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Biodiversity status and conservation strategy of elasmobranchs (sharks) at gulf of manner, Thoothukudi district

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Abstract
India is ranked second in top of 20 shark catching nations of the world. Indian shark landing is decreased tendency in recent years. The main motivation of shark catching is for their fins. Millions of sharks were killed every year for their fin soup. Indian Government has banned the sharks catch (only for their fins), however, it is illegally exported to Asian countries viz. China, Singapore, Thailand, Malasia and Hongkong for their festivals and functions. In addition, shark products are filleted, salted and dried shark meat and liver oil also have a good demand in both international and domestics markets. The present study is aimed to collect data from fish landing centre and assess the biodiversity status and conservation strategy of sharks at Thoothukudi district Southeast Coast region.

Keywords: sharks, biodiversity, conservation, gulf of manner, by-catch, southeast coastal

Introduction
Sharks are crucial to marine ecosystems. They maintain a balance in populations of prey species and keep the ocean healthy by removing ill or diseased animals. They are an important resource supporting local economies through fishing and as an attraction to dive tourists. But sharks are in a global decline. Overfishing has reduced many shark populations around the world to levels that threaten their continued existence. Shark numbers have fallen by more than 80% in many cases, and the continued existence of some species is at immediate risk in some regions.

Sharks have typically been exploited as a by-catch of commercial fisheries targeting more valuable bony fishes, especially tuna and billfish (ICCAT, 2005). In many countries, shark by-catch is partially or primarily retained for the fin, liver oil, teeth and food trade. But even where living sharks are released at sea because they are considered unwanted catch, post-release mortality rates can exceed 18 per cent for some species (Campana *et al.*, 2009; Musyl *et al.*, 2011) [10]. In the North-West Atlantic, blue shark by-catch from an international pelagic long line fleet outnumbers the target swordfish catch by about 3:1, resulting in an annual post-release blue shark mortality of ~20,000 mt (Campana *et al.*, 2009) [10].

Similar calculations of capture and post-release mortality of released sharks, using conservative mortality estimates for all shark species, suggest total shark mortalities of non-landed sharks of about 34,000 mt per year (Worm *et al.*, 2013) [4].

In recent decades, an increasing demand for shark fins from the Asian market stimulated the conversion of many industrial fisheries from bony fishes to sharks (Aires-da-Silva *et al.*, 2008). For countries in Central America and in southeastern Asia, shark fining has become an important source of income (Dell'Apa *et al.*, 2014) [7].

The commercial trade in shark fins has been a primary driver of shark mortality. With prices of up to 2,000 United States dollars per kg, and a total estimated market value of about 350 million dollars, the fin trade is a strong motivator for retaining shark by-catch (Worm *et al.*, 2013). The fin trade (which also includes fins of landed sharks) has been linked to a median annual estimate of 38 (CI: 26 – 73) million sharks landed, resulting in fishing mortality rates which are unsustainable for some species (Clarke *et al.*, 2006, 2013) [6].

These features motivate the peoples to involve in shark fishery and the profit of shark catching is higher even at a low catch than that of the traditional fisheries. In addition, exploitation of sharks in commercial fisheries potentially threatens the survival of rare and vulnerable species and, by removing large numbers of top predators from the oceanic system may have dramatic and undesirable ecological impacts and is crucial to maintain a biological balance. Moreover, by catch of immature shark juveniles is also considered as the major problem for reduction of shark population due its slower growth rate. According to Part II A of Schedule I of Indian Wildlife Protection Act, 1972, the shark species such as *Anoxypristis cuspidata*, *Carcharihnus hemiodon*, *Glyphis gangeticus*, *Gluphis glyphis*, *Pristis microdon*, *Pristis Zijsron*, *Rhyncobatus djiddensis* and *Urogymus asperrimus* catch were banned by Government of India. Moreover, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has listed five species of sharks includes oceanic white tip shark (*Carcharhinus longimanus*), scalloped hammerhead shark (*Sphyrna lewini*), great hammerhead shark (*Sphyrna mokarran*), smooth hammerhead shark (*Sphyrna zygaena*) and porbeagle shark (*Lamna nasus*). Though, these listed shark species were caught in some places due to lack of awareness, short of knowledge on species identification also forms a major bottleneck to turn down the population of

sharks by the fishermen's. However, it is time to evolve the shark fishing policy in our country for regularizing the shark fishing activities for the sustainable harvesting. The work done by me will address the issues, threats and status of shark landings from the major fish landing centers of south east coast of India.

Material and Methods

The data collection and specimens were collected from five major fish landing centers are Thoothukudi, Threshpuram, Tharuvaikulam, Vembar and Vellapatti. Sampling was done monthly three times in the above landing centers. The specimens were collected from the catches of trawl net, bottom set gill nets and hook and lines. The trawl net is operated with trawler and the other gears are operated with plank built boat locally called as 'Vallam' on an average of fifty boats per sampling day. The data collected were station-wise for calculation of various biodiversity indices. To study the species-wise distribution, elasmobranch specimens were collected and identified twice in every fortnight from the above said landing centers during September 2016 to March 2017.

Species abundance data were calculated by the total number of individual species collected from all the five stations during the study period. Measure the every species length and weight. Elasmobranchs are the targets for this study. Thoothukudi district having a coastal line of 163.5 km stretches from Vembar in the north to south of Manappad (i.e., between 8° 9' 00" to 9° 7' 30" N latitude and 78° 2' 30" to 78° 25' 00" E longitude). Thoothukudi fishing harbour (TFH) is one of the oldest fishery ports in the east coast of India. Due to its commercial and economic importance from the marine fisheries point of view, nowadays it is considered as one of the major fishing harbours on the east coast of India. For the sake of easy management the fishing areas are divided into north of Thoothukudi and southern Thoothukudi. Of which the southern area cover up to Chinna muttom in Kanyakumari district and northern side covers up to Ervadi in Ramanathapuram district.

Calculation

Simpson's diversity index (D)

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. In essence it measures the probability that two individuals randomly selected from an area will belong to the same species. The formula for calculating D is presented as:

$$D = \frac{\sum n_i (n_i - 1)}{N (N - 1)}$$

Where n_i is the total number of organisms of each individual species, N is the total number of organisms of all species. The value D ranges from 0 to 1.

Shannon Index (H)

The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled.

$$H = \sum_{i=1}^{s} Pi \ln Pi$$

Where P is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), ln is the natural log, ∑ is the sum of the calculations, and s is the number of species.

Margalef's diversity index (DMg)

Measurement of species richness Margalef's index was used as a simple measure of species richness (Margalef, 1958). This measure is strongly dependent on sampling size and effort.

$$D_{Mg} = \frac{(S-1)}{ln\ N}$$

Where S is the total number of species, N is the total number of individuals in the sample, in is the natural logarithm

Results

An intensive study was taken up for six months (September, 2016 – April, 2017) to assess the biodiversity and by-catch of elasmobranchs along the Gulf of Mannar Southeast coastal region at thoothukudi district.

Table 1: Checklist of Elasmobranchs in Gulf of Mannar.

Family	Binomial Name
Alopiidae	Alopias pelagicus (H.Nakamura, 1935) Pelagic Thresher Shark
	Alopias vulpinus (Bonnaterup, 1788) Long tail thresher shark
	Alopias supercilious (R.T.Lowe, 1840) Big eye thresher shark
Proscyllidae	Eridacnis radcliffei (Smith, 1913) Pygmy ribbontail Catshark
Sphyrnidae	Sphyrna lewini (Griffith & Smith, 1834) Scalloped hammerhead
	Sphyrna zygaena (Linnaeus, 1758) Smooth hammerhead
Squatinidae	Squatina albipunctata (W.T.White, 2008) Eastern Angel Shark
Echinorhinidae	Echinorhinus brucus (Bonnaterre, 1788) Bramble Sharks
Hemiscylliidae	Chaenogaleus macrostoma (Blecker, 1952) Hook tooth shark
Stegostomatidae	Stegostoma fasciatum (Hermann, 1783) Zebra Shark
Rhinobatidae	Rhina ancylostoma (Bloch, 1801) Bowmouthed angel shark
Carcharhinidae	Carcharhinus amblyhynchus (Whitley, 1934) Grey Reef Shark
	Carcharhinus hemiodon (Muller,1839) Pondicherry Shark

	Carcharhinus Milberti (Müller and Henle, 1841) Sand bar Shark
	Carcharhinus Plumbeus (Nardo, 1827) Sand bar reef Shark
	Carcharhinus obscurus (Lesueur, 1818) Dusky Shark
	Carcharhinus Taurus (Rafinesque, 1810) Grey Nurse Shark
	Eulamia Spallanzani (Paron & Lesueur, 1822) Spot-tail Sorrah
	Carcharhinus indicum (J.P.Muller & Henie, 1839) Monkey Sorrah
	Carcharhinus limbatus (Muller & Henle, 1839) Blacktip Shark
	Carcharhinus falciformis (Muller & Henle, 1839) Silky Shark
	Carcharhinus melanopterus (Gaimard, 1824) Blacktip reef Shark
	Rhizoprionodon acutus (Ruppell, 1837) Milk Shark
	Rhizoprionodon oligolinx (Springer, 1964) Grey Sharpnose Shark

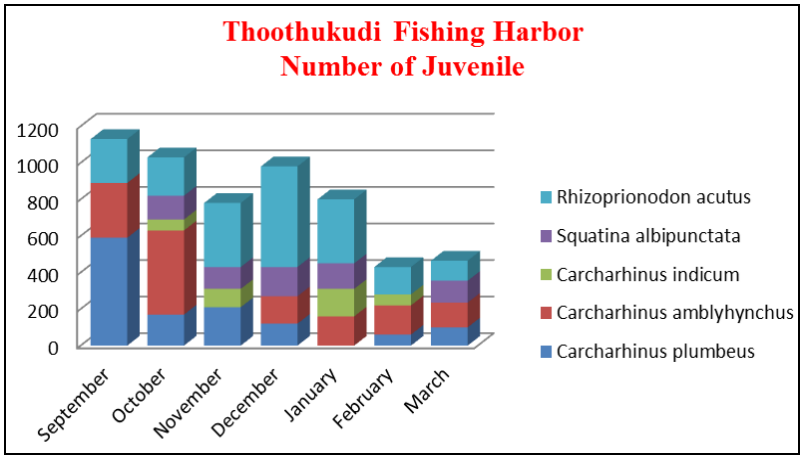

Fig 1: Month Wise Data for Juvenile Abundance in Thoothukudi Fishing Harbor

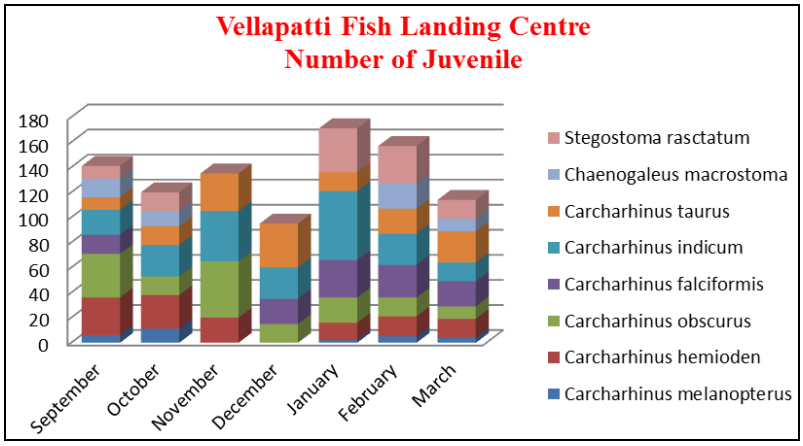

Fig 2: Month Wise Data for Juvenile Abundance in Vellapatti Fish Landing Centre.

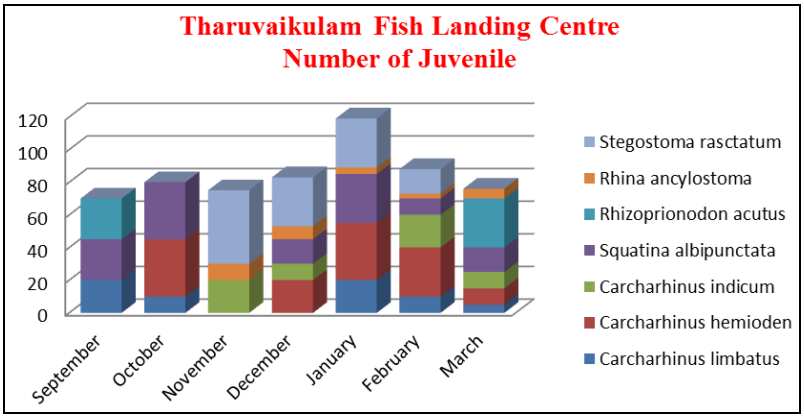

Fig 3: Month Wise Data for Juvenile Abundance in Tharuvai Fish Landing Centre.

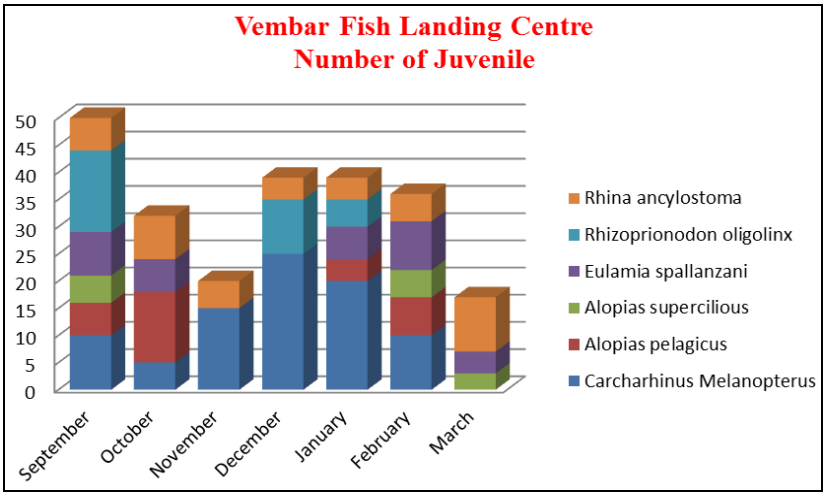

Fig 4: Month Wise Data for Juvenile Abundance in Vembar Fish Landing Centre.

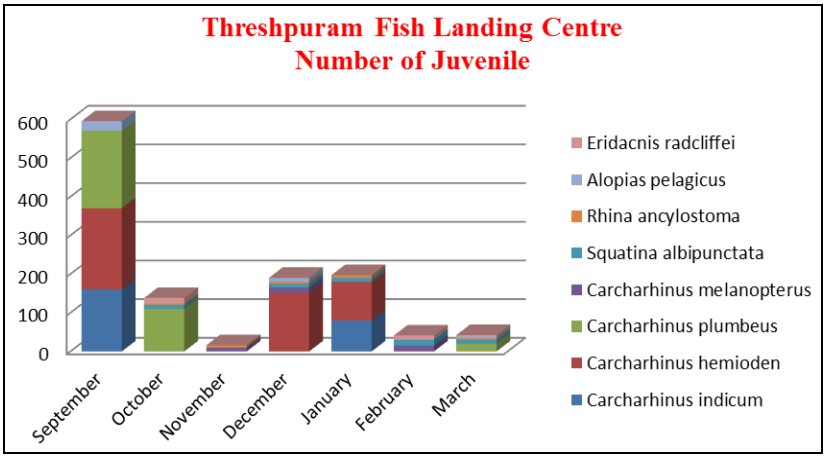

Fig 5: Month Wise Data for Juvenile Abundance in Threshpuram Fish Landing Centre.

A checklist of elasmobranch species recorded was prepared with their systematic position. In the present study, 24 species of elasmobranchs belonging to 6 orders, 10 families and 11 genera were recorded in Gulf of Mannar, Tamil Nadu, Southeast coast of India. Among the 11 genera, the genus, Carcharhinus was found to have the largest representation with 10 species followed by the genus, Carcharias with 1 species, Alopias with 3 species, Rhizoprionodon with 2 species, Sphyrna with 2 species, Rhina with 1 species, Squatina with 1 species, Eridacnis with 1 species, Echinorhinus with 1 species, Chaenogaleus with 1 species, Stegostoma with 1 species. The checklist of elasmobranchs species are recorded in Gulf of Mannar is given in Table 1.

Species composition and dominance

The number of species recorded in Thoothukudi fishing harbor, Threshpuram fish landing centre, Tharuvaikulam fish landing centre, Vembar fish landing centre and Vellapatti fish landing centre during the September 2016 to March 2017.

Spatial variations in Simpson's diversity index (D)

The Spatial variations in Simpson's diversity index (D) was calculated to be ranges of 0.7186 – 0.8117 for Thoothukudi. The index was in the ranges of 0.7105 – 0.9051 for Threshpuram. The index was in the ranges of 0.6830 – 0.8588 for Tharuvaikulam. The index was in the ranges 0.5549 – 0.8787 for Vembar and 0.7783 – 0.8766 for Vellapatti.

Spatial variations in Shannon –Wiener diversity index (H')

The Shannon – Wiener diversity index (H' (log2) was calculated to be ranges of 1.094 – 1.386 for Thoothukudi. The index was in the ranges of 0.691 – 1.594 for Threshpuram. The index was in the ranges of 1.052 – 1.745 for Tharuvaikulam. The index was in the ranges of 0.656 – 1.773 for Vembar and 1.374 – 1.920 for Vellapatti.

Spatial variations in Margalef Species richness (d)

The Spatial variations in Margalef Species richness (d) was calculated to be ranges of 0.7791 – 1.378 for Thoothukudi. The index was in the ranges of 0.8285 – 1.418 for Threshpuram. The index was in the ranges of 0.7386 – 1.659 for Tharuvaikulam. The index was in the ranges 0.5526 – 1.765 for Vembar and 0.957 – 1.852 for Vellapatti.

Discussion

Present elasmobranchs by-catch investigation revealed presence of 24 species of elasmobranchs belonging to 6 orders, 10 families and 11 genera were recorded in Gulf of

Mannar, Tamil Nadu, South east coastal of India. Among the 11 genera, the genus, Carcharhinus was found to have the largest representation with 10 species followed by the genus, Carcharias with 1 species, Alopias with 3 species, Rhizoprionodon with 2 species, Sphyrna with 2 species, Rhina with 1 species, Squatina with 1 species, Eridacnis with 1 species, Echinorhinus with 1 species, Chaenogaleus with 1 species, Stegostoma with 1 species. All the five fish landing centre were represented with reasonably good number of juvenile and mature sharks throughout the year.

Shannon diversity (H')

Shannon – Wiener diversity is very widely used for comparing diversity between various habitats. In the present study, Shannon – Wiener diversity (H') was in the range of 1.07 – 1.70. The number of species was observed to be in the range of 8 – 11. Ajmal khan *et al.* (2005) reported H' in the range of 1.6698 – 3.3879 for brachyuran crabs for the species in the range of 5 – 30 in Pitchavaram mangroves. The high value of Shannon diversity index (H') observed presently is due to increase in the number of species and their abundance. In Vellapatti fish landing centre, H' value is high in range. In Threshpuram fish landing centre, H' value is low in range.

Simpson's diversity (D)

Simpson's diversity index (D) was calculated in the present study ranged from 0.7698 – 0.8432. The narrow range in 'D' value in the present study is due to less difference in the number of species. This agreed with the study conducted by Sreenivasan and Natarajan (1999) who obtained 'D' in the range of 0.999 – 0.967 in the Hare Island, Gulf of Mannar. Among the five fish landing centre, the highest 'D' value was obtained for Vellapatti fish landing centre value of 0.8432 with 8 species and lowest value 0.7698 for Vembar fish landing centre.

Margalef Species richness (d)

The Margalef Species richness (d) was calculated in the present study ranged from 8.12 – 16.93. The narrow range in'd' value in the present study is due to less difference in the number of species. Kolanginathan (2008) estimated 'd' in the range of 11.070 – 12.950 for gastropods represented by species in the range of 115 – 138 in Gulf of Mannar.

A total five fish landing centre, the highest 'd' value for Thoothukudi fishing harbor (16.93) with 8 species. The species richness was the lowest 'd' value for Tharuvaikulam fish landing centre (8.12) with 10 species.

Conclusions

In could be summed up that an intensive biodiversity and bycatch assessment studies should be undertaken for the highly exploited elasmobranch species. In addition, 'closed seasons' and ban of trawlers in particular area should be enforced. The mesh size regulations need to be implemented strictly to avoid the exploitation of undersized elasmobranchs. This will be highly helpful in the conservation of these precious resources.

The proportion of sharks that are killed for their fins is well known since the early 2000 (Fig 6). However a number of regions now have anti-finning legislation that may reduce the incidence of finning and discarding of carcasses, and hence possible reduce the mortaliy of sharks. Yet, despite these legislative changes there is presently no apparent sign of leveling off in the global fin trade. The exploitation of sharks in commercial fisheris for thir fins, meat, liver oil, cartilage and other parts has led to large decline in the population size of many species of sharks worldwide. Finning causes the death of tens of millions of sharks.

This potentially threatens the survival of rare and vulnerable species and, by removing large numbers of top predators from the oceanic system, may have dramatic and undesirable ecological impacts that could potentially threaten yields of other species.

Conservation Measures: Indiscriminate fishing could wipe out a whole generation of sharks. So it is necessary to enforce regulatory limits on the size of sharks which would in turn provide a chance for the immature sharks to mature and reproduce. India needs to take some regulations and only allow for trade in shark products such as meat and fin that have been captured under a sustainable balance. India's natural heritage does not start and end with tigers. There are a number of other species too that need immediate attention and if India does not gear up right now, there is much to be lost very soon.

Scalloped hammerhead shark (Dorsal Side) Scalloped hammerhead shark (Ventral Side)

Fig 6

Acknowledgment

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