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POPULATION CHARACTERISTICS AND FISHERY OF YELLOWFIN TUNA, *THUNNUS ALBACARES* LANDED ALONG THE GULF OF MANNAR COAST, TAMILNADU, INDIA

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ABSTRACT

Fishery and population characteristics of yellowfin tuna, *Thunnus albacares* were studied. Their annual landings from Gulf of Mannar ecosystem varied between 3 (1991) and 1,006 t (2003). Annual average production for 1989-1995 was 90 t, 1996-2000 was 326 and 2001-'06 was 635. Catch was constituted by relatively small fishes. Population parameters such as growth, mortality and exploitation rates were estimated from length frequency data. Length at first capture was estimated as 52.7 cm, length at first maturity as 71.1 cm and optimum length for exploitation as 96.8 cm. Average standing stock and spawning stock biomass was 675 t and 455 t respectively. Maximum sustainable yield (MSY) was estimated as 690 t. Study revealed that yellowfin resource is subjected to intensive exploitation during 1998-2006. Recruitment pattern indicated that recruitment occurs almost round the year with peak in May-August with 60.5% of the annual recruitment. Food and feeding studies show that they feed mainly on pelagic fishes dominated by carangids, clupeids, beloneids and hemiramphids. Other components in their food are crustaceans and cephalopods.

1. INTRODUCTION

Gulf of Mannar along the south east coast of India is famous for its floral and faunal richness and is considered as one of the stable and self sustained ecosystem of the world. This ecosystem is characterized by the unique presence of seagrass and seaweed meadows, rocky bottom, coral reefs and gorgonid beds. It also acts as home for several endangered marine mammals, sea cows and marine turtles.

Tuna is one of the important fishery resources exploited commercially from Gulf of Mannar. Annual average tuna production was 2,383 t during 2001-'06 and formed nearly 2% of the total marine production of the region. Yellowfin is the most dominant exploited oceanic resource of the region. They form about 26.7% of the tuna catch with an average annual production of 635 t during the period. They are fished from oceanic waters beyond 100 m depth round the year with peak during June-September. Their fishing ground shifts northwards after peak season with the migration of the stock.

Besides some earlier reports by Silas (1967) and Pon Siraimeetan (1985) on the fishery and bionomics of yellowfins from the Gulf of Mannar there are no other scientific studies on the resource and their fishery.

2. MATERIAL AND METHODS

Present study is based on the catch effort data of tuna by gillnets and hooks and line and the size distribution data of the species in the catch during 1998-2006. Catch statistics for the period 1989-1998 were also used for the analysis. Information regarding the fishing grounds, distribution and movement of the species were collected from the fishermen. Population parameters were estimated from the length frequency data

using ICLARM's FiSAT software (Gayanilo *et.al.*, 1997) and probability of capture and size at capture by probability curve (Pauly, 1984).

Maximum sustainable yield (MSY) was estimated as per Corten (1974) and Alagaraja (1984). Empirical relationship proposed by Froese and Binohlan (2000) was used to estimate optimum size and age for exploitation of the species.

3. RESULTS

Yellowfin tunas were exploited almost exclusively by large meshed gillnets and to a small extent by hooks and line. Mainly Tuticorin type of boats (Vallam) fitted with inboard engines and few trawler converted gillnetters were engaged in the yellowfin fishery. About 99% of the catch was by gillnets and the rest by hooks and lines. Abundance of the resource was observed only in deep waters beyond 100 m depth. Catch data of the species is available from 1989 (Table 1). Average annual production was 90 t during 1989-95, 326 t during 1995-2000 and 655 t during 2001-'06. Contribution of yellowfin tunas to total tuna catch also increased from 6.5% to 27.2% during the period. Though catch is fluctuating widely over the years; analysis shows there is a general increasing trend.

Yellowfins were landed almost round the year with peak during June-September, which accounts 78% of the annual catch. Large congregations of yellowfins were formed off Manapad waters during the peak season. Gillnetters from other region also migrate to areas like Kayalpatinam during the peak season to harvest the resource. By the end of September the resource migrates northwards and the fishermen follow their course up to off Mandapam or Rameswaram.

3.1. Food and feeding

Food of yellowfin tuna was constituted mainly by teleost fishes (69.9%), followed by crustaceans (17.4%) and cephalopods (12.7%) (Fig 2). Carangids dominated the fish component and are represented mainly by *Decapterus* and *Selar* species. Clupeids in the gut were constituted largely by anchovies and sardines. Crustacean component in the gut was represented by pelagic and demersal crabs and deep sea prawns and cephalopods by squids.

3.2. Growth:

Growth parameters $L\infty$ and K were estimated using von Bertallanffy growth equation as 141.0 cm and 0.65 respectively. This equation shows that the species grow to a size of 67.4 cm. 102.6 cm, 120.9 cm, 130.5 cm and 135.5 cm respectively by the end of 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} year.

Table (1): Yellowfin tuna yield (in tones) from Gulf of Mannar region during 1989-2006.

Year	Total Tuna	*T. albacares*	% in total tuna	Year	Total Tuna	*T. albacares*	% in total tuna
1989	1347	46	3.4	1998	1869	232	24.4
1990	1099	114	10.4	1999	1867	440	23.6
1991	838	3	0.4	2000	2211	529	23.9
1992	3469	25	0.7	2001	1881	460	24.5
1993	1453	26	1.8	2002	2371	921	38.8
1994	652	212	32.6	2003	2722	1006	37.0
1995	882	206	23.4	2004	3863	822	21.3
1996	628	120	19.1	2005	739	169	22.9
1997	631	86	13.7	2006	2891	550	19.0

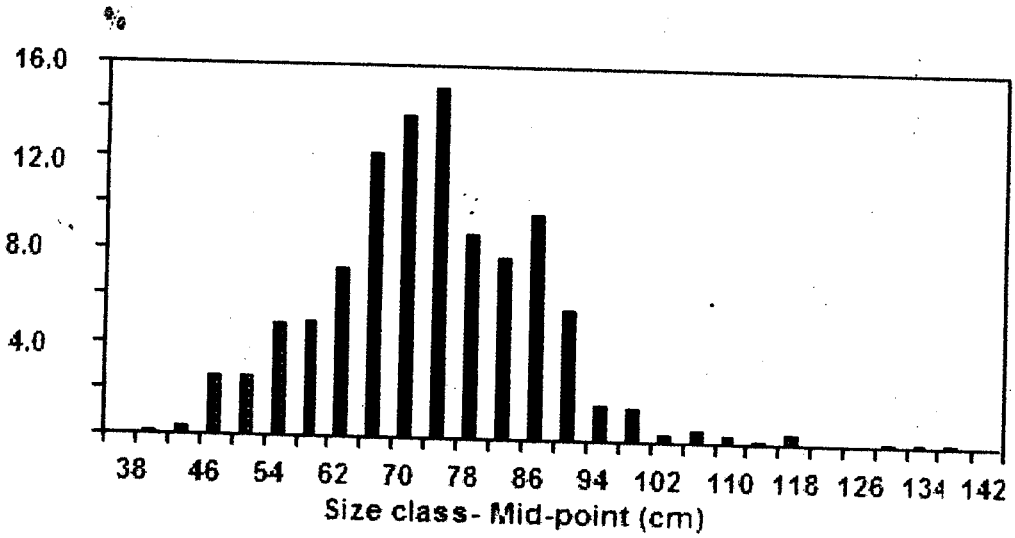

Fig (1): Average annual length frequency of yellowfin tuna the catch during 1998- 2006

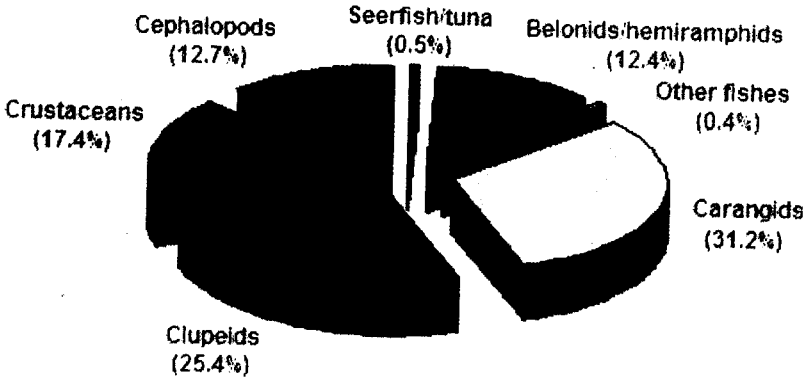

Fig (2): Food composition yellowfin tuna.

3.3. Size distribution in the catch

Fishery was supported by 38-138 cm fishes during 1998-2006 (Table 2, Fig 1). The most common size groups in the catch were 60-90 cm, which represent about 83% of the catch. Annual mean size of the fish in the catch varied between 68.6 and 79.4 cm with 72 cm as the mean size for the period. The above growth study shows that most of the fishes landed were in the age group of 1 to 1.6 year. Their size at first capture (L_{c50}) varied between 43.8 and 83.7 cm with 59.4 cm as the mean value. The analysis shows that both mean size and L_{c50} shows declining trend during the period with the latter at sharper rate.

3.4. Biomass

Estimates of standing and spawning stock biomass are given in Table 3. Analysis shows an increasing trend for standing stock biomass and a declining trend for spawning stock biomass over the period.

3.5. Mortality and Exploitation:

Estimates of fishing mortality and natural mortality are 1.77 and 0.89 respectively during the period (Table 3). Former was always larger than the latter. Exploitation rate during the period of study was 0.66. Year-wise estimate shows that it was larger than the E_{max} (0.585) throughout the period.

3.6. Yield per recruit and maximum sustainable yield:

Relative yield per recruit (Y/R) increases steadily with the exploitation until the exploitation rate reaches 0.585. Thereafter it declines with increasing exploitation. Relative biomass/recruit reduced to 50% at an exploitation rate (E) of 0.35. It reduces to 24% at the maximum Y/R. The maximum sustainable yield (MSY) will be obtained at this point and was estimated as 690 t.

3.7. Other important population parameters.

Optimum size of the fish (L_{opt}) for exploitation was estimated as 96.8 cm. The age of the fish at this size will be 1.8 year. Length at first maturity of the species was estimated as 71.1 cm and their corresponding age as 1.1 year.

Table (2): Size composition (in cm) of yellowfin tuna in the gillnet catch.

Year	Size -Range	Modes	Mean	L_{c50}
1998	52-106	68, 86, 98	79.4	83.7
1999	60-98	62, 78, 84	79.1	75.6
2000	44-102	64, 72, 80	68.6	62.4
2001	44-118	58, 62, 76	71.0	52.6
2002	38-120	58, 68, 72	70.2	60.5
2003	42-102	44, 54, 64	68.6	43.8
2004	48-106	74, 84	72.8	52.8
2005	48-138	62, 68, 74	71.9	51.2
2006	52-138	66, 80, 84	76.6	52.7
Mean	38-138	54, 74, 84	71.9	59.4

Table (3): Estimates of mortality (F-fishing mortality, Z-total mortality), exploitation rate, yield, stock, biomasses and recruitment numbers of yellowfin tuna during 1998-2006 (M-0.890, E_{max} – 0.585).

Year	F	Z	E	Standing stock biomass	Spawning stock biomass	Recruitment No's ('000)
1998	5.65	6.54	0.86	545	407	82
1999	5.37	6.26	0.86	225	194	61
2000	7.81	8.70	0.90	233	94	115
2001	1.37	2.26	0.61	721	540	145
2002	3.18	4.07	0.78	917	577	271
2003	1.39	2.28	0.61	633	367	228
2004	1.73	2.62	0.66	452	266	156
2005	1.77	2.66	0.67	323	262	53
2006	1.49	2.38	0.63	618	304	292
Mean	1.70	2.59	0.66	675	455	174

4. DISCUSSION

Present study indicated that yellowfin tuna start aggregation at off Gulf of Mannar coast beyond 100 m depth by the end of May every year. Their aggregation at this area continues till the end of September/October. Maximum catch of the species was recorded during this period. Thereafter they move northwards and the catch declines sharply.

Size of the fish caught from the area was comparatively smaller compared to their size in the commercial catch reported from other areas of the Indian coast (Premchand *et.al.*, 2005; Sivaraj *et.al.*, 2005; Gopakumar and Ajithkumar, 2005). The fishing ground of yellow fin tuna along Gulf of Mannar is relatively shallow compared to the fishing grounds reported by these workers, where the fishing grounds were generally beyond 250 to 300 m depth. It shows that only smaller fishes enter shallow waters and large fishes remain in deeper areas. This may be the reason for the occurrence of relatively smaller size groups in the catch. The size at first capture of the species is lower than the estimated size of the fish at first maturity; whereas mean size is very close to it but lower than optimum size of exploitation. This is an indicator for over exploitation and so justify the present estimate of larger exploitation rate for the species than the E_{max}.

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