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MFiS

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Pseudanthias pillai landed by deep-sea trawlers at Kollam, Kerala (Photo credit: Kishor, T.G.)

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 greetings to all

We welcome the esteemed readers to this issue of MFIS with a bouquet of articles on various facets of the marine fisheries sector in India. The National Policy on Marine Fisheries (NPMF), 2017 notified by the Government of India on 28th April, 2017 provides guidance to usher in a Blue Revolution. This involves the sustainable utilization and management of the marine fish stocks occurring in the Indian Exclusive Economic Zone (EEZ) of 2.02 million square kilometres through suitable fisheries governance protocols. Successful fishery management ensures sustainability for fish stocks, food for consumers, and livelihood for those in the industry. In this context, the lead article explores the various facets of marine fisheries governance in India, in the realm of Marine Spatial Planning and conforming to the FAO's voluntary Code of Conduct for Responsible Fisheries (FAO-CCRF). Timely availability of credit is of crucial importance in the fisheries sector. The findings of a case study on fishery credit delivery system in Kerala gives several valuable insights that will help in formulation of appropriate policies for the benefit of all stakeholders and bring about economic development in the sector. Bivalve farming with its ample scope to bring good financial returns and livelihood options attracted the attention of fish farmers but availability of seeds of the right quality and adequate quantity was always a serious constraint. The development of an indigenous micro-nursery system with a proven capacity to produce seeds on a large scale is a cherished achievement of ICAR-CMFRI. It has opened the door for a wider adoption of the bivalve farming in the country. The various facets of marine fisheries sector has also been captured in the various research and short communications presented in this issue of MFIS.

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Contents

Lead Paper

Integrated spatial management of marine fisheries of India for more robust stock assessments and moving towards a quota system

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Abstract

In order to overcome the challenges in administering and regulating marine fisheries in the Indian EEZ under central government administration (area 1.86 million km^2, which is 92% of the total 2.02 million km^2), a zonal management system is proposed. Besides the Territorial Waters (TW) zones regulated by maritime states, the broad marine biogeographic area of the Indian subcontinent were divided into 4, the northwest coast (northeast Arabian Sea - NEAS), southwest coast (southeast Arabian Sea - SEAS), southeast coast (southwest Bay of Bengal - SWBOB) and the northeast coast (northwest Bay of Bengal - NWBOB). There are 13 maritime states based TW zones and 6 regional zones (4 mainland and 2 island) in this proposed plan for fisheries management. The straightening of the coastline through notified baseline points for determining the breadth of TW and EEZ has resulted in 0.11 million km^2 of internal waters which are not under any regulations. All these zones are planned to be placed under co-management through specific fisheries management councils as advocated by the National Policy on Marine Fisheries 2017. Besides, the catch and effort data reporting, stock assessments and fisheries management under the new regime are highlighted. In fisheries management, a switch to a total allowable catch (TAC) and quota system is recommended. The advantages of zonal management, TAC system and fleet wise quotas are discussed.

Keywords: Marine fisheries, zonal management, TACs, quota system

Introduction

India's newly crafted National Policy for Marine Fisheries (NPMF, 2017) states the need for area specific management of fishery resources. Article 8 and 12 of the policy clearly states the need for species specific and area specific management plans and creation of fisheries management areas to ensure that resource depletion is contained. As per the Constitution of India, 'division of subjects', fishing within the 12 nautical mile (territorial waters) is to be regulated and managed by respective maritime states. The area outside the 12 nautical mile (nmi) zone up to the 200 nautical mile of the Exclusive Economic Zone (EEZ) is mandated to be managed by the Union Government. All maritime states of India have fisheries regulatory acts to govern fishing in their territorial waters. However, the act to govern the centrally administered area is yet to be put in place. The area of Indian EEZ under the central administration is 1.86 million km^2 (which is 92% of 2.02 million km^2 EEZ). The areas which are under maritime state administration are shown in Table 1.

At present the area under central administration is very large and administration and regulation of fisheries in such a large area is a challenging task. Zonal management is a way to delineate areas of the coastal and marine environment to specific allowable or prohibited activities in time or space. Zonal management is very different from the longstanding concept of open access to the seas and oceans. Different forms of zoning have occurred on land for thousands of years, and there have been traditional

and customary marine tenure systems in certain locations throughout history as well. It is only more recently that formally planned zonal management systems are being applied to marine and coastal areas around the world. Some examples are the fisheries management councils and zones in the USA, European Union, Australia and New Zealand among developed countries, and the fisheries management areas in other countries like Indonesia, Thailand and Malaysia. All the Marine Fisheries Regulation Acts (MFRAs) of Indian maritime states allow for specific zones reserved for traditional fishers for protecting their livelihoods and customary rights. The NPMF (2017) encourages maritime states to extend this zone up to the limit of territorial waters (12 nmi), although none of the states have currently done so.

Much earlier, regional fisheries management outputs were recognized as a solution to the country's diverse and vast coastline, multi-species and multi-gear nature of fisheries (Vivekanandan *et al*., 2003). Consequently, from 2005 onwards, the ICAR-CMFRI reorganized its fisheries resource assessment projects revolving around each maritime state, with the main objective of developing state-wise Fishery Management Plans (FMPs). This resulted in development of FMPs for the states of Karnataka (Rohit *et al*., 2016); Andhra Pradesh (Muktha *et al*., 2018), Tamil Nadu, Maharashtra and Gujarat (all to be published) under the guidance of the Marine Policy Cell of ICAR-CMFRI.

Depending on the resource distribution, abundance and degree of overcapacity, already more than 70% of India's marine fish landings are taken from the centrally administered 12-200 nmi zone by boats operating from all fish landing ports in India (Mohamed *et al*., 2014; Dineshbabu *et al*., 2017). It is also a fact that these vessels currently are not given a license to operate in the specific area, although they are all registered with the Department of Fisheries (Ministry of Fisheries, Animal Husbandry and Dairying-MoFAHD). Also, these vessels often land

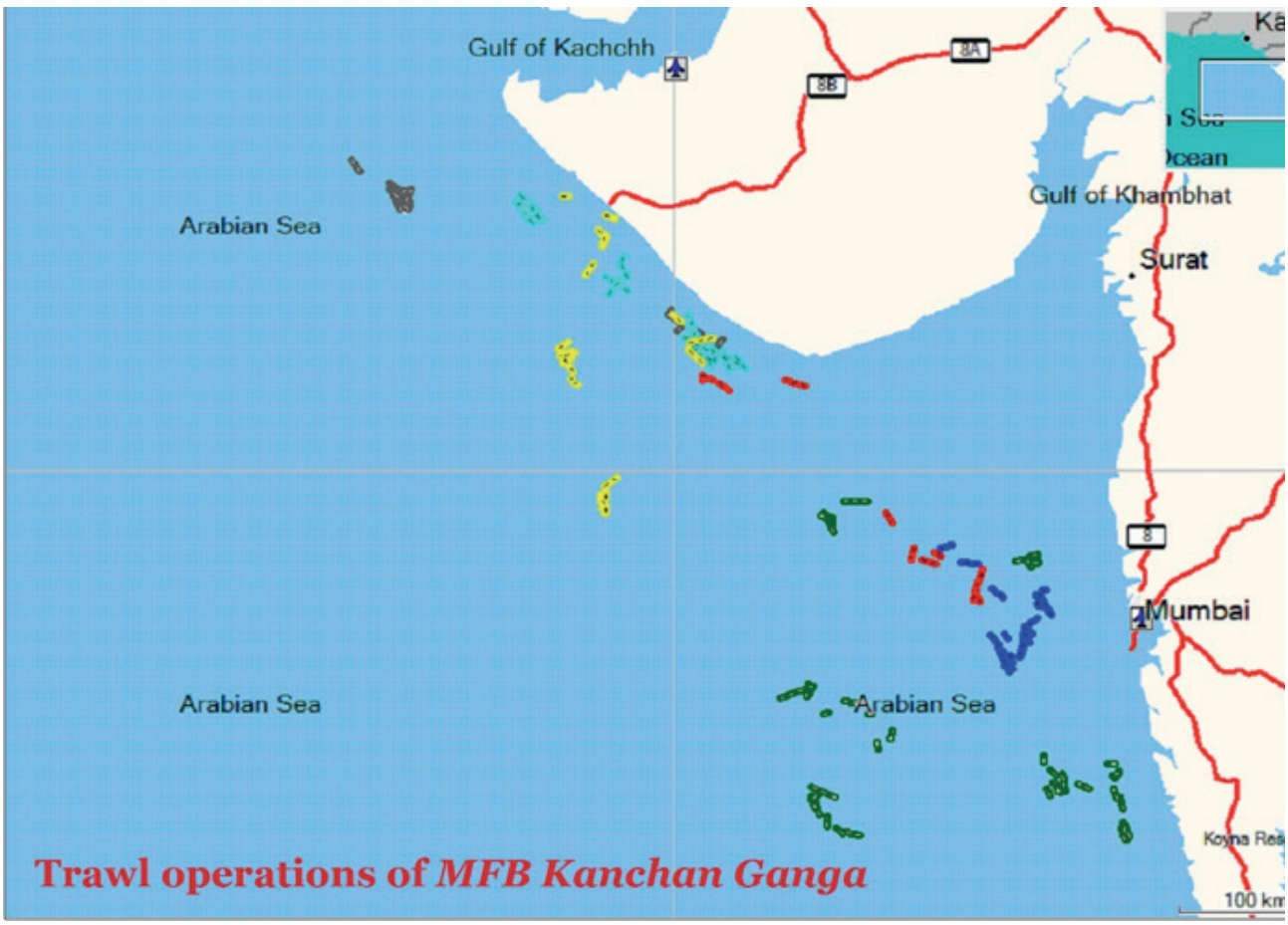

Fig.1. Month wise locations of trawl operations of a Veraval based trawler (MFB Kanchan Ganga) during the 2008-09 fishing season in northwest Arabian Sea. A substantial number of hauls are made off Maharashtra. Map from Mohamed *et al.* (2010).

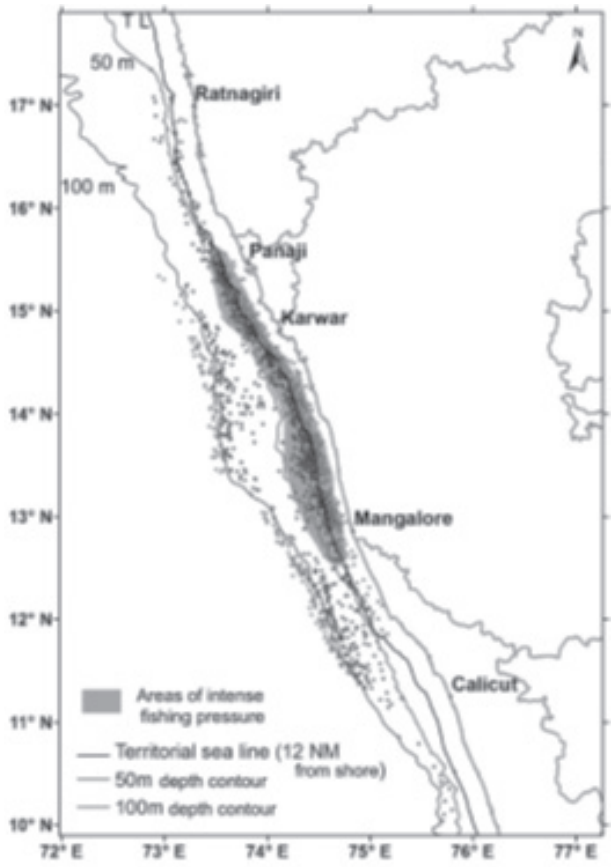

Fig.2. Distribution of trawl fishing effort in Karnataka during 2007-13 fishing seasons (from Dineshbabu *et al.,* 2017). Based from Karnataka fishing operations made off Goa, Maharashtra and Kerala.

catches taken from the 12-200 nmi off one maritime state, in landing centres of another maritime state. For example, a Gujarat based fishing trawler operating off Maharashtra or Goa or even further south will land its catch in a Gujarat fishing port (Fig.1), making state-wise estimate of catches erroneous. Similarly, Karnataka based trawlers operate off Goa, Maharashtra and Kerala (Fig.2) but land their catches in Karnataka fishing ports. This affects the precision of stock assessments as an accurate estimation of catch and effort for each state is an important input for any type of fish stock assessment. The ICAR-CMFRI's catch reporting and stock assessments always use maritime state as a unit in order to help planning and co-ordination. With increasing efficiency and capability of present day fishing vessels such errors are multiplied. Besides, there are reports of clashes between fishermen of neighbouring states (Fig.3) because of competition for resources and lack of clarity regarding who can fish where. Hence, there is an urgent need to rationalize and manage the system within the framework of existing laws and/or new regulations and keeping in view the


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THE TIMES OF INDIA

Fishermen from Maharashtra and Gujarat clash at high seas

TNN | Feb 4, 2016, 05.15 AM IST

RAJKOT/AHMEDABAD: Gujarat's fishermen are not only facing threats from Pakistan security agencies but also from neighbouring Maharashtra. Around 20,000 fishermen in Jafrabad and surrounding coastal villages of Amreli have stopped venturing out to the sea since February 2 to protest against the alleged intimidatory tactics by fishermen from Maharashtra who have invaded their territory.

In the past four months, four incidents of assaults on Jafrabad fishermen have taken place, including one in which eight of them were rescued after their boat sank following a scuffle with Maharashtra fishermen.

Bhaghu Solanki, presi dent, Kharva Machhimar Boat Association, told TOI that as many as 400 trawlers from Maharashtra have forcibly occupied the area where they fish.

"Their trawlers are much bigger and they use huge Persian nets in the area where we fish. Moreover, those from Maharashtra are operating illegally which is evident from the absence of display of licence number, the yellow colour code and necessary papers," Solanki said.

"There have been instances where their trawlers have rammed into our fishing boats and damaged them," he said.

Fig.3. News report of clashes between Maharashtra and Gujarat fishermen in the Arabian Sea (Source: *The Times of India, TNN | Feb 4, 2016*).

policy directions in NPMF 2017.

Creation of marine fisheries management zones

The territorial waters (TW) of each maritime state which are administered by respective MFRAs will become the primary coastal zones. They are numbered starting from Zone A1 (Gujarat) to Zone D11 (West Bengal) moving down along the west coast and then proceeding up along the east coast. The broad marine biogeographic area of the Indian subcontinent are generally divided into 4, the northwest coast (northeast Arabian Sea - NEAS), southwest coast (southeast Arabian Sea - SEAS), southeast coast (southwest Bay of Bengal - SWBOB) and the northeast coast (northwest Bay of Bengal - NWBOB). This division is also on the basis of broad oceanographic realms and unique biodiversity of the resources and is mostly aligned with international classifications (Spalding *et al*., 2007). These zones are named Zone A, B, C and D corresponding to NEAS, SEAS, SWBOB and NWBOB respectively (Fig.4). Since the main island territories of India, Lakshadweep Islands and the Andaman and Nicobar (A & N) Islands are isolated from the mainland, their territorial waters and 12 - 200 nmi area would form 3 separate zones (Table 1).

There are 13 TW zones and 6 regional zones in this proposed plan for fisheries management zones (Table 1 and Fig.4). Among the TW zones, A&N Island has the largest area followed by, Lakshadweep, Tamil Nadu,

Table 1. Classification of marine fisheries management zones of India, its extent and proposed regulatory regime.

Zone Code	Name of Zone	Internal Waters in km²	EEZ Area in km² (TW & outside)	Regulatory Authority	Management Councils
A1	TW Gujarat	26962.89	10873.12	Govt of Gujarat	GJSFMC
A2	TW Daman & Diu	112.09	337.32	UT Daman & Diu	DDSFMC
A3	TW Maharashtra	3173.81	11847.18	Govt of Maharashtra	MHSFMC
B4	TW Goa	834.99	2199.49	Govt of Goa	GOSFMC
B5	TW Karnataka	2110.25	5256.10	Govt of Karnataka	KNSFMC
B6	TW Kerala	1409.05	11529.64	Govt of Kerala	KLSFMC
C7	TW Tamil Nadu	2533.88	18863.83	Govt of Tamil Nadu	TNSFMC
C8	TW Puducherry	98.69	788.37	UT of Puducherry	PUSFMC
C9	TW Andhra Pradesh	8157.96	17436.13	Govt of Andhra Pradesh	APSFMC
D10	TW Odisha	9462.97	7591.32	Govt of Odisha	ODSFMC
D11	TW West Bengal	8129.89	3198.12	Govt of West Bengal	WBSFMC
E12	TW Lakshadweep	44611.57	22965.50	UT of Lakshadweep	LKSFMC
FG13	TW A&N Islands		53683.10	UT of A&N Islands	ANSFMC
A	NEAS		324301.62	Union Govt	NEAS RFMC
B	SEAS		466761.92	Union Govt	SEAS RFMC
C	SWBOB		410099.55	Union Govt	SWBOB RFMC
D	NWBOB		106834.44	Union Govt	NWBOB RFMC
F	EBOB		384565.19	Union Govt	EBOB FMC
G	AN Sea		165654.80	Union Govt	ANS FMC
Total		107598.05	2024786.73		

The area estimates given are indicative. Abbreviations: TW- territorial waters; NEAS - northeast Arabian Sea; SEAS - southeast Arabian Sea; SWBOB - southwest Bay of Bengal; NWBOB - northwest Bay of Bengal; LKS - Lakshadweep Sea; EBOB - eastern Bay of Bengal; ANS - Andaman Sea; SFMC - State Fisheries Management Council; RFMC - Regional Fisheries Management Council; FMC - Fisheries Management Council. Also refer Fig. 4.

Andhra Pradesh and Maharashtra. Together the TW zones, which are the managed areas with enacted laws, account for only 8% of the total EEZ.

Internal Waters: The Government of India has notified the baseline points for measuring seaward the limits of TW and EEZ in 2009 (Ministry of External Affairs - NY/PM/443/1/2009 dated 13 August 2009, *Bulletin No. 71 of the United Nations, Law of the Sea, 2010*). The baseline points are indicated in Fig.4. The creation of the baseline which straightens the coastline, and also takes into account the many small islands off the coast, creates internal waters which is the sea area between the coast and the inner boundary of the TW. Such internal waters are present in all maritime states of India (Table 1) and the total area of internal waters is 0.11 million km² (shown stippled in Fig.4). This is not part of the Indian EEZ. The largest internal waters are in the Lakshadweep Islands (41.5%) as the sea area encircling the TW of these islands are considered as internal waters. The second largest internal water area is in Gujarat where the Gulf of Kutch and Gulf of Kambhat are included as internal waters. For the purpose of fisheries administration and management, these internal waters have not been accorded proper jurisdiction. It will be appropriate to include the operational control of these waters to the maritime states along with TW when the laws are being amended.

Area wise, the zones managed by the Union Government accounts for 92% of the EEZ (1.86 million km²). The largest among these is the SEAS Zone (B) followed by SWBOB (C), EBOB (F) and NEAS (A). The fisheries in the TW zones are governed by the respective maritime states or UTs through the MFRAs.

Making the zones operational: The regulatory authorities have to notify the zones and the zonal management system through appropriate amendments in the legislation in the case of TW zones as has been done by the Government of Kerala. However, for regional zones appropriate provision has to be made in the proposed new law by the Union Government.

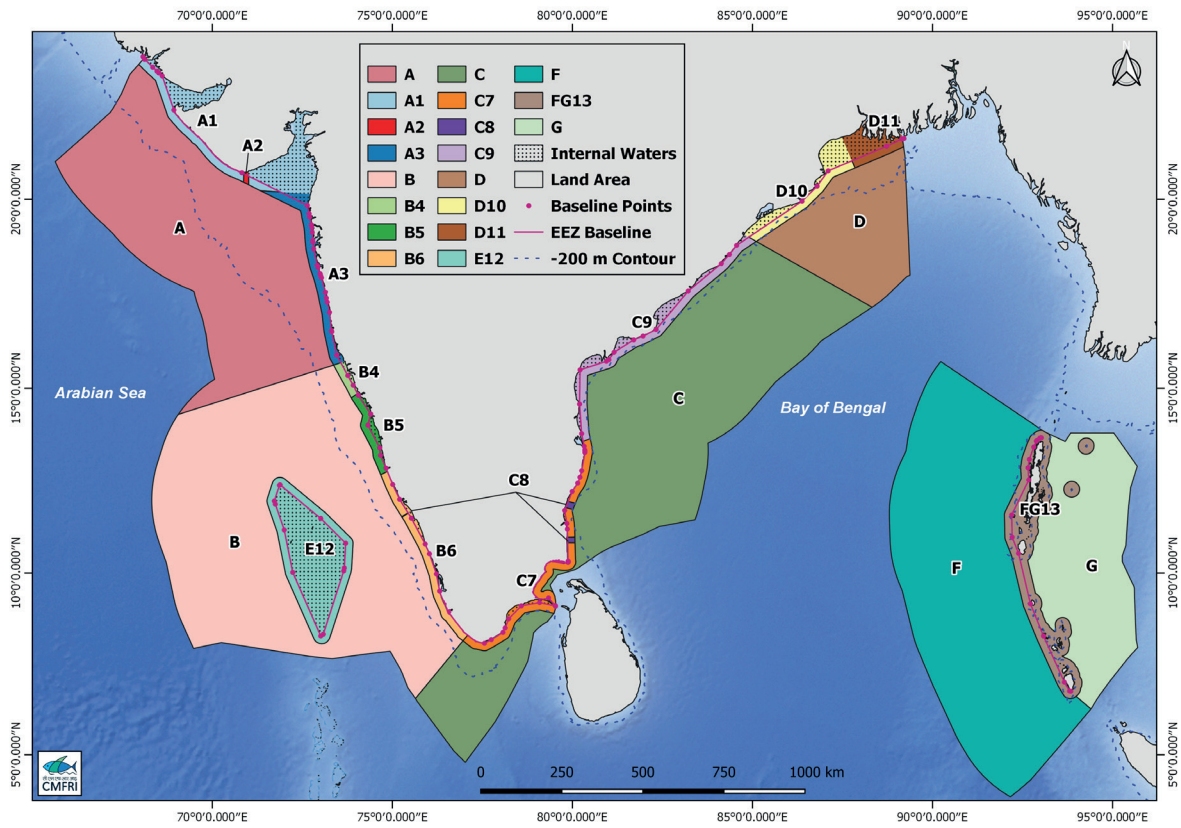

Fig. 4. Map showing proposed fishing zones in Indian EEZ. The map is only for the purpose of geographic information reference and the area estimates are indicative. Map source: Flanders Marine Institute (2014), Union of the ESRI Country shapefile and the Exclusive Economic Zones (version 2).

Reporting catch and effort under the new regime

The ICAR - CMFRI which estimates all India marine fish catch and effort follows a maritime state based reporting from 1950 onwards. Finer spatial resolution data (district/ fishing harbours etc.) are also available in its database (NMFDC - National Marine Fisheries Data Centre). Following the initiation of electronic tablet based field data collection from 2018, spatial data reporting through passive geo-referencing has become possible. Since vessel-gear combinations which fish inside and outside the TW are well known, it is possible to categorize the reporting to reflect this spatial information in all parts of the country. Once the zonal fisheries management system becomes formal, the data reporting to the states/UT and centre would be for TW of each maritime state/UT and for the 6 RFMC areas. ICAR - CMFRI should also make concerted efforts to split the historical data from 2007 (year in which complete species reporting was enabled) to enable long-term comparisons and for model fitting.

Stock assessments under the new regime

One of the aims of introducing area based zonal fisheries management is to bring in more robust and accurate stock assessments. For coastal, shallow water species the catch and effort data generated for state-wise TW zones would be used for doing stock assessments. Most of the species/stocks in the regional zones exploited by trawls have limited latitude-wise movements. Therefore, for the outside TW regional zones, the catch and effort data for the regional zones would be used for stock assessments. This would result in species/stock MSYs (Maximum Sustainable Yields) for state-wise TW zones and regional zones leading to better management of fish stocks. The derived MSY figures for each major stock (forming more than 5% of total catch in a fleet) in different zones can then be used to fix zone based precautionary total allowable catch (TAC) quotas at 80% of the MSY. With advent of electronic tablet based data collection and reporting system, the catch

estimates have only a lag of one month at present as compared to the 3 - 4 months period earlier. This means that management agencies can quickly act to caution a fisheries when a quota is approached or completed based on advisories from ICAR - CMFRI.

The highly migratory fish stocks such as tunas would need a different approach since their distribution transgresses several management zones. It would be advisable to derive estimates of MSY separately for the Arabian Sea and Bay of Bengal for such fish stocks and then allocate quotas for each zone based on the relative fishing intensity.

Method of allocation of quota

Once a TAC has been determined, allocation of this quota for different resource users becomes imperative. In a multispecies and multigear scenario, this becomes a complex and difficult exercise, and we can only learn as we move forward. Several objective criteria have been used elsewhere in the world including provision for resource rents and management costs with regional variations (Morgan, 1997). In the TW zones which are under the control of maritime states, we envisage a property rights based allocation to traditional fishers. Here, the multitude of gears and high diversity in the resources have to be taken into account. In the regional zones, there is the additional dimension of multiple state vessels besides the multispecies and multigear nature of the fisheries. Another important facet in quota allocation is the consideration for social and economic status of the fishers, which needs factorization after initial trials. Besides, as tropical ecosystems have high turnover and high fluctuations in biomass, we recommend a variable (not fixed) quota system based on the frequency of the stock assessment for each stock. Currently, we present one example each from TW zone (oil sardine, Kerala) and regional zone (SWBOB, threadfin bream, states of Tamil Nadu, Puducherry and Andhra Pradesh).

The first example of oil sardine is worked out by taking 0.8MSY as a precautionary annual catch quota, and by giving more weightage to (p1) those fishing fleets which harvest oil sardine in high proportions (targeted fishery, oil sardine catch by the fishing fleet divided by total oil sardine catch) and (p2) weightage to those fleets in which oil sardine forms a major proportion (oil sardine catch by the fishing fleet divided by total catch by the fishing fleet). By this rule those fishing fleets having high values for both p1 and p2 will have the maximum allocation. This is illustrated in Table 2.

One way of limiting the harvest to allotted quota of the fishing fleets can be by controlling the number of trips by each fishing fleets. Using information on fishing effort in terms of number of trips as well as hours of fishing available in NMFDC and information on fishing crafts in the fishery available from Marine Fisheries Census 2016, the allowable number of trips can be calculated.

In the second example, we take the case of the trawl fishery for threadfin breams (*Nemipterus japonicus*) in SWBOB zone comprising the states of Tamil Nadu, Puducherry and Andhra Pradesh. Using the same proportions (p1, p2 and its product) as applied above for oil sardine, we first apportion the quota for different fleets, and then applying this proportion in the total proportion of all states to the fleet quota, the state-wise fleet-wise quota can be determined (Table 3).

Table 2. Gear-wise annual quota allocation for oil sardine stock in TW of Kerala. Proportion of the species caught by each gear (p1) and proportion of the species in total catch by the gear (p2) and its product (p1*p2) are used to apportion the quota.

Gear ID	p1	p2	p1*p2	Quota (tonnes)
MRS	0.481	0.726	0.349	121814.4
IBRS	0.046	0.725	0.033	11633.2
MPS	0.002	0.164	0.000	127.3
OBRS	0.403	0.597	0.240	83959.2
OBGN	0.046	0.238	0.011	3796.5
NM	0.022	0.343	0.008	2677.4
Total/0.8MSY				224008.0

MRS - Mechanized raing seine; IBRS - Inboard ring seine; MPS - Mechanized purse seine; OBRS - Outboard ring seine; OBGN - Outboard gillnet; NM - Non-mechanized gears.

Table 3. Gear-wise and state-wise annual quota allocation for *Nemipterus japonicus* stock in SWBOB. Proportion of the species caught by each gear (p1) and proportion of the species in total catch by the gear (p2) and its product (p1*p2) are used to apportion the quota first, and then this proportion is applied the fleet-wise quota for determining the state-wise quota.

Gear ID	AP	PU	TN	Total Quota (tonnes)
MMT	0.2	2575.2	1005.1	3580.5
MST	0.0	3591.2	9238.8	12830.0
OBGN	35.3	0.1	0.1	35.5
Total/0.8MSY	36	6166	10244	16446

MMT - Mechanized multiday trawl; MST - Mechanized singleday trawl; OBGN - Outboard gillnet;

AP - Andhra Pradesh; PU - Puducherry; TN - Tamil Nadu

Marine fisheries management under the new regime

A systemic plan has to be developed for ushering in a healthy marine fisheries management system for the country. Since the TWs are under the regulatory control of respective maritime states through their MFRAs, this is fairly straightforward. The main action would be to amend or update the MFRAs in tune with modern fisheries management principles with proper vision, mission and objectives. As advised by the NPMF (2017), this may be done by drafting a model bill by the Union Ministry of Fisheries to be enacted by all maritime states. It is important to have new legislation for zonation by both the maritime states and the Centre.

The Indian Marine Fisheries Code (IMFC) advises adopting a participatory or co-management approach for the entire country (Mohamed *et al.*, 2017) by creating fisheries management councils with adequate representation for fishers and other stakeholders. In this bottom-up tiered system the consensus decisions taken in the lower councils with scientific support are ratified by the upper councils, finally enabling equitable decisions and rule making. The National Marine Fisheries Management Council (NMFMC) will be the apex council under the Union Ministry of Fisheries which will have oversight of all councils In a maritime state, the Village FMC is at the lowest rung, which reports to the District FMC which in turn reports to the State FMC (Fig.5). The management councils

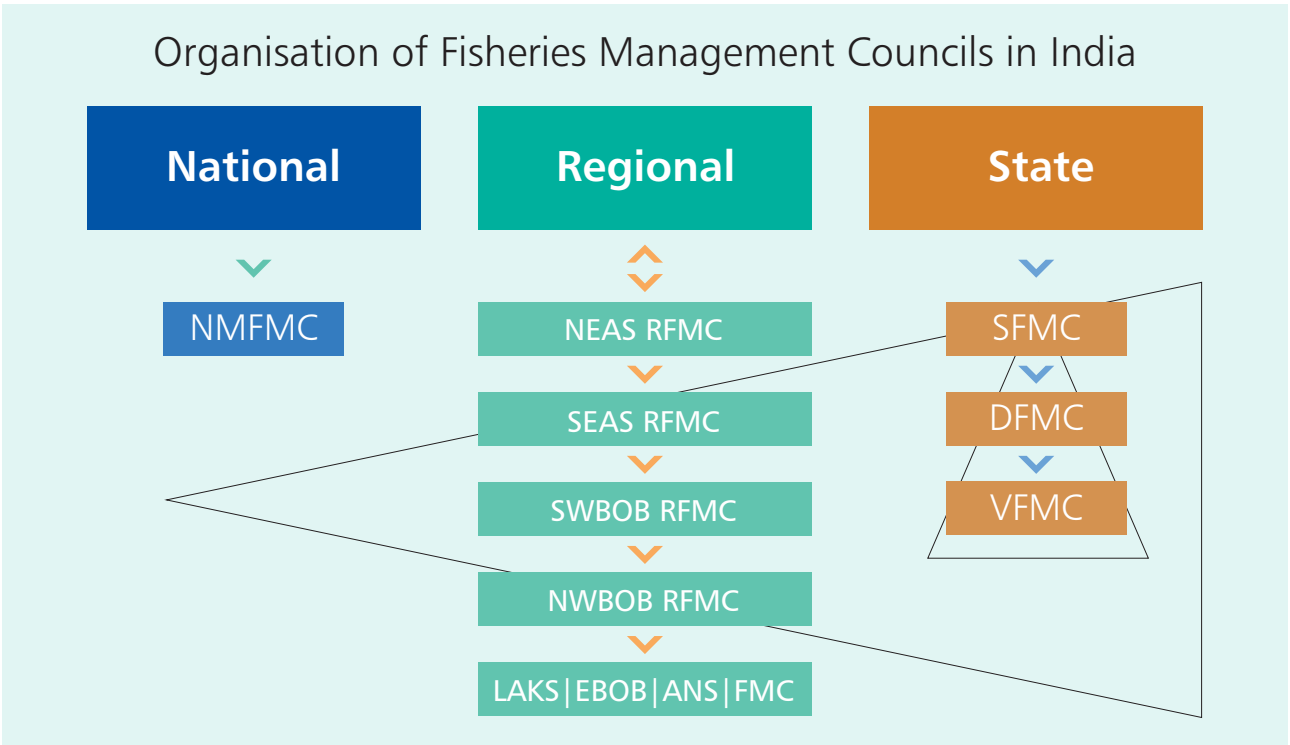

Fig. 5. Infographic of the proposed council based fisheries management for India (adapted from Mohamed *et al.*, 2017). Triangle apices shows the top of hierarchy within the system.

proposed for managing the fisheries in the respective zones are shown in Table 1. The Kerala MFRA has been amended in 2017 to accommodate this system, and the Kerala SFMC has already made terms of reference for the FMCs and the SFMC has had its first meeting. The regional FMC (RFMCs) have representations from multiple maritime states as per Table 1 and Fig.5.

Fishing licenses as a means of regulatory control

It is necessary to ensure that vessels licensed to fish in a particular zone fish in this zone only (through implementation of VMS/AIS systems) and land their catches in fishing ports lying within the zone. This would lead to more accurate zone-wise catch and effort estimate, and in turn, more meaningful and robust stock assessments. According to the FAO CCRF (Code of Conduct for Responsible Fisheries), Article 8.1.2, every country should maintain records on all vessels which are authorized (licensed) to fish and Article 7.6.2 states that no vessel be allowed to fish unless so authorized. Further, Article 8.1.1 also states that fishing operations allowed by them are conducted within waters under their jurisdiction, indicating area specific licensing of fishing vessels. These clauses are crucial to implement the zonal fisheries management plan.

Currently there is lack of clarity in the system of registration and licensing for vessels fishing in the 12 - 200 nmi zone. The DoF (MoFAHD) currently registers the vessels allowing fishing operations throughout the Indian EEZ (12 - 200 nmi). The State Department of Fisheries (DoF) gives a license for the same vessel to fish in the TW of the respective state. When zone based management is introduced this system has to be radically changed. A license is the authorization to fish in a particular area using a particular gear, and registration of a vessel is only to ensure that the vessel is seaworthy and complying with all sea safety requirements. Under the new regime licenses to fish should be given on a zonal basis by each maritime state for TWs and for the 6 regional zones by the Union Government. Since many of the regional zones

Table 2. Comparison of current fisheries management system and the proposed changes.

No.	Current regime	Proposed change
1	TW fisheries management	
	• Done by all maritime states under their respective MFRAs. • Limited area based (within TW) exclusive right to traditional small-scale fishers in all maritime states. • Mechanized fishing is also done in this zone. • Catch reported on maritime state basis without delineating inshore and offshore resources	• Change in name of zone. • Include Internal Waters within this management regime. • Introduction of council management system (already done by Kerala State through amendments in KMFR Act). • Gear-wise quotas for major coastal stocks and stock managed on the basis of this. • Assuring exclusive rights to traditional and modified traditional fishing methods. • No mechanized or industrial fishing in this zone. • Catch and effort data reporting only for inshore resource in TW zones to facilitate stock assessments.
2	Outside TW fisheries management	
	• Entire outside TW area, up to 200 nm considered as one large fishing area • The DoF (MoFAHD) registers the vessel and the DoF (maritime state) issues the license (legally valid only in TW). • Vessels permitted to operate in any area outside of State TWs. • Vessels can land their catch in any fishing port if respective state allows it by paying user fee. • Temporal closure during monsoon along west coast and during summer along east coast is the only management practiced.	• Outside TW area split into 4 regional and 2 island zones • Zone based licenses issued for fishing, allowing licensee to fish only in that zone. • Vessels can land their catches only in ports of respective zones. • Introduction of regional council management system. • Gear-wise quotas for major offshore fish stocks • Quota allocation based on an objective criteria • Temporal closures reworked based on breeding period of major offshore stocks. • Catch and effort data reporting based on offshore zones to facilitate stock assessments.

are shared between States, it would be appropriate if this authority is given to respective maritime states based on current fleet sizes. The number of licenses forms a point for input control by the respective RFMCs based on TACs.

Advantages of spatial management and TACs

Changing over to a spatial fisheries management is a profound change from the present system of functioning and a big challenge (Table 2). However, the advantages outweigh the hard work by a big margin in our journey towards putting India's marine fisheries on a sound sustainable footing. Some of the advantages are listed below:

- More organized and systematic fishing operations and its regulation.
- By bringing in council based management, introduce co-management into the system ensuring equity among all participants and comply with EAFM (Ecosystem Approach to Fisheries Management) principles.
- Reduce inter-state conflicts among fishermen arising out of competition for resources.
- More accurate and meaningful stock assessments leading to practical harvest control rules.
- Introduce quota management system based on TACs which leads to assured incomes and sustainable fish stocks.
- More effective science based management of key resources leading to sustainability.
- Traditional fishers get exclusive rights and zone exclusivity assures conflict reduction.
- Favours price stabilization by avoiding boom and bust situations in fish catches.

Endnote

The spatial management and TAC proposal given above represents a radical change in the manner in which marine fisheries in India is governed. It is quite possible that there may not be sufficient backing from decision makers in effecting these changes immediately considering the effort involved and also due to the perception that business-as-usual is a safer option. But, in the long-term interest of safeguarding the country's resources and ensuring equity and sustainability it is necessary to make these changes. Managing the tuna and allied fisheries based on quotas is already a requirement for India as per IOTC (Indian Ocean Tuna Commission) obligations. Many developing countries have already put similar systems in place.

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Some insights into the credit transactions of small - scale fishers along the Kerala coast, India

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Abstract

This study examines the fishery credit delivery system in the state of Kerala that mainly involves informal players such as auctioneer-middlemen, third-party shareholders and private money lenders; and formal sources such as Matsyafed societies, co-operative banks, commercial banks and non-banking financial entities. The main features and credit contract conditions associated with each major type of credit source is discussed and their share in the credit basket of ring seine vessels is assessed empirically based on sample survey data collected from major landing centres. The findings from the study throw several insights into the general state of affairs related to Kerala's fishery credit delivery system and provide some policy prescriptions for improving the service delivery.

Keywords: Small-scale fisheries, financial institutions, fisheries credit

Introduction

Credit plays a central role in propelling fishing and allied activities in developing economies. Fishers' dependence on credit to meet their operational and capital investment requirements have been ever-growing due to the increasing adoption of capital-intensive techniques in fishing. As in several other coastal economies, Kerala's marine fisheries sector accommodates distinct financial market systems with multifarious financial intermediaries, involved in diverse but regular credit-based economic transactions. There has been a steady growth in institutional financing of Kerala's marine fisheries over the past three to four decades, under the umbrella of the co-operative sector. The coverage of formal banking in the coastal belts has also undergone notable improvements during this period. Despite this, recent studies have shown the obstinate presence of informal financial institutions that wield significant economic-power among fishing communities in Kerala. Several reasons have been pointed out, that mainly include (i) the reluctance of the institutional agencies, including that of the co-operative sector, to risk their loanable funds beyond certain limits, given the inability of the fishers to offer entitlements other than a share of their harvest and (ii) the 'Banker on the Beach' advantage enjoyed by the informal sector. Further, the informal credit system has evolved over the years, mainly by virtue of changes in ownership pattern of factors of production, investment requirements and the wider socio-economic fabric of the fisher folk community. Against this backdrop, this article discusses the broad categories of credit sources in Kerala's fishery sector, their inter-linkages, the main actors involved and their general features. Further, the results obtained from a primary survey is discussed to throw light on the fishers' predominant borrowing practices, types of credit contracts, the conditions of borrowing and repayment as well as the costs associated with certain predominant modes of borrowing. Various constraints in the way of financial inclusion are deliberated upon, and policy perspectives to circumvent them are discussed.

Fishery credit market in Kerala: An overview

Formal sector

The formal financial sector in Kerala's coastal arena includes the scheduled commercial banks such as public sector banks, private banks and regional rural banks (RRBs) as well as the cooperative banking institutions and societies.

The banking sector presently comprises of 43 commercial banks, one Regional Rural Bank (Kerala Gramin Bank), Kerala State Co-operative Bank with 14 affiliated District Co-operative Banks (DCBs), 1638 Primary Agriculture Co-operative Societies (PACS) and the Kerala State Agriculture and Rural Development Banks (PCARDBs). Besides these, the Kerala State Co-operative Federation for Fisheries Development Ltd. (Matsyafed) deals with diverse credit delivery services. The South Indian Federation of Fishermen Societies (SIFFS) is another non-governmental entity that provides a variety of services including small-scale credit to the artisanal fishermen. The National Marine Fisheries Census, 2010 reported a total of 289 bank branches and 276 fishery co-operative societies in the marine fishing villages of Kerala that to the financial requirements of fisher folk. Though bank lending has increased, both in terms of actual quantity of money disbursed and as a share of fisheries in priority sector lending, it is worth noting that the latter accounts to be less than one percent.

Matsyafed presently operates with a two-tier co-operative institutional framework with the apex body at the state level and the fishermen co-operative societies at the primary level. It has strategically placed itself in a unique position so as to meet the distinctive credit requirements of the fishing community in the best possible way, by abating the rigidities of the banking sector. Every loan granted by the Matsyafed Societies has a commission component and an interest component. Commission generally includes the charges towards the services, including auctioning, rendered by Matsyafed through its primary societies, as well as the mandated savings for the debtor fisher. Interest is a fixed charge decided at the time of disbursal of the loan. This is operationalised through designated auctioneers, who are empowered to auction fishers' harvests on behalf of Matsyafed Societies. They collect commissions as a percentage of gross value of catch per-trip. On getting good catches, a part of the proceeds (generally 40%) are deducted, which is subsequently apportioned between principal and interest. Such apportioning is made by the societies on a flexible basis considering the outstanding credit amount. The savings part collected is returned to the fishers as lump sum during festivals as bonus payments. The system in a way mimics the strategy of the informal lenders/auctioneers who accept a share of the fishers' harvest towards loan repayment.

Though a minority, certain non-banking financial entities also finance fishermen. These are financial companies registered under the Companies Act, 1956 and are engaged in providing loans and advances, acquisition of shares, stocks, bonds, hire-purchase, insurance business or chit business adhering to the rules and regulations of the Reserve Bank of India (RBI). Companies lending money against gold as collateral security are a dominant category under this, with interest rates generally higher than the banking institutions.

Informal credit sources

Among the many informal credit choices, the output/market-tying credit contract is the dominant one in the study area. This is typically characterized by inter-linked deals wherein, the commission agent/auctioneer creditor enters into an output-tying contract with vessel-owner fishers who are in need of credit. Here, the beneficiary fisherman obtains credit on condition that the future catches from his vessels are marketed through the commission agent/auctioneer at an agreed upon rate of commission. It is interesting to note that the commissions are based only on the daily catch volumes, and has no correlation whatsoever to the amount of outstanding debt. As long as a debtor fisherman has an outstanding loan, he is bound by the contract not only to continue selling their catches through the creditor-auctioneer, but also to pay the due commission per catch. The loanee fishermen are supposed to repay part of their outstanding loan in lump sum on getting good catches, so that the creditors can restore their capital on a regular basis. However, the creditors generally discourage complete closure of a loan, as it means loss of a steady stream of commission for them. The contracts are unwritten, legally untenable and are purely based on mutual trust and reciprocal dependence between the parties involved.

Third-party share is another common mode through which the fishers raise funds for capital expenditure or other unforeseen expenditures like repairs and maintenance works. These are shares disbursed generally to people outside the fishing community or to businessmen in the locality interested in investing in fishing business. Unlike the primary shareholders of a fishing vessel, who are active fishermen themselves, the third-party shareholders generally stay detached from routine fishing activities. The interest is paid in the form of share of harvest revenues accrued from routine fishing. The value of a share on a fishing vessel is generally fixed rather arbitrarily by the primary share holders, but is strongly linked to

the economic performance of the vessel in question, experience of the skipper and general reputation of the shareholders as well as the crew. Third-party share is understood to be a relatively new practice that has emerged in the wake of financial prosperity attained by rural and coastal dwellers of Kerala through foreign remittances over the past two decades.

The loans obtained from private money lenders involve predetermined interest charges payable at definite intervals. Though interest payments are collected on regular intervals without fail, such obstinacy is not shown in collecting repayments to the principal. The loans may involve collateral security such as land titles, jewellery or promissory notes. However, money lenders do not always insist on collateral security, but follow their own compulsive means to enforce interest payments and principal repayments. Factors such as urgency in fund requirements and quick access with minimal procedural formalities make them much sought after entities within fishing communities.

Other than the above mentioned informal loans, fishermen also resort to reciprocal loans, which are one-to-one interest-free financial transactions between fellow fishermen based on a triadic relationship. The triadic relationship between the debtor, the creditor and the community at large ensures that the parties involved are insured against extreme financial distress at any point in time through mutually enforced transaction systems.

Borrowing pattern and credit contract conditions

This section presents the borrowing pattern of Kerala fishermen as revealed based on a primary survey conducted by ICAR - CMFRI in 2017 in 8 maritime districts covering 137 inboard ring seine units. Table 1 provides estimates of average borrowing by fishermen from various formal and informal lending sources. Average credit outstanding was found to be generally higher among informal sources compared to the formal. The annual interest rate on loans varied between 11-15 per cent in case of commercial banks, between 11-14 per cent in co-operative banks and 4 -13 per cent in Matsyafed. Non-banking entities were found to charge an interest rate between 18 - 20 per cent as observed from the three cases in the sample. The auctioneers and third-party share-holders did not charge any interest rates as noted earlier. However, the rates on loans advanced by private money lenders were quite high falling in the range of 24-60 per cent on an annual basis; with lenders actually specifying the rates on a monthly basis. Commissions on harvest proceeds are charged by auctioneers (4-10%) and Matsyafed (3-6%). Quite obviously, the rates of commission charged by auctioneers were higher compared to Matsyafed in most of the cases. Loan term is another important factor that determines the demand for loans across sources. Hundred per cent of loans advanced by commercial banks, co-operative banks and non-banking entities required a repayment within 2-7 years. About 97 per cent of the loans given by Matsyafed also fall in this category. In contrast, none of the loans from informal sources are time-bound. Scrutiny of the repayment schedule prescribed by various types of lending sources suggests that only two types of scheduling is prevalent in the study area - either monthly or flexible. While all commercial banks and 67 per cent of co-operative banks and non-banking financial entities followed monthly schedule of repayment, the rest followed flexible schedule. In case of Matsyafed, 74 per cent of the active loans required monthly repayment. Notably, all loans advanced by the informal sources are scheduled for flexible repayment thereby better suiting the requirement of a clientele like fishermen. However, it is worth noting that interest / commission payments for these loans were done on regular schedule, either monthly or as per availability of catches. Any delays or default in such payments attracted penalties that varied from case to case.

Costs of loans from auctioneers and third-party shares

The actual costs of loan sourced from auctioneers and third-party share-holders are not explicitly known as the interest payments on them are paid on a per-trip basis in the form of auction commission and owners' share of catch revenue respectively. Their annual imputed values was estimated based on full set of trip-wise cost and earnings information collected from 10 sampling units (Table 2). The four units that obtained loans from Matsyafed incurred costs varying from 15.1 per cent to 38.1 per cent of the loan amount per annum in the form of auction commission. In contrast, the imputed value of interests on loans from auctioneers range from 34.4 per cent to as high as 159.8 per cent. It could be seen that, in addition to higher

Table 1. Main characteristics of fishery credit contracts by source in Kerala, India

Particulars	Formal credit sources			Informal credit sources				
	Commercial banks	Cooperative banks	Matsyafed	Non-banking entities	Auctioneer	Private money lenders	Third-party shares	Friends & relatives
Average credit availed (million Rs.)	1.22	1.03	1.20	1.03	0.77	1.01	1.19	0.25
Average credit outstanding as a share of total (%)	57	73	65	90	96	90	90	80
Annual interest rate (%)	11-15	11-14	4-13	18-20	NA	24-60	NA	0
Commission on harvests (% of catch revenue)	NA	NA	3-6	NA	4-10	NA	NA	NA
Loan term (%)								
One year or less	0	0	2	0	0	0	0	100
2-7 years	100	100	97	100	0	0	0	0
Above 7 years	0	0	1	0	0	0	0	0
Unspecified	0	0	0	0	100	100	100	0
Repayment schedule (%)								
Monthly	100	67	74	67	0	0	0	0
Quarterly/ Semi-annual	0	0	0	0	0	0	0	0
Annual	0	0	0	0	0	0	0	0
Flexible	0	33	26	33	100	100	100	100

Source: Parappurathu *et al*., 2019

auction commission charged by the auctioneers (2 to 3 percentage points higher in relation to Matsyafed), relatively lower amounts of loans disbursed by them push up the interest rates. The imputed value of interest on third party shares ranged between 8.8 per cent and 45.8 per cent across the units studied, based on their relative fishing performance. These are in fact the rates of return on equity realized by the concerned third-party investors. The above results show that, the interest burden incurred by an average fisherman on output-tying loans and third-party shares is generally much higher compared to those offered by banks and other formal financial institutions. Though commission payments on Matsyafed loans also go beyond bank rates many a times, its co-operative mode of operation and quasi-state-ownership nature ensure that a part of the commission payments are returned to the debtors in the form of their savings and the profits are ploughed back to benefit the fishing community through multiple channels from time to time.

Constraints in the way of financial inclusion

The main factors leading to the continuance of informal financing in Kerala, as revealed by the survey include (i) strict terms and conditions prescribed for disbursement of formal credit; (ii) collateral requirements; (iii) procedural complexities; (iv) delays in sanction; (v) political interference; (vi) non-flexibility in the schedule for repayment; (vii) attachment of collateral property in cases of loan defaults; (viii) general aversion of fishermen to institutional formalities involved; (ix) hesitation on the part of banks to fund fishers due to risks involved and (x) lower credit allocation for the fisheries sector in general. The main advantage of the output-tying credit deals and third-party shares, the dominant sources of informal credit, is the non-essentiality of collateral and the willingness of the creditors to accept interest payments as a share of harvest. Another attraction is the high level of flexibility

Table 2. Estimated imputed interests paid as harvest shares and third-party share payments of selected ring seine units, 2017

Ring seine unit No.	No. of trips	Catch revenue (million Rs.)	Auction commission paid (million Rs.)	Total operating cost (million Rs.)	Crew share (million Rs.)	Owners' share (million Rs.)	Loan from Matsyafed (million Rs.)	Loan from auctioneer (million Rs.)	Third-party loan (million Rs.)	Imputed interest paid as share of harvest (%)	Imputed interest paid on third-party share (%)
Unit 1	196	5.80	0.43	3.66	1.50	0.64	0	1.00	0.50 (3)	34.4	25.7
Unit 2	133	11.77	0.59	4.63	5.15	2.75	0	0.50	1.50 (6)	47.1	45.8
Unit 3	141	26637	1.33	8.98	13.31	4.34	0	0.50	3.00 (5)	159.8	24.1
Unit 4	110	18072	0.45	7.19	7.88	3.00	3.60	0	1.00 (3)	15.1*	15.5
Unit 5	139	25404	1.02	6.39	14.81	4.20	2.00	0	0	38.1*	0
Unit 6	222	30861	1.54	6.87	16.91	6.98	0	1.50	0	82.3	0
Unit 7	172	18171	0.91	5.93	9.87	2.41	0	1.20	0	60.6	0
Unit 8	101	15921	0.79	4.56	8.63	2.75	0	0.80	0	79.6	0
Unit 9	76	4152	0.17	1.96	0.46	1.36	0.70	0	5.00 (20)	17.8*	8.8
Unit 10	182	14852	1.48#	5.11	8.10	1.64	1.20	0.70	0	37.1* 127.3	0

Notes: Auction commission includes service charges (1-2%). This is deducted before working out the imputed interest rate; *denotes imputed value of interest paid to Matsyafed. This does not include the regular interest due, which varies from 4-13% of the loan outstanding; #Covers auction commission paid to both Matsyafed and auctioneer; Figures in parentheses show the number of shares allotted to the third-party share holder/s.

Source: Parappurathu *et al.,* 2019

allowed for repayments to the principal, depending on the revenue obtained from routine fishing trips. They are also free from other hassles that constrain timely availability of credit. Over and above, the fishermen fear that in case of bankruptcy due to economic loss of fishing units, the formal institutions would proceed to attach their collateral property, which in most cases would be the only asset at their disposal.

On the contrary in the informal system, a loss making vessel operator generally is able to clear his dues by selling off his fishing assets (vessel / gear / equipment) and sharing the resultant proceeds among his many creditors. This is an accepted lenience shown by majority of the informal creditors, which also helps the defaulter fisherman to take an honorable exit from the debts involved. The extensive social networks and information-base maintained by the creditors within the community help to minimize chances of willful defaults, thereby maintaining the sanctity of the system.

Notwithstanding the many perceived merits, the output-tying system cannot be treated as one which is fully endorsed by the fishing community. There is widespread concern for the implicit exploitation involved. As evident from Table 2, the cost of such loans is often exorbitant, with interest payments in the form of auction commission estimated to be several multiples of the rates charged by the formal financial institutions. The biggest demerit of the output-tying credit system is that it leaves the fisherman an eternal debtor, never actually able to get rid of his outstanding loans, and forcefully tied to the perpetual bond of commission payments. Similarly, the third-party share system also ends up as a debt trap wherein the real owners' share to harvests keeps on narrowing commensurate with their third-party dues. Nevertheless, the fishermen consider private money lenders as the last resort and approach them only when other formal and informal financial sources are either exhausted or inaccessible.

Policy options for enhancing financial inclusion

A logical solution to the fishermen's problem of dearth of collateral security would be to secure acceptance

of borrowers' fishing vessels as collaterals by the lending institutions. The banks generally reject such arrangements citing high vulnerability of fishing boats to unforeseen risks in the seas. Such risks however, can be mitigated to a great extent if the vessel in question is insured by a recognized insurance company. An insured vessel would be free from the risks of monetary loss in case of accidents and hence should qualify as a collateral security. The government-supported Fisheries Mutual Insurance Scheme (FMIS) in Japan is a well quoted example for such a system, wherein it necessitates financial institutions to extend loans against insurance claims of fishers which are considered as collaterals. However, the coverage of vessel insurance in India is quite limited, exposing majority of the vessel owners to high level of risks. In this context, if the institutional lending agencies can facilitate insurance coverage of vessels they lend and simultaneously accept them as a collateral security, the twin problems mentioned above could be addressed at one go. Due to non-essentiality of any immovable collateral security under such an arrangement, the fishermen should find it as an option worthy of trial. To make things easier, the lending banks can tie up with insurance companies to smoothen the transition. As a result, if the enrollments to vessel insurance schemes go up, the premiums would naturally decline, further catalyzing the process. The government can play a facilitating role by incentivizing the fishermen who opt for such schemes and by enforcing adequate regulatory mechanisms to minimize misuse of any sort. Nonetheless, the outcomes indicated above are certainly not easy to realize and would require concerted and co-ordinated efforts by multiple stakeholders. Moreover, success in this regard would depend on a number of factors such as banks' willingness to try such innovative lending models, technological readiness of the insurance industry for effective fishery insurance administration and the fishermen's inclination to participate in such experiments.

Bringing about flexibility in credit contracts is another sensible way of improving financial inclusion. Credits cards offer such flexibility whereby the consumers have a reasonable amount of freedom in scheduling withdrawals and repayments within their credit limits. Considering the success of credit cards in agriculture sector (Kisan Credit Card) in India and the high demand for incessant credit in the fishery sector, introducing credit cards for the benefit of fishers seems to be a worthy option. India's union budget 2018-19 has made an allocation in this regard which needs to be capitalized for the benefit of fishermen. Other than banks, institutions such as Matsyafed can also venture in this direction.

Though informal lending agencies serve a role, which cannot be understated, in meeting the credit demand of fishermen, moral hazards associated with such borrowing often result in bankruptcy of fishermen. However, while addressing such concerns, a systematic approach towards enhancing financial inclusion is necessary, fully acknowledging the role played by the informal sector in meeting the much needed liquidity requirement of fishers over decades. Bringing about reforms in the fish auctioning system by introducing electronic/automated auction systems at the landing centres with proper state supervision as well as strict monitoring of informal lending activities may be explored. Considering the alluring role played by fishery cooperatives in advancing financial inclusion by far, and their collective bargaining potential to achieve some of the above mentioned reforms in the days to come, measures to further boost their reach and penetration are also called for.

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Micro-nurseries for bivalve seed production

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Abstract

Along the southwest coast of India, mussel farming is practiced by thousands of farmers in the estuarine areas using rack and rope method or on-bottom method, during the post monsoon months. Production of farmed mussel after the peaking in 2009 (18400 t) has stagnated around 9000-10000 t per year. Large scale collection of seed from the natural mussel beds following increased adoption of green mussel farming has led to conflicts between wild mussel pickers and farmers in the past. Moreover, mussel and oyster farmers face an unpredictable wild seed supply and lack of dependable supply of quality seed from hatcheries. Vizhinjam Research Centre of ICAR-CMFRI has developed micro-nursery systems with down-welling and up-welling subsystems for the settlement and metamorphosis of floating larvae to spat and for further nursery rearing of green mussel spat to seed size suitable for farming. This will make large scale bivalve seed production of mussels, edible oyster, pearl oyster and clam possible in the hatchery which can cater to the requirements of thousands of bivalve farmers in coastal areas of India.

Keywords: *Mussel seed, micro-nursery, bivalve farming*

Bivalve larvae settled in the hatchery as spat have to be reared for a short period in the nursery until they reach a size which can tolerate field culture conditions. Land based and field based systems are used for nursery rearing of bivalve seed. Common land based systems used are down wellers, upwellers and race ways. On-bottom, off-bottom containers, floating up-wellers and floating rafts are the common field based systems for nursery rearing.

Micro-nursery (upwelling and down welling), one of the land based culture systems used for bivalve seed production needs continuous circulation of seawater, regular cleaning and monitoring of seeds. Even though the fabrication of these systems are costly, survival and growth rates of spat are better. Therefore these systems are successfully used in USA (especially in the Gulf of Mexico, Georgia, North and South Carolina) for nursery rearing of hard clam species, *Mercinaria mercinaria* and single oyster (cultchless oyster seed) of *Crassostrea virginica*. This system is also used in countries like Canada, France and Australia for bivalve seed rearing.

In the case of commercially important bivalves such as green mussel *Perna viridis*, brown mussel *Perna indica*, edible oyster *Crassostrea madrasensis*, pearl oyster *Pinctada fucata* and short neck clam *Paphia malabarica* fertilization is external and the fertilized egg takes 18 hrs to develop in to D shaped larvae. In 17-21 days the larvae attains eyespot larval stage after passing through morula, D veliger and umbo stages. Then it passes through the pediveliger and palntigrade stage and reaches the spat stage. The typical bivalve larval life stages as recorded for the commercially important green mussel is given (Fig. 1).

Micro-nursery system: This consists of one down-welling and one upwelling sub systems and each with separate reservoir tanks and pumps for providing water circulation (Fig 2). In the down-welling system eyed stage larvae of mussel, oyster or clam can be stocked at high density for settlement and further growth. When the settled spat reaches 4 mm size it can be transferred to upwelling system for further rearing.

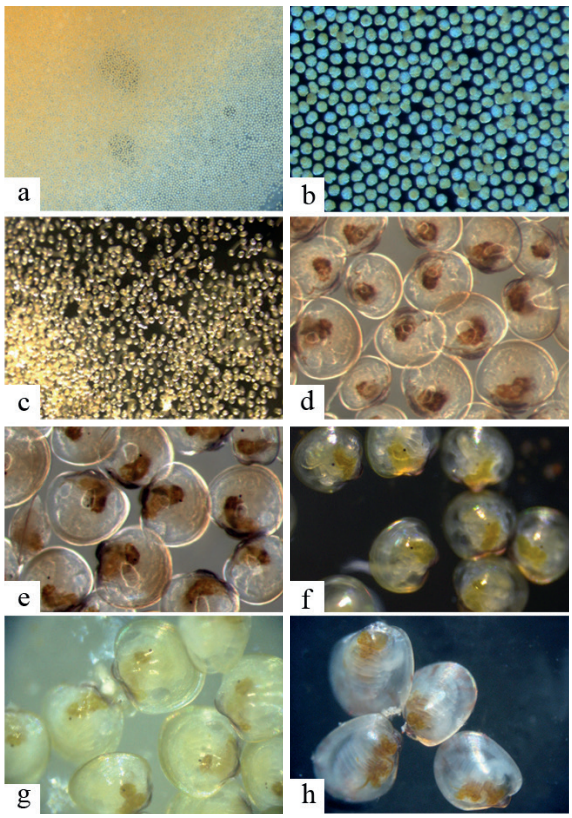

Fig. 1. (a-h) Larval stages of green mussel *Perna viridis* (a) Fertilized eggs (b) Morula stage (c) D-veliger stage (d) Umbo stage (e) Eye-spotstage larvae (f) Pediveliger stage (g) Plantigrade stage (h) Spat

Fig.2 Micronursery

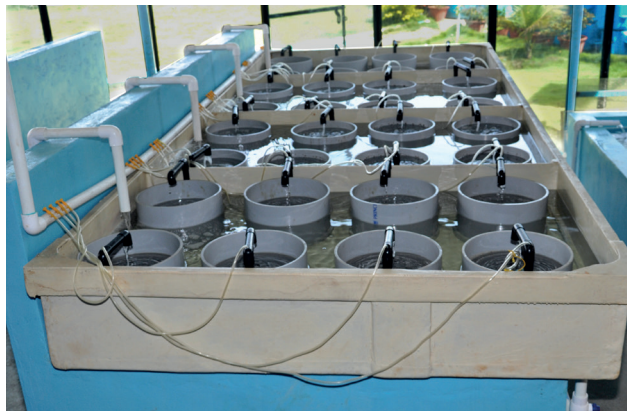

Fig. 3. Down-welling compartments and wells

Down welling system: This unit has 2000 litre capacity divided into 4 compartments of equal size (Fig.3). Down-wellers are the containers or vessels designed to rear the eyespot larvae until they metamorphose to spat. Each compartment has eight PVC wells each of 30 cm diameter and 25 cm height. Wells are provided with air lift mechanism for pumping water to the well from the compartment system. There are downwellers with 150 μ, 250μ, and 750μ mesh which can be used in succession as the growth of the bivalve larvae proceeds. Spat is allowed grow in the down welling containers or wells till they reach 4 mm size that can be transferred to 2 mm upwellers.

Through all the 32 wells water passes from surface to down the system through the mesh (down-welling). Eyed stage bivalve larvae can be transferred directly to down-welling wells with 150 micron mesh. A 30 cm diameter down-weller can accommodate up to 0.3 million eyed larvae. Eyed stage will settle in the wells and can be grown till 2 mm (15-20 days) size by changing to 250 μ and 500 μ wells. On the 20th day the spat are transferred to 750 μ mesh and grown there till they reach 4 mm (15-20 days).

Up-welling system: It has two race way compartments with a total 1500 litre volume capacity (Fig.4). Each compartment has 8 wells provided with the bottom mesh of 2 mm size. Here spat can be grown from 4 mm to seed size of 20 mm in 60 days. Water flows from these compartments up through the mesh (upwelling) of the wells upwards to the middle drainage section through a half inch pipe and from where water is drained to the reservoir. Stocking rate in the upwelling wells is from 50000-100000 depending on size and species.

Seawater with required feed is circulated through the systems from the reservoir by two dedicated pumps of 0.2 hp. Required quantity of the feed proportional to the stocking density and size of the spat is directly poured in to the respective reservoirs of upwelling and down welling systems. In the micron nursery usually the feed given is ratio of 2:1:1 *Chaetoceros calcitrans*: *Isochrysis galbana:Nanochloropsis salina.*

About 0.1 million spat can be nursery reared to seed size (8-12 mm) in a micron meshed nursery within 45

Fig. 4. Up-welling system

days and 17-20 mm on 60 days. On the other hand, spat reared in hatchery shows only limited growth and low stocking density. Seed grown in the micro-nursery nursery can be used for seeding ropes or used for on-bottom farm nurseries for further growth.

Every alternate day the wells are cleaned by spraying seawater through a nozzle connected to 0.5 hp pump and water is fully drained from the compartment and reservoirs and refilled with fresh seawater so that all the accumulated waste materials are removed.

There is a high demand for bivalve seed especially mussel and oyster seed as the quantity of seed available from the wild are erratic. Also, most of the time when it reaches the farmer it is of lowered quality. Bivalve seed of required quality and quantity can be made available using the present technology.

Brief Communications

An emerging fishery for the jellyfish *Crambionella annandalei* along the coast of Andhra Pradesh

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Crambionella annandalei is a rhizostomatid jellyfish (class Scyphozoa) and locally known as *Munthakaya* (Fig.1). The swarms of this species was considered a menace to coastal fisheries as it caused damaged to fishing nets and hindered the fishing operations. However, the species is emerging as a targeted fishery resource along the coast of Andhra Pradesh due to increased demands of processed oral arms of jellyfish in south-east Asian countries and delivers additional income to coastal fisher folk involved in this activity.

An estimated landing of 0.02 lakh tons of the species was recorded in 2017, which increased to 0.033 lakh tons in 2018. The fishermen operate a gillnet (*Polusuvala*) from traditional crafts (motorized and non-motorized) at water depths of 10 to 40 m to catch jellyfish. The fishing season is during the period from March to July with the peak fishing season being June and July. On an average about 60-70 boats with 6-7 persons in each boat are going to the sea everyday to catch jellyfish. Fishermen often cut off the umbrellas while at the sea and only the oral arms are loaded into the boat (Fig.2). Sometimes when catches are less they bring the whole

Fig. 1. *Crambionella annandalei*

Fig. 2. Unloading of oral arms from motorized craft

jellyfish and sorting is done at the landing centre. A single boat can land about 150-330 kg oral arms per day with average weight of such landings being 240 kg. Fishermen sell the jellyfish at price of ₹700 to ₹2000 per crate. The oral arms constitute 30-35 % of wet weight of the body. The price of one kilogram of unprocessed oral arms of jellyfish ranges from ₹20 to ₹55 depending on the size. Local traders and processors purchase the jellyfish from fishermen. Oral arms of jellyfish are also processed into a semi-dried product through a stepwise procedure of soaking in various mixtures of salts (Fig.3). Then, semi dried oral arms are packed in 20 liters plastic bucket. Each bucket is filled with 16 kg semi dried oral arms and 4 litres salt water (Figs.4 &5) which are transported to Chennai and from there, exported to south-east Asian countries mostly China.

Fig. 3. Salt curing of oral arms of the jellyfish

Fig. 4. Semi dried oral arms

Fig. 5. Packing of salted semi dried oral arms in plastic buckets

Morphology of the sagittal otoliths of *Ariomma brevimanum* and *Ariomma indicum*

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The family Ariommatidae has only one genus *Ariomma* Jordan & Snyder, 1904 and 7 valid species (Froese and Pauly, 2018) which is grouped into two, as deep bodied or elongated type species based on the body shape (Ajiad and Mahasneh, 1986). Of the seven species of *Ariomma* so far described, two species *Ariomma indicum* (Day, 1871) with widespread distribution in Indian EEZ and *Ariomma brevimanum* (Klunzinger, 1884), recently reported occur in Indian waters. The two species can be easily identified based on general body profile with *A. indicum* having a deeper body (body depth 40-46% of standard length) and *A. brevimanum* having long and slender body (body depth <26% of standard length).

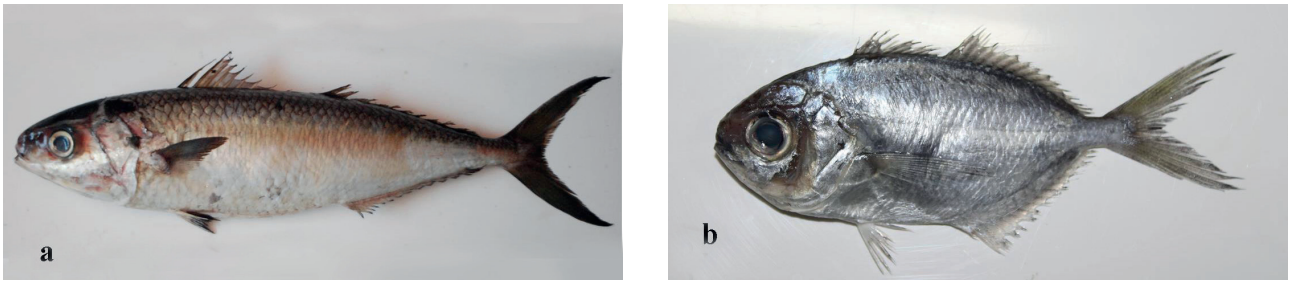

Fig. 1. *A. brevimanum* of 605 mm standard length (a) and *A.indicum* of 142 mm standard length (b) recorded from landings in Cochin Fisheries Harbour.

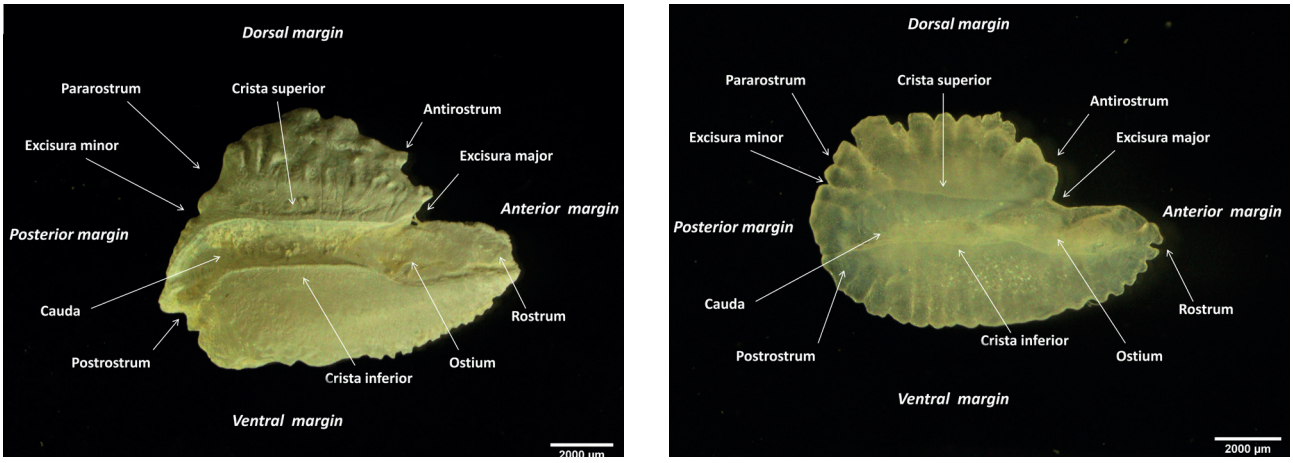

Fig. 2. Sagittal otolith of (a) *Ariomma brevimanum* (605 mm SL) and (b) *Ariomma indicum* (142 mm SL)

Otolith morphology, especially of sagittal otolith has been used in various fish taxonomic studies and investigations on age, growth, feeding habits, and stock identification in fishes. The variations in the shape of the sagitta otolith are species specific (Paxton, 2000) and efforts to document the otolith shapes of several fishes are in progress globally. Otoliths were extracted using "up through the gills method" (Secor *et al*. 1991), cleaned gently with fresh water, air dried, and then stored in labelled 10 ml glass vials. Images of medial face of the otoliths were captured using a stereo microscope (Nikon SMZ1270). The left and right sagittal otoliths of each species were similar in gross morphology and shape. The otolith shape of *A. brevimanum* was found to be somewhat rounded whereas in *A. indicum* it was relatively elongate. The rostrum was prominent and relatively longer in *A. indicum.* The otolith of both the species was heterosulcoid with crista superior and crista inferior running parallel to each other and bending ventrally at the posterior end. The dorsal margin in both the species were round but differences were observed in ventral and posterior profile (Fig. 2). Pointed antirostrum was observed in *A. brevimanum* unlike the gradually sloping shape in *A. indicum.* Otolith shape analysis is becoming an increasingly popular tool in fish taxonomy studies. Hence the present study used comparison of the otolith shape of two ariommatids from Indian waters collected as part of a species based sagittal otolith shape and morphology database, that can be used in fish taxonomy studies for species confirmation and diet composition studies to identify the possible prey to species level based on digested food materials in fish guts.

Brief Communications

Report on occurrence of Purple back flying squid in hook and line fishery off Vizhinjam, Kerala

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Three specimens of Purple back flying squid, *Sthenoteuthis oualaniensis* (Lesson, 1830) were landed on 23.3.18.They were caught by hook and line operated at a distance of 25-30 km from the shore with the aid of LED lights from multiday gill netter unit based at Vizhinjam Fisheries Harbour. This fast growing oceanic species belongs to

Table 1: Morphometrics (in mm) of Purple back flying squid specimens landed at Vizhinjam Fisheries Harbour

Characters	Sample -1	Sample -2	Sample -3
Dorsal mantle length	220	221	214
Ventral mantle length		215	205
Mantle width	110	95	90
Head length	56	48	56
Head width	38	42	40
Tentacle length	360	405	322
Fin length	103	Damaged fins	86
Fin width	90		66
Weight (g)	590	437	359

the family Ommastrephidae typically occuring in the depth range of 200-400 m. (FAO Species Catalogue for Fishery Purposes No. 4, Vol. 2). Previously, on 15.2.2018, landing of 17 kg of Purple back flying squid was reported by the Fishery Resources Asssessment Division (FRAD) during routine Random Stratified Multi-stage Survey of fish landings at Vizhinjam Fisheries Harbour.

Sucker on the manus had 4 large, pointed teeth on each quadrant which is characteristic feature of purple back flying squid. Based on dorsal photophore and cladius morphology and size differences in matured specimens, these squids are grouped into 5 different forms. Present specimens belonged to typical middle sized form**,** characteristic yellow chromatophore on the dorsal mantle surface. All three specimens were females in partially spent condition indicated by flaccid nidamental gland with remnant eggs. Dorsal mantle length varied between 214-221 mm and their weight ranged between 359-590 g.

Fig.1. Purple back flying squid, *S. oualaniensis* a) dorsal view b) ventral view (c) cut open to show flaccid nidamental gland, oviducal gland and ovary

Heavy landing of small sized Indian mackerel by ring seine units

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Pazhaverkadu in Thiruvallur district of Tamil Nadu is unique in that ring seine operations are rampant here while in the adjacent Chennai area, these are not operated, mainly as a result of consensus among the fishermen against its use. On 2.5.2017, heavy landing of Indian mackerel by the ring seines operated at Pazhaverkadu as per operational details gathered from the fishermen. Each mother boat unit of 12 m overall length (OAL) had 5 to 6 carrier boats with a capacity of 1500 kg each. An estimated 60 t of mackerel whose size varied from 170 to 185 was landed by around 80 units. All were in immature stage with gut containing zooplankton. Because of their small sizes, the price per kilogram of mackerel was around ₹30 only and this too only because it was the annual fishing ban period when catches are generally low. The entire catch was transported to Kerala. Enquiries revealed the landing of mackerel by ring seines had started from 26.4.2017 and continued up to 4.5.2017.

Speargun fishing off Kovalam coast

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As an adventure underwater sport, speargun fishing is practiced at Kovalam coast near Thiruvananthapuram, Kerala. Spearguns are designed to launch a spear at fish or other underwater animals based on a trigger mechanism. The spear has a flopper or barb that is attached to the muzzle of the gun by a monofilament line and basically the two types of guns used are pneumatic and rubber band powered spear guns. Off Kovalam coast, mainly imported ones obtained from the visiting foreign tourists are popular (Fig.1).

Fishermen as well as expert skin divers whenever free from other fishing and livelihood activities, are involved in spear gun fishing designed for sport tourists, which occurs throughout the year but peaks during October - March period. A fisherman or an expert diver who can do dives of about 12-15 m from the surface proceeds to the ground located around 2 km from the coast along with the tourists. A fibre boat with an overall length of 9 m fitted with an outboard engine of 40 hp with a fish hold on the deck to hold the catch in fresh condition is employed. The duration of the trip varies from 3-5 hours and can bring in about 12-30 kg of high valued table fishes. Assorted reef fish, such as groupers, red snappers, jacks, barracudas, mackerels, cobia, leather skin, sweet lips, spade fish, surgeon fish

and big trevally in extremely fresh condition, fetches high price from the nearby star hotels at Kovalam which in turn provides further income to the fishers. Harpooning or spear fishing is restricted mainly to sport fishing in most of the countries. Often, the fishermen selectively target the biggest fish they can find, which often will be the brooders whose excessive removal can affect the reproductive potential of that particular stock. Also with prevalent low concern about diving safety, several divers carrying a loaded spear gun in a restricted area during the peak seasons can be potentially dangerous. This adventurous fishing activity, needs to be focused and developed as a sport with proper guidelines for safety of the sports fishermen as well as the fishermen community who guide and conduct these programmes.

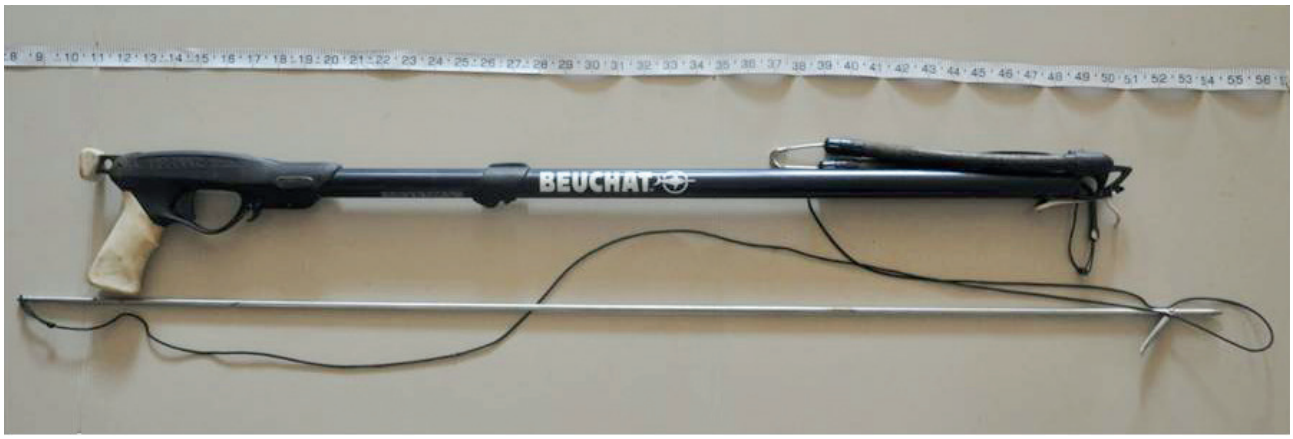

Fig.1. A spear gun operated along Kovalam coast

Kaleidoscope

Nesting of Olive Ridley turtles at Chavakkad Beach

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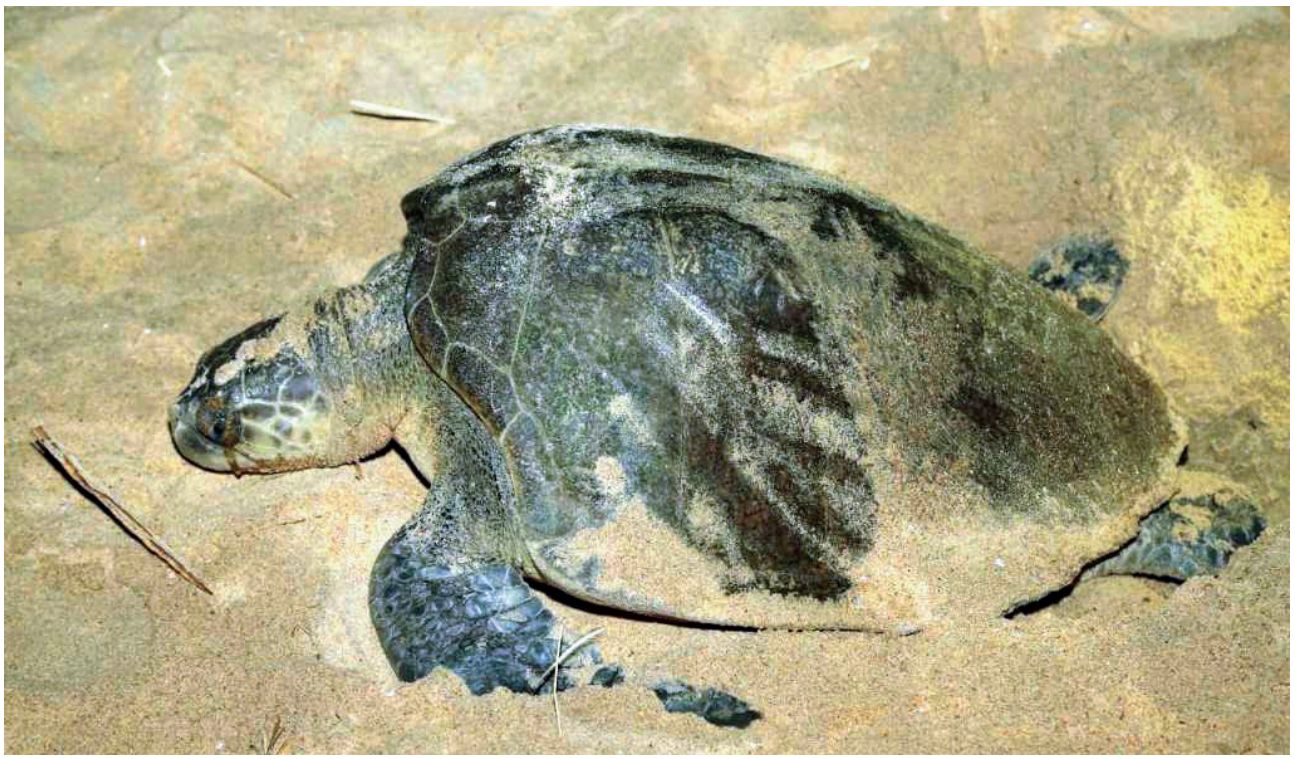
There are several reports on the nesting of Olive ridley turtles, *Lepidochelys olivacea* from the east coast of India and the Andaman Islands but similar reports for the west coast of India are scanty. Every year Olive ridley turtles nest during November to March with important sites being Panchavadi, Edakkazhiyur and Akalad beaches along Chavakkad coast in Kerala. The turtles come to the shore during night time to lay their eggs in pits created by scraping out sand with its hind flippers and after covering the same wit sand again, returns to the sea. It was found that jackals and stray dogs were digging the nests and devouring the eggs disrupting the recruitment of these turtles. Hence, volunteers of Green Habitat, an NGO committed to conservation, built a hatchery which was also used for education and public awareness programmes on turtle conservation. The collected eggs were transferred to this hatchery. During the breeding season of 2017-18, ten nests were saved from these three



nesting sites in Chavakkad. The clutch size varied from 40 to 129 eggs and the eggs hatched after 45-50 days. Out of 1025 eggs that were saved, 490 eggs hatched. Local people, fishermen, students. were invited when the baby turtles were released in to the sea (Plate 3). In Kerala turtle nesting has been reported from Puthen Kadappuram beach and Palapetty beach in Thrissur district. Olive Ridley turtles are categorized as Vulnerable on the IUCN Red List (IUCN, 2010) and are included in Schedule-I of the Indian Wildlife (Protection) Act, 1972. To protect these turtles, use of trawlers and fishing nets during mating and nesting season should be regulated and awareness among fishermen should be created to release the accidentally caught turtles back into the sea.

Unusual landings of the anthiine fish, *Pseudanthias pillai* at Neendakara Fisheries Harbour

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Fishes of the genus *Pseudanthias* (Family Serranidae) also known as "fairly basslets" or "anthias" are mostly small sized, reef-dwelling fishes, which are highly sought after marine ornamental fish in the international market due to its beautiful coloration and striking patterns. An unusual landing of the anthiine fish, Pillai's anthias *Pseudanthias pillai* was observed at Neendakara Fisheries Harbour, Kollam on 9.5.2018 (Fig.1). About 750 kg (25 boxes of 30 kg each) of anthiine fishes, dominated by *Pseudanthias pillai* (99%) and *Pseudanthias* spp. were landed in a multiday (3 days fishing trip) trawler operated at 120-130 m depth off Kollam waters, Arabian Sea. Other commercially important fish catch of the same trawler was threadfin bream *Nemipterus randalli* (350 kg) and Indian scad *Decapterus russelli* (400 kg). Size of *Pseudanthias pillai* ranged between 85 - 135 mm in total length and between 10 - 45 g in weight. These fishes locally called as "*Thathamma meen*" meaning Parrot fishes in Malayalam were sold at the landing center at the rate of ₹50-60/kg for local consumption. Pillai's anthias, a rare beautiful anthine fish, with distribution known from Ratnagiri to Vizhinjam on the southwest coast of India is rarely observed in the commercial fishery landings and occurs in few, stray numbers only. Such unusual high catch of *P. pillai* shows that the species maybe forming schools.

Fig.1. Landing of Pillai's anthias at Neendakara Fisheries Harbour, Kollam, Kerala

Incidence of whale strandings in Uttara Kannada, Karnataka

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Two instances of the whale strandings were observed in the Uttar Kannada district of Karnataka recently. The first one occurred on 06.05.2017 at Mungodlu, Kumta and the second at Karwar on 18.02.2018. The whale stranded at Mungodlu, near Vannalli village of Kumta Taluk, Uttara Kannada district, Karnataka (14° 26' 034" N and 74° 23' 005" E) was washed ashore in highly decayed condition with its dorsal portion upside down and species could not be identified. The total length of the whale was approximately 9 metres. The vertebrae were found exposed in the beach and a few numbers were collected and preserved in the museum of Karwar Research Centre of ICAR- CMFRI (Fig. 1).

The second dead whale washed ashore on the Tagore beach (14^0 82' 37" N and 74^0 12' 55" E) of Karwar city on 18.02.2018 in the early morning hours was identified as *Balaenoptera* sp. by external characters. It was found in two pieces, one near the Tagore beach (Fig.2.) and another near the Kodibag beach. Detailed morphometric measurements could not be taken since it was in decomposed condition, probably dead 8-10 days before it washed ashore. It was measuring approximately 15 metres in length and around 12 tonne weight. No external injuries were observed on the body while trunk portion was tied with the rope (Fig 3).

Fig. 1. Whale stranded at Mungodlu, near Vannalli of Kumta Taluk

Fig 2. Part of the whale stranded at Tagore beach, Karwar

Fig 3. Whale tied with the rope

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

Friedman and Bell. 1996. *J. shellfish Res*., 15: 535-541. (Reference with two authors)

Pauly, 1980. *FAO Fish. Tech. Pap*., 234.

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