, a seasonal trend is followed by the different gears. Moreover as a measure to conserve the fishery, there is a fishing

Table 4. Details of lines operated along Andhra Pradesh

Length of mainline (m)	Length of branch line (m)	No. of hooks	Hook type	Hook no.	Depth of operation (m)	Period of operation	Target species
2000	10	100	Round bent	1	>100	Throughout the year	Tunas, billfish, seerfish, sharks
88	9	5	Round bent	2	>100	Throughout the year	Sharks, tunas, billfish, dolphinfish
300	5	30	Round bent	4	>100	Throughout the year	Tunas, seerfish, billfish
70	0.5	20	Round bent	9	<60	Throughout the year	Little tunnies, seerfish, flyingfish, dolphin fish
700	1.5	350	Round bent	9	<50	Throughout the year	Little tunnies, flyingfish, dolphin fish
50	0.2	35	Round bent	16	<45	Throughout the year	Little tunnies, seerfish, carangids, croakers

ban for 45 days on the operation of mechanized crafts during mid April to entire May. The traditional crafts operating gillnets, seines and the lines fish throughout the year except when there is cyclone warning and the fishermen are advised by the government to abstain from any fishing activity out at sea.

On an annual basis, November to January is the peak season when 34.3% of the total annual catch is landed. As the mechanized sector is the major contributor to the fishery of the region the ban period (April-May) naturally is the lean fishing period. Only 7.3% of the total annual catch is landed during this period. The average monthly catch landed by all gears in Andhra Pradesh in percentage is given in Fig.14. Of the four quarters, the fourth quarter (Oct-Dec) was the most productive followed by the first quarter, third and the second quarter respectively (Fig.15). The mechanized sector which include mainly the trawlers and at some centres a few mechanized gill netters and hook and lines operate throughout the year except during the ban period (April- May). Maximum production by this sector is during January followed by November and December. Minimum operation as well as landing is as expected during April-May due to trawl ban (Fig.16).

The motorized sector operated throughout the year with good landings from September to April with peak production in March. Minimum landings were observed during June (Fig.17).

The non-mechanized sector also operated throughout the year with their operation depth ranging between inshore waters to offshore oceanic waters.

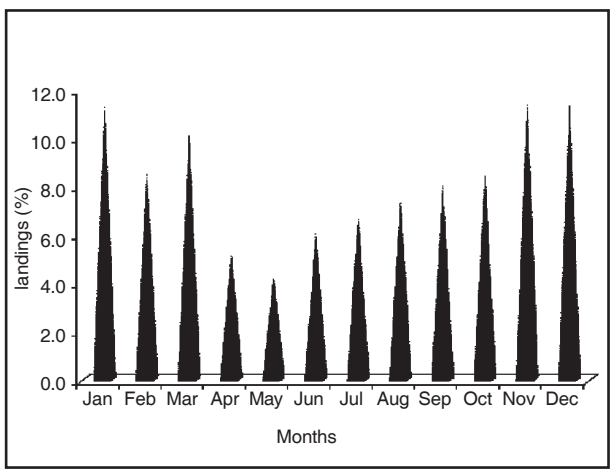

Fig. 14. Annual landings (%) of all fish by all gears at Andhra Pradesh

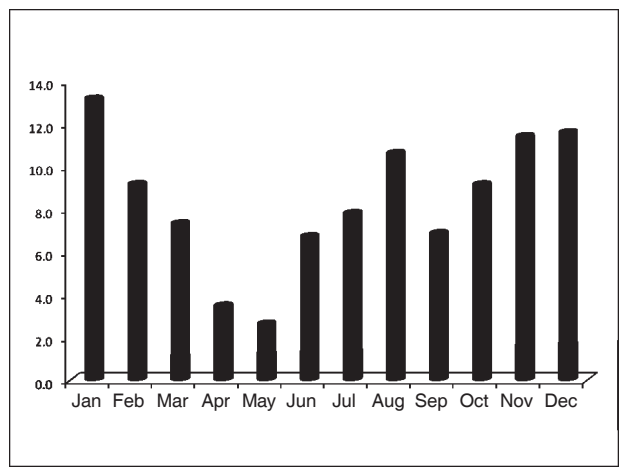

Fig. 16. Annual landings (%) of all fish from mechanized sector at Andhra Pradesh

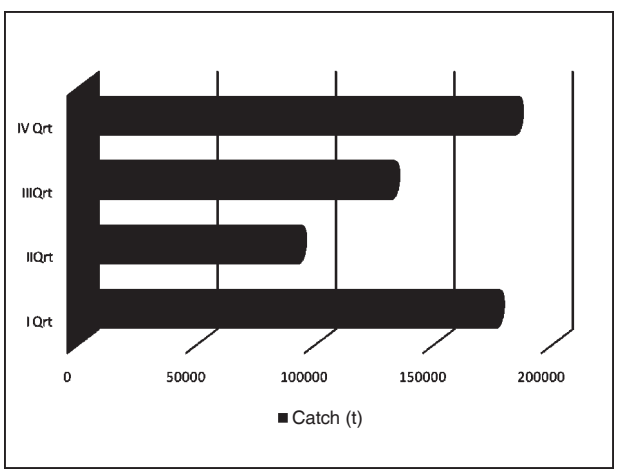

Fig. 15. Quarterwise landing of all fish by all gears at Andhra Pradesh

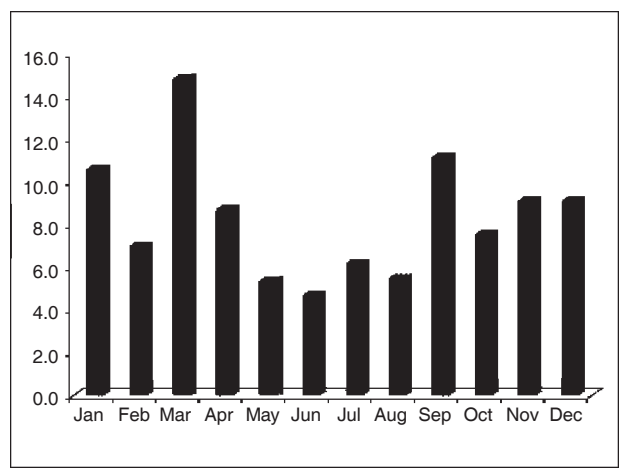

Fig. 17. Annual landings (%) of all fish from the motorized sector at Andhra Pradesh

The fish landings were good during November-March with peak production in November. Least catch was recorded during August (Fig.18).

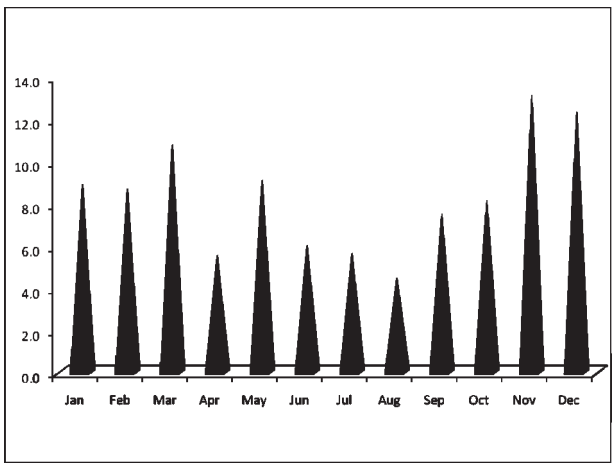

Fig. 18. Annual landings (%) of all fish from the non-mechanized sector at Andhra Pradesh

the total length and mean (all gears combined) for the major commercially important pelagic fishes during 2005 and 2006 combined are given in Table 5a.

Similar trends were noticed in the case of commercially important demersal fin fishes and crustaceans. The trawl net was the major gear for demersal and crustacean resources. Studies on the biology and growth of the different species were based on samples taken from trawl landings (Table 5b). The catch of most of the groups studied (threadfin breams, lizardfish, sciaenids, goatfishes and pomfrets) registered an increase since 2000.

Sex-ratio (Male:Female) and length at first maturity (L_m) of commercially important species were studied. The details are given in Table 6. Length-weight relationship of major species was estimated during this study (Table 7). The 'b' value ranged from 2.6 for *Sardinella gibbosa* to 3.3 for *Rastrelliger kanagurta* The growth and stock parameters of commercially important finfish and crustacean species were estimated (Table 8). The annual growth coefficient ranged from 0.2 (*Trichiurus lepturus*) to 1.7 (*Rastrelliger kanagurta*).

Table 5a.Contribution of major pelagic species with their length range and mean in different gears

Group	Species	% of species in group	Gearwise percentage Trawl	seines	Gillnet	H&L	Total length	mean
Mackerel	*Rastrelliger kanagurta*	96.3	24.8	35.4	39.7	0.1	7.0-25.5	19.5
	R.faughni	3.7	96.2	3.8				
Sardines			8.9	51.9	39.1	0.1		
	S.gibbosa	76.3					3.5-19.0	12.3
Ribbonfish	*Trichiurus lepturus*	100.0	60.2	17.0	22.8		16.0-90.0	52.7
Seerfish	*S.commerson*	68.0	6.9	9.0	72.9	11.2	35-100	
	S.guttatus	32.0	6.9	9.0	72.9	11.2	20-58	36.3
Tunas	*Thunnus albacares*	56.4				100.0	30-172	107.9
	Euthynnus affinis	20.5				100.0	24-54	
	Katsuwonus pelamis	23.1				100.0		

Biology of important groups

Important biological parameters, biological reference points, growth and stock structure of thirteen commercially important species that formed regular fishery along the Andhra coast were studied. Among the pelagic fishes, studies were carried out on mackerel, sardines, ribbonfish, seerfish and tunas. During the study period, catch of most of the pelagic fishes like sardines, ribbonfish and seerfish registered an increase. However, the catch of mackerel declined (Fig.5). Species composition, gearwise distribution,

The total marine fish production along Andhra Coast has indicated positive trend during the past few years despite fluctuations in annual catch. Increase in catch over the years has been due to several factors like increased landings of sardines, mackerel, ribbonfish, croakers, carangids and elasmobranchs

Table 5b. Contribution of major demersal finfishes and crustaceans along with their total length range and mean to the trawl fishery

Group	Species	% of spp. in group	Total length	Mean
Lizardfish	*Saurida undosquamis*	47.9	9.5-36.5	20.1
	S.tumbil	34.2		
	S.micropectoralis	10.7		
	S.longimanus	3.3		
	Trachinocephalus myops	3.9		
Goatfish	*Upeneus vittatus*	62.8	6.5-24.5	14.1
	U.sulphurus	22.4		
	U.molluccensis	14.8		
Threadfin bream	*Nemipterus japonicus*	69.7	8.5-28.5	18.8
	N.mesoprion	18.4		
	N.delagoae	3.0		
	N.tolu	6.2		
	N.luteus	2.7		
Sciaenids	*Johnius carutta*	5.7	9.5-23.5	16.1
	Otolithes ruber	18.9	5.5-38.5	21.0
	Pennahia macrophthalmus	24.4		
	Kathala axillaris	8.2		
	Johnieops vogleri	8.0		
Pomfret	*Pampus argentius*	45.2	6.5-29.5	18.5
	P.chinensis	9.7		
	Parastromateus niger	45.1	6.5-50.5	20.8
Prawn	*Metapenaeus monoceros*	30.8	9.3-20.4	13.3 (m) 15.3 (f)
	M.dobsoni	6.6	5.8-11.3	83.6 (m) 93.8 (f)
	Penaeus indicus	6.9		
	P.monodon	4.1		
Crab	*Portunus pelagicus*	17.2		
	P.sanguinolentus	69.3	6.8-18.8	11.8
	Charybdis cruciata	13.5		
Cuttlefish	*Sepia aculeata*	52	7.5-25.5	20.5
	S.pharaonis	30	7.8-26.5	18.5
	S.innermis	14		
Squid	*Loligo duvaucelli*	100	5.5-14.5	11.5

(Plate 4); expansion of operational areas (which in turn resulted in better harvesting of resources in deeper areas as well as harvesting of non-conventional resources like bull's eye, drift fishes etc.); surge in the demand of certain resources *viz*., cepahalopods, ribbonfish, yellowfin tunas etc., in the export markets and an overall increase in the effort expended. On the other hand, the steep increase in construction as well as operational costs and the sudden fluctuations in the market rates both in the domestic and export sector is making fishing activity a high risk job and has put several fishermen to great hardships. The fishery therefore has to be managed judiciously so that the resource is sustained at healthy levels and the fishermen too get their due returns.

Plate 4. Major resources contributing to the marine fish catch of Andhra Pradesh

Table 6. Sex-ratio (Male: Female) and length at first maturity (L_m) of important species

Species	Sex ratio	Length at first maturity
S.longiceps	1:0.8	16.0
S.gibbosa	1:0.9	14.5
R.kanagurta	1:1	19.7
T.albacares	1:0.5	93
T.lepturus	1:1.4	37.0
N.japonicus	1:0.7	12.8
S.undosquamis	1:0.9	23.0
U.vittatus	1:1.5	13.8
J.carutta	1:1.8	15.4
O.ruber	1:1.2	-
M.monoceros	1:1.5	9.5 (m) 11.5 (f)
M.dobsoni	1:1.2	6.8 (m) 8.8 (f)
P.sanguinolentus	1:1.9	9.0 (f)

to natural ecological changes. In Andhra Pradesh, the fishery is sustained mainly by finfishes and crustaceans. Of the thirteen species of finfishes and crustaceans studied twelve are being exploited at levels higher than that desired (Table 8). Comparison with earlier studies has shown that the mean length as well as the length at first maturity has reduced over the years. These facts indicate that there is great pressure on the commercially important fish and prawn species. These disturbing facts call for adoption of conservative measures to ensure long term sustained fishery along the Andhra coast. The government of Andhra Pradesh keeping this fact in mind has been strictly imposing a fishing ban for 45 days from mid-April to May. However, certain other measure like mesh size regulation, limiting the number of different crafts, demarcation of fishing grounds for different categories of boats, fishing quota, *etc*., will have to be taken up to sustain the fishery of commercially important fishes/crustaceans at present levels and to increase the overall fish

Table 7. Length - weight relationship of major species

Species	'a' value	'b' value
Sardinella longiceps	0.012339	2.836
S.gibbosa	0.022806	2.6075
Rastrelliger kanagurta	0.003687	3.3623
R.faughni	0.00574	3.2043
T.albacares	0.00863	3.12
S.guttatus	0.023	2.782
Trichiurus lepturus	0.0006	3.05
J. carutta	0.00002145	3.0279
U.vittatus	0.013969	2.9899
S.undosaquamis	0.000003754	3.1025
M.monoceros	Male:0.00635Female:0.003857	Male:2.9580Female:3.1936
M.dobsoni	Male:0.007339Female: 0.010715	Male: 2.9477Female: 2.7870
P.sanguinolentus	Male: 0.060253Female: 0.09415	Male: 2.9440Female: 2.7942

Fluctuations in catch is an inherent quality of any tropical fisheries system, but steep decline in catch of commercially important fishes especially, those which are subjected to higher fishing pressure (prawns, mackerel, ribbonfish, threadfin breams) is not a healthy indicator for the fisheries system. Fisheries being a renewable resource are fully capable of recouping its stock back to healthy levels under normal circumstances. However, of late it has been noticed that steep decline in catch of certain species is also due to human interference in addition production of the state in the coming years. Of the several limiting restrictions that will have to be considered for implementation, the most important measure will have to be on the number of units operating in an area. The catch rates of major resources especially those in the mechanized sector are on a steady declining trend. It is observed that the fishing effort in the coastal zone exceeds its resource potential. Though the implementing agency has not so far succeeded in bringing out certain strictures to limit the number of units, the adverse

Table 8. Growth and stock parameters of commercially important species off Andhra coast

Species	L∞ (cm)	K (annual)	Z	M	F	E
S.gibbosa	19.1	1.5	5.41	1.5	3.91	0.7
R.kanagurta	27.9	1.7	13.8	1.38	11.7	0.9
T.lepturus	115.0	0.2	1.8	0.4	1.4	0.8
S.guttatus	67.7	1.2	2.44	1.63	0.81	0.33
T.albacares	240					
N.japonicus	34.0	0.53	2.78	0.48	2.30	0.83
S.undosqaumis	39.4	0.33	2.19	0.42	1.78	0.81
U.vittatus	25.1	0.67	7.05	0.75	6.30	0.89
J.carutta	29.7	0.32	2.09	0.44	1.65	0.79
O.ruber	45.0	0.20	0.90	0.29	0.61	0.68
M.monoceros Male	18.9	1.35	6.7	1.28	5.42	0.81
Female	22.9	1.43	5.6	1.26	4.34	0.78
M.dobsoni Male	11.8	0.71	4.92	0.96	3.97	0.74
Female	12.1	0.81	3.91	1.03	2.88	0.81
P.sanguinolentus	17.1	1.1				
Male	17.2	1.1				
Female						

economics of operation (increase in operational costs and fall in earnings) is in a way forcing some of the boat owners to reduce the number of operating days or altogether abstain from fishing. Reducing the fishing pressure in the presently fished zone is of crucial importance. The optimum fleet strength in relation to the fishable stocks as determined by various studies have to be taken into account and steps have to be taken to limit the number of boats.

The presence of several resources especially the oceanic yellowfin tuna off Visakhapatnam along Andhra coast presents an ideal situation for diversification of fishing activities. In order to harvest the presently underfished yellowfin stocks as well as to reduce the fishing pressure, it is suggested to modify suitably and deploy some of these crafts in the deeper waters. Targeted fishing for yellowfin tunas by the local fisherfolk is a recent trend. It is still dominated by the traditional fisheries sector. There is therefore a need to adopt focused operational strategies to optimally harvest these oceanic resources. A number of indigenous crafts from Pudimadaka and Lawsons Bay villages are operating in the oceanic waters to harvest the yellowfin tunas. The crafts used are traditional wooden catamarans (Plate 5) fitted with huge sails. The prohibitive cost of wood and recurring expenses incurred to maintain them has in a way induced the local fishermen to opt for the more durable and less expensive fibre crafts. The sail driven crafts are able to reach the fishing grounds (>200 m depth) in about three hours when the wind conditions are good. Fishing is carried out using long lines as well as trolls for about 2-3 hours after which the crafts return to the shore. Normally, when good weather conditions prevail a single fishing day takes 8-9 hours. However, when poor wind conditions prevail, the catamaran takes much longer to reach the fishing ground and return after the fishing. Fishing by these catamarans is totally stopped if wind conditions are not suitable and also when the sea is

Plate 5. Traditional wooden *tepalu* used for hunting the oceanic yellowfin tunas occuring off Andhra coast

stormy and cyclone warnings are proclaimed by the Government. The catamarans are not equipped with any storage facility or other electronic fish catching aids. A small portable ice box is taken to store the bait fishes. Baits usually consist of sardines, flying fishes, smaller tunas (*Auxis* spp.) etc. Each unit on an average gets 2-3 yellowfin tunas, 1-2 billfishes and at times a couple of king seers. The availability of these resources in the oceanic waters off Visakhapatnam and the better returns the fisherfolk get from the export market has induced the fishermen to take up night fishing. The fork length of yellowfin tunas landed by the catamarans at Visakhapatnam ranged from 38 to 175 cm and weighed between 1 and 82 kg. They have a good demand in the export market and fetch three times more money than that obtained in the domestic market. The small indigenous crafts operating specifically for tunas are sparsely equipped and have no facility to either store the fishes caught or any electronic equipment to aid them in fishing. Tunas when hooked are dragged onto the deck of the craft, stunned by hitting several times on its head with a wooden club and then left as such on the deck. These dead tunas are given a sea water bath once in a while till they are brought ashore. As most of the catamarans still depend on the wind power to reach the fishing ground and back, the time of return is not fixed. The local fishermen however, are skilled in catching these big high valued oceanic yellowfin tunas and on good fishing day's 15-20 t of yellowfin tunas are landed at one centre (Plate 6). Once the fish is brought to the land the buyers take charge of the fish and are responsible for distributing to the processors. The processors have their own quality testers who grade the yellowfin tunas for export and domestic markets. The graded fishes are then gutted, washed properly and transported chilled to Chennai from where they exported mostly to south East Asian countries. Yellowfin tuna meat is not preferred by the local population of Andhra Pradesh. However, there is a great demand for this fish in Kerala. The tunas which have not been accepted for export market are iced and sent as such to markets in Kerala. The returns to the fishermen engaged in tuna fishing can be greatly enhanced by adopting some simple quality control measures. Steps are to be taken to maintain the freshness of the tuna meat so that major part of the catch is graded for export. As a quality control measure, bleeding and gutting of fish immediately after capture must be made mandatory. The fishermen must be trained to do this on board. This will ensure better meat quality as well as chance for being exported. This in turn will fetch better returns for the fishermen engaged in tuna fishing. Presently, the hooked fishes are killed brutally by hitting it several times on its head with a wooden club. Easier and instant killing techniques as used in slaughter houses may be adopted to prevent cruelty and prolonged agony to the dying fish. Instant killing prevents release of histamines and adrenalin which are in turn responsible for rapid tissue damage. In addition, instant killing helps in proper bleeding and thus improves the shelf life of the tuna meat.

Plate 6. Yellowfin tunas landed by the tepalu brought to market for auction

The availability of rich yellowfin tuna resources in the deeper waters, the demand for it in the export market has been noted by several entrepreneurs. There are about 40 chartered long liners operating off Visakhapatnam under LOP (Letter of permission). But, till date there is no information either on the quantity of tunas caught and exported from our waters, the species composition as well as the biological details of the fishes caught. However, some of the larger trawlers operating off Visakhapatnam have been converted into long liners recently and are actively involved in fishing. Financing organizations are coming forward to finance long lining activity along this coast. Till date six large trawlers have been converted into long

lining units to harvest the stocks of yellowfin resource occurring off Visakhapatnam. Many more conversions of trawlers into long liners are in the process. Such change overs are good for the fishery in general and should be encouraged. However, the growth and population characteristics of the harvested stock have to be carefully monitored to prevent exploitation higher than desired levels. Till date no scientific stock assessment of the yellowfin tuna resources available along the western Bay of Bengal region has been made. This study has to be taken up immediately and the fishing effort as well as catch has to be carefully and regularly monitored. So far, there is no marked Indian fishing effort beyond the coastal zone except in Andaman and Nicobar regions. Appropriate fleet of vessels has to be introduced for sustained exploitation of fisheries beyond territorial waters or the existing units have to be suitably modified to take up such activities. The exploited stocks have to be monitored and assessed for judicious exploitation.

Water bodies have no boundaries but conflicts among the fisherfolk of different states are causing great concern to the fishery managers and planners. The present system of zonation of coastal waters based on state boundaries needs modification based on a new set of criteria of viability that would promote sustainability and provide equal opportunities without imposing a disadvantage to fishermen of any of the states concerned.

Taking up large scale cage culture in suitable areas in the open sea using the naturally available seed will also help in augmenting the total marine fish production and gainfully utilize the young juveniles which are presently brought to the shore in live condition by the shoreseines. A concerted effort by the implementing agencies as well as the coastal fisherfolk of Andhra Pradesh will definitely result in sustained harvesting of the available resources, better exploitation of the presently under fished resources of the region and gainful utilization of the juveniles landed by shoreseines.