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Landings of Yellowfin tuna in Mangalore Fisheries Harbour

(Photo credit: Nataraja, G. D.)

Marine Fisheries Information Service Technical and Extension Series envisages dissemination of information on marine fishery resources based on research results to the planners, industry and fish farmers and transfer of technology from laboratory to the field.

MFiS

Marine Fisheries Information Service
Technical & Extension Series

From the Editorial Board

Warm greeting to all our esteemed readers

It is reported that marine wild fisheries and mariculture accounts for nearly 70% of the global production of edible meat presently. However, there are also projections made that by 2050 upto 44% of the edible marine food production would be through mariculture. Hence, the need to focus on development of marine fisheries in a sustainable manner as well as explore mariculture is flagged. The Indian Ocean is one of the world's most important fishing grounds for tunas and other large pelagic fishes such as tunas, seerfishes, billfishes, dolphinfishes and barracudas. Several of theses species are highly migratory and support seasonal fisheries in different countries in the Indian Ocean realm. Owing to the high quality of their meat, they are much sought after commodities in the seafood markets globally and hence targeted fishery resources by an industrial fishing fleet as well as small scale, artisanal sector. In India also there is considerable research focus on large pelagic fisheries and their sustainable management considering the economic value and livelihoods supported by these fisheries. Recognising that the fishery trends are important indicators to arrive at management options, the status of fisheries for large pelagics on the south west coast of India is highlighted, to be followed by the rest of the maritime states and regions. Also included are articles that focus on the marine biodiversity and findings related to mariculture activities in our country.

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Contents

Fishery trends of large pelagics along the Kerala coast

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Abstract

The estimated average annual landings of large pelagics in Kerala during 2013 -2019 was 35678 t, which formed about 16% of the national average landings of large pelagics of India. The average group wise contribution during 2013-2019 was mainly by tunas (54%), billfishes (15%), seer fishes (14%) and barracudas (8%). The peak fishery occurred during October to March with trawl nets, gill nets and hooks & lines employed. The mechanized, motorized and traditional sectors tap the resources which have demand in the domestic as well as export markets and a supply chain is well established. Appropriate management measures for sustainable utilization are flagged.

Keywords: Large pelagics, Kerala, supply chain, fisheries management

Introduction

Among the maritime states of India, Kerala is holding the topmost position in the landings of large pelagics which comprises tunas (both neritic and oceanic), seerfishes, billfishes, large-sized carangids (rainbow runner and queenfish), dolphinfish, needlefish and cobia. The estimated average annual landings of large pelagics in Kerala during 2013 -2019 were 35678 tonnes (t) which contributed an average of 6% to the total annual landings of Kerala. The major large pelagic landing centres in the state are Neeleswaram (Kasargod district), Azhikkal, Ayikkara (Kannur district), Chembola, Puthiyappa&Beypore Fisheries Harbours (Kozhikode district), Ponnani (Malappuram district), Chettuva (Thrissur district), Munambam and Cochin Fisheries Harbours (Ernakulam district), Omanapuzha (Alappuzha district), Neendakara Fisheries Harbour, Vadi (Kollam district) and Vizhinjam Fisheries Harbour (Thiruvanathapuram district).

The average group-wise contribution of large pelagics landed during 2013-2019 were tunas (54%), billfishes(15%), seer fishes (14%), barracudas (8.34%), dolphinfishes (5%), Cobia (1.4%), Queen fishes (0.68%) and Needlefishes (1.38%) and major species are indicated in Table 1. Annual landing trends of the various groups indicated an increase (Fig.1).

Large pelagics are fished by large mechanized vessels such as trawlers (9.1- 16m OAL and 89-122 hp) and gillnetters cum liners (7.1-14m OAL and 60-99 hp). The motorized and traditional crafts operate boat seines, gill nets and hook and line. Trolling by towing baited hooks or lures through the water and longlining is used for catching tunas and billfishes. Hook and line fishing is done with monofilament twines categorized into numbers (40, 60, 80) inversely based on their thickness. For day fishing, No. 80 main lines with No. 60 branch line is used and for night fishing No. 30 is used for both main and branch lines. Similarly,

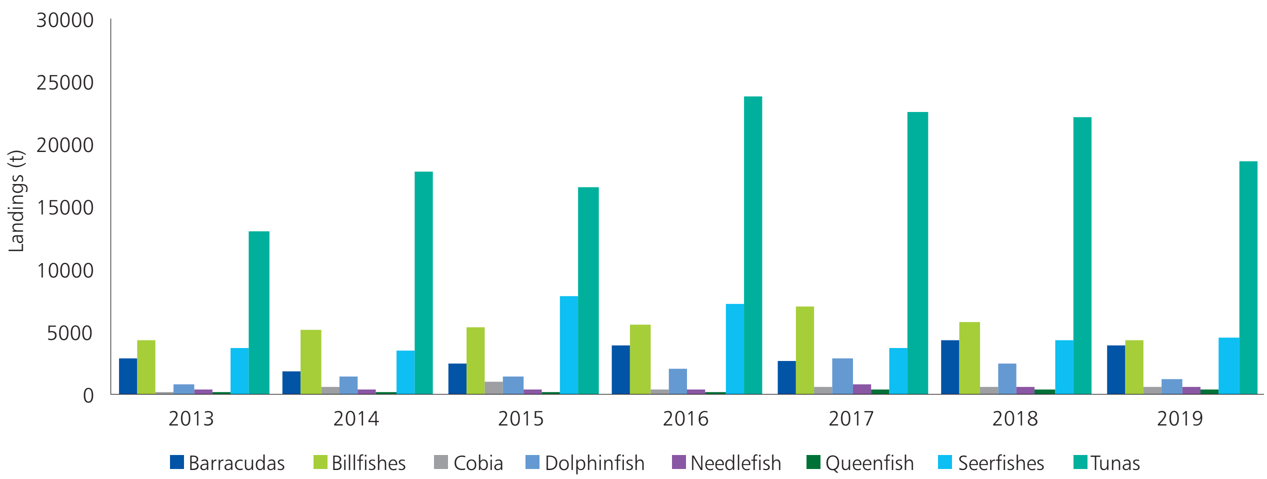

Fig.1. Trends in annual landings (t) of large pelagics in Kerala

Table 1. Major species of large pelagics landed along the Kerala coast

Group	Species	Vernacular name
Tunas	*Euthynnus affinis*	*Choora*
	Auxis thazard	*Choora*
	Auxis rochei	*Kudukka*
	Thunnus tonggol	*Vaalan Kera*
	Thunnus albacares	*Kera*
	Katsuwonus pelamis	*Varayan choora*
	Sarda orientalis	*Neymeen choora*
	Gymnosarda unicolor	*Pallan choora*
Billfishes	*Xiphias gladius*	*Pannikkatta*
	Istiophorus platypterus	*Olameen*
	Istiompax indica	*Parappankkatta*
	Makaira mazara	*Olakkatta*
	Kajikia audax	*Mullamkkatta*
Barracudas	*Sphyraena barracuda*	*Seelav*
	Sphyraena arabiansis	*Neelanseelav*
	Sphyraena jello	*Seelav*
	Sphyraena putnamae	*Seelav*
Belonids	*Ablennes hians*	*Parappan Kolan*
	Tylosurus crocodilus	*Urulankolan*
	Tylosurus acus melanotus	*Urulankolan*
Seerfishes	*Acanthocybium solandri*	*Chundan Neymeen*
	Scomberomorus commerson	*Neymeen/ Ayikoora*
Queenfish	*Scomberoides commersonnianus*	*Neyvatta*
	Scomberoides lysan	*Neyvatta*
	Scomberoides tol	*Polavatta*
Rainbow runner	*Elegatis bipinnulata*	*Poomeen*
Cobia	*Rachycentron canadum*	*Motha*
Dolphinfish	*Coryphaena hippurus*	*Chainvatta*

different types of hooks are also categorized into numbers. Hooks used during day fishing ranged from No. 8 to No. 13 and hook No. 15 is used for night fishing. The baits commonly used are scads, sardines and anchovies. Until recently, live baits were used along the Vizhinjam coast. Presently the crafts

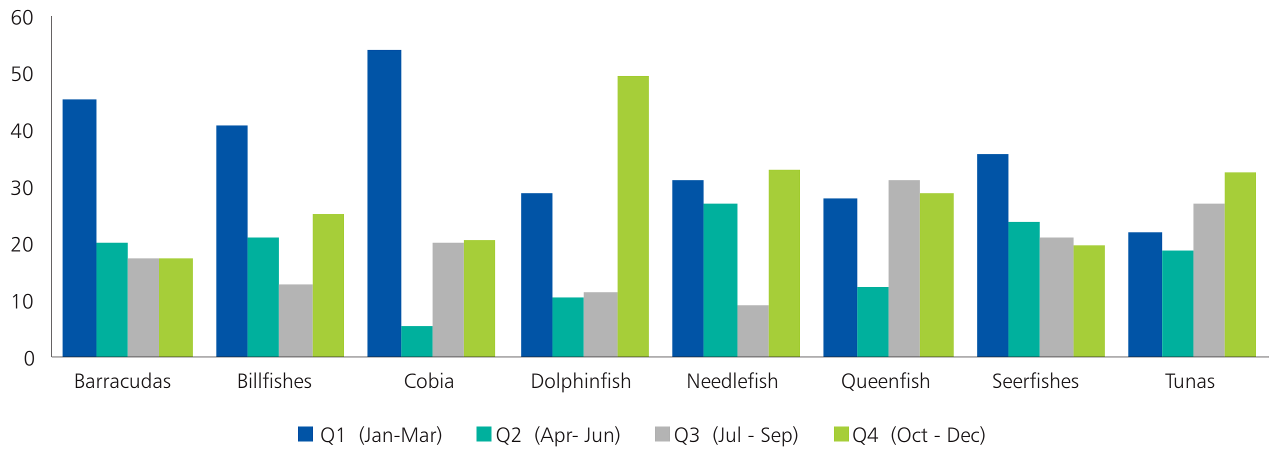

Fig. 2. Seasonal landing trends of large pelagics along Kerala coast

are equipped with artificial baits to attract fishes and aids the fishers to reduce searching time for live bait collection. The imported double hooks with artificial bait are used to catch seerfishes.

During the monsoon fishing ban period, large mechanized vessels are not allowed to fish along the Kerala coast and traditional fishers operate outboard motor fitted canoes for operating gill nets and hooks and lines. At Trivandrum, the entire coast is exclusively for the small scale fishing practices mainly using gillnets or lines and the catch is dominated by tunas. The gillnet operations are mainly carried out during the night, while hook and line fishing done during the daytime takes about 5-7 hours for operating the gear. Most of the fishers engaged in this fishery are from Poziyoor and Poovar villages of southern Kerala and Thothoor and Colachel villages of Tamil Nadu.

The peak period for large pelagic fishery along the Kerala coast was from October to March (Fig.2). The major volume of the annual landings of barracudas, billfishes, cobia and seer fishes were during the January- March period while dolphinfish and needlefish landed mostly during October – December. Landings of Queen fishes were higher in volumes landed during July – September.

The adult population supports the fishery of large pelagics along the Kerala coast except for King seer, Sword fish, Cobia and certain species of barracudas. Juvenile landings of these species were reported during post-monsoon months from trawls and gillnets (Tables 2 & 3).

Table 2. Size range of major large pelagics landed along the south Kerala coast

Species	Size range(mm)
Acanthocybium solandri	232-512
Scomberomorus guttatus	191-830
S. commerson	136-856
Coryphaena hippurus	375 -890
Rachycentron canadum	287-786
Sphyraena putnamae	310-435
S. jello	578-830
S. barracuda	845-1026
S. obtusata	105-332
S. forsteri	309-480
Elegatis bipinnulata	204-835
Scomberoides tol	298-344
S.commersonnianus	136-856
S. lysan	268-550
Euthynnus affinis	215-678
Thunnus albacares	343-1022
Sarda orientalis	456-510
Katsuwonus pelamis	326-715
Ablennes hians	680-1252
Strongylura strongylura	598-655
Tylosurus crocodilus	600-1080
T. acus melanotus	1074-1167
Istiophorus platypterus	435-2120
Xiphias gladius	670-1950
Auxis rochei	260-310
A. thazard	280-450

Table 5. Size range and price of major large pelagics landed along the central Kerala coast

Species	Size (cm)	Price/kg (₹)
Euthynnus affinis	28–70	80–140
Auxis sp.	26–48	60–100
Thunnus tonggol	42–80	100–160
Thunnus albacares	38–182	120–200
Katsuwonus pelamis	36–75	80–140
Acanthocybium solandri	65–141	200–500
Scomberomorus commerson	28–135	200–850
Xiphias gladius	75–233	90–220
Istiophorus platypterus	90–228	160–220
Istiompax indica	139–332	180–240
Makaira mazara	122–240	180–240
Sphyraena barracuda	65–136	180–350
Sphyraena arabiansis	60–152	180–350
Sphyraena jello	40–132	180–350
Sphyraena putnamae	32–78	160–220
Ablennes hians	60–130	140–200
Tylosurus crocodilus	65–142	160–220
Tylosurus acus melanotus	60–122	140–200
Scomberoides commerssonianus	36–122	120–350
Scomberoides lyssan	28–64	120–250
Scomberoides tol	22- 48	80–120
Elegatis bipinnulata	40–138	120–300
Rachycentron canadum	28–142	200–550
Coryphaena hippurus	28–152	120–200

Market chains

At Cochin Fisheries Harbour, a well-developed market chain for tunas and billfishes due to better handling and preservation on-board adopted as the fishes are taken by fish processing units for export is observed. Those of lower quality are transported to local hotels and interior markets through cold chains with carangids, needlefishes and cobia mostly reaching the domestic markets. Also, large pelagics are transported from other states and including Lakshadweep islands to the processing units and interior markets. Most of the catch is beach landed in very fresh condition along Trivandrum coast since it is single day fishery system here. The quality of the fish determines its price at landing centre. Because of the demand in the domestic as well as export markets, the supply chain is well established and local processing units are also involved.

Large pelagic fisheries mainly constitute a targeted fishery along the Kerala coast. The occurrence of juveniles of some species in trawls during the monsoon and post-monsoon months in significant numbers highlight need for so measures to control growth overfishing. Minimum Legal Sizes (MLS) have not been determined for several species and need attention. Another major issue is the poor quality of the fishes landed by multi-day fishing fleets. Modernization to accommadate high standard handling and preservation facilities on-board to maintain the freshness of the catches at *Sashimi* grade is needed. The fishery of large pelagics is mostly seasonal, with most species being migratory nature. Currently, there is scope for value addition and enhanced utilization of fish landed through the creation of fish cold storages and value chains in the market.

Status of large pelagic fishery in Karnataka

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Abstract

Tunas, seerfishes, barracudas, queenfishes and fullbeaks are the major large pelagic fishes landed along Karnataka Coast, while, landings of cobia, dolphinfish, billfishes and rainbow runner are limited. The fishery trends, crafts and gears operated to tap large pelagics, seasonal pattern of landings, species composition and post- harvest utilization and market chains in Karnataka is detailed.

***Keywords**: Large pelagic fish, Karnataka, fishery trends, post-harvest*

Introduction

Large pelagic fishes (LPF) comprising of several genera and species have a wide ranging distribution and their high market value usually make them a targeted species during fishing. Information on the fishery biology and population status of most large pelagic fishes is limited. Detailed studies on fishery, taxonomy and biology of billfishes, barracudas, queenfishes, fullbeaks, cobia and dolphinfish was taken up to aid in proposing measures for management of these fisheries.

Fishery trends

The estimated landings of LPF in Karnataka over the decade varied from 16,200 t in 2007 to 71,451 t in 2016 and it contributed 9.3% to 30.5% of total LPF landings of the country during the respective years (Fig. 1). Large scale adoption of big meshed purse seine net (mesh size of > 45 mm) locally called as *Kotibale* and light fishing beyond 12 nm on a regular basis could be the reasons for the increased landings of LPF in Karnataka during 2015-17 but later the catch

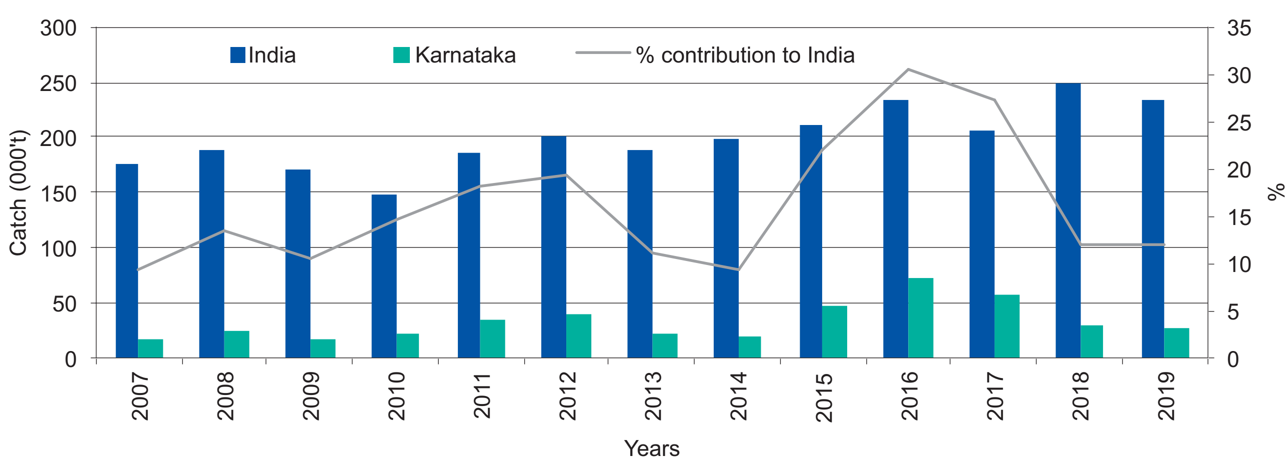

Fig. 1. Large Pelagic fish landings in India and Karnataka

Table 1. Mean landings (%) of large pelagic fishes from different gears during 2007-19

Gears	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Seerfish													
Trawl	35.7	11.2	11.9	65.7	25.7	29.4	36.2	68.4	61.6	71.8	46.4	51.0	52.0
Purse seine	3.2	30.4	45.2	11.5	5.2	27.0	12.6	11.8	16.0	19.2	38.3	37.0	42.0
Gillnet	58.9	57.9	41.5	22.5	68.8	42.6	49.1	18.2	21.3	7.6	15.2	9.0	4.1
Others	2.3	0.6	1.5	0.4	0.4	0.9	2.2	1.7	1.1	1.4	0.1	3.0	1.9
Tunas													
Trawl	0.6	0.4	1.3	0.1	0.6	0.0	0.7	3.7	5.0	8.0	8.0	0.3	7.9
Purse seine	35.2	75.7	65.0	72.3	90.2	67.9	63.4	85.6	86.9	87.5	83.6	90.0	83.6
Gillnet	64.2	23.2	33.7	26.6	9.3	25.0	19.2	8.1	7.9	4.3	8.4	8.0	8.4
Others	0.1	0.7	0.0	1.0	0.0	7.1	16.7	2.6	0.2	0.1	0.0	1.7	0.1
Billfish													
Trawl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.7	69.7	10.3	35.0	0.0	43.0
Purse seine	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	13.0	4.0	1.0
Gillnet	100	98.7	100	61.9	100	91.7	100	19.3	25.2	84.1	51.5	76.0	41.0
Others	0.0	0.0	0.0	38.1	0.0	8.3	0.0	0.0	5.2	0.0	0.5	20.0	15.0
Barracudas													
Trawl	88.6	86.2	84.1	94.5	90.5	95.5	92.1	96.0	97.3	90.2	90.7	60.5	96.6
Purse seine	2.7	3.9	7.6	2.0	0.1	1.5	0.5	2.0	0.8	9.0	8.4	5.0	3.2
Gillnet	7.2	7.6	4.7	1.6	1.8	2.3	3.7	1.4	1.3	0.6	0.7	0.5	0.0
Others	1.5	2.3	3.4	2.0	7.6	0.7	3.8	0.5	0.5	0.2	0.1	26.0	0.20
Queenfish													
Trawl	27.8	11.3	36.3	30.5	80.7	59.5	53.5	88.9	84.0	78.0	68.2	79.0	73.7
Purse seine	48.3	70.0	56.3	68.8	13.7	21.1	40.7	9.5	8.7	15.6	31.7	20.9	25.0
Gillnet	23.8	16.0	3.7	0.7	5.5	16.0	3.8	1.3	4.5	4.6	0.1	0.1	1.7
Others	0.0	2.6	3.7	0.1	0.0	3.5	1.9	0.2	2.7	1.7	0.0	0.0	0.0
Fullbeaks													
Trawl	3.3	1.8	3.4	11.5	56.4	16.1	73.1	83.1	50.8	40.7	69.5	37.0	69.9
Purse seine	10.9	18.3	12.2	20.6	20.6	38.3	5.4	9.4	34.4	54.1	28.1	59.0	28.0
Gillnet	85.8	76.4	84.0	67.3	21.8	24.1	20.9	7.0	9.1	2.8	2.3	3.0	1.8
Others	0.0	3.5	0.3	0.7	1.1	21.5	0.6	0.5	5.7	2.3	0.1	1.0	0.3
Cobia													
Trawl	56.9	17.7	42.7	71.5	72.3	73.6	61.9	76.6	87.4	80.4	91.7	84.0	83.5
Purse seine	0.0	0.0	0.2	4.2	0.6	0.0	2.1	15.1	2.7	6.6	0.1	2.0	2.0
Gillnet	42.0	82.2	54.0	24.1	27.1	22.9	35.7	7.8	9.8	11.3	8.1	10.0	14.1
Others	1.2	0.1	3.2	0.2	0.0	3.5	0.4	0.4	0.1	1.7	0.0	4.0	0.3
Dolphinfish													
Trawl	21.0	2.0	2.9	50.0	27.6	42.7	34.5	26.4	53.2	43.6	77.5	27.0	54.7
Purse seine	0.0	1.9	2.1	1.7	8.4	0.2	20.1	15.3	9.6	35.4	10.9	25.0	13.6
Gillnet	78.7	96.1	95.1	47.7	64.0	56.4	45.5	46.5	37.0	20.0	11.5	33.0	26.5
Others	0.2	0.0	0.0	0.7	0.0	0.8	0.0	11.8	0.1	1.0	0.0	15.0	5.2
Rainbow runner													
Trawl	-	96.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Purse seine	-	0.0	100.0	41.4	0.0	0.0	0.0	100	0.0	93.2	0.0	100.0	100.0
Gillnet	-	3.9	0.0	12.6	100.0	100.0	0.0	0.0	100.0	6.8	100.0	0.0	0.0
Others	-	0.0	0.0	46.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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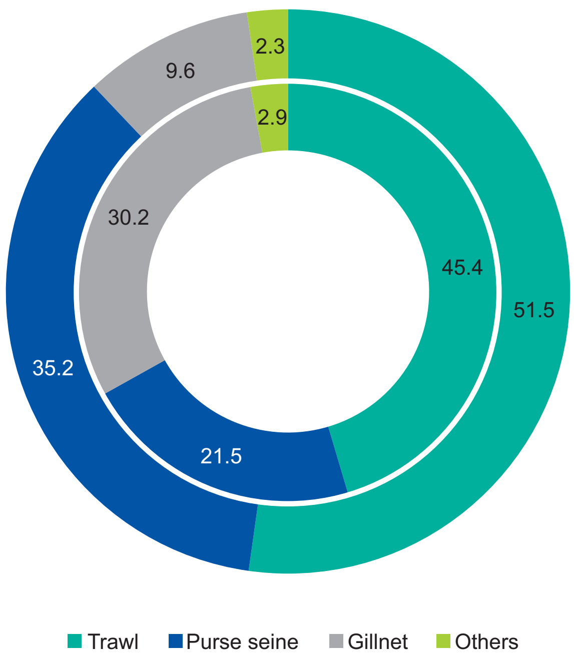

Fig. 2 Comparison of Large pelagic landings from different gears during 2007-2012 (Phase-I, Inner circle) and 2013-2019 (Phase-II, Outer circle) in Karnataka

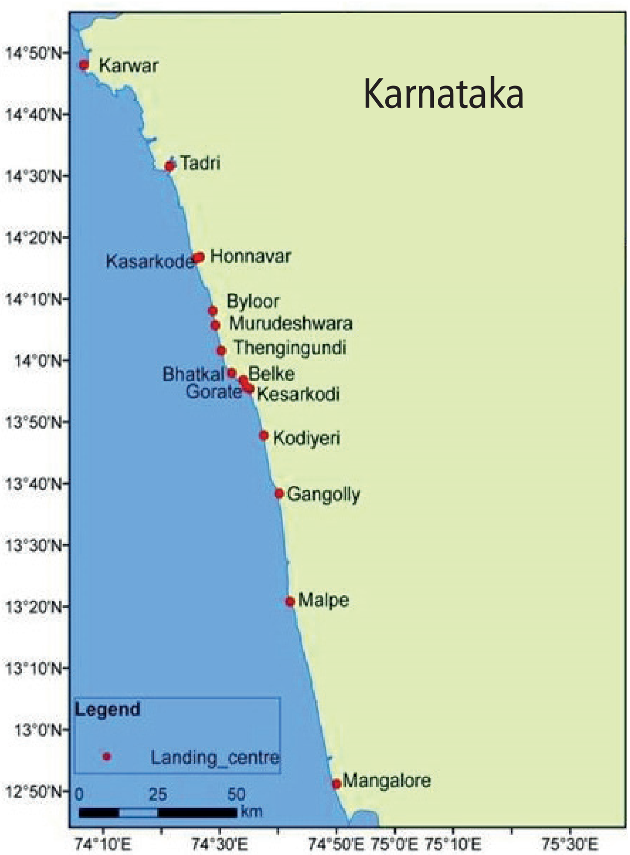

Fig. 3. Major and minor landing centers for large pelagic fishes in Karnataka

was reduced due to the ban imposed on light based fishing in the state.

Gears operated from multiday fishing vessels such as trawlers (MDT), purse seiners (MPS) and gillnetters (MGN) operate beyond the 12 nautical miles or territorial waters, at depths ranging from 40 to 250 m. The landings since 2007 reveal trawl net as the major gear, except during 2008, 2016 and 2017 when the large meshed purse seines emerged as the dominant gear landing LPF (Table 1). The gearwise average landings from 2007 to 2012 (phase I) and 2013 to 2019 (phase II) indicated that the landings by trawlers increased from 45.4% in phase I to 51.5% during phase II. The landings of LPF by purse seines increased from 21.5% to 35.2% during Phase I and Phase II respectively. However, the gillnet landings reduced to 9.6% during Phase II from 30.2% in Phase I. The contribution of ring seines and other indigenous gears did not exhibit much variation between the two phases (Fig.2). The increased landings from trawl net during the second phase could be due to the operation of pelagic trawls and speed engines for the exploitation of LPF. Similarly, the increased landings of LPF from purse seine were mainly because of the operation of big meshed *Kotibale* and exploitation by attracting the fishes using lights.

Seasonal pattern of landings indicated a maximum (49.6%) during the post-monsoon period of September-December followed by pre-monsoon period of January-May (40.5%) and monsoon period of June-August (9.9%). Post-monsoon period was the major fishing season for seerfish (43.7%), tunas (52.9%), billfish (39.5), barracudas (51.5%) and queen fishes (55%). However, the landings of fullbeaks (51.8%) and cobia (40.5%) were maximum during pre-monsoon season (Table 2). The annual species composition of large pelagic fish landings are indicated in Table 3.

Landing Centres

The multiple crafts engaged in catching the LPF landed them at both major and minor landing centres (Fig. 3 & Table 4). However, as most LPF are valued high both in the domestic and export market, fish brought in considerable quantity to minor landing centers are transported by road to the major landing centers (Mangalore, Malpe, Bhatkal, Tadri, Honnavar and Karwar) in Karnataka where adequate transportation, icing facilities and several marketing agents are present thus ensuring competitive price to the fishers. However, as LPFs (seerfish, neritic tunas and barracudas) have good demand in the domestic market,

Table 2. Mean monthly landings (%) of large pelagic fishes (2013- 2019)

Fish species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Seerfish	8.5	9.7	9.2	8.7	7.1	0.7	0.5	11.9	14.6	11.3	6.9	10.9
Tuna	12.3	2.2	4.4	13.3	6.4	0	0.4	8.1	24.9	12.2	3.4	12.4
Billfish	0.5	3.7	6.3	20.4	6.2	0.1	3.1	20.2	27.3	6.5	1.7	4.0
Barracuda	7.5	9.6	7.8	7.7	10.5	0.2	2.1	3.1	17.7	12.9	10.3	10.6
Queenfish	3.9	10.4	6.8	7.5	8.7	0	0	7.7	17.8	9.6	14.2	13.4
Fullbeaks	4.2	11.3	14.6	12.6	13.3	1.7	7	5.9	14.7	2.8	5.8	6.1
Cobia	8.3	9.4	7.9	11.8	11.4	0.4	0.1	3.8	13.5	11.6	10.5	11.3
Dolphinfish	2.8	5.6	5.3	5.7	5.5	0	0.3	7.6	26.9	22.6	9.5	8.2

Table 3. Species composition of large pelagic fishes and their % contribution

Fish species	2013	2014	2015	2016	2017	2018	2019
Seerfish							
S. commerson	91.8	94.1	98.4	93.9	98	91.2	82.5
S. guttatus	8.2	5.9	1.6	6.1	1.9	8.7	17.4
A. solandri	0.001	0.002	0.013	0.002	0.019	0.1	0.1
Tuna							
A. rochei	10.4	3.7	0.1	3.9	5.4	17.2	13.7
A. thazard	15	4.2	3.1	19.8	9.1	13	4.1
E. affinis	73.3	85.5	88.4	74	80.8	66.9	74.6
K. pelamis	0.2	0.1	0.3	0.1	0.5	1	1.9
S. orientails	0.1	0	0.1	0.8	0.6	0.5	1.2
T. albacares	0.2	2	0.2	0.1	2.2	0.2	0.2
T. tonggol	0.8	5.5	7.8	1.2	1.4	1.2	4.2
Billfishes							
I. platypterus	63.1	81.9	57.4	93.1	93.1	73.8	26.2
I. indica	36.9	18.1	42.6	6.9	6.9	80	20
Barracudas							
S. barracuda	31.5	28.6	36.9	17.4	21.6	11.4	5.4
S. arabianensis	0.0	0.0	0.0	9.4	8.2	1.8	7.5
S. obtusata	38.7	35.7	22.5	28.4	28.6	26.5	12.5
S. putnamae	16.5	19.1	19.3	25.9	28.7	46.5	59.8
S. jello	13.3	16.6	21.3	18.9	12.9	13.8	12.7
Queenfishes							
S. commersonianus	65.7	53.1	45.1	34.3	51.7	54.3	36.4
S. tol	17.9	44.2	48.2	50.1	43.8	36.2	57.6
S.tala	16.4	2.7	6.4	15.6	3.2	9.3	3.5
S. lysan	0.0	0.01	0.4	0.1	1.3	0.2	2.4
Fullbeaks							
A. hians	26.2	10.1	39.6	23.6	32	38.8	39.0
T. crocodilus	70.9	88	57.3	75.6	59.4	49.4	60.0
S. strongylura	2.0	1.9	3.1	0.8	8.6	9.8	1.0

Table 4. Landing centres, types of boats operated and landings of large pelagic fishes

Landing centre	Boats operated	Common name	Scientific name
Mangalore, Malpe and Karwar	SDF, MDF, Purse seines, Multiday gillnet, outboard gillnet and other indigenous gears	Seerfishes	*Scomberomorus commerson* *S. guttatus* and *Acanthocybium solandri*
		Tunas	*Euthynnus affinis, Auxis thazard, A. rochei, Thunnus albacares* and *Katsuwonus pelamis*
		Billfishes	*Istiophorus platypterus* and *Istiompax indica*
		Barracudas	*Sphyraena obtusata, S. putnamae, S. jello, S. barracuda, S. arabiensis, S. fosteri* and *S. flavicauda*
		Queenfishes	*Scomberoides tol, S. tala, S. lysan* and *S. commersonianus*
		Fullbeaks	*Ablennes hians, Strongylura strongylura, Strongylura leiura* and *Tylosurus crocodilus*
		Cobia	*Rachycentron canadum*
		Dolphinfish/Mahimahi	*Coryphaena hippurus*
		Rainbow runner	*Elagatis bipinnulata*
Gangolly, Kodiyeri, Kesarkodi, Gorate, Belake, Bhatkal, Thenginagundi Murudeshwara, Byloor, Honnavar, Kasarkode, Tadri	SDF, Out board Gillnet and other indigenous gears	Seerfishes	*Scomberomorus commerson* and *S. guttatus*
		Tunas	*Euthynnus affinis, Auxis thazard* and *A. rochei*
		Barracudas	*Sphyraena obtusata* and *S. putnamae*
		Cobia	*Rachycentron canadum*
		Dolphinfish/Mahimahi	*Coryphaena hippurus*

even when landed in small quantity by outboard gillnet and ring seines, are sold at minor landing centers itself.

Post-harvest

The study conducted on utilization pattern of seerfish landed in Karnataka revealed that 35% goes for the local consumption in fresh condition, 45% are processed for export and 20% are purchased by interstate traders and transported to neighbouring states of Kerala and Goa. Consumer preference for tunas is comparatively low in Karnataka and only 5% of the total tuna landed was utilized for local consumption while 85% was taken by interstate traders. The remaining catch was utilized by processing (9%) and canning plants (1%) respectively. More than 95% of the billfish landed are taken by the interstate traders especially from Kerala and only 5% is taken up by local hotels and restaurants. The market linkage of barracudas is minimal as transactions takes place directly between boat owners, auctioneers, local markets and interstate traders. *S. obtusata*, the smallest fish in the group is utilized for local consumption when landed in good quality and very small and partially spoilt fishes are taken by fish meal plants. As there is very good demand for barracudas in Kerala and Goa, major portion (80-85%) goes to these states through interstate traders and the rest goes to local markets. The preference of queenfishes for domestic consumption is comparatively low and preference is only for *S. commersonianus.* Therefore, 90% of the landings are taken by interstate traders especially from Kerala. There is very good local demand for fullbeaks and 35-40% goes for the local consumption and rest to other states through interstate traders. Cobia has good demand locally and nearly 90% of the landings were used for local consumption and rest marketed to other states. There is not much demand for the dolphinfish in Karnataka and nearly 90% is taken to Kerala by the interstate traders.

Facilities for onboard handling of LPF are minimal in single day fishing crafts (SDF), such as purse seiners, ring seiners, gillnetters and other small indigenous gears. The fish caught are placed on the deck and brought back to the landing centre. The multiday crafts such as trawlers (MDTN), purse seines (MPS) and gillnet (MGN) have fish holds with a capacity ranging from 15 to 20 t where the fish caught is preserved in ice. Onboard handling is thus limited to just preserving the fish with ice till it is landed. Creating awareness and training fishermen to adopt better post-harvest onboard handling procedures would ensure better quality and also fetch higher remuneration for the LPF catch in Karnataka.

Research Communications

Trends of large pelagic fishery in Goa

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Abstract

The large pelagic fish catch in Goa over the decade varied from 3,095 t in 2011 to 13,247 t in 2013. Their percentage contribution to the total large pelagic fish landings of the country ranged from 1.4 in 2016 & 2018 to 7.0 in 2013. Purse seine is the major gear targeting large pelagic fishes such as tunas, seerfishes, barracudas and queenfishes. Fishery trends, crafts and gears involved in exploitation, seasonal pattern of landings, species composition, onboard handling and preservation of large pelagic fishes landed in Goa are described.

Key words: Large pelagic fishes, Goa, Seerfish, Tunas, Barracudas, Queenfishes

Fishery trends

The large pelagics fish catch estimated in Goa over the decade revealed that the quantity of landings varied from 3,095 t in 2011 to 13,247 t in 2013 (Fig.1). Purse seine was the major gear and its contribution was always more than 90% except in 2007 (79.7%). The other gears operated were the gillnets, trawls and shore seines. The comparison of the average landing of the resources between 2007-2012 (phase I) and 2013 to 2019 (phase II) indicated purse seine landings marginally increased from 93.6% in phase I to 98.0% in phase II (Fig.2). Landings by gillnets reduced to 0.5% in phase II from 4.4% recorded during phase I while trawl and other indigenous gears did not exhibit much variation between the two phases. Contribution by the major fishing gears tapping seerfish, tunas, barracudas, queenfish, fullbeaks, cobia and dolphinfish resources and the specieswise monthly landing trends were studied (Tables 1 & 2).

The major landing centres are Cutbona, Vasco Da Gama, Talpona, Mahlim, Baina-Bimber, Pale and Colva along Goa where large numbers of purse seiners, few multiday

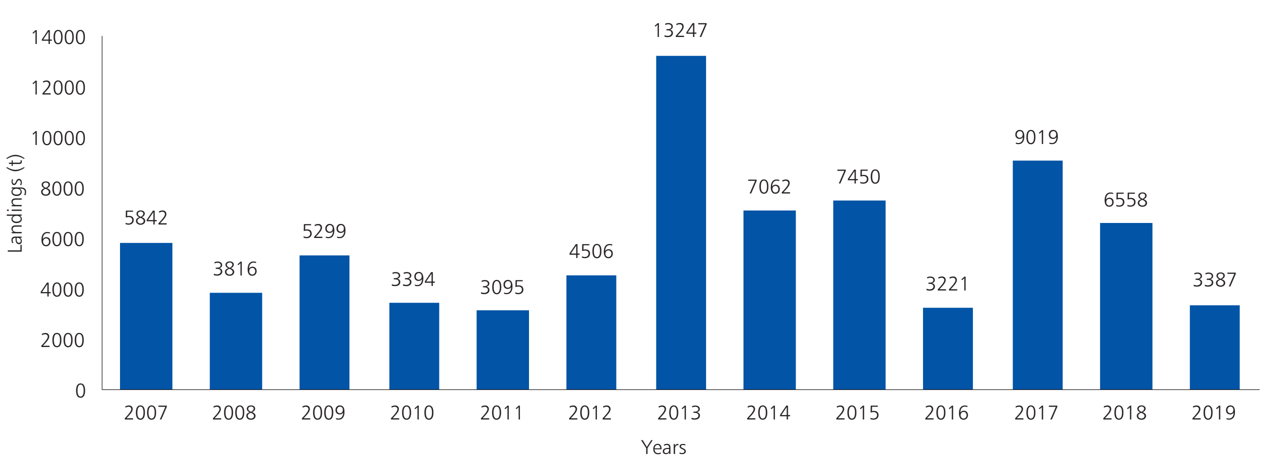

Fig. 1. Trend of Large pelagic fish landings in Goa during 2007 -2019 period

Table 1. Landings (%) of large pelagic fishes from different gears during 2007-19

Gears	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Seerfish													
Purse seine	46.8	0.0	95.0	42.0	64.0	91.0	44.0	83.2	83.0	45.0	16.8	84.8	87.0
Gillnet	10.5	44.5	4.5	3.3	30.2	5.8	20.1	5.2	11.8	53.2	75	5.5	0.9
Others	42.7	55.5	0.5	54.7	5.8	3.2	35.9	11.6	5.2	1.8	8.3	9.7	12.1
Tunas													
Purse seine	89.8	96.3	99.2	98.9	100.0	99.8	100.0	99.8	100.0	100.0	100.0	84.8	100
Gillnet	10.0	3.6	0.0	1.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	5.5	0
Trawl	0.2	0.0	0.7	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	3.6	0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	0.0
Barracudas													
Purse seine	94.3	99.4	98.3	41.3	98.0	97.5	99.4	98.9	93.9	100.0	96.7	99.6	100
Gillnet	1.8	0.6	0.0	58.7	1.1	0.9	0.5	0.0	0.0	0.0	0.3	0.4	0
Trawl	3.9	0.0	1.7	0.0	0.9	1.6	0.1	1.1	6.1	0.0	3.0	0	0
Queenfish													
Purse seine	100	100	99.2	100.0	100.0	99.98	99.5	98.4	99.6	100	100	100	99.5
Others	0	0	0.8	0	0	0.02	0.5	0.6	0.4	0	0	0	0.5
Fullbeaks													
Purse seine	98.2	30.7	99.9	48.6	92.1	99.2	97.7	68.9	100.0	93.3	93.0	99.3	99.4
Gillnet	0.0	37.9	0.0	51.4	0.0	0.5	1.7	9.5	0.0	0.0	6.3	0.0	0.0
Trawl	0.0	0.0	0.0	0.0	6.3	0.2	0.3	21.7	0.0	6.7	0.7	0.0	0.0
Others	1.8	31.5	0.1	0.0	1.5	0.1	0.3	0.0	0.0	0.0	0.0	0.7	0.6
Cobia													
Purse seine	43.9	100	92.1	0	96.9	0	100	100	0	0	100	0	100
Trawl	0.0	0	7.9	0	0.0	100	0.0	0	0	0	0	0	0
Gillnet	56.1	0	0.0	0	3.1	0	0.0	0	0	0	0	0	0
Dolphinfish													
Purse seine	73.2	100	0	0	0	0	0	85.8	100	0	97.7	100	100
Trawl	17.4	0	0	0	0	0	0	0	0	0	2.3	0	0
Gillnet	9.4	0	0	0	0	0	0	14.2	0	0	0	0	0

Table 2. Mean monthly landings (%) of Large pelagic fishes (2013-19)

LPF	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Seerfish	2.7	6.5	3.3	1.2	1.5	0.0	0.1	13.9	29.1	17.2	3.8	20.7
Tuna	4.6	3.6	1.8	2.2	6.6	0.0	0.0	27.3	31.5	7.1	5.6	9.7
Barracuda	15.9	18.2	9.7	1.7	11.3	0.0	0.0	0	17.2	4.5	15.4	6.1
Queenfish	1.3	6.1	10.6	2.9	10.3	0.0	0.0	6.8	29.1	3.2	12.6	17.1
Fullbeaks	3.0	45.6	5.2	1.5	0.0	0.0	0.0	1.1	34.8	2.1	1.5	5.2
Dolphinfish	6.9	47.6	0.8	0.8	7.7	0.0	0.0	0	31.4	2.6	1.1	1.1
All LPF	3.7	3.6	2.5	1.8	6.3	0.0	0.0	26.8	34.3	6.5	4.2	10.3

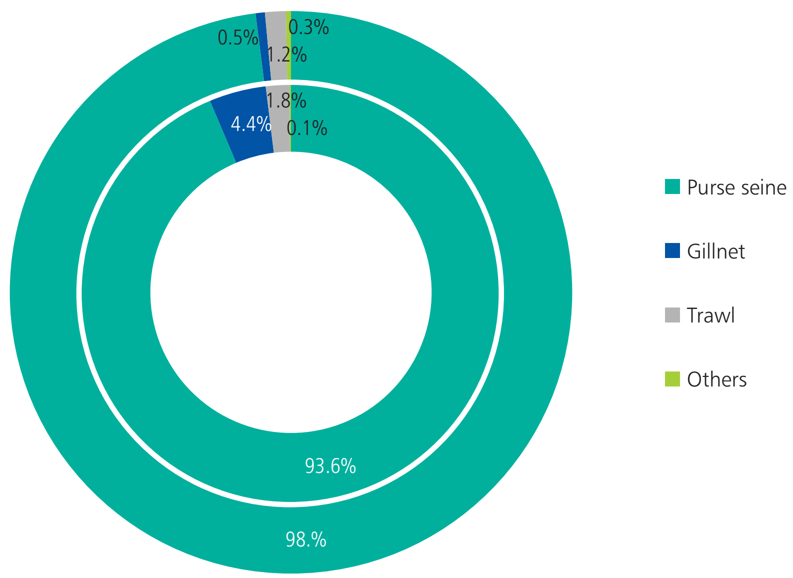

Fig.2. LPF landings by different gears during 2007-2012 (Phase-I, Inner circle) and 2013-2019 (Phase-II, Outer circle) in Goa

Table 3. Landing centres, types of boats operated and landings of large pelagic fishes

Landing centre	Boats operated	LP species		
Cutbona Vasco Da Gama Talpona Mahlim Baina-Bimber Pale and Colva	Purse seines, Trawl, Gillnet, Shore seines	Seerfish	:	*Scomberomorus commerson* and *S. guttatus*
		Tunas	:	*Euthynnus affinis, Auxis thazard, A. rochei* and *Thunnus albacares*
		Barracudas	:	*Sphyraena obtusata, S. putnamae, S. jello* and *S. barracuda,*
		Queenfish	:	*Scomberoides tol, S. tala* and *S. commersonianus*
		Fullbeaks	:	*Ablennes hians, Strongylura strongylura* and *Tylosurus crocodilus*
		Cobia	:	*Rachycentron canadum*
		Dolphinfish	:	*Coryphaena hippurus*
Harmal Mandremvado Baga Carandalem Dona Paula Siridona Cansaulim Utroda	Gillnet, Trawl and Shore seines	Seerfish	:	*Scomberomorus commerson, S. guttatus*
		Tuna	:	*Euthynnus affinis, Auxis thazard, A. rochei*
		Barracuda	:	*Sphyraena obtusata, S. putnamae*
		Cobia	:	*Rachycentron canadum*
		Dolphinfish	:	*Coryphaena hippurus*

Table 4. Species composition of large pelagic fishes landed in Goa and their % contribution

Fish species	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Seerfish													
S. commerson	63.6	55.5	99.8	49.4	95.9	99.7	97.0	99.5	94.0	62.3	72.4	81.3	79.8
S. guttatus	36.4	44.5	0.2	50.6	4.1	0.3	3.0	0.5	6.0	37.7	27.6	19.7	20.2
Tuna													
A. rochei	5.3	0	0.2	0	0	0	0.0	3.8	0	34.3	77.2	39.2	5.5
A. thazard	90.0	100	99.8	100	78.6	10.6	1.9	9.0	0	0	4.3	60.6	0.4
E. affinis	4.7	0	0	0	21.4	89.4	98.1	87.2	100	65.3	18.3	0.2	54.3
T. albacares	0	0	0	0	0	0	0	0	0	0.4	0.1	0	0
T. tonggol	0	0	0	0	0	0	0	0	0	0	0	0	39.9

Fig.4. *E. affinis* that emerged as a dominant tuna species post 2010

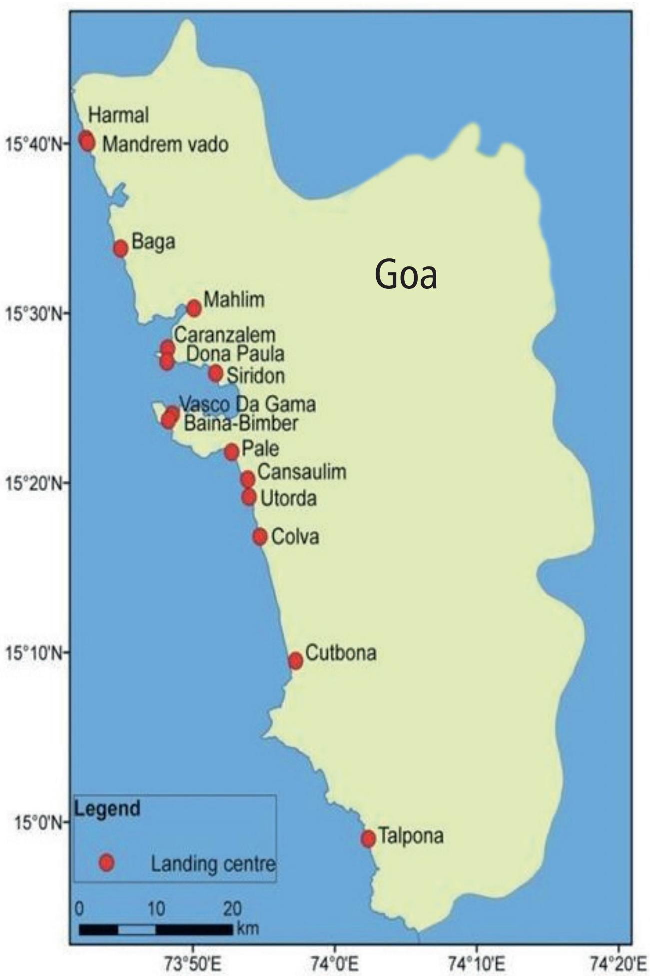

Fig. 3. Major and minor landing centers where Large pelagic fishes are landed along Goa Coast

gillnetters and trawlers land LPF in good quantity. Seerfish, neritic tunas and barracudas were landed in some minor landing centres where outboard gillnets, small trawl boats

Fig.5. Dolphinfish *Coryphaena hippurus*

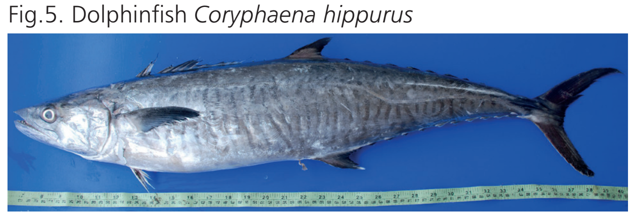

Fig.6. Seerfish *Scomberomorus commerson*

and shore seines operate (Table 3 & Fig.3).

Catch trend and species composition indicated among two species of seerfish landed in Goa, *Scomberomorus commerson* was dominant in almost all the years except in 2010. Among the four species of tunas landed, *Auxis thazard* was the dominant species and contributed 90-100% of the total tuna landing during 2007-2010 period. However, during 2011 -2016 period *Euthynnus affinis* emerged as the major species (Table 4 & Figs. 4-6).

The facilities available for onboard handling are minimal in single day fishing crafts while mechanised fishing vessels such as multiday trawlers, purse seiners and gillnetters have fish hold tanks to preserve the fish with ice. However even here, awareness of fishermen on importance of proper on-board handling of fish is poor and training needs are flagged.

Harvesting of microalgae *Nannochloropsis oculata* by electroflocculation

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Abstract

Harvesting of biomass from microalgal culture needs high energy inputs, as small algal cells need to be separated from a large volume of surrounding media. The biomass harvest of *Nannochloropsis oculata* was evaluated using electroflocculation. Different electrodes like Aluminum, Zinc, Copper, Brass and Iron were used as both anode and cathode. The electrodes were connected to DC supply and the flocculation was performed at different voltages viz; 20,40,60,80 and 100 V at constant power (90mA) and time (30 minutes). From the above study, it was concluded that Zinc electrodes performed better with 80% harvesting efficiency at 40V. The flocculated cells by Zinc electrode were 80% viable which was confirmed by inoculating the flocculated cells.

***Keywords**: Electroflocculation, Nannochloropsis oculata, zinc electrodes*

Introduction

The microalgae, *Nannochloropsis oculata* plays an important role in marine finfish larval rearing as major feed for zooplankton like rotifers as well as in green water rearing systems used to maintain the water quality during the hatchery phases. Mass culture of microalgae on a commercial scale is essential to satisfy its huge requirement in the hatchery as well as for biomass production for application as functional food and nutraceuticals (Hu, 2014). Preserved microalgal concentrates are used during the summer months as an alternate source of feed for rotifer culture as well as inoculum to support marine finfish and shell fish hatcheries (Biji *et al.,* 2018).

Nannochloropsis being a temperate species, mass cultures at outdoor can be performed better during the winter months. After cultivation of microalgae on a large scale, there is a need to reduce the volume for concentrating the microalgal cells. Standardizing proper harvesting techniques is of paramount importance and commonly practiced harvesting methods include centrifugation, sedimentation, filtration, flotation and flocculation (Milledge and Heaven, 2013). Among these, flocculation is considered superior and during the process the cells are made to coagulate with the addition of flocculants by which larger particles are produced with higher settling velocity. Chemical flocculation involves using metal salts or polyelectrolytes, pH induced flocculation or bioflocculation with the intervention of bacteria or filamentous fungi are effective to concentrate the microalgae. In electroflocculation, with the use of aluminium electrodes and iron elecrodes, the metal ions released from the sacrificial electrode plays the role of a floculant (Vandamme *et al*., 2011). It is based on the principle that the surface of microalgae is negatively charged and behaves as colloidal particles which can move in an electric field. Once they are attracted towards the anode, they are neutralised and form algal aggregates (flocs), which can be easily be collected. During electrolysis of water, H_2 and O_2 gas in the form of bubbles are produced in the electrodes and this will rise to the surface taking with them the algal aggregates (flocs) and forms a layer of microalgal cells. In this study harvest of *Nannochloropsis* by electroflocculation with various metals at different voltages was tried and evaluated.

Microalgae electroflocculation

Marine microalgae, *Nannochloropsis oculata* culture maintained for larviculture of commercially important marine finfishes was used. was used as the culture medium. The algae were cultured in Conway medium at temperature of 18-21^{0}C, pH of 7.8-8.4, salinity of 23-25ppt and light intensity of 2000lux and culture in its exponential phase was used for the electroflocculation study. Five metals electrodes viz., comprising Zinc (Zn), Aluminium (Al), Copper (Cu), Brass and Iron (Fe) were used individually as both cathode and anode. The anode and cathode were placed at a distance of 7cm with depth of immersion of the plat es as 5cm. The experiment was performed in 1000ml capacity graduated beaker using 900ml of microalgae culture. The beaker was placed on a stirrer and the culture was gently stirred with a magnetic stirrer. The electrodes were connected to a DC power supply and the voltage was adjusted to 20, 40, 60, 80 and 100V with the current kept constant at 90mA. After 30 minutes the stirrer was stopped and the flocculated cells pulled up with the current formed a layer (Fig.1). The supernatant solution was siphoned out and the flocculated cell layer was collected by centrifugation, weighed and kept for further study. The flocculated cells collected with different metals as electrodes at different voltage were checked for its viability and were inoculated again for its reproducibility by estimating their cell counts.

Among the different metals used, Zinc performed better with 80% harvesting efficiency at 40V (Table 1), followed by the same metal at 100 V (57%). Copper electrode

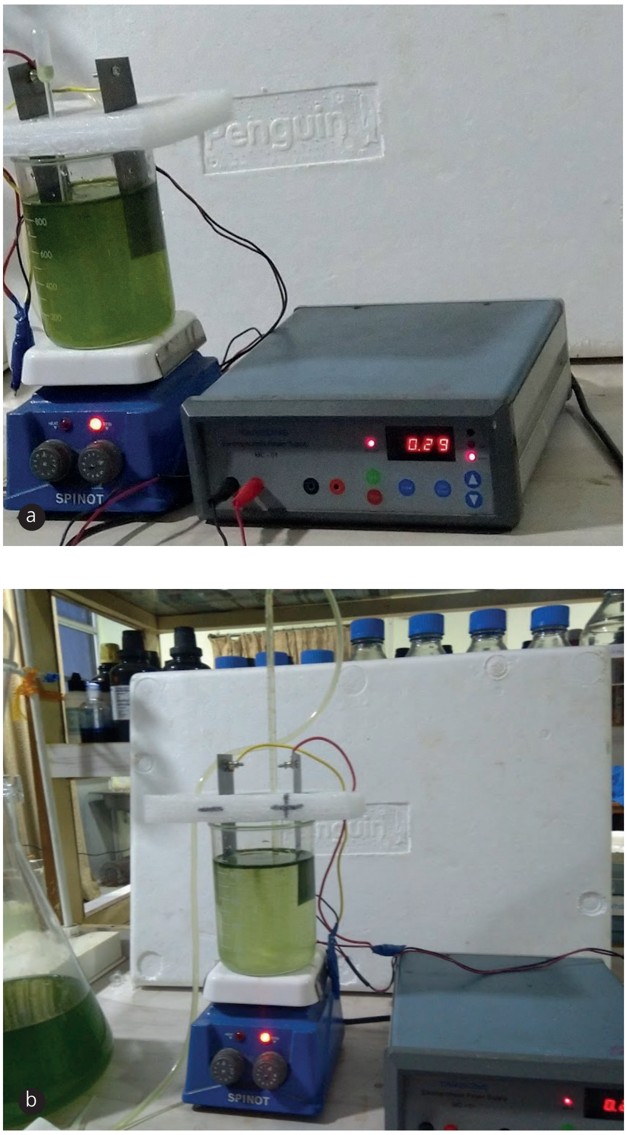

Fig.1. The electroflocculation process for *N.oculata* culture. a. Before electrofloculation and b. After electrofloculation

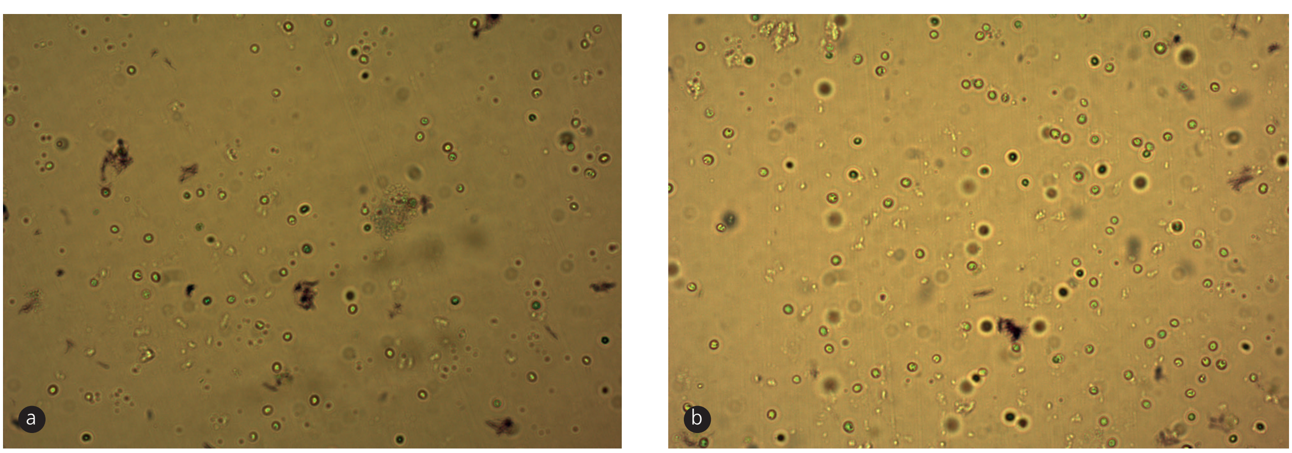

Fig 2. Flocculated *Nannocholoropsis* cells after Evan's blue staining following electroflocculation with Zn electode at 40 V (a) and 100 V (b)

Table 1. Cell count and harvesting efficiency before and after electroflocculation by electrode metals at different voltages

Metal	Voltage	Cell count before flocculation millions (10^6)/ml	Cell count of after flocculation billions (10^9/ml)	Harvesting efficiency (%)
Zn	20V	24	6.48	30
	40V	24	9.68	80
	60V	24	5.32	25
	80V	18	12.9	44
	100V	18	9.84	57
Cu	20V	32	8.32	29
	40V	32	6.16	21
	60V	32	5.12	18
	80V	28	10.8	37
	100V	28	9.36	32
Br	20V	40	4.2	12
	40V	40	6.24	17
	60V	40	7.3	20
	80V	40	9.6	27
	100V	40	9.0	25
Al	20V	32	6.8	24
	40V	32	9.6	33
	60V	32	9.52	33
	80V	32	8.36	29
	100V	32	4.0	14
Fe	20V	28	7.9	31
	40V	28	1.92	7.6
	60V	28	8.4	33
	80V	28	8.84	35
	100V	28	7.68	30

Note: cell count was estimated from 900ml of *Nannochloropsis* culture before and after flocculation.

showed maximum harvesting efficiency of 37% at 80V. Other metals like Brass and Fe, the flocculation efficiency was 27% and 35% respectively. When Cu, Brass and Fe were used, the coagulated cells settled at the bottom and were not lifted up. When Al was used, the algal cells flocculated and some were lifted up, but most settled at the bottom with a white precipitate. Aluminium electrode showed a maximum harvesting efficiency of 33% at 40V and 60V.

Cell viability test

Evan's Blue stain was used for testing the cell viability of the flocculated *Nannochloropis* cells. For staining, a 20 mL sample of each fresh or stored algal suspension was treated with 1 mL of 1% (w/v) stock solution of Evan's Blue. The samples were allowed to stand at room temperature for a minimum of thirty minutes before microscopic examination. A subsample of each stained suspension was then inspected at 250 X magnification using an Improved Neubauer Haemocytometer (Superior Co., Berlin, Germany).

Zinc performed better with superior viability at different voltages compared to other metals. During the Evan's blue staining, most of the *Nannochloropsis* cells were greenish in colour and were hence not stained (80% viability). For other metals, the flocculated cells were with less percentage of viability (<5%).

Inoculation of flocculated *Nannochloropsis* culture

Pre-treated sea water passing through slow sand filter and UV filter and further treated with ozone was used. The flocculated microalgal cells, to be used as inoculum were diluted and mixed properly with the help of magnetic stirrer to ensure the uniform distribution of individual cells. The initial cell count was maintained at $5x10^5$ cells /ml. These were cultured at temperature of $18\text{-}21^0$C, pH of 7.8-8.4, salinity of 23-25ppt and light intensity of 2000lux on Conway medium. Cell count was estimated after 7 days of inoculation. Among the various metal electrodes used, zinc electrode performed better with a maximum cell count of $8.5x10^6$/ml at 80V. Aluminium and iron electrodes could reach a maximum count of $5.0x10^6$/ml. The cell count in *Nannochloropsis* cells flocculated with copper and brass electrodes did not increase after inoculation of the flocculated cells. Further studies are required for its commercial application in fish hatcheries.

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Demonstration of scientific farming of flathead grey mullet among tribal fishers of Balasore, Odisha

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Abstract

The flathead grey mullet *Mugil cephalus* has good market demand in Odisha yet the farming of this fish is minimal. Scientific capture based farming both in cages and coastal saline ponds was initiated under a Tribal Sub-Plan (TSP) programme operated in ICAR-CMFRI and small-scale fishers belonging to Bhumija tribe of Jugadiha village in Balasore district of Odisha were trained for this. 3200 fingerlings of grey mullet of 20-45 g body weight each and measuring 7-18 cm in total length were procured and stocked in ponds during October 2019. Acclimatized seeds were released in square GI cage (6 x 6 m) in November 2019. Feed prepared with wheat flour and ground nut oilcake as well as floating pellet feed was given @ 5% of body weight. After eight months culture period, a harvest of about 480 kg of grey mullet along with 20 kg of various local shrimp species was obtained from the ponds which provide the tribal fish farmers an additional income of ₹153,000 which proved helpful during the economically tough times during COVID-19 pandemic.

Keywords*: Mullet, Mugil cephalus, cage farming, TSP*

Introduction

The flathead grey mullet *Mugil cephalus* Linnaeus, 1758 is a species found in diverse habitats of marine, brackish and even freshwater. The species is hardy and can survive in waters with a wide range of dissolved oxygen levels. The larvae are planktivorous while juveniles and adults feed mainly on detritus and benthic microalgae. In Odisha various fishing gears such as gill nets, cast nets, shore seines and stake nets capture the grey mullets. Among the several species of mullets contributing to the fishery along Odisha coast *M. cephalus* is most sought after as a table fish and commands good market value. Adults are mostly targeted by small-scale fisheries and juveniles collected from coastal waters and estuaries can be utilized for capture based aquaculture. Even though market demand for mullets in Odisha and neighbouring West Bengal is substantial, the farming is still not widespread. Successful demonstration of the scientific farming of *M. cephalus* in both open sea cage and coastal pond through Tribal Sub-Plan (TSP) and training of the selected members from tribal community engaged in small scale fisheries of Balasore district, Odisha for their socio-economic development was achieved. The important aspects of a successful fish farming venture include suitable site selection, proper designing of cages/ponds, selection of species, proper stocking size and density, feeding and maintenance which was demonstrated during this farming trial.

Mullet farming in cages

Under the Tribal Sub-Plan (TSP) programme of Government of India aimed at the socio-economic development of tribal communities of the country sixteen members of the Bhumija Tribes of Jugadiha Village, Baliapal Block of Balasore District were identified. A self-help group (SHG) named *Nilamadhab Matsyajibi Swayam Sahayak Gosthi* was formed and using locally available seed resources of *M. cephalus* aquaculture in GI cage was initiated. The cage site was located in the Subarnarekha estuary, Balasore having a depth of about 8 m even during low tide. A nursery rearing cum reserve pond of 0.3 ha was arranged for seed acclimatization. The pond was prepared before stocking of seed following the standard methodologies of total drying and ploughing, application of 750 kg of cow dung and saline water nearly 5-8 ppt from the estuary while maintaining the water depth of 1 to 1.5 feet and allowing ten days for growth of natural food in the pond. Later, the water level was increased to 5 to 6 feet and stocked with 3,200 wild caught fingerlings of *M. cephalus* (7-18 cm total length, 20-45 g body weight) procured from a farmer of West Bengal (Fig. 1). Mustard seed oilcake (25 kg) with raw cow dung (10 kg) made to slurry and chemical fertilizers (SSP @ 1.5 kg) was applied at regular interval of 30 days for production of natural food. Seeds were acclimatized to the pond salinity, local condition and artificial feed prior to stocking in cage. Fishes were fed with 5% of their body weight daily in two split doses during early morning and afternoon. Wheat flour, ground nut oil cake with floating artificial pelleted feed (containing 28-30% protein) was used as supplementary feed during the acclimatization in pond.

Cage fabrication, installation, seed stocking, feeding and cage maintenance were demonstrated. All inputs for culture including the square GI cage (6 x 6 m) with al 2 sets of outer, inner and bird protection nets, mooring, floats and surveillance facilities were provided. The cage was moored

Fig.1. Wild caught mullet fingelings for stocking in cages

Fig. 2. Cage fabrication in progress

with bunch of concrete blocks and acclimatized advanced fingerlings from the rearing pond were sorted and stocked during November, 2019 (Figs. 2&3). Regular fortnightly monitoring of health and growth with all technical support and guidance was extended by the TSP team of of ICAR -CMFRI. Exchange of outer and inner nets and cleaning and the daily feeding of fishes was done by the SHG members. A harvest mela organized on 2nd June 2020 provided about 370 kg of *M. cephalus* (each weighing 400 to 650 g). Additional of mixed shrimp species was also harvested from the nursery pond. The catch was sold to the local vendors and auctioning agents at price of ₹280 to 300 per kg and members earned additional income of ₹153,000, helping them considerably by providing an additional livelihood support (Fig. 4,5 & 6).

The activity can also be continued in saline shrimp ponds of adjacent coastal areas as several youth and women show their inclination to adopt the capture based aquaculture of *M. cephalus* when provided with inputs, training and regular monitoring scientifically. The poor and first time fish farmers are also more interested to culture mullet in unutilized ponds rather than cages.

Fig.3. Fixing of nets on cage frame

Fig.4. Harvest in progress

Fig.5. Mullets harvested from cage

Fig.6. *Mugil cephalus* harvested after capture based aquaculture process

Impact of Cyclone *Amphan* on marine fisheries of Odisha

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Introduction

Odisha has a coast line of 480 km with six coastal districts: Ganjam (60 km coast line), Puri (155 km), Jagatsinghpur (67 km), Kendrapara (68 km) Bhadrak (50 km) and Balasore (80 km. With 813 fishing villages and a fisherfolk population of six lakhs (CMFRI, 2010) marine fisheries of Odisha has an important role in the socio-economic development of the state.

The east coast of India is one of the six most cyclone prone areas and of the 1019 cyclonic disturbances that occurred in India during the last 100 years, 890 alone were over the east coast. An area of low pressure was developed in the south-eastern Bay of Bengal about 1,020 km to the south-east of Visakhapatnam, Andhra Pradesh on 13th May, 2020 and in due course of time it became a cyclonic storm where it was named as *Amphan*. On 17th May, 2020 the *Amphan* rapidly intensified into an extremely severe cyclonic storm, with an increase in wind speed from 140 km/h to 215 km/h. The *Amphan* made its landfall in West Bengal on 20th May, 2020. It was a powerful and deadly tropical cyclone that caused widespread damage in eastern India, specifically northern Odisha, West Bengal and Bangladesh. In the present communication, a preliminary assessment of the damage to marine fisheries along Odisha coast has been made based on the information collected from various sources such as telephonic discussion with local Fishery Officers, fishermen, reports of Odisha fishery department, reports from Special Relief Commissioner, Government of Odisha and other media sources.

Economic losses and Damage assessment

Only four districts of Odisha namely Jagatsinghpur, Kendrapara, Bhadrak and Balasore were affected severely by Cyclone *Amphan* and ₹10,59,57,000 was estimated as financial losses in marine fisheries sector (Table 1).

Table 1. Amphan cyclone- Preliminary damage assessment of damage to marine fishery in Odisha (₹)

Item damaged	Approx. Financial Loss (₹)
Crafts	9,96,000
Katcha Houses	4,60,000
Marine Fishery Infrastructure	12,00,000
Employment and income loss of fishermen	7,68,00,000
Employment and income loss of marketing and processing persons	2,65,00,000
Health Loss	1,000
Total	10,59,57,000

Source: Estimated from various Government sources

Table 2. Loss estimated due to craft damage

District	Loss due to Partially damage of Mechanized Trawler per unit ₹20,000. (Approx.)	Loss due to Partially damage of IPBB/ OBFT* per unit ₹ 8,000. (Approx.)	Loss due to Fully damage of NPBB** per unit ₹40,000. (Approx.)	Loss due to Partially damage of NPBB** per unit ₹5,000. (Approx.)	Total
Jagatsinghpur	1,40,000 (7)	32,000 (4)	Nil	80,000 (16)	2,52,000 (27)
Kendrapara	Nil	1,20,000 (15)	Nil	Nil	1,20,000 (15)
Bhadrak	20,000 (1)	56,000 (7)	Nil	10,000 (2)	86,000 (10)
Balasore	4,00,000 (20)	48,000 (6)	40,000 (1)	50,000 (10)	5,38,000 (37)
Total	5,60,000 (28)	2,56,000 (32)	40,000 (1)	1,40,000 (28)	9,96,000 (89)

*IPBB- inboard plank built boat
*OBFT-outboard fibre *teppa*
**NPBB-Non-motorized plank built boat
Figures in bracket indicate number of units.

There were no losses recorded due to damage of fishing gears and losses of craft damage are tabulated in Table 2. The highest numbers of partially damaged crafts were recorded for Balasore District (36) followed by Jagatsinghpur (27), Kendrapara (15) and Bhadrak (10) whereas, only one fully damaged craft was recorded in Balasore and total loss estimated at ₹9,96,000 (Table 2).

About 115 kuchha houses were damaged during the cyclone with highest number recorded for Balasore (45) followed by Kendrapara (30), Jagatsinghpur (25) and Bhadrak (15) and total losses estimated at ₹4,60,000 (Table 3).

About ₹12 lakhs was estimated as losses for marine fishery infrastructure. Partial damage of Paradeep fishing harbour, Jagatsinghpur whereas, severe damage recorded for Dhamara fishing harbour, Bhadrak was estimated (Table 4).

Employment and income loss of fishermen: Altogether 19,200 fishermen were affected due to the cyclone across the four coastal districts of Odisha with highest record for Kendrapara followed by Balasore, Jagatsinghpur and lowest was for Bhadrak district. Due to the advance warning of India Meteorological Department (IMD) and local administration, fishermen were not allowed for fishing and other activities since 15.05.2020.They have lost their income/livelihood nearly 10 days from 15th to 25th May, 2020. The total employment and income loss to traditional fisherman of Odisha due to *Amphan* Cyclone was estimated about ₹7,68,00,000. Highest loss

Table 3. Loss of Kuchha house damage due to Amphan Cyclone in Odisha

District	Loss due to partially damage of kuchha house *
Jagatsinghpur	1,00,000 (25)
Kendrapara	1,20,000 (30)
Bhadrak	60,000 (15)
Balasore	1,80,000 (45)
Total	4,60,000 (115)

Note: Figures in bracket indicate number of units.
*per unit ₹4000 (Approx.)

Table 4. Loss of Marine fishery infrastructure due to Amphan Cyclone in Odisha

District	Type of infrastructure	Extent of damage	Amount required for restoration (₹) (Approx)
Jagatsinghpur	Roof, doors and windows of auction hall of Paradeep Fisheries Harbour.	Partially	5,00,000
Kendrapara	Nil	Nil	Nil
Bhadrak	Roof, Glass and gate of Dhamara Fisheries Harbour, Bhadrak.	Severely damaged	7,00,000
Balasore	Nil	Nil	Nil
Total			12,00,000

Table 5. Employment and income loss of traditional fisherman of Odisha due to Amphan Cyclone

District	Fishermen affected	Days lost per fishermen	Average income per day (₹)	Total Employment lost (man days)	Total income loss (₹)
Jagatsinghpur	~4,300	10	400	43,000	1,72,00,000
Kendrapara	~6,400	10	400	64,000	2,56,00,000
Bhadrak	~3,800	10	400	38,000	1,52,00,000
Balasore	~4,700	10	400	47,000	1,88,00,000
Total	19,200	10	400	1,92,000	7,68,00,000

Table 6. Employment and income loss of marketing and processing persons related to marine fisheries of Odisha due to Amphan Cyclone

District	Active Traditional Fishermen (Approx.)	Fishermen in auction, trade, small businessmen etc. (Approx.)	Fishermen in Dry Fish and fish processing (Approx.)	Miscellaneous (Approx.)	Total income loss* (₹)
Jagatsinghpur	1000	500	400	100	50,00,000
Kendrapara	1500	750	600	150	75,00,000
Bhadrak	1200	600	480	120	60,00,000
Balasore	1600	800	600	200	80,00,000
Total	5300	2650	2080	570	2,65,00,000

*@₹500 per day for 10 days

for the same was recorded for Kendrapara followed by Balasore, Bhadrak, Jagatsinghpur and lowest was for Bhadrak district (Table 5).

The total employment and income loss of marketing and processing persons was estimated about ₹2.65 lakhs with highest loss in Balasore followed by Kendrapara, Bhadrak and Jagatsinghpur districts (Table 6).

More than 1.4 lakh people were shifted to shelters in coastal Odisha. The Odisha Government took a more targeted evacuation approach than during previous cyclones where more widespread evacuations were made thereby minimising damage to life. No cases were recorded for the damage of hatchery and mariculture activities across the four districts. Damage to electricity lines were restored by the distribution agency within 3 to 4 days of cyclone and no major damages for drinking water were recorded during the period.

Brief Communications

Impact of Cyclone *Amphan* on marine fisheries of West Bengal

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West Bengal has three coastal districts, namely, North 24-Praganas, South 24-Praganas and East Medinipur with a coastline of 158 km. With 59 marine fish landing centres, 76,981 fishermen households comprising of 3.8 lakh fisherfolks who are mostly traditional fishermen (Marine Fisheries Census, 2010) West Bengal contributes about 6-8% of the total marine fish landings of India. The predominantly exploited resources are Bombay duck, anchovies, Hilsa, ribbon fishes, sciaenids, pomfrets, catfishes, flatfishes, penaeid and non-penaeid prawns. Cyclones and storm surges are frequently occurring natural calamities in the state. On 20th May, 2020 the super cyclonic storm, *Amphan* caused wide spread damage whose provisional estimates of damage in the marine fisheries sector of West Bengal is presented. Due to travel restrictions in force to curb the spread of COVID-19, data was mainly collected by interviewing affected stakeholders over video conferencing. The published media reports were also collected and corroborated with the information provided by the Department of Fisheries, West Bengal to arrive at conclusions. The information on fishing crafts and gear loss (fully and partially damaged), infrastructure losses (fully and partially damaged houses), employment and livelihood loss and life loss were collected from secondary sources and also through telephonic conversation with various officials.

The financial losses in the marine fisheries of West Bengal due to the cyclone *Amphan* was estimated at ₹31.77 crores (Table 1).

Losses due to damage of fishing gears were not recorded. District-wise the highest numbers of partially damaged crafts were in South24-Paraganas (549), followed by East Medinipur (344). In no districts were crafts fully damaged and losses due to craft damages across the districts were estimated at ₹1.984 crores (Table 2).

About, 8,188 houses were damaged during the cyclone with highest number recorded for South24-Parganas (7,254) followed by East Medinipur (934) and total losses across the affected districts were estimated at ₹24.872 crores (Table 3).

Table 1. Preliminary assessment of damage to marine fishery in West Bengal (₹Lakhs)

Item damaged	Approx. Financial Loss
Partially damaged trawlers	42.50
Partially damaged motorized gill netters	86.75
Partially damaged non-motorized traditional crafts	69.15
Employment and income loss of fishermen	276.44
Employment and income loss of marketing and processing persons	214.60
Partly damaged houses	1071.20
Fully damaged houses	1416.00
Total	3176.64

Data Source: Enumerators, Survey personnel and officials of Department of Fisheries, Govt. of West Bengal

Table 2. Economic loss due to craft damage due to Amphan Cyclone in West Bengal

District	Trawlers (₹ lakhs)	Motorized Gill netters (₹ lakhs)	Non-motorized traditional crafts (₹ lakhs)	Total (₹ lakhs)
East Medinipur	26.00 (52)	41.75 (167)	18.75 (125)	86.50 (344)
South24-Paraganas	16.50 (33)	45.00 (180)	50.40 (336)	111.90 (549)
Total	42.50 (85)	86.75 (347)	69.15 (461)	198.40 (893)

Figures in bracket indicate number of units. Trawlers partially damaged economic loss @₹50,000 per unit. Motorized Gill netters partially damaged economic loss @₹25,000 per unit. Non-motorized traditional crafts partially damaged economic loss @₹15,000 per unit

Table 3. Loss through house damages

District	Partly damaged houses (₹ lakhs)	Fully damaged houses (₹ lakhs)	Total (₹ lakhs)
East Medinipur	18.00 (90)	422.00 (844)	440.00 (934)
South24-Parganas	1053.20 (5266)	994.00 (1988)	2047.20 (7254)
Total	1071.20 (5356)	1416.00 (2832)	2487.2 (8188)

Note: Figures in bracket indicate number of units. Partly damaged houses @₹20,000 per unit. Fully damaged houses @₹50,000 per unit

Table 4. Employment and income loss of traditional fisherman of West Bengal due to Amphan Cyclone

District	Number of fishermen affected	Days lost per fishermen	Average income per day (₹)	Total Employment lost (man days)	Total income loss (₹ lakhs)
East Medinipur	2527	10	400	25,270	101.08
South24-Parganas	4384	10	400	43,840	175.36
Total	6911	10	400	69,110	276.44

Table 5: Employment and income loss in marine fish marketing and processing sector

Name of the district	Active Traditional Fishermen (Approx.)	Fishermen related to auction, trade, small businessmen etc. (Approx.)	Fishermen related to Dry Fish and allied to fry fish processing (Approx.)	Miscellaneous (Approx.)	Total income loss* (₹ lakhs)
East Medinipur	1651	826	660	165	82.55
South24-Parganas	2641	1321	1056	264	132.05

*@₹500 /day for 10 days

Altogether, 6911 fishermen were affected due to the cyclone across the two coastal districts of West Bengal with the highest in South 24-Parganas, followed by East Medinipur. Due to the advance warning of India Meteorological Department (IMD) and local administration, fishermen were not allowed for fishing and other activities since 15.05.2020, which averted the loss of human lives. They have lost their income/ livelihood for nearly 10 days, from 15th to 25th May, 2020 was estimated about ₹2.76 Crores. Highest loss for the same was recorded for South 24-Parganas followed by East Medinipur (Table 4). The total employment and income loss in marketing and processing sectors related to marine fisheries was estimated at ₹2.15 crores (Table 5). There was no information on the damage of marine hatcheries or any mariculture installations across the coastal districts of West Bengal.

The fisher folk highly impacted by the *Amphan* cyclone were mostly first time victims of such a huge cyclone. They suffered loss of craft, damage to houses and employment and income loss and Governmental support (48%) provided was perceived as not enough. Local village committees should be sensitized with appropriate adaptation and mitigation options for dealing with natural disasters. Customized training programmes for increasing the awareness of natural disasters such as cyclones and floods are required as in recent years they are predictable with a reasonable degree of certainty.

Heavy landing of *Charybdis smithii* and need for proper utilization

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Heavy landings *of Charybdis smithii* during the January to March, 2020 was documented in Mangalore fisheries harbour. These crabs were the part of trawl discards as geo-coded *in situ* data collection on trawl discards showed that *C. smithii* was available along Karnataka coast during August to December and in May as pelagic or semi-pelagic shoals from a depth range of more than 100 m. Landing of this species in Fisheries Harbours was generally rare since there was very limited market demand for these crabs. Unprecedented, heavy landings of *C. smithii* in Mangalore Fisheries Harbour and studies thereof is communicated. On 24 January, 2020, ten trawlers landed an estimated catch of 2 tonnes *C. smithii*. In earlier years, these crabs

Figure.1. *C. smithii* landing in Mangalore Fisheries Harbour

were not accepted by fish meal industry and were used only for drying purpose. However in year 2020, *C. smithii* was accepted by fish meal units, @ rate of ₹10 per kilogram (kg) initially and the procurement price increased to ₹13 per kg, when these crabs were landed in good quantity. On February 5th, 2020 15 boats landed each with approximately 500kg and by the second week of February the average landing of *C. smithi* per boat was 200 to 650kg. On 13 February, 2020 above 10 t of crabs were landed by 25 trawlers and this trend extended till end of February. On 28 February, heavy landing of *C. smithii* with a catch rate ranging from 650 to 1,500kg per trawler, which incidentally formed more than one fourth of the total multiday trawlboats' landings of the day was observed. With increase in quantity of landing, the procurement price for the crabs were hiked to ₹13/kg. On 4th March, 2020, with landing per unit between 1,250 to 1,600 kg approximately 24t of *C. smithii* by 17 multiday trawl units was recorded. Quantity of landing of the species reduced thereafter and by 14 March, 2020 landing reduced to 100 to 200 kg per boat and most of the fish meal plants stopped their procurement and price for the crab was reduced to ₹ 5 per kg. Poor catch of commercial species during this period forced the fishermen to land the crabs considered as a "low value species". Implementation of Minimum Legal Size (MLS) for commercial species and restriction of fishing in shallow coastal waters where juvenile fishes are common, was one of the reasons the fishermen moved to deeper waters for fishing. Shellfishes generally not accepted by fish meal industry, were accepted this year for making supplements for poultry feed and fish feed.

The deep-water brachyuran crab, *Charybdis smithii* inhabits the shelf edge and have a wide distribution throughout the coast. Generally caught from deeper waters, they are mostly discarded in the sea itself due to lack of demand in the market. Mass concentration of this species in the benthic zone of lower continental shelf and upper slope of Indian coasts were well documented as early as the 60s. These crabs play a major role in the trophic structure of the south east Arabian Sea ecosystem by forming a major food of cobia, scombroid fishes, pelagic sharks and other demersal fishes.

Globally, bringing more non-conventional species to meet increasing seafood demand in the markets is evident. Early in 1990s exploratory surveys indicated good prospects of fishery of *C. smithii* and its meat content and proximate studies were estimated. However, regular trawl fishery during that time was restricted within 100m depth, so that the species was not a part of regular trawl catch. From year 2000 onwards the species started appearing on a regular basis while trawling at a depth beyond 100m in trawl catch of Kerala and Karnataka. Even though the meat content is comparatively low (10 to 15%), protein content in *C. smithii* is comparable and even better than that of those of conventional crabs such as *Portunus pelagicus* and *P. sanguionolentus.* The protein content in the meat estimated as 10 to 11% by wet weight (73 to 77% by dry weight), rich in essential amino acid and essential ω -3 and ω -6 fatty acids, which qualifies its meat as excellent for human nutrition. Since the crabs were brought for non-edible purpose, they were brought without proper preservation. If proper preservation, processing and marketing of this species is streamlined, this species will be an asset to meet the crab meat requirements for domestic market as well as meeting the export demand. With proper advisories on preservation and handling, these crabs can become part of the commercial fishery utilised for edible purposes.

Unusual landing of Spine tail devil ray from Andhra Pradesh

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Bandaruvanipeta is a major landing centre near Kalingapatnam in Srikakulam district of Andhra Pradesh and nearly 120-140 motorised fibre *teppa*, 20 to 30 non-motorized fibre *teppa* and *masula* boats (*kuttupadava*) are operated from this base. The major fishing gears used from these boats include gillnets (*Kavvalavala*, *Jogavala*, *Chanduvavala*), drift gillnet (*Panduvala*) and hooks & line (*Jamu thradu*).

Thirty nine individual Spine tail devil rays, *Mobula mobular* (Bonnaterre, 1788) locally called as *Yenuguteku* (sometimes *chinnadeyyapu*) were landed at Bandaruvanipeta landing centre during 06.04.2017 to 10.04.2017. Ranging in size from 111-130 cm disc width, the individual weight of the rays ranged between 12-26 kg (Table 1). Information collected from fishermen confirmed that the rays were caught incidentally in monofilament gillnets (*Jogavala*), a gillnet operated from inboard and outboard fibre *teppa* throughout the year for catching *R. kanagurta*, *Selar* sp., *Alepes* sp., *S. guttatus*, croakers and *Caranx* sp.. The *Jogavala* that caught the rays had a mesh size 5 to 5.5 cm and net length of 250 to 350 m and the net was operated 12 to 20 km away from the shore, in areas of 50-65 m depth, south- east of Kalingapatnam. The fishermen had modified the gear by stitching thermocol pieces on the top of the mother wire for enabling surface drifting of the net. This is locally called *Teluvala* and is operated mostly during April to July. The spine tail devil rays were sold by local auction at a price ranging between ₹35-45 per kg.

Identification of *M. mobular* is based on morphometric characters such as spine on base of tail, dorsal fin white tipped, tail very long, spiracles above anterior margin of pectoral fin (Fig.1). The species give birth to young ones with sizes of such pups ranging from 90-160 cm disc width. Since the animals were caught over 4 days it can be assumed to have been in residence in the area during the time. Further studies would be needed to confirm if this is a regular pup shoaling area for the species since elsewhere the species is known to seasonally aggregate in the same area (Celona, 2004).

Table 1. Morphometric measurements of specimens of *Mobula mobular* landed at Bandaruvanipeta

	06.04.2017			07.04.2017		08.04.2017	
Character	1	2	3	1	2	1	2
Disc length (cm)	56	52	54.5	57	50	58	48
Disk width (cm)	128	120	125	130	117	128	111
Length of mouth (cm)	18	16	17	18	15	18	13
Width between cephalic fins (cm)	21	19.5	20.5	21	19	20	17
Length of head (cm)	24	21	19	20.5	20.5	20	19
Length of tail (cm)	102	116	105	122	108	118	102
Sex	F	M	F	F	M	M	M
Weight (kg)	23	18	20	26	13	22	11
Auction price (₹)	900	500	750	1100	400	1000	400
Per Kg price (₹)	30-45	30-45	30-45	30-45	30-45	30-45	30-45

An important biological factor that makes devil rays vulnerable to overfishing is that they produce only one young each pregnancy and hatch eggs inside their body giving birth to a single pup after an extended gestation of approximately one year which is followed by a prolonged interval to another breeding cycle. These life history traits along with their vulnerability as bycatch led to the IUCN declaring it as an "Endangered" species (Marshall *et al*., 2019). The species is also listed under Appendix II of CITES wherein its international trade is monitored. In India, there is no targeted fishing of mobulids but it occurs mostly as incidental or bycatch. The gill rakers of mobulid rays are in demand in China, Singapore and Japan and dried gill rakers and livers form an export item. The salted and dried flesh of the rays along with their livers are usually transported to Chennai and Kerala for consumption.

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Kaleidoscope

New distributional record of spiny lobster *Panulirus longipes longipes*

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Among the known species of spiny lobsters in India, *Panulirus longipes longipes* is striking due to its colorful appearance. Globally, fishery of this species is of low volume distributed along eastern Africa to Thailand, Taiwan, Philippines, Indonesia and India. Purely marine inhabiting up to a depth of 130 m it is mostly found within 18 m depth along shallow coral reefs or rocky sea bottom. Live lobsters of this species occasionally exported from the Philippines and Indonesia. On 15 June 2020, during the visit to a live lobster holding center functioning at Vizhinjam in Thiruvananthapuram district of Kerala, one male specimen of *P. longipes longipes* having 158 mm length and 150 g weight was noticed along with *P. homarus* stock. Upon enquiry, it was understood that the lobster was brought by one of the fishermen operating bottom set gill nets in the adjacent coastal waters where they regularly fished within 18 m depth. This live specimen was acclimatized for 1 day in a syntax tank filled with filtered sea water, provided with aeration and was subsequently transferred into one of the display glass tanks placed in the Marine Research Aquarium. In India, the concept of using lobsters as ornamentals in Marine Aquariums and in the ornamental fish trade sector are not quite popular. Calado *et al*. (2003), enlisted seven species of tropical Palinurid lobsters traded in marine aquarium industry wherein average price of one of its counterpart, the painted spiny lobster *P. versicolor* reported as ₹2647 per specimen.

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Whale shark landed in Sakthikulangara Fisheries Harbour

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Fig. 1. An immature female whale shark landed at Sakthikulangara Fisheries Harbour

An immature female whale shark *Rhincodon typus* accidently caught by a multiday trawler on 19th August 2019 was landed on the same day at Sakthikulangara Fisheries Harbour (Fig. 1) Listed as an endangered species by International Union for Conservation of Natural Resources, locally the shark is known as '*pullisravu*.' The whaleshark measured 265cm and weighed approximately 250kg. As there was no buyer for this species which is protected under the Indian Wildlife (Protection) Act, 1972, the carcass was discarded into the sea.

The morphometric measurements are given below:

Total length	:	267 cm
Standard length	:	195 cm
Snout vent length	:	139 cm
Anal length	:	166 cm
Length of dorsal caudal space	:	26 cm
First dorsal length	:	122 cm
Second dorsal length	:	167 cm
Caudal fin length	:	122 cm
Pre pelvic fin length	:	32 cm
Pre pectoral fin length	:	56 cm
Inter dorsal space length	:	27 cm
Pre branchial length	:	44 cm

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Taylor *et al*., 1998. *Aquaculture*, 162: 219-230. (Reference with more than two authors)

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