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## Operational parameters and mapping of fisheries resources of gillnets in Bhayander estuary, Maharashtra, India

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### Abstract

Fishermen use both bottom set gillnet and drift gillnet in Bhayander estuary, Maharashtra to catch high valued lobsters and demersal fishes respectively. Gillnet fishing in this estuary is seasonal and consists of five months from January to May mostly targeting high valued and large size fishes. Fortnightly sampling has been done to record the catch per unit effort (CPUE) and a thematic map for the monthly abundance of the fisheries resource mapped. Low availability of resources forced the drift gillnetters to go near or beyond 10-meter depth contour for fishing. The map showed that the monthly variation of the catch is very high, due to the uncertainty in catch and pollution as well.

**Keywords:** gill net, estuary, geographical information system (GIS)

### 1. Introduction

Topography plays an important role in the availability and diversity of fish species in different parts of the country. Based on the availability and type of species the region-specific gears employed to catch the fish. Gill net which is basically a size selective gear having its high coefficient of selectivity proves it more environmentally friendly. Gill nets are mostly used in the capture of fishery resources particularly pomfrets, clupeids, silver bellies, polynemids, catfishes, sharks etc. along the Indian coast. As passive gear, their catching ability relies on the movement or migration of fish through the area where the nets are set and operculum of fishes get entangled in the meshes of nets when the fishes try to pass through it<sup>[1]</sup>. Gill netting is a more eco-friendly method compared to some of the active fishing operations. Large and average size fishes of better these gears since they are handled individually<sup>[2]</sup>. The estuarine fisheries of Thane district of Maharashtra are mostly dominated by the gill netters<sup>[3]</sup>. Both drift gill nets and bottom set gill nets used for catching the high valued fishes in this region.

The estuary is a coastal water body which is the transition zone between land and sea and the estuarine water continuously fed with the fresh water from rivers and sea waters through tidal action<sup>4</sup>. Among many issues which hamper the estuarine resources, bycatch is a major issue. It creates conservation failure in case of bycatch of endangered species such as aquatic mammals, turtles, fish etc.<sup>[5]</sup> The Bhayander estuary is mostly affected by the industrial and sewage effluents which is gradually increasing due to the rise in population and urbanization, and the pollution and plastic affects both breeding and nursery ground of the estuary, which ultimately impacts the livelihood of the local fishermen.

In fisheries, the application of Geographical Information System (GIS) is useful to manage the resources with the selection of primary and secondary data and there are various methods by which the mapping can be done to visualize and interpret the information<sup>[6]</sup>. Fisheries information in the field level varies with the spatial and temporal pattern, but GIS is an effective tool for the integration of these data and helpful to the decision maker for the better management of the resource<sup>[7]</sup>. The visualization is a very potent tool in the provision of decision support in fisheries information systems<sup>[8]</sup>. But the problem associated with the use of this advanced software is the lack of efficient personnel, high licensing cost, and more time requirement to understand the features and plugins of the software<sup>9</sup>. But due to the availability of the open access software like QGIS, the mapping of the resource and habitat in the field of

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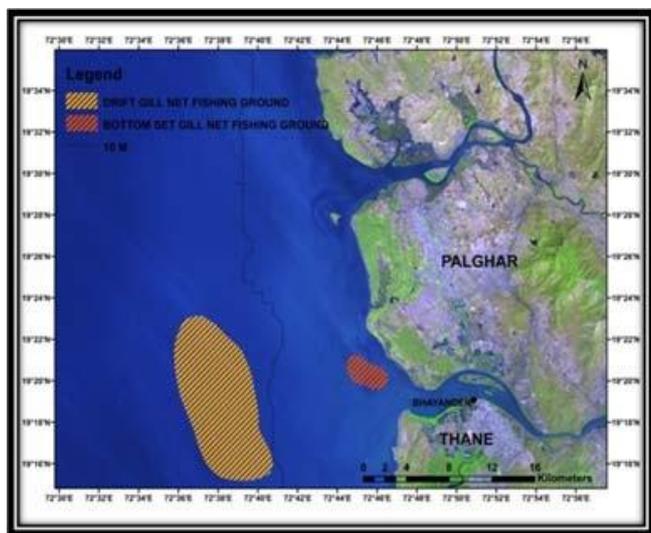
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fisheries and aquaculture gets increased day by day. In India, the fisheries resource management by the advanced software like GIS is less, so the present study is an attempt to apply the primary data associated with the fisheries and gear operation to the software.

## 2. Materials and Methods

The Bhayander estuary located in Thane district (19° 18' 02" N to 19° 21' 23" N, 72° 34' 55" E to 72° 53' 16" E), Maharashtra is a transitional zone of Arabian Sea and diluted by the river Ulhas. It provides a conducive environment for many marine species. It acts as an ecotone or buffer zone between freshwater of the river and saltwater of the sea. Gill net information on design and catch composition collected from January to May 2017. These species were identified [10, 11]. Operational parameters used for the study were the distance from the shore, depth of operation, latitude and longitude, soaking time, the colour of nets and details of catch. Geographical location of study area given in Fig.1.



**Fig 1:** Drift gillnet and bottom set gill net fishing ground

The Arc GIS 10.3 was used for the present study. The arc GIS, one of the most powerful GIS software for mapping, developed by Environmental System Research Institute (ESRI) Redlands, California was used for analyzing the geographic data. It was used for making thematic maps, build-up and edit geographic data, analyzing mapped information, sharing and discovering geographic information, using maps and geographic information in a range of various applications, and managing geographic information in a database. Portable Garmin GPS used for the study. Sony cyber shot DSC-W830/S with 20.1 megapixels with 8X optical zoom was used to capture onboard fishing activities and different fish species caught during fishing operations. All the primary data collected from various sources, along with the geographic position in Degree decimal minute that was converted to Degree decimal format were entered into Microsoft excel sheet and converted into a database file and CSV (Comma Delimited) format. Before entering the catch data to the Arc GIS 10.3, excel data had been converted to DBF (Data Base File) format. Data interpolation had done in IDW (Inverse Distance Weighting) format. These database files were later used in the geodatabase. The geodatabase is the necessary data structure for Arc GIS and is the primary data format used for editing in Arc GIS. Geo-database is an alternate way to store GIS information and all data (raster, vector etc.) in one

large file, using database management system (DBMS) or file system, which can contain multiple points, polygon, and polyline layers. The geo-database helps in data management and with its natural editing features makes GIS analysis more efficient and less time-consuming. For research analysis, Bhayander estuary geo-database created in Arc catalogue. Bhayander estuary geo-database file needed dataset features (total catch in terms of catch per unit effort and predictive maps of total catch). Different features class (polygon, line, point) were created in Arc- catalogue with WGS 84 spatial reference and edited in Arc map.

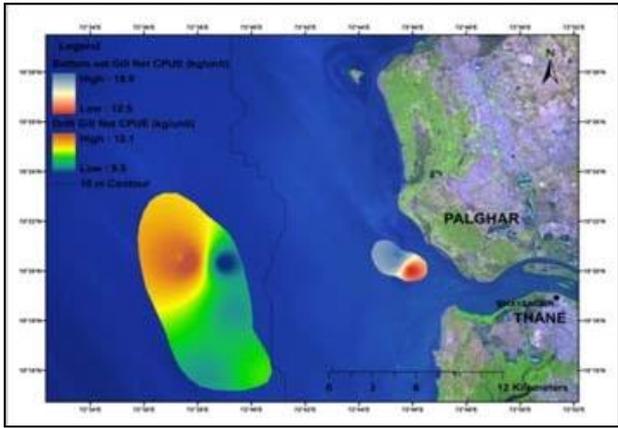
## 3. Result and Discussion

The Bhayander village has no fishermen society and the jetty is 20 m long which is subjected to low tide and high tide. The jetty was used for fish landing and transport purpose. There were no proper ice plants or processing facilities available in the village. The use of gill net in the Bhayander estuary is seasonal, whereas dol net (a type of bag net) is used all around the year. The catch rate was highest in January and April, whereas the lowest in May for bottom set gillnet and highest in February and April, whereas the lowest in May for drift gill net. Fishermen use bottom set gill net for targeting lobsters, which is a high valued species and fetches a good market price in the local market. Mostly this type of gears used in the rocky area of the estuary where lobster is more abundant (hide beside the rock), and with the knowledge on the behaviour of the lobster fishermen target rocky area. But the wear and tear of the bottom set gillnet is often more frequent on the rocky surface. The drift gillnet is used by the fishermen near or beyond 10m depth contour to get high valued pelagic (seer fish, pomfrets, barracudas etc.) and demersal (croakers, catfishes, elasmobranchs) fishes of large size ranges. Fishermen forced to go deeper waters for fishing, due to the unavailability of the high valued fishes and the high rate of plastic and pollution in the coastal waters. The operational parameters of drift gillnet and bottom set gill net shown in Table 1.

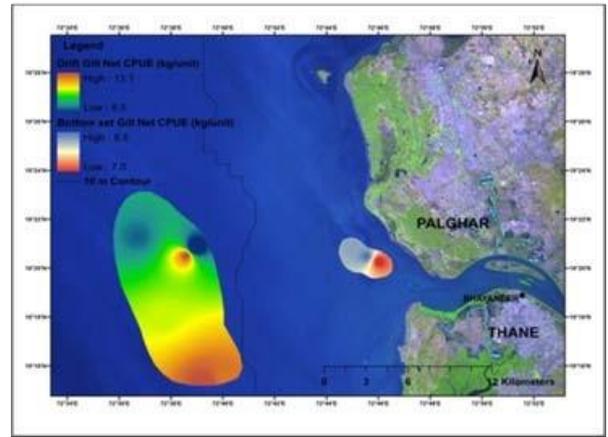
**Table 1:** Operational parameters of drift gillnet and bottom set gillnet

Operational parameters	Drift gillnet	Bottom set gillnet
Latitude and longitude	19°15'40"N- 19°24'38"N 72°34'05"E- 72°41'19"E	19°19'24"N- 19°20'46"N 72°44'15"E- 72°47'41"E
Distance from the shore (km)	17 - 20	8 - 10
Depth of operation (m)	10 - 12	6 - 8
Time duration for operation (hrs)	5 - 8	4 - 5
Soaking time (hrs)	4 - 6	3 - 4
Colour of the net	Brown, Grey	White, Green
CPUE (kg/unit)	12.5	12.2
Fishing ground	Muddy	Rocky

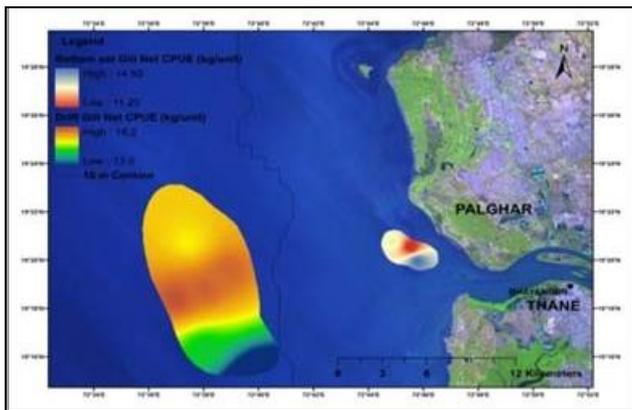
The catch per unit effort (CPUE) has been recorded on-board and the thematic map showing the seasonal variations in the abundance of the resource. Mapping of fisheries resources was achieved on a spatial scale with geographical coordinates and base map prepared (Fig.2 to Fig.6). Researchers in the past had recognized GIS as a decision support tool for fisheries managers. It was noted during the present study that there was no logbook maintained in the boats. Limited visits of staff of the state fisheries department to the landing centre of Bhayander implied that accuracy of the data is an issue and also that less importance was given to the catches from estuarine areas.



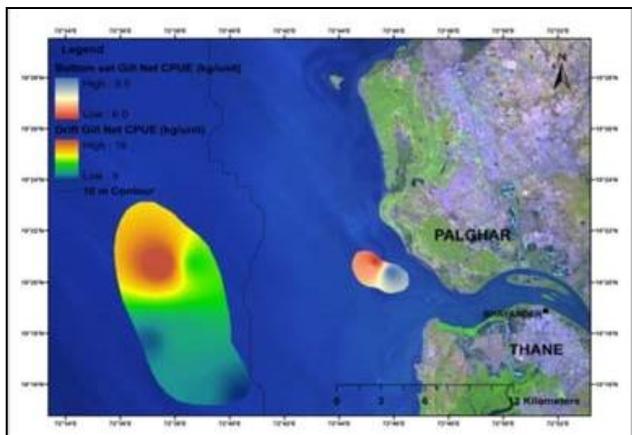
**Fig 2:** Thematic map of gill net CPUE for January



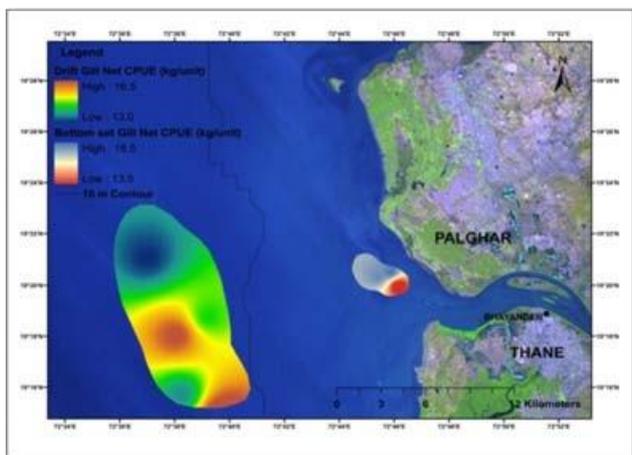
**Fig 6:** Thematic map of gill net CPUE for May



**Fig 3:** Thematic map of gill net CPUE for February



**Fig 4:** Thematic map of gill net CPUE for March



**Fig 5:** Thematic map of gill net CPUE for April

The catch from estuarine regions of India by indigenous gears should be closely monitored temporally as the estuaries are the nursery grounds for several species and the estuary of Maharashtra are categorized as minor type [12]. More intensify research on the effect of pollution on the estuarine resources and the related study on season-specific use of fishing gear with respect to the species abundance can be further encouraged in this estuary. Some commercially important species which landed throughout the gill net fishing season are shown below (Fig. 8 to Fig. 15). The chronospatial frequency of fishing gears operated in Ulhas river estuary also reported [13]. If pollution and degradation were tackled, then the fishery resources could be revived in the Ulhas estuary of Maharashtra [14]. Total of 37 species was recorded in the gill net during the winter fishing season [15].



**Fig 7:** Gill-netter landing at Bhayander estuary



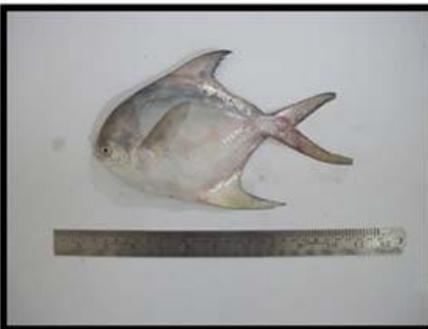
**Fig 8:** Portunus (Portunus) sanguinolentus



**Fig 9:** Thyryssa vitirostris



**Fig 10:** Panulirus polyphagus



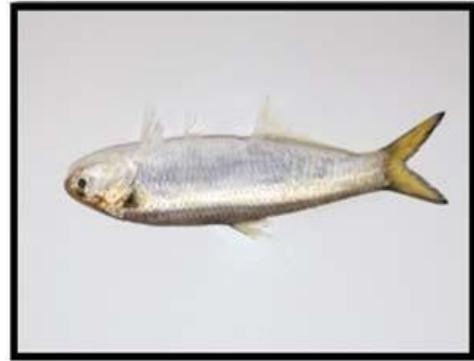
**Fig 11:** Pampus argenteus



**Fig 12:** Pellona ditchela



**Fig 13:** Mugil cephalus



**Fig 14:** Thyryssa mystax



**Fig 15:** Thyryssa hamiltonii

#### 4. Conclusions

Now it's high time to stress on the estuarine fisheries as the ecosystem is highly dynamic as well as rich in species diversity. Also, there is a need for studies on the trophic status of the fishes in order to establish a relationship between the fish species and spatiotemporal use of gears in the estuary. Arc GIS 10.3 was used for preparing the maps of the spatiotemporal changes of selected resources, areas of fishing grounds and CPUE. The geodatabase generated would be helpful for students, researchers, academicians, policy makers and managers to gather exact spatiotemporal information on the important fisheries resources of gill net and dol net of Bhayander estuarine area. By using advanced information management technology like GIS, it will be easier for the managers to better manage the fisheries resources.

#### 5. Acknowledgement

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