Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(6): 61-66

Received: 13-09-2019
Accepted: 15-10-2019

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# Spatial: Temporal distribution of cephalopods off veraval coast, Gujarat

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**Abstract**
Gujarat is one of the most important maritime state of the nation contributing to the nation's economy and Veraval is the major landing center of the state. The present study was conducted to understand promising fishing grounds of commercially important Cephalopods using GIS mapping method. The precise data in the form of geographical coordinates of fishing and allied information on the time of fishing, depth of the fishing area, catch details, etc. in a structured schedule were collected from the identified multiday trawlers operated along Veraval coast of Gujarat. Information was then mapped on GIS platform to get the promising fishing grounds and the spatio-temporal distribution of different groups of Cephalopods. The favorable fishing grounds for Cephalopods were located along the south off Gir-somnath district and off Daman coast at a depth range upto 30 m, which resulted in moderate to high CPUE in all the seasons.

**Keywords:** Cephalopods, Gujarat, GIS, spatial analysis, veraval

## Introduction
India is the country blessed with the total of 8129 km coastlines covering 9 maritime states and 2 union territories. The marine fish landings from the coast of the main land of India in 2017 was estimated as 3.83 million tonnes showing an increase by about 5.6% compared to the landings in 2016 [3]. In the year 2016, marine fish production of the country has shown an increase of 6.6% compared to 2015 recording a total of 3.63 million tonnes. The marine fish production in the year 2015 was 3.40 million tonnes. Among the four regions of the Indian peninsular coast line, the north-west coast comprising of Maharashtra, Gujarat and Daman & Diu contributed maximum share with 33% of the total landings (11.83 lakh tonnes) [3].
Spatial analysis deals with data that is geo-referenced, in that it has a spatial component. As survey data is geo-referenced with respect to longitude and latitude it is an ideal candidate for spatial analysis. A suitable approach, which incorporates various qualitative and statistically robust methods to interpret this geo-referenced and multivariate data, uses a Geo- graphical Information System (GIS) [1].
Geographical Information System (GIS) is altogether a system of hardware, software and procedures to facilitate the management, manipulation, analysis, modeling, representation and display of geo - referenced data to solve those complex problems regarding planning and management of resources. Procedure and Functions of GIS include data entry, data display, data management, information retrieval and analysis. The applications of GIS include mapping of locations, quantities and densities of resources, finding distances, mapping and monitoring the changes. A GIS is an information system that is designed to work with data referenced to spatial or geographic coordinates. It is both a database system with specific capabilities for spatially referenced data, as well as a set of operation for working with data.
Study on distribution of different commercially important fishes with technology such as GIS may help researchers gain a new insight about that particular fishery, their migration pattern and their habitat or area of abundance. It can be used to collect, check, integrate, and analyze information related to the earth's surface, allowing the integration of non-traditional data sets [9]. The digital nature of GIS software allows the data and their analyses to be easily updated, transferred, manipulated, and displayed [11]. In the case of fish and shellfish distribution, GIS could be used to evaluate possible associations between fishery and geo-referenced data. By using GIS mapping capabilities, the distribution and trends of commercially important commodities in time and space can be evaluated to wider and strengthen knowledge on our fish resource distribution altogether.

The use of Geographical Information System (GIS) appears as a potential and powerful tool in fisheries management and ecosystem studies to analyze and map the distribution of species and allows combining their biological characteristics, mainly spawning and recruitment, with the environmental features, as shown by several studies [12] [13]. GIS facilitate the storage, manipulation and analysis of a variety of map and non-map data formats. GIS also allow the analysis of traditional fisheries data derived from quantitative scientific sources including catch characteristics (number, weight and health of species caught per time period), species recruitment and locations of feed stocks. A GIS centered method is applied to data on harvester-reported catch locations to account for likely locational inaccuracies. The method allows harvest "hot spots", or areas of potential overfishing, to be identified that may require specific management strategies to ensure their long-term viability.

The coast of Saurashtra between the Gulf of Kutch and Gulf of Kambhat presents unique oceanographic features, which is endowed with a wide variety of highly relished table fishes. Though there are around 190 marine fish landing centers along Gujarat coast, the Gir-Somnath districts contributes the major share of the marine fish landings, followed by Valsad, Jamnagar, Amreli, Kutch, Bhavnagar, Morbi (part of the erstwhile Rajkot district), Surat, Baruch and Kheda.

The present study was conducted to discover and identify their suitable fishing ground by relating Global Positioning System (GPS) data with Catch Per Unit Effort (CPUE) and mapping of the spatio-temporal distribution off Veraval coast.

**Materials and Methods**

The present study was conducted off the Veraval coast of Gujarat. The precise geographical coordinates of fishing and other information on time of fishing, depth of the fishing area, catch details, etc., in a structured schedule were collected from the identified trawlers operated basing the Veraval fishing grounds (Lat- 20°54' N Long - 79°22'E) situated in the Gir-Somnath district of Gujarat, India.

Basically for this work the most important material utilized were the GPS device, GIS softwares and a well programmed hardware or computer system. The different types of GIS softwares used during the research in order to map the distribution of the species were the following.

a) Microsoft excel 2010
b) Geo Media Professional 2014 v 14.2
c) ArcGis 10.0
d) Qgis 3.6
e) Google Earth 7.3.2.5776

Information on commercial catch at each of the fishing G.P.S points with the details of the fishing, total catch and the bycatch, etc., were collected from the trawlers to meet the objectives of the study. The data collection schedule prepared in Gujarati for the convenience of the fishermen had fields for the information such as the latitude and longitude of shooting the net, date, time, depth of the fishing area, trawling speed, latitude and longitude of hauling the net, total catch in the haul, total and size wise catch of ribbonfishes in the haul, quantity of bycatch, discards if any, etc.

Observations of monsoon had to be omitted because the data were incomplete due to fishing ban. Haul wise catch and biology data were fed into MS excel 1997-2003 format compatible to GIS platform as queries. The catch were queries as attribute feature included geographical position of trawling operation (latitude and longitude), depth of operation, trawling duration, total catch (kg) and squid catch, etc. against the respective haul and the date of trawling. Records of all the sampling stations had a unique ID number (haul number) for querying and analyses works.

GIS Softwares and their extensions were used to create a georefrenced map for the abundance and distribution of commercially important fishes and their promising fishing grounds in the waters off Veraval coast. Coastline and bathymetry maps were digitized from available nautical maps (Fig 1) and saved in shape file format (.shp). The latitude and longitude points were converted into decimal degree using the appropriate formula as given below.

$$\text{Decimal degree} = \text{Degree} + \frac{\text{Minutes}}{60} + \frac{\text{Seconds}}{3600}$$

Flow chart for the plotting map on GIS platform is given below in figure 2. Operation of GIS software included creating a Microsoft Access Database (.mdb) format file in warehouse, where all the analyze were saved. Once the Microsoft Access Database has been created, MS excel file and bathymetry shape files (figure 1) were attached on Geo workspace for mapping over the shape file. Following this the study area is defined. Cruise data as attribute feature was used for spacing and linking each shooting and hauling points using specific order ID. It was used to generate new feature class; classification to which each instance of a feature is assigned. Cruise line is the line, which represents the trawling done by trawler thus cruise line joins both the shooting and hauling points by cruise number. Each trawling operations has its unique cruise number. Cruise line and its number were used as unique vector feature and queries were attached as functional attribute to this new feature class for plotting the maps. Polygons were made around cruise line for interpolation to analyze and define the study area. Interpolations were made using geostatistics, which has allowed a value at unsampled locations to be estimated from sparse sampled data points [10]. The interpolated data then smoothen the resultant layer of the map to make groups of different classes. This map was inserted into the layout window and added the legends of map, north direction arrow, scale and cartographic grid as latitude and longitude on the margin of the map. This final layout window was saved as JPG image format in the computer.

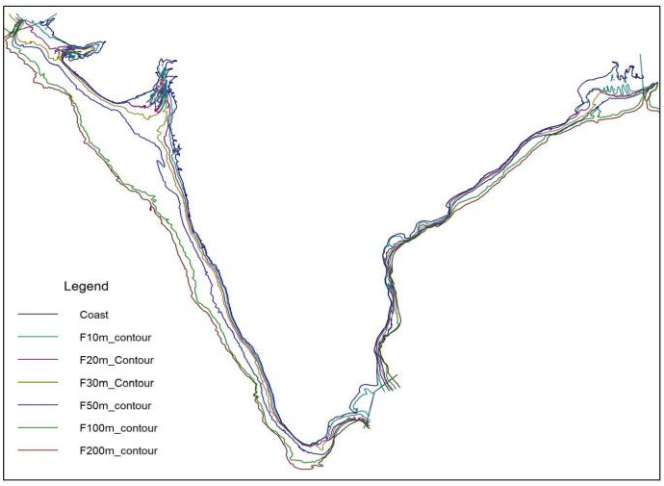


**Fig 1:** Map of coastline and bathymetric contour used as shape file

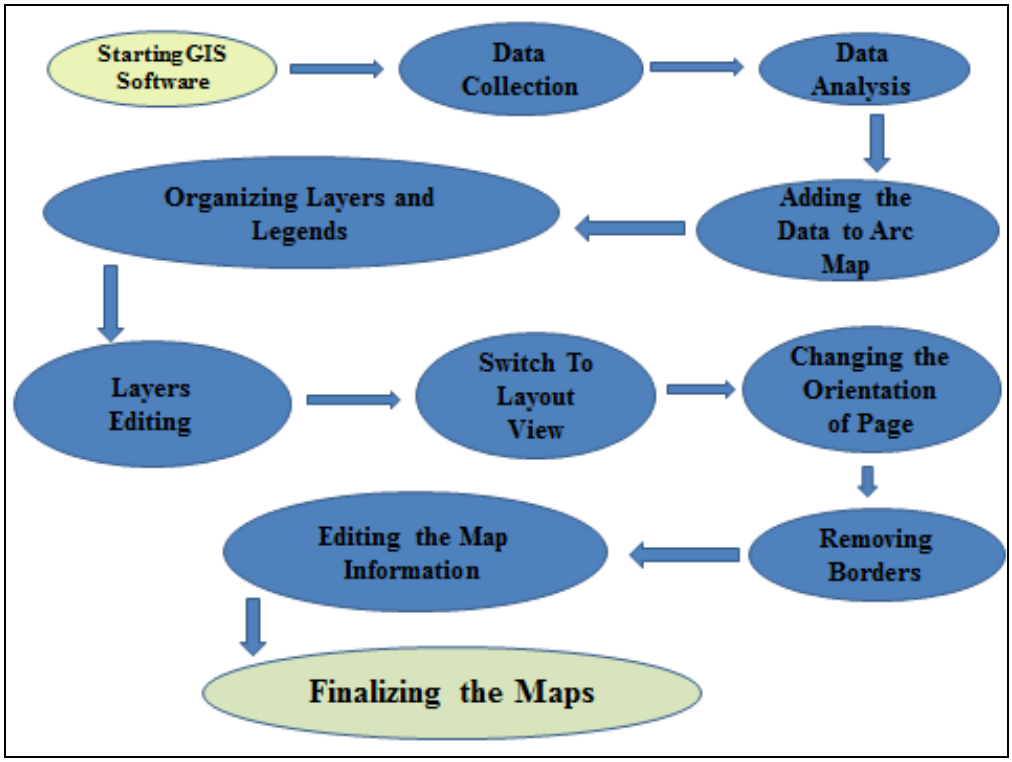


**Fig 2:** Flowchart or procedure for making GIS Maps

## Results and Discussion

### Spatio Temporal Fishing Grounds Of Cephalopods

Cephalopod fishing is mostly practiced at night time and the resources are available at the depth more than 30m. There is no special gear designed for cephalopod fishing. Cephalopods include Squids, Cuttle fishes and Octopus. However squid jigging is the method used by many fishermen but they do not take it to the commercial level. Most of catch landed is caught together with ribbon fishes and other pelagic and mid water fishes.

The distribution of cephalopods during post monsoon is given in Figure 3. The group formed part of the fishery throughout the year and was found at the coastal stretch from Dwarka (22.2442° N, 68.9685° E) to Kerala coast (10.8505° N, 76.2711° E) with varying catch rates. Waters off Dwarka (22.2442° N, 68.9685° E), Gir somnath district (21.0119° N, 70.7168° E) and Karnataka coast (15.3173° N, 75.7139° E) in the depth range between 30 and 200 m exhibited the lowest aggregation (10 - 26 kg per haul) of cephalopod group during the post monsoon, whereas the highest aggregation (75 – 90 kg per haul) existed in the deeper waters off Mumbai coast (19.0760° N, 72.8777° E) at a depth more than 100 m. The waters off Porbandar, Gir somnath,Daman, Goa and Kerala coast had a moderate level (27 - 42 kg per haul) of these molluscan's abundance in waters (20-100 m depth) and the same trend continued in deeper waters (100-150 m depth) also In general, the distribution of cephalopods in post monsoon off Veraval coast was moderate in inshore waters and it continued to increase towards the south and in deeper waters at the depth more than 200 m reaching the highest level in west of Mumbai.

The distribution of cephalopods during winter is given in Figure 4. These group of species formed part of the fishery throughout the west coast with varying catch rates. Waters off Alibag coast (18.6554° N, 72.8671° E) in the depth range between 50 and 100 m exhibited the lowest aggregation (10 – 24 kg per haul) of cephalopods during the winter, whereas the highest aggregation (66 – 80 kg per haul) existed in an area around Daman (20.4283° N, 72.8397° E), Mumbai (19.0760° N, 72.8777° E), Ratnagiri (17.2478° N, 73.3709° E), Goa (15.2993° N, 74.1240° E) and Kerala coast (10.8505° N, 76.2711° E) at a depth of 30 -200 m. The waters off Junagadh and Dwarka district had a moderate level (33 – 54 kg per haul) of cephalopod abundance in waters (20-50 m depth) and the same trend continued in deeper waters (100-150 m depth) also.

The distribution of cephalopod during pre monsoon is given in Figure 5. The species formed part of the fishery throughout the year with varying catch rates. Waters off Mumbai coast (19.0760° N, 72.8777° E) in the depth range between 50 and 100 m exhibited the lowest aggregation (10 – 30 kg per haul) of cephalopods during the pre monsoon, whereas the highest aggregation (99 – 120 kg per haul) existed in an area around Diu port (20.4283° N, 72.8397° E) at a depth more than 50 m. The waters off Junagadh and Dwarka district had a moderate level (33 – 54 kg per haul) of squid abundance in waters (20-50 m depth) and the same trend continued in deeper waters (100-150 m depth) also. In inshore waters (20-50 m), the abundance of cephalopods was relatively at lower level (10-50 kg per haul), but in deeper waters it was moderate. In general, the distribution of squid in pre monsoon along Saurashtra coast was moderate in inshore waters and it continued to increase towards the deeper waters at the depth more than 50 m reaching the highest level in south-west of Diu.

In inshore waters (20-50 m), the abundance of cephalopods was relatively at moderate level (10-50 kg per haul), and the abundance increased as it moved towards the deeper waters upto the depth of 200 m. In general, the distribution of cephalopods in winter was along the entire west coast of India except some parts of Gulf of Kutch and Junagadh district, ranged from moderate to the highest level. The maximum catch was caught from the regions with the depth more than 100 m.

The distribution of Cephalopods off Veraval coast was irregular and influenced primarily by the depth of water and to certain extent by the season. Various factors might affect the abundance of cephalopods. The study confirms that the catch rates of this species along Saurashtra coast remained steadily high, especially along south Saurashtra coast (below 20˚48' N), which confirms that the south Saurashtra waters as a favourable fishing ground. This ground is closer to the mouth of gulf of Kambhat, which is very likely to be highly productive due to the estuaries of Narmada and Tapti. Large quantities of detritus are known to provide a preferred feeding habitat to *Acetes* spp. [4], leading to their higher levels of abundance. It is also been reported about *Acetes* spp. being the favourite food item preferred by the cephalopods [7].

Seasonal abundance of cephalopods recorded during winter, Post monsoon and pre monsoon did not vary much from the earlier reports [5]. Although there were some differences in the distribution of the highest percentage of cephalopods between the three seasons, the areas of the highest distribution were almost the same (one in off Gir-Somnath district and another one off Daman coast). It has also been stated that the squids congregate for spawning (copulation) in near shore areas after which the females migrate to the shallow subtidal regions with hard substratum for laying the fertilized eggs [6]. The findings of the study confirm that the cephalopods migrated to inshore areas and therefore the aggregation of cephalopods was relatively high in inshore waters, especially during winter and post monsoon, which could be their breeding and spawning season. This can only be confirmed by correlating the GIS maps and the biological data of the samples collected from those specific geographical locations.

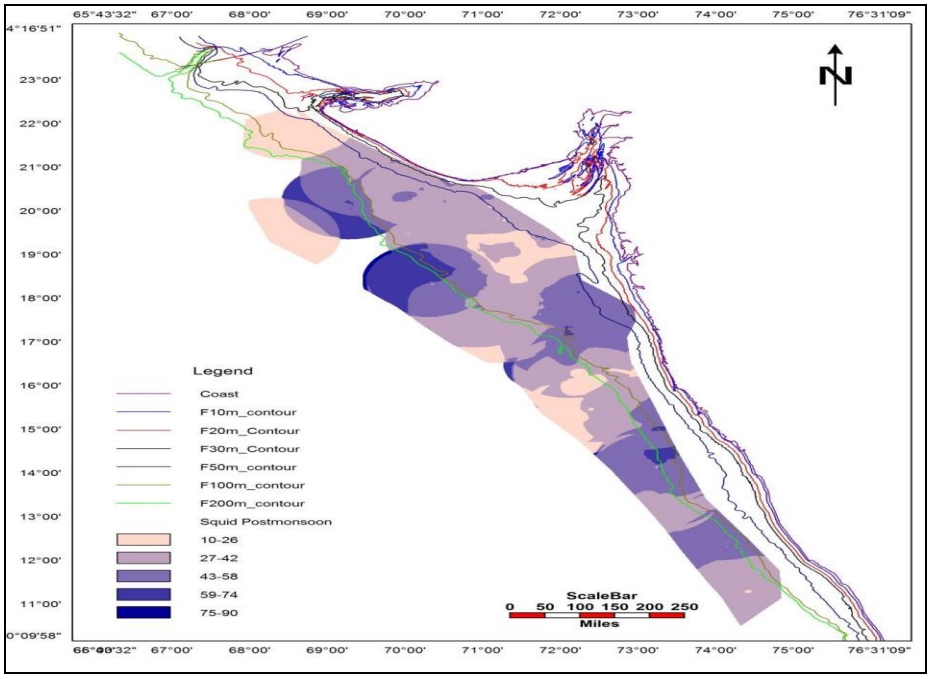


**Fig 3:** Spatio-Temporal Fishing Grounds for Cephalopods during Post Monsoon Season

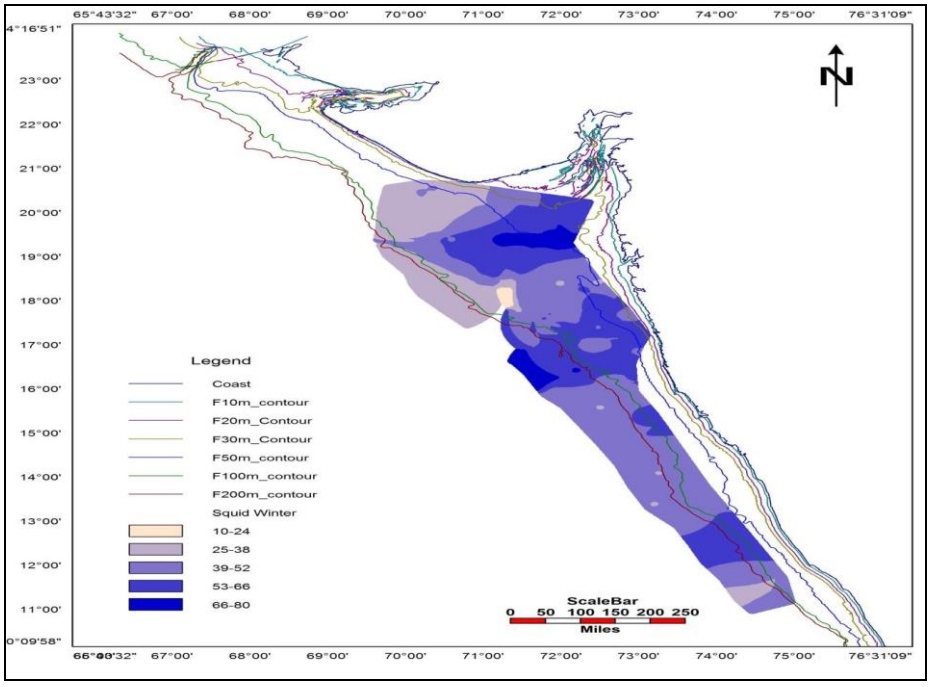


**Fig 4:** Spatio – Temporal Fishing Grounds for Cephalopods during Winter Season

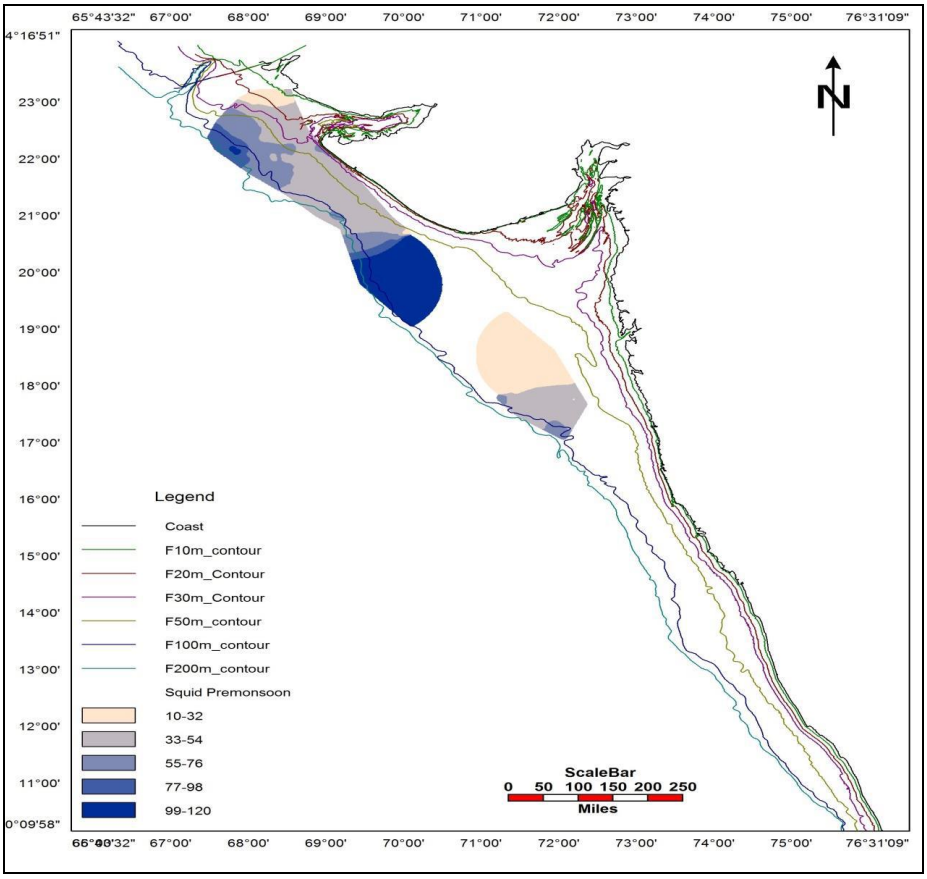


**Fig 5:** Spatio - Temporal Fishing Grounds for Cephalopods during Pre Monsoon Season

## Conclusion

Cephalopods are among the commercially important commodities in the export sector. Cephalopods from Gujarat are exported all around the world. These cephalopods are more preferred due to their texture, taste and year round availability. The trawlers are neither size selective nor species selective. In order to make the business profitable the fishers take out even the small size specimens and low value fishes, so there has to be some strict provisions taken up by the authority. The focus from some of the species and groups must be shifted. Some inshore areas must be declared as protected areas or some limitations regarding the human interference must be imposed. Some of the species have declined or disappeared in the recent years, whereas some new species are added up in the catch composition of the multiday trawlers. Possible efforts were made to plot the maps for different species season-wise, but still there is scope for mapping of other leftout species. The migration patterns of different fish groups can be studied with further GIS mapping. Together with Remote sensing & GIS, more comprehensive & interactive maps can be prepared.

## Acknowledgement

The study appears in its current form due to the assistance, support and guidance of several people. I would like to offer my sincere thanks to all of them. Special appreciation goes to my mentor my Major advisor, Dr. A.Y. Desai for his supervision and constant support. I am extremely grateful to my family and friends for their love, prayers, encouragement and support.

## References

1. Booth AJ. Spatial analysis of fish distribution and abundance patterns: A GIS Approach. Fishery Stock Assessment Models (Alaska Sea Grant College Program). 1998, 719-740.
2. CMFRI. Annual Report 2016-17. Central Marine Fisheries Research Institute, Kochi, 2017.
3. CMFRI. Annual Report 2017-18. Central Marine Fisheries Research Institute, Kochi, 2018.
4. Deshmukh VD. Biology of Acetes indicus (Milne Edwards) in Bombay waters. Indian Journal of Fisheries. 2002; 49(4):379-38
5. Meiyappan MM, Mohamed KS, Vidyasagar K, Nair KP, Ramachandran N, Lipton AP *et al*. A review on cephalopod resources, biology and stock assessment in Indian seas. Marine Research and Management. 2000, 552-557.
6. Mohamed KS. Spawning congregations of the Indian squid *Loligo duvauceli* (Cephalopoda: Loliginidae) in the Arabian sea off Mangalore and Malpe. Indian Journal of Marine Science. 1993; 22:172-175.
7. Panja Tehseen AY, Desai, Jyoti Saroj, Joshi Art. Feeding Biology and Length-Weight Relationship of Indian Squid (*Uroteuthis duvauceli*) in Coastal Waters of Gujarat. Journal of Experimental Zoology, India. 2019; 22(1):609-613.
8. Panja TH, Fishery, Biology and Distribution of Indian squid *Uroteuthis* (*photololigo*) *duvauceli* (d'orbigny, 1848) on GIS platform off Veraval coast, Gujarat. M.F. Sc. Thesis. Junagadh Agricultural University, Junagadh, India, 2016.
9. Rhind DW. A GIS research agenda. International Journal of Geographical Information Systems. 1998; (2):23-8.
10. Rivoirard J, Simmonds J, Foote KG, Fernades PG, Bez N. Geostatistics for Estimating Fish Abundance.

Blackwell Science, Oxford, 2000.
11. Star JL, Estes JE. Geographical Information Systems: An introduction. Prentice Hall, NJ, 1998.
12. Valavanis VD, Georgakarakos S, Kapantagakis A, Palialexis A, Katara IA. GIS environmental modelling approach to Essential Fish Habitat Designation. Ecological Modelling. 2004; 178:417-427.
13. Valavanis VD, Georgakarakos S, Koutsoubas D, Arvanitidis C, Haralabous J. Development of a marine information system for cephalopod fisheries in the Greek seas (Eastern Mediterranean). Bulletin of Marine Science. 2002; 71:867-882.