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Evaluation of the effect of lunar cycle and monsoon on catch of yellowfin tuna

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Original Article

Abstract

The sea around Andaman and Nicobar islands is one of the best tuna fishing ground and catches of yellowfin tuna forms a major constituent of Tuna longline fishery. The present study is an attempt to evaluate the effect of the lunar cycle and monsoon on the catch rate of yellowfin tuna based on exploratory tuna longline survey carried out by *M.V. Blue Marlin*, Fishery Survey of India, Port Blair. Present study provided information on the abundance of resources in time and space, environmental factors affecting its distribution and its significance in abundance of yellowfin tuna. The results of the present study indicated that there is a significant effect of the lunar cycle on the catch rate of yellowfin tuna occurring in the Andaman and Nicobar waters. The result showed that monsoon also significantly affects the catch rates of yellowfin tuna. Downward trend of year wise catch rate noticed during the study period warrant strict management measures on the tune longline fishery.

Keywords: *Yellowfin tuna, catch rate, abundance, lunar & monsoon effect, Andaman Sea.*

Introduction

In India, yellowfin tuna *Thunnus albacares* (Bonnaterre, 1788) contributes 52% of the oceanic tuna fishery resources around Andaman and Nicobar (A&N) Islands (Pillai and Abdussamad 2008). In spite of high commercial importance of yellowfin tuna in international market, around 82,000 tones of estimated potential tuna resources of A&N Islands is yet to be commercially exploited (John *et al.*, 2005). Lack of in-depth knowledge on the distribution and abundance of this resource is a major hurdle for the profitable exploitation. There are scientific evidences that water movement and lunar cycle play a major role in feeding, spawning and migratory movements of the fishes (Carey and Robinson, 1981; Taylor, 1984; Luecke and Wurtsbaugh, 1993; Millar *et al.*, 1997; Libini and Khan, 2012)

Mohan & Kunhikoya (1987) studied the effect of the lunar cycle on bait- fish & tuna catches of pole and line fishery at Minicoy Island (Lakshadweep). Lowry *et al.* (2007) and Poisson *et al.* (2010) too made some preliminary studies on the effect of the lunar cycle on yellowfin tuna occurring along Australian waters and Reunion Islands, of which Poisson *et al.* (2010) could not make any analysis due to insufficient number of fishes. Lowry *et al.* (2007) however reported significant lunar effect on yellowfin tuna catches. Except these studies,

no attempt has been made to understand the effect of the lunar cycle on the tuna resources.

John & Somvanshi (2000), John *et al.* (2005) and Somvanshi *et al.* (2008) provided information on spatial variation and seasonality in catches of the longline fishery around A & N Islands. The above studies lack statistical significance test and has not made any attempt to correlate the effect of the monsoon and the lunar cycle on longline caught pelagic fishes.

Yellowfin tuna being a major constituent of tuna longline fishery an attempt has been made here to evaluate the effect of the monsoon and the lunar cycle on yellowfin tuna occurring in A& N waters. This information on the distribution of yellowfin tuna in time and space and effect of the major environmental factors likes monsoon and lunar cycle will definitely help with scheduling exploitation strategy. Moreover, the knowledge of aggregation with changes in key environmental factors will be vital in managing the stock. The present study is first of its kind on the effect of the lunar cycle on tuna longline caught yellowfin tuna, hence may invite greater attention and catalyze further research in this line.

Material and methods

Exploratory tuna longline survey data collected by *M.V. Blue Marlin*, survey vessel attached to the Fishery Survey of India (FSI), around A & N Islands (Fig. 1) was the source material for this study. Data collected during the period January 2006 to December 2008 was utilised. Three hundred and two sets of multifilament tuna longline gear with five hooks (3.6 sun) per basket were operated around the A & N Islands between latitudes 06°N and 14°N. 625 hooks baited with either frozen sardines or mackerels were normally shot in the morning before sunrise and hauled in after providing five to six hours of immersion time. Catch per unit effort (CPUE) was estimated in catch rate as the number of yellowfin tuna caught (successful hooks) per 1000 hooks.

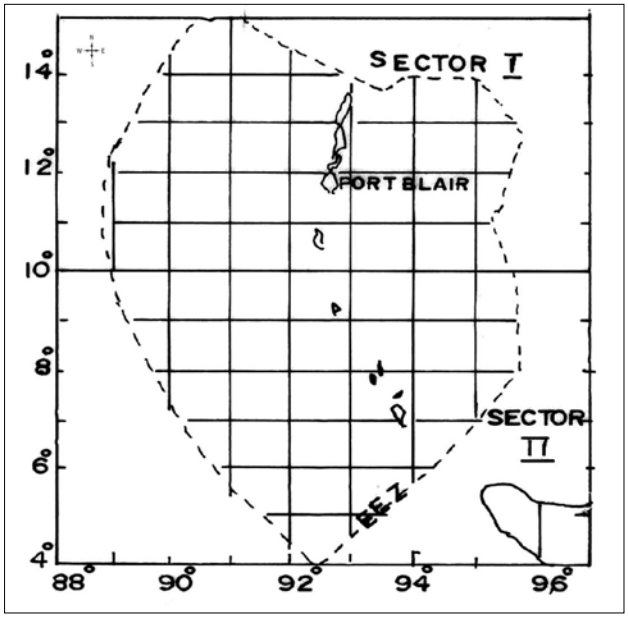

Fig. 1. Location map of the study area.

Month-wise aggregate catch rates were estimated to understand the variation in fish abundance in time. The effect of the monsoon on the yellowfin tuna was estimated by grouping the months into Pre-monsoon (January to April), Monsoon (May to August) and Post monsoon (September to December) periods following Sajeevan and Rajashree (2012). Aggregate catch rates recorded during these periods in each year were utilized to understand the effect of the monsoon on yellowfin tuna.

Lunar days from January 2006 to December 2008 (GOI 2005, 2006, 2007) in each month was pooled into three periods according to the lunar phase as new moon period, the waxing & waning period and full moon period. New moon period refers to new moon day ± 3 days, full moon period refers to full moon day ± 3 days and the in between periods were pooled as the waxing & waning periods. Aggregate catch rates recorded during these lunar phases in each season and year was separately estimated to evaluate the lunar cycle effect on yellowfin tuna.

Fishery data of tuna longline gear were analysed following general linear model using SYSTAT-13 software. Standard statistical procedures (Courtney *et al.,* 1996; McDonald, 2009) were followed for the analysis of data and to arrive at the conclusion of the effect of the lunar cycle and monsoons on catch rate.

Results

Catch rate in space and time

The average catch rate of yellowfin tuna recorded from the study area was 1.87 (Table 1). The highest catch rate was

Table 1. Latitude-wise aggregate catch rate during 2006-08.

Latitude	Catch rate in one fish per thousand hooks		Latitude	Catch rate in one fish per thousand hooks	
	TOTAL	Yellowfin Tuna		TOTAL	Yellowfin Tuna
06°N	6.37	0.53	11° N	8.61	2.01
07° N	7.79	2.12	12° N	7.52	3.17
08° N	8.41	1.16	13° N	5.29	1.79
09° N	8.58	1.19	14° N	4.11	0.46
10° N	6.7	1.54	Average	7.39	1.87

obtained from the late. 12°N followed by 7° N and 11° N. Comparison between the catch rates recorded from Andaman waters (1.86) and Nicobar waters (1.31) revealed that yellowfin tuna catch rates are more in Andaman waters.

The catch rate recorded during 2006 was drastically reduced during the year 2007 and 2008 (Fig. 2). The statistical test too proved that there were significant differences in the aggregate catch rates recorded in different years.

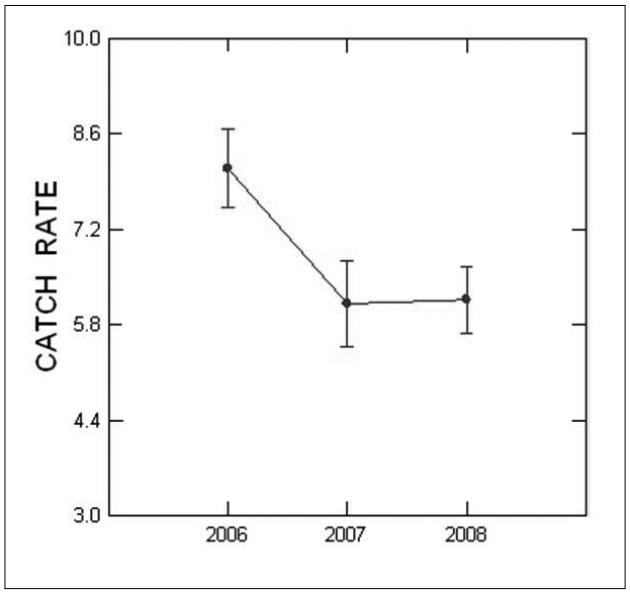

Fig. 2. Year wise catch rate of yellowfin tuna during 2006-08.

Effect of monsoon and lunar cycle on catch rate

Monthly catch rates were pooled according to season and analysed to find the effect of monsoon on catch rate (Fig. 3). The best aggregate catch rate was recorded during the pre monsoon period and the catch rates showed a reducing trend towards the post monsoon period.

Aggregate catch rates recorded during the new moon period, waxing & waning period and full moon period are shown in Fig.4. As shown in Fig. 4. aggregate catch rates of yellowfin tuna were more during waxing & waning days, followed by full moon period. Precisely, lower catch rates were observed during the new moon period.

Result of general linear model ANOVA is furnished in Table 2. As revealed from Table 2, there was a significant difference in the catch rates of yellowfin tuna recorded during the different phases of the moon. A similar trend was noticed in the case of catch rates recorded during different seasons of the year. Further the cumulative effect of season, year and lunar cycle also was found significant.

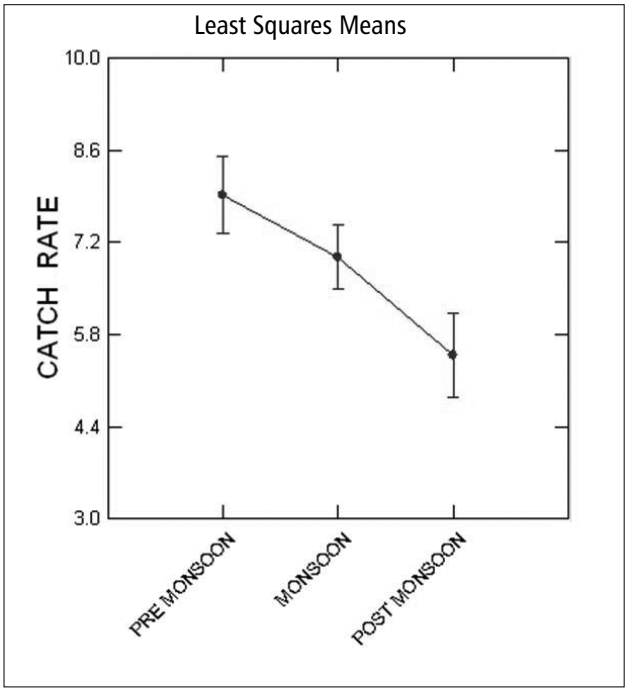

Fig. 3. Effect of Monsoon on catch rate yellowfin tuna

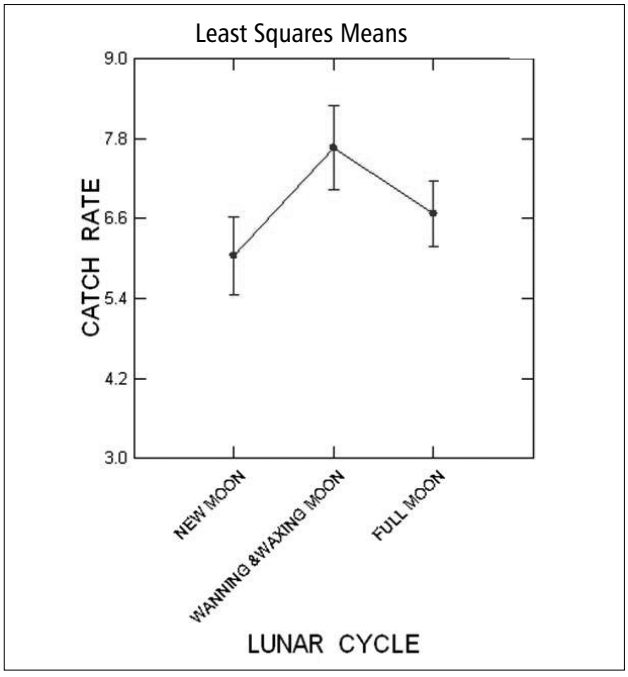

Fig. 4. Effect of lunar cycle on catch rate of Yellowfin Tuna

Turkey's honestly - Significance - Difference test of aggregate catch rates showed that the new moon catch rate was significantly different from the catch rate recorded during waxing and waning period (Table 3). But the differences in catch rates recorded during other two periods were not significant. Catch rate recorded during pre monsoon & post monsoon and monsoon & post monsoon were found

Table 2. Effect of monsoon and lunar cycle- general linear model analysis of variance

cource	Type III Sum of Square	Degrees of freedom	Mean square	F-Ratio	p- value
Year	15.771	2	7.885	24.337	0.003*
Season	15.736	2	7.868	24.283	0.003*
Lunar cycle	6.975	2	3.488	10.764	0.015*
Season*lunar cycle	33.547	4	8.387	25.885	0.002*
Year*season	150.749	4	37.687	116.318	0.000*
Year*lunar cycle	52.748	4	13.187	40.700	0.001*
Error	1.620	5	0.324		

* Significant at 5% level

Table 3. Turkey's honestly - significance - difference test of catch rates of lunar cycle, monsoon and year

Lunar cycle	Lunar cycle	Difference	p- value	95% confidence interval	
				Lower	Upper
New moon	Waning &waxing moon	-1.618	0.013*	-2.577	-0.660
New moon	Full moon	-0.630	0.177	-1.530	0.270
Waning &waxing moon	Full moon	0.988	0.054	0.055	1.922
Pre monsoon	Monsoon	0.945	0.053	0.045	1.845
Pre monsoon	Post monsoon	2.430	0.002*	1.472	3.389
Monsoon	Post monsoon	1.485	0.011*	0.552	2.419
2006	2007	1.984	0.006*	1.026	2.943
2006	2008	1.924	0.003*	1.024	2.824
2007	2008	-0.060	0.980	-0.993	0.873

• Significant at 5% level

significant, but the difference between pre monsoon and monsoon catch rate was not significant. Differences in catch rates recorded during the years 2006 & 2007 and 2006 & 2008 were found significant whereas there was no significant difference in the catch rates of the years 2007 and 2008.

Discussion

Catch rate in space and time

Yellowfin tuna is a major component of the oceanic fishery resources around A&N islands. The latitude-wise catch rates recorded during the study divulge that yellowfin tuna doesn't follow any significant distribution pattern in A&N waters. The highly migratory nature of the species may be the reason for this irregular distribution. An increased catch rate recorded from Andaman waters indicates the abundance of yellowfin tuna in the area. John and Somvanshi (2000) and John *et al.* (2005) also reported similar phenomena and hence the result of the present study is in agreement with their findings.

The year-wise aggregate catch rates recorded during the period showed a decreasing trend towards recent years. A similar trend was reported by John & Somvanshi, 2000; John *et al.*, 2005; Somvanshi *et al.* 2008 and Sajeevan & Rajashree, 2012. Above workers studied the tuna resources of A&N waters since 1989 and reported a declining trend in catch rate of yellowfin tuna during their study period. They also reported a reduction in the contribution of yellowfin tuna towards the total catch during recent years (Sajeevan and Rajashree, 2012). These reductions in catch rates and percentage of composition towards the total catch warrant an in-depth study on the status of yellowfin tuna stock of the Andaman Sea.

Effect of monsoon on catch rate

The results of the present study indicated that aggregate catch rates for yellowfin tuna were more during the pre monsoon period. A reduction in catch rates towards the post monsoon period was also recorded during the study. Statistical analysis too confirmed the significance of differences in catch rate. These findings establish the fact that the best season for yellowfin tuna around A&N Islands is the pre-monsoon period. John and Somvanshi (2000) and Somvanshi *et al.* (2008) reported that better hooking rates for yellowfin tuna were obtained during January. Above studies doesn't analysed seasonal abundance of tunas from Andaman and Nicobar waters. However, January being a pre monsoon period it can be inferred that the results of the present study is in agreement with John and Somvanshi (2000) John, (2005) and Somvanshi *et al.,* (2008).

Effect of lunar cycle on catch rate

The best catch rates for yellowfin tuna were recorded during waxing and waning period followed by full moon period and catch rates were comparatively poor during new moon days. Changes in the pattern of vertical migration of prey organism according to the lunar cycle may be the reason for the less catch rate during full moon and new moon period.

During the new moon period there will be abundance of natural food organisms in the surface layers hence yellow fin tuna may be feeding on them effectively and this may result in less attraction towards the bait fishes. Moreover yellow fin tuna depends on both surface and deeper organism as their prey (Allain, 2005) and hence changes in the abundance of surface prey may have little effect on the feeding intensity of the fish. Lowry *et al.* (2007) studied on the lunar effect on the catch rates of yellowfin tuna occurring in Australian waters and reported better catch rates during the first quarter of the moon which is in agreement with the present study.

An exhaustive search of literature indicated that except some preliminary mentioning by Mohan and Kunhikoya (1987) and Libini and Khan (2012), not much studies have been carried out to understand the effect of the lunar cycle on tunas, tuna like

fishes and other large pelagics in Indian waters. The present study points to the significant effect of the lunar cycle on the catch rate of yellowfin tuna occurring in Indian waters.

The present study also indicate the abundance of yellowfin tuna in Andaman waters and provided information on distribution pattern of fish in time and space. Better hooking rates recorded during the waxing and waning periods indicated that lunar cycle play a significant role in the catch rate of yellowfin tuna. Meantime results suggest that pre monsoon plays a significant role in the hooking rates. The results of the present study may lead to formulate an exploitation strategy aimed at a viable and sustainable yellowfin tuna fishery.

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