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Biomass and CPUA Estimation and Distribution Pattern of *Saurida tumbil* from Northwest of the Persian Gulf

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Abstract

This paper reports on the results of a trawls survey in 2011 to assess the amount of biomass and Catch Per Unit of Area (CPUA) as well as to determine the distribution pattern of Synodontidae family of demersal fishes (with emphasize on great lizardfish, *Saurida tumbil*) as one of the most important and commercial fish species in the northwest of the Persian Gulf. Samples were collected from 65 trawl stations selected at stratified random procedure. The study area was stratified to five strata (A to E) covering the depth layers of 10-20, 20-30 and 30-50 m. The catch rates of CPUA and biomass of lizardfishes were estimated 316.20 kg/nm^2, and 2902.1 tons, respectively. The highest value of biomass for synodontids was recorded in Bordkhoon to Dayer (D and E strata, 1310.6 tones) and in depth layer of 30-50 m in the east of the study area, and the lowest value was estimated for stratum A (west of Khuzestan province) and in depth layer of 10-20 m. On the other hand, the highest CPUA was recorded in stratum D and depth layer of 20-30 m; and the lowest CPUA was recorded in stratum A and depth layer of 10-20 m. It was concluded that stratum D (namely from Bordkhoon to Dayer) harbors the best fishing area as per higher density and distribution of Synodontidae and depth of distribution deeper than 30 m.

Keywords: *Saurida tumbil, CPUA, Biomass, Distribution, Fishing area, Persian Gulf*

1. Introduction

The fisheries and exploitation of marine fishes, represent the second most important natural resources (next to oil), and the most important renewable natural resources (Carpenter et al., 1997) in the Persian Gulf. More than 110,000 traditional and industrial fishermen are active and employed in this industry in the study area (Planning and Programming Deptartment, 2014). In order to have sustainable exploitation of marine fish resources, it is advised to monitor the aquatic resources, and process data of catch per unit of effort, catch statistics, fishery indices and catch per unit of area, CPUA (Sparre and Venema, 1992) for further management advises either towards sustainable exploitation or conserving of threatened and endangered species or

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species groups (Valinassab et al., 2011).

The ecosystem of the Persian Gulf is considered as one of the unique regions in whole biosphere, it contains high species diversity, because of its mangrove forests, coral reefs and many islands. The most common fishing methods in the study area are gillnet, trap, two-boat purse seine, hook and line, gargur and shrimp trawl to catch different ecological groups of aquatics with emphasize on demersal fishes (Valinassab et al., 2013). As an important fisheries management policy, the fish trawling has been banned in Iranian waters of the Persian Gulf, since 1993, in order to rehabilitate the ecosystem and restrict the fishing effort (Valinassab et al., 2006). The amount of total catch in the Persian Gulf for years 2009, 2010 and 2011were estimated at 227000; 245100, and 275500 tones, respectively. This is (as much as 42, 43 and 35%) far beyond the set quota for the northwest of Persian Gulf were 94890, 104700, and 97000 tones (Planning and Programming Deptartment, 2012).

Lizardfishes belong to the family Synodontidae and comprise of 4 genera and 57 species in the world (Nelson, 1994). They are mostly found at sand bottom in shallow to deep waters and are widely distributed in the tropical and subtropical regions. Synodontidae family with the main and most abundant species of *Saurida tumbil* are one of the important demersal fishes both in traditional and industrial fisheries (Carpenter, 1997; Dehghani et al., 2003; Valinassab et al., 2006; 2011 and 2013). Lizardfishes are generally small, although the largest species measures about 60 cm (24 in) in length. They have slender, somewhat cylindrical bodies, and heads that superficially resemble those of lizards. The dorsal fin is located in the middle of the back, and accompanied by a small adipose fin placed closer to the tail (Johnson and Eschmeyer, 1998). *Saurida tumble* had total catch of 3634, 2977, and 4353 tones for years 2010, 2011, and 2012 in the northwest of Persian Gulf (Planning and Programming Deptartment, 2012). It is found mostly in coral reefs from depths of 20 m to 60 m (Sattari et al., 2008; Sadeghi, 2001).

The first studies on demersal fishes in the study area were carried out in 1976-1979 under a United Nations Food and Agriculture Organization regional project covering all southern and northern Persian Gulf and Oman Sea waters using four research vessels (Sivasubramanian, 1981). Further studies in the northern Persian Gulf waters to estimate the biomass of demersal fishes took place between 1994 and 1995 based on seasonal cruises (IFRO Experts Group, 1996). Then from year 2002, it was decided in order to provide further advise for the management of demersal resources, a comprehensive research project, covering all Iranian waters of the Persian Gulf and Oman Sea, was designed (Valinassab et al., 2006) using swept area method (Venema, 1975; Sparre and Venema, 1992).Valinassab et al. (2003) designed and carried out monitoring surveys of demersal resources by swept area method in the Oman Sea waters.

The main objectives of this research are: to estimate the amount of catch per unit area (CPUA) and biomass of commercial family of Synodontidae for different strata and depth layers in the northwestern Persian Gulf; to analyze fluctuations through comparing data with previous estimation records; too. Prepare the distribution pattern and determine the main fishing areas of *Saurida tumbil* as target species.

2. Materials and Methods

The study area was restricted to the Iranian waters of the northwest Persian Gulf, between longitudes 49° 00' E borderline of Iran and Kuwait in the west and 52° 45' E, Ras-Naiband in the east; and isobaths of 10 to 50 m deep (Figure.1). The study area was stratified into 5 strata (A to E) and then each stratum was classified into three depth layers: 10-20, 20-30, and 30-50 m.

The total area and area of each stratum or depth layer was calculated with a plannimeter (Tables 1, 2). A total of 65 trawl stations were selected randomly. The number of hauls in each substratum depended to proportional of the stratum and depth layer.

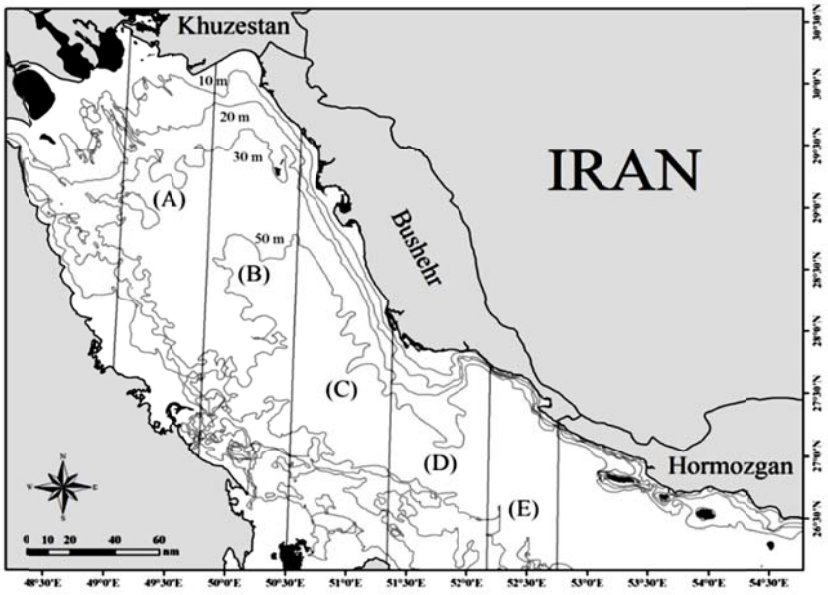

Fig. 1: Map of the study area for sampling

Table 1: The number of trawl stations and area of each stratum in the northwest of the Persian Gulf

Stratum	A	B	C	D	E	Total
	West of Khuzestan to Doheh-Daylam	Doheh-Daylam to Genaveh	Genaveh to Boordkhoon	Boordkhoon to Dayer	Dayer to Ras-Naiband	
Area (nm^2)	621.7	1415.6	1415.1	909.1	227.5	4589.0
Proportion of total area (%)	13.5	30.8	30.8	19.8	5.1	100
No. of Station	3	19	21	16	6	65

Table 2: The number of trawl stations and area of each depth layer in the northwest of the Persian Gulf

Depth layer	10-20m	20-30m	30-50m	Total
Area (nm^2)	1554.8	1102.5	1931.7	4589.0
Proportion of total area (%)	33.9	24.0	42.1	100
No. of Station	23	19	23	65

A total of two cruises were carried out in 2011using R/V Ferdows-1. This vessel is a stern bottom trawler equipped with a fish bottom-trawl net (headline 72m and mesh size of cod end 80mm). For each trawl, date, time, duration, bottom depth, GPS position, towing distance, and towing speed were recorded in special log sheets. Each trawl lasted 1h and then the net was transferred on board and following operations consisted of separation, identification, counting and weighing of Synodontids. The amount of biomass and CPUA index were estimated based on (Sparre and Venama, 1992) using following formula:

Swept area of each haul was estimated as: a = d* h* X1

Where: d: towing distance (nm) registered by Simrad Plotter;a: swept area (nm2); h: headline (m) and divided on 1852 to change it to nautical mile (nm); X1: wingspread coefficient = 0.65 (derived from Valinassab et al., 2010)

The catch per unit area (CPUA) is then given by: CPUA = Cw / a

Where: Cw= catch amount of Synodontids separated

from the total catch;

a: swept area (nm^2) and after estimating the mean CPUA, the total biomass(B) is estimated as:

B = CPUA * A / 0.5

Where: A: total area (nm^2); and 0.5: catch coefficient (Sparre and Venama, 1992)

Statistically, there was no normal distribution in CPUA values for Synodontids ($P<0.05$, $Z=0.03$), therefore the non-parametric test of Kruscal-Walis was used to determine any significant difference between strata and depth layers; and if there were significant differences, then Man-Whitney test was applied for comparing the mean CPUA for different strata and depth layers. Also, the Arc-GIS software (Version 9.2) was used for preparing the distribution pattern maps accompanied with Inverse Distance Weighted Method (IDW).

3. Results

The most abundant species caught was *Saurida tumbil* with more than 98% of total catch. The other identified species of Synodontids were *Saurida longimanus, S. undosquamis* and rarely *Trachinocephalus myops*. The total mean CPUA and biomass of Synodontids in northwest of the Persian Gulf (Khuzestan and Bushehr Provinces) were estimated at 316.20 kg/nm2 and 2902.10 tones with a frequency of 6.5% of total catch of demersal fishes for year 2011.

A comparison among different strata, it was revealed that the highest mean CPUA and biomass of lizardfishes were found in stratum D (Bordkhoon to Dayer) with 720.83 kg/nm^2 and 1310.62 tones, respectively. In contrast, the stratum A had the lowest amount of CPUA and biomass with estimated values of 17.27 kg/nm2and 21.47 tones, respectively (Tables 3-6). This comparison was done for different depth layers and the highest CPUA (496.92 kg/nm^2) was observed in waters of 20-30 m depth and the highest biomass (1505.55 tones) was for depth layer of 30-50 m. The lowest values of CPUA and biomass were estimated for depth layer of 10-20 m as 96.74 kg/nm^2 and 300.83 tones, respectively. There was a decreasing trend of biomass of Synodontids with descending of depth.

Table 3: Mean of CPUA (kg/nm^2) of Synodontids for different strata in the northwest of the Persian Gulf

Stratum	A	B	C	D	E	Mean
CPUA	17.27 ±1.87	324.79±11.56	148.84±32.14	720.83±84.24	503.73±56.84	316.20±76.95

Table 4:Mean CPUA (kg/nm^2) of Synodontids for different depth layers in northwest of the Persian Gulf

Depth layer (m)	10-20	20-30	30-50	Total
CPUA	17.27±1.87	324.79±11.56	148.84±32.14	316.20±76.95

Table 5: Mean of biomass (tones) of Synodontids for different strata in northwest of the Persian Gulf

Stratum	A	B	C	D	E	Total
Biomass	21.47±6.45	919.55±94.28	421.24±101.27	1310.62±79.61	229.19±83.74	2902.10±167.58

Table 6: Mean of biomass (tones) of Synodontids for different depth layers in northwest of the Persian Gulf

Depth layer (m)	10-20	20-30	30-50	Total
Biomass	300.83±27.15	1095.71±95.67	1505.55±183.84	2902.10±241.35

There was significant difference (P<0.05) for mean CPUA of Synodontids for different depth layers especially shallower depths contained lower density. Also, different strata indicated significant difference (P<0.05) in abundance especially for strata D (Bordkhoon to Dayer) and E (Dayer to Ras-Naiband).Table 7 shows the variance analysis in separate depth layers (from 10 to 50 m).

Table 7: Variance analysis of strata, strata and depth in separate depth layers in the Northwest of Persian Gulf

Depth (m)	Strata	Strata and Depth
	Asymp. sig.	Asymp. sig.
10-20	0.30	0.47
20-30	0.04	0.00
30-50	0.00	0.21

For depth layer 20-30 m variance analysis showed significant difference among strata and also strata and depth interaction. Also, highly significant difference was observed in depth layer 30-50 m. According to variance analysis, significant difference was observed between different depth layers (and intensity was observed between depth layers and strata (Table 8).

Table 8: Variance analysis of depth layers, strata and interaction of strata and depth layers in the Northwest of Persian Gulf

Strata	Depth	Strata and Depth
Asymp. sig.	Asymp. sig.	Asymp. sig.
0.30	0.04	0.00

As it was mentioned, the distribution pattern of *Saurida tumbil* as the main and the most abundant species was provided using Arc-GIS software and it was found that this species is distributed all over of the study area with the highest density in the southern-east parts (Boordkhoon to Ras-Naiband) in strata D and E (Fig. 2).

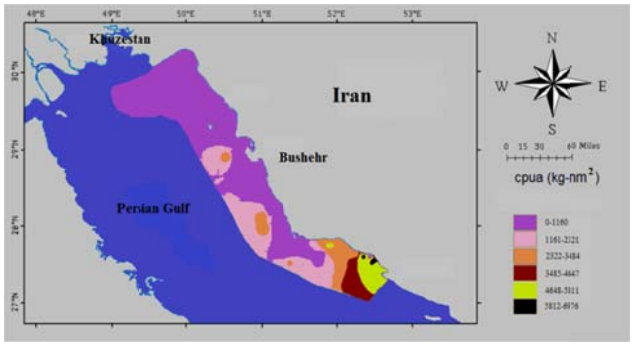

Fig. 2: The distribution pattern of *Sauridatumbil* in the northwest of Persian Gulf

4. Discussion

Two water bodies of the Persian Gulf and Oman Sea are located in subtropical area and contain different ecological fish species including demersal fishes (Valinassab et al., 2006).The mean CPUA of lizardfishes for year 2011 with the most dominant species of *Saurida tumbil* was estimated at 316.20 kg/nm2. The total biomass was 2902.10 tones (Tables 3 and 5). Dehghani (2003) reported the total biomass of Saurida tumbil 2900.1 tones for eastern part of the Persian Gulf. Comparing to the previous studies during years 2003-2010, it can be concluded that excluding the year 2003, the amount of biomass showing unstable trend (Valinassab et al., 2013); but it is emphasized that any overfishing by fishermen should be taken into consideration.

A comparison among biomass estimation for different five strata of A to E showed that the stratum D (Boordkhon to Doheh-Daylam) contains the highest value with 1310.62 tones. In spite of smaller area of stratum D (909.1 nm2) comparing to two other strata of B and C (with area of approximately 1415.5 nm2) (Table 1), the highest biomass is inhabited in this stratum. The main reason could be due to rough condition of sea in this region and its far distance from shore; therefore, fishing boats and even small dhows cannot have any activities and fishing effort in stratum D and only some bigger dhows are active there. These factors contribute to lower fishing effort in total and thus, more demersal resources are found with higher biomass (Valinassab et al., 2005). On the other hand, the lowest value belongs to stratum A (21.47 tones) located in West Khuzestan province in Doheh-Daylam at the end of northwest of study area and it is completely in agreement with previous cruises carried out in years 2004 up to now in which is due to lower area of this region with only 621.7 nm2 namely 13.5% of total of study area (Table 1) comparing to other strata for instance stratum B with 1415.6 nm2 (Valinassab et al., 2006).

From point of depth, the maximum CPUA and biomass of lizardfisheswere found in depth layers of 20-30 and 30-50 m, respectively with values of 496.09 kg/nm^2 and 1310.62 tones; and the lowest values were

estimated for depth layer of 10-20 m consist of 96.74 kg/nm^2 and 21.47 tones, respectively. The results of previous studies for years of 2003 to 2010 indicated that the maximum CPUA of lizardfishes was estimated for depths of more than 10-20 m (with more emphasize for 30-50 m)and also in previous study (Valinassab et al., 2013), the most biomass was estimated in 30-50 m depth layer and it is in agreement with findings of this research showing the highest amount of biomass and CPUA for 30-50 m depth layer (Fig. 2) as the best recommended depths for commercial fishing. Synodotidae is family commonly found in the mesopelagic layers of the Oman Sea (Venema, 1975).

As an overall review on previous studies and including the obtained findings of this investigation, it can be concluded that the strata Dand E (Boordkoon to Ras-Naiband) located in Bushehr Province have higher abundance of Synodontids in the northwest of Persian Gulf and higher distribution in these areas. As such, these areas are considered as the main fishing ground for this family and with considering the most abundant species of Saurida tumbil.This family was presented at 86.6% of catch composition in bottom trawl bycatch in the fishing grounds of Hormozgan province (Raeisi et al., 2012).We can advise and lead the fishermen to have their commercial fishing activities in two above-mentioned strata. One of the main reason of lower abundance of lizardfishes in the stratum A can be due to different reasons consist of overexploitation, use of non-standard fishing gears, higher catch per unit of effort (CPUE) such as number of fishermen, number of boats and number of fishing gears especially gillnets. King (1995) believes that the overexploitation causes lack of having a safe and suitable ecosystem and consequently cause the obligatory migration of fishes to other areas and shifting to new fishing grounds.

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