# EXPLORATORY FISHERY SURVEY ON BILLFISHES WITH SPECIAL REFERENCE TO BIOLOGY OF SWORDFISH (*XIPHIAS GLADIUS*) ALONG WEST AND EAST COASTS OF INDIA

**S.RAMACHANDRAN[1], H.D.PRADEEP[2], D.K.GULATI[3], L.RAMALINGAM[3]**

[1]Fishery Survey of India, Govt. of India, Kochangadi, P.B.No.853, Kochi, Kerala-682005, India

[2]Fishery Survey of India, Govt. of India, Mormugao Zonal Base, Opp. Microwave Station, Mormugao, Goa-403803, India

[3]Fishery Survey of India, Govt. of India, New Fishing Jetty, Sassoon Dock, Colaba, Mumbai, Maharashtra– 400005, India

**Abstract**

Exploratory survey conducted during the last decade (2010-2019) by the longliners of Fishery Survey of India within Indian EEZ was analysed and briefly presented about the distribution and biology of bill fishes with emphasis on Sword fish *Xiphias gladius*. The long line survey throughout the Indian EEZ during the period under report revealed *Istiophorus platyperus* dominated the catches by 49% followed by *Xiphias gladius* (45%), whereas *Makaira nigricans* was 6% of the total bill fish abundance in west coast of India. However, 66% of total *X. gladius* catch was recorded from west coast of India, followed by Andaman waters (26%) and remaining from East coast of India (8%). The abundance of *Xiphias gladius*showed a declining trend from the year 2010 to 2019in generalin Andaman sea,but *X. gladius* was dominated among the bill fish catches in Andaman sea by 54.6%. The lengthrange of *X.gladius* occurred in Indian seas was between 59cm and 324cm (including commercial landing data), the length weight relationship was 0.000002 $L^{3.12}$ during the period under report. The growth parameters estimated for *Xiphias gladius,* where, the asymptotic length ($L\infty$) was340 cm (LJFL), growth coefficient (K) was 0.03/yr. Gut content studies during the past decade revealed that *X. gladius* following heterogeneous feeding strategy in the tropical waters of Indian EEZ, wherein the squids dominated among the food items observed in west coast and Andaman waters, but in East coast species of the family exocoetidae conquered most frequent

observations. Month wise sex ratio of *X. gladius* during the period 2017-18 from the west coast revealed that, comparatively higher female occurred during June to August.

**Keywords**: *Xiphius gladius*, biology, asymptotic length, growth coefficient, heterogeneous, sex ratio, billfish

## Introduction

Billfishes contributed 1.6 % of total fish landing in India during 2018.However in India, the estimated billfish landing was 18,357 t. during the year 2018, whereas Sail fish (10026t.) Marlin (5455t.) and sword fish (2877t.) were the important components of the oceanic bill fish fishery(CMFRI 2019). The billfishes are generally landed as bycatches of tuna long liners and gill netters in India. India's oceanic fishery exploitation augmented by fishing fleet includes coastal multipurpose boats operating a number of traditional gears, small pole and line boats, small long liners and industrial longliners (Ramachandran and Ramalingam 2019). Thelarge scale swordfish exploitation from Indian seas, especially Billfish fishery in the Indian Ocean was concentrated in the southwest Indian Ocean, however, it has extended eastward due to the increased piracy threats in the western Indian Ocean (IOTC–SC14, 2011). Billfishes are reported to migrate to coastal waters for feeding and spawning and have an affinity for the shelf area thereby forming part of coastal fisheries of many countries in the Indian Ocean including India (Campbell and Tuck, 1998).

The total production of oceanic resources such as tunas and tuna-like fishes, including neritic and oceanic tunas, billfishes and seerfishes during the year 2011 was 15,9924 tonnes, against a total production of 12,7616 tonnes during the year 2010, where in 2014 it was 1,54,850 tonnes however during 2018 it reached around 2,01,717t in India. However, in Indian Ocean it was reported to have tripled from 14,568 t in 1983 to 52,221 t in 1995 and the average annual catch during 2002 - 2006 was around 24,000 t (Campbell and Tuck, 1998) it reached 29860t in 2014 (IOTC–2015–WPB13–26- updated 2017). The catch of billfish in the western

region of the Indian Ocean (FAO Area 51) is always higher than the eastern region (FAO Area 57) and the countries with high catches of sailfish are Iran, Sri Lanka, India and Pakistan (Ganga *et al.* 2008 and Ramachandran and Ramalingam, 2019). Studies on billfish fisheries its distribution, abundance and biology in different regions (De Sylva, 1957, 1974; Morrow, 1964; Williams, 1970; Chiang et al., 2004; Hoolihan, 2004, 2006; Hoolihan and Luo, 2007, Pradeep etal.,2017; Ramachandran and Ramalingam 2019). Fishery Survey of India for the past three decades continuing its exploratory survey in the Indian ocean (mostly restricted to Indian EEZ) by deploying longline fishing vessels (Sudarsan et al., 1988; John et al., 1995; Somvanshi et al., 1998; Sivaraj et al., 2005; Varghese et al., 2005; Ramalingam and Kar 2011; Premchand et al., 2015; Pradeep et al.2017; Ramachandran and Ramalingam 2019). Being a highly migratory species, the bill fishes move freely across international borders and Exclusive Economic Zones (EEZs) and contribute to fisheries on their migratory routes. An understanding of the local fisheries is an important step to assess the bill fish stock. Data on fishing effort and size groups of billfishes in the catches from the countries of the Indian Ocean region to make a quantitative regional assessment of the stocks (Campbell and Tuck, 1998) Swordfish (*Xiphias gladius*) is one of the most commercially important species among the billfishes exploited by the Indian longline fleets particularly in west coast of India in large scale. However, published information on the distribution, abundance and biology of this ecologically and commercially important species is lacking for the eastern Arabian Sea, western Bay of Bengal and Andaman and Nicobar waters. In this viewpoint, the present study had beencarriedout to contribute to the abundance and biology of *X. gladius* in oceanic waters around India.

Considering these facts the data on bill fishes for the past 10 years from 2010-2019 from the exploratory survey were analysed for the understanding of distribution, abundance and some biological aspectsin the different sectors of Indian EEZ to ensure better management measures within the frame work of IOTC.

**Material and method**

Exploratory fishery survey data were collected on board tuna longline survey vessels belongs to Fishery Survey of India plying in Arabian sea, Bay of Bengal and Andaman waters during 2010 to 2019and analysed for understanding the distribution abundance and biology of Billfishes. There are four tuna long line fishing vessels (*M.F.V. Blue marlin, M.F.V Yellow fin, M.F.V Matsya Vrushti and M.F.V Matsya Drushti*) were involved for this survey cruises during the period from 2010 – 2019. The vessels, M.F.V.*Matsya Vrushti* (OAL 37.5 m, GRT 465 t) and M.F.V *Yellow Fin* (OAL 36.0 m, GRT 290 t,) operated for conducting survey in the west coast of India (eastern Arabian Sea), while the other two vessels, M.F.V *Matsya Drushti* (OAL 37.5 m, GRT 465 t) and M.F.V *Blue Marlin* (OAL 36.0 m, GRT 290 t) Port Blair Base surveyed the Andaman and Nicobar waters. Conventional Japanese multifilament longline with 5 hooks ('J' hook) per basket was operated from the vessels Yellow Fin and Blue Marlin, whereas, the other two vessels operated monofilament longline gear with 7 hooks (Circle hook) per basket. Every month, these vessels were envisaged for long line fishing in the scheduled area with 20 days endurance, and about 15 longline operations (sets) were conducted in each voyage by operating an average of 9000 hooks/voyage. Shooting of the line commences before sunrise and is completed in about 2-2.5 hours. On an average 550 hooks are operated in a set. Immersion period was 5 hours. The fish caught during the survey, after the identification, were subjected to morphometric measurements using a measuring tape to the nearest cm and then weighed using digital weighing balance having a precision of 1.0 kg. The fish were dissected out to study their sex, maturity stages, stomach condition etc. The data from East coast of India including Andaman waters (FAO area 57) and West coast of India (FAO area 51) were divided in to 5 degree Latitude / Longitude grid. Seasonal and temporal variation of bill fish abundance during the study period of 10 years were given in this report. For length frequency analysis commercial landing data were also included. For data analysis, seas around India was divided in to three regions viz., eastern Arabian Sea, western Bay of Bengal and Andaman and Nicobar waters and further divided in to 5 x 5 degree grid for analysing abundance of each species.

Hooking Rate (HR), the number of fish caught in 100 hooks and Catch Rate (CR), weight of fish caught in kg per 1000 hooks operated was expressed as relative abundance index.Stomach of individualfishes were analysed in laboratory, each stomach was analysed by visual examination and using a dissection microscope. Length lower jaw fork length (LJFL) and weight data are collected following standard methodology adopted for Bill fishes (Su et al., 2005). Data on Sex and maturity from the period from 2010 to 2019 were analysed following standard methods.

**Results and Discussion**

**Abundance Bill fishes in West coast of India**

There were about 0.85 million hooks were operated in west coast during the period from 2009-2019 (Fig.1).In the area of 7 grids of 5degree lat. and 5 degree long. viz. from Lat. 4-7°N/long.64-69°E to Lat.17-22°N/long.74-79°E were surveyed by operating longline. In west coast of India *Istiophorus platyperus* dominated the catches by 48.9% followed by *Xiphias gladius* (45.1%), whereas *Makaira nigricans* was 5.9% of the total bill fish landings). Area wise distribution revealed that the area Lat.12-17°N/Long.69-74°E was moderately productive throughout the period under report, as for as the abundance of *Xiphias gladius* concerned a marginal difference from the neighbour areas of the west coast may be due to highly productive sea mounts attract the foraging bill fish groups throughout the year (Ramachandran and Ramalingam 2019). The highest catch rate for *Makaira nigricans* of 41.3kgs/1000hooks was recorded during the year 2016, whereas it was 6.2kg/1000hooks during the year 2018 (Fig. 3). The present study revealed that the 65.8% of total bill fish production in India was obtained from west coast (FAO area 51). The pertinent literature also revealed that Bill fish catches always higher in western Indian Ocean (FAO area 51) than Eastern (FAO area 57) Indian region (Ganga et al., 2008). Hooking rate and catch rate of *Xiphias gladius* showed a declining trend

from 2010 to 2018 (Fig. 5 and 7), however during 2017 a comparatively higher hooking rate was registered (table.1 and 2).

**Abundance of Bill fishes in East coast of India**

Therewere about 91,015 hooks were operated during the period from 2009-2019 (Fig.1) in East coast of India. There are 4 grids of 5 degree lat. and 5 degree long. viz.Lat. 7-12°N/long.79-84°E to Lat.17-22°N/long.84-89°E were surveyed by operating longline. In East coast of India, average CPUE (hooking rate) for the study period of past 11 years revealed that *Makaira nigricans* was dominated the catches by 47.6%, followed by *I. Platypterus* (35.1%) and *X.gladius* (17.3%), of the total bill fish landings. Area wise distribution of bill fish species was revealed that the area Lat.12-17°N/Long.79-84°E was comparatively more productive throughout the study period. The Indo Pacific sailfish *I. platypterus* shown moderate catch rate throughout the year in East coast of India, however during the year 2011, the a highest catch rate of 40kg/1000hooks was recorded(Fig.4). Hooking rate of *Xiphias gladius* shown comparatively lesser abundance but there was no much change in the area 12-17°N/79-84°E during study period (Fig. 6), however, during 2010 a higher catch rate of 39.43kgs/1000 hooks was reported afterwards till 2019 it was less than 2 kgs /1000 hooks (table 3). The highest catch rate for *Istiopmax indica* of 100.3kgs/1000 hooks was reported during the year 2014, whereas it was 37.6kg/1000hooks during the year 2018.

**Abundance of bill fishes in Andaman waters**

There are about 4 grids of 5 degree lat. and 5 degree long. viz. lat.4-7°N/Long.89-94°E to Lat.17-22°N/long.94-99°E have been surveyed for the period of 10 years from 2010-2019 by operating tuna longline, there were about 0.43 million hooks were operated in these area (Fig.1). In Andaman waters, average CPUE (hooking rate) for the study period of past 10 years revealed that *X.gladius* dominated the catches by 54.6% followed by *I. platypterus* (36.5%), however *Makaira nigricans* was 8.9% of the total bill fish landings. Area wise distribution of

sailfish species was revealed that the southern part of Andaman i.e. Nicobar waters was comparatively more productive throughout the study period, whereas the relatively more abundance was observed between 1.53kg/1000 hooks and 9.7 kg/1000hooks. Moreover,*Istiophorus platypterus* shown a maximum catch rate of 15.7kgs/1000hooks during the year 2012. However, a highest catch rate of 144 kg/1000hooks was recorded for *Xiphias gladius* in the area 4-7°N/94-99°E during study period (table 4). The habitat preference of bill fishes was reported to be waters above the thermocline and close to islands (Suzuki et al., 1977; Hoolihan and Luo, 2007).The *X.gladius* catch rate was moderate throughout the study period under report, which ranged between 13kg/1000hooks and 16.89 kg/1000hooks in the area 7-12°N/89-94°E of Andaman waters (Fig.2). The highest catch rate for *Makaira nigricans* of 53.96kgs/1000hooks was observed during the year 2016, whereas the catch rate of *Istiopmax indica* ranged between 1.2 kg/1000hooks and 5.8 kg/1000hooks in the year 2018 the catch rate of this species was 2.67 kg/1000hooks.

**Biological observations on *Xiphias gladius***

**Population parameters**

Length frequency study during the period under report revealed that mostly moderate size *X. gladius* specimen were reported in the exploratory survey throughout the Indian EEZ was between 59 and 289 cm LJFL, whereas according to the commercial landing data maximum length of 324cm LJFL recorded in west coast during 2018.However, the commercial landing from the landing centre have more larger specimen, it may be due to the commercial tuna long line fishing vessels mostly operating during night targeting the Oceanic resources of commercial size preferably foraging on surface waters and thus made available more larger specimens of sword fishes in the landing centres, whereas, the exploratory survey (fishing operation) of Fishery Survey of India have been carried out only at day time. Length weight relationship of *X. gladius* was 0.000002 $L^{3.12}$ during 2018. Theasymptotic length (L∞) was 340 cm, growth coefficient (K) was 0.03/yr. However, Varghese et al (2013) reported the

asymptotic length between 243.79 (male) and 311.11 (Female) and the K value of 0.5-0.37 respectively. The observation on the recent data corroborated with existing literature (table5).

**Food and feeding**

Analysis of data food and feeding habits of *X.gladius* in West coast, East coast and Andaman & Nicobar waters of Indian EEZ are separately furnished (Fig. 8.a,b &c). Data on west coast specimen revealed that *Sthenoteuthis* sp. dominated among the various food items by 25% followed by Myctophids (20%) and other teleosts (Fig. 8 c). East coast data revealed that fishes under the family Exocoetidae dominated among the diet composition of *X. gladius* by 24% followed by other teleost (19%) and other Squid spp. (Fig.8.b ). However, Varghese *et al.,* (2013) reported that *Sthenoteuthis s*p. dominated the diet of *X.gladius* in west coast of India. Data on Andaman specimens revealed that Squid spp. are dominated in the diet composition of the *X. gladius* by 49% followed by other teleost (14%) and Benthosema spp. (Fig.8.a)

**Sex and maturity**

Sex ratio of *Xiphias gladius* in west coast of India revealed that during June and August the female ratio was higher (Fig.9) which may related to its spawning season. Spawning ground was identified in the Lakshadweep waters of west coast of India (FAO area 51) as mature females with hydrated oocytes were observed during December to April (Varghese *et al.*,2013 ,2014). However, the female ratio was more during August and November during the year 2017-18 related to the breeding season of *Xiphias gladius* in west coast of India.

**Conclusion**

Oceanic fishery resources in India, is beginning to face severe issues mainly due to declining the catches of oceanic resources. As these resources are highly migratory in nature, the over exploitation in one region has impact on the abundance in other regions. India's contribution to total oceanic fishery resources from the Indian Ocean during 2006 was 2.01%. Our oceanic tuna catches are far below the potential estimated (Anon, 2018). India adopts a precautionary

approach and thus practicing fishing ban for a period of 65 days in East coast (FAO area 57) and West coast (FAO area 51). India is also committed to the conservation and management measures within the framework of the IOTC for sustainability of the Oceanic tuna and allied fishery without affecting the livelihood of millions of coastal fishermen in the country.

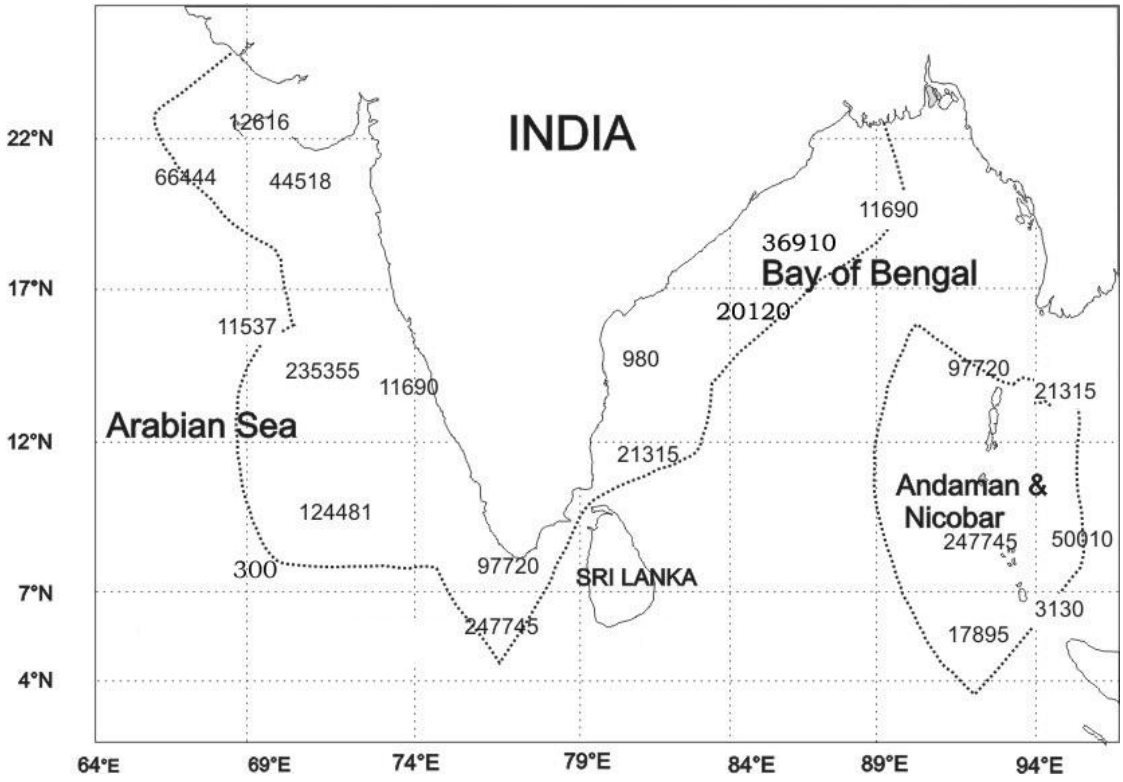
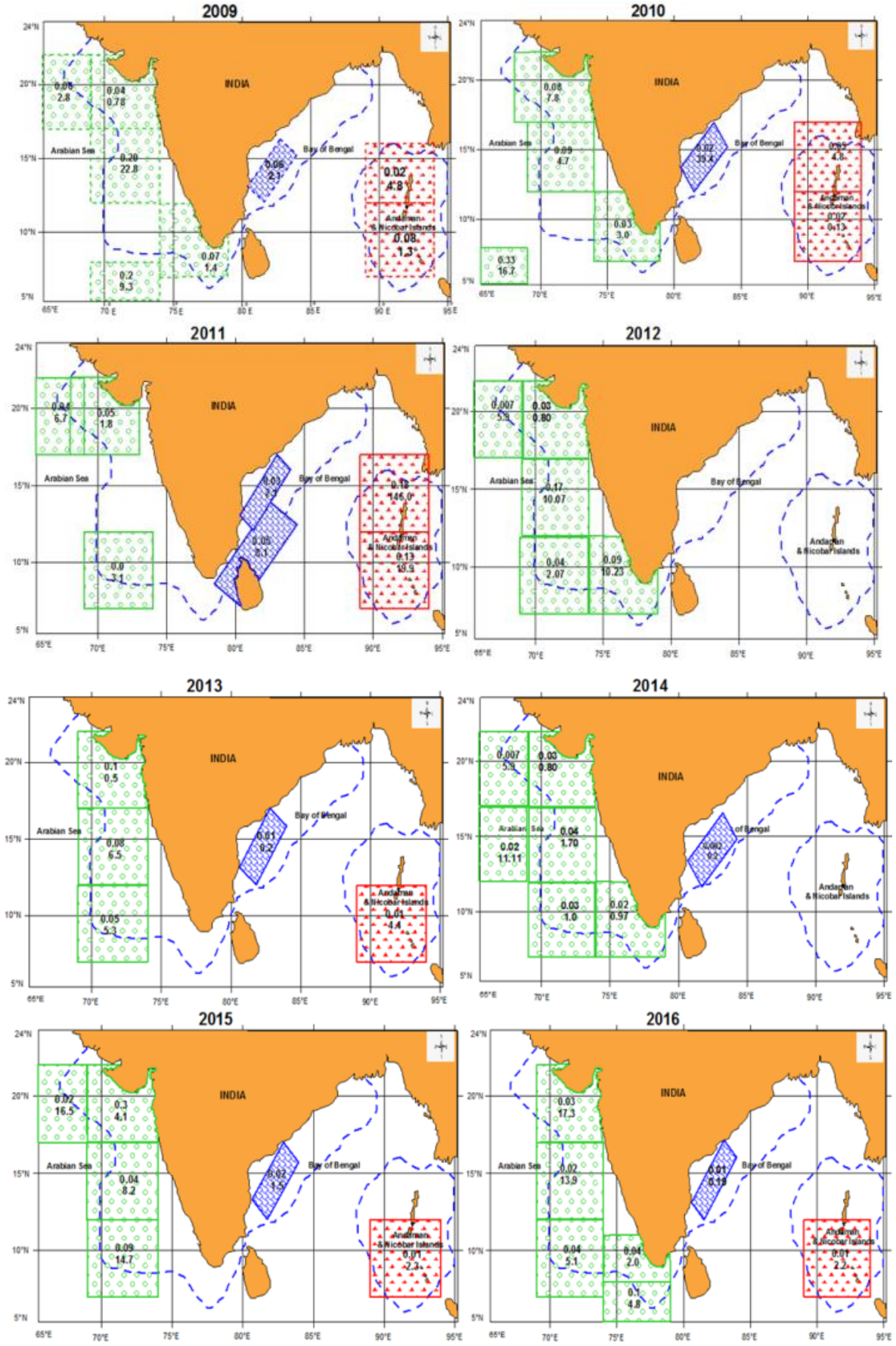
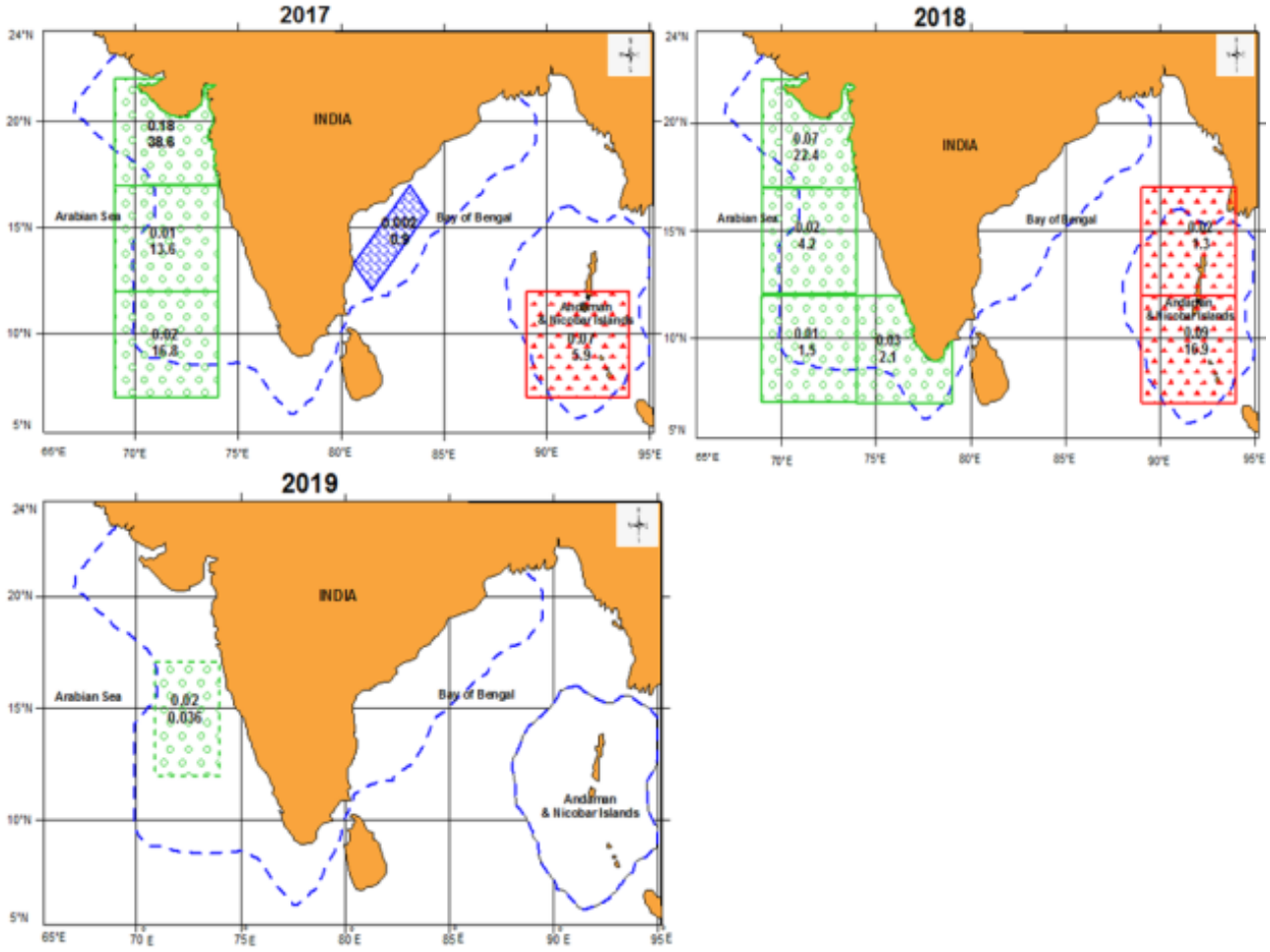



**Fig.1. Map showing distribution of fishing effort in Nos.of Hooks in different sectors of Indian EEZ during the period form 2009-2019**

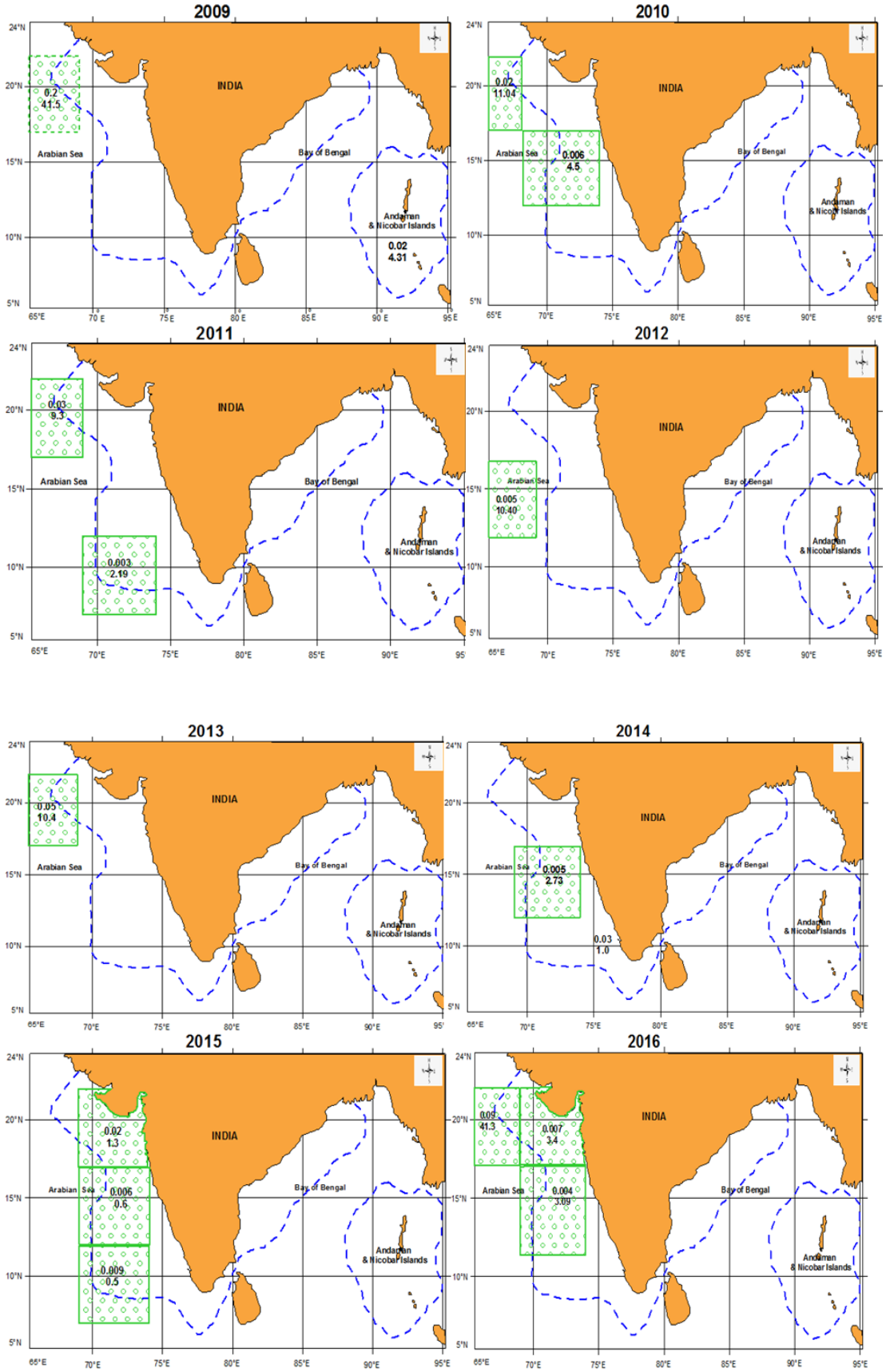

2009
2010
2011
2012
2013
2014
2015
2016
INDIA
Arabian Sea
Bay of Bengal
Andaman & Nicobar Islands
Hooking rate Nos./100 hooks
Catch rate Kgs./1000 hooks




Hooking rate Nos./100 hooks

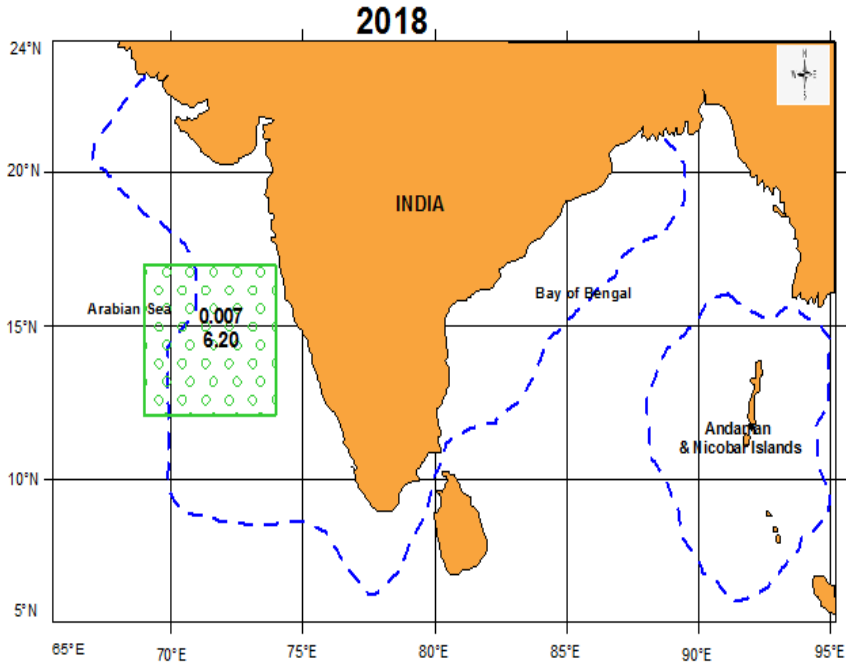
Catch rate Kgs./1000 hooks

**Fig. 2. Area-Wise hooking rates/catch rates of *Xiphius gladius* along Indian Coast (FAO area 51&57)**




Hooking rate Nos./100 hooks

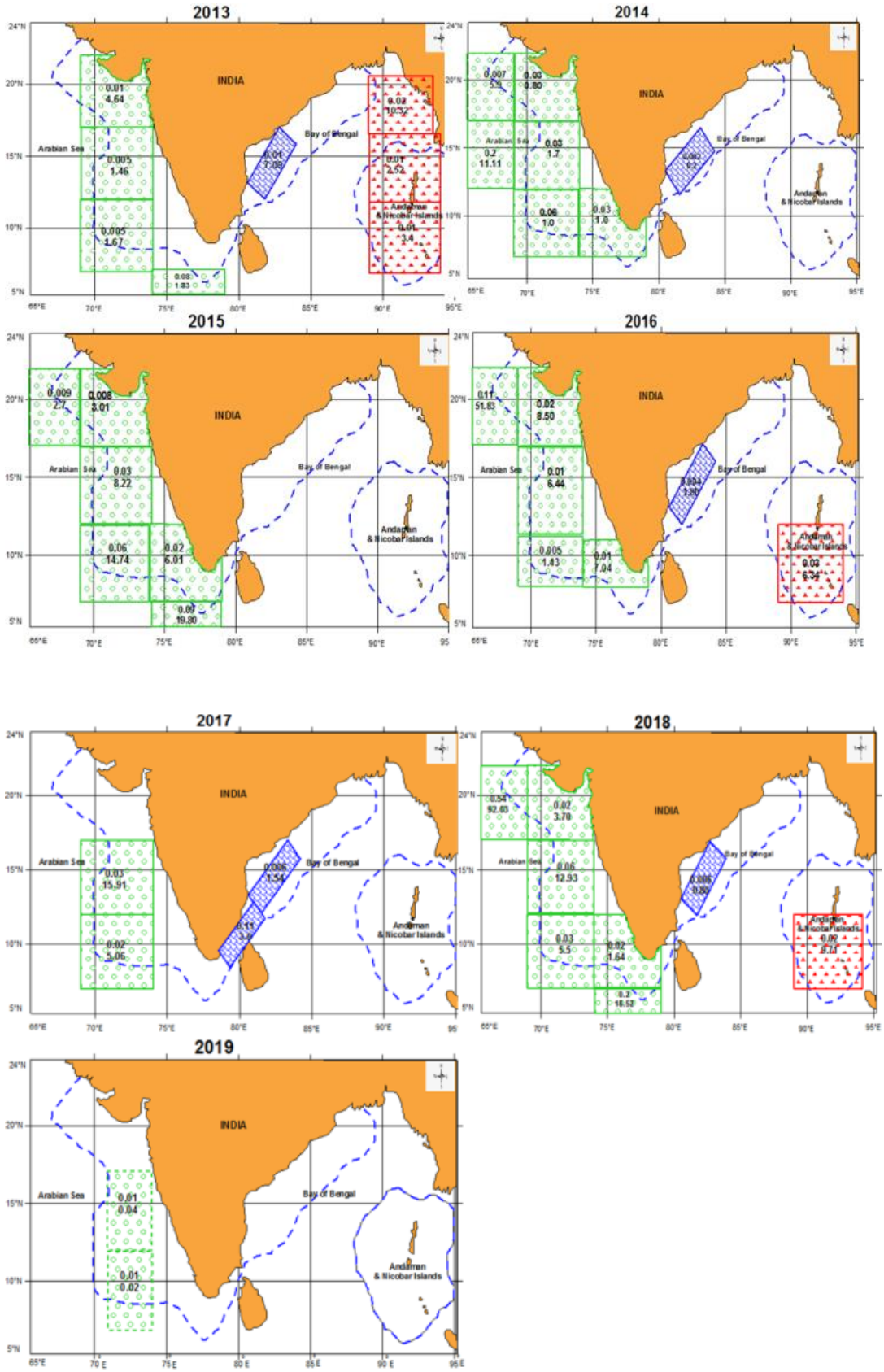
Catch rate Kgs./1000 hooks




Hooking rate Nos./100 hooks

Catch rate Kgs./1000 hooks

**Fig. 3. Area-Wise hooking rates/catch rates of *Makaira nigricans* along Indian West Coast (FAO area 51)**




Hooking rate Nos./100 hooks

Catch rate Kgs./1000 hooks

**Fig.4. Area-Wise hooking rates/catch rates of *Istiophorus platypterus* along Indian Coast (FAO area 51&57)**

Fig.5.Hooking rate of *Xiphius gladius* in East coast of India (FAO area 57) during 2010-2018

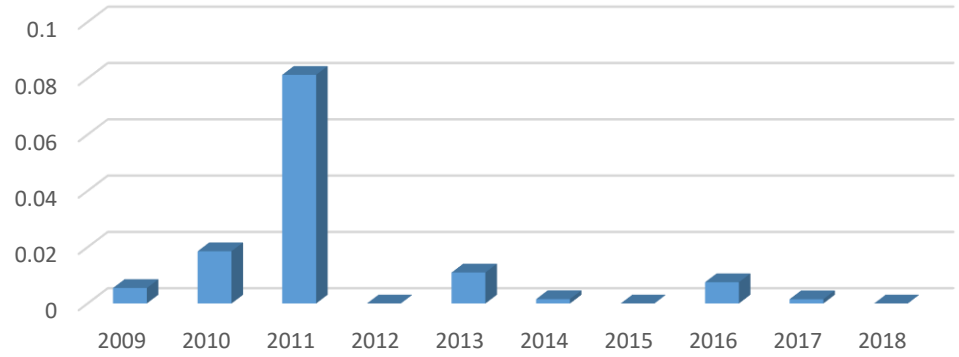



Fig.6. Hooking rate of *Xiphius gladius* in the area 12-17N/79-84E (FAO area 57 during 2010-2018

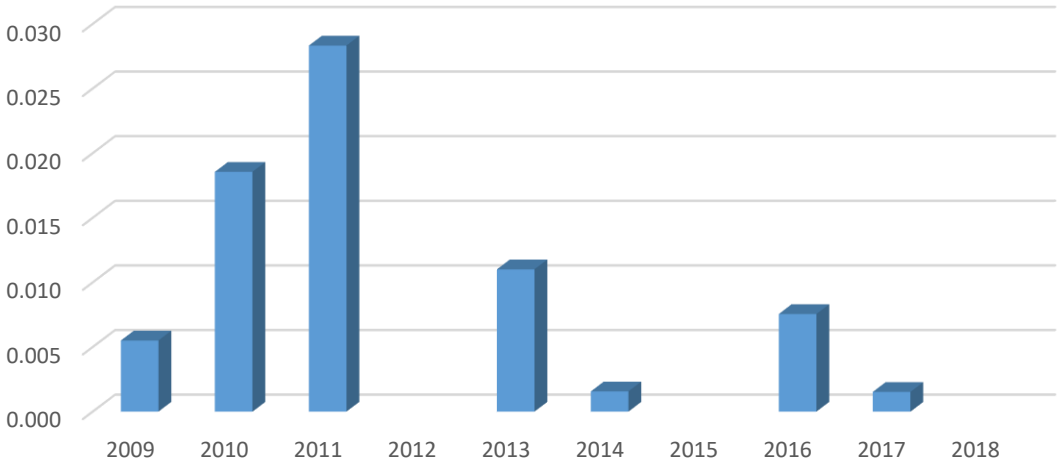


Fig. 7.Area wise contribution of Catch rate (Kg/1000 hooks) of *Xiphius gladius* production *in* West coast of India

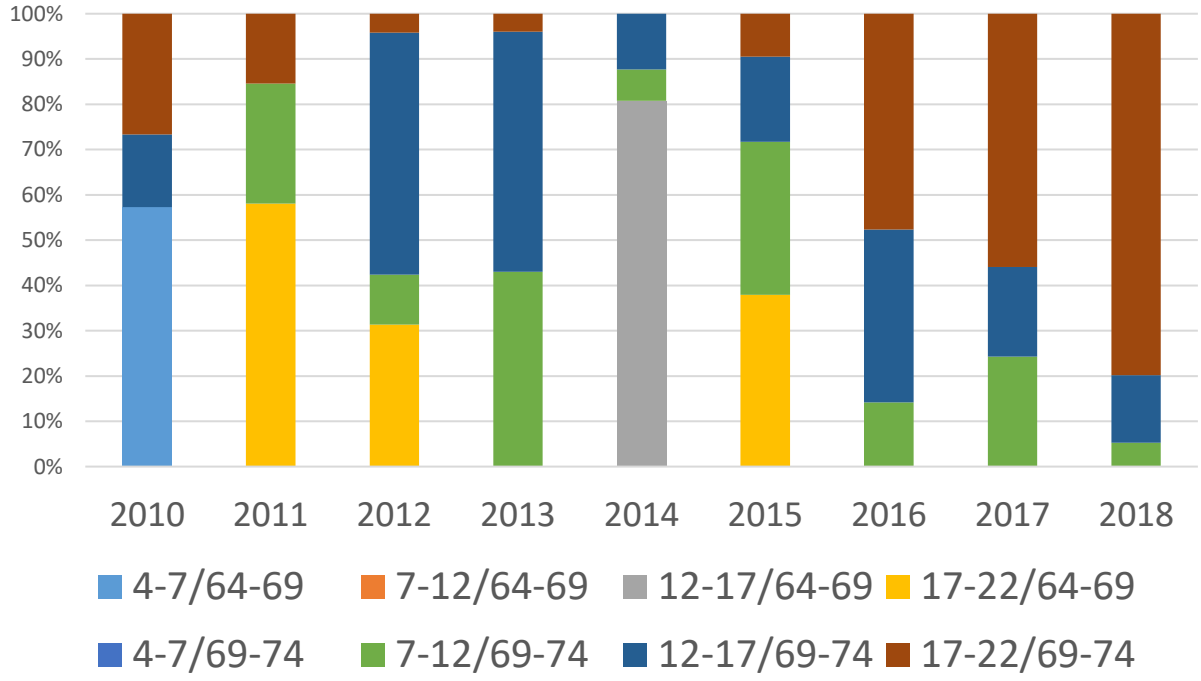



Fig. 8.a. percentage diet composition of *X. gladius* in Andaman waters

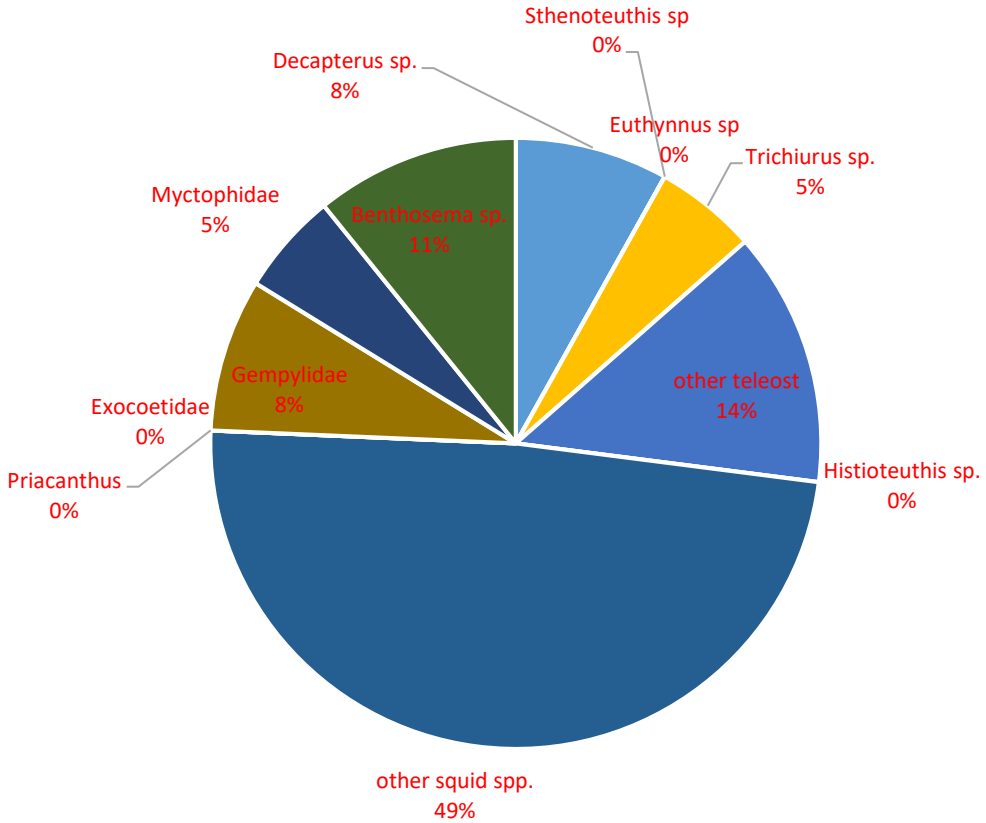


Fig. 8.b. percentage diet composition of *X. gladius* in East coast

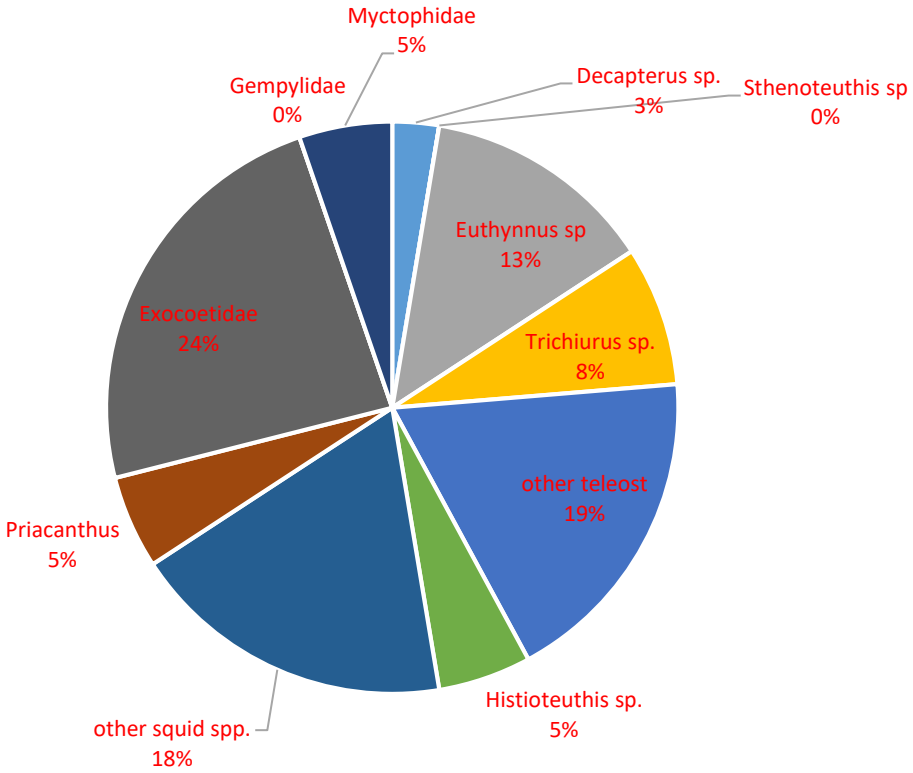
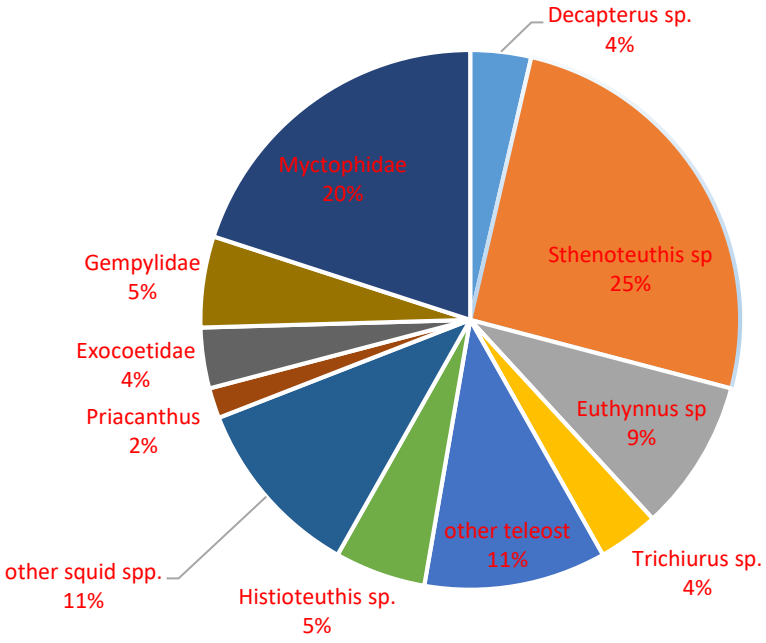



Fig. 8.c. percentage diet composition of *X. gladius* in west coast



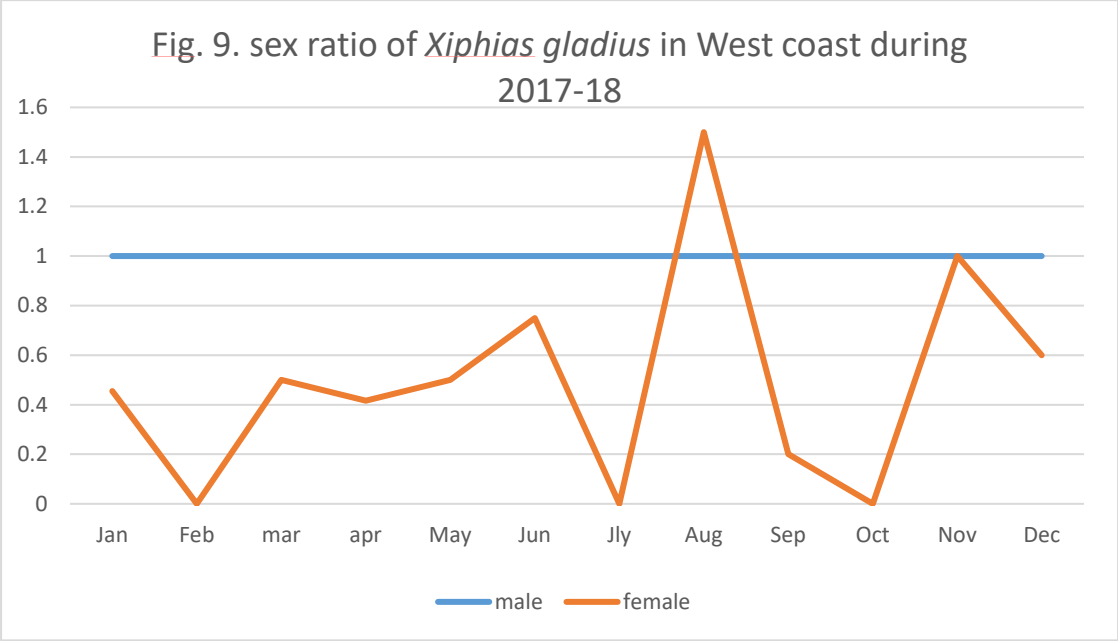



Table 1. Area wise hooking rate of *Xiphius gladius* in west coast of India

| | | Hooking rate nos / 100hooks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Area Lat.°N/Long.°E | 2010 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| 4-7/64-69 | | 0.33 | | | | | | | | |
| 12-17/64-69 | | | | | | 0.16 | | | | |
| 17-22/64-69 | 0.06 | 0.07 | 0.04 | 0.007 | | | 0.02 | | | |
| 4-7/69-74 | 0.20 | | | | | | | | | |
| 7-12/69-74 | | | 0.07 | 0.04 | 0.05 | 0.03 | 0.09 | 0.02 | 0.02 | 0.01 |
| 12-17/69-74 | 0.2 | 0.09 | | 0.17 | 0.08 | 0.04 | 0.04 | 0.02 | 0.01 | 0.02 |
| 17-22/69-74 | 0.04 | 0.077 | 0.05 | 0.03 | 0.01 | | 0.02 | 0.03 | 0.18 | 0.07 |
| 4-7/74-79 | | | | | | | | 0.10 | | 0 |
| 7-12/74-79 | 0.070 | 0.030 | | 0.000 | | 0.02 | | 0.04 | | 0.03 |
| 12-17/74-79 | 0.03 | | | 0.09 | | | | | | |

Table 2. Area wise Catch rate of *Xiphius gladius* in west coast of India

| | | Catch rate kgs./1000 hooks | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Area Lat.°N/Long.°E | 2010 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| 4-7/64-69 | | 16.7 | | | | | | | | |
| 12-17/64-69 | | | | | | 11.11 | | | | |
| 17-22/64-69 | 2.8 | 0.00 | 6.7 | 5.9 | | | 16.5 | | | |
| 4-7/69-74 | 9.3 | | | | | | | | | |
| 7-12/69-74 | | | 3.07 | 2.07 | 5.3 | 1.0 | 14.7 | 5.1 | 16.8 | 1.5 |
| 12-17/69-74 | 22.8 | 4.7 | | 10.07 | 6.5 | 1.7 | 8.2 | 13.9 | 13.6 | 4.2 |
| 17-22/69-74 | 0.8 | 7.8 | 1.8 | 0.80 | 0.5 | | 4.1 | 17.3 | 38.6 | 22.4 |
| 4-7/74-79 | | | | | | | | 4.8 | | 0 |
| 7-12/74-79 | 1.4 | 3.0 | | 0.00 | | 1.0 | | 2.0 | | 2.1 |
| 12-17/74-79 | 1.06 | | | 10.2 | | | | | | |

Table 3. Hooking rate and catch rate of *Xiphius gladius* in East coast of India

| | Hooking rate nos./100hooks | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Area Lat.°N/Long.°E | 2010 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | |
| 4-7/79-84 | | | | | | | | | | |
| 7-12/79-84 | | | 0.05 | | | | | | | |
| 12-17/79-84 | 0.006 | 0.019 | 0.03 | | 0.01 | 0.002 | | 0.008 | 0.002 | |
| 4-7/79-84 | | | | | | | | | | |
| | Catch Ratewt. In kgs/1000hoks | | | | | | | | | |
| 7-12/79-84 | | 39.43 | 8.11 | | | | | | | |
| 12-17/79-84 | 2.01 | 0 | 2.05 | | | 0.16 | 1.5 | 0.2 | 0.9 | |

Table 4. Hooking rate and catch rate of *Xiphius gladius* in Andaman waters (FAO area 57)

| | hooking rate nos. /100 hooks | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Area | 2010 | 2010 | 2011 | 2013 | 2015 | 2016 | 2017 | 2018 |
| 7--12/89-94 | 0.08 | 0.02 | 0.13 | 0.01 | 0.01 | 0.01 | 0.07 | 0.09 |
| 12--17/89-94 | 0.02 | | 0.2 | | | | | 0.02 |
| 4--7 /94-94 | | | 0.2 | 0.3 | | | | |
| 7--12/94-99 | | 0.02 | 0.04 | | 0.01 | | 0.01 | |
| 12--17/94-99 | | 0.00 | 0.1 | | 0.05 | | | |
| 17--22/94-99 | | | | | | | | |
| Catch Rate wt. In kgs/1000hoks | | | | | | | | |
| 7--12/89-94 | 5.3 | 0.13 | 19.9 | 4.4 | 2.3 | 2.2 | 5.9 | 16.9 |
| 12--17/89-94 | 1.3 | 4.8 | 146.00 | | | | | 1.3 |
| 4--7 /94-99 | | | 9.60 | 144.00 | | | | |
| 7--12/94-99 | | | 8.5 | | 7.7 | | 0.2 | |
| 12--17/94-99 | | 3.9 | 49.0 | | 1.1 | | | |
| 7--12/89-94 | 5.3 | 0.1 | 19.9 | 4.4 | 2.3 | 2.2 | 5.9 | 16.9 |

Table .5. Population parameters of *Xiphias gladius* compared with pertinent literature

| L∞ (cm) | K (1/y) | to (years) | Sex | Country/locality | Reference |
|---|---|---|---|---|---|
| 340 | 0.03 | | Pooled | Indian Ocean | Present record |
| 321 | 0.14 | -1.3 | Pooled | Central Pacific | Uchiyama *et al.*, 1998 |
| 300.66 | 0.04 | -0.75 | F | Taiwan | Sun *et al.*, 2002 |
| 296 | 0.08 | -3.7 | F | Australia | Young & Drake, 2004 |
| 434.7 | 0.053 | -3.46 | F | New Zealand | Griggs *et al.*, 2005 |
| 394.4 | 0.044 | 5.86 | M | New Zealand | Griggs *et al.*, 2005 |
| 221 | 0.07 | −0.15 | M | Hawaii | DeMartini, 2007 |
| 234.002 | 0.169 | -2.181 | M | Indian Ocean | Wang *et al.*, 2010 |
| 274.855 | 0.138 | -1.998 | F | Indian Ocean | Wang *et al.*, 2010 |
| 243.79 - 311.11 | 0.17 -0.22 | -0.53 –0.37 | F-M | Indian ocean | Varghese et al 2013 |

## References

**Campbell, R. A. and G. N. Tuck. 1998**. Preliminary analysis of billfish catch rates in the Indian Ocean. 7thExpert Consultation on Indian Ocean tunas, IOTC Proceedings; 192-210.

**Chiang, W. C., C-L Sun and S-Z. Yeh. 2004**. Age and growth of sailfish (*Istiophorus platypterus )* in watersoff eastern Taiwan. *Fish. Bull., 102: 251 -263.*

CMFRI 2019. Annual Report 2018-19. Central Marine Fisheries Research Institute, Kochi. p. 320

**De Sylva, D. P. 1957**. Studies on the age and growth ofthe Atlantic sailfish *Istiophorus americanus* (Cuvier), using length frequency curves. Bull. Mar. Sci. Gulf Caribb., 7(2): 1-20.

De Sylva, D.P. 1974. A review of the world sport fishery for billfishes (Istiophoridae and Xiphiidae). *NOAA Tech. Rep*., part 2: 12 -23.

**Ganga,U. N. G. K. Pillai and M. N. K. Elayathu 2008**. Billfish fishery along the Indian coast with special reference to the Indo-Pacific sailfish *Istiophorus platypterus* (Shaw and Nodder 1792) *J. Mar. Biol. Ass. India*, 50 (2) : 166 – 171

**Hoolihan, J. P. 2004**. Managing Arabian Gulf sailfish –Issues of transboundary migration. In: Payne, A. I. L,C. M. O. Brian and S. I. Rogers (Eds.) Management of Shared Fish Stocks. Blackwell Publishing, Oxfordshire, UK, p. 339-347.

**Hoolihan, J. P. 2006**. Age and growth of Indo- Pacificsailfish *Istiophorus platypterus* from the *Arabian Gulf.Fisheries Research*, 78(2-3): 218 -226.

**Hoolihan, J. P. and J. Luo. 2007**. Determining summer residence status and vertical habitat use of sailfish *Istiophorus platypterus* in the Arabian Gulf. ICES J.Mar. Sci., 64(9): 1791 -1799.

**John M. E., A. K. Bhargava, V. Rane and A. S. Kadam. 1995**. Some aspects of the distribution and biology of the Indo-Pacific sailfish *Istiophorus platypterus* (Shaw and Nodder, 1792) in Indian waters. Proc. Sixth Expert Consultation on Indian Ocean Tunas, IPTP Coll., 9:286 -292.

**Morrow, J. E. 1964.** Marlins, sailfish and spearfish in the Indian Ocean. Proc. Symposium Scombroid Fishes, *Marine Biol. Assoc. of India*, Mandapam Camp, Part 1: 429 – 440.

**Pradeep.H.D, Swapnil S. Shirke, M.Nashad, Pratyush Dhas and M.K.Farejiya (2017)** "Distribution, Abundance and Diversity of Billfishes occurring in Andaman and Nicobar

waters of Indian Exclusive Economic Zone (EEZ)". Journal of the Andaman Science Association Vol. 22(1):76-84.

**Premchand, L. Ramalingam, A. Tiburtius, A. Siva, Ansuman Das, Rajashree B Sanadi and Rahul Kumar B Tailor. 2015.** India's National Report to the Scientific Committee of the Indian Ocean Tuna Commission'2015 IOTC–2015–SC18–NR09[E]

**Ramachandran, S and L.Ramalingam 2019.** Distribution, Abundance and some biological aspects of Bill fish species under the family Xiphiidae (*Xiphias gladius*) and Istiophoridae (*Istiophorus platypterus, Istiompax indica Makaira nigricans*) in Indian EEZ. IOTC-2019-WPB17-26

**Ramalingam, L. and A.B.Kar 2011**. Distribution, abundance and biology of indo pacific sailfish, *Itiophorus platypterus* (shaw and nodder, 1792) in the Indian EEZ around Andaman and Nicobar. IOTC–2011–wpb09–26

**Sivaraj, P., S. A. Rajkumar, M. K. Sinha, A. B. Kar and S. K. Pattnayak. 2005**. Distribution, abundance and biology of Indo-Pacific sailfish in Andaman sea. In: V. S. Somvanshi, S. Varghese and A. K. Bhargava (Eds.) *Proc. Tuna Meet*-2003: p. 216 - 225.

**Somvanshi, V. S., N. G. K. Pillai and M. E. John. 1998**. Current status of tunas and tuna-like fishes in India.7th Expert Consultation on Indian Ocean tunas, IOTC Proceedings, 1: 31 - 38.

**Su, N.J., C.L. Sun, S.Z. Yeh, W.C. Chiang, S.P. Wang, and C.H. Liu 2005**. LJFL and EFL relationships for the billfishes caughtby the Taiwanese offshore and coastal fisheries.ISC/05/MAR&SWO-WGs/ 4Joint Intercessional Meeting of the Swordfish and MarlinWorking Groups of ISC. August 29 to September 2, 2005, Shimizu, Japan.

**Sudarsan, D., V. S. Somvanshi and M. E. John. 1988**. Atlas of Tunas, Billfishes and Sharks in the Indian EEZ and Adjacent Oceanic Regions. Fishery Survey of India, 57 pp.

**Varghese, S., V. S. Somvanshi, D. K. Gulati, S. P. Varghese and B. J. Parakkal. 2005.** Distribution, abundance and biology of Indo-Pacific sailfish, Istiophorus platypterus (Shaw and Nodder, 1792) in the north western Indian EEZ. In: V. S. Somvanshi, S. Varghese and A. K. Bhargava (Eds.) Proc. Tuna Meet-2003: p.191- 208.

**Varghese, Sijo P. K. Vijayakumaran, A. Anrose, Vaibhav D. Mhatre 2013**. Biological Aspects of Swordfish, *Xiphias gladius* Linnaeus, 1758, Caught During Tuna Longline Survey in the Indian Seas *Turkish J. of Fish. and Aquatic Sci.* 13: 529-540

**Varghese, Sijo P. V. S. Somvanshi, Rishikesh S. Dalvi 2014.** Diet composition, feeding niche partitioning and trophic organisation of large pelagicpredatory fishes in the eastern Arabian Sea. *Hydrobiologia*. 736, 99-114.

**Vijayakumaran, K. and Sijo P. Varghese 2012**. India's National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2012 *IOTC–2012–SC15–NR09*[E]

**Williams, F. 1970**. The sport fishery for sailfish at Malindi, Kenya, 1958 -1968, with some biological notes. *Bull. Mar. Sci*., 20(4): 830 - 852.