

Seasonal variation of catch per unit effort and catch composition in a Persian Gulf longline fishery

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Abstract. Paighambari SY, Eighani M. 2018. Seasonal variation of catch per unit effort and catch composition in a Persian Gulf longline fishery. *Biodiversitas* 19: 888-892. The catch per unit effort (CPUE), and catch composition of a Persian Gulf longline fishery were investigated during the study to develop essential information regarding the needs of longline fishing in Persian Gulf just to assist the artisanal fishermen. A total number of 2990 deployed hooks were set during spring and winter seasons. One catch contained 8 teleost fish and one elasmobranch species belonging to 8 families. In the spring season, 357 fish were counted during sampling out of which *Netuma thalassina* with 183 specimens (F= 51.3%) was the most abundant one. In winter season 235 specimens were collected, of which 17.7% were represented by the *N. thalassina*. So, there is no significant difference in fish assemblages were obtained between spring and winter seasons ($R=0.567$, $P>0.05$). Proportion of all caught fish below length at maturity was higher in the winter season than spring season. Data revealed significantly higher CPUE at spring season compared to winter ($P<0.05$), suggesting that in general, fishing at the spring season was necessarily more efficient than winters. Difference in CPUE between spring and winter seasons may be explained by the species response to the temperature cycle in the Persian Gulf. A better understanding of the complete catch including catch rate, catch composition, and their sizes, is therefore, an important step towards a sustainable Persian Gulf longline fishery. □

Keywords: Catch composition, CPUE, Seasonal variation, Longline, Persian Gulf

INTRODUCTION

Longline fishing gear is currently used throughout the world's oceans for the harvesting of commercially important fish species (Erzini et al. 1999; Kerstetter and Graves 2006). Longline gear can be set at the seabed targeting demersal species, or above the bottom also targeting pelagic or semi-pelagic species. □

Bottom trawl is the most common fishing technique in Persian Gulf but with negative effects on seabed environment and high value of by-catch (Eighani et al. 2016). Concerns about sustainable exploitation of marine resources has recently focused on the proper management of commercially valuable fish stocks by using longlining which is considered as an environmentally friendly fishing method (Lokkeborg 2003). Pelagic longlines are considered more selective when compared to other fishing gears like trawls or gillnets (Gilman et al. 2006). In 2016, for tuna and tuna-like catches more than 21760 days fishing efforts were carried out by artisanal longline fisheries in Persian Gulf that landed 5760 mt catch annually (IOTC 2017).

Regarding high price of fresh fishes, small-scale longliners continues to increase in Persian Gulf coastal area. Obviously, small-scale longliners are more economical than large sized longliners.

However, an insufficient data regarding fisheries, either due to inadequate monitoring often limits policy approach to implementing a long-term sustainable yield based fisheries management (Ludwig et al. 1993). So, the main

objective of this study was to provide essential information regarding catch rate and catch composition of longline fishery in Persian Gulf. Also, this information will also be useful for the improving the knowledge base for the management of coastal fisheries in Persia Gulf longline fishery. Comparison between catch per unit effort (CPUE), and catch compositions during different seasons was also explained in the present study.

MATERIALS AND METHODS

A total of 35 experimental longline fishing sets, with 2990 deployed hooks were carried out in the Northern Persian Gulf (26°-40°N, 56°-07°E), from February 2016 to May 2017. Sampling operations were performed by using artisanal fishing vessel (7-m long, with 45 horsepower engine).

Bottom longlines consist of a series of baited hooks attached to a mainline that is suspended from floating buoys that are deployed in daily operations to catch large benthic and semi-pelagic fish species.

The fishing gear consisted of standard monofilament propylene mainline of 2 mm diameter (400 m long) and 100 gangions. Each gangion was 0.5 m in length and constructed of 0.5 mm diameter propylene monofilament. The hook type was the Mustad J-style hook size 6/0. All hooks were hand baited. All hooks were baited with squid. The average weight of the bait was 30 ± 1.5 g. The same hook and bait type was used in all fishing trips.

Soak time was 6 h and depended on fish availability and weather conditions, with the gear fishing mostly at depths between 35 and 40 m. All characteristics of the fishing gear and practices (e.g., hook placement, deployed the number of hooks of each style per set, bait size, setting time, etc.) were standardized throughout the study. All the fish were identified to species, their total length measured (nearest to cm) and their weight recorded for each season separately. The proportion of fish below length at maturity (L_m) was calculated by different seasons. This proportion could not be determined for some of the species due to the small number of specimens.

Catch per unit of effort (CPUE) was expressed as the weight of specimens (kg) caught per 100 hooks. This was calculated for each of the fishing trips at different season separately. Catch composition by different seasons was recorded for all fish species. The occurrence of a given species was also determined. It is defined as the number of samples of the species present in the catch divided by the total number of deployment (n=35), usually expressed in percentage (%).

Species diversity was calculated using the Shannon index (Shannon and Weaver 1949):

$$\sum H' = Pi \log Pi$$

Where, P_i is the proportion of species i in numbers

First, the homogeneity of variances and normalization of data were evaluated. The non-parametric Mann-Whitney U test was applied to examine differences between CPUE at each trip in spring and winter seasons.

Two sample Kolmogorov-Smirnov tests ($P < 0.05$) were performed to compare the length frequency distributions of the three most abundant fishes between the spring and winter seasons. Multivariate data of relative fish abundance were analyzed with one-way ANOSIM (Clarke 1993) to test the difference between seasons. Comparisons were based on the calculation of Bray-Curtis resemblance matrix (Bray and Curtis 1957). Differences among seasons, factors

within each season, were represented by 2-dimensional plots with non-metric multidimensional scaling ordinations (nMDS) considering season centroids (Clarke 1993; Clarke and Warwick 1994). Stress values are shown for each nMDS plot to indicate the goodness of fit between the distances among points implied by nMDS and the matrix data input. These indicated that the smaller the stress, the better the representation (stress < 0.15 is good; < 0.10 is ideal) (Clarke 1993). SIMPER analysis (cut off 90%) (Clarke 1993) enabled us to identify the “important taxa” that contributed to the overall dissimilarity between seasons. All statistical analyses were performed using R software (version 3.3.2, R Development Core Team 2016).

RESULTS AND DISCUSSION

Results

During the study, 17 and 18 longline sets were conducted in spring and winter seasons respectively, resulting in the capture of 592 fish with a total weight of 520.48 kg (Table 1). The catch contained 8 teleost fish and one elasmobranch species belonging to 8 families (Figure 1). In the spring season, 357 fish were counted during sampling. *Netuma thalassina* with 183 specimens (F= 51.3%) was the most abundant species. In winter season 235 specimens were collected, of which 17.7% were represented by the *N. thalassina*. Two species, *Lutjanus ehrenbergii* and *Lutjanus malabaricus*, were caught exclusively in the spring season.

According to SIMPER analysis (pairwise comparison), average dissimilarity in catch composition in numbers was 24.75% between spring and winter seasons. Three species, *L. malabaricus*, *A. indicus* and *C. dussumieri* contributed highly to catch composition differences between spring and winter seasons.

No significant difference in fish assemblages was obtained between spring and winter seasons ($R=0.567$, $P>0.05$). Once the area centroids were ordered by nMDS, representing no differences in fish assemblages among seasons, and overlapping occurs among groups (Figure 1).

Table 1. Total abundance of the fish species related to different season in Persian Gulf longline fishery

Species	Spring			Winter			Mean length (cm)±SD
	Total number	Freq. %	% Occurrence	Total number	Freq. %	% Occurrence	
<i>Alectis indicus</i>	9	2.5	0.10	42	14.2	1.47	35.3±5.2
<i>Argyrops spinifer</i>	37	10.3	0.94	50	16.9	1.70	38.5±7.6
<i>Netuma thalassina</i>	183	51.3	5.45	52	17.7	1.74	45.0±5.5
<i>Carcharhinus dussumieri</i>	10	2.8	0.26	38	16.2	1.21	57.6±8.1
<i>Epinephelus coioides</i>	19	5.3	0.56	12	4.1	0.40	29.8±6.3
<i>Lethrinus nebulosus</i>	61	17.1	1.64	31	10.5	1.17	37.8±5.7
<i>Lutjanus ehrenbergii</i>	10	2.8	0.30	0	0	0	28.8±4.4
<i>Lutjanus malabaricus</i>	22	6.2	0.66	0	0	0	30.8±4.2
<i>Pomadasys kaakan</i>	6	1.7	0.16	10	3.4	0.33	36.4±4.1

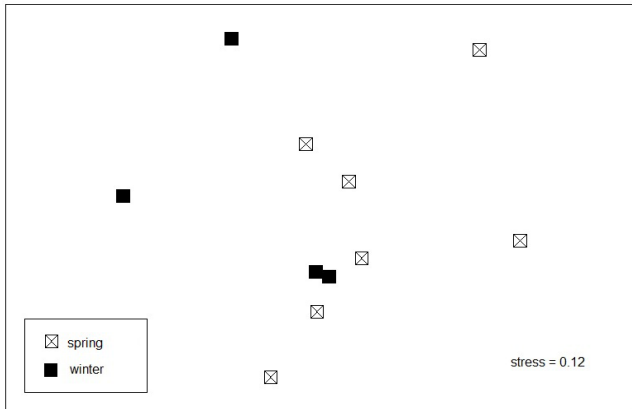


Figure 1. Non-parametric multi-dimensional scaling (nMDS) plots representing no differences in fish assemblages among seasons

The Shannon species diversity index was calculated 1.569 and 1.818 for spring and winter seasons respectively. CPUE (kg/100 hooks) was calculated 2.82 ± 0.55 and 1.60 ± 0.41 for the spring and winter seasons respectively. CPUE (kg/100 hooks) range was varied 0.3-21.74 in spring and 0.07-10 in winter seasons. Mann-Whitney U test results showed that the catch per unit of effort in spring season was significantly higher than winter season ($P < 0.05$).

Length frequency distribution of three most abundant species; *N. thalassina*, *A. spinifer*, and *L. nebulosus* were compared between spring and winter seasons (Figure 2). Larger individuals of *N. thalassina* were caught significantly more at spring season ($P < 0.05$). In case of *A. spinifer*, and *L. nebulosus* no significant differences were observed in length frequency distributions between spring and winter seasons ($P > 0.05$).

The size range and proportion of individuals caught below length at maturity (L_m) differed between spring and winter seasons (Table 2). The proportion of all caught fish below L_m was higher on the winter season than on the spring season.

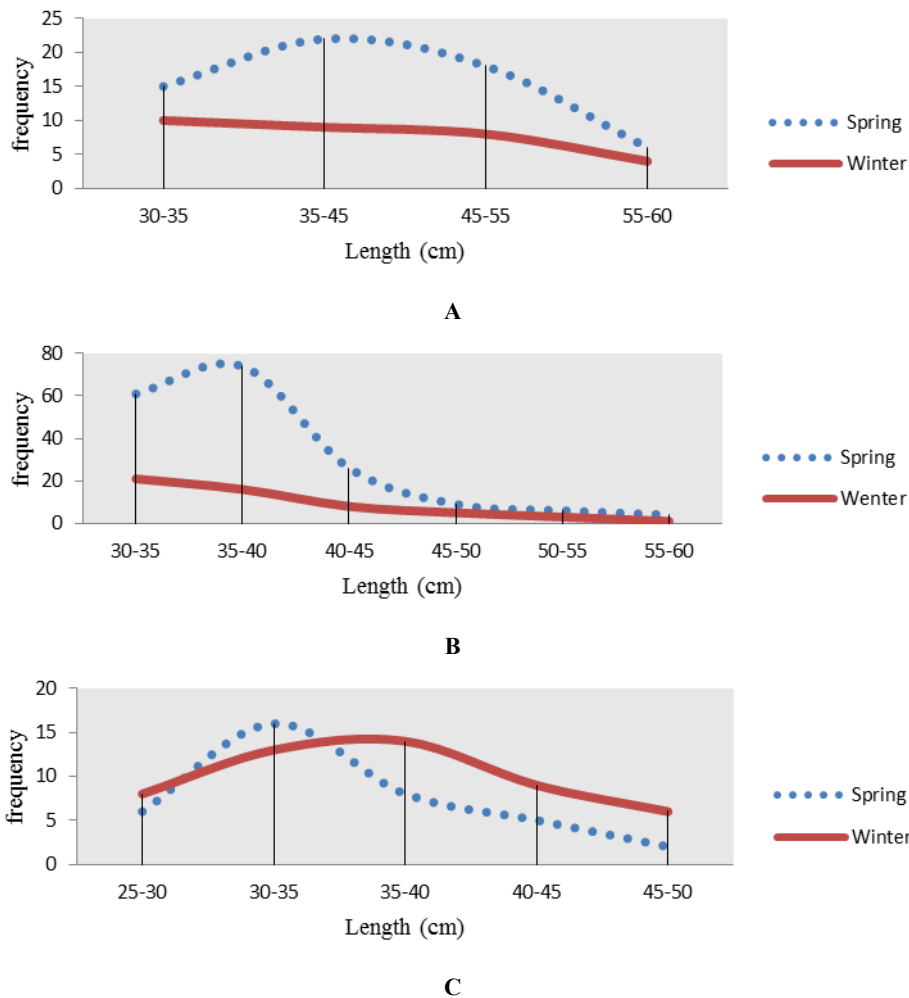


Figure 2. Length-frequency distributions of three most abundant fish species compared between spring and winter seasons in Persian Gulf longline fishery. A. *L. Nebulosus*, B. *N. Thalassina*, C. *A. spinifer*

Table 2. Size range and proportion of fish below Lm in Persian Gulf longline fishery

Species	Spring		Winter	
	Size range (cm)	% Below Lm	Size range (cm)	% Below Lm
<i>Alectis indicus</i>	25-45	34	27-44	39
<i>Argyrops spinifer</i>	30-50	15	25-48	18
<i>Netuma thalassina</i>	32-60	8	35-57	14
<i>Carcharhinus dussumieri</i>	55-75	67	55-75	71
<i>Epinephelus coioides</i>	23-50	48	20-43	52
<i>Lethrinus nebulosus</i>	35-60	5	30-55	9

Discussion

This study was the analysis of the catch rate, catch composition, and biodiversity of longline fishery for two seasons in Persian Gulf. Fishermen consider a large part of their catch as target species. No by-catch and discard were caught in the study area. All the fishes caught during the study are marketable and consumed by local communities. Catch compositions were dominated by *N. thalassina*, *A. spinifer* and *L. nebulosus*, which made up about 70% of the landed biomass. This catch composition was consistent with published studies from other tropical longline and handline fisheries (Erzini et al. 1999; Curran and Bigelow 2011; Zimmerhackel et al. 2015; Paighambari and Eighani 2017). Longlining is mostly performed in tropical waters and around coral reefs, which have similar species compositions. However, changing spatial-temporal and environmental conditions can impact the similarities between the different fish assemblages. In our study, the catch composition between spring and winter season was not significantly different. However, it was observed that some of the species, such as *L. ehrenbergii* and *L. malabaricus*, were caught exclusively in the spring season and some other species, such as *A. indicus*, were caught mostly in winter season. Present study allowed us to understand better how seasonal variation have an impact on the catch composition in small-scale Persian Gulf longline fisheries which should lead to the development of more specific conservation and fisheries management measures.

CPUE were significantly higher at spring season compared to the winter season, suggesting that in general, fishing at the spring season was necessarily more efficient than the winter season. Also, Niella et al. (2017) revealed that catch rate and catch composition both were significantly influenced by seasonal variation. The existence of a significant seasonal effect was verified on the catch rates, which dropped from March to September in artisanal longline fishery in Chile (Queirolo and Ahumada 2009). The CPUE was substantially differed between the sampling months in New Zealand longline fisheries (Francis et al. 2004). The difference in CPUE from one season to another are explained by variations in the physical environment (temperature, salinity, currents) and others that are ecological factors (migration, food availability, predation, recruitment, and fishing pressure) (Kingsford 1999). Difference in CPUE between spring and winter seasons may be explained by the species response to the temperature cycle in the Persian Gulf. In this study, average temperatures in spring and winter seasons were

27.7±2.1 and 21.8±1.9, respectively. Sea surface temperature affects population abundances and distributions of many pelagic fish in Indian Ocean (Marsac 2008; Lan et al. 2013).

Length frequency distribution did differ between spring and winter seasons for *N. thalassina*. But for two other species; *A. spinifer*, and *L. nebulosus*, no significant differences were observed. Laptikhovski et al. (2006) also found that the seasonal variation did have a significant effect on the length frequency distribution of the caught species. The results indicated that longline selectivity was satisfactory for most of the fish species for two seasons except *E. coioides* and *C. dussumieri*. The impact of longlining on sharks and rays stocks around the world is currently the focus of considerable international concern (Gallagher et al. 2014). The results of present study revealed that a larger proportion of *C. dussumieri* was below length at maturity (Lm) as compared to other species. Our results demonstrate the need to integrate management measures in future management plans in order to minimize the fishing pressure on threatened and protected species. For the studied fishery to approach sustainability, future research is required to investigate increase hook and bait size for improving size selectivity of *E. coioides* and *C. dussumieri*.

Monitoring longline fisheries data assemblages including catch rate, catch composition, and their sizes, is therefore, an essential step towards a sustainable Persian Gulf longline fishery in future. Therefore, a better understanding of the spatiotemporal, environmental, and biological variables responsible for the overlapping distributions of longline fishery resources is needed to develop efficient multispecific management strategies (Niella et al. 2017).

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