ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2015; 3(2): 24-34

www.fisheriesjournal.com
Received: 27-08-2015
Accepted: 28-09-2015

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Fisheries profile of Zuari estuary

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Abstract
The inshore coastal waters where traditional and motorised fisheries operate contain rich fishing grounds. The gears such as shore seines and drag nets are operated from the beach, while gillnets, drift nets, traps and hooks and lines are operated from boats along the coastal waters. Estuaries are important coastal ecosystems that yield rich variety of fishes, crustaceans and molluscan resources. These ecosystems provide breeding, hiding and nursery grounds for more than 200 species of marine fishes and shellfishes. However, no extensive studies were done earlier to catalogue the fishery and species diversity in these ecosystems. The Zuari estuary, one of the major estuaries of Goa, located in the southwest coast of India connecting to the Arabian Sea through Mormugao Bay represents a very rich coastal ecosystem for fishery resources. A traditional fishery comprising of motorised and non-motorised boats operate gillnets and hook lines exist in the Zuari estuary. An effort was made in this study to catalogue the fisheries profile and fish and shellfish diversity in Zuari estuary.

Keywords: Zuari estuary, gillnet fishery, hook and line, fisheries management

Introduction
The margins of Zuari estuary have dense mangrove vegetation filled with silt, clay and detritus that has been transported by riverine influx from upper reaches. The entire mudflats along with mangrove vegetation make the region highly productive supporting large number of economically important species. This region receives the maximum precipitation during the southwest monsoon accompanied by stormy weather, while quieter conditions prevail during rest of the year. The Zuari mouth in this study is characterized by the estuarine influences of the river. Reports say that that the region is very important to a number of finfishes and shellfishes of commercial significance. These areas are utilized both as a nursery ground by marine species and as a residence for euryhaline coastal and estuarine species. Apart from these, the juveniles of many of these species are also frequently abundant in these bays and estuaries. The existence of typical tropical conditions is characterized by high temperature and longer photoperiod which is conducive to greater biological productivity. The tidal regime also results in a long flushing period and thus, there is a prevalence of greater species diversity in the estuary. Traditional fishery within this coastal zone (mouth of Zuari estuary) is considered to be an activity which will be significantly correlated to the finfish and shellfish diversity along the coastal ecosystem. The entire coastal zone has a bed of rocky patches (which makes it unsuitable for trawling) and hence the gillnet fishery represent majority of the landed catch. The region holds a medium fish landing centres like Siridao, Cacra, Odxal, Bambolim and Nauxim which lands about 1000 tonnes of fish every year (Table 1). The gillnet fishery is found to be a major subsistence activity of the traditional and motorised fishermen along these regions along the Zuari mouth with catches consisting of diverse fish and shellfish taxonomic groups. Moreover, occasional hook and line fishing and skin diving for bivalves are also included in the fishery of Zuari.

General fisheries profile of Zuari estuary

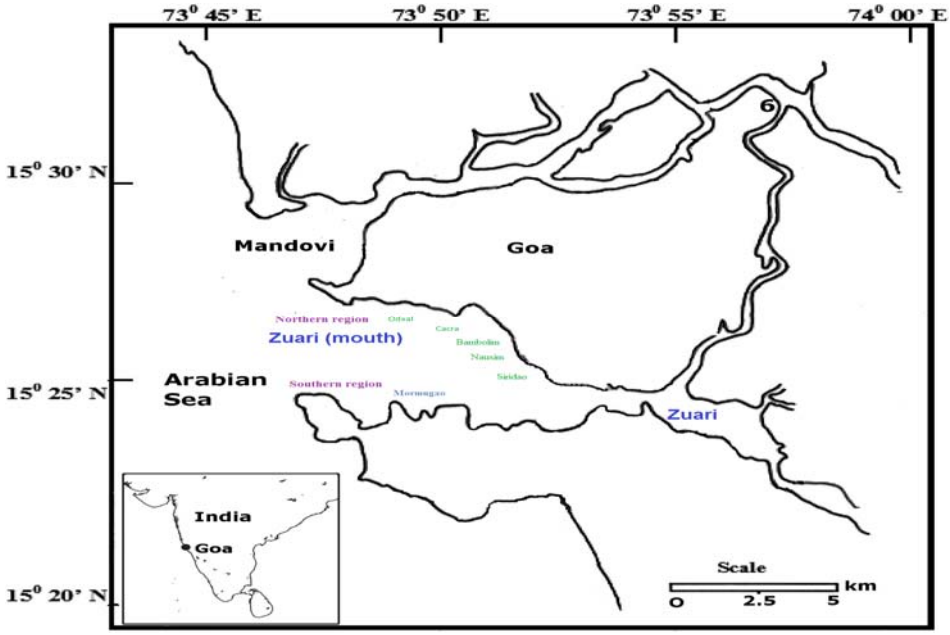
Particulars	Details
Fishermen families	1000
Fishermen population	3000
Average size of family	4.5
Active fishermen	500
Major occupation	Fishing
Methods of fishing	Gillnetting, Hook and line fishing and skin diving
Fishing craft types	Fibre glass (4-8 m LoA) and Wooden (2 to 5 m LoA)
Mode of operation	Manual and motorised (8.8 to 9.9 HP)
Gears used	Gillnets, seine nets, hook & lines and traps
Mesh size (mm)	30-200 (Gillnet)
Average Catch Per Unit Effort (kg/hr)	10-12
Value Per Unit Effort (Rs./hr)	500-700
Average monthly income	6000-7000
Average fish landings in an year (tonnes)	1000
Major species in fishery	Mackerel, sardines, white sardine, mullets, white baits, moustached anchovy, mullets, silver bellies, carangids, croakers, cat fish, crabs, shrimps

Fishing conflicts and actions

The introduction of more efficient fishing technology and the expansion of the fishery were necessary to tap the unexplored fishery potential along the Indian coast. This led to the division of two social, economic and ethnic fishing groups - one representing the artisanal or small-scale sector and the other, the mechanised fishing sector, both competing and exploiting the same resource in the inshore waters. The present study area is subjected to a relatively high mechanized fishing pressure which has resulted in changes in the major taxonomic groups and size structure of some of the dominant genera and species. The operation of illegal mechanised vessels in the coastal ecosystems is reported. This will have negative impacts on the populations of resident species, semi-resident species and migrant species in the coastal system. Moreover, there is a division in the fishing operations like the mechanised, motorised and traditional operations. The traditional and motorised fishermen are represented by the coastal communities who operate their gears from motorised (Out Board Motor (OBM) upto 10 HP) and non-motorised boats within the 5 km stretch and the power of motor will be upto 10 HP. Moreover, they will be using vessels less than 12 m in length. However, the intrusion of mechanised vessels into the coastal zones as well as the exposure of motorised fishermen beyond 5 km have created a critical social concern in fishing operations and resulted in fishing conflicts. Similarly, there is also a conflict in the fishing fleet between the mechanised and traditional fishing sector in this estuary. However, recently the fisheries department has introduced a fisheries patrolling boat and become functional since October, 2014 which has thinned this conflict as the intrusion of mechanised vessels was reduced since then. Thus, the fisheries department has taken a very good initiative to conserve the fish diversity and preserve the traditional fishery in this estuary

In order, to state the importance of coastal ecosystem to the stakeholders, a cataloguing effort was essential along the proposed site. Hence, the present study was carried out to document the species diversity of Zuari estuarine mouth from September 2013 to March 2015.

Traditional fishery of Zuari estuary



The major fish landing sites and fishing villages in Zuari estuary

View of the traditional fish landing site in Zuari estuary (Siridao)

Fishing is found to be a major subsistence activity of the people in this region. Therefore the main settlements on the estuary are the rural communities of tribal fishermen (Gawde Tribe) which consist of mostly of Kongini speaking people. There are about 300 active fishermen operate gillnets throughout the year. Since early 1850s, the people of these communities are engaged in fishing. However, most of the people who were fishing in the estuary are moved to Portugal through Portuguese visa followed by India's independence in 1947. Motorised boats (made of FRP (4-8 m LoA) or wood (2-5 m LoA) which use an OBM are used in the gillnet fishery. Monofilament nylon bottom set gillnets are commonly used in the estuary targeting mackerel, sardines, white sardine, mullets, white baits, moustached anchovy, mullets, silver bellies, carangids, croakers, cat fish, crabs and shrimps (Table 1). The gillnets of different mesh sizes ranging from 30-200 mm are used in fishing grounds of 2 to 5 m depth. They are usually set early in the morning and hauled after two hours. Moreover, they also operate hook and lines during the pre-monsoon season (February to May). Skin diving for collection bivalves like mussels and oysters also happens during the pre-monsoon. The catches are marketed fresh in major fish markets of Goa (Panjim and Mapusa) and about of 10% catch is used for their own consumption. The fisherwomen are engaged in the marketing of fish.

FRP boats operated in Zuari estuary

Non-motorised wooden boat **Motorised wooden boat**

Gillnet fishery

Gillnet fishery represents the major fishery and contributes to 90% of the total fish production from Zuari estuary. Gillnets are operated from FRP and wooden boats with and without OBM. Gillnets of various mesh sizes ranging from 30-200 mm are used for fishing while the gillnets of 30-60 mm are used regularly. A total of 184 aquatic species comprising 145 finfish species (Pelagic-58, Demersal-87) and 39 shellfish species (17 crustacean species and 22 molluscan species) were collected during this survey (Table A2).

Species caught in gillnets of different mesh sizes in Zuari estuary

S. No.	Mesh size of gillnet	Species
1	30 mm	Mixed catch
2	36 mm	Mixed catch
3	40 mm	Mixed catch
4	46 mm	Mixed catch
5	52 mm	Mixed catch (large size)
6	60 mm	Mixed catch (large size)
7	120 mm	Crabs and catfishes
8	160 mm	Seabass and snappers
9	200 mm	Rays

Fish gillnet (36 mm) **Fish gillnet (40 mm)**

Crab gillnet (120 mm) **Seabass gillnet (160 mm)**

Ray gillnet (200 mm) **Gillnet catch sorting**

Species composition (This includes catch composition analysis from 30-60 mm gillnets)

White sardine, *Escualosa thoracata*: this pelagic single species is found to be the major constituent of the fish catch in the mouth of Zuari estuary. It has contributed to 13.3% of the total abundance (numbers) of fish catch.

Penaeid shrimps: Penaeid shrimps contributed to about 9.7% of the total abundance (numbers) of fish catch. The major species caught in the estuary were *Fenneropenaeus indicus, Marsupenaeus japonicus, Metapenaeus affinis, M. brevicornis, M. dobsonii, M. monoceros* and *Parapenaeopsis stylifera*.

Silverbellies: They are the common demersal resources along the Zuari estuary. They have contributed about 9.5% of the total abundance (numbers) of fish catch. The major species caught were *Leiognathus brevirostris, L. blochii, L. bindus, L. dussumieri, L. splendens, L. daura, L. equulus* and *Secutor insidiator*.

Crabs: Crabs are found to be one of the major resources along the coastal region of Zuari mouth. They have contributed about 8.2% of the total abundance (numbers) of fish catch. The major species caught in the estuary were *Portunus pelagicus, P. sanguinolentus, Scylla serrata, S. tranquebarica, Charybdis lucifera* and *C. natator.*

Mullets: They are the most dominant typical estuarine species along the coastal regions. They have contributed about 8% of the total abundance (numbers) of fish catch. The major species caught were *Mugil cephalus, Valamugil cunnesius, Liza parsia, Liza tade* and *Liza macrolepis.*

Shads: They are one of the important pelagic resources available along the Zuari estuarine system. They have contributed about 7.4% of the total abundance (numbers) of fish catch. The major species caught were *Tenualosa toli, Ilisha filigera, I. megaloptera* and *I. melastoma.*

Moustached anchovies: They are also one of the common pelagic resources available along the Zuari estuarine system. They have contributed about 7% of the total abundance (numbers) of fish catch. The major species caught were *Thryssa malabarica, T. mystax, T. setirostris* and *T. hamiltonii*.

Carangids: They are also one of the diverse pelagic resources available along the Zuari estuarine system. They have contributed about 5.2% of the total abundance (numbers) of fish catch. The major species caught were *Alepes kleinii, A. kalla, S. commersonianus, Megalaspys cordyla, A. melanoptera, Atule mate, Trachinotus mookalee* and *Carangoides praeustus.*

Bony breams: They are one of the common pelagic resources along the mouth of the Zuari estuary. They have contributed about 4.3% of the total abundance (numbers) of fish catch. The major species caught were *Nematalosa nasus* and *Anodontostoma chacunda.*

Sardines: They are one of the common pelagic resources along the Zuari estuary. They have contributed about 3.7% of the total abundance (numbers) of fish catch. The major species caught were *S. longiceps, S. gibbosa* and *S. albella.*

Croakers: They are one of the important resident demersal resources along the Zuari estuary. They have contributed about 3.1% of the total abundance (numbers) of fish catch. The major species caught were *Johnius macrorhynus, J. belangerii, J. dussumieri, Otolithes ruber, O. cuvieri, O. argenteus, Johnieops sina, J. borneensis, Dendrophysa russelli, Nibea albida* and *N. soldado*.

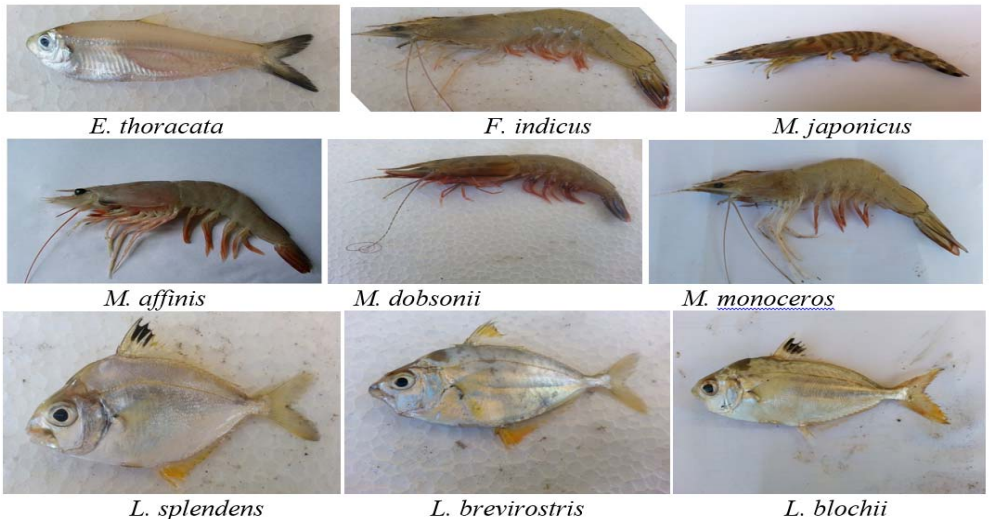
Indian mackerel, *Rastrelliger kanagurta*: This is one of the most important pelagic single species contribute to the fish catch from Zuari estuary. It contributes about 3.1% of the total abundance (numbers) of fish catch.

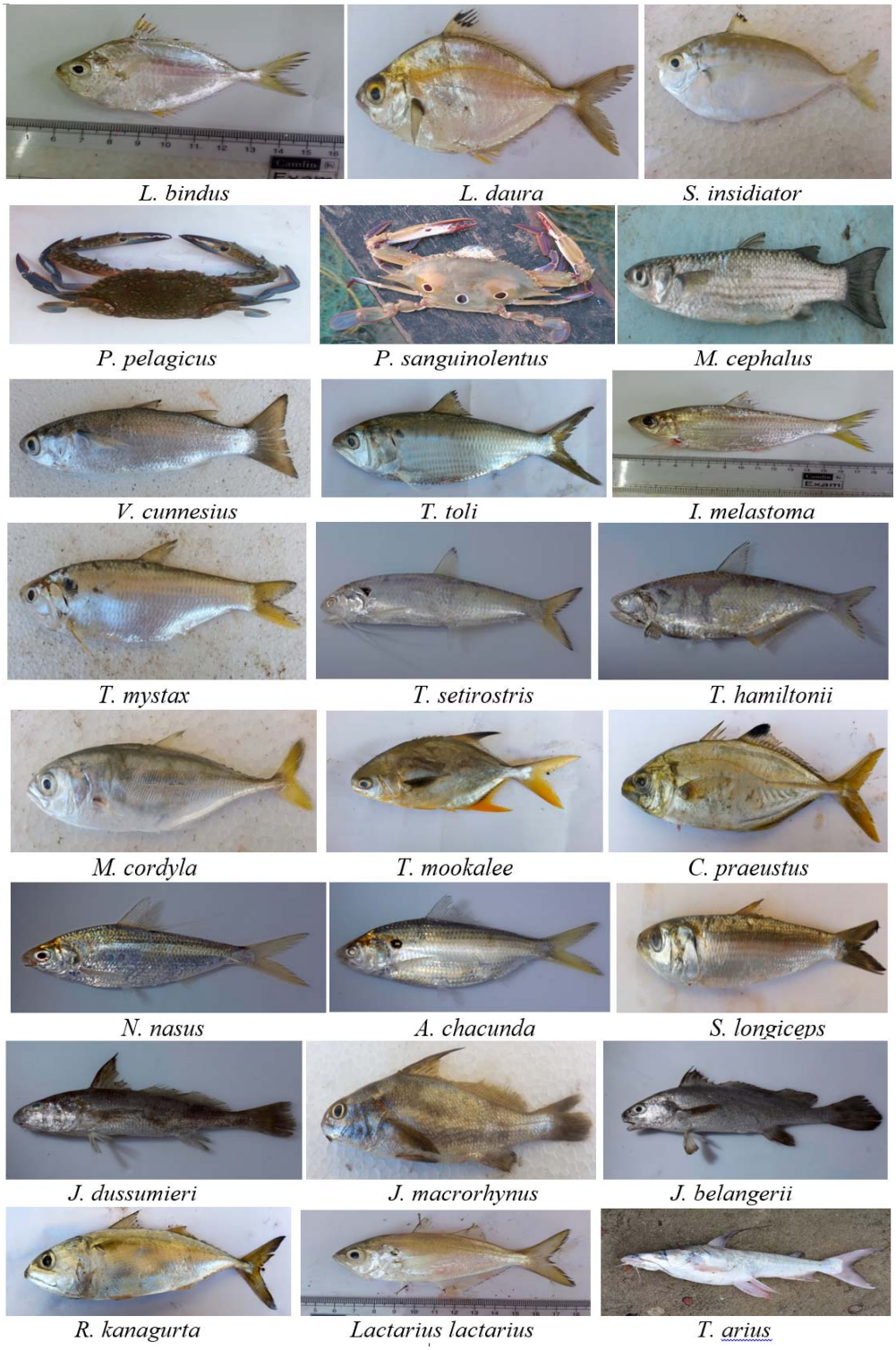
Whitebaits: They are one of the common pelagic resources along the Zuari estuary. They have contributed about 2.3% of the total abundance (numbers). The major species caught were *Stolephorus commersonii* and *S. indicus.*

Bigjawed jumper, *Lactarius lactarius*: It is one of the important single species demersal resources along the Zuari estuary. It contributes about 1.7% of the total abundance (numbers) of fish catch.

Catfishes: They are one of the common demersal resources along the Zuari estuary. They have contributed about 1.1% of the total abundance (numbers) of fish catch. The major species caught were *Arius platystomus, Tachysurus arius, A. caelatus, A. dussumieri, A. thalassinus* and *A. jella*.

Silverbiddies: They are one of the common demersal resources available all along the Zuari estuary. They have contributed about 1% of the total abundance (numbers) of fish catch. The major species caught were *Gerres filamentosus, G. setifer, G. oyena, G. limbatus* and *G. longirostris.*

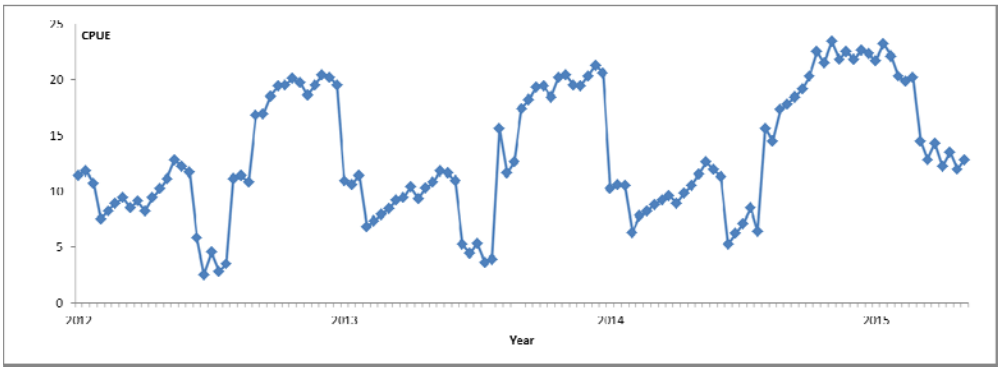




Fishes caught in gillnet fishery

Trend in fish catch in the estuary

The traditional fishermen catch per unit effort (CPUE in kg/hr) in gillnet fishery has followed a fluctuating trend during 2012 to 2015 (2012-2013 data collected from fishermen's log book and fisheries department) with highest catches during the post-monsoon season (October to January) and lowest catches during pre-monsoon season (April and May). However, the catch rates have not declined seriously from 2012 to 2015. Moreover, there was an increase in catch rates since 2014. The increase in catch rates during this period may be attributed to the reduction of illegal intrusion of mechanised fishing due to the continuous surveillance from patrol boat of fisheries department. The total fish catch in the estuary has also portrayed that the fish catches were high during post-monsoon season in comparison with the other seasons. In this estuary, the average annual fish catch during 2012-2015 was 1050.5 tonnes with highest and lowest values during post-monsoon (542.3 tonnes) and pre-monsoon (145 tonnes) seasons respectively. The average fish catch during monsoon season was 322.1 tonnes.



Source: Interview with key fishermen and the data collected during this study

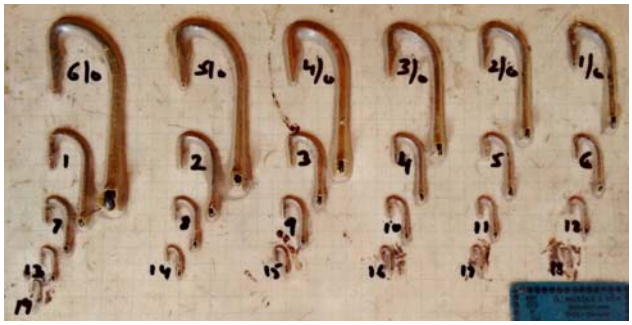
The trend in CPUE during 2012-2015

Hook and line fishery

Hook and line fishery represent a minor fishery in Zuari estuary in which about 60-80 fishermen are involved. The contribution of this fishery is negligible in comparison with the gillnet fishery. However, this fishery deals with large sized specimens and unit value of catch is on the high. They use different types of hooks for catching different species of fishes. The hook and line fishing is season specific and mostly carried out during the end of post-monsoon season and pre-monsoon season. A total number of 50 species support the hook and line fishery in Zuari estuary.

Species caught in hook line fishing

S. N.	Hook type	Fishes caught	Species
1	No. 13 and 15	Indian Whiting, rabbit fishes, wrasses, gobies, small groupers, scat	*Sillago sihama, Siganus canaliculatus, S. javus, S. vermiculates, Halichoeres nigrescens, Istigobius diadema, Epinephelus diacanthus, Scatophagus argus*
2	No. 1 to 3	Seabass, snappers, groupers	*Lates calcarifer, Lutjanus argentimaculatus, L. johnii, L. rivulatus, L. indicus, L. fulvus, Epinephelus diacanthus, Epinephelus coioides, Cephalopholis formosa,*
3	No. 4 to 6	Sea bream, snappers, mullets, carangids, seerfishes, polynemids	*Acanthopagrus latus, A. berda, Lutjanus argentimaculatus, L. johnii, L. rivulatus, L. indicus, L. fulvus, Mugil cephalus, Caranx sp., Scomberomorus commerson, Eleutheronema tetradactylum*
4	No. 1/0 to 6/0	Snappers and Groupers (large sized)	*Lutjanus argentimaculatus, L. johnii, L. rivulatus, Epinephelus coioides*



Hooks of various dimensions

Multiple hooks for seabass

Fishes caught in hook and line fishing

Collection of mussels, oysters and sea slugs

The mussel, *Perna viridis* and oysters, *Crassostrea madrasensis* and *Saccostrea cuculata* are the important bivalves available in the estuary. They are concentrated on the rocky patches along the estuary. There are about 20-25 skin divers among fishermen who collect mussels and oysters in the pre-monsoon season. Due to the drastic decline in the production of mussels and oysters from the estuary, there is religious restriction in the collection of mussels during the spawning and growing stages (September to February). The spawning season for mussels is reported as from September to October. Thus, the collection of mussels and oysters starts in the Zuari estuary after the religious pooja offered to Goddess during February and the collection extend till the third week of May. The clams are collected throughout the year in the estuary. However, the sea slugs are collected from the rocky regions during post-monsoon and pre-monsoon seasons.

Information on collection of bivalves and sea slugs

S. N.	Species	Season of collection	Length range (Total length in cm)
1	Green mussel, *Perna viridis*	February to May	5.8-9.2
2	Indian backwater oyster, *Crassostrea madrasensis*	February to May	8.5-18.2
3	Sea slug, *Onchidium sp.*	October to April	4.5-8.5
4	Clams (*Paphia malabarica*, *Meretrix meretrix*)	Year round	3-6

Collection of bivalves in Zuari estuary

High diversity and species richness is a characteristic feature of sub-tropical and tropical estuaries of the Indo-Pacific region. The present information on fisheries profile of the Zuari estuary contributes additional knowledge for the estuaries and bays of the Indian coast. There should be immediate actions to protect the species rich coastal zones like the Zuari estuarine system.

Practical solutions for the management of fishery

Fisheries co-management

The development of a system of "co-management" can be a solution which will be based on the co-operation between fishing community, interested stake-holders, research institutions, NGOs and Government departments for the sustainability of Zuari estuary. In this system, village level traditional societies and boat owners groups will be the major stakeholders. This can be developed using pilot scale experimental systems of management under the Department of fisheries and research institutions. However, the successful development of co-management system requires huge awareness and capacity building programmes to the fishing community and other stake-holders. Care should be also taken to include spatio-temporal resource and environmental patterns (biology, spawning, juvenile grounds and critical habitats) under the broad co-management regime. This system should also include the accurate reporting of fisheries data (mesh size used, area of fishing, total catch, catch rates, value of catch, size of fish species caught) directly from fishermen to fisheries department and research institutions. Moreover, the mesh size regulations for gillnet operations, closed seasons and areas for fishing as well as for collection of bivalves should be implemented. Strengthening of the religious restrictions for the collection of bivalves should be also included under the co-management framework.

The fisheries department of Goa has already initiated an active patrolling system to monitor the illegal and indiscriminate fishing operations in the coastal areas of Goa including the Zuari estuary. The fishermen of the estuary also monitor and inform the department once they come across the indiscriminate fishing operations. This has succeeded in regulating the entry of mechanized vessels into coastal waters and motorised/non-motorised boats into offshore areas. This system can be strengthened using coastal police surveillance and by including more patrol boats.

Enhancement techniques

About 80% of the fish production in Goa comes from coastal waters. Thus, there is an overexploitation in this region and it is high time to carry out biological resource enhancement activities such as the deployment of artificial reefs and sea ranching of commercially important species. An excellent artificial reef habitat can be established near shore areas for attachment of corals and fishes in different trophic level to popularize the eco-tourism as well as to enhance the fishery resources. This can be used by fishermen for fishing, students for education, scientists for research, tourists for snorkeling, SCUBA diving, sport fishing with angles (hooks & line), trap fishing for live ornamental fishes and recreational diving. Mouth of the Zuari estuary which opens into Arabian Sea holds suitable sites for the installation of small scale and small sized artificial fish habitats (rectangular, triangular and reef ball modules). This will help to augment the fishery resources in this region and contribute to the sustainable livelihood of fishermen in this estuary. This will also help to rehabilitate the aquatic species and fish stocks which might have disappeared due to degradation of habitats by environmental pollution and other anthropogenic factors.

There is a scope for brackish water finfish and shellfish culture in the estuary with the participation of fishermen community. The seeds of the fish and shellfish are available in the estuary. The small scale finfish cage culture and bivalve culture (rack, raft and tray methods) can be attempted to improve the fish production from the estuary. Thus, it can contribute to regulate the demand for fish in the state.

The sampling sites used in the present study are situated in the mouth of Zuari estuary which represents an important coastal ecosystem of Goa where major commercial gill net operations are carried out. The study may not have documented the complete species in the coastal region. Moreover, the study may not have addressed the complete fisheries profile of the study site. However, this study has definitely addressed the finfish and shellfish diversity profile upto an extent. Hence,

this will obviously remain as a strong reference point for future investigations in this region and other tropical coastal ecosystems.

Other species obtained from Zuari estuary

Table A1: List of Species obtained in the gillnet fishery in Zuari estuary

Group	Species	Family	Class	Group	Species	Family	Class
Barracudas	*Sphyraena jello*	Sphyraenidae	Pelagic	Groupers	*Epinephelus tauvina*	Serranidae	Demersal
Barracudas	*S. obtusata*	Sphyraenidae	Pelagic	Groupers	*Epinephelus coioides*	Serranidae	Demersal
Bony breams	*Anodontostoma chacunda*	Clupeidae	Pelagic	Grunts	*Plectorhinchus gibbosus*	Haemulidae	Demersal
Bony breams	*Nematalosa nasus*	Clupeidae	Pelagic	Grunts	*P. chubbi*	Haemulidae	Demersal
Carangids	*Alepes kleinii*	Carangidae	Pelagic	Lizardfish	*Saurida tumbil*	Synodontidae	Demersal
Carangids	A. *melanoptera*	Carangidae	Pelagic	Wrasse	*Halichoeres nigrescens*	Labridae	Demersal
Carangids	*A. kalla*	Carangidae	Pelagic	Bannerfish	*Heniochus acuminatus*	Chaetodontidae	Demersal
Carangids	*Atule mate*	Carangidae	Pelagic	Pufferfishes	*Lagocephalus wheeleri*	Tetraodontidae	Demersal
Carangids	*Carangoides praeustus*	Carangidae	Pelagic	Pufferfishes	*L. inermis*	Tetraodontidae	Demersal
Carangids	*Scomberoides lysan*	Carangidae	Pelagic	Pufferfishes	*Tetraodon fluviatilis*	Tetraodontidae	Demersal
Carangids	*S. tol*	Carangidae	Pelagic	Silverbellies	*Leiognathus dussumieri*	Leiognathidae	Demersal
Carangids	*S. commersonianus*	Carangidae	Pelagic	Silverbellies	*L. bindus*	Leiognathidae	Demersal
Carangids	*Trachinotus mookalee*	Carangidae	Pelagic	Silverbellies	*L. brevirostris*	Leiognathidae	Demersal
Carangids	*Alectis ciliaris*	Carangidae	Pelagic	Silverbellies	*L. blochii*	Leiognathidae	Demersal
Carangids	*A. indicus*	Carangidae	Pelagic	Silverbellies	*L. equulus*	Leiognathidae	Demersal
Carangids	*Gnathanodon speciosus*	Carangidae	Pelagic	Silverbellies	*L. splendens*	Leiognathidae	Demersal
Full beaks	*Strongylura strongylura*	Belonidae	Pelagic	Silverbellies	*L. daura*	Leiognathidae	Demersal
Golden anchovies	*Coilia dussumieri*	Engraulidae	Pelagic	Silverbellies	*Secutor insidiator*	Leiognathidae	Demersal
Halfbeaks	*Hyporamphus dussumieri*	Hemiramphidae	Pelagic	Silverbiddies	*Gerres filamentosus*	Gerreidae	Demersal
Halfbeaks	*H. limbatus*	Hemiramphidae	Pelagic	Silverbiddies	*G. setifer*	Gerreidae	Demersal
Halfbeaks	*Hemiramphus lutkei*	Hemiramphidae	Pelagic	Silverbiddies	*G. longirostris*	Gerreidae	Demersal
Horse mackerel	*Megalaspys cordyla*	Carangidae	Pelagic	Silverbiddies	*G. oyena*	Gerreidae	Demersal
Mackerel	*Rastrelliger kanagurta*	Scombridae	Pelagic	Silverbiddies	*G. limbatus*	Gerreidae	Demersal
Glassy perchlets	*Ambassis commersonii*	Ambassidae	Pelagic	Snappers	*Lutjanus johni*	Lutjanidae	Demersal
Glassy perchlets	*Ambassis urotaenia*	Ambassidae	Pelagic	Snappers	*L. indicus*	Lutjanidae	Demersal
Glassy perchlets	*A. gymnocephalus*	Ambassidae	Pelagic	Snappers	*L. argentimaculatus*	Lutjanidae	Demersal
White pomfret	*Pampus argenteus*	Stromateidae	Pelagic	Asian seabass	*Lates calcarifer*	Latidae	Demersal
Moustached anchovies	*Thryssa malabarica*	Engraulidae	Pelagic	Rabbitfishes	*Siganus canaliculatus*	Siganidae	Demersal
Moustached anchovies	*T. mystax*	Engraulidae	Pelagic	Soles	*Euryglossa orientalis*	Soleidae	Demersal
Moustached anchovies	*T. setirostris*	Engraulidae	Pelagic	Soles	*Solea sp.*	Soleidae	Demersal
Moustached anchovies	*T. hamiltonii*	Engraulidae	Pelagic	Soles	*Synaptura commersonii*	Soleidae	Demersal
Mullets	*Liza macrolepis*	Mugilidae	Pelagic	Soles	*Pseudorhombhus triocellatus*	Paralichthyidae	Demersal
Mullets	*L. parsia*	Mugilidae	Pelagic	Soles	*P. arsius*	Paralichthyidae	Demersal
Mullets	*L. tade*	Mugilidae	Pelagic	Threadfins	*Polynemus heptadactylus*	Polynemidae	Demersal
Mullets	*Mugil cephalus*	Mugilidae	Pelagic	Threadfins	*Eleutheronema tetradactylum*	Polynemidae	Demersal
Mullets	*Valamugil cunnesius*	Mugilidae	Pelagic	Tiger perches	*Terapon jarbua*	Terapontidae	Demersal
White sardine	*Escualosa thoracata*	Clupeidae	Pelagic	Tiger perches	*T. theraps*	Terapontidae	Demersal
Long finned herring	*Opisthopterus tardoore*	Pristigasteridae	Pelagic	Tiger perches	*T. Puta*	Terapontidae	Demersal
Rainbow sardine	*Dussumieria acuta*	Dussumieriidae	Pelagic	Tiger perches	*Pelates quadrilineatus*	Terapontidae	Demersal

Sand whiting	*Sillago sihama*	Sillaginidae	Pelagic	Tongue soles	*Cynoglossus macrolepidotus*	Cynoglossidae	Demersal
Sardines	*Sardinella albella*	Clupeidae	Pelagic	Tongue soles	*C. macrostomus*	Cynoglossidae	Demersal
Sardines	*S. gibbosa*	Clupeidae	Pelagic	Tongue soles	*C. dispar*	Cynoglossidae	Demersal
Sardines	*S. longiceps*	Clupeidae	Pelagic	Tongue soles	*C. puncticeps*	Cynoglossidae	Demersal
Scat	*Scatophagus argus*	Scatophagidae	Pelagic	Tongue soles	*Paraplagusia bilineata*	Cynoglossidae	Demersal
Shads	*Ilisha filigera*	Pristigasteridae	Pelagic	Gobies	*Trypauchen vaginalis*	Gobiidae	Demersal
Shads	*I. megaloptera*	Pristigasteridae	Pelagic	Gobies	*Acentrogobius nebulosus*	Gobiidae	Demersal
Shads	*I. melastoma*	Pristigasteridae	Pelagic	Gobies	*Istigobius diadema*	Gobiidae	Demersal
Shads	*Tenualosa toli*	Clupeidae	Pelagic	Rays	*Himantura uarnak*	Dasyatidae	Demersal
Shads	*Pellona sp.*	Pristigasteridae	Pelagic	Rays	*H. imbricata*	Dasyatidae	Demersal
Whitebaits	*Encrasicholina devisi*	Engraulidae	Pelagic	Rays	*H. fluviatilis*	Dasyatidae	Demersal
Whitebaits	*Stolephorus commersonii*	Engraulidae	Pelagic	Rays	*Aetobates narinari*	Myliobatidae	Demersal
Whitebaits	*S. indicus*	Engraulidae	Pelagic	Toad fishes	*Amphichthys cryptocentrus*	Batrachoididae	Demersal
Ribbonfishes	*Trichiurus lepturus*	Trichiuridae	Pelagic	Tripod fishes	*Triacanthus brevirostris*	Triacanthidae	Demersal
Ribbonfishes	*Lepturacanthus savala*	Trichiuridae	Pelagic	Crabs	*Charybdis lucifera*	Portunidae	Crustacean
Seerfishes	*Scomberomorus commerson*	Scombridae	Pelagic	Crabs	*Charybdis feriatus*	Portunidae	Crustacean
Seerfishes	*S. guttatus*	Scombridae	Pelagic	Crabs	*C. natator*	Portunidae	Crustacean
Tenpounder	*Elops machnata*	Elopidae	Pelagic	Crabs	*Portunus sanguinolentus*	Portunidae	Crustacean
Tarpon	*Megalops cyprinoides*	Megalopidae	Pelagic	Crabs	*P. pelagicus*	Portunidae	Crustacean
Bamboo sharks	*Chilloscyllium griseum*	Hemiscyllidae	Demersal	Crabs	*Scylla serrata*	Portunidae	Crustacean
Big Jawed Jumper	*Lactarius lactarius*	Lactariidae	Demersal	Crabs	*S. tranquebarica*	Portunidae	Crustacean
Breams	*Acanthopagrus berda*	Sparidae	Demersal	Crabs	*Matuta lunaris*	Matutidae	Crustacean
Catfishes	*Arius arius*	Ariidae	Demersal	Penaeid shrimps	*Fenneropenaeus indicus*	Penaeidae	Crustacean
Catfishes	*A. caelatus*	Ariidae	Demersal	Penaeid shrimps	*Marsupenaeus japonicus*	Penaeidae	Crustacean
Catfishes	*A. dussumieri*	Ariidae	Demersal	Penaeid shrimps	*Metapenaeus affinis*	Penaeidae	Crustacean
Catfishes	*A. jella*	Ariidae	Demersal	Penaeid shrimps	*M. brevicornis*	Penaeidae	Crustacean
Catfishes	*A. platystomus*	Ariidae	Demersal	Penaeid shrimps	*M. dobsonii*	Penaeidae	Crustacean
Catfishes	*A. subrostratus*	Ariidae	Demersal	Penaeid shrimps	*M. monoceros*	Penaeidae	Crustacean
Catfishes	*A. thalassinus*	Ariidae	Demersal	Penaeid shrimps	*Parapenaeopsis stylifera*	Penaeidae	Crustacean
Catfishes	*A. venosus*	Ariidae	Demersal	Stomatopods	*Lysiosquilla sp*	Squillidae	Crustacean
Catfishes	*A. maculatus*	Ariidae	Demersal	Stomatopods	*Oratosquilla nepa*	Squillidae	Crustacean
Croakers	*Dendrophysa russelli*	Sciaenidae	Demersal	Cephalopods	*Loligo duvaucelli*	Loliginidae	Molluscan
Croakers	*Johnieops borneensis*	Sciaenidae	Demersal	Cephalopods	*Loliolus investigatoris*	Loliginidae	Molluscan
Croakers	*Johnieops sina*	Sciaenidae	Demersal	Cephalopods	*Sepiella inermis*	Sepiidae	Molluscan
Croakers	*Johnius macrorhynus*	Sciaenidae	Demersal	Cephalopods	*Octopus dolfusi*	Octopodidae	Molluscan
Croakers	*Johnius macropterus*	Sciaenidae	Demersal	Gastropods	*Bursa sp.*	Bursidae	Molluscan
Croakers	*J. belangerii*	Sciaenidae	Demersal	Gastropods	*Hemifusus pugilinus*	Melongenidae	Molluscan
Croakers	*J. dussumieri*	Sciaenidae	Demersal	Gastropods	*Tibia curta*	Rostellariidae	Molluscan
Croakers	*Nibea albida*	Sciaenidae	Demersal	Gastropods	*Telescopium*	Potamididae	Molluscan
Croakers	*N. soldado*	Sciaenidae	Demersal	Gastropods	*Natica sp.*	Naticidae	Molluscan
Croakers	*N. sp.*	Sciaenidae	Demersal	Gastropods	*Trochus radiatus*	Trochidae	Molluscan
Croakers	*Otolithes ruber*	Sciaenidae	Demersal	Gastropods	*Babylonia spirata*	Babyloniidae	Molluscan
Croakers	*O. cuvieri*	Sciaenidae	Demersal	Bivalves	*Placuna placenta*	Placunidae	Molluscan
Croakers	*O. argenteus*	Sciaenidae	Demersal	Bivalves	*Paphia malabarica*	Veneridae	Molluscan
Croakers	*Paranibea semiluctosa*	Sciaenidae	Demersal	Bivalves	*Paphia textile*	Veneridae	Molluscan
Eels	*Congresox talabon*	Muraenesocidae	Demersal	Bivalves	*Villorita cyprinoides*	Corbiculidae	Molluscan
Eels	*Muraenesox bagio*	Muraenesocidae	Demersal	Bivalves	*Perna viridis*	Mytilidae	Molluscan
Eels	*M. cinereus*	Muraenesocidae	Demersal	Bivalves	*Crassostera madrasensis*	Ostreidae	Molluscan
Drift fishes	*Drepane*	Drepanidae	Demersal	Bivalves	*Saccostrea cuculata*	Ostreidae	Molluscan

	punctata						
Drift fishes	*Drepane longimana*	Drepanidae	Demersal	Bivalves	*Meretrix metretrix*	Veneridae	Molluscan
Flatheads	*Rogadius pristiger*	Platycephalidae	Demersal	Bivalves	*Meretrix casta*	Veneridae	Molluscan
Flatheads	*Platycephalus indicus*	Platycephalidae	Demersal	Bivalves	*Donax variabilis*	Donacidae	Molluscan
Groupers	*Epinephelus diacanthus*	Serranidae	Demersal	Bivalves	*Marcia opima*	Veneridae	Molluscan

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Reg. No. RNP/GOA/32/2021-2023

RNI No. GOAENG/2002/6410

Panaji, 22nd September, 2022 (Bhadra 31, 1944)

SERIES I No. 25

OFFICIAL GAZETTE

GOVERNMENT OF GOA

PUBLISHED BY AUTHORITY

NOTE

There are two Extraordinary issues to the Official Gazette, Series I No. 24 dated 15-9-2022, namely:—

(1) Extraordinary dated 15-9-2022 from pages 793 to 796, Department of Law, Notifications regarding various Acts.

(2) Extraordinary (No. 2) dated 16-9-2022 from pages 797 to 806, Department of Finance, Notification No. 5-1-2-2022--Fin(DMU)/1032 regarding Market Borrowing Programme of State Government 2022-23; and Notifications regarding various Acts from Law Department.

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GOVERNMENT OF GOA

Department of Environment Climate Change

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Notification

15-1/2020-21/GSBB/BMC-141/015/788

In exercise of the powers conferred by sub--section (*a*) of Section 23 & sub-section (*2*) of Section 24 of the Biological Diversity Act, 2002 (Central Act No. 18 of 2003) the Government of Goa hereby notifies the below mentioned Guidelines/recommendations for sustainable utilization, conservation and management of bioresources with special emphasis on controlled harvesting and conservation of edible clams, other shell fish & critical bio-resources within the jurisdiction of the Biodiversity Management Committees along the riverine & coastal areas in the State of Goa.

General guidelines/recommendations for sustainable utilization, conservation and management of bioresources with special emphasis on controlled harvesting and conservation of edible clams, other shell fish & critical bio-resources within the jurisdiction of the Biodiversity Management Committees along the riverine & coastal areas in the State of Goa

Preamble.—

Growth of the blue bio-economy has potential for contributing positively towards, social upliftment and sustainable development goals. Natural bio-resource management of land, water, soil, plants and

animals, should focus on its effect on the quality of life for both present and future generations. It deals with managing the way in which people and natural habitats interact. It brings together land use planning, water management, conservation, and the future sustainability of major areas like agriculture, tourism, fisheries and forestry. The community-based approach combines conservation objectives with the generation of economic benefits for communities.

The present recommendations are made on the key assumptions that:

(*1*) Locals are better placed to conserve natural resources;

(*2*) People will conserve a resource only if benefits exceed the costs of conservation, and

(*3*) People will conserve a resource that is linked directly to their quality of life or livelihood.

It recognizes that people and their livelihoods rely on the health and productivity of their habitats and their actions, as stewards play a critical role in maintaining this health and productivity. Natural resource management specifically focuses on a scientific and technical understanding of resources, ecology and the life-supporting capacity of those resources. In academic contexts, the sociology of natural resources is closely related to unique local Biological Resources and therefore there is a need to assess, protect, conserve and manage such economically important bio-resources. Areas considered for deriving the guidelines were from Chicalim & Sancoale with participation from local Biodiversity Management Committee (BMC) Chairpersons along with other members. However, they could be made applicable to entire State with customization wherever felt necessary in consultation with local BMCs, GSBB and Fisheries Department till proposed legal framework is derived by Department of Fisheries.

Need.—

The clam resources in these estuarine habitats form one of the localized marine live assets for the local inhabitants and those residing within an area of about 5 kms radius. The livelihood of the local communities is dependent on these resources that sustain their day-to-day survival. Therefore, it is very important that these resources are conserved with the help of the local stakeholders for sustainable harvesting.

Local Ownership of resources.—

Ownership and control over the use of bio-resources is most effectively ensured if locals are sensitized. Individuals, groups and local stakeholders may be able to make use of the resources, but only with the sustainable approach. Traditionally existing sustainable practices have always ensured equitable & fair utilization of local resources. But it is observed in this case that over-exploitation was reported wherein local BMCs raised complaints with GSBB, that led to formulation of these guidelines.

As approved by GSBB's 'Committee to prepare guidelines for controlled harvesting & conservation of edible clams, other shell fish and critical bio-resources within the jurisdiction of Biodiversity Management Committees (BMCs) in the State of Goa & along the riverine and coastal areas of Goa State" (Clams Committee), GSBB is notifying guidelines till rules are framed from time to time in order to protect and conserve these bio-resources considering the interest of the local beneficiaries as far as such resources are concerned.

Further, the local bodies, BMCs, Stakeholders and Fisheries Department with GSBB could jointly workout further plans for implementation. GSBB would be willing to further support if needed.

Administration and guidelines.—

1. The available clam resources should be allowed to be harvested only with the traditional method of hand picking and exclusively by the local villagers & those residing within an area of about 5 kms radius from the site by road or water on alongside of location and does not include opposite side of riverbank.

2. Those beyond above specified distance should not be allowed to exploit these resources without the permission of the local bodies [or suitable regulatory or Enforcement mechanism to be worked out by the Panchayat office, through Biodiversity Management Committees (BMCs)].

3. Efforts should be made by BMC to involve the local stakeholders to ascertain the sustainability of these bio-resources. This will enable to safeguard the intactness of resources available in this locality.

4. Ideally the lower limit of size for harvesting should not be less than 3cms. length and therefore harvesting of clams less than 3 cms. length should not be allowed (Size to be measured as shown in Figure 1. The harvesting should be done only with hand picking method, and no dredging or sweeping the bottom should be permitted in such critical habitats like Chicalim and Sancoale bay, as such dredging operations are known to alter the sediment texture leading to re-suspension and affecting the bio-geochemistry causing an ecological imbalance. In case of requirement of desilting of such areas approval of competent authority based on impact assessment by accredited experts is to be obtained. In other locations, these guidelines may be further fine-tuned on case-to-case basis.

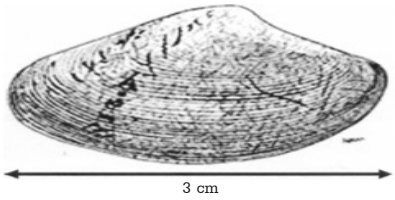


Figure 1: Reference for measurement of size of clam for harvesting.—

5. To ensure proper management and conservation of these endemic resources unique to this localized site, Quota system or alternate harvesting or appropriate mechanism developed by BMC in consultation with local body, may be implemented among the potential harvesters that depend on these resources for their livelihood. The appropriate quota levels may be decided by BMC and local body depending upon the level of dependence of families for their livelihood. This need to be worked out based on the quantity of harvests obtained in the past. This will also fulfill the objectives of the Biodiversity Board for sustainable harvesting and equitable sharing of the bio-resources.

6. Closed season may be imposed during the months of July to October every year to facilitate breeding and recruitment in these habitats as this period happens to be the peak breeding time for these species. Even while harvesting no one should be allowed to take away micro habitats like rocks on which shell fish such as oysters grow. This is required for the maintenance of the stock of population.

7. Further to this, the habitat (clam bed) may be categorized in different zones based on the level of exploitation. The vulnerable zones with respect to exploitation and habitat degradation need to be managed with increased control of the local community to reduce the level of exploitation. This should be done by BMC under the guidance of experts designated by GSBB.

8. The months of April-May being the peak tourist season in Goa coupled with high temperatures in these habitats, the entry of tourist population should be restricted in identified vulnerable zones as it is known to lead to habitat alteration and water quality deterioration which is responsible for increased mortality of the clams.

9. The months of September-October, although found to be coinciding with recruitment, partial or controlled harvesting may be carried out to regulate the population of the clam in these habitats.

10. The local body/BMC/authority should be able to levy some license fees to be

obtained from the beneficiaries who are involved in the harvesting of this bio-resource. In this system, this revenue could possibly be used by the local Panchayat towards management of these resources by involving the local community/stakeholders. Amount could be decided by BMC based on norms such as local market costs of Biological Resources, possibility to harvest per hour, etc.

11. Regarding dependent harvesters, decision about levy fee, number of people to be allowed in a day shall be taken by BMC and Village Panchayat. There could be category of 2 types—

i) Directly dependent local population of those traditionally accessing such biological resources. Their Traditional Knowledge should be recorded and they should be involved in conservation initiatives & should be charged notional amount in such a way that it does not become prohibitive and does not exceed 0.1 % of selling price (0.1 % is derived from minimum percentage of Access Benefit Sharing under the Biological Diversity Act 2002 & Rules, 2004) or they may be exempted from such levy fee.

ii) Those who harvest such biological resources as a delicacy and should be charged more amount as felt appropriate by BMC in consultation with the local body. In case of any dispute, decision of GSBB shall be final and binding.

12. The proposed field study also needs to work on identifying an area "a small plot" within main clam bed to be identified as "NO-TAKE- ZONE", which can be used to protect the breeding clam population and will serve as a so-called "SEEDBANK". The No Take Zone to be identified by GSBB based on field inspections with Expert Scientists, Fishermen, Fisheries Department Officials, Biodiversity Management Committee members and at least 3-5 local inhabitants.

13. The Chicalim Bay has a brood stock of clams and diverse marine species of commercial value, including the flagship species of Window Pane Oyster *(Placuna placenta)*. However, it must be emphasized that the bay has been sustainably utilized by several generations of people from Sancoale, Chicalim, Dabolim (Sancoalekars, Chicalikars and Dabolikars) and other adjoining villages. Hence decision about levy fee and other local restrictions like number of people to be permitted per day should be decided by concerned BMC under guidance by GSBB and experts designated by GSBB.

14. Previously the traditional ecological knowledge systems were prevalent and ensuring sustainable management and smooth resource renewal dynamics in the bay and adjoining areas.

15. Clam collectors from the jurisdiction of the Chicalim and Sancoale villages will be prioritized. Disallowing access to others should be checked for its tenability in law. While regulating, restriction to certain extent could be wise approach as approved by the Clams Committee.

Note: While above guidelines predominantly mention clams, the guidelines are applicable to other marine and riparian Biological Resources such as oysters, mussels and other vulnerable species under threat of over harvesting.

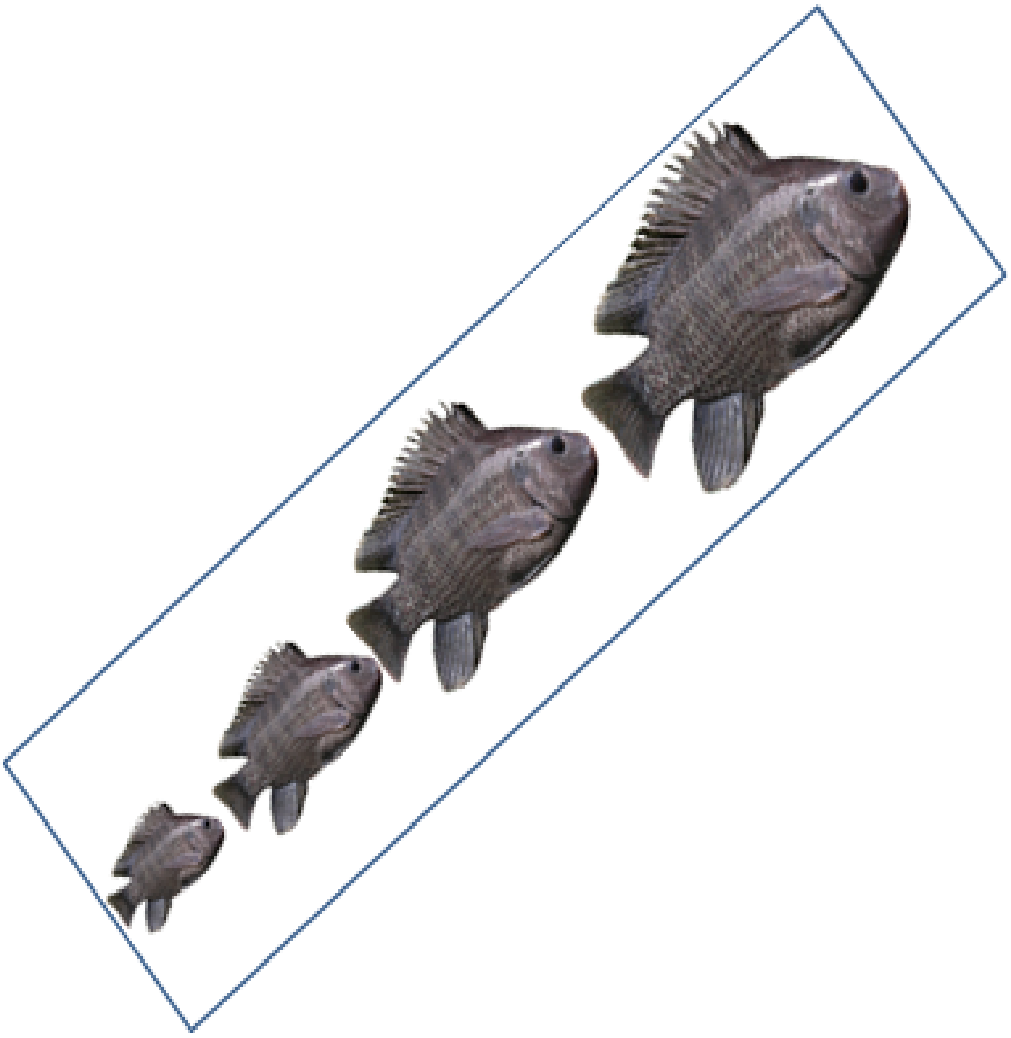
This notification comes into effect from the date of publication in the Official Gazette.

By order and in the name of the Governor of Goa.

Dasharath M. Redkar, Director (Enviroment & CC).

Panaji, 19th September, 2022.

GUIDELINES FOR RESPONSIBLE FARMING OF TILAPIA IN INDIA



सत्यमेव जयते

Government of India

DEPARTMENT OF FISHERIES
MINISTRY OF FISHERIES, ANIMAL HUSBANDRY AND DAIRYING

सत्यमेव जयते

Government of India

GUIDELINES
FOR
RESPONSIBLE FARMING OF TILAPIA IN INDIA

Country:	India
Guideline Applicable to:	All states and Union territories of India
Revised Guideline:	Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India
Scope:	Breeding, seed production and grow-out culture of tilapia
Year:	April, 2020
Published by:	Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying Government of India
Drafted by:	Dr. P. Routray and other members of the National Steering Committee to Oversee and Monitor Tilapia seed and Grow out Production.

CONTENTS

ABBREVIATIONS

°C:	Degree Celsius
µg:	Microgram
CAA:	Coastal Aquaculture Authority
CIFA:	Central Institute of Freshwater Aquaculture
MT:	Methyl Testosterone
ECGIFT:	Genetically Improved Farmed Tilapia
FAO:	Food and Agriculture Organization
FY:	Financial Year
GMP:	Good management practice
ha:	hectares
HACCP:	Hazard analysis at critical control point
ICAR-:	Indian Council of Agricultural ResearchCryoprotective Agents
DoF:	Department of Fisheries
IM:	Intra-muscular
IMC:	Indian major carp
IP:	Intra-peritoneal
Kg:	Kilogram
GOI:	Government of India
MPEDA:	Marine Products Export Development Agency
ppt:	Parts per thousand
ppm:	Parts per million
RAS:	Re-circulatory Aquaculture System
RGCA:	Rajiv Gandhi Centre for Aquaculture
WorldFish:	World Fish Centre, Malaysia
SOP:	Standard Operating Procedures
SRT:	Sex Reversed Tilapia
MT:	Metric Tone
BFT:	Bio floc technology

Introduction

Tilapia, the omnivore cichlids are becoming a natural choice as a candidate species for aquaculture throughout the world. Tilapia is native to Africa and Middle East, and has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world. The farming of tilapias, especially of Nile tilapia (*Oreochromis niloticus*) in its crudest form is believed to have originated more than 4000 years ago from Egypt. The first recorded scientific method of culture of tilapia was reported in Kenya during 1924. Tilapia was later transplanted and became established as a potential farmed species by the 1940s in the Far East and a decade later spread in Americas. The culture of tilapia has become commercially popular in many parts of the world and the fishery experts have dubbed the tilapia as "aquatic chicken" due to its quick growth and low maintenance cultivation. Tilapia is not only the second most important farmed fish globally, but also described as the most important aquaculture species of the 21st century (Shelton, 2002). The fish is reported to being grown in about 85 countries around the world (FAO 2008). Today, if any fish that could be named as global fish, no better name can be thought of than tilapia. It has emerged as a strong aquaculture species from the land of Africa and Middle East. However, the development of hormonal sex-reversal techniques in the 1970s, followed with research on nutrition and culture systems, alongwith market development and processing advances, led to rapid expansion of the industry since the mid-1980s. Though several species of tilapia are cultured commercially Nile tilapia is the predominant cultured species worldwide.

The last three decades have seen significant developments in farming of tilapias worldwide. Tilapias are being farmed in about 85 countries worldwide (FAO, 2008) and about 98% of tilapia produced in these countries are grown outside their original habitats (Shelton, 2002). The tilapias have recently been classified into three genera, based on parental incubation of eggs. There are about 70 species of tilapias, of which nine species are used in aquaculture worldwide (FAO 2008). Important commercial species include: the Mozambique tilapia (*Oreochromis mossambicus*), blue tilapia (*O. aureus*), Nile tilapia (*O. niloticus*), Zanzibar tilapia (*O. hornorum*), and the red belly tilapia (*O. zilli*). Several varieties of tilapia are commercially available that are either derived through selective breeding or hybridization from *O. niloticus*. Some of the prominent ones are GIFT, Chitralada, Red-Stirling, genetically super male Indonesian tilapia" (GESIT) etc. GESIT fish are genetically engineered to hatch eggs which will produce 98% - 100% male tilapia.

In India, tilapia (*Oreochromis mossambicus*) was introduced in 1952, with a view to filling up unoccupied niches, such as ponds and reservoirs. The species spread all across the country within a few years due to its prolific breeding and adaptability to wide range of environmental condition. Overpopulation of the species affected the fisheries of several reservoirs and lakes as in Vaigai, Krishnagiri, Amaravati, Bhavanisagar, Tirumoorthy, Uppar and Pambar reservoirs in Tamil Nadu, Walayar, Malampuzha,

Pothundy, Meenkara, Chulliar and Peechi reservoirs of Kerala, Kabini reservoir of Karnataka and Jaisamand Lake of Rajasthan. Introduction of *O. mossambicus* in Jaisamand lake not only resulted in reduction of average weight of major carps, but also posed threat to species like mahseers (*Tor tor* and *T. putitora*), which are on the verge of extinction. The Fisheries Research Committee of India had imposed ban on tilapia propagation in 1959.

Studies carried out at CIFA for a period of three years during 1998 to 2000 with GIFT tilapia had demonstrated production levels of 5-6 MT per crop of 4-6 months duration. Further, the study also showed the possibility of tilapia farming under polyculture with the three Indian major carps showing higher growth over rohu and mrigal at similar stocking levels. Monosex population (all male) is also produced with provision of 17α Methyl Testosterone treated feed for four weeks.

As the demand for fish is increasing, diversification of species in aquaculture by including more species for increasing production levels has become necessary. Introduction of tilapia in our culture systems is advantageous because it represents lower level in food chain, and thus its culture will be economical and eco-friendly. Mono sex culture of tilapia is advantageous because of faster growth and larger and more uniform size of males. The development of improved variety of tilapia by selection/ hybridization or genetic improvement technology is based on traditional selective breeding and is meant to improve commercially important traits of tropical farmed fish which is a major milestone in the history of tilapia aquaculture. Through combined selection technology, the GIFT program achieved 12-17% average genetic gain per generation over five generations and cumulative increase in growth rate of 85% in *O. niloticus* (Eknath and Acosta, 1998). Other varieties like 'red tilapia' also hold promise. There is high potential of export of tilapia to US, Europe and Japan. Further in recent years the technology of selection and breeding programmes are using modern biotechnological tools along with genetic information to derive good varieties of tilapia. So, National Breeding Programme on tilapia in India needs to be undertaken to overcome several problems associated with frequent imports.

In order to facilitate the culture of Tilapia in India in responsible manner, the Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying has framed the Guidelines for Tilapia Culture, Establishment Hatchery for Breeding/Seed Production in India.

GUIDELINES FOR TILAPIA CULTURE, ESTABLISHMENT OF HATCHERY FOR BREEDING/SEED PRODUCTION/ IN INDIA

I. Role of Central Government and State/UT Governments

A. National Steering Committee

i. The Department of Fisheries (DoF), Ministry of Fisheries, Animal Husbandry and Dairying, Government of India constituted a National Steering Committee to oversee and monitor the tilapia seed and grow-out production. This Committee may empower respective State Fisheries Departments for monitoring, controlling and surveillance (MCS) of Hatchery/Farming (Nursery as well as Grow-out) facility.

ii. The National Steering Committee shall recommend standard guidelines with regard to quarantine measures required for tilapia brood stock/seed importation for Hatchery and Breeding Programmes for consideration of the National Committee on Introduction of Exotic Aquatic Species.

iii. The National Steering Committee is empowered to modify/revise the guidelines as and when required.

iv. The National Steering Committee may consider proposal for establishment of tilapia National Breeding Programme (tNBP) for tilapia through ICAR fisheries research institutes and other similar agencies.

v. The National Steering Committee shall ask for report on registered farms, the permission given to tilapia hatcheries by the State Governments/UTs.

B. Role of State/ UT Steering-Cum- Monitoring Committee

i. If any entrepreneur intends to establish a hatchery for Tilapia breeding and seed production shall apply to the State Fisheries Department in the prescribed Proforma (Annexure-I) for permission. If the proposal involves import of tilapia from overseas sources, the proposal shall require approval of the Government of India (DoF).

ii. Farmers/ Entrepreneurs who intend to take up Tilapia farming shall apply to the State Fisheries Department in the prescribed Proforma (Annexure-II) to register their farm.

iii. The States/UTs shall constitute a Steering-Cum-Monitoring Committee headed by the Commissioner/Director of Fisheries with fisheries experts and such other members as deemed appropriate by the States/UTs.

iv. This Committee shall monitor and regulate the hatcheries including nurseries and grow-out facilities as per the provision of the Guidelines for Responsible Farming of Tilapia in India.

v. This Committee shall also examine the proposals for establishment of hatchery/breeding/nursery facilities of Tilapia and based on the recommendation of the Committee, the Secretary (Fisheries) of the State Governments/UTs shall issue the permission for the same.

vi. The States/UTs shall furnish quarterly reports to Government of India showing the details of hatcheries permitted, monitored and farms registered which in turn will be reviewed by the National Steering Committee to Oversee and monitor Tilapia Seed and Grow-out Facilities.

vii. The permission accorded by the States/UTs for establishment and operation of hatcheries/breeding/nurseries shall be placed on their websites for transparency.

viii. The State level Steering Committee is authorized to call for details from any registered farm/hatchery /breeding/ nursery facilities of tilapia and take appropriate action in case of violation of the provisions of the Guidelines.

ix. In case the tilapia farming is proposed to be undertaken within the jurisdiction of CAA, the facilities shall be required to be registered with CAA as per the CAA Act and Rules. However, these guidelines shall be followed for all other practical purposes.

x. Evaluation and impact assessment will be studied periodically by the State Steering Committee and send the report to the National Steering Committee about the effectiveness of preventive steps taken up to prevent escape of tilapia from ponds and cages and improve them.

xi. Impact of escapees on ecosystem and how they would modify the invasive capacity of existing tilapia species to be determined. If required the States/UTs may employ an external expert in this field.

xii. The State Governments/UTs shall ensure that all the provisions of the guidelines are implemented by the farmers and entrepreneurs indulge in the Tilapia farming, breeding and nursery practices.

II. Culture systems and practices

i. **Registration:** Tilapia culture shall be under taken by the farmers who have registered their farm with the State Fisheries Department.

ii. **Location:** Farms may be located in areas which are not prone to floods or in a buffer zone around a declared sanctuary or bio-reserve or other vulnerable areas in order to avoid escape to the open water bodies.

iii. **Culture type:** Farming of only Monosex male/sterile (through either hormonal manipulation or cross breeding)/super male (YY) is permitted.

iv. **Area of culture systems:** Farms of any size are allowed to do tilapia culture. Culture of tilapia in indoor systems, peri-urban aquaculture systems, Re-circulatory Aquaculture System (RAS) and Biofloc Technology (BFT) is also permitted.

v. **Species:** Tilapia is the common name applied to three genera of fish in the family *Cichlidae*: *Oreochromis*, *Sarotherodon*, and *Tilapia*. The species that are most important for aquaculture are in the genus *Oreochromis*, including the Nile tilapia, *O. niloticus*, the Mozambique tilapia, *O. mossambicus*, the blue tilapia, *O. aureus*, and *O. urolepis hornorum*. However, only Nile tilapia (*Oreochromis niloticus*) or its improved strains/hybrids shall be allowed for culture in India. Farming of only monosex male/sterile (through either hormonal manipulation or cross breeding) of *O. niloticus* shall be permitted.

vi. **Size of the seed to be stocked:** Grow-out ponds should be stocked with sex reversed tilapia (SRT) seed of more than 10 g. About 30 Days old sexually reversed tilapia (SRT) to be reared to 10 g size raised in on-farm nurseries or in registered seed farms. The stocking size of tilapia in cages and pens, RAS, BFT systems should be at least 30g or above.

vii. **Stocking density:** 5 nos/m^2 or as the diversified system demands.

viii. **Bio-security:** The approval for farming of tilapia shall be accorded only to those ponds/farms which could maintain bio-security of the farm to ensure no escape of the biological material from the farm to the water source or to any other source even in

situations like flooding. Therefore, there should be a standard design specifying the minimum requirement of bund height water management systems and other bio-security measures which are necessary for farming. Outlet water from culture ponds must be screened and treated before released into drains/canals/rivers during culture practice or subsequent to harvesting in order to prevent escape of eggs into natural water bodies (b) Provision of Bird scaring device/fencing is mandatory, (c) Bund height should be high enough to avoid fish escape and (d) sluice gates must be provided with appropriate mesh size to prevent escape of fish/eggs/fry.

ix. **Sale of seed and broodstock:** No grow out farm should be allowed to sale seed and broodstock from his grow-out ponds/tanks or residual stocks. A strict discipline in this aspect may be followed to ensure good quality seed reaching to the farmers.

x. **Earthen pond culture**:

- **Size of the seed to be stocked:** Grow-out ponds should be stocked with sex reversed tilapia (SRT) seed of more than 10 g. About 30 Days old sexually reversed tilapia (SRT) to be reared to 10 g size raised in on-farm nurseries or in registered seed farms.
- **Area**: The area of tilapia pond may be a few decimals to several acres. Ideal area should be 0.05–0. 2 ha.
- **Shape and Size**: Rectangular is preferred for fish harvest and all other management activities. However, for tilapia culture, the shape of the water body does not have much impact on the production.
- **Dyke/Embankment**: The pond dyke should be elevated enough to protect flooding during rains and escape of tilapia to wild areas.
- **Dyke slope**: Slope of pond dyke should be minimum of 2: 1. As tilapia build nest after digging soil, steep dyke becomes easily damaged. Therefore for tilapia pond, dyke with appropriate slope is essential.
- **Pond Soil**: Loamy soil should be preferred for tilapia culture. In sandy soil generally a thick layer of mud is built-up in 3 years' time that increases the water holding capacity and makes it suitable.
- **Depth**: About 1.5 meter water depth is regarded as ideal. On the other hand, if there is no provision of water supply from outside, pond should be such deep so it can hold at least 3 feet water in summer season. In these situations, decision should be taken after necessary survey of the ponds located in the region.
- **Water supply and drainage system:** Regular water supply and draining out are necessary for aquaculture intensification. Therefore, inlet and outlet pipes / drain are required. Generally, a pipe of 6-8 inches diameter is sufficient for a pond of 1 acre.
- **Stocking management**
- Fry should be released after 5 – 6 days of fertilizer application in grow out pond. Fry may be stocked into the ponds in the morning hours. If water is cool, fry can be released in any time of the day.
- **Stocking density**: In tilapia monoculture high stocking density of fry results low growth. Therefore, fry should not be released at high stocking density in tilapia culture. If 35000-40000 fry/ha are stocked, the average weight of fish will be 300 – 350 g within 3 - 4 months. Farmers should decide the stocking density of tilapia culture considering their ability and experience.
- A standard lay out for the farm is given at Annexure-III.

xi. **Cage culture**

Cage culture of tilapia shall be restricted to those reservoirs which are having already established stocks of tilapia. Before initiation of such farming assessment studies should be carried out by respective State Fisheries Departments in order to ascertain the presence of tilapia population in such reservoirs. Risk Assessment report from ICAR-CIFA or similar Central Institutes may be obtained before giving permission. Cage area in the reservoir should not exceed 1% of effective water area (EWA). Stocking size in cages must be more than 50 g weight. Accordingly, cage net should have appropriate mesh size. Use of formulated floating pellet feed with minimum protein content of 25% is encouraged in cage culture. Cage culture of Nile tilapia is useful for producers who use public or communal waters, including reservoirs, lakes, bays, irrigation systems, or village ponds. Tilapia culture in cages placed in abandoned mining pits may be encouraged as it is practiced in US State of Florida and in watershed ponds in Alabama (Popma and Rodriquez, 2000). Cages vary widely in construction, from simple bamboo enclosures to complex steel and plastic designs. Capital investment is low compared with ponds, and by concentrating fish the farmer has better control over feeding and harvesting.

xii. Cemented/FRP/Polyline Tanks

Tilapia culture in cement tanks/FRP tanks/poly lined tanks following available standard protocol may be permitted. However, these farms are not allowed to produce seed through breeding and sale seed to other farmers for stocking purposes. There are several foldable PVC, tarpaulin made tanks that are also used for tilapia production.

xiii. RAS

Indoor RAS solves a number of concerns to the aquaculture sector as they provide a higher degree of environmental control and are the only means for a fish producer to grow tilapia year-round in northern India during winter without using a thermal effluent or high flow geothermal heating. These systems require less water and less land area per kg of fish produced. They can be located in relatively close proximity to markets to reduce transportation costs and stress and mortalities during live transport. RAS have the potential to mitigate much of the environmental impact of fish production systems by reducing the volume of water discharged. Waste solids are concentrated as a sludge that is more easily disposed of by land application, or could be discharged to municipal waste treatment systems. Finally, RAS can increase biosecurity by minimizing the interaction of cultured fish with external biota to maintain integrity of both natural systems and the cultured stocks.

xiv. Biofloc Technology (BFT)

Biofloc systems were developed to improve environmental control over production. In places where water is scarce or land is expensive, aquaculture must be practiced for cost-effective production using BFT. There are strong economic incentives for an aquaculture business to be more efficient with production inputs, especially the most costly (feed) and most limiting (water or land). High-density rearing of fish typically requires some waste treatment infrastructure. At its core, biofloc is a waste treatment system. Biofloc systems use a counter-intuitive approach— allow or encourage solids and the associated microbial community to accumulate in water. Managing biofloc systems is not as straightforward as that, however, and some degree of technical sophistication is required

for the system to be fully functional and most productive. The BFT s may be encouraged in India, but at the same time cost effectiveness must be worked out before substantial investment.

xv. **Intensive Tilapia culture:** Farms intending to undertake re-circulatory farming practice including RAS and BFT should register with State Fisheries Departments with a stocking density of not more than 150 nos/m^3 with provision of floating feeds. Biosecurity measures followed in this case must conform to the standards specified for Grow-out farms.

III. Establishment of hatchery for breeding and seed production of tilapia

i. Entrepreneurs who intend to establish tilapia seed hatcheries without involvement of import shall require approval of the State Governments/UTs. The approved hatcheries shall obtain broodstock from the approved sources within the country. Hatcheries shall sale seed only to the registered nurseries/farms. Hatcheries should comply with the lay-out as given in Annexure-III.
ii. The broodstock/brood seed for the approved hatcheries shall be procured from the overseas/Indian source as approved by Government of India.
iii. Importer should have qualified and trained technical staff (Aquaculture/ Fishery/Zoology/Genetics) Graduates or post-graduates.
iv. Traceability of the particular strain till culture should be in place to avoid illegal import trade across border).
v. Importer should demonstrate that imported fishes are kept under biosecurity measures.
vi. The broodstock supplier/ exporter and the importer need to demonstrate or understand that the imported stock/sample is subject to independent disease surveillance for relevant viral diseases.
vii. The State Steering-Cum-Monitoring Committee shall inspect the design to ensure that it is in conformity with the designed and lay-out for hatchery including quarantine facility as approved by the National Steering Committee at Annexure-III.
viii. The brood stock/seed imported from overseas shall be subject to quarantine for a period of 21 days as per the standard protocol.
ix. Production of mono-sex male tilapia by the hatcheries should conform to the standard protocols available.
x. Tilapia breeding programme with an objective of selective breeding for genetic improvement in subsequent generations involving geneticist should be encouraged to avoid future catastrophe due to inbreeding.
xi. Sex reversal using non-hormonal techniques/technology should be encouraged. (take to appropriate place)

IV. Seed nurseries

Nurseries which are intending to raise seed (Seed Farms) for tilapia culture have to be registered with State Fisheries Departments following the guidelines available for Grow-out farms. Nurseries should procure sex reversed tilapia (SRT) seed only from the registered hatcheries.

V. Monitoring of the farm/hatchery/breeding/nursery facilities

i. The District Fisheries Officers (DFO) will regularly monitor and inspect the Tilapia farm/hatchery/breeding/nursery facilities in order to ensure that all the biosecurity measures are in place and the guidelines are fully implemented.

ii. The DFO will also monitor and inspect the health of the stock periodically and in case of disease incidence, permissible therapeutics may only be recommended for judicious use. The occurrence of disease and the action taken shall be informed to the Government of India by the States/UTs immediately.

iii. The DFO will send a Quarterly inspection report to the Commissioner/Director of Fisheries.

iv. The State Steering-Cum- Monitoring Committee shall establish a monitoring and inspection system for periodic checkup of disease status, biosecurity managements and report immediately (if any disease incidence is there) and suggest remedial/therapeutic measures for the same.

v. The inspection and monitoring shall be done as per the monitoring checklist at Annexure-VI.

vi. The State Steering-Cum- Monitoring Committee shall at least inspect the approved facility once in the year to review the report submitted by the DFO.

vii. The State Steering-Cum- Monitoring Committee shall develop a Schedule of Inspection including the schedule of inspection for the DFO of the States/UTs for under taking inspection of the approved facilities.

VI. Record Management

Records should be maintained regarding pond wise and day to day management of the farm indicating the details of stocking, source of seed, inputs, sampling details, water quality details, health, growth etc. The records should be produced at the time of inspection by the concerned fisheries authorities. The Data Sheet for daily recordings of feed and water quality management is at Annexure-V.

VII. Harvesting, Post-Harvest and Transport/marketing

i. Feeding should be suspended one/two days prior to harvest. Harvesting may be done using drag nets or any other quick harvesting methods. Termination of crop after each crop is highly advocated. This will ensure procurement of good quality seed from reputed hatcheries each time.

ii. Harvested fish should be immediately iced and transported for domestic markets/processing plants. Adequate infrastructure facilities for processing of tilapia in value added items should be encouraged. Live fish transport may be included.

VIII. Further technical suggestions

i. **Fertilization:** Fertilization in pond culture using organic manures can be done depending on the nutrient status of the soil as and when required.

ii. **Types of feeds:** Formulated standardized certified floating pellet feed/farm made pellet feed with minimum protein content of 20% should be used.

iii. **Feed storage:** Proper feed storage facility should be provided at the farm site with proper ventilation and management of humidity. The feed should be stacked on raised wooden platforms without touching the walls to avoid mold. The feed should be used within three months from the date of production.

*****

Annexure-I

Application for Permission to Establish Hatchery and Breeding of Tilapia

1. Name of the Applicant (s) / registered company/ establishment (in BLOCK LETTER with permanent address, fax number, email etc.) :

2. Communication address :

3. If already farming Tilapia, Details of registration by the State Fisheries Department.(Please furnish a copy of the registration Certificate. In case certificate has not been issued, mention the Registration Number, date and other details.) :

4. Hatchery details
   - 4.1. Land area :
   - 4.2. Area allotted for hatchery :
   - 4.3. Proposed seed production capacity :
   - 4.4. List out area/dimension details of different sections of the hatchery :
   - 4.5. Enclose a copy of the Hatchery diagram :
   - 4.6. Water source and water quality details :
   - 4.7. Soil Quality Details :
   - 4.8. Land ownership details :
   - 4.9. Any other information :

5. Proposed source of broodstock :
   - 5.1. Broodstock supplier :
   - 5.2. Number of broodstock to be procured :
   - 5.3. Genetic information of the broodstock to be supplied by the suppliers :
   - 5.3.1. Generation from which the broodstock procured :
   - 5.3.2. Growth Rate at optimal environment :
   - 5.3.3. Growth Rate under monosex culture :
   - 5.3.4. Growth Rate under mixed culture :

5.4 How the genetic vigour of the broodstock will be maintained? :

5.5 Details of the technicians available with the hatchery. Give their Qualification & experience :

6. State how the seed produced by your hatchery will be distributed :

7. Whether your seed will be sold to registered

farmers only? If yes, whether sales registers are maintained? :

8. Please provide a self-contained proposal alongwith details of the purposed biosecurity measures :

9. In case the broodstock is proposed to be imported from overseas supplier: :

9.1. Please provide the details of quarantine facility at the hatchery premises :

9.2. Please provide details of the overseas supplier alongwith documents on the quality of the broodstock to be imported. :

10. Do you have Effluent Treatment Plant provided With measures to prevent escape of GIFT Tilapia into natural waters? If yes, please give the details thereof. :

11. If GIFT Tilapia seeds are to be stocked in reservoirs in cages, information to be provided by the State Department of Fisheries as to whether any farming assessment study (as per the Guidelines) was carried out to ascertain presence of Tilapia population in such reservoirs? :

12. How much area (EWA) in reservoirs is proposed to be brought under cage culture of Tilapia? :

13. What is the total area of the reservoir (EWA)?

14. Any other information. :

Signature of the Applicant

DECLARATION

I/ We hereby declare that the information furnished above is true to the best of my knowledge.

I/We undertake to abide by the rules, regulations and guidelines of the Government of India.

Signature of the Applicant

Annexure-II

Format for Application for Culture/Farming of Tilapia

S.No	Particulars	Remarks
1.	Name and address of the Applicants(s)/ registered company/establishment in full (in Block Letters with permanent address)	
2.	Status of the Farm: Individual/Society/Private/Proprietary/Partnership	
3.	Address for communication	
	Street:	
	City:	
	District:	
	State:	
4.	Location of the farm	
	State: District: Taluk/ Mandal Revenue Village: Survey No:	
5.	Ownership (Whether free hold or on lease)	
6.	If on lease, Specify the lease period and attach copy of the lease period	
7.	Whether the farm is registered with DoF and approved by CAA/ Other Agency (Enclose a copy of the certificate)	
8.	Attested Copy of the layout of the farm approved by DoF/MPEDA/Chartered Engineer	
9.	List of species that are cultured in the farm	
10	Source of water	
11.	Pond History	
	a) Month & year of construction of the ponds and financial assistance received if any.	
	b) Production details of Fish/ shrimp from the year of construction	
	c) Whether assistance for fish farming received under any scheme of the Central / State Government? If so, please provide the details:	
	d) Present condition of the ponds, if existing	
12.	Details of the proposed ponds construction/renovation/ repair works of the ponds	
13.	Proposed date of operation of the farm and tentative	

	schedule of activities	
14.	List of Machinery and facilities available at the farm (As per to the Performa at Appendix-1.	
15.	Estimates regarding input costs and economics of operations in culture of Tilapia in ponds and cages	

Place:
Date:

Signature of the applicant:
Name:
Address:

Note:
This form should be accompanied by the additional information regarding available infrastructure at the farm as per the Appendix-I and the declaration by the applicant as per the Appendix-II.

Appendix-1

Proforma for furnishing details of infrastructure available at the farm

Name of the Owner/Lessee: Place:

Physical facilities

Farm Extent	:
No. of Ponds	:
Area of each Pond	:
Bund high of each pond	:
Water outlet (Hume pipes/ Sluice gates)	:
Sedimentation tank	:

Buildings

a) Office/ Admn	:
b) Living Quarters	:
c) Stores	:
d) Lab for undertaking basic tests	:

Machinery:

Pumps	:
Aerators	:
Gen Set	:
Machine Room	:

Appendix-II

Declaration to be furnished by the owner of the farm along with the application (to be signed on the Rs 100/- Non- judicial stamp paper).

1. I/ We……., aged ……son(s) of ……

…….and owner(s) of the farm at ……

…….declare that I/ We have read and understood the norms for undertaking tilapia culture and agree to abide by the conditions laid down in the guidelines.

2. I/We hereby declare that/We shall follow the guidelines specified issued ……

by Govt of India ……guidelines for farming tilapia.

3. I/We also agree to abide by any instructions that may be issued by concerned agency from time to time regarding the culture of Tilapia/ failing which I/We understand that the registration may be cancelled.

4. I/We also agree to the inspection of the farm by any designated officer(s) of the Agency at any time, with prior intimation.

5. I/We also agree to provide information regarding source of the seed, production record, laboratory analysis sheets to the inspection team and shall submit regular reports.

6. I/We also agree to abide by the specifications and penalty clause laid down in the guidelines in the farming of tilapia failing which shall be liable to the cancellation of the approval issued by ……., destruction of stock and pond(s).

7. We also undertake that a quality certificate shall accompany the consignment of fish shipped from my establishment (Self certification) regarding the chemicals/ antibiotics residue status of the fish.

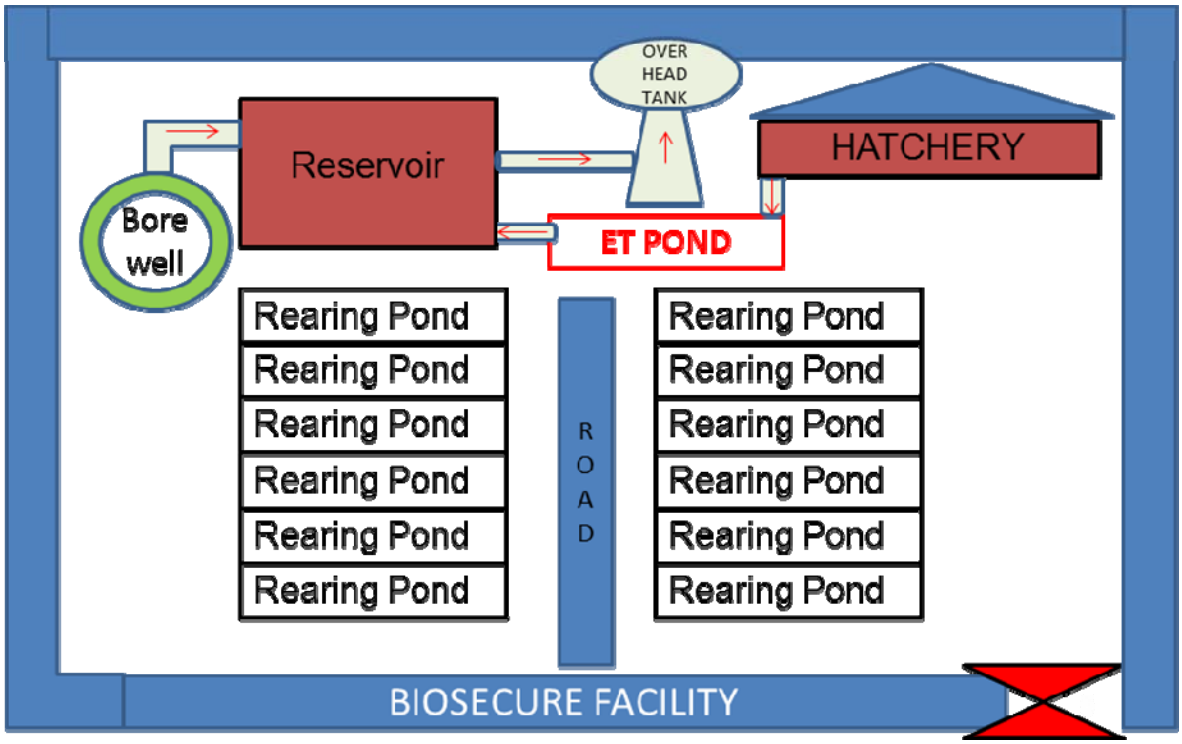
Place: Signature
Date: Address:

Annexure-III

STANDARD LAY-OUT PLAN FOR TILAPIA FARM AND HATCHERY

Generally in a tilapia farm where hatchery is envisaged, an area 0.2 ha of area should be earmarked for hatchery and the rest should be for nursery and grow-out ponds. In tilapia culture, hapa nursery is a modern technique. When setting up of nursery in pond / canal is not possible during monsoon, fry mortality can significantly be reduced in hapa nursery. Hapa is usually made from synthetic blue nylon net. It may be of different sizes. The stocking density of fry in hapa is 250 – 300 fry. Hapa should be cleaned after every 4-5 days so algae do not clog the net mesh and prevent water flow. It is better to use commercial floating feed in hapa.

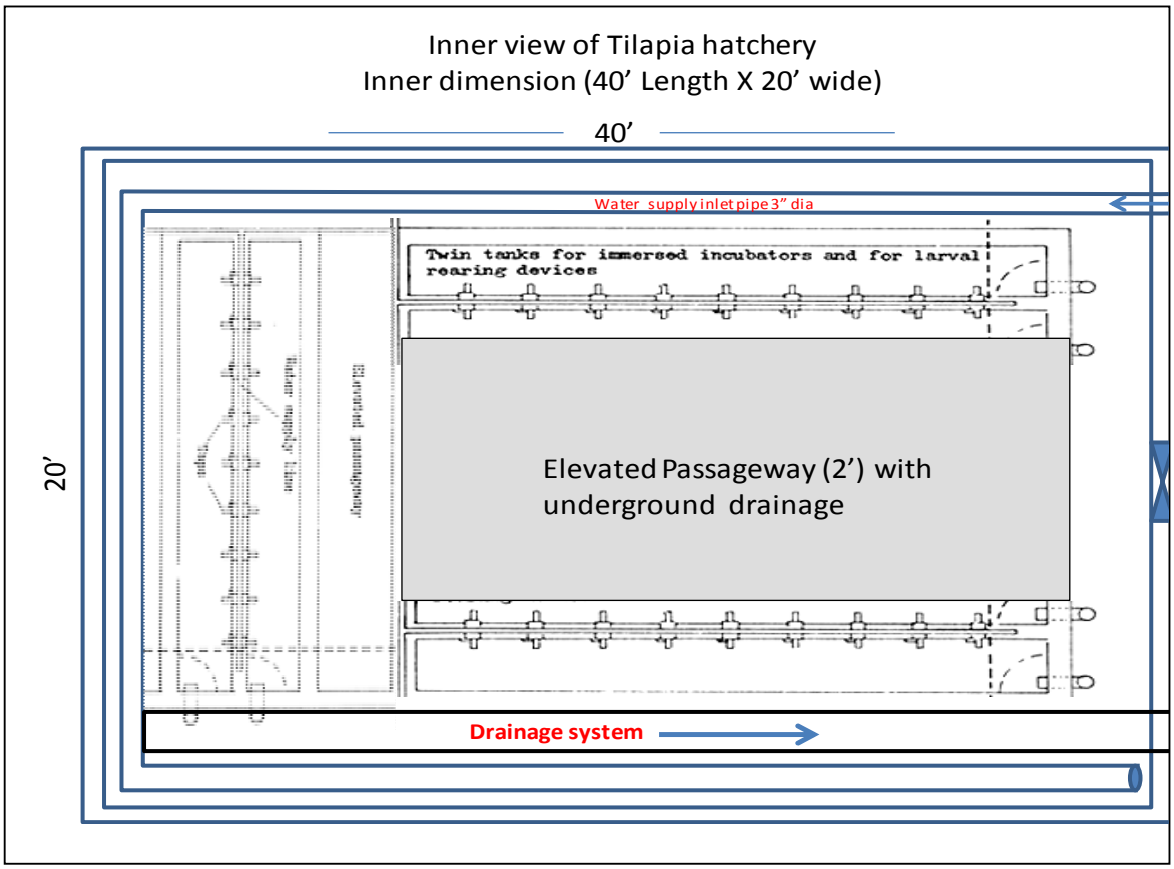
A STANDARD LAY-OUT FOR TILAPIA HATCHERY (NOT TO SCALE)



Specifications of hatchery

Hatchery Unit	
Hatching unit floor area	500 square feet
Number of jars	50
Jar capacity	10 liters
Egg holding capacity of each jar	10,000
Trays for incubation of just hatch larvae	50 nos (2000-4000 nos/tray)
Maximum unit capacity of hatchery	2.5-3.0 million eggs per month
Maximum output capacity	0.5 – 1.0 million larvae per month

Indoor Unit of All-Male tilapia Production	
Floor Area	1000 sq ft
Water Storage	2 x 10,000 liter FRP/Sintex or cement tanks
Culture Tanks	15nos (20 x 10 ft) cement or FRP Tanks
Tank Capacity	50000 fry/tank @ 20-25 fry/lit
Production Capacity	Approx 4-5 Lakh seed per month
Recirculation System with Biofilter	Must be functional



A STANDARD LAY-OUT FARM FOR TILAPIA FARMING

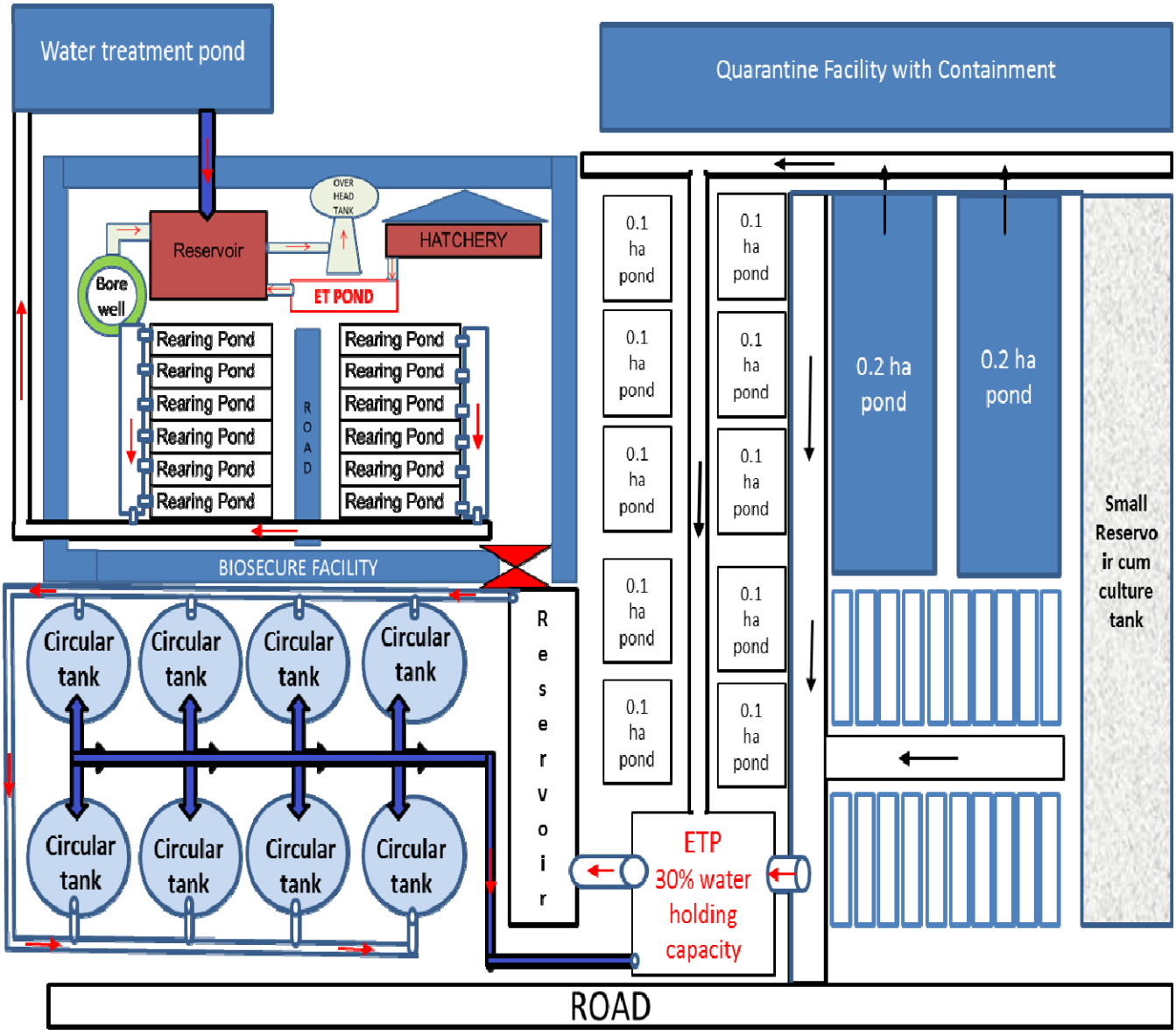
Farm layout for a tilapia farm refers to the compiling of physical structures such as store house, hatchery, outbuildings, waterways, contours, camps, water supply roads and the layout of farm ponds etc.However, a standard farm lay out in a 2ha area involving hatcheryand farm is given below (not to scale). It is important to note that the area where the farm is situated, the topography, the availability of natural resources such as water is of prime importance for tilapia farming. Moreover, as per the guidelines it is important to note that the farm and hatchery should not have a direct connection to the natural streams and arivers and canals. The availability of capital and the preference of the farmer/owner may also affect the farm layout.

Principles of site selection

It is necessary to draw a map indicating the proposed farm's topography, boundaries as well as soil and water resources. This essential information is needed in the planning process when

selecting a site for a specific purpose, e.g. building a hatchery and farm for tilapia farming.Generally, eastern slopes are preferred for maximum sunlight, warmth and protection from winds. Slopes do have a tendency to erosion and need to be cultivated with care. Attention must be paid towards the following while selecting the site:

- Soil types, soil depth and fertility
- Drainage of the soil
- Availability of water
- the natural vegetation
- Access to the area
- Water flow onto and off the farm.
- Aquatic organisms found on the farm.



Layout of a tilapia hatchery cum farm complex

Annexure-IV

Monitoring Checklist

1. Operation of in house Quarantine Facility (for hatcheries)
2. Hatchery layout
3. Breeding and maintenance of broodstock (for hatcheries)
4. Diseases including the Tilapia Lake Virus (TiLV)
5. Basic laboratory for health management measures
6. Seed and feed quality
7. Health management including emergency preparedness to prevent the introduction of pathogenic agents and to deal with occurrence of diseases.
8. Biosecurity measures such as disinfection, water quality monitoring, disposal of dead/ moribund fish, waste and wastewater disposal.
9. Restriction on visitors & workers, equipment maintenance, staff training
10. Environment Impact Assessment
11. Basic Data Management and register maintenance
12. Other requirements as per the Guidelines or as considered by the State Steering-Cum-Monitoring Committee

ANNEXURE 'C'

551C

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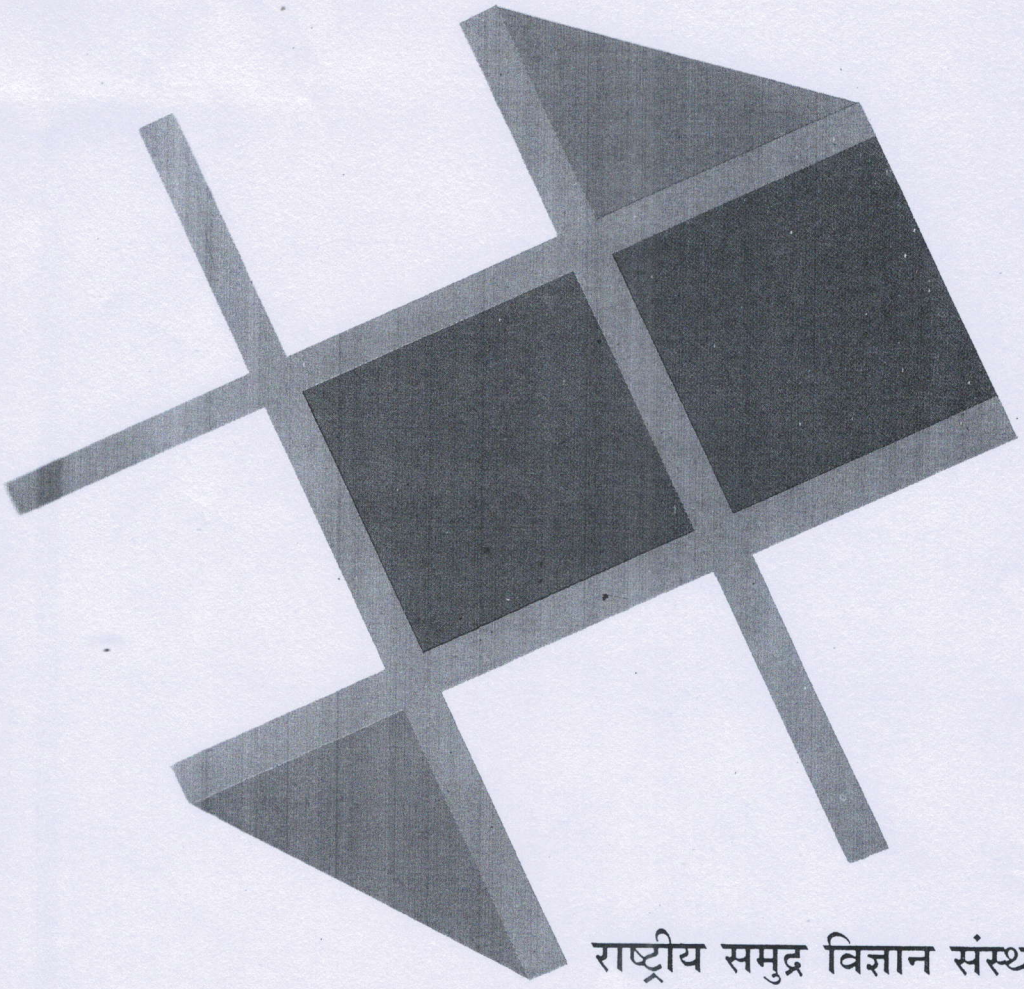
On

Assessment and revalidation of the demersal fisheries resources with particular reference to penaeid prawns of Goa coast

Submitted to

Director of Fisheries
Government of Goa
Panaji



May 2006

राष्ट्रीय समुद्र विज्ञान संस्थान

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First Progress Report

Progress report of the work done during April – December 2005

On

Assessment and revalidation of the demersal fishery resources with particular reference to penaeid prawns of Goa coast.

Submitted to
Director of Fisheries
Govt. of Goa,
Panjim

National Institute of Oceanography
(Council of Scientific & Industrial Research)
Dona Paula, Goa - 403 004

53/C

Progress report of the work done during April – December 2005

On

Assessment and revalidation of the demersal fishery resources with particular reference to penaeid prawns of Goa coast.

By

National Institute of Oceanography
Dona Paula, Goa,
Fishery Survey of India, Vasco, Goa
&
Directorate of Fisheries, Panaji, Goa

521C

Assessment and Revalidation of Demersal Fisheries Resources with particular reference to Penaeid Prawns of Goa Coast"

Introduction: The proven and traditionally utilized relation between fishery and the environment has existed for long. However, an explicit understanding of the same for their better management of the living resources have not been attempted. Overexploitation of marine living resources is a typical pattern of global environmental changes posing threats to mankind's food security and marine biodiversity. The share of fish in total world animal protein supply amounted to 16% in 2001 (FAO, 2004). Today we have realized that the fishery can succumb to pressure from overfishing, recruitment failure or due to natural climate changes in the marine environment. The understanding of such factors is therefore important in our quest for food from the sea. To achieve this task, a systematic examination of the biotic and abiotic factors is a precondition. Major factors, both environmental and biotic, affecting the exploitation of fishery resources in particular the demersal resources have been attempted in this preliminary report.

Sampling and analysis: For monitoring the water quality and biological parameters, three stations (Fig.1) were selected within the 20 meter depth zone. The station positions were fixed by GPS. Exploratory fishing were also done from these stations for the assessment of demersal fishery resources. The locations of the stations are given in Fig.1. with geographical position as follows :

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Stn. 1: Aguada (Lat 15^0 27' 444" N & Long 73^0 45' 801" E)

Stn. 2: Calangute (Lat 15^0 18' 105" N & Long 73^0 52' 801" E)

Stn. 3: Colva (Lat 15^0 31' 37" N & Long 73^0 44' 06" E)

Water quality :

pH

Water pH was measured immediately using Lab-India pH Analyser (PHAN) after standardizing it with standard pH buffers.

Dissolved Oxygen

Wrinkler's method was followed for the determination of DO by fixing a measured volume of water sample immediately after collection with the reagents A (maganous chloride) and B (alkaline potassium iodide). Standard iodometric titration with sodium thiosulphate was followed. DO is expressed in mg/l.

Ammonia – Nitrogen (NH_4-N)

Ammonia – Nitrogen in seawater samples was determined with the indophenol blue method using trione. Care was taken for the analysis of ammonia and the distilled water used was ammonia free and fresh to avoid any contamination as ammonia is highly soluble in water. The absorbance measurements were made at 630nm. NH_4 – N is expressed in μM. All photometric measurements were made through Perkin Elmer (Model Lambda 15) UV/VIS spectrophotometer.

Nitrite – Nitrogen (NO_2- N)

Nitrite was determine by the method of Bendschneider and Robinson whereby the nitrite in water sample was diazotised with sulphanilamide and coupling with N-1-Naphthyl ethylene diamine dihydrochloride. The absorbance of the resultant azodye was measured at 543 nm. NO_2 – N is expressed in μM.

Nitrate – Nitrogen (NO_3-N)

Nitrate in sea water samples was first reduced to nitrite by hetrogenous reaction by passing the buffered samples through an amalgamated cadmium column and the resultant nitrite was determined as above. The measured absorbance was due to initial nitrite in the sample and nitrite obtained after reduction of nitrate. Necessary correction was therefore made for any nitrite initially present in the sample. NO_3-N is expressed in μM.

Phosphate- Phosphorus (PO_4-P)

Inorganic phosphate was measured by the method of Murphy and Riley in which the samples were made to react with acidified molybdate reagent and ascorbic acid. The absorbance of the resultant phosphorus molybdenum blue complex was measured at 880 nm. PO_4 is expressed in μM.

Silicate-Silicon (SiO_4- Si)

Silicate-Silicon was estimated by reaction with acid – molybdate and ascorbic acid in the presence of oxalic acid. The interference of phosphate is prevented by additon of oxalic acid. The absorbance of the resultant silico – molybdenum blue complex was measured at 810 nm. SiO_4-Si is expressed in μM.

Suspended Solid :

One liter bottom water was collected and brought to the laboratory. The water was filtered through a pre weighed 0. 7 μm GF/F filter paper. The filter paper was dried in an oven at 60°C to a constant weight. The difference in the weight was taken as weight of suspended solid (seston) and expressed as g/l.

Biological parameters

Biological sampling was carried out on monthly basis. The specific tasks included collection of water samples for phytoplankton pigment (*chl a*) primary productivity, zooplankton (200 micron net) and benthos (grab) samples as per protocols detailed below.

Chlorophyll & Primary Productivity

In the case of phytoplankton, one liter water was collected at the surface. All samples were fixed in leugol solution and stored until analysis in the laboratory. The unit samples (1litre volume) on the other hand were treated with leugol iodine (10%) before storage. In the laboratory, these samples were allowed to

stand for 36-48 hrs in tall one liter measuring jars until all phytoplankton settled. Quantitative analysis was carried out on these samples and phytoplankton enumerated using a Sedgewick Rafter counting chamber after concentration with gravity sedimentation following a standard protocol (UNESCO, 1978).

Chlorophyll a

One litre of water sample was collected in duplicate and filtered through GF/F filter (dia. 47mm, pore size 0.7 μm). The filters were individually transferred into 20ml Torson vials and immediately frozen in liquid nitrogen until the analysis. Chlorophyll a was extracted in dark for 12 hr by adding 10 ml of 90% acetone under refrigeration. Chlorophyll a content was estimated using a Turner design flurometer.

Primary production

For measurement of primary production, water samples were taken in four 250 ml graduated polycarbonate bottles (three light, one dark for each depth). After adding one ample of ^{14}C ($NaH^{14}CO^3$), the bottles were incubated on deck with running sea water for a minimum period of six hours. ^{14}C incorporated into the phytoplankton cells was measured by filtering the whole volume of incubated sample through 0.7 μm GF/F filter (25 mm diameter). The filters were individually kept in 8 ml Torson vials. After acid treatment, 5ml of liquid scintillation cocktail was added to each vial and the radioactivity was measured in a scintillation

counter. The primary production rate in term of mg C m^{-3} d^{-1} was calculated from the disintigration per minute (DPM's).

Zooplankton

A Heron Tranter net was using for the collection of zooplankton samples, which has a mouth area of 0.25 m^2 and mesh size of 200 micron. A flow meter was employed to measure the amount of water filtered through the net. At each station, the net was operated for 10 minutes. The samples were collected in a 500 ml bottle and preserved with 5% formalin for further analysis. The biomass of this samples were determined using the displacement volume method (ml/m^3). The samples were split using the Folsum plankton splitter. The splitter divides the sample in four halfs ie. 25%, hence the sample split for a known percentage and calculated later. The samples were enumerated using the Bogorov's chamber under the Stereo zoom stereoscopic microscope. The different taxa were identified using keys like Marine Planktology, Coastal Marine Zooplankton, etc.

Benthos

Benthic investigations consisted of collection of seabed samples from 3 locations Samples were collected with the help of a naturalist's dredge (wherever possible) and a van Veen grab (0.04 m^2). The sample were sieved through 0.5 mm sieve for separating macrobenthos and washed the sediment with large volume of seawater. Sieving was carried out onboard. After sieving, the fauna (live animals) were carefully separated and together with residual sediment, if any, the samples

were fixed in 5-7% (neutral) formaldehyde-rose Bengal solution, labeled and, stored for further examination. In the laboratory, the sediments were washed again under tap water and the material preserved in 5-7% formaldehyde or denatured spirit containing Rose Bengal stain. For qualitative enumeration, each sample was examined under a binocular microscope. The organisms were separated into different taxonomic groups for further identification. All taxa were identified to their specific, generic or, other higher levels to the extent possible with the help of standard taxonomic references (e.g. Polychaeta: Fauvel, 1953; Day, 1967) and available expertise.

Fish and Fisheries

On each sampling date a trawling was done at each station for the study of fish and fisheries. Exploratory trawling was carried out to collect demersal fish catch data in the target area. Trawl net of different size were used by NIO and FSI. The trawl net used by NIO had a mouth opening area of 8.5 m2 and cod end mesh size of 20 mm. On each sampling date the trawl net was towed parallel to coast for one hour at the constant speed of 1.5 knot. At the end of each trawling the total weight of the fish catch and group wise numerical count were carried out on board.

The fisheries survey of India carried out parallel collection. During the period from June 2005 to November 2005, in which total 53 sampling stations were covered in 20-50 m depth under the project by deploying the survey vessel MFV Sagarika. Samples were taken off Goa and adjoining waters by using Shrimp

trawl and Fish trawl. Species wise quantity, length frequency and other biological data were collected. Due to non-availability of fishing vessels in inactive monsoon season no sampling could be done and hence no results available for that period.

Result

Water quality

The water chemistry plays very important role in the distribution and abundance of fish stock. The nutrient cycle help in the development of strong biological base on which the ecosystem function. For example the availability of nitrite, nitrate, silicate and phosphate help in phytoplankton production which in turn support high zooplankton biomass. The available zooplankton biomass is then used by plankton feeding fishes. Similarly the other physico-chemical parameters such as temperature, salinity and dissolved oxygen play vital role in the distribution and abundance of fishes. Hence a knowledge of these parameters become very important in assessment of fisheries resources.

The physico-chemical parameters of the three stations is given in Table 1. The variation in temperature of the surface and bottom water was within expected range of variability. Low temperature (21.6^{0}C) was recorded in monsoon season and highest temperature (31.2^{0}C) was in the month of May. The salinity of the coastal water of Goa remains high (>30ppt) throughout the year both at surface and bottom. The high salinity during monsoon is result of upwelling which occurs

every year around the monsoon time. Dissolved oxygen showed a contrasting feature pronounced. Sub-oxic layer was recorded in the bottom water of all stations. The surface water remained well oxygenated. The degree of anoxia was not restricted to monsoon period. Sub-oxic layer at bottom was also noticed a few stations in the post monsoon period. The nutrients showed clear seasonality. The nitrate values fluctuated widely between 0.03 and 14.1 μM. The values were generally low at surface and high at bottom. The nitrite values showed similar trend and the consumption was much lower, minimum being 0.001 and maximum being 4.66 μM. The phosphate values fluctuated moderately between 0.15 and 1.92 μM at the surface and 0.15 to 16.47 μM at the bottom. The distribution of nutrient showed normal behaviour. The silicate values ranged between 1.7 and 52.59 μM at the surface and 0.98 and 29.26 μM at the bottom. Ammonia becomes toxic at certain level of concentration and hence may be regarded an important parameter. The reduction of nitrates may lead to ammonia. The values of ammonia were high at the bottom than at the surface. The suspended solid at the bottom remained low and within the reported range. The near anoxic conditions developed in the bottom particularly during monsoon due to denitrification may play an important role the demersal fisheries resources particularly solar prawn.

The understanding of the biological process are important as the knowledge of physical environment in the fisheries management. Table 2 gives the values of biological parameters. The chlorophyll concentration remained low particularly during premonsoon and monsoon season. The value during post monsoon

season remained low. Although values of surface were higher than at bottom, the difference was insignificant. The primary productivity estimation is in progress.

The zooplankton biomass ranged between 3.5 and 12 ml. High biomass values were recorded during monsoon period. The copepoda and decapoda comprised more than 50% of the total zooplankton numerically. The benthic organisms were dominated by polycheate worms, crustaceans and bivalves. The biomass ranged between 0.5 in August to 12.5 ml/m^3 in May.

Monthly fish catch statistic is given Table 3. The catches showed wide variation in quality and quantity as expected. The catches in the south (station 3) were always higher than at north (station 2). The catch composition showed high variability in the occurance of species, different species dominated in different month and season.

Monthly fish catch statistics is given Table 3. This statistic is based on the fish caught in the trawl net within 20 m depth contour. The catches showed wide variation in quality and quantity as expected. The catch composition showed high variability in the occurrence of species, different species dominated in different months and seasons. The penaeid prawns in the catches was constituted mainly by *Metapenaeus dobsoni* and *Parapenaeopsis stylifera* which was followed by *Metapenaeus monoceros*, *Metapenaeus affinis*, *Penaeus merguiensis*, *Penaeus indicus* and *Parapenaeopsis hardwikii*. Among fishes, clupeids and leognathids were available during most part of the year. Small sciaenids were dominant during the post monsoon season. Detailed study of the dominated species of demersal resources is being carried out and will be included in the final report.

The coastal water of Goa follows a clear seasonal pattern in distribution of chemical parameters. The physico-chemical properties of the water are given in Table 1. The salinity and temperature showed normal feature and the values were within the expected range. Similarly the values of nutrients (NO_2, NO_3, PO_4, and SiO_4) were within the normal range. The most striking feature of the water quality is hypoxia or anoxic condition observed in the bottom waters. Such depletion in dissolved oxygen in the shallow water (<20 m depth) will act as limiting factor in the distribution of bottom dwellers. The pH and suspended solid were normal.

Salient feature of demersal fisheries catch data

The experimental trawling was conducted at each site in the inshore water (<15 m depth) at the time of collection of other data. The results are shown in Table 4. In the monsoon time, due to the bad weather condition, no sampling was done in July. In August a fishing vessel from Fishery Survey of India was used to collect data from Station 1. The catch in different months showed dominance of different fish species. The prawn catch was always very poor. The solar prawn (*Metapenaeus dobsoni*) appeared in good numbers only in December at 8-10 meter while other prawns (white) medium and small were observed in depth more than 10 meters. An interesting observation was that during August while trawling at 20 m depth no fish/prawn were caught. During Nov-Dec the main catch was Squilla. The wide fluctuation in the catches reflects on poor conditions

in the inshore water. Total 32 species were recorded during the period of which, 24 species of fin fish, 6 species of crustaceans and 2 species of cephalopods.

Fisheries resources beyond 20 m along Goa coast

The catch (Kg) composition is presented in Table 4. The catch was dominated by finfishes (96.92%) followed by Crustaceans (1.68%) and Cephalopods (1.39%). Among finfishes, *Epinephelus dicanthus* (44.48%) dominated the catch and other major varieties were *Rastrelliger kanagurta* (10.42%), *Alepes djdaba* (8.14%), *Trichiurus lepturus* (5.95%), *Johnius dussimieri* (4.36%), *Sphyraena obtusata* (3.17%) *and Megalaspis cordyla* (3.17%).

In crustaceans, *Penaeus indicus* (1.39%) forms major catch followed by *Penaeus monodon* (0.29%), *Metapenaeus affinis* (0.29%) and *Metapenaeus monoceros* (0.29%).

In cephalopods, *Sepia pharaonis* (0.99%) was the major component and *Loligo duvaucelii* was (0.39%).

The length frequency and other biological studies carried out is presented in Table 5.

Total 14 species were measured for length frequency study and made 1542 observations in 45 samples and for other biological study such as maturity and food and feeding habit, data for 12 species were collected and made 380 observations in 20 samples.

Salient finding

1. Among the environmental parameters dissolved oxygen appeared to be critical because of significantly low or anoxic condition at the bottom during monsoon period.
2. The demersal resources appears to be dominated by shrimp in the water depth of less than 20 m while finfishes become more abundant in more than 20 m.
3. further studies are in progress.

Table 1: Monthly variation in physico-chemical parameters

Month	Stn.	Depth (m)	Temp (^{o}C)	Salinity (psu)	DO (ml/L)	NO_3^- (µM)	NO_2^- (µM)	PO_4^{3-} (µM)	SiO_4^{4-} (µM)	NH_4^+ (µM)	pH	S.S. (g/l)
April (2005)	1	0	30.2	35.12	4.16	6.1	0.55	1.25	36.62	2.14	7.9	
		14	28.9	35.44	4.0	10.43	0.34	1.4	10.41	1.65	7.9	0.062
	2	0	29.8	35.14	3.53	10.0	0.71	1.7	18.42	1.88	7.8	
	3	0	30.4	34.3	4.2	6.77	0.52	1.52	14.54	2.26	7.8	
		14	29.7	35.42	3.62	9.42	0.40	1.40	12.18	2.18	7.6	
May	1	0	31.2	35.24	4.49	0.96	0.82	0.45	11.89	2.35	7.6	
		12	29.5	35.68	2.42	3.36	0.87	0.97	16.41	1.36	7.7	0.045
	2	0	30.6	35.34	3.84	0.53	0.04	1.92	17.68	1.94	7.8	
		12	28.2	35.67	1.78	1.99	1.87	1.41	37.11	1.88	7.9	0.064
	3	0	30.4	34.2	4.22	2.55	0.77	0.87	14.29	1.98	8.1	
		12	28.6	34.8	1.86	4.92	0.92	1.55	18.66	1.72	8.2	0.055
July	1	0	23.54	35.01	4.23	7.1	0.66	1.38	38.76	0.66	8.06	
		20	20.18	35.24	0.57	10.55	0.36	1.52	10.46	1.89	7.61	0.062
	2	0	22.4	35.04	3.86	10.17	0.81	1.78	19.0	0.82	8	
		27	21.6	35.22	0.48	14.1	0.44	1.9	11.95	2.45	7.67	0.044
Aug	1	0	24.5	35.21	5.74	0.22	0.17	1.8	52.59	0.36	7.9	
		20	21.8	35.48	0.05	7.51	4.66	3.08	29.26	2.17	7.7	0.083
	2	0	23.8	35.27	0.74	0	0.05	1.0	22.62	0.72	7.9	
		29	22.5	35.41	0.12	10.32	3.76	16.47	26.88	1.57	7.8	0.032
Oct	1	0	29.2	34.82	3.48	0.29	0.02	0.82	12.08	0.62	7.98	
		12	28.0	34.69	2.7	0.51	0.004	0.37	3.64	0.95	7.82	0.22
	2	0	29.3	35.92	2.03	0.18	0.001	0.17	2.25	0.54	7.93	
		13	28.6	34.35	3.39	0.47	0.007	0.15	0.98	1.72	7.76	0.036
	3	0	30.2	35.31	4.62	0.21	0.01	0.18	3.31	0.43	8.1	
		14	29.4	34.5	3.4	0.39	0.02	0.36	2.69	0.98	8.02	0.036
Nov	1	0	28.6	34.92	2.75	0.29	0.14	2.85	2.24		8.11	0.041
		13	26.7	35.32	1.97	0.29	1.86	0.84	5.45		8.04	
	2	0	28.5	35.68	4.34	0.03	0.02	0.15	1.7		8.28	
		13	29.5	34.51	4.17	0.26	1.02	0.45	3.7		8.16	0.040
	3	0	27.5	34.92	3.98	0.14	0.11	0.44	6.17		8.24	
		13	27.0	34.92	1.1	1.67	3.36	0.92	13.61		8.02	0.042
Dec	1	0	29.4	34.97	5.26	0.71	0.1	0.37			8.19	
		14	28.5	34.71	3.56	0.83	0.4	0.58			8.17	0.041
	2	0	29.6	34.7	4.1	0.71	0.62	1.07			8.24	
		14	28.5	34.79	3.74	0.83	0.87	1.02			8.05	0.032
	3	0	28.5	34.73	4.27	0.72	0.26	0.55			8.21	
		13	28.0	34.56	4.69	1.43	0.34	0.67			8.09	0.11

Table 2 : Biological productivity of the selected stations.

Month	Stations	Chl. a (mg/m3)		P. P (mg C $m^{-3}d^{-1}$)		Zooplankton biomass (ml)	Macrobenthic biomass (g/m2)
		Surface	Bottom	Surface	Bottom		
May	1	2.38728	2.63231	0.280667128	0.021203781	3.5	12.5
	2	2.72832		1.124723783		6	5.2
	3	2.5438		0.37694		4.2	10.6
July	1	1.47784	1.68932	0.273707517	0.281646947	6	0.9
	2	2.50096	2.72351	0.021350462	1.131264067	7.5	1.4
	3					3.3	2.7
August	1	1.59152		0.276081134	0.27976896	11	3.8
	2	1.47784		0.021081547	1.121453642	12	0.5
October	1	0.59682	0.62154			3.5	3.2
	2	0.34104	0.42518			4	0.8
	3	6.74	3.32				
November	1	0.73892	0.76325			2.3	3.8
	2	0.59682	0.62321			4	1.7
	3	0.69682	0.75421			3.2	6.6
December	1	0.26578	0.29214			5	5.2
	2	0.25578	0.29125			3.6	2.6
	3	0.17052	0.21548			4	9.2
January	1	0.17052	0.19245			5	9.2
	2	0.19894	0.20145			4	2.5
	3	0.28432	0.29021			3.8	7.8

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Table 3 : Monthly fish catch statistics.

Obs. Month	Stn. No.	Water Depth (m)	Speed of Trawl net (knot)	Trawling Time (Hr)	Total Catch (Kg)	Biomass per Haul (Kg)	Dominant Groups
April	1	12	1.5	1	76	76	Leognathids, Prawns, *Epinephelus dicanthus*
	2	12	1.5	1	12	12	Ribbonfish, Lesser sardine, Prawns
May	3	12	1.5	1	35	35	Prawns (60%), Solar
August	1	20	1.5	1	Nil	Nil	Zero catch
October	1	12	1.5	1	32	32	Jelly fish (90%) and Oil Sardine, Scienids
	2	12	1.5	1	38	38	Leognathids, Oil Sardine and Sciaenids
	3	12	1.5	1	36	36	Oil Sardine, Leognathids and Ribbonfish
November	1	12	1.5	1	12	12	Leognathids (40%)
	2	12	1.5	1	25	25	Puffer fish *Lagocephalus inermis*), Scienids
	3	12	1.5	1	10	10	Leognathids (50%)
December	1	8	1.5	1	15	15	Sciaenids, Crabs
	2	14	1.5	1	25	25	Sciaenids (small Size) and Crabs
	3	8	1.5	1	6	6	Solar prawns (30%)
	3	12	1.5	1	15	15	*Leognathus bindus*
January	1	8	1.5	1	Nil	Nil	--
	2	8	1.5	1	18	18	Sqilla and prawn
	2	18	1.5	1	60	60	Sqilla, Crab and Prawn
	3	14	1.5	1	40	40	Solar prawns(90%)
	3	12	1.5	1	25	25	Prawns(30%), Crabs.

Table 4 : List of species and abundance recorded in fishing vessel of FSI along Goa coast

Sr.No	Species	Depth (m)			Total Catch(Kgs)
		20-30	30-50		
		ST	FT	ST	
1	*Elasmobranch (Shark, Ray)*	2	-	-	2
2	*Epinephelus dicanthus*	2	210	12	224
3	*Sphyraena obtusata*	1	15	-	16
4	*Tachysurus maculates*	13	-	-	13
5	*Trichiurus lepturus*	14	16	-	30
6	*Rastrelliger kanagurta*	-	52.5	-	52.5
7	*Megalaspis cordyla*	4	12	-	16
8	*Katsuwonus pelamis*	-	2	-	2
9	*Decpterus russelli*	1.250	18	-	19.250
10	*Johnius dussumieri*	22	-	-	22
11	*Scombroides tala*	-	10	-	10
12	*Caranx ignobilis*	-	2	-	2
13	*Caranx malbaricus*	-	2	-	2
14	*Pampus argenteus*	2	-	-	2
15	*Nemipterus mesoprion*	-	1	1	2
16	*Alectus indica*	1 no.	1	-	1
17	*Muraenesox cinereus*	-	5	-	5
18	*Alepes djdaba*	-	41	-	41
19	*Silver bellies*	10	-	-	10
20	*Dussumierri acuta*	5	4	-	9
21	*Rachycentron canadus*	2	4	-	6
22	*Lagocephalus inermis*	-	1	-	1
23	*Odonus niger*	-	0.250	-	0.250
24	*Pomadasys maculates*	2 no.	-	-	
25	*Penaeus indicus*	7	-	-	7
26	*Penaeus monodon*	-	0.5	-	0.5
27	*Metapenaeus affinis*	-	-	0.5	0.5
28	*Metpenaeus dobsoni*	-	-	5 no.	
29	*Metapenaeus monoceros*	-	-	0.5	0.5
30	*Crab spp.*	2 no.	-	-	
31	*Loligo duvaucelii*	0.5	1.5	-	2
32	*Sepia pharaonis*	5	-		5
	Total	90.75	398.75	14	503.5

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Table 5. Biological parameters of important species under study

Sr. No	Species	Length-frequency study		Maturity stage study		Food and Feeding habit	
		No.of Sample	No.of observations	No.of Sample	No.of observations	No.of Sample	No.of observations
1	*Epinephelus dicanthus*	7	294	3	35	3	35
2	*Rastrelliger kanagurta*	7	235	3	60	3	60
3	*Trichiurus lepturus*	6	209	1	20	1	20
4	*Decpterus russelli*	6	222	3	54	3	54
5	*Megalaspis cordyla*	3	83	1	20	1	20
6	*Alepes djdaba*	6	218	3	60	3	60
7	*Sphyraena obtusata*	2	42	-	-	-	-
8	*Scombroides tala*	1	23	-	-	-	-
9	*Johnius dussumieri*	1	34	1	20	1	20
10	*Dussumierri acuta*	2	77	1	20	1	20
11	*Nemipterus mesoprion*	1	24	1	10	1	10
12	*Metapenaeus affinis*	1	60	1	60	1	60
13	*Metpenaeus dobsoni*	1	5	1	5	1	5
14	*Loligo duvaucelii*	1	16	1	16	1	16
	Total	**45**	**1542**	**20**	**380**	**20**	**380**

ANNEXURE "C"

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Second Progress report of the work done during January – December 2006

On

Assessment and revalidation of the demersal fishery resources with particular reference to penaeid prawns of Goa coast.

Submitted to
Director of Fisheries
Govt. of Goa,
Panjim

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Progress report of the work done during January – December 2006

On

Assessment and revalidation of the demersal fishery resources with particular reference to penaeid prawns of Goa coast.

By

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Assessment and Revalidation of Demersal Fisheries Resources with particular reference to Penaeid Prawns of Goa Coast"

1. Introduction

Fisheries is an important industry of the coastal state of Goa. The information on fish stock and their potential is a vital input in the formulation of strategies for the judicious exploitation and monitoring of this renewable resource. The fish resources along Goa coast appears to be on the decline as the catches have remained around 70 thousand tones. The current pattern in catch, area and the period is setting a stage for collapse of sustainable fishing due to over-exploitation. The total potential and exploitable demersal fishery resources data base needs to be strengthened by incorporating more data on species-wise resource availability from inshore fishable water of less than 100 m along Goa coast. The understanding of the oceanographic and environmental variables in relation to fisheries is a vital link in the management of these renewable and self-replenishing resources.

1.1 Sampling and analysis

Three stations were selected for the collection of water and biological samples within the 20-meter depth zone. The station positions are given in Fig.1 and were fixed by GPS. The specific tasks included the collection of water samples for the analysis of Dissolved oxygen (D.O), salinity and nutrients. The biological samples included phytoplankton pigment (chl *a*), primary productivity, zooplankton and benthos. Sampling was carried out on monthly basis and all

stations were covered on each sampling date. No sampling was done for July due to non-availability of fishing boat.

Geographical positions of Sampling Station:

Stn. 1: Aguada (Lat 15^0 27' 444" N & Long 73^0 45' 801" E)

Stn. 2: Calangute (Lat 15^0 31' 37" N & Long 73^0 44' 06" E)

Stn. 3: Colva (Lat 15^0 18' 105" N & Long 73^0 52' 801" E)

Materials and methods

Water quality:

The Physico-chemical parameters were measured onboard and in Laboratory conditions.

pH :

Seawater pH was measured onboard with the Lab-India pH meter (PHAN) after calibration with standard pH buffers.

Salinity :

A suitable volume of the water sample was titrated against silver nitrate (20 g/l) with potassium chromate as an indicator. The salinity was calculated using standard tables.

Temperature:

The water temperature was measured with the help of a mercury thermometer for both surface and bottom waters. As soon as the water was collected the temperature was recorded.

Dissolved oxygen (D.O)

Winkler's method was adopted for the estimation of DO by fixing a measured volume of water samples immediately after the water collection with reagents A (Manganese chloride/sulphate) and reagent B (alkaline potassium iodide). The samples were analysed later in the laboratory by the standard iodometric titration with sodium thiosulphate. DO was calculated and is expressed in mg/l.

Ammonia- Nitrogen (NH_4-N)

Ammonia - Nitrogen in seawater samples was determined with the indophenol blue method using trione. Care should be taken for the analysis of ammonia and the distilled water should be ammonia free and afresh to avoid any contamination as ammonia is highly soluble in water. The absorbance measurements were made at 630 *nm* spectrophotmetrically. The concentration of ammonia is expressed in µM. All photometric measurements were made through Perkin Elmer (Model Lambda 15) UV/VIS spectrophotometer.

Nitrite-Nitrogen (NO_2 - N)

Nitrite was measured by the method of Bendschneider and Robinson where by the nitrite in the water sample was determined by diazotised with sulphanilamide and coupling with N-(1-Naphthyl)-ethylene diamine dihydrochloride. The absorbance of the resultant azodye was measured at 543 nm in a spectrophotometer. Nitrite is expressed in µM.

Nitrate - Nitrogen (NO_3 - N)

Nitrate in the seawater sample was first quantitatively reduced to nitrite heterogeneously by passing the buffered samples through an amalgamated

cadmium column and the resultant nitrate was analysed. The measured absorbance was due to initial nitrate in the sample and nitrite obtained after the reduction of nitrate. Necessary correction was therefore made for any nitrite initially present in the sample. The unit for Nitrate is µM.

Phosphate - Phosphorus (PO_4 -P)

Inorganic phosphate was measured by the Murphy and Riley method, in which samples were made to react with acidified molybdate reagent and then reduced using ascorbic acid. The absorbance of the resultant phosphorus molybdenum blue complex was measured at 880 *nm.* The concentration of phosphate was measured in µM.

Silicate - Silicon (SiO_4 - Si)

Determination of dissolve silicon in seawater is based on the formation of yellow silicomolybic acid, which results from a more or less acidic sample, when treated with a molybdate reagent. Since this yellow silicomolybdic acid is rather weak in color, ascorbic acid is used as a reductant in order to reduce to an intensely blue colored complex. Oxalic acid is used for prevention of phosphate interference in this method. The absorbance of the blue colored complex was measured at 810 nm and silicate concentration is given in µM.

Suspended solid

A liter of seawater was filtered through pre-weighed 0.7 µm GF/F millipore filter paper, dried in an oven at 60°C and weighed again. The difference between the two weights was the amount of suspended solid. The suspended solid is expressed in terms of g/l.

Biological parameters

Monthly collection of biological samples was carried out, which included collection of water samples for chlorophyll a, phytoplankton, primary productivity, zooplankton and benthos. Protocols for each sampling are detailed below.

Primary Productivity

For the measurement of primary productivity, water samples were collected in four, 250 ml graduated polycarbonate bottles (three light, one dark for each depth). After adding one ample of 14C (NaH14CO3), the bottles were incubated on deck with running seawater for a minimum period of six hours. 14C incorporated into the phytoplankton cells was measured by filtering the whole volume of the incubated sample through 0.7 μm GF/F filter (25 mm diameter). The filters were individually preserved in 8 ml Torson vials. After acid treatment, 5ml of liquid scintillation cocktail was added to each vial and its radioactivity was measured in a scintillation counter. The primary production rate in term of mg C m-3 d-1 was calculated from the disintegration per minute (DPM's).

Chlorophyll a

A liter of water collected by Niskin water sampler was filtered through GF/F filter paper (dia. 47mm, pore size 0.7 μm) in duplicates. The filters were than individually transferred into 20ml Torson vials and immediately frozen in liquid nitrogen until further analysis. Chlorophyll *a* was extracted in dark after 12 hr, by adding 10 ml of 90% acetone under refrigeration. Chlorophyll a content was estimated using a Turner design flurometer.

Zooplankton

An HT (Heron Tranter) net of mouth area 0.25 m^2 and gauze of mesh size 200 micron was used to collect zooplankton samples. A flow meter was employed to measure the amount of water filtered through the net. At each station, the net was operated for 5 minutes and samples obtained were preserved in 4-5 % buffered formaldehyde for further analysis. The different taxa were identified according to Kasturirangan (1963). In the laboratory, each sample (for quantitative analysis) was made up to 1000 ml volume and an aliquot of 10 ml was taken. Each time, 3 replicates were examined and an average obtained. The value was then converted to 1000 ml and the final estimate obtained extrapolating the flow meter reading. Biomass was determined by displacement volume method (ml/m^3) according to UNESCO (1968). Prior to the analysis, excess water was removed using a filter paper and samples were transferred into a glass measuring cylinder (50 ml) containing a known quantity of water. The difference in displacement was noted, which gave the displacement volume and is expressed as ml/100m^3.

Benthos

Benthic investigations consisted collection of seabed samples from 3 locations with the help of a Van Veen grab (0.04 m^2 area). The samples were then sieved onboard through a 0.5 mm sieve for separating macro benthos and washed the sediment with seawater. The fauna retained on the sieve (live animals) were carefully separated along with residual sediment, if any. The samples were fixed in 5% (neutral) formaldehyde-Rose Bengal solution, labeled and stored for

further examination. In the laboratory, the sediments were washed again under tap water and the material preserved in 5% formaldehyde or denatured spirit containing Rose Bengal stain. For qualitative enumeration, each sample was examined under a binocular microscope. The organisms were separated into different taxonomic groups for further identification. All taxa were identified to their specific, generic or, other higher levels to the extent possible with the help of standard taxonomic references (e.g. Polychaeta: Fauvel, 1953; Day, 1967) and available expertise.

Fish and Fisheries

Demersal fish catch data was collected using exploratory trawling in the target areas. Trawling was carried out by the NIO and FSI by different trawl net size. The trawl net used by NIO had a mouth area of 8.5 m^2 and cod end mesh size of 20 mm. On each sampling site the trawl net was towed parallel to the coast for an hour at constant speed of 1.5 knot. The fishes caught were identified and their numerical abundance recorded. An estimate of the total catch was also made after each haul.

The Fishery Survey vessel 'MFV Sagarika' (OAL 28.8m) was deployed under the project for demersal fisheries resources survey along Goa coast (15°N Latitude) by FSI during the period from January 2004 to April 2006. The vessel carried out bottom trawl survey using 27.5m Fish Trawl and 30m Shrimp Trawl between 20-200 m water depth. A total of 310 sampling stations were covered randomly during the survey, expending total fishing efforts of 465 hrs. (355.5 hrs for FT & 109.5 hrs for ST). 88 species were recorded during the survey, of which 65

species were finfishes, 12 species of crustaceans, 3 species of cephalopods and 8 species of elasmobranchs.

Result

The dynamic nature of the marine environment may change over space and time, with or without the influence of anthropogenic activities. With an increasing magnitude of developmental activities along the coast the real impacts need to be monitored. A cumulative effect of the natural and anthropogenic activities should be determined to understand the changes occurring in the system. Understanding the ground conditions over a period of time becomes essential for monitoring, planning and managing a system and its valuable resources.

Water quality

The unique chemical property of marine water plays an exigent role in growth, development, distribution and abundance of the organisms inhabiting the aquatic system.

The changes in water properties influence the marine ecosystem at large.

Marine waters contain nutrients, which are utilized by living organisms to produce food and energy. Therefore nutrients are the limiting factor that determines the marine ecosystem productivity. Hence fluctuation in nutrients contents directly perturb the biological parameters in the marine environment.

The presence of nutrients like nitrate, nitrite, phosphate and silicate in the water are helpful for the development of the phytoplankton, as the primary producer. Phytoplanktons are grazed upon by the zooplankton, and are totally depended

upon the former. The planktivore fishes use the availability of zooplankton biomass. The Physico-chemicals oceanographic parameters also affect the development and growth of the marine fishes and the fisheries as a whole.

Physico-chemical parameters of all three stations are given in the Table 1. The variation in temperature of surface and bottom waters was within expected range of variability. Lowest temperature (25.5 °C) was recorded in January and highest temperature (32 °C) was in the month of April. The variation of salinity in Goan waters was 20 to 37 ppt throughout the year both at surface and bottom. The relatively high salinity during monsoon (>35 ppt) is result of upwelling, which occurs every year around the monsoon time. Dissolved oxygen showed a contrasting feature. Pronounced suboxic layer was recorded in the bottom water of all stations during monsoon period. The surface water remained well oxygenated. The degree of anoxia was not restricted to monsoon period. Suboxic layer at bottom was also noticed a few stations in the post monsoon period.

The nutrients showed clear seasonality. Nitrate concentration fluctuated widely between 0.002 and 7.45 μM with values generally low at surface and high at bottom. The nitrite values showed similar trend and the consumption was much lower, minimum being 0.02 and maximum being 3.92 μM. The phosphate values fluctuated moderately between 0.04 and 2.19 μM at the surface and 0.06 to 3.19 μM at the bottom. The distribution of nutrient showed normal behavior. The silicate values ranged between 1.12 and 61.39 μM at the surface and 0.04 and 34.30 μM at the bottom. The suspended solid at the bottom remained low and within the reported range. The near anoxic conditions developed in the bottom

particularly during monsoon due to denitrification may play an important role in the demersal fisheries resources particularly solar prawn. It may be noted that mass inshore migration of mature solar prawn takes place along Goa coast.

The coastal water of Goa follows a clear seasonal pattern in distribution of chemical parameters.

Similarly the values of nutrients (NO_2, NO_3, PO_4, and SiO_4) were within the normal range. The most striking feature of the water quality is hypoxia or anoxic condition observed in the bottom waters. Such depletion in dissolved oxygen in the shallow water (<20 m depth) will act as limiting factor in the distribution of bottom dwellers. The pH and suspended solid were normal.

Biological properties

The knowledge of biological processes alongwith physical environment of the system helps in the prediction of fisheries resources and management. Table 2 gives the values of biological parameters. The chlorophyll concentration ranged between 0.05684 to 2.8483 mg/m^3 on the surface and 0.0588 to 2.51096 mg/m^3 at the bottom. The primary productivity estimation is in progress and will be presented in the final report. The zooplankton biomass ranged between 0.26 to 40.04 ml/100m^3. The copepods and decapods comprised more than 50% of the total zooplankton numerically. The benthic organisms were dominated by polychaete worms, crustaceans and bivalves. The biomass ranged between 0.15 to 108.57 g/m^2. The numerical abundance was in the range of 50 nos./m^2 to 10,650 nos./m^2.

Monthly fish catch statistic is given in Table 3. This statistic is based on the fish caught in the trawl net within 20 m depth contour. The catches showed wide variation in quality and quantity as expected. The catch composition showed high variability in the occurrence of species, season based dominance of species was observed.

Total catch varied between 2–70 Kg/haul and the highest being in the month of May. It suggest a wide fluctuation in catches of shallow water. The catch composition showed the multispecies dominance which varied in different season. The penaeid prawns in the catches was constituted mainly by *Metapenaeus dobsoni* and *Parapenaeopsis stylifera* which was followed by *Metapenaeus monoceros*, *Metapenaeus affinis*, *Penaeus merguiensis*, *Penaeus indicus* and *Parapenaeopsis hardwikii*. Among fishes, clupeids and leognathids were available during most part of the year. Small sciaenids were dominant during the post monsoon season. Detailed study of the dominated species of demersal resources is being carried out and will be included in the final report.

Salient feature of demersal fisheries catch data

The experimental trawling was conducted at each site in the inshore water (<15 m depth) at the time of collection of other data. The results are shown in Table 4. In the monsoon time, due to the bad weather condition, no sampling was done in July. The catch in different months showed dominance of different fish species. The catches were generally poor with dominance of squilla and jelly fishes. The prawn catch was always very poor. The solar prawn (*Metapenaeus dobsoni*)

appeared in good numbers at 8-10 meter depth while other prawns (white) medium and small were observed in depth more than 10 meters. The wide fluctuation in the catches reflects on poor conditions in the inshore water. Total 30 species were recorded during the period.

Fisheries resources beyond 20 m depth along Goa coast

The inshore waters of about 80% bear the brunt of all exploitation of the world fisheries recources . A depth-wise Catch composition (Kg), Percentage contribution, Catch rate(Kg/h) and Biomass of the fisheries resources of Goa coast is presented in Table 4 & 5.

(A) 20-30 m Depth:

Catch composition (%):

The percentage contribution of major groups of fishes that are contributed to the total catch in 20-30m depth were finfishes (72.36%), cephalopods (4.49%), crustaceans (3.38%), elasmobranchs (0.21%) and others (19.56%). Among finfishes, the catch was dominated by Trichurus savala (20.01%) and other major varieties were Leiognathus bindus (8.83%), Rastreilliger kanagurta (7.31%), Arius thalassinus (6.8%), Sardinella longiceps (6.2%), Johnius dussumeri (4.36%), Decapterus russelli (3.94%) and Megalapsis cordyla (3.4%).

In cephalopods, Loligo duvaucelii (4.14%) formed the major component and followed by Sepia pharonis (0.35%).

In crustaceans shrimps accounted 2.44% and contribution of crabs was 0.95%.

In shrimps, Penaeus indicus (2.24%) dominated the catch followed by

Metapenaeus dobsoni (0.11%) and Metapenaeus affinis (0.07%). Portunus Pelagicus (0.74%) was major species in crabs followed by Portunus sanguinolentus (0.21%) .

Catch rate (Kg/h):

In finfishes Pomadasys maculatum showed the highest catch rate (26.67 Kg/h) followed by Arius thalassinus (10.78 Kg/h) , Trichurus savala (9.66 Kg/h) , Decapterus russelli (9.38 Kg/h) , Sardinella longiceps (7.38Kg/h) , Leiognathus bindus (6.44 Kg/h) and Rastrelliger kanagurta (4.18 Kg/h) . In Shrimps, highest catch rate of 1.64 Kg/h was recorded for Penaeus indicus followed by 0.67 Kg/h for Metapenaeus affinis and 0.5 Kg/h for Metapenaeus dobsoni. Loligo duvauceli reported catch rate of 3.58 Kg/h.

Biomass:

Total biomass estimated in 20-30 m depth for various groups was 3171.32 tonnes. Among these finfishes accounted 2430.68 tonnes , cephalopods 108.50 tonnes , crustaceans 151.26 tonnes and elasmobranch 41.4 tonnes. The highest biomass of 613.28 tonnes was recorded for Pomadasys maculatum followed by Arius thalassinus (223.08 tonnes), Trichurus savala (222.27 tonnes), Decapterus russelli (194.05 tonnes), Sardinella longiceps (152.65 tonnes), Rastrelliger kanagurta (33.59 tonnes), etc. The biomass of shrimp was estimated at 61.57 tonnes while crabs at 89.70 tonnes. (Table 4)

B) 30-50 m Depth:

Catch (%) composition:

The percentage contribution of major groups in 30-50m depth were Fin fishes (76.65%) followed by cephalopods (6.75%), crustaceans (0.89%), elasmobranchs (0.33%) and other trawl by -catches 15.38%.

In finfishes, Trichurus savala (13.09%) contributed higher catch followed by Decapterus russelli (11.2%) , Rastreilliger kanagurta (9.06%), Epinephelus dicanthus (8.26%), Megalapsis cordyla (6.43%), etc.

In shrimps, Parapenaeopsis stylifera accounted 0.06% followed by Metapenaeus affinis and Penaeus semisulcatus 0.02%, Metapenaeus dobsoni and Metapenaeus monoceros 0.01%. Portuns cruciata (0.38%) formed major catch in crabs followed by Portunus sanguinolentus (0.24%) and Portunus pelagicus (0.15%).

Loligo duvauceli was the major species (6.7%) in Cephalopoods.

Catch rate:

The highest catch rate of 16.67 Kg/h was recorded for Protonibea dicanthus in finfishes, 3.2 Kg/h for Loligo duvauceli in cephalopods, 4.15Kg/h for Portuns cruciata in crustaceans. Shrimps represented catch rate of 1.58 Kg/h in 30-50m depth .

Biomass:

The biomass estimated in 30-50m depth for different groups was 11525.57 tonnes, in which finfishes accounted 8613.8 tonnes followed by crustaceans (494.16 tonnes), elasmobranchs (378.87 tonnes), cephalopods (213.89 tonnes).

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The highest biomass was reported for Protonibea dicanthus (868.98 tonnes) (Table 5).

The Length-Frequency and other Biological studies carried out during the survey is presented in Table 6.

The total 26 species were measured for Length-Frequency study and 8808 observations made from 195 samples and for other biological study such as food and feeding habit and maturity study, data of 24 species were collected and made 2711 observations from 160 samples. The detail results will be included in the final report.

Summary:

The two year survey of demersal fisheries resources in particular the penaeid prawn of Goa has shown clear depth distribution and seasonality in the species occurrences. The mass exceeds of solar prawn towards shallow coastal water appears to be triggered by oceanographic conditions developed in the monsoon season in the Central West Coast of India. The detailed report will be submitted soon.

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Table 1. Monthly variation in Physico-chemical parameters

Month	Station	Depth (m)	Temp (°C)	Salinity (psu)	DO (ml/L)	NO_3^- (µM)	NO_2^- (µM)	PO_4^{3-} (µM)	SiO_4^{4-} (µM)	pH	S.S. (gm/l)
Jan	1	0	29	34	5.46	0.32	0.22	0.27	3.93	6.5	
		11	26.8	32	4.19	1.93	0.11	0.49	9.32	6.5	0.0343
	2	0	27	33	4.76	0.71	0.43	0.39	4.32	7.5	
		8	25.5	32	4.34	1.62	0.63	0.67	10.91	7.5	0.0349
	3	0	28.5	36	5.23	0.18	0.17	0.45	3.63	8.5	
		12	28	34	4.19	1.32	1.13	0.86	10.21	8.5	0.0435
Feb	1	0	27	33	5.31	0.67	0.43	0.32	4.19	7.0	
		12	26	34	4.14	1.84	0.61	0.53	11.30	7.2	0.2128
	2	0	30	32	5.52	0	0.08	0.62	3.85	7.5	
		11	29	33	4.32	0	0.08	1.63	10.23	7.5	0.0596
	3	0	30	32	5.13	0.31	0.24	0.73	4.13	8.5	
		13	29	33	4.82	1.32	1.24	1.27	10.73	8.5	0.2576
Mar	1	0	28.5	36	5.63	0.46	0	0.11	5.94	6.5	
		11	28	34	4.76	0.02	0.02	0.28	12.04	6.5	0.0395
	2	0	28.5	32	4.5	0.08	0.06	0.13	6.27	7.5	
		13	28	34	4.28	0.10	0.02	0.29	7.7	7.5	0.037
	3	0	30	34	5.21	0.002	0.02	0.24	8.74	8.5	
		14	29	34	4.95	0	0.04	0.37	18.53	8.5	0.0419
Apr	1	0	30	33	5.13	0.84	0.10	0.06	8.25	7	
		8	29	34	3.49	2.75	1.31	0.09	12.98	7.2	0.0731
	3	0	32	23	5.13	0.58	0.06	0.04	4.45	7	
		13	31	33	4.28	0.66	0.17	0.06	9.07	7	0.0975
May	1	0	31	33	5.08	0.82	0.74	0.30	10.38	7	
		12	29	32	1.63	2.13	0.78	0.63	17.41	8	0.0345
	2	0	30	37	5.53	0.61	0.13	1.73	19.40	8	
		11	29	36	2.42	1.72	1.75	1.39	34.30	7.5	0.0999
	3	0	29.5	34	4.79	1.04	0.42	0.62	12.40	7	
		12	29	35	4.28	3.16	0.89	1.37	17.06	7	0.0504
Jun	1	0	30	25	7.2	0.91	0.31	0.47	14.30	6.5	
		12	28.5	35	4.3	1.32	0.79	0.73	16.53	6.5	0.0458
	2	0	30	36	4.74	1.91	0.63	1.41	17.59	8	
		13	29.3	35	4.51	3.37	1.89	1.32	32.13	7.5	0.013
	3	0	29.5	35	5.51	0.87	0.57	0.89	11.40	6.5	
		13	28.5	35	4.2	2.19	1.96	1.67	18.50	6.5	0.0307
Aug	1	0	28.5	20	3.49	0.43	0.26	1.73	61.39	7.92	
		12	27.5	35	0.22	4.13	3.92	3.19	31.91	7.8	0.0525
	2	0	28.5	25	4.28	0.53	0.07	1.19	19.20	8.02	
		13	28.2	35	0.22	7.45	2.93	15.19	27.01	7.8	0.5686
Oct	1	0	29.5	35	3.69	0.39	0.32	1.61	15.21	7.5	
		12	28.7	34	2.87	0.48	1.26	2.34	3.52	7.9	0.3256
	2	0	29.3	34	4.12	0.21	0.09	0.19	3.58	7.7	

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		13	28.4	34	3.56	0.35	1.12	0.41	0.96	7.6	0.0563
	3	0	30.5	35	4.59	0.25	0.16	0.39	3.56	8.26	
		12	29.6	34	3.25	1.38	2.29	0.72	2.19	7.8	0.0259
Nov	1	0	29.4	33	4.96	0.26	0.18	2.19	10.01	8.09	
		12	29.1	35	3.17	0.46	1.79	0.62	2.31	7.89	0.0374
	2	0	30.1	32	4.42	0.13	0.05	0.12	1.12	8.14	
		11	29.5	34	3.88	0.19	1.03	0.39	0.40	7.92	0.0309
	3	0	30	33	4.3	0.19	0.17	0.43	4.91	8.12	
		12	29.6	34	3.89	1.41	3.13	0.69	2.52	7.84	0.0286
Dec	1	0	27.4	35	3.72	0.41	0.18	0.48	4.85	7.98	
		12	27.4	35	3.8	0.63	0.40	0.92	3.13	8.05	0.0288
	2	0	29.7	35	4.2	0.81	0.51	1.19	5.91	8.1	
		9	29	33	3.36	1.21	0.75	1.03	3.30	8.05	0.0298
	3	0	29.2	34	3.88	0.42	0.36	0.62	6.30	7.9	
		8	28.5	35	3.51	1.79	0.52	0.93	2.19	8.08	0.0411

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Table 2. Biological Productivity of the selected stations.

Month	Stations	Chl. a (mg/m3)		*P. P (mg C $m^{-3}d^{-1}$)		Zooplankton biomass (ml/100m^3)	Macrobenth biomass (g/m2)
		Surface	Bottom	Surface	Bottom		
January	1	0.17052	0.19245			35.56	21.36
	2	0.19894	0.20145			40.04	1.09
	3	0.28432	0.29021			3.72	108.57
February	1	0.05684	0.07105			20.57	36.29
	2	0.34104	0.51156			14.78	0.88
	3	0.31262	0.19894			0.98	7.65
March	1	0.88102	0.34104			21.54	2.23
	2	0.22736	0.39788			15.26	0.15
	3	0.3345	0.23456			14.95	17.82
April	1	1.47794	1.48784			12.99	0.78
	2	0.51056	0.5674			10.58	0.69
	3	0.25478	0.25478			8.74	5.82
May	1	2.18721	2.25231			22.90	0.18
	2	2.84832	2.1435			13.07	32.74
	3	2.4538	1.8315			19.3	0.88
June	1	1.47794	1.48784			1.57	1.29
	2	2.50106	2.51096			15.16	1.82
	3	1.59162	1.60152			5.82	1.31
Aug	1	0.52386	0.51356			10.01	4.3
	2	0.97858	0.96828			8.72	9.35
	3	0.21124	0.20094			7.26	2.14
Oct	1	0.97858	0.96828			4.26	3.6
	2	0.06914	0.05884			5.21	0.6
	3	0.08335	0.07305			8.49	1.32
Nov	1	0.35334	0.34304			3.03	17.54
	2	0.52386	0.51356			6.38	5.44
	3	0.32492	0.31462			31.27	5.10
Dec	1	0.21124	0.20094			2.2	18.35
	2	0.89332	0.88302			0.26	6.72
	3	0.3856	0.35236			5.15	4.18

*Data on PP will be added in the final report

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Table 3. Monthly fish catch statistics

Obs. Month	Stn. No.	Water Depth (m)	Speed of Trawl net (knot)	Trawling Time (Hr)	Total Catch (Kg)	Biomass per Haul (Kg)	Dominant Groups
January	1	8	1.5	1	Nil	Nil	--
	2	8	1.5	1	18	18	Squilla and prawn
	2	18	1.5	1	60	60	Squilla, Crab and Prawn
	3	14	1.5	1	40	40	Solar prawns (90%)
	3	12	1.5	1	25	25	Prawns (30%), Crabs.
February	1	12	1.5	1	35	35	Epinephelus dicanthus and Crab
	1	13	1.5	1	70	70	Crabs and prawns
	2	8	1.5	1	55	55	Crabs and prawns
	2	12	1.5	1	60	60	Squilla
March	1	12	1.5	1	5	5	Leognathids (80%)
	2	13	1.5	1	15	15	Squilla
	3	12	1.5	1	20	20	Leognathids
April	1	13	1.5	1	25	25	Vodang
	3	12	1.5	1	25	25	Squilla
May	2	10	1.5	1	70	70	Leognathids (85%)
	3	12	1.5	1	2	2	Puffer fish (75%)
June	2	13	1.5	1	20	20	Leognathids
	3	13	1.5	1	35	35	Leognathids (90%)
Aug	1	12	1.5	1	18	18	Leognathids
	2	13	1.5	1	10	10	Leognathids
Oct	1	12	1.5	1	15	15	Jelly fish (90%), Sciaenids
	2	12	1.5	1	8	8	Leognathids, oil sardine
	3	13	1.5	1	Nil	Nil	--
Nov	1	10	1.5	1	Nil	Nil	--
	2	12	1.5	1	2	2	Jelly fish (70%)
	3	10	1.5	1	Nil	Nil	--
Dec	2	10	1.5	1	10	10	Epenephelus sp.(40%)
	3	8	1.5	1	6	6	Oil sardine (60%)

Table 4. List of species and abundance recorded in fishing vessel of FSI along Goa coast.

Depth of operation (m) 20-30
No. of Hauls 45
Fishing Effort (hrs) 67.5

SL. NO.	GROUPS	SPECIES	CATCH (Kgs)	PERCENTAGE	CPUE Kg/hr	BIOMAS (Tonnes
1	Elasmobranchs (Sharks, Skate & Rays)	*Carcharhinus limbatus* *	1	0.070101647	0.667	13.798
		Scoliodon laticaudus *	1	0.070101647	0.667	13.798
		Aetobatus narinari	1	0.070101647	0.667	13.798
2	Cephalopods (Squids, Cuttle fish)	*Loligo duvauceli* *	59	4.135997196	3.576	74.0122
		Sepia pharaonis *	5	0.350508237	1.667	34.4972
3	Crustaceans (Shrimps & Crabs)	*Metapenaeus affinis* *	1	0.070101647	0.667	13.798
		Metapenaeus dobsoni	1.5	0.105152471	0.5	10.3491
		Penaeus indicus	32	2.243252716	1.641	33.9665
		Penaeus merguensis	0.25	0.017525412	0.167	3.44972
		Portunus pelagicus	10.5	0.736067298	2.333	48.2961
		Portunus sanguinolentus	3	0.210304942	2	41.3966
4	Barracuda	*Sphyraena obtusata*	2	0.140203295	1.333	27.5977
5	Carangids	*Alectis indicus*	2	0.140203295	1.333	27.5977
		Alepes Vari	1	0.070101647	0.667	15.3321
		Carangoides malabaricus	11.5	0.806168945	2.556	52.8957
		Decapterus russelli	56.25	3.943217666	9.375	194.04
6	Cat fishes	*Arius thallassinus*	97	6.799859797	10.78	223.082
7	Clupeiodes	*Anodontostoma chacunda*	10	0.701016474	3.2	73.5941
		Chirocentrus dorab	1.5	0.105152471	0.5	10.3491
		Chirocentrus nudus	1	0.070101647	0.667	13.798
		Dussumieria eloposidesi	4	0.28040659	1.3	29.8976
		Sardinella fimbriata	2	0.140203295	0.667	13.798
		Sardinella longiceps	88.5	6.203995794	7.375	152.650
8	Lizard fishes	*Saurida tumbil*	3	0.210304942	0.667	13.798
9	Eels	*Muraenesox cinereus*	4	0.28040659	2.667	55.1955
10	Rock cods	*Epinephelus chlorostigma*	2	0.140203295	1.333	27.5977
		Epinephelus diacanthus	48	3.364879075	3.215	73.9348
11	Scieanids	*Johinus dussumieri*	62.25	4.36382755	1.994	45.855
12	Horse mackerel	*Megalaspis cordyla*	48.5	3.399929898	3.241	74.5310

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13	Mackerel	*Rastrelliger kanagurta*	104.25	7.30809674	4.179	96.10676
14	Seer fishes	*Scomberomorus commerson*	8	0.560813179	1.778	36.79706
		Scomberomorus guttatus	5	0.350508237	1.667	34.49724
15	Pomfrets	*Pampus argenteus*	2	0.140203295	1.333	27.59779
		Pampus chinensis	3	0.210304942	2	41.39669
		Parastromateus niger	4	0.28040659	0.889	18.39853
16	Thread fin bream	*Nemipterus japonicus*	2	0.140203295	1.333	27.59779
17	King fish	*Rachycentron canadum*	1	0.070101647	0.667	13.7989
18	Ribbon fishes	*Trichirus savala*	285.5	20.01402033	9.665	222.273
19	Others	*Lactarius lactarius*	7	0.490711532	1.1	25.29798
		Leiognathus bindus	126	8.832807571	6.439	148.0826
		Pomadasys maculatum	40	2.804065896	26.67	613.2843
		Squilla raphidis	266	18.64703821	16.12	333.6824
		Jelly fish	5	0.350508237	3.333	68.99448
		Shell	8	0.560813179	1.778	36.79706
	TOTAL		**1426.5**	**100**	**146.4**	**3171.321**

11/c

Table 5. List of species and abundance recorded in fishing vessel of FSI along Goa coast.

Depth of operation (m) 30-50
No. of Hauls 116
Fishing Effort (hrs) 174

SL NO.	GROUPS	SPECIES	CATCH (Kgs)	PERCENTAGE	CPUE (Kg/hr)	BIOMASS (Tonnes)
1	2	3	4	5	6	7
1	Elasmobranchs	*Carcharhinus limbatus* *	2	0.060654676	1.333333	69.5182481
	(Sharks, Skate &	*Carcharhinus sorrah* *	2	0.060654676	1.333333	69.5182481
	Rays)	*Scoliodon laticaudus* *	1	0.030327338	0.666667	31.2832116
		Rhinobatus granulatus	5	0.151636691	3.333333	173.79562
		Himantura bleekeri	1	0.030327338	0.666667	34.759124
2	Cephalopods	*Loligo duvauceli* *	221.055	6.704009729	3.202246	166.960918
	(Squids, Cuttle fish)	*Sepia brevimana*	1.5	0.045491007	1	46.9248174
3	Crustaceans	*Metapenaeus affinis* *	0.5	0.015163669	0.333333	17.379562
	(Shrimps & Crabs)	*Metapenaeus dobsoni*	0.25	0.007581835	0.166667	7.82080291
		Metapenaeus monoceros	0.25	0.007581835	0.166667	7.82080291
		Parapenaeopsis stylifera	2	0.060654676	0.666667	34.759124
		Penaeus semisulcatus *	0.75	0.022745504	0.25	13.0346715
		Portunus cruciata	12.5	0.379091727	4.15	216.375547
		Portunus pelagicus	5	0.151636691	1.111111	57.9318734
		Portunus sanguinolentus	8	0.242618705	2.666667	139.036496
4	Barracuda	*Sphyraena jello*	6	0.181964029	4	208.554744
		Sphyraena obtusata	76.07	2.307000611	2.532333	132.032533
		Sphyraena putnamiae	13	0.394255396	1.733333	90.3737225
5	Carangids	*Alectis indicus*	23.5	0.712692446	5.222222	272.279805
		Alepes djedaba	41	1.243420863	6.833333	356.281021
		Atropus atropos	2	0.060654676	1.333333	69.5182481
		Carangoides malabaricus	12	0.363928057	1.6	83.4218977
		Caranx ignobilis	16.5	0.500401079	1.222222	63.7250607
		Caranx sexfasciatus	5	0.151636691	1.666667	86.8978101
		Decapterus russelli	369.225	11.19761142	10.69942	557.853715
		Scomberoides tol	10	0.303273381	6.666667	347.59124
		Selar crumenophthalmus	2	0.060654676	1.333333	69.5182481
		Trichinotus mookali	5	0.151636691	3.333333	173.79562
6	Cat fishes	*Arius thallassinus*	67.705	2.053312428	11.28417	588.341623
7	Clupeiodes	*Anchoviella commersonii*	1	0.030327338	0.666667	34.759124
		Anodontostoma chacunda	8	0.242618705	2.666667	139.036496
		Chirocentrus dorab	14	0.424582734	1.333333	69.5182481

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		Chirocentrus nudus	5	0.151636691	1.111111	57.9318734
		Dussumieria acuta	5	0.151636691	1.088889	56.7732359
		Sardinella fimbriata	14	0.424582734	2.333333	121.656934
		Sardinella longiceps	14	0.424582734	0.848485	44.2388851
8	Lizard fishes	*Saurida tumbil*	21.25	0.644455935	1.089744	56.8177989
		Saurida undosquamis	13	0.394255396	2.166667	112.967153
9	Eels	*Muraenesox cinereus*	21	0.636874101	2.333333	121.656934
		Uroconger lepturus	2	0.060654676	1.333333	69.5182481
10	Rock cods	*Epinephelus diacanthus*	272.5	8.264199639	6.454762	336.542804
11	Sciaenids	*Johinus dussumieri*	28.25	0.856747302	1.558333	81.2494524
		Protonibea diacanthus	25	0.758183453	16.66667	868.978101
12	Horse mackerel	*Megalaspis cordyla*	212.025	6.430153866	4.705	245.312518
13	Mackerel	*Rastrelliger kanagurta*	298.8	9.061808631	4.326087	225.55649
14	Seer fishes	*Scomberomorus commerson*	37	1.122111511	2.740741	142.898621
		Scomberomorus guttatus	37.15	1.126660611	2.257576	117.707034
		Scomeromorus lineolatus	4	0.121309352	2.666667	139.036496
15	Pomfret	*Pampus argenteus*	6	0.181964029	2	104.277372
		Parastromateus niger	12	0.363928057	1.133333	59.0905109
16	Thread fin bream	*Nemipterus japonicus*	55.825	1.693023651	2.326042	121.276756
		Nemipterus mesoprion	3.25	0.098563849	0.525	27.3728102
17	King fish	*Rachycentron canadum*	7	0.212291367	0.92	47.9675912
18	Ribbon fishes	*Trichirus savala*	431.5	13.0862464	10.63704	554.601135
19	Others	*Drepane punctata*	5	0.151636691	3.333333	173.79562
		Echeneis naucrates	1	0.030327338	0.666667	34.759124
		Katsuwonus pelamis	1.5	0.045491007	1	52.138686
		Lactarius lactarius	9	0.272946043	1.45	75.6010948
		Lagocephalus inermis	61	1.849967626	2.541667	132.51916
		Leiognathus bindus	138	4.185172661	5.107407	266.293511
		Leiognathus insidator	44	1.334402877	4.888889	254.900243
		Odonus niger	0.25	0.007581835	0.166667	8.68978101
		Pomadasys maculatum	36	1.091784172	3	156.416058
		Scatophagus argus	0.25	0.007581835	0.166667	7.82080291
		Terapon jarbua	34	1.031129496	7.555556	393.936739
		Squilla raphidis	231	7.005615107	17.11111	892.15085
		Jelly fish	266	8.067071941	14.72222	767.597322
		Shell	10	0.303273381	3.166667	165.105839
	TOTAL		**3297.355**	**100**	**221.2727**	**11525.5718**

9/c

Table 6. Biological parameters of important species under study.

S.N.	Species	Length-frequency study		Maturity stage study		Food and Feeding habit	
		No. of Samples	No. of Observations	No. of Samples	No. of Observations	No. of Samples	No. of Observations
1	*Alepes djedaba*	6	218	3	60	3	60
2	*Arius thalassinus*	4	159	6	121	6	121
3	*Decapterus macrosoma*	1	43	-	-	-	-
4	*Decapterus russelli*	21	1496	16	401	16	401
5	*Dussumeri acuta*	2	77	1	20	1	20
6	*Epinephelus dicanthus*	24	1015	16	174	16	174
7	*Ilisha megaloptera*	2	107	1	20	1	20
8	*Johnius dussumeri*	1	34	1	20	1	20
9	*Megalaspis cordyla*	19	568	15	221	15	221
0	*Nemipterus japonicus*	15	1091	6	78	6	78
	Nemipterus mesoprion	10	574	9	169	9	169
12	*Parastromatus niger*	2	8	-	-	-	-
13	*Priacanthus hamrur*	13	493	12	224	12	224
14	*Rastrelligar kanagurta*	20	725	17	261	17	261
15	*Saurida tumbil*	3	116	-	-	-	-
16	*Sardinella fimbriata*	2	108	-	-	-	-
17	*Scoberomorus commerson*	6	47	5	26	5	26
18	*Scoberomorus guttatus*	1	4	4	11	4	11
19	*Scomberoides tol*	1	23	-	-	-	-
20	*Selar crumpthalmus*	1	25	-	-	-	-
21	*Sphyraena obtusata*	9	286	9	109	9	109
22	*Trichurus savala*	8	406	1	20	1	20
23	*Loligo duvaucelli*	21	1039	8	146	8	146
24	*Metapenaeus affinis*	1	67	3	82	3	82
5	*Metapenaeus dobsoni*	1	57	7	164	7	164
26	*Metapenaeus monoceros*	-	-	6	125	6	125
27	*Parapenaeopsis stylifera*	-	-	3	68	3	68
28	*Penaeus indicus*	1	22	8	184	8	184
29	*Penaeus merguiensis*	-	-	1	3	1	3
30	*Penaeus monodon*	-	-	2	4	2	4
	TOTAL	**195**	**8808**	**160**	**2711**	**160**	**2711**

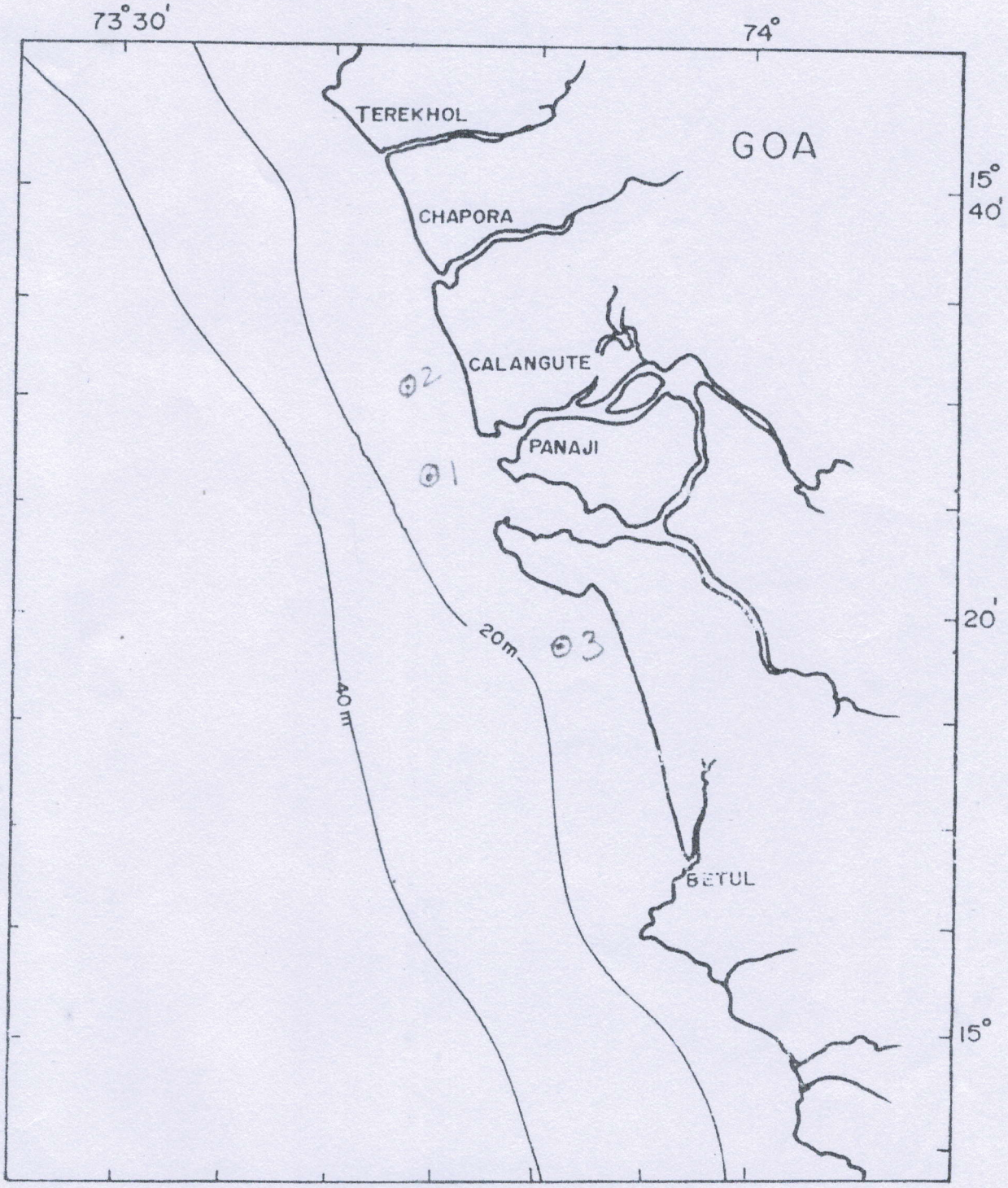

Fig. 1 Map showing the location of station positions of present study.

Reg. No. G-2/RNP/GOA/32/2018-20

RNI No. GOAENG/2002/6410

Panaji, 31st October, 2019 (Kartika 9, 1941)

SERIES I No. 31

OFFICIAL GAZETTE

GOVERNMENT OF GOA

PUBLISHED BY AUTHORITY

INDEX

GOVERNMENT OF GOA

Department of Fisheries

Directorate of Fisheries

Notification

DF/ENF/Amendment/MFR ACT/2019-20

In exercise of the powers conferred by sub-section (2) of section 1 of the Goa Marine Fishing Regulation (Amendment) Act, 2019 (Goa Act 12 of 2019), the Government of Goa hereby appoints the 1st day of November, 2019 as the date on which the provisions of the said Act shall come in force.

By order and in the name of the Governor of Goa.

Vinesh Arlenkar, Director & ex officio/Joint Secretary (Fisheries).

Panaji, 31st October, 2019.

Reg. No. G-2/RNP/GOA/32/2018-2020

RNI No. GOAENG/2002/6410

Panaji, 17th September, 2019 (Bhadra 26, 1941)

SERIES I No. 24

OFFICIAL GAZETTE

GOVERNMENT OF GOA

PUBLISHED BY AUTHORITY

EXTRAORDINARY

No. 4

GOVERNMENT OF GOA

Department of Law & Judiciary

Legal Affairs Division

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Notification

7/13/2019-LA-244

The Goa Marine Fishing Regulation (Amendment) Act, 2019 (Goa Act 12 of 2019), which has been passed by the Legislative Assembly of Goa on 08-08-2019 and assented to by the Governor of Goa on 10-09-2019, is hereby published for the general information of the public.

D. S. Raut Dessai, Joint Secretary (Law).

Porvorim, 17th September, 2019.

The Goa Marine Fishing Regulation (Amendment) Act, 2019

(Goa Act 12 of 2019) [10-09-2019]

AN

ACT

further to amend the Goa, Daman and Diu Marine Fishing Regulation Act, 1980 (Act No. 3 of 1981).

Be it enacted by the Legislative Assembly of Goa in the Seventieth Year of the Republic of India as follows:—

1. *Short title and commencement.*— (*1*) This Act may be called the Goa Marine Fishing Regulation (Amendment) Act, 2019.

(*2*) It shall come into force on such date as the Government may by notification in the Official Gazette, appoint.

2. *Amendment of section 2.*— In section 2 of the Goa, Daman and Diu Marine Fishing Regulation Act, 1980 (Act No. 3 of 1981) (hereinafter referred to as the "principal Act"),—

(*i*) after clause (*c*), the following clauses shall be inserted, namely:—

"(*ca*) "Directorate of Fisheries" means the Directorate of Fisheries of the Government of Goa;

(*cb*) "fish" includes shell fish and crustaceans;

(*cc*) "fish landing centre" means the landing place where landing or berthing facilities have been provided for fishing vessels and their adjoining areas set apart for repair yards, fuel and ice supply installation, auction hall and such limits as may be specified by the Government from time to time;

(*cd*) "fishing" means any act or activity connected with the catching of fish from any water by using fishing vessel, fixed

machine, free net or otherwise and includes stocking of shell fish, conchs and any type of filtration and culturing of them;

(*ce*) "fishing stake" or "stake" or "fishing net" or "fishing gear" or "fixed engine" means any trap or such other contrivance for catching fish either fixed in the soil or river bed or made stationary in any other way in a creek, canal, river, stream, water course or sea;";

(*ii*) after clause (*f*), the following clause shall be inserted namely:—

(*fa*) "prescribed" means prescribed by rules made under this Act;";

(*iii*) in clause (*g*), after item (*ii*), the following item shall be inserted, namely:—

"(*iii*) a fishing vessel registered under section 435 G of the Merchant Shipping Act, 1958 (Central Act 44 of 1958);".—

3. *Amendment of section 3.*— In section 3 of the principal Act, for clause (a), the following clause shall be substituted, namely:—

"(a) Any Officer of the Directorate of Fisheries not below the rank of Fisheries Officer or any Police Officer not below the rank of Police Sub-Inspector; or"

4. *Insertion of new section 8A.*— After section 8 of the principal Act, the following section shall be inserted, namely:—

"8A. *Erection of fishing stakes and registration of net.*— (*1*) no person shall erect a fishing stake without obtaining permission from the authorized officer.

(*2*) The application for permission under sub-section (*1*) shall be made in such form and with such fees as prescribed.

every person in possession of a fishing net shall register his net with the Directorate of Fisheries and shall apply in such form alongwith such fee as prescribed to obtain a licence for operating the same. The fishing nets operated by the Central or State Government are exempted from this provision.

(*3*) The authorized officer shall after making inquiry as deem fit in the matter grant licence in such form as prescribed.

No person shall use net the mesh size whereof is less than 24 mm for catching fish and 20 mm for catching prawns.

5. *Amendment of section 11.*— In section 11 of the principal Act, after sub-section (*1*), the following sub-sections shall be inserted, namely:—

"(*1A*) where a licence granted under section 6 is suspended or cancelled by the Authorised officer, the holder of such license shall within a period of fifteen days from the date of such suspension or cancellation surrender such licence to the Authorised officer and berth his fishing vessel near the jetty or port or near his residence and under his control and whenever Authorised Officer demands, he shall bring such fishing vessel before such officer for the purpose of inspection.

(*1B*) where the licence granted under section 6 is suspended, once the suspension period expires the holder of such licence shall collect such licence from the Authorised Officer."

6. *Insertion of new section 17 A.*— After section 17 of the principal Act, the following section shall be inserted, namely:—

"17A. *Notifying the fish landing centre for landing and berthing of the fishing vessel.*— The Government may, by notification in the Official Gazette, notify the fish landing centre".

7. *Substitution of section 18.*— For section 18 of the principal Act, the following section shall be substituted, namely:—

"18. *Power to enter, search fishing vessels and carry out inquiry.*—

(*1*) The Authorised officer may, if he has reason to believe that any fishing vessel

is being or has been used in contravention of any provisions of this Act, or any rule or order or Notification made thereunder or any of the conditions of the licence granted under this Act, he, shall, enter and search such fishing vessel and demand from the tandel or owner or any crew or master of such fishing vessel to produce all the documents related to the registration of fishing vessel, licence of fishing vessel and licence of fishing net or any other documents which is required on vessel under the law in force and may make such inquiry as deemed fit by him and in case he finds violation of the provisions of the Act, or any rule, order or notifications made thereunder or may condition of the licence, he may impound the fishing vessel and seize any fish found in it. The fishing vessel and its accessories shall be released by the Authorised Officer after making necessary enquiry as he deems fit and taking necessary undertaking from the owner of the fishing vessel in such form as prescribed.

(2) Every owner/tandel/master of fishing vessel shall allow the Authorised Officer to inspect and search the fishing vessel in order to ascertain the contravention of any of the provisions of the Act or any rule or order or notification made thereunder or any of the conditions of the licence. The Authorised Officer shall be not liable for the loss or damage if any caused to the fishing vessel, accessories or fishing gear while impounding the fishing vessel".

8. *Insertion of new section 18A.*— After section 18 of the principal Act, the following new section shall be inserted, namely:—

"18A. *Prohibition on destruction of fish by explosives in inland waters and on coast.*—

(1) No person shall use any dynamite or other explosive substance, with intent to catch or destroy fish in any waters.

(2) No person shall put any poison, lime or noxious material in any waters, with intent thereby to catch or destroy any fish therein.

Explanation:— The word water shall include the sea within the distance of 12 Nautical Mile of the sea coast".

9. *Amendment of section 21.*— In section 21 of the principal Act, for sub-section (1), the following sub-section shall be substituted, namely:—

"(1) The adjudicating officer shall, after the enquiry under section 20, decide whether any person has used or caused or allowed to be used any fishing vessel in contravention of any of the provisions of this Act or any rule or order or notification made thereunder or any condition of licence and any such person on being found guilty by the adjudicating officer, shall be liable to such penalty as may be prescribed".

Secretariat,
Porvorim, Goa.
Dated: 16-09-2019

CHOKHA RAM GARG
Secretary to the
Government of Goa.
Law Department
(Legal Affairs).

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Printed and Published by the Director, Printing & Stationery,
Government Printing Press,
Mahatma Gandhi Road, Panaji-Goa 403 001.

PRICE – Rs. 3.00

PRINTED AT THE GOVERNMENT PRINTING PRESS, PANAJI-GOA—214/220—9/2019.

Reg. No. RNP/GOA/32/2021-2023

RNI No. GOAENG/2002/6410

Panaji, 7th January, 2021 (Pausa 17, 1942)

SERIES II No. 41

OFFICIAL GAZETTE

GOVERNMENT OF GOA

PUBLISHED BY AUTHORITY

EXTRAORDINARY

GOVERNMENT OF GOA

Department of Fisheries

Directorate of Fisheries

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Order

No. DF/ENF/NOTI-IMPL-MLS/2020-21/5042

Whereas, Clause (c) of sub-section (1) of Section 4 of Goa, Daman and Diu Marine Fishing Regulation Act, 1980 (Act 3 of 1981) provides that Government by an order notified in the Official Gazette, regulate, restrict or prohibit the catching in any specified area of such species of fish and for such period as may be specified in the notification;

And Whereas, the Government of Goa have declared the "specified area" vide Government Notification No. 2-1-81-FSH (V) dated 04-09-2001, of Department of Fisheries published in the Official Gazette, Series I No. 24 dated 13-09-2001.

And Whereas, sub-section (2) of Section 4 thereof provides that while making an order under sub-section (1) the Government shall have regard to the matters such as the need to protect the interest of different sections of persons engaged in fishing, particularly those engaged in fishing using traditional fishing crafts such as catamaran, country craft or a canoe, the need to conserve fish and to regulate fishing on a scientific basis, the need to maintain law and order in the sea;

And Whereas, it has come to the notice of the Government that a large quantity of low value (non-target), smaller size fishes (juveniles) are caught by mechanized fishing vessels, and are found killed and discarded in varying proportions. The juveniles of various species of fishes are caught before they attain maturity and this severely affects the fish population. Along with juvenile fishes, other non-edible biota, which are vital to the existence of marine eco-system are caught extra in a fishing operation.

And whereas, the Government has considered the matter of serious concern and this current practice will affect the juvenile population and in the long run may bring about a disaster in the fishing industry making it unsustainable and uneconomical and has decided to prohibit catching of the different species of juvenile fishes in the above specified area.

Now, therefore, in exercise of the powers conferred by Clause (c) of sub-section (1) read with sub-section (2) of Section 4 of the Goa, Daman and Diu Marine Fishing Regulation Act, 1980 (Act 3 of 1981) the Government of Goa hereby prohibits catching of the following species of juvenile fishes having less than the size noted against their names in the area specified in the Schedule hereunder from the date of publication of this Order.

SCHEDULE

Sr. No.	Species Name	Common Name	Local Name	MLS (cm)
(1)	(2)	(3)	(4)	(5)
1.	Sardinella longiceps	Indian oil sardine	Tarlo (ताल्लो)	10TL
2.	Rastrelliger kanagurta	Indian mackerel	Bangdo (बांगडो)	14TL
3.	Trichiurus Lepturus	Ribbon fish	Balle (बाळो)	46TL
4.	Scomberomorus commerson	King seer	Wiswan (विस्वण)	50FL
5.	Stolephorus indicus	Indian anchovy	Motiyale (मोतयाळें)	7.0TL
6.	Parastromateus niger	Black pomfret	Sorngul (सुरंगुटी)	17TL
7.	Euthynnus affinis	Little tuna	Bokdo (बुगडो)	31FL
8.	Sillago sihama	Silver sillago	Mudoshi (मुरदोशी)	11.3TL
9.	Escualosa thoracata	White sardine	Velli (वेल्ली)	8.9TL
10.	Nemipterus japonicus	Threadfin bream (yellow)	Rano (राणो)	12TL
11.	Lactarius lactarius	White fish	Sondhalo (सवनाळो)	10TL
12.	Cynoglossus macrostomus	Sole fish	Lepo (लेप)	9TL
13.	Pampus argenteus	Silver pompfret	Paplet (पांपलेट)	13TL
14.	Epinephelus diacanthus	Grouper	Gobro (गोबरो)	18TL
15.	Johnius spp.	Sciaenid	Dhodiaro (दोडयारो)	15TL
16.	Otolithes spp.	Croaker	Dhodiaro (दोडयारो)	17TL
17.	Uroteuthis photololigo duvauceli	Indian Squid	Manki (माणकी)	8DML
18.	Portunus Sanguinolentus	Spotted crab	Kulli (कुल्ली)	7CW
19.	Parapenaeopsis stylifera	Kiddi prawn	Sungat (सुंगट)	7TL
20.	Metapenaeus affinis	Jinga prawn	Sungat (झिंगा श्रिम्प)	9TL

Abbreviations:- TL-Total Length, FL-Fork Length, DML- Dorsal Mantle Length, CW-Carapace Width of crabs, MLS-Minimum Legal Size.

Consider the catch as violation if more than 50% of the catch sample is composed of fishes at or below the prescribed MLS.

By order and in the name of the Governor of Goa.

Dr. *(Smt.) Shamila Monteiro,* Director and ex officio Jt. Secretary (Fisheries).

Panaji, 6th January, 2021.

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Printed and Published by the Director, Printing & Stationery,
Government Printing Press,
Mahatma Gandhi Road, Panaji-Goa 403 001.

PRICE – Rs. 2.00

PRINTED AT THE GOVERNMENT PRINTING PRESS, PANAJI-GOA—310/160—1/2021.