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Seasonal Abundance of the Tropical Tunas around Fish Aggregating Devices anchored off the Coast of Mauritius (2010-2012)

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ABSTRACT

Catch rates of the pelagic species around the Fish Aggregating Devices (aFADs) anchored off the Western coast of Mauritius show that the seasonal variation of the sea surface temperature (SST) has a significant influence on the abundance of the tropical tuna.

The results of the study carried out over the period 2010 to 2012 suggest that the season of relative abundance for the skipjack tuna (Katsuwonus pelamis) is more pronounced during the summer months when SST is higher. The study on the other hand indicates that the yellow fin tuna (Thunnus albacares) prefers the cooler waters which prevail both at start of winter and at the outset of the summer season. The broad annual migration of the yellow fin and skipjack tunas around the anchored FADs is noticeably associated with the annual SST cycle. The results also indicated a marked scarcity in the presence of the big eye tuna (Thunnus obesus) in the landings of the artisanal FAD fishery.

In contrast, data on landings from the licensed industrial foreign long liners operating mostly in the EEZ of Mauritius illustrate that both the yellow fin and the skipjack tunas abound during the summer season. In addition, the landings of the semi-industrial local fleet (long liners <24m) primarily targeting swordfish in Mauritius waters included the big eye tuna (mostly caught in the winter season) and the yellow fin tuna (all year round).

This paper highlights the results based on the analyses on the fish catch data collected from the professional artisanal fishermen operating around FADs off the Western coast of Mauritius with discussion on the relation between effort, SST and the seasonal abundance of the tropical yellow fin and skipjack tuna.

Keywords: anchored FADs, pelagic fish, sea surface temperature, tropical tuna

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INTRODUCTION

The island of the Republic of Mauritius located in the South West Indian Ocean *(Latitudes 19°58.8' and 20°31.7' South and Longitudes 57°18.0' and 57°46.5' East)* is endowed with an Exclusive Economic Zone (EEZ) extending over more than 2 million square kilometres.

Presently, there is no local industrial fishing fleet operating for the exploitation of the tuna stocks in the waters of Mauritius except for a tiny fleet of semi-industrial local long-liners with boats (less than 24m) targeting swordfish and an artisanal off-lagoon Fish Aggregating Device (FAD) pelagic fishery off the coast around the island. The last landing of tuna exploited by local purse seiners dates back to more than fifteen years.

During the Fourteenth Session of the IOTC Working Party on Tropical Tunas held in Mauritius in October 2012, it was reported that Mauritius was envisaging the building up of a fishing fleet comprising four industrial tuna purse seiners to operate within the IOTC area of competence. In August 2013, one local purse seiner was registered and would embark on fishing expeditions by end of the year while a second one is expected to be registered and start operation as from 2014.

The exploitation of tuna and tuna-like species in Mauritius waters is, at the moment, mostly carried out by licensed foreign long liners and purse seiners, which fish in the EEZ of Mauritius and outside in the South West Indian Ocean. Foreign flagged vessels licensed to operate in the waters of Mauritius have to comply with the regional and international conservation and management measures and are required to land their catch in Mauritius. As a result, the tuna and tuna-like species which are landed/transshipped by the licensed foreign flagged vessels do not give a factual reflection of the tuna resources in the EEZ of Mauritius.

The Port-Louis harbour in Mauritius also serves as a platform for transshipment for unlicensed foreign long liners (EU and other flags). Around 40,000 metric tons (t) of tuna and tuna-like species were transshipped by the licensed and unlicensed foreign long liners in 2012.

Transshipment at sea is not allowed in the Mauritian EEZ according to national legislations.

TUNA FISHERY IN MAURITIUS

Licensed foreign flagged purse seiners

Licenses are issued mainly to European and Seychelles purse seiners to fish in the waters of Mauritius and their fishing zones were mostly distributed between latitudes 01º S- 20º S and 43º E - 66º E mostly outside the Mauritian waters. The yellow fin tuna *(Thunnus albacares)* was the main species landed followed by the skipjack *(Katsuwonus pelamis)* and big eye tuna *(Thunnus obesus).* The total landings amounted to around 10,800 t in 2010 to increase by more than twofold to some 22,000 t in 2011 and then to fall back to about 14,100 t in 2012.

Licensed foreign long liners

The industrial long line fishery is carried out by foreign fishing fleets mostly from countries of the Eastern and South Eastern Asia and an average of 120 licenses are issued yearly. The main fishing zones were located between latitudes 02º N - 27º S and longitudes 50º E - 87º E with most of the effort being distributed between latitudes 10º S - 19º S and longitudes 55º E - 64º E in the EEZ of Mauritius. Species landed/transshipped comprised mainly albacore with a lesser amount of yellow fin tuna and big eye tuna. Around 7,660 t were landed 2010 falling to around 6,000 t in 2011 and then declining by almost 40% to about 3,650 t in 2012.

National semi-industrial long liners

Three local boats (less than 24m) targeting swordfish are in operation in the local semi-industrial long-line fishery landing some tropical tunas. The main fishing zones lied between latitudes 15° - 19° S and longitudes 56° - 60° E in the Mauritius EEZ. Landings for 2011 amounted to about 90 t which declined by around 60% in 2012 to about 36 t. More than 50% of the catch consisted of swordfish while that of the yellow fin tuna comprised about 20%, the big eye tuna around 15% and the albacore tuna (*Thunnus alalunga*) about 10%.

ARTISANAL FISH AGGREGATING DEVICE (FAD) FISHERY

The local artisanal FAD fishery which involves fishing of pelagic species around anchored FADs (aFADs) deployed along the coast of Mauritius is practiced both by the recreational/sports anglers and local professional artisanal fishermen (RP-Fishermen). The total annual catch is estimated to be around 1000 t and the main species caught are the albacore tuna, the yellow fin tuna and skipjack tuna while the tropical big eye tuna was rare. Other species include the dolphin fish , wahoo, marlin, sailfish and sharks.

The analyses of the data on fish caught around aFADs provide valuable scientific information on the seasonal migration of the tropical tunas and other pelagic fish thriving off the coastal waters around Mauritius. Though, the data available were only those collected from the RP-Fishermen along the coasts of the island, the results indicate trends which are comparable if not similar to those observed in the Mauritius EEZ and the high seas in the region.

There is definite evidence of seasonal peak in abundance occurring during specific periods of the year for each species. However, as to how far the data can be related upon to attributing the migrating patterns and the abundance of a particular species in a particular region is debatable and would unquestionably require in-depth investigation.

Background and Importance

Aggregation of pelagic fish under floating debris is a known fact to fishermen and the phenomenon has led to the further development of a fish aggregating device associated fishery by many coastal countries.

In Mauritius, the declining fish landings from the artisanal fishing sector and the increasing fishing pressure on the lagoon stocks have led to the development of an off-shore artisanal FAD fishery to divert fishing effort away from the lagoon or from traditional fishing grounds to the outer/off-lagoon areas and to increase supply of fish on the local market . The artisanal FAD fishery offers several advantages in: increasing availability of fish, reducing scouting time thus reducing costs, increasing safety at sea, diversifying artisanal fishery, decreasing pressure on exploited fish resources and targeting pelagic stocks.

In 1985, the FAD fishery were introduced in Mauritius through an UNDP/FAO project with the objective to design an aFAD model suitable to the local conditions with appropriate fishing techniques, to promote artisanal fishing around FADs and empower fishermen. Presently, the artisanal FAD fishery has been well established in Mauritius and the catch per fisherman day (CPFD) around aFADs, has been observed to be much higher than that in the lagoon

The FAD fishery has acquired relative importance over the past years in the South West Indian Ocean with the implementation of the SWFIOP programme under the World Bank. A project was launched whereby aFADs were deployed along the coastal areas of some SWIOFP member states during 2009 to 2012. Besides, a fish tagging programme (2010-2013) for collection of data utilising acoustic telemetry for the remote tracking of tagged fish around aFADs to study their behaviour was also developed under the SWIOFP with the assistance of Institut de Recherche pour le Développment (IRD-France) for countries in the South Western Indian Ocean.

Development of the artisanal FAD fishery

In Mauritius, an aFAD is composed of 70 resistant plastic floats mounted in two rows in form of a rosary bearing a mast with a radar reflector and a flag, for easy detection, at the upper end. At the lower end the floats are anchored to the seabed by a mooring rope and a system of anchors consisting of scrap iron or concrete weights. As the aFADs are constantly under the action of waves, currents and other physical stress at sea and prone to wear and tear, they have to be regularly maintained, repaired and replaced whenever lost. The average lifetime of an aFAD has been estimated to be around 500 days.

Location of aFADs

The aFADs are set at a distance ranging from 2 up to 12 nautical miles from the coast in the open sea and are anchored at depths varying from 800 to 3000m. The mooring site is determined by the proximity of fishing villages, need of the RP-Fishermen, navigational access, general sea conditions in the region, bathymetry and water current patterns and occurrence of pelagic fish in the area. Presently, 28 aFADs are active around Mauritius and most of them are deployed in the Western coast as shown in Fig. 1.

Fig. 1 Location of anchored FADs around Mauritius

Fishing around aFADs

Fishing around FADs is carried out by RP-Fishermen, local amateurs, dedicated tourists and sports anglers on board pirogues and sports fishing boats. The RP-Fishermen usually three to make a fishing team sail from the shore in the early morning to reach the aFAD by sunrise on board pirogues (small boats 6-7m) propelled by 15-horsepower outboard motor. The navigation time from shore to the fishing area may extend to a maximum of 2 hours. The team will usually fish around the aFAD for some time and may move to another one depending on the catch. The average time spent fishing at sea by the RP-Fishermen may vary from 4 to 12 hours depending on the season, sea conditions and availability of fish

The fishing techniques generally practised around aFADs are: trolling with artificial bait, slow trolling with live bait, hand lining, horizontal long lining, vertical long lining, drift line (yowka).

MATERIALS AND METHODS

Study area – West coast

The artisanal FAD fishery carried out around the aFADs mostly involve those deployed along the Western coast of Mauritius due to the coastal structure of the island - narrow lagoons in the West and broader ones in the East and North and practically none in the South. In addition, the Western off-lagoon areas are more accessible, as being in the leeward side from the influence of the trade winds, they harbour a relatively calm sea and weaker currents which is safer for navigation. Out of the 28 aFADs deployed around the island, 21 aFADs are set off the Western coast while 5 are located in the East and 2 in the South (refer Fig. 1).

Data collection, methodology & processing

According to the existing national legislation registered fishermen (RP-Fishermen) operating in any of the artisanal fishery are required to land their catch at one of the 60 fish landing stations (FLS) prescribed under the national Fisheries Marine and Resources Act. Collection of data on fish landings are effected by enumerators posted at different FLS.

As the lagoon/off-lagoon artisanal fishery in Mauritius is an open access fishery, the sports and other recreational/amateur fishers (who are not currently registered) are not compelled to land at the FLS and thus their catches are not captured and are based on estimates. As a result, the study was focused on the catch from the RP-Fishermen operating around the aFADs.

The stratification method which reduces the error in sample estimates by systematically removing as much as possible data variability through sample design was adopted and the 60 FLS were divided into 2 strata. Stratum No 1 incorporated all those FLS which were reported to have higher catches and there were nine (9) of them all located in the Western coast while Stratum 2 comprised the remaining 51 FLS which registered lower catches and were scattered all around the island. The selection of sampling station (FLS) in both strata was done on a monthly basis by random sampling with selection probabilities proportional to size using the Cumulative Total Method. The method consisted of associating a FLS from each of the stratum with a range of numbers (cumulative total of average annual catch or cumulative total of number RP-Fishermen operating around FADs) and selecting a number at random using the Table of Random Numbers. A total of 16 FLS comprising 4 from one stratum and 12 from another stratum were surveyed each month. Data were collected by four enumerators at the selected FLS and recorded according to a pre -designed sheet - the "Daily Catch Survey Form" for the period 2010, 2011 and 2012. The data collected included boat registration, number RP-Fishermen, aFAD No, fishing mode, departure/arrival, daily landings of fish and species, effort and other associated information. The records were verified, validated, coded and input before being processed and analysed using the Statistical Package for Social Sciences (SPSS) software.

Sea surface temperature

Mean sea surface temperatures (SST) for waters around Mauritius for year 2010 - 2012 were acquired from the Mauritius Meteorological Services. The least mean SST recorded was 23.7 ^{0}C while the highest was 29.1 ^{0}C over the period under study as shown in Table 1.

Table 1 Mean sea surface temperature (degrees Celsius) around Mauritius 2010-2012

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Average
2010	28.2	29.0	28.6	28.6	27.7	26.0	25.0	24.7	24.0	25.0	26.2	27.2	26.7
2011	28.2	28.2	28.6	28.1	27.0	26.1	24.0	24.1	24.0	24.8	26.7	27.4	26.4
2012	28.5	29.1	28.1	28.7	26.6	25.4	24.5	23.9	23.7	24.4	25.3	26.7	26.2

Source : Mauritius Meteorological Services

ANALYSIS AND RESULTS

The arguments in this paper are based on the results of the analyses effected on the fish catch data collected from the RP-Fishermen operating along the Western coast where most of the

aFADs are deployed for period 2010 to 2012 in determining the seasonal variation in abundance of the tropical tunas around the aFADs off the Western coast of Mauritius.

Landings

The total annual landings recorded were around 330 t in 2010, to drop to about 250 t for both 2011 and 2012. The albacore tuna comprised around 60% of the catch followed by the tropical yellow fin tuna which accounted for about 30% and the skipjack tuna with about 5%.(Table 2).

Table 2 Total landing of pelagic fish (t) from artisanal FAD fishery

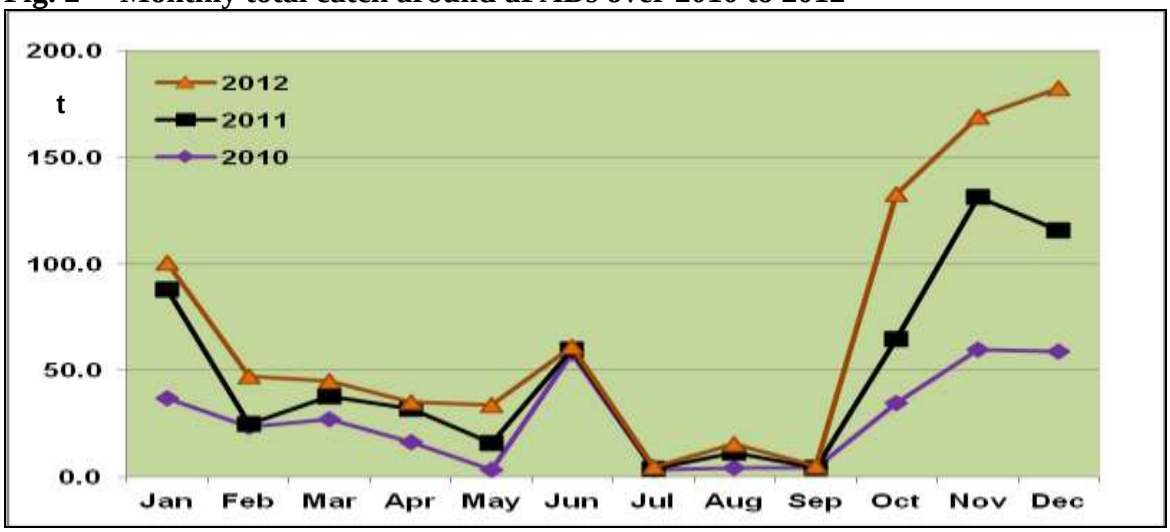
Year	Albacore	Yellow Fin	Skipjack	Other species	Total
2010	190.7	118.5	15.6	5.8	330.6
2011	147.5	80.1	9.8	21.4	258.8
2012	162.1	49.7	18.9	12.3	243.0

Monthly total catch around aFADs over 2010 to 2012

The monthly total catch (including all species) around the aFADs as shown in Fig. 2 indicate that the landings generally followed a similar trend for the years 2010 - 2012.

Maximum abundance in catches for all the pelagic species occurred at the outset of summer when the waters began to warm up as from October through January with peak catches recorded in November and December. The season of lowest abundance for all the pelagic species lied in the winter months of July, August and September when the mean SST was lowest.

Fig. 2 Monthly total catch around aFADs over 2010 to 2012

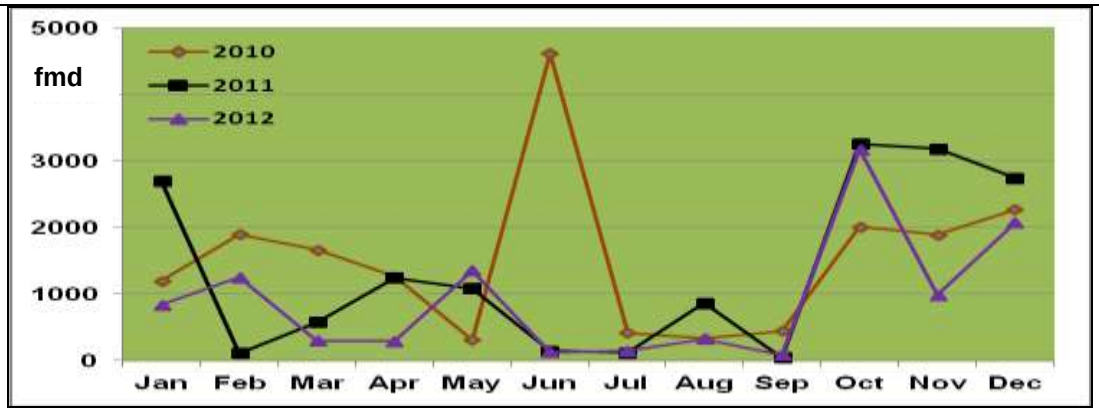


Fishing Effort

The fishing effort expressed as fisherman-days (fmd) varied with the number of active RP-Fishermen, number of actual fishing days considering the bad weather days and the time spent at sea around aFADs. The annual fishing effort which was around 18,400 fmd in 2010 declined to about 16,100 fmd in 2011 to further plummet to some 11,000 fmd in 2012. The fishing effort was more intense in the summer months .

It is to be noted that a high peak in the fishing effort was observed in June 2010 (winter) which corroborated with a high total catch of around 60 t for that month as expected as shown in Fig. 3.

Fig. 3 Monthly total fishing effort around aFADs over 2010 to 2012



The CPUE (CPFD) varied form 18.0 kg in 2010 to 16.0 kg in 2011 and then up to 22.1 kg in 2012. Annual number of bad weather days recorded over the period 2010, 2011 and 2012 were 130, 106 and 124 days respectively and had had no effect on the dwindling fishing effort. The sharp decrease in the fishing effort in 2012 seemed to have not impacted on the total catch as expected as the landings in 2011 and 2012 were practically the same as shown in Table 3.

Table 3 Total catch, fishing effort, bad weather days and CPUE/CPFD (2010-2012)

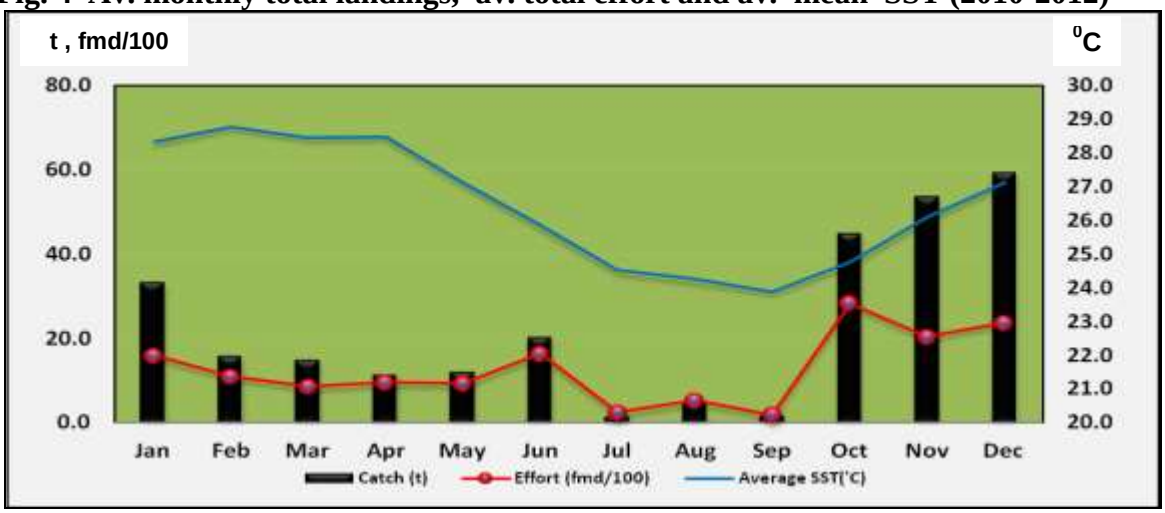
Year	Total Catch (t)	Fishing Effort (fmd)	Bad Weather (days)	Average Annual CPUE/CPFD (kg)
2010	330,6	18363	130	18.0
2011	249.2	16115	106	16.0
2012	243.0	10977	124	22.1

Average monthly total landings, average total fishing effort and average mean SST over 2010-2012

The average monthly total landings (including all pelagic species) over period 2010-2012 indicated that highest catches were recorded during the warmer season in summer as from October to peak in December when average mean SST started to rise and the average fishing effort was more intensive as illustrated in Fig 4.

On the other hand, the season of minimal abundance of the pelagic fish around aFADs, for period 2010-2012, was found to be from July to September when the average mean SST was at its lowest, and when the average fishing effort had also considerably declined.

Fig. 4 Av. monthly total landings, av. total effort and av. mean SST (2010-2012)

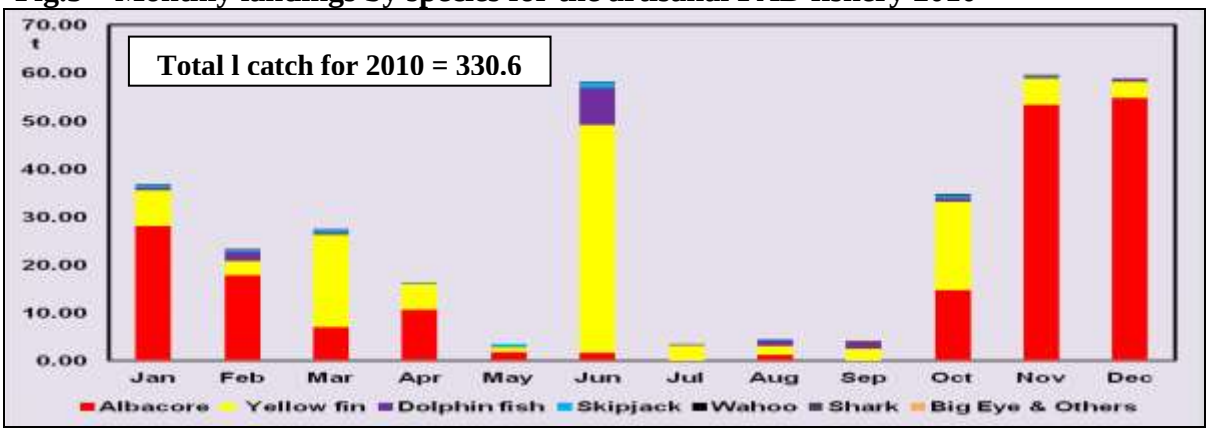


Catch analysis of all species (2010-2012)

Monthly landings all species for the artisanal FAD fishery –2010

Variation in the presence the pelagic species around the aFADs during 2010, indicated peaks of abundance corresponding to June (winter) and November/December (summer) with landings of around 60 t for each of these months. The lowest annual catches were recorded in May, July, August and September during the winter season. The main species landed were the albacore tuna with a total landing of some 190 t (about 57% of the total annual catch) followed by the yellow fin tuna with a total landing amounting to about 120 t (about 36%) and the skipjack tuna with some 16 t (around 5%). The yellow fin tuna was most abundant in June (winter) with about 50 t or 80% of the monthly catch recorded for that month. Significant landings of yellow fin tuna were also observed in March and October with catches amounting to around 20 t in each month. The skipjack tuna was also most abounding in June (winter). Some big eye tuna were landed in November in summer as illustrated in Fig. 5

Fig.5 Monthly landings by species for the artisanal FAD fishery 2010



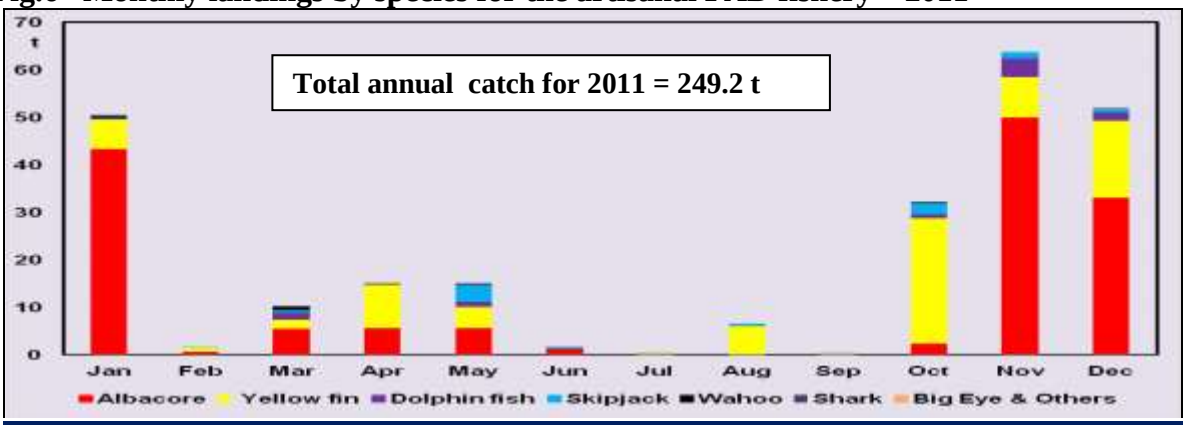
Monthly landings all species for the artisanal FAD fishery –2011

Peak landings were observed during summer season in November with nearly 25% of the annual catch (about 64 t), in December and January with around 20% (around 52 t) each in 2011. Lowest landings were recorded in July (0.5 t) and in September with only about 0.2 t.

The albacore tuna comprised around 60% (some 148 t) of the catch while the yellow fin tuna around 32% (about 80 t) whereas the tropical skipjack tuna constituted only about 4%. Approximately 3.7% of the catch included dolphin fish while the remaining catch (around 1%) was made up of wahoo and sharks. No catch of for the big eye tuna was recorded.

Landings of the yellow fin tuna were relatively high in October and December and at the outset of winter in April. Maximum landings of the skipjack tuna were recorded in May (around 3.4 t) and in October (about 2.4 t) as shown in Fig. 6

Fig.6 Monthly landings by species for the artisanal FAD fishery – 2011

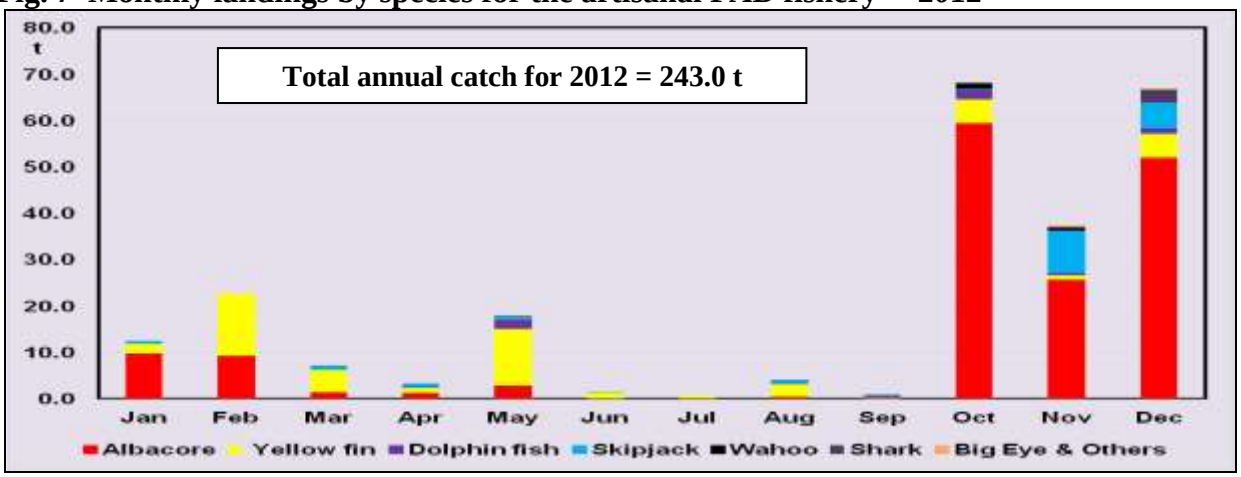


Monthly landings all species for the artisanal FAD fishery –2012

Total maximum landings for 2012 were noted in each October and December corresponding to around 28% (about 68 t) of the annual catch. Lowest catches were observed in June, July and

September (winter season).The total landings of some 250 t consisted largely of albacore tuna (around 67% or 162 t) while the yellow fin tuna contributed to about 21% (around 50 t) and the skipjack tuna accounted for around 8% (about 19 t). Dolphin fish comprised around 2.7% of the total annual catch , wahoo and sharks constituted about 2% and a low amount of the big eye tuna (less than 0.4%) was recorded. Maximum catches of the yellow fin tuna were recorded in February and May (winter) with around 13 t and 12 t respectively (around 60% of the total annual yellow fin tuna catch). The lowest catch of the yellow fin tuna was noted in September.
Skipjack tuna landings were higher compared to 2010 and 2011 attaining approximately 19 t with a maximum catch of around 10 t recorded in November. A significant amount of the skipjack tuna was also caught in December as depicted in Fig. 7.

Fig. 7 Monthly landings by species for the artisanal FAD fishery – 2012

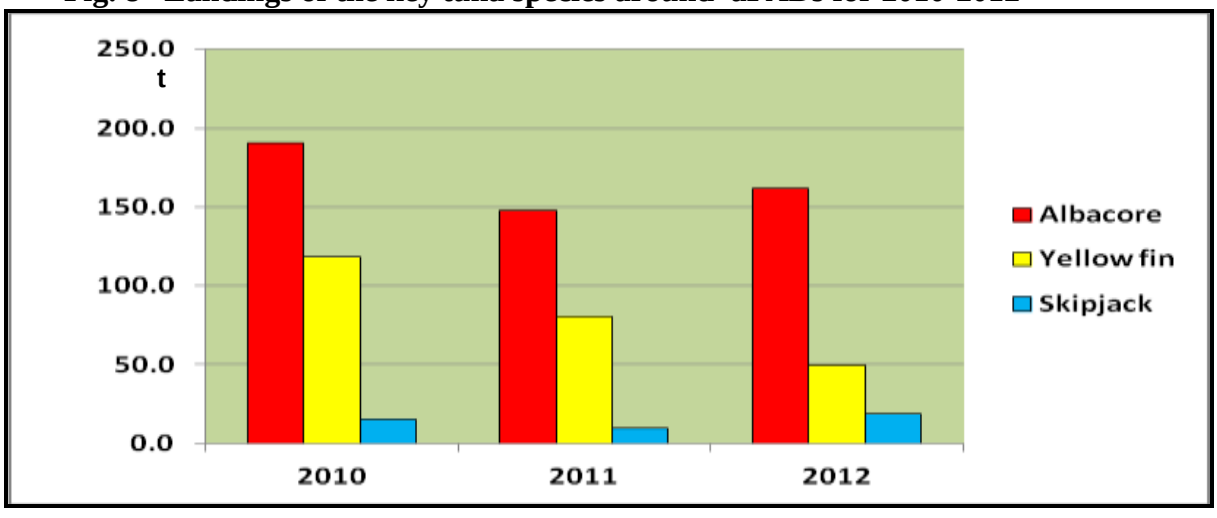


Tuna catch analysis (2010-2012)

Total landings of all the tuna species for the artisanal FAD fishery (2010-2012)

The landings of the key species of tuna in the artisanal FAD fishery over 2010 to 2012 showed that the catch comprised mainly the albacore tuna followed by the tropical tunas yellow fin and the skipjack. The occurrence of the big eye tuna was scarce around the aFADs (Fig. 8)

Fig. 8 Landings of the key tuna species around aFADs for 2010-2012



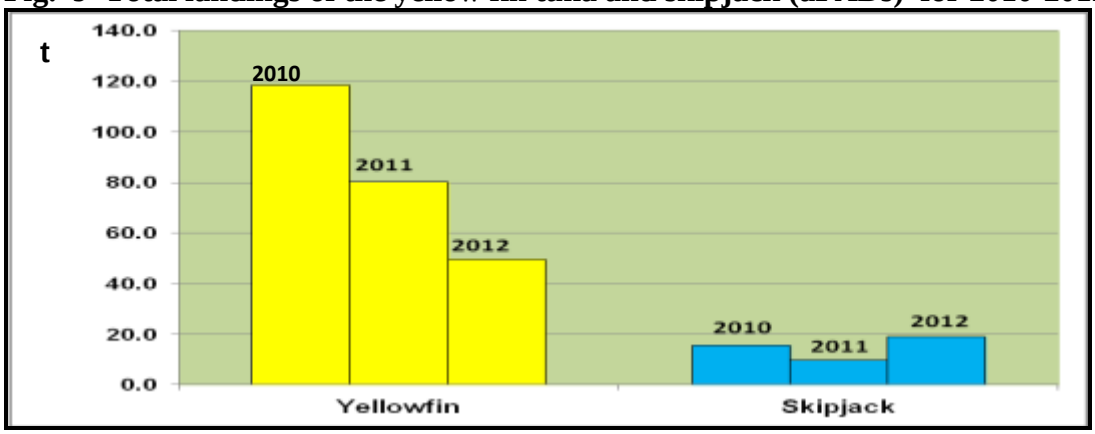
Total landings of yellow fin tuna and skipjack for the artisanal FAD fishery (2010-2012)

Results of analyses showed that the overall catch of the tropical yellow fin tuna has gradually been decreasing from around 120 t in 2010 to about 80 t in 2011 and to around 50t in 2012. The

total annual landings of the skipjack tuna which was around 15.6 t in 2010 fell down to about 9.8 t in 2011 and to shoot up sharply by nearly 100% to some 19 t in 2012.

If the catch of yellow fin tuna has shown a steady decline over the three years under study, it is not the case for the tropical skipjack tuna(nor for the albacore tuna) as illustrated in Fig. 9.

Fig. 9 Total landings of the yellow fin tuna and skipjack (aFADs) for 2010-2012

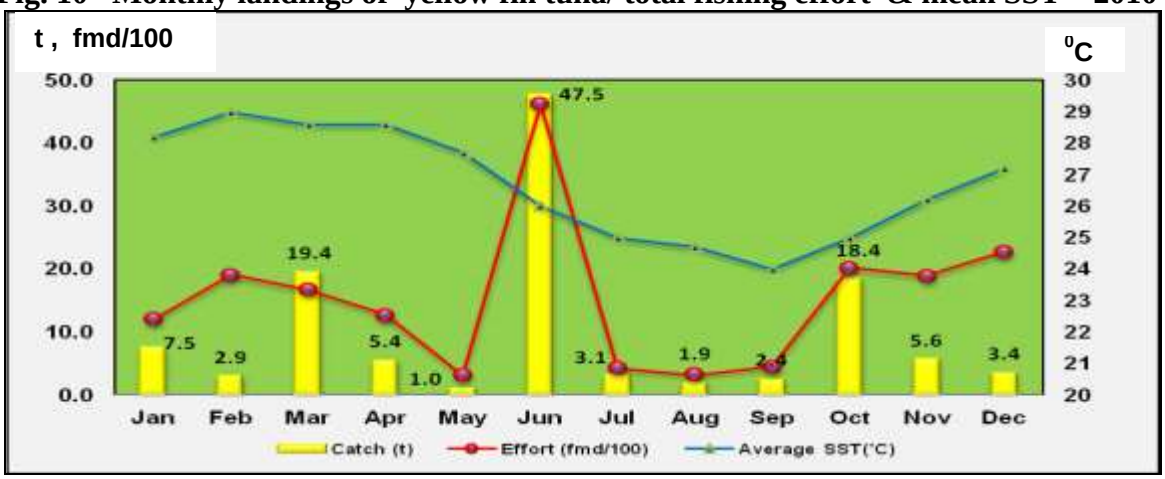


SEASONAL ABUNDANCE OF THE YELLOW FIN TUNA AROUND AFADS

Monthly landings of yellow fin tuna (aFADs) – 2010

In 2010, the catch of the yellow fin tuna was highest in June (winter) with landing amounting to 47.5 t when maximum effort was deployed and mean SST around 26^0 C. Two lesser peaks of abundance were observed in March and October when the catch was around 19 t. Low catches were recorded in February, July, August and September and the minimum catch was recorded in May when the mean SST was around 28^0C as depicted in Fig. 10.

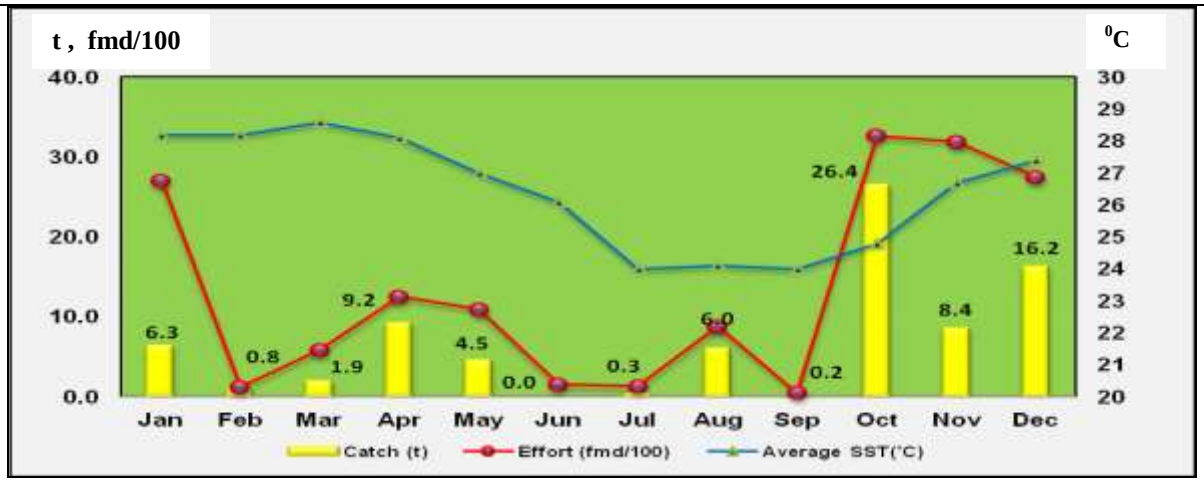
Fig. 10 Monthly landings of yellow fin tuna/ total fishing effort & mean SST – 2010



Monthly landing yellow fin tuna (aFADs) – 2011

The peak abundance of the yellow fin tuna during 2011 fell in the months of October and December with catches amounting to some 26 t and around 16 t respectively and when the mean SST varied between 24.5^0 C and 27.5^0 C. The maximum catch was reflected by the fishing effort which was also highest during this period. Very low catch was noted during the winter season in July and September with no catch observed in June. The fishing effort was lowest in February, June, July and September (Fig. 11).

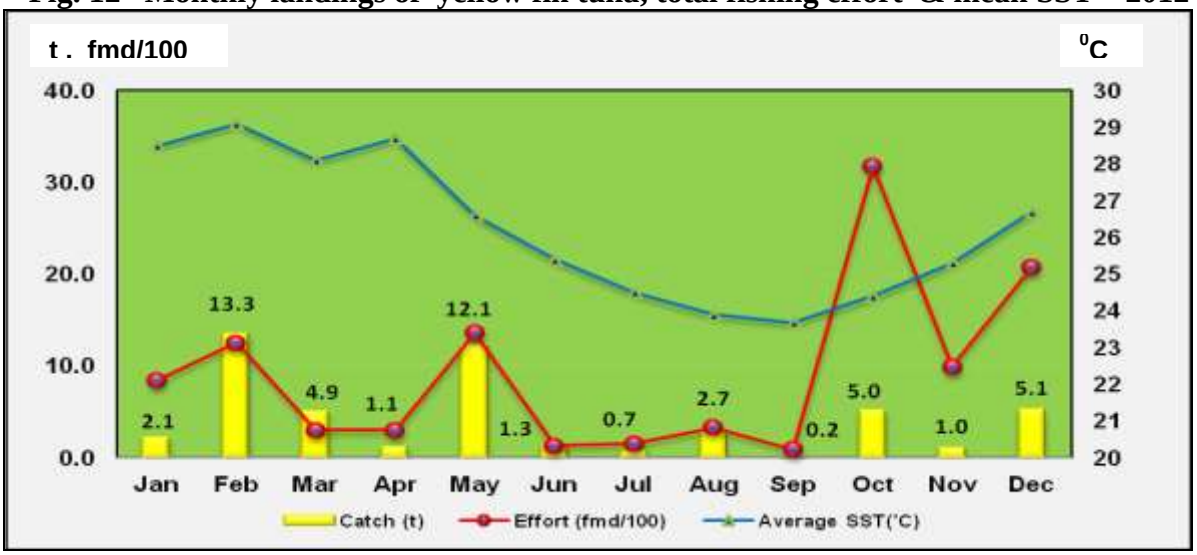
Fig. 11 Monthly landings of yellow fin tuna, total fishing effort & mean SST – 2011



Monthly landings of yellow fin tuna (aFADs) – 2012

During 2012 two peaks of abundance for the yellow fin tuna were detected namely in February with around 13.5 t when the mean SST was around 29^0 C and in May (SST about 27^0 C) with about 12 t. As from June with the decrease in the SST, a decline in both the catch and effort was observed. Lowest catch was recorded in September when the SST was less than 24^0 C and effort were also at minimum. With the rise of the SST as from October, the catch rose mildly whereas fishing effort reached its maximum. The highest peaks of abundance for the yellow fin tuna were observed during the summer and at the outset of winter as represented in Fig. 12.

Fig. 12 Monthly landings of yellow fin tuna, total fishing effort & mean SST – 2012

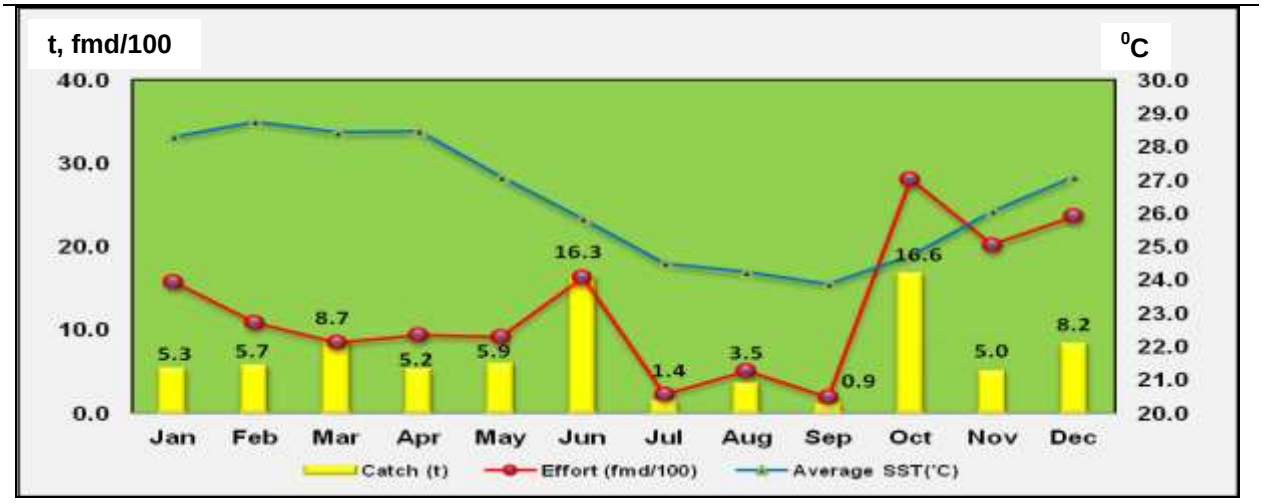


Average monthly landings of yellow fin tuna (aFADs) over period 2010 – 2012

Fig. 13 illustrates the average monthly landings of the tropical yellow fin tuna over the whole period 2010 to 2012. Two peaks of maximum abundance for the species were observed during June and October when the fishing efforts were maximum and the water temperature low with average mean SST around 25^0 C. Least abundance in their presence was in July and September when fishing effort was least and the SST was around 24^0 C.

The average peak season of abundance for the yellow fin tuna during 2010 to 2012 occurred at the start of winter and outset of summer when the mean SST was in the range of 25^0 C.

Fig. 13 Average monthly landings (2010 to 2012) of yellow fin tuna, average total fishing effort &average mean SST



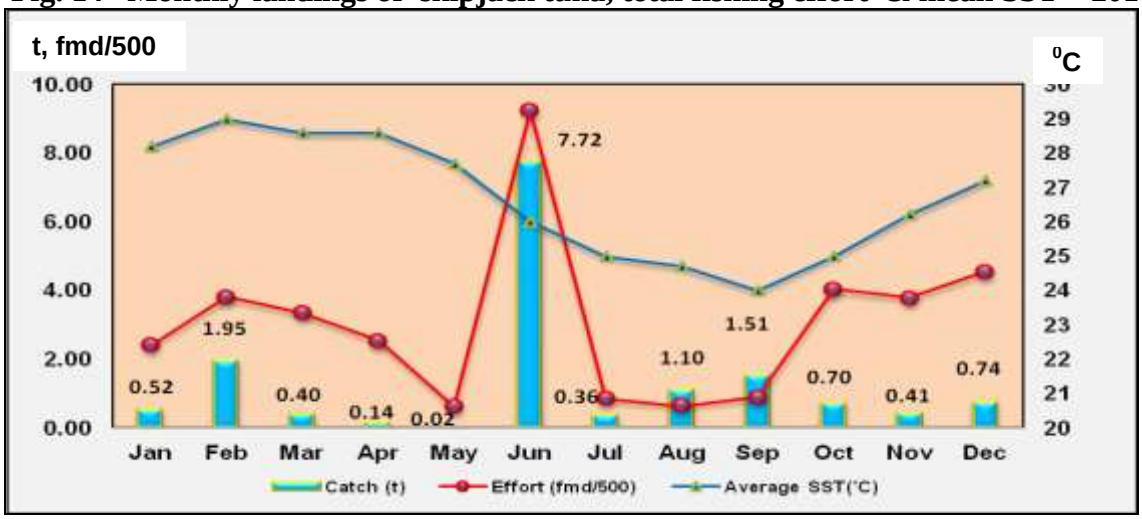
SEASONAL ABUNDANCE OF THE SKIPJACK TUNA AROUND AFADSS

Monthly landings of skipjack tuna (aFADs) – 2010

The general trend in the occurrence of the skipjack tuna around aFADs showed rather low presence of the species throughout 2010 except during the month of June, in winter (SST around 26^0 C), when a significantly high landing with a catch of some 7.7 t was recorded and when the total fishing effort was at its maximum for the year .

Lesser peaks of abundances were noted with one corresponding to a maximum mean SST of about 29^0 C in February (summer) and another one in September (winter) when mean SST was minimum - 24.0^0 C. Sparse landings were recorded in March, April, July and November with the minimum landing observed in May (winter) as depicted in Fig. 14.

Fig. 14 Monthly landings of skipjack tuna, total fishing effort & mean SST – 2010



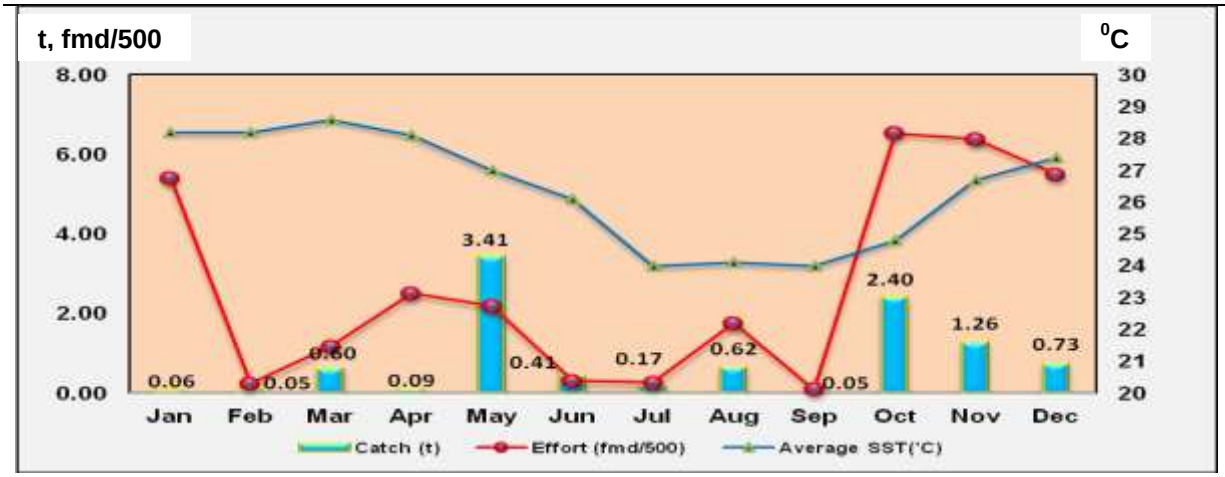
Monthly landings of skipjack tuna (aFADs) – 2011

Total landings of the skipjack tuna amounted to less than 10 t in 2011 showing a sharp decrease by about 50% as compared to that of the 2010 and 2012.

Two distinct peaks of abundance for the species were detected namely in May (start of winter) when SST was about 27^0 C and in October (winter) when a fairly low SST of 24.8^0 C prevailed. Lowest catches were noted in January, February and April in summer when the water around the aFADs was warmest and in July and September it was coolest.

Peak seasonal abundance of the skipjack tuna for 2011 occurred at milder temperatures when the SST ranged between 25 ^{0}C and 27 ^{0}C as shown in Fig. 15.

Fig. 15 Monthly landings of skipjack tuna, total fishing effort & mean SST – 2011

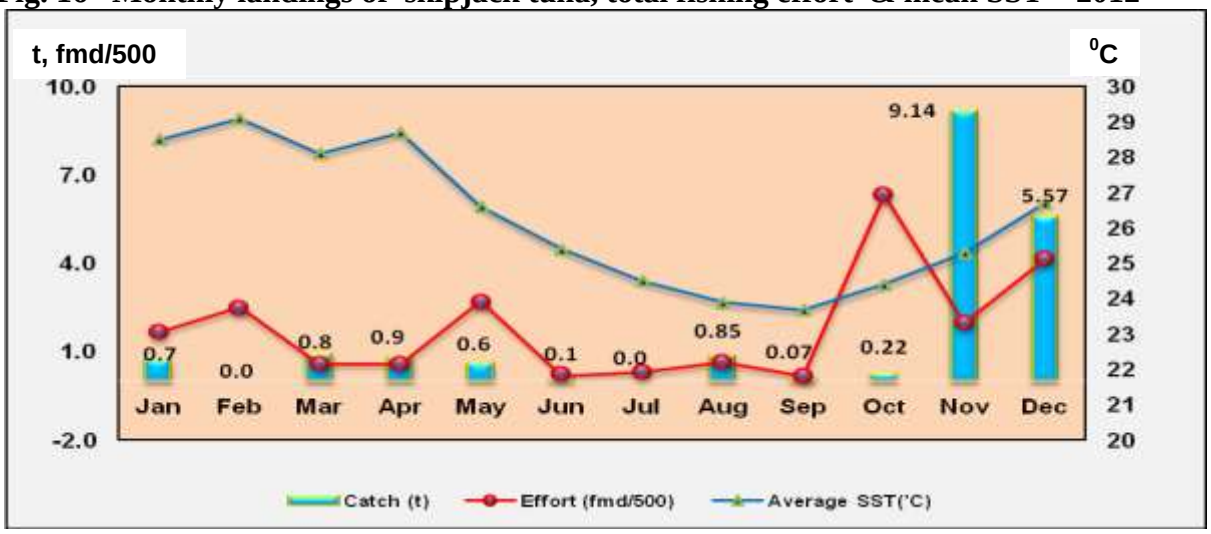


Monthly landings of skipjack tuna (aFADs) – 2012

The annual catch of the skipjack tuna saw a sharp increase attaining a total of around 19 t in 2012 with a distinct peak landing in November (around 50% of the annual catch). High landing of the skipjack tuna, was also noted in December (about 30% of the annual yield).

The catches of the skipjack tuna for the month of January through October were comparatively low with no catch recorded in February and July. The skipjack tuna thus started to abound around the aFADs as from the start of summer in October to peak in November when the mean water temperature started to rise as from around 25.5^0 C to about 26.5^0 C as shown in Fig. 16.

Fig. 16 Monthly landings of skipjack tuna, total fishing effort & mean SST – 2012

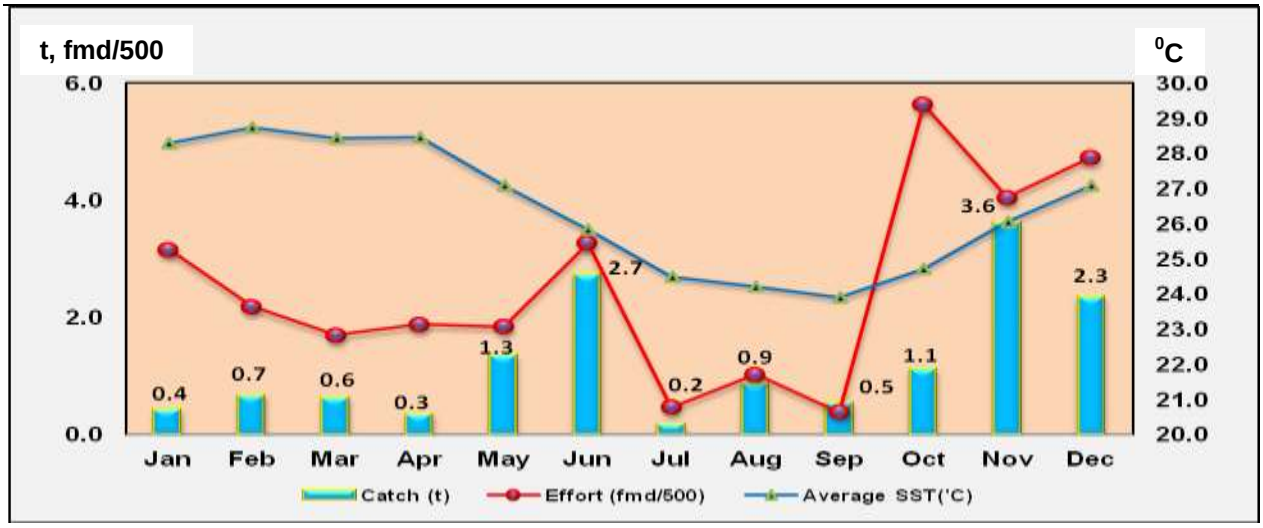


Average monthly landings of skipjack tuna (aFADs) for period 2010 – 2012

The average monthly landings of the skipjack tuna over the three years from 2010 to 2012 indicate maximum abundance in summer during November and moderate peaks in December and as well as in winter in June. Presence of the species was low during other months mainly from January to April and July to September.

The highest catches were recorded in June (winter) and November (summer) when during both of these months the average mean SST was around 26 ^{0} C. The results tend to infer that the season of maximum abundance of the skipjack tuna for period 2010 to 2012 was more closely influenced by the mean SST related to the annual seasonal variation as shown in Fig. 17.

Fig. 17 Av. monthly landings (2010 to 2012) skipjack tuna, Av. total effort & Av mean SST



COMPARATIVE SEASONAL ABUNDANCE OF THE SKIPJACK TUNA AND YELLOW FIN TUNA AROUND AFADS (2010-2012)

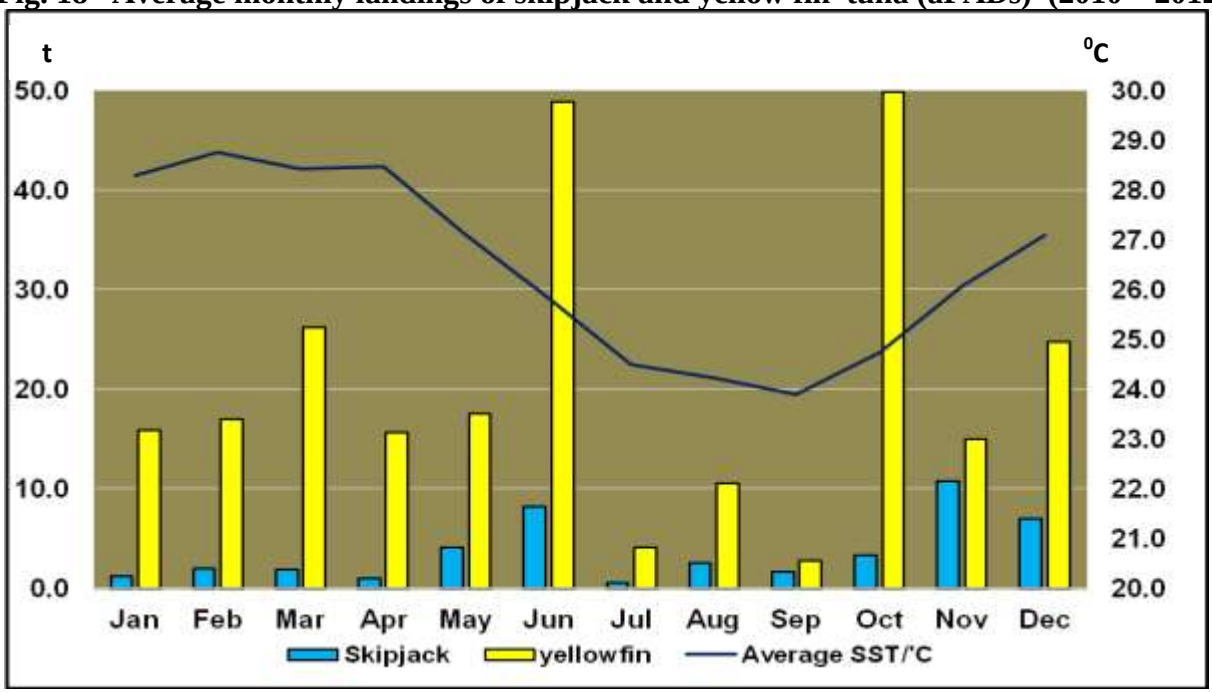
The average monthly landings of the skipjack tuna over period 2010-2012 were observed to be generally much lower than that of the yellow fin.

Peak abundance of yellow fin was noted when the mean SST was around 25^0 C which occurred twice annually namely at the outset of winter and beginning of summer and similarly that of the skipjack tuna was also observed both in winter and summer but when mean SST ranged from 25^0 C to 27^0 C. Minimum abundance of both the yellow fin tuna and skipjack tuna was detected in the winter season from July to September.

The presence of the yellow fin tuna was less significant though not very low during the summer months as from December to May and very low in mid- winter.

On the other hand, the abundance of the skipjack tuna unlike that of the yellow fin tuna was low during both the summer and winter months except during the particular months when the mean SST was around 26^0C illustrated in Fig.18.

Fig. 18 Average monthly landings of skipjack and yellow fin tuna (aFADs) (2010 – 2012)



CONCLUSIONS

The artisanal FAD fishery which involves fishing of pelagic species revolves around anchored FADs mostly deployed off the West the coast of Mauritius. Fishing which is practiced by the recreational, sports and artisanal fishermen occurs throughout the year.

The main species caught are the albacore tuna and the tropical yellow fin tuna and skipjack tuna.

The season of higher abundance of the pelagic fish (including all species) from the artisanal FAD fishery over period 2010-2012 corresponded to the period of the year when water temperature started to rise as from October to peak in December, during summer, when fishing effort was more intensive but not at its highest. The season of minimal abundance of pelagic fish (including all species) around aFADs lied from the months of June to September, in the winter, when the mean SST was at its lowest.

The landings of the key species of tuna in the FAD fishery over the study period showed that the catch comprised mainly the albacore tuna (around 60%) followed by the tropical tunas yellow fin (about 30%) and the skipjack tuna which made up some 5% of catch. The skipjack tuna was thus significantly less abundant as compared to the yellow fin tuna around the aFADs while the presence of the big eye tuna was observed to be scarce.

If the catch of yellow fin tuna has shown a steady decline over the three years, it is not the case for the albacore tuna nor for the tropical skipjack tuna.

Peak abundance of the yellow fin tuna was observed to be closely related to the temperature of the surrounding waters - at the start of winter and at the outset of summer when the mean SST was in the range of 25^0 C. Minimum abundance of the yellow fin tuna was noted in July and September in winter when the water temperature was at its lowest at around 24^0 C.

On the other hand, the period of highest abundance of the skipjack tuna was likewise observed to be more directly impacted by the water temperature around the aFADs. The season of peak abundance of the skipjack tuna was recorded when the mean SST was around 26 ^{0}C in June (winter) as well as in November (summer). Presence of the skipjack tuna, unlike that of the yellow fin, was low during other months of the year.

Both the yellow fin and skipjack tuna were thus observed to favour specific water temperatures which occurred both during winter and summer around the aFADs rather than the conditions prevailing during a particular season of the year.

REFERENCES

ROULLOT, J. et VENKATASAMI A., 1986 – Dispositif de concentration de piossons, L'experience Mauricienne – Expert consultation on the stock assessment of tunas in the Indian Ocean – Colombo, Sri Lanka, 4 – 8 December 1986, 20 p.

ROULLOT, J. et VENKATASAMI A. et S. SOONDRON, 1988 – The first three years experience in the use of fish aggregating devices in Mauritius – RAF/87/008/WP/55/90/E.

VENKATASAMI, A., 1990 – Introduction of Fish Aggregating Devices in the Southwest Indian Ocean. A case study.

VENKATASAMI, A., and MAMODE A. S., 1995 – Fish Aggregating Devices (FADs) as a tool to enhance production of artisanal fishermen problems and perspective.