Iran small-scale tuna longline fishery targeting yellowfin tuna *(Thunnus albacares)* in Oman Sea: A preliminary study

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Abstract

Longline fishery for yellowfin tuna in Iran EEZ was initiated in 1992 with an industrial Taiwanese style longliner owned by Iranian company. Artisanal longline fishery in Iranian EEZ in Oman Sea has been experienced in recent 3 years by local fisherman through the operation on trials and errors. So, this preliminary study is the first in which the information on the artisanal tuna longliners in Iran are observed in terms of gears and catch data. Data on technical parameters of the gear and fishing operation were provided by the logbooks distributed to the local fishermen, in which totally 359 line sets were available. In this paper, the features of artisanal longliner and the gear configuration are shown in details. Fishing ground is limited to the narrow area in EEZ waters, but it needs be confirmed by more data from the field. Average nominal CPUE were estimated to be at 104.6 fish/100 h and 2.36 fish/100 h for the target species, i.e. yellowfin tuna *(Thunnus albacares)*. This value in comparable to those of longline fisheries in Indian Ocean. CPUEs trend also revealed a clear trend by season, which has to be investigated further in future work. Catch composition in number showed that yellowfin tuna accounted for 79.7%, Common dolphinfish *(Coryphaena hippurus)* 10.2%, marline 3.2%, sea turtle 2.4%, ray fish 2%, sharks 0.1% and miscellaneous fishes 2.4% of the total catch. A comparison of length frequency of yellowfin tuna between longline and drift gillnet fishery was made, on which a significant difference was observed between the both fisheries; for gillnets, the size distribution varied between 37-170 cm with three dominant modes of 55cm, 85 cm and 133 cm and for longline, the length distribution ranged from 90-175 cm, peaking at one mode of 130 cm. The issue of feeding and spawning migration is discussed for the larger yellowfin tuna in EEZ waters.

Artisanal longline fish is still the first step in the process, and needs to be mechanized to the technical parameters of gears and equipment with the aim at improving the catch quantity and quality.

Introduction

Longline fishery experience in Iran EEZ dates back to 1995 which was operated with an industrial Taiwanese style, but owned by Iranian company known as Jahad Pozm (Talebzadeh, 1999). The longliner had a length overall (L_{OA}) of 55 m and holding capacity of 570 Mt for fish. The industrial longliner operation actively continued for two successive years in EEZ waters, and since then the fishing operation was done on occasion depending on the condition until 2002.
Due to the history of industrial fishing, local fishermen have always tried to use longline gear for exploiting tuna, namely targeting yellowfin tuna *(Thunnus albacares)*, in artisanal scale, and in 2015, the results of the fishing test have been successful in pilot level. By achieving such a good experience, the artisanal longlining has been used in a small numbers of fiberglass boats and wooded or FRP (Fiber-reinforced Plastic) dhows. The boats used are varied for the length overall (L_{OA}) of 5.5 to 7 m equipped with petrol engines of 48 to 55 hp. The L_{OA} for dhows ranged from 18 to 32 m which are operated by diesel engines of 240 to 850 hp.

The present longline fishing operation is normally multiday extending from 7 to 27 days for dhows and daily trip for boats. The longliners have a crew complement of 6 to 10 for dhows and 2 to 3 for boats. At present, combination fishing vessels viz., gillnet cum longline are used for yellowfin longlining, with seasonally changing the operation from gillnets to longline, and vice versa. Longliners are equipped with traditional hydraulic winches fitted on the starboard side of forward deck for both hauling and setting the line. The lines are operated during day time. As the vessel reaching the fishing ground, baits are attached to the gear and the lines are released from the winches on bow of the vessel which move forward.

Yellowfin tuna is of major commercial importance to the income of the local fishermen and the supply chain involved (Hosseini and Kaymaram, 2015).This species performs a rapid growth and high swimming ability, which allow them to track and feed on fast swimming epipelagic prey species, such as sardine or anchovies (Itano, 2000). In Iran, the catches of the species have been increased by 2.8 times from 2008 (19,482 t) to 2017 (56,121 t) (Anonymous, 2017). Yellowfin tuna is the second most important tuna species in Iran after longtail tuna (*Thunnus tonggol)*, accounting for an average of 24% of total six tuna species landings for the recent 3 years (Appendix 1). The other four tuna species being exploited include Skipjack (*Katsowonus pelamis),* Kawakawa (*Euthynnus affinis),* frigate tuna (*Auxis thazard*), and bigeye tuna (*Thunnus* obesus)
Four types of fishing gears are used for catching tuna; gillnets, purse seine, longline and trolling, with gillnets (drift gillnet type) is considered as the main fishing gear, contributing to around 93% of the total tuna landings on average for the recent 2 years (2016-2017). The longline operation by artisanal vessels has been expanded in recent 2 years, so that the catch of targeted species, i.e. yellowfin tuna, for the fishery increased from 5.760 t to 8,452 t in the respective years, although gillnets were also susceptible with increase in catches, but with less pronounced compared to the longline (Appendix 2). On average, gillents are responsible for the around 80% of the yellowfin tuna catches, followed by longline fishery (Appendix 3).

Since the introduction of tuna longline fishing to the artisanal fishery in the area, no report has been issued so far to clarify the characteristics of the gear deployed and its catch composition. This paper presents the technical features of the longline gear operated by the artisanal vessels

that target yellowfin tuna, incorporating recent catch-and-effort and length frequency data. It also discusses bycatch from the fishery, along with a comparison of length distribution of yellowfin tuna species caught by longline and gillnets deployed in Oman Sea.

Material and Methods

Information on technical characteristics of the gear, operation, catch and effort and catch composition were collected from a numbers of sampled vessels through fishery logbooks distributed from April 2017 to September 2018. The required data were collected form a logbook system which was reported by the fishing vessel captains. Regarding the gear, any dimensional feature of the gear components such as main line, branch line, hook, number of hooks between basket and bait used were included in details in the logbook. For each fishing operation, the data were recorded for setting and hauling position, the duration of setting and soaking time.

The starting and finishing times of both shooting and hauling were recorded to calculate the soaking time of each operation. Soaking time is the duration between completion of setting and the initiation of hauling of the longline (Bigelow, 2002)

Along with recording these data at sea, size data in fork length (FL) were also recorded for the yellowfin tuna from some of the vessels at the landing sites when the fish were offloaded.

Results

The gear configuration consists of a main line made of Polyamide (PA) monofilament material with a diameter of 3 mm to which 4 branch lines are attached between pairs of floats or a basket. Branch line is made of PA monofilament in 2 mm diameter. Each branch line is connected directly to the hook.

Polypropylene (PP) rope of 4 mm diameter is mainly used as buoy line. Buoys and buoy lines are used to position the longline at the appropriate fishing depth. Poles constructed from bamboo with flags are attached to the longline to keep track of the line during daytime. A schematic representation of longline gear is given in Fig. 1, with details of structure in table 1.

Branch lines are connected with main line by snap clip. A swivel is used to connect the branch lines to the snap clip to avoid twist. The hooks are made of hardened and tempered steel. Japanese tuna hook numbers 3-4 are commonly used for yellowfin tuna longlining. In each set, a total of 300-600 hooks are operated for the dhows, and 70-90 hooks for boats. The total length of the main line ranged from 5-7 km for the boat, and 27-52 km for dhows. The hooks are allowed to be soaked for 2 to 9 h, with an average of 5h, after which they are hauled up.

Sardines and Indian mackerel fishes have been the most common baits used in longline operation. Ice stored baits carried onboard in insulated boxes and live baits are used for longline operations.

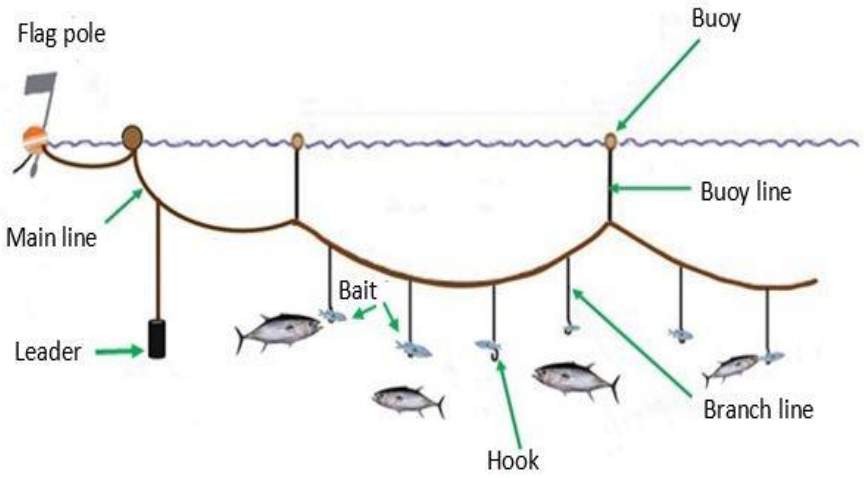

Fig.1. General structure of a typical longline operated in coast of Iran in Oman.

Table 1. Specifications of longlines operated by different vessels in Oman Sea.

Vessel	Total length (km)	Number of hooks	Main line Material and diameter (mm)	Branch line Material and diameter (mm)	Length of branch line (m)	Hook Size/type	Soaking time in hour (average)
Boat	5-7	70-90	PA mono; 3	PA mono; 2	31-34	3-4; Japanese	???
Dhows	27-52	300-600	PA mono; 3	PA mono; 2	31-34	3-4; Japanese	2-9 (5)

During the sampling, the data on a total of 359 line sets were available from the logbooks distributed to the artisanal longliners. The catch data on logbooks were recorded in terms of number or weight depending on the circumstances, and also many of the vessel captains only recorded the target catch, i.e. yellowfin tuna. So, CPUEs were calculated in separate terms according to the catch data were recorded.

The spatial data on line setting of the longliners covered the narrow area of Oman Sea, distributing two distinct location, i.e. eastern and western sides of the covered area. In terms of depth, almost all the setting operations were made at a water depth ranging from 100 to 3000m (Fig.2). The spatial CPUEs were distributed dominantly by 0.1-1.13 kg/100h, and then by 1.14-2.04 and 2.05-3.15 kg/hook. The CPUEs were not available for the whole round year, but it shows that the values increased from March onwards, attaining higher values during June to August (Fig. 3).

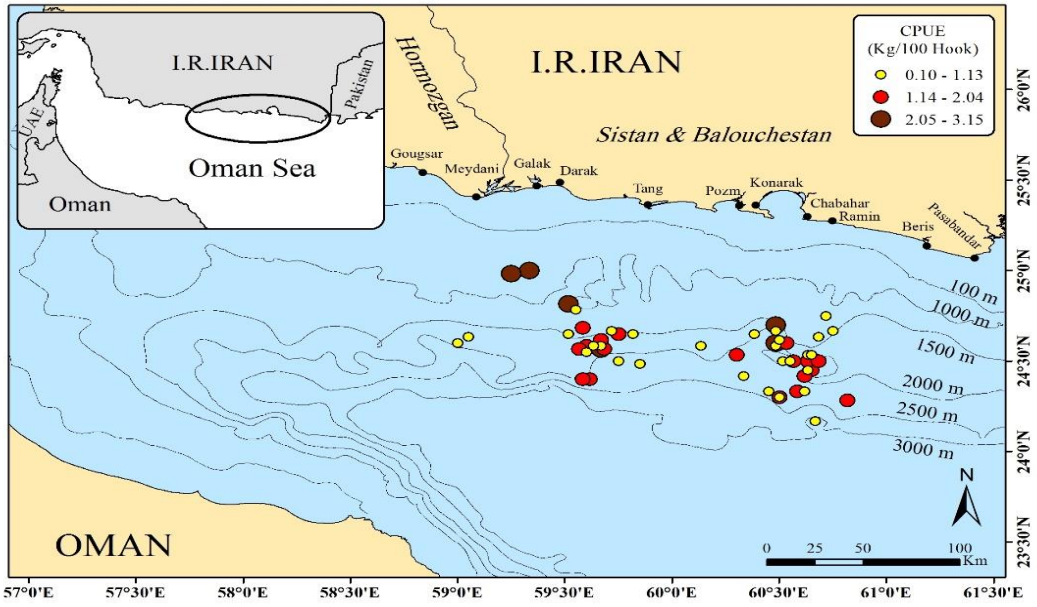

Fig.2. Spatial frequency index of yellowfin tuna caught by artisanal longliners operated in Oman Sea.

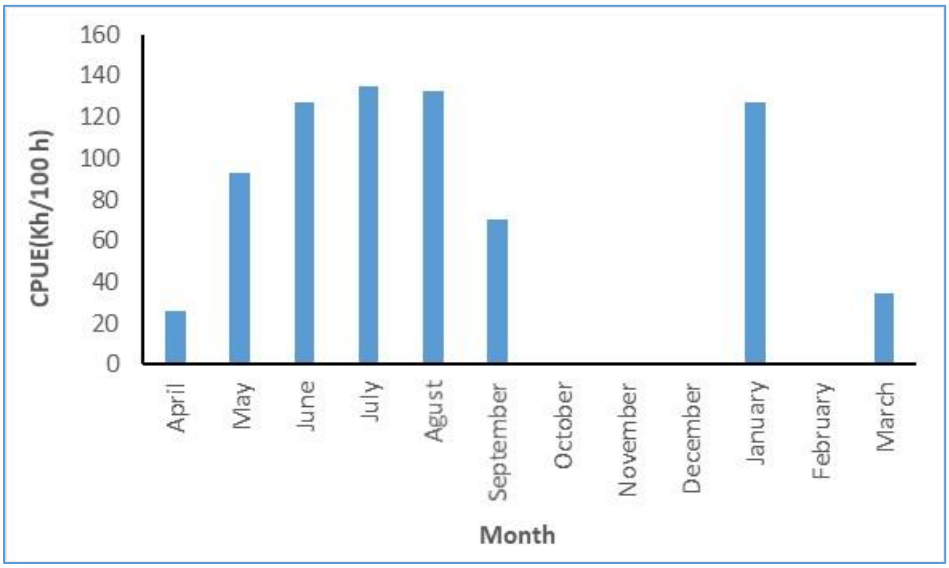

Fig.3. CPUE trend of yellowfin tuna by month from artisanal longliners operated in in Oman Sea. Gaps indicate months for which there were no recordings.

For the combined time data, mean nominal hook rate for yellowfin tuna was estimated to be 2.36 fish /100 hooks, whereas it was at 100.56 kg/100 hooks (Table 2). Of the total sets availed, 52 was investigated for the catch composition in terms of number. Based on this, yellowfin tuna

accounted for 80%, common dolphinfish *(Coryphaena hippurus)* 10 %, marline 2%, swordfish 1.2%, sea turtle 2.5%, ray fish 2%, sharks 0.1% and miscellaneous fishes 2.4% of the total catch (Fig. 4).
Surprisingly, longtail tuna was observed in the catch composition for 245 longline sets, for which the data was only recorded in weight. According to this, catch was dominated by yellowfin tuna (93.4%), with the remaining represented by marline (4.6%), longtail tuna (1.3%) and common dolphin (0.7%).

Table 2. Mean nominal CPUE for yellowfin in terms of weight and number for artisanal longlines in Oman Sea during study period.

Variable	**Setting day**	**Effort (day*hook)**	**YFT**	
			Weight (kg)	**Number**
Total	359	196,530	205,529	4,630
CPUE (kg or N/100h)			**104.60**	**2.36**

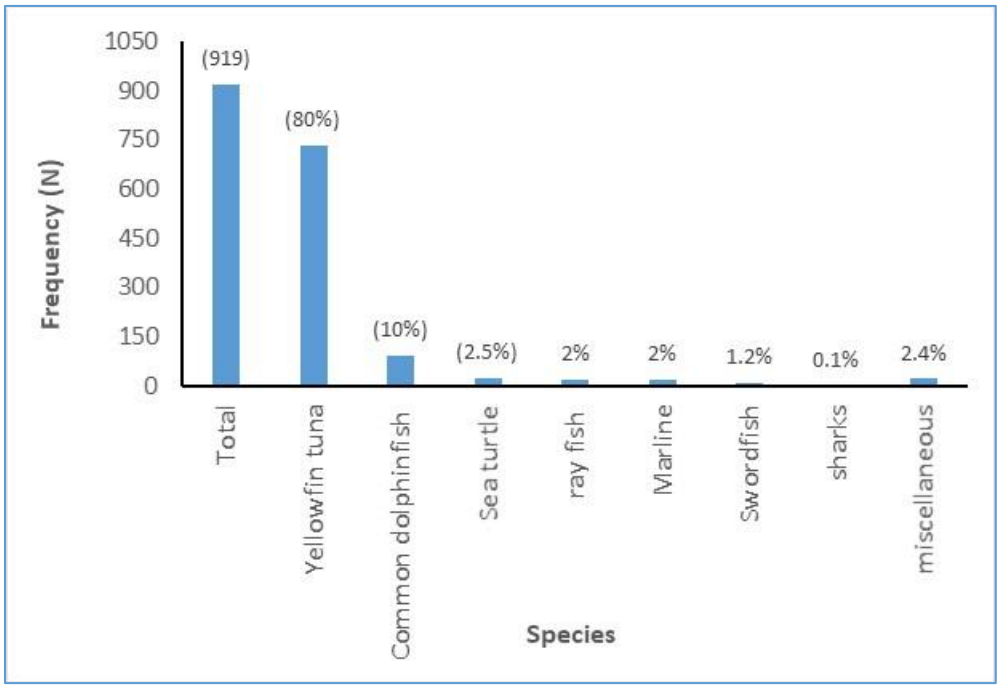

Fig.4. Catch composition in terms of number for artisanal longliners operated in coast of Iran in Oman for the data driven from 56 sets.

A comparison of length frequency of yellowfin tuna between longline and gillnet fisheries indicated distinct fish groups and length parameters (Fig. 5 and 6). That is to say that fish smaller than 88 cm were not observed in longline, but both fisheries were overlapped by larger fish (> 88 cm) with difference in proportion. For gillnets, the size distribution was varied between 37-166

cm, consisting of three prominent modes at 55cm, 85 cm and 133 cm. Regarding longline, the length distribution ranged from 90-175 cm, peaking at one mode of 130 cm, and averaged on 134 cm.

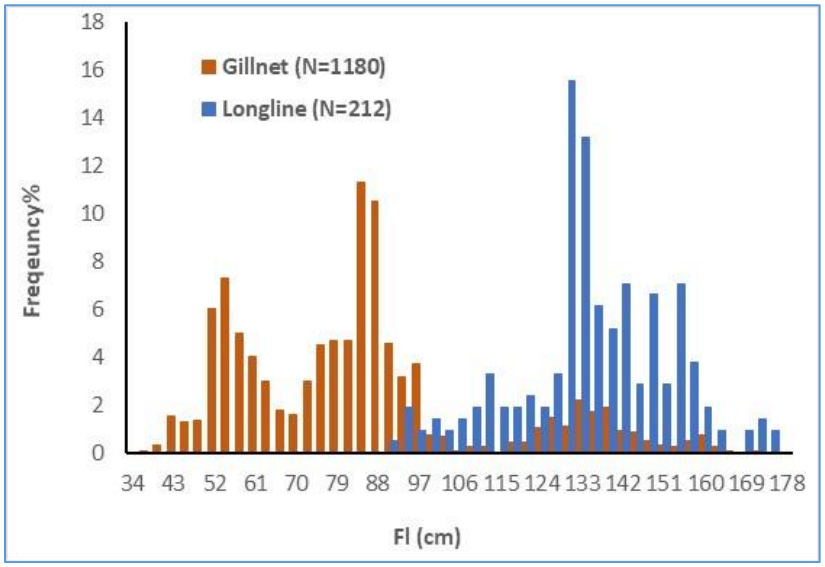

Fig.5. Length distribution of yellowfin tuna by fishery from artisanal vessels operated in coast of Iran in Oman Sea.

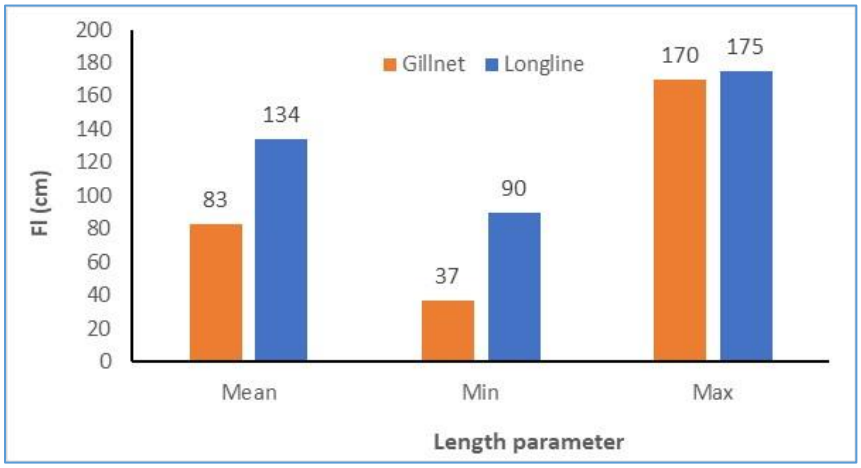

Fig.6. Length parameters of yellowfin tuna by fishery from artisanal vessels operated in coast of Iran in Oman.

Discussion

Longline fishery in Iran has not a long history in the marine fisheries of the country. It has been started for just three years ago, and is still the first step in the process. Local fishermen have

experienced the operation by trials and errors to get the better results of the catches for target species, i.e. yellowfin tuna.
During fishing operation by industrial longliner, Jahad Pozm, in Oman Sea in Iranian sides, the catch composition showed that yellowfin tuna accounted for 99.2% of the total catches in weight, with the rest being sharks and marline (Talebzadeh, 1999), which is in consistent with the present study for yellowfin tuna as a dominant species.

In the present study, it was found that the fishing area for yellowfin tuna longlines include a limited area, extending from Meydani to tang in west coast and from Pozm to Ramin in east coast. But, it seems that other fishing grounds can be used by fishermen for the longline fishery targeting yellowfin that would be confirmed by more data coverage in the future.
Nominal CPUE based on different months shows that the average nominal CPUE is subjected to seasonal changes. Although data on CPUE for all the periods of a year along with covering more vessels and larger area of sampling are necessary for judging the season at peak fishing, it is more likely that the catches of yellowfin tuna by longline reach its higher values during south-west monsoon (June-August) which associated with environmental condition. This period is consistence with the presence of a high density of tuna prey organisms (small pelagic fish) and the rise in sea surface temperatures from 24 to 26°C that are considered suitable for migrating large numbers of adult yellowfin tuna into Oman Sea (Hosseini and Kaymaram, 2015). These adult yellowfin tuna is assumed to be part of spawning population from *T. albacares* stock further south. From March to August, the tuna schools feed actively on flying fish, sardines, and anchovies close to the sea surface. Small pelagic fish schools are frequently abundant in the Oman Sea and are chased by foaming schools of yellowfin (Salarpouri, 2014).

Average nominal CPUE of yellowfin tuna for the whole year indicated an index of 104. 6 kg/100h and 2.36 fish/ 100 h, which are considerably larger in terms of number when compared to the Indonesian longliners operated in EEZ waters (0.186 fish/100 h) (Setyadji and Jatmiko, 2017).
The bycatch fisheries is of great concern for sharks, sea turtles, sea birds, billfish, and marine mammals that are highly susceptible to incidental capture in tuna fisheries (Dulvy et al. 2014). Many of these species are existed over large areas, and hence have a large overlap with tuna fishing grounds. In this study, common dolphin (10% of the total catch in number for 52 set) was estimated to be a dominant bycatch specie for the longline fishery targeted on yellowfin tuna. Report from the local fishermen indicated that the sea turtles are returned to the sea alive when the hook is hauled up on board.

The present study indicated that the size distribution of yellowfin tuna exploited by drift gillnet in Oman Sea to be ranged from 37 to 170 cm FL, which are in agreement with report from Hallier (2003), that the fork length of yellowfin tuna taken from gillnet fishery are within the 40-165 cm range in the Oman Sea. Based on the size data from longline we can see that the larger fish, i.e. size at 88 cm and above, are susceptible to be caught by the gear in deeper layer where the hook is positioned there. These sizes (fish of larger than 88 cm) are so larger to be gilled or wedged by gillnets of mesh size of 146 mm, resulting to the smaller proportion in the catches (Hosseini, 2003). Judging from the length distribution of both fisheries, it can be concluded that the larger fish (fish of 88 to 175 cm, which dominated by adult specimen of 130 cm), exists in Oman Sea

during the year, peaking in the period of July-September (Kaymaram and Hosseini, 2014). This outcome is supported by the idea of migrating large numbers of spawning population of yellowfin tuna into Oman Sea to chase the small pelagic fish schools which are frequently abundant in area during the period.

For tuna longline, 95% of the size frequency was greater than 100 cm and thus can be considered as matured according to the previous work (Zhu et al., 2008), which mentioned that size of yellowfin tuna at first maturity to be 100 cm in the Western Indian Ocean.
There are sufficient sashimi grade tuna to sustain a potential and viable tuna export industry from longline tuna offloaded at the landing sites, but still the artisanal longline operation needs to be mechanized for improving the catch in terms of quantity and also for quality. Using line setter in an appropriate deck arrangement is an alternative for the mechanized system. In this way, the longline would be set properly within the mixed layer to target efficiently yellowfin tuna, as yellowfin tuna is strongly related to with the mixed layer (Beverly et al., 2003). This layer extends from the surface down to the thermocline; the place in which the water temperature decreases sharply over a relatively small depth range. For this, knowledge on sagging ration, SR, expressing as the ratio of the distance the boat travels to the length of line ejected by the line setter during the same period, would be helpful to lead the hooks in an appropriate depth layer (Bolaky, 2006), that needs to be investigated in the artisanal longline in Oman Sea in near future.

Conclusion

This study is a preliminary report for artisanal longliners in Iranian EEZ in terms of catch efficiency on target species, namely yellowfin tuna, and other species as an accidental catch. Despite this, it carries informative data on the potential catch of larger yellowfin tuna in the local waters, which has to be exploited effectively in the mechanized longliners. Also, a considerable difference between the longline and gillnets fisheries for yellowfin tuna sizes is an indicative of existence of larger fish (88 cm) in the area that the fish girth are not suitable to the present opening mesh size of gillents used, predominantly 146 mm. The hooks are set at deep water in compared to gillnets (the net depth would be at 25 m), which is targeted by the bigger yellowfin tuna existed there. Still, the longline operations are in artisanal scale and future work needs to be done for some modification with the aim at optimizing the deck arrangement and the fishing operation.

More importantly, organizing statistical system to collect data on catch and effort for longline fisheries is one of the essential things in terms of management issue that should be put on the agenda so soon.

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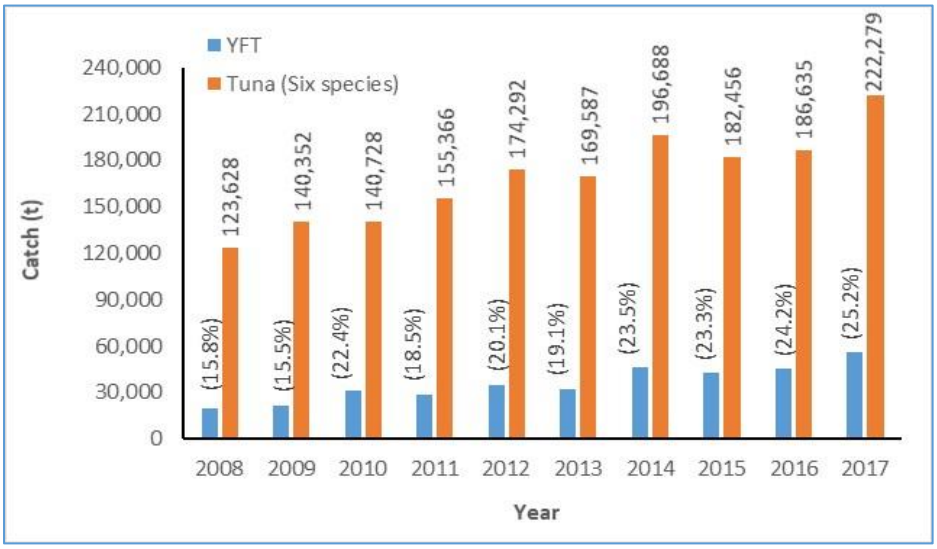
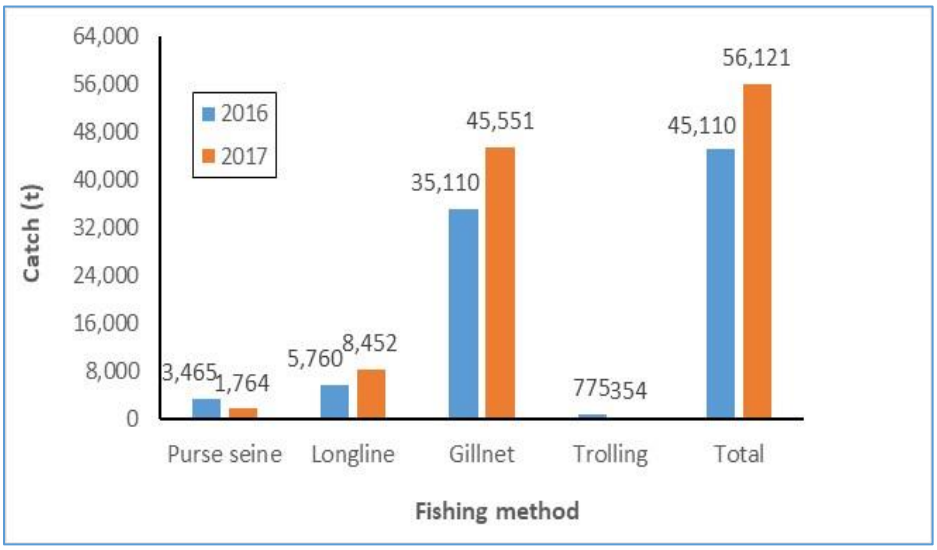
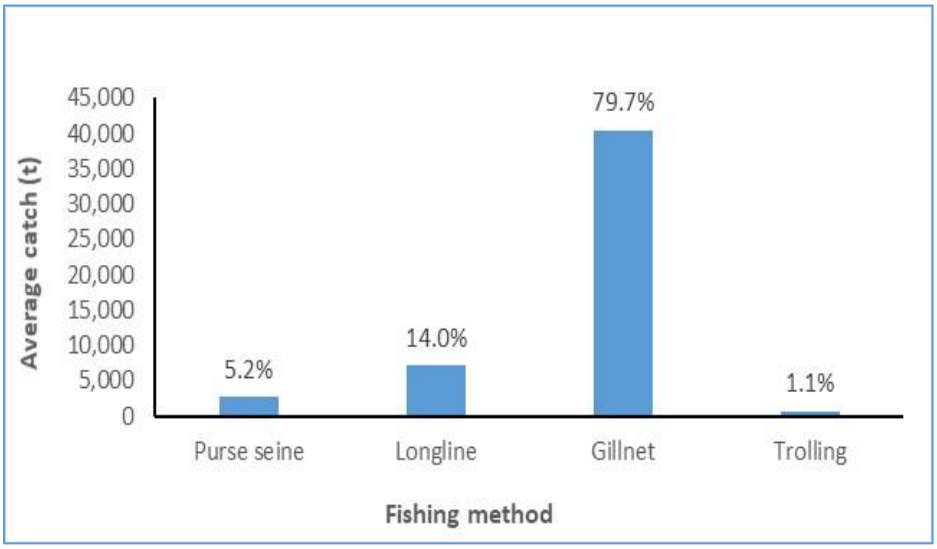
Appendix



Appendix 1: The trend of tuna (combined species) and yellowfin tuna catches by all Iranian fleets (irrespective of fishing method). Values in parenthesis show the proportion of yellowfin tuna catch to the total tuna landing in the corresponding year.



Appendix 2: The trend of yellowfin tuna catches by Iranian fleets in the years 2016 to 2017.



Appendix 3: The averaged amount of yellowfin tuna catches by Iranian fleets. The data for two years of 2016-2017 were combined. The values on the bars show the proportion of the fishing gear to the total yellowfin tuna landings.