On the fishery Stock evaluation

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A R T I C L E   I N F O

A B S T R A C T

In this study, samples were collected at 44 selected trawl stations following a stratified random procedure by R/V SHANAK. Catch rates (catch per unit effort, CPUE and catch per unit area, CPUA) and total biomass of shrimp were estimated. Total shrimp biomass was approximately 445 tonnes. Mean CPUA was calculated as 124.5 Kg. n.m^{-2}. The highest and lowest CPUA was recorded in the stratum D (approximately 351 Kg. n.m^{-2}) and stratum A (approximately 14.8 Kg. n.m^{-2}) respectively. There was no significant difference between mean CPUE and CPUA of different depths (ANOVA, P>0.05).

1. Introduction

Persian Gulf is connected to the Oman Sea through the Strait of Hormuz, with the surface area of 2.39 × 105 km^2. Since average depth of the Persian Gulf is 36 meter, the entire water column is well mixed and therefore it is classified as a eutrophic sea (Reynolds, 1993; Valinassab et al., 2006). Although it has many good fishing grounds, extensive coral reefs, and abundant pearl oysters, but its ecology has come under pressure from industrialization, and in particular, oil and petroleum spillages during wars in the region.

Penaeid shrimps are widely distributed in the sub-tropical and tropical regions of the world. They are particularly abundant in Southeast Asia, India, Gulf of Mexico, Australia and the Persian Gulf (Fischer and Bianchi, 1984; Niamaimandi et al., 2007). The commercial shrimp fishing first began in earlier 60s on the Iranian waters of the Persian Gulf (Boerema, 1969). During these times, fishing was limited to the Bushehr waters (NW Persian Gulf) and was based on green tiger shrimp, *Penaeus semisulcatus* (De Haan, 1884). Except shrimp fishing seasons, trawling has been banned in Iranian waters of the Persian Gulf since 1992. Opening fishing season is based pre-season cruises that appraise the abundance and carapace length (CL) of shrimp, also the closure time is based on the CPUE (Catch per Unit Effort) index when it indicates that only 20% of the shrimp stock has remain.

In order to provide further advice for management of shrimp resources, the present study

was designed and performed in 2011. The main purpose of this research was:

1) to estimate the catch rates (CPUE and CPUA) and biomass of shrimp in Bushehr coastal waters. and

2) to provide baseline information required for fisheries management.

2. Materials and methods

2.1 Design project

The total area was divided into 5 strata (A to E) (Fig. 1), and each stratum was categorized into three substrata: <10m, 10-20m and 20-30m.

The total area and areas of each substratum was computed using Arc GIS software (Table 1). A total of 44 trawl stations were selected following a stratified random sampling procedure.

2.2. Collection of data

Sampling was done in 2011 on board R/V (Research Vessel) SHANAK (an outrigger trawler with 26m length, 7.4 m wide and 600 hp). Vessel was equipped with echo sounder, GPS platter, radar and two bottom trawl nets (mesh size of cod-end and body net 40 and 50 mm and 31m headline).For each haul, data of towing time, bottom depth, GPS position and towing speed was recorded. After each haul, the total catches were depleted on the deck and by catch was separated from shrimp.

The biomass and CPUA were calculated based on Sparre and Venema (1992). For each trawling, swept area was computed using the following formula:

$$a = D.hr.X_2 \qquad (1)$$

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Table 1
The number of trawl stations and area of each stratum in Bushehr coastal waters from the Persian Gulf.

	A			B			C		
Substrata	<10m	10-20m	20-30m	<10m	10-20m	20-30m	<10m	10-20m	20-30m
Area (n.m.²)	149.6	268.7	380.2	123.6	78.8	175.3	142.9	116.4	123.6
Total area		798.5			377.7			382.9	
Station		11			9			9	
	D			E					
Substrata	<10m	10-20m	20-30m	<10m	10-20m	20-30m			
Area (n.m.²)	76.0	106.0	90.6	216.9	216.4	255.0			
Total area		272.6			688.2				
Station		9			6				

Where D is the towing distance, hr is the length of head rope and $X2$ is the fraction of the head rope length (The value of $X2$ was taken to be 0.5 in this study).

The towing distance was estimated in units of nautical miles (nm), by:

$$D = 60 \times \sqrt{(Lat1 - Lat2)^2 + (Lon1 - Lon2)^2 \times \cos^2\big(0.5 \times (Lat1 + Lat2)\big)} \qquad (2)$$

Lat1: Latitude at start of haul (degrees), Lat2: Latitude at end of haul (degrees); Lon1: Longitude at start of haul (degrees), Lon2: Longitude at end of hauls (degrees). The catch per unit area (CPUA, kg n.m^{-2}) for each haul was obtained, by:

$$CPUA = \frac{\frac{Cw}{t}}{\frac{a}{t}} = \frac{Cw}{a}\frac{kg}{nm^2} \qquad (3)$$

Where Cw/t: is the weight of catch and a/t: is the swept area (n.m²). The total biomass for each stratum was estimated using formula:

$$B = \frac{\overline{\left(Cw/a\right)} \times A}{X_1} \qquad (4)$$

Where A: is the total area of substratum and X_1: is the catch coefficient (the value of X_1 is usually chosen between 0.5 – 1.0. the value of X_1 was taken to be 0.5 in this investigation).
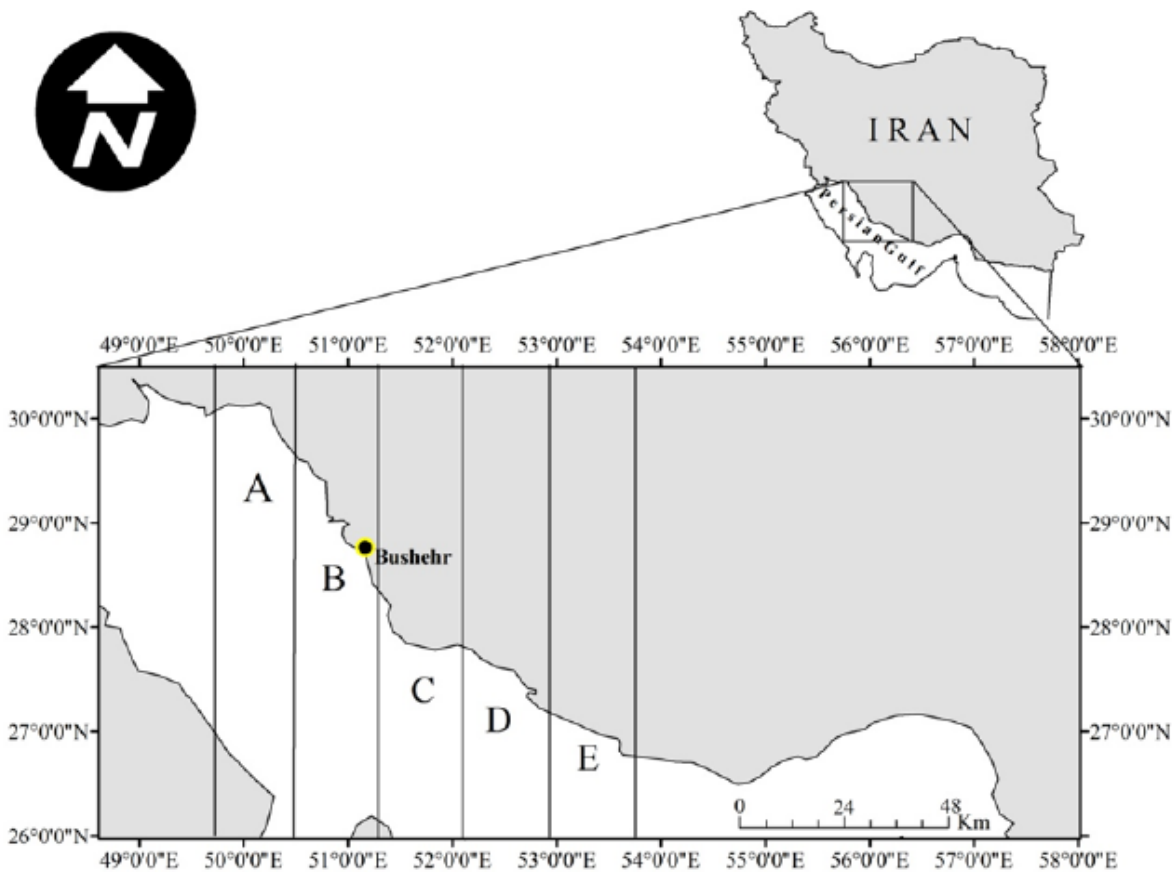

Fig. 1. Map of the Persian Gulf showing study area for stock assessment of shrimps in Bushehr coastal waters (A: Bandar-e Deylam to Jazire Shomali; B: Jazire Shomali to Rasolshat; C: Rasolshat to Rostami; D: Rostami to Rasolkhan and E: Rasolkhan to Motaf).

3. Results

At the present study *Penaeus semisulcatus* composed was about 97.5% of the total catch. However, other shrimp species, *Metapenaeus affinis*, *Metapenaeus stebbingi*, *Parapenaeopsis stylifera* and *Metapenaeopsis stridulans* were also found rarely. The results of the fishing surveys have been summarized in Tables 2, 3 and 4. The total biomass of shrimp was estimated 455 tonnes (Table 4). Mean CPUE of shrimp was 9.7 Kg.h-1. Maximum and minimum CPUE were found in strata A (0.7 Kg.h^{-1}) and D (22.3 Kg.h^{-1}), respectively (Table 2). Mean CPUA was calculated as 124.5 Kg. n.m^{-2}. The D and A stratums had higher and lower mean CPUA (351 Kg. n.m^{-2} and 14.8 Kg. n.m^{-2}), respectively (Table 3). A one-way analysis of variance (ANOVA) was used to investigate whether the catch rates (CPUE and CPUA) differed among different depths and showed not significant differences between them ($P > 0.05$). The highest biomass of shrimp was found in D stratum, in Rostami to Rasolkhan region, and in the depths of 10-20m (Table 4).

Table 2
Mean of catch per unit effort (CPUE, Kg. h^{-1}) of shrimp in Bushehr coastal waters of the Persian Gulf in 2011.

	A	B	C	D	E	average
CPUE in different spatial strata	0.7 <10m	4.9	6.7 10-20m	22.3	4.7 20-30m	**9.7**
CPUE in different depth zones	7.9		15.2		5.9	

Table 3
Mean of catch per unit area (CPUA, Kg. n.m.$^{-2}$) of shrimp in Bushehr coastal waters of the Persian Gulf in 2011.

	A	B	C	D	E	average
CPUA in different spatial strata	14.8 <10m	78	105 10-20m	351	74 20-30m	**124.5**
CPUA in different depth zones	100.2		197		124.6	

Table 4
Estimated biomass (tonnes) of shrimp in Bushehr coastal waters of the Persian Gulf in 2011.

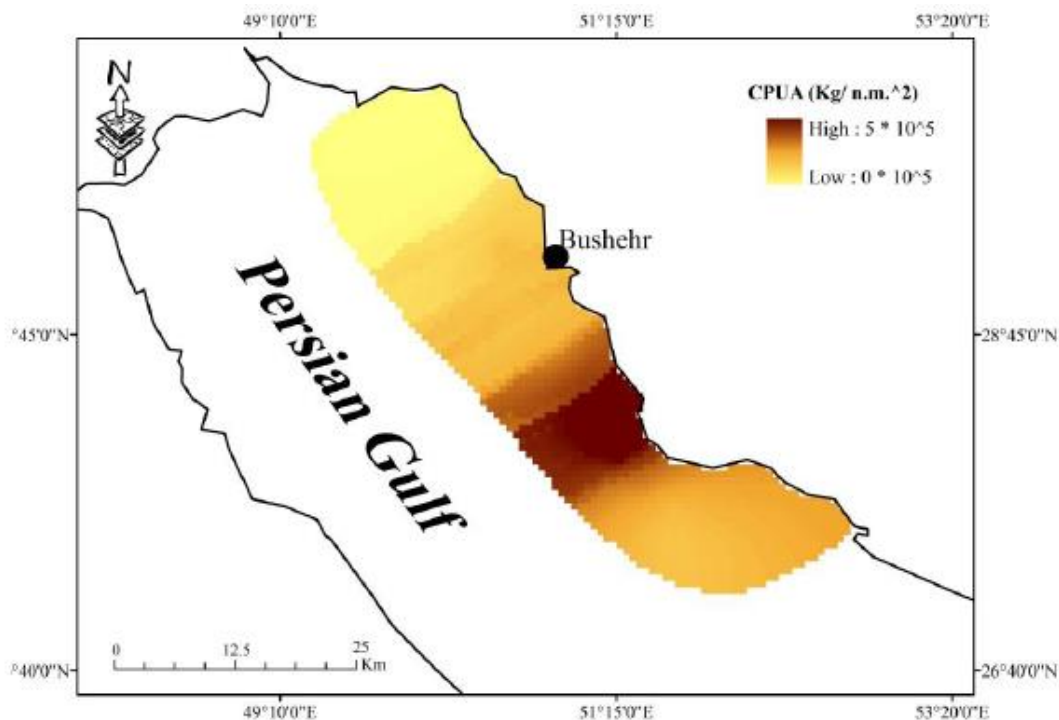|	A	B	C	D	E	average
Biomass in different spatial strata	26 <10m	46	81 10-20m	203	99 20-30m	**455**
Biomass in different depth zones	133		212		84	

Fig. 2. The abundance of shrimp in Bushehr coastal waters of the Persian Gulf in 2011.

4. Discussion

In order to access a sustainable management it is necessary to collect the biological data of that particular area. Biomass and CPUA are commonly used as stock indices for management of shrimp and fish (Sparre and Venema, 1992). Biomass estimates based on results from fishery trawl surveys are

considered to be more reliable than those derived strictly from commercial fisheries data because survey effort and trawl catchability can be controlled through standardization to minimize variability of these two parameters in time and space (Stauffer, 2004; Kotwicki et al., 2011). Shrimp is an important component of the coastal fisheries resources in Bushehr province. Other fisheries resources in this area are demersal fish, small pelagic fish and large pelagic fish (Fig. 3 indicate the status of fishing industry in Bushehr coastal waters during the years 2000-2010).
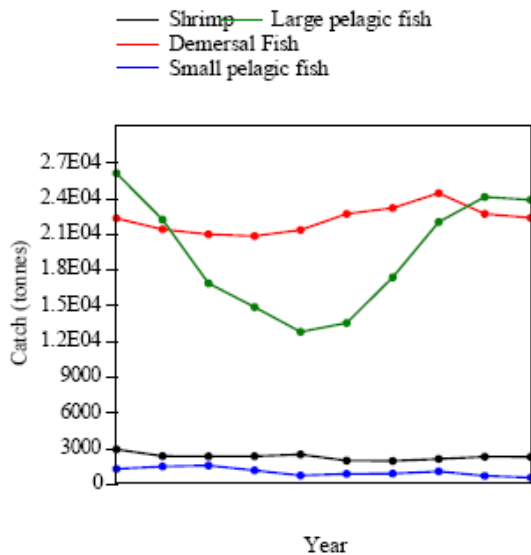
CPUE (Kg/h)

Fig. 4. The catch per unit effort (kg/h) of shrimp in Bushehr coastal waters during the years 2000-2011.

Fig. 3. Trends in fishing in Bushehr Province, northern Persian Gulf, 2000 to 2010 (data courtesy of the Iranian Fisheries Company).

Since the abundances of species (shrimp and fish) in the Persian Gulf are slowly decreasing (UNEP, 1999; UNEP, 2002), a rational and long-term approach to management is necessary to fisheries managers in the area. The decline can be due to adverse climatic and ecological conditions and unsustainable fishing practices.

Fig. 4 shows the catch rates of shrimp (Kg/h) in the waters of Bushehr in 2000 to 2011. Results indicate the lack of Sustainability in the exploitation of shrimp resources.

5. Conclusion

In order to access a sustainable management on shrimp resources, fishery managers should identify nursery grounds of shrimp and protect these areas in the near future.
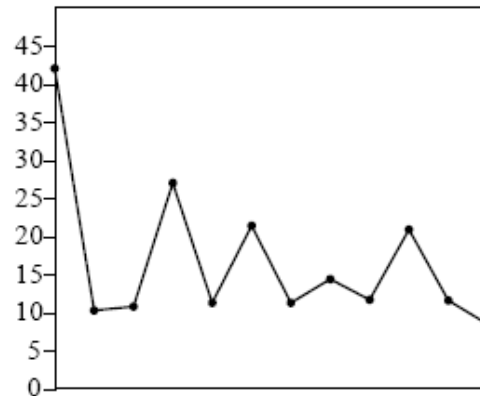
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