

# The By-catch Composition of Shrimp Trawl Fisheries in Bushehr Coastal Waters, the Northern Persian Gulf

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*Received: November 2011*

*Accepted: January 2012*

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## Abstract

This paper is a comprehensive study of the shrimp trawl by-catch from Bushehr coastal waters (N. Persian Gulf). Sampling operation was carried out in two shrimp fishing seasons using the (Saber and Jahanara) commercial trawlers. Generally, 87.5% of the total catch was by-catch and 12.5% was target species (shrimp). The catch composition included: 114 species from 45 teleostei families, 13 species from 7 elasmobranchs families and 13 species from 13 invertebrate families. Species composition of By-catch included: 72% teleosts, 14% elasmobranchs and 13.9% invertebrates. By-catch-to-shrimp ratio, CPUE index and catch percentage of species (based on Wt %) were computed. On average By-catch-to-shrimp ratio was estimated 7:1. It's estimated that 283.4 tonnes of By-catches are taken annually in Bushehr coastal waters by 12 steel trawlers.

Keywords: *Shrimp, Bottom trawl, By-catch, Bushehr, Persian Gulf*

## 1. Introduction

Bottom trawl nets are one of non-selective active fishing gears. Non-target species that are caught by bottom trawl are kept if they have commercial value and other species are discarded (Saila, 1983). The Food and Agriculture Organization (FAO) defines discards as "contribution of the total organisms in the catch composition which are returned to the sea (except aquatic plants)" (Bellido et al., 2011). Nowadays, By-catch and discarding catch are the most important topics in fishery management.

Because of the lack of data on By-catch and discards, it falsifies stock assessment (Walmsley et al., 2007). Also, discarding is significantly important due to economical aspects and environmental pollutions (Alverson and Hughes, 1996).

The Persian Gulf is in a subtropical zone, which is separated from the Oman Sea via the Strait of Hormuz (Fig. 1). The surface area of the Persian Gulf is approximately  $2.39 \times 10^5$  km<sup>2</sup> and its mean depth and volume are 36 m and  $8.63 \times 10^3$  km<sup>3</sup>, respectively (Reynolds, 1993). The fishing industry in the Persian Gulf has been important since archaic times. Major target species in the Persian Gulf

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include shrimps, mackerels and various Perciformes fishes, but abundances of these species are slowly declining (UNEP, 1999; UNEP, 2002).

Penaeid shrimps are valuable aquatics which their commercial exploitation began in 1959 in the Iranian waters of the Persian Gulf. During these times, fishing was limited to the Bushehr coastal waters on one species, *Penaeus semisulcatus* (Boerema, 1969). Currently, the Bushehr shrimp fishing is carried out by two types of industrial and traditional vessels. The industrial vessels consist of 12 steel trawlers and the traditional sector includes 372 wooden vessels and 630 fishing boats.

Unfortunately, data on catch composition of shrimp trawl fishery in the Persian Gulf is lacking and few researches have investigated about By-catch and discard in this area (Azar, 1981; Ibrahim et al., 1989; Yimin et al., 2000; Paighambari et al., 2003; Valinassab et al., 2006). As there is few documented reports about By-catch composition of shrimp trawl fisheries in Bushehr coastal waters, the purpose of this research was to estimate the catch composition, By-catch and discard in the shrimp trawl fishery and By-catch-to-shrimp ratio in Bushehr coastal waters (N, Persian Gulf).

## 2. Materials and Methods

This research was carried out in the shrimp fishing grounds of Bushehr province in Iranian waters during two shrimp fishing seasons in 2001 and 2002. The study area was limited to an area between 50° 6' - 52° 58' E and 27° 14' - 30° 16' N. Shrimp fishing grounds in Bushehr province included three regions: Northern part (Emam Hassan and Bandar-e Rig), Middle part (Bushehr and Tangestan) and Southern part (Motaf, Dayyer and Taheri).

Sampling operations were performed by C/V<sup>1</sup> Saber (bottom trawler with 27m length and 650 horse power engine) and C/V Jahanara (bottom trawler with

30m length and 850 horse power engine). Vessels were equipped with bottom trawl nets with a 14 fathom head rope (1 fathom=183 cm), a 15 fathom foot rope and 40 mm mesh size (STR) in the wings and body net and 30 mm (STR) in the cod-end. Bottom trawl nets and their covers were made of Polyamide (PA) with twine No: 210 D/39 and Polyethylene (PE), respectively. Towing ranged from 2 to 3 h (mean 2 h) at speeds of 2.5-3 knots and was carried out in depths between 6 and 33.5 m. Sub-samples were collected at 130 haul (Table 1) as follows:

Table 1. The number of hauls conducted in different depths of Bushehr coastal waters.

Region	Depth (m)		
	<10	10-20	20-30
Bushehr coastal waters	8	72	50

After unloading of the total catch on deck, all sea snakes and other poisonous species were removed. Also, turtles were separated and if alive, were returned to sea.

Sub-samples were provided from total catch (5-10% catch volume) and the shrimps and fishes (commercial fish and discards) species were recognized based on valid identification keys in the scientific references (Roper et al., 1984; Dore and Frimodt., 1987; Habibi, 1988; Tajalipour, 1994; Dehghaniposhtrodi and Asadi., 1996).

The fishes (commercial fish and discards) and shrimps were counted and weighed in each sub-sample. Subsequently, distributed to the total catch.

The Gulland equation's was used to assess CPUE<sup>2</sup> index for each species:

$$CPUE = \frac{C_w}{h}$$

Where  $C_w$  is the weight of catch (kg) and  $h$  is the tow times (hours) (Gulland, 1983). Also, the portion of total catch was estimated for each species (based on total weight). Data analysis was done by Excel and SPSS 19 softwares.

<sup>1</sup>. Commercial vessel

<sup>2</sup>. Catch per Unit Effort

### 3. Results

The total catch (kg) and CPUE (kg per each haul) of shrimp and By-catch in each fishing season are summarized in Table 2.

Table 2. Total catch (kg) and CPUE (kg per each haul) of shrimp and By-catch in each fishing season in Bushehr coastal waters.

Time	N	Total catch of shrimp	Shrimp CPUE	Total By-catch	By-catch CPUE	Total catch
Shrimp fishing season 1	52	2139	41.1	14498	278.8	16637
Shrimp fishing season 2	78	1599	20.5	11588	148.6	13187

N: The number of hauls

The contribution of target species (shrimp) and By-catch from the total catch was 12.5% and 87.5%, respectively. The catch composition included: 114 teleostei species from 45 families with average CPUE  $74.63 \pm 1.65 \text{ kg h}^{-1}$ , 13 elasmobranchs species from 7 families with average CPUE  $14.93 \pm 2.45 \text{ kg h}^{-1}$  and 13 invertebrates species from 13 families with average CPUE  $13.29 \pm 2.33 \text{ kg h}^{-1}$  (Table 3 and Fig. 1). The total By-catch weight consisted of 72% teleostei, 14% elasmobranchs and 13.9% invertebrates.

Table 3-1. The catch composition of shrimp trawl fisheries in Bushehr coastal waters (Northern Persian Gulf).

Family	Species	First fishing season			Second fishing season		
		Total weight (kg)	%of total catch	CPUE (kg/h)	Total weight (kg)	%of total catch	CPUE (kg/h)
Penaecidae	<i>Penaeus semisulcatus</i>	1839.540	11.107	17.689	1218.438	9.24	7.810
	<i>Metapenaeus affinis</i>	299.460	1.808	2.879	380.562	2.886	2.439
	<i>Parapenaeopsis stylifera</i>	246.466	1.488	2.370	295.494	2.241	1.894
Teleosts							
Carangidae	<i>Alectis indicus</i>	26.096	0.157	0.251	18.541	0.141	0.119
	<i>Alepes djedaba</i>	11.598	0.070	0.111	44.034	0.334	0.282
	<i>Alepes melanoptera</i>	42.044	0.254	0.404	52.146	0.395	0.334
	<i>Atropus atropos</i>	59.442	0.359	0.571	40.558	0.307	0.26
	<i>Atule mate</i>	2.175	0.013	0.021	37.082	0.281	0.238
	<i>Carangoides chrysophrys</i>	31.896	0.192	0.307	28.970	0.22	0.186
	<i>Carangoides armatus</i>	24.647	0.149	0.237	35.923	0.272	0.230
	<i>Carangoides malabaricus</i>	27.546	0.166	0.265	45.193	0.343	0.29
	<i>Caranx para</i>	50.743	0.306	0.488	77.640	0.589	0.498
	<i>Gnathanodon speciosus</i>	17.398	0.105	0.167	12.747	0.097	0.082
	<i>Megalaspis cordyla</i>	14.498	0.087	0.139	22.017	0.167	0.141
	<i>Parastromateus niger</i>	114.534	0.691	1.101	49.828	0.378	0.319
	<i>Scomberiodes commersonniaus</i>	88.438	0.534	0.850	17.382	0.132	0.111
	<i>Selaroides leptolepis</i>	15.948	0.096	0.153	-	-	-
	<i>Trachinotus mookalee</i>	11.598	0.070	0.111	6.953	0.053	0.044
	<i>Ulua mentalis</i>	-	-	-	15.064	0.114	0.096
	Clupeidae	<i>Anodontostoma chacunda</i>	150.779	0.910	1.450	34.764	0.264
<i>Dussumieria acuta</i>		82.639	0.499	0.795	165.708	1.257	1.062
<i>Ilisha megaloptera</i>		456.687	2.757	4.391	412.533	3.128	2.644
<i>Ilisha melastoma</i>		365.350	2.206	3.513	312.876	2.373	2.006
<i>Nematolosa nasus</i>		88.439	0.534	0.850	44.034	0.334	0.282
<i>Sardinella gibbosa</i>		102.936	0.621	0.990	127.468	0.967	0.817
<i>Sardinella longiceps</i>		78.290	0.473	0.753	46.352	0.351	0.297

Table 3-2. The catch composition of shrimp trawl fisheries in Bushehr coastal waters (Northern Persian Gulf).

Family	Species	First fishing season			Second fishing season		
		Total weight (kg)	%of total catch	CPUE (kg/h)	Total weight (kg)	%of total catch	CPUE (kg/h)
Haemulidae	<i>Sardinella melanura</i>	62.341	0.376	0.599	77.640	0.589	0.498
	<i>Tenualosa ilisha</i>	5.800	0.035	0.056	4.635	0.035	0.030
	<i>Diagramma pictum</i>	26.096	0.157	0.251	17.382	0.132	0.111
	<i>Plectorhinchus flavomaculatus</i>	11.598	0.070	0.111	-	-	-
	<i>Plectorhinchusgaterinus</i>	-	-	-	13.906	0.105	0.089
	<i>Plectorhinchus pictus</i>	4.349	0.026	0.042	-	-	-
	<i>Pomadasys furcatus</i>	8.700	0.052	0.084	3.476	0.026	0.022
	<i>Pomadasys kaakan</i>	130.482	0.788	1.255	149.485	1.133	0.958
	<i>Pomadasys maculatum</i>	34.795	0.210	0.334	46.352	0.351	0.297
	<i>Pomadasys stridens</i>	855.382	5.165	8.225	718.456	5.448	4.605
Lutjanidae	<i>Lutjanus erythropterus</i>	-	-	-	10.429	0.079	0.067
	<i>Lutjanus fulviflammus</i>	4.349	0.026	0.042	1.854	0.014	0.012
	<i>Lutjanus johni</i>	39.145	0.236	0.376	92.704	0.703	0.594
	<i>Lutjanus lutjanus</i>	1.406	0.008	0.013	-	-	-
	<i>Lutjanus malabaricus</i>	1.450	0.009	0.014	-	-	-
	<i>Lutjanus russelli</i>	7.249	0.044	0.07	10.429	0.079	0.067
Leiognathidae	<i>Liognathus bindus</i>	1725.262	10.417	16.589	1436.912	10.897	9.211
	<i>Liognathus equulus</i>						
	<i>Liognathus lineolatus</i>						
	<i>Secutor insidiator</i>						
Sciaenidae	<i>Argyrosomus hololepidotus</i>	27.546	0.166	0.265	24.335	0.184	0.156
	<i>Otolithes ruber</i>	282.711	1.707	2.718	162.232	1.230	1.04
	<i>Pennahia macrophthalmus</i>	111.635	0.674	1.073	185.408	1.406	1.188
	<i>Protonibea diacanthus</i>	-	-	-	3.476	0.026	0.022
	<i>Minous dempsterae</i>	-	-	-	2.318	0.017	0.015
	<i>Pseudosynanceia melanostigma</i>	0.870	0.005	0.008	1.854	0.014	0.012
	<i>Pterois russellii</i>	0.580	0.003	0.005	-	-	-
	Sphyraenidae	<i>Sphyraena forsteri</i>	43.494	0.263	0.418	82.275	0.624
<i>Sphyraena jello</i>		37.695	0.227	0.362			
<i>Sphyraena obtusatus</i>		50.743	0.306	0.488			
Gerreidae	<i>Gerres filamentosus</i>	27.546	0.166	0.265	95.022	0.720	0.609
	<i>Gerres poieti</i>	11.598	0.070	0.111	17.382	0.132	0.111
	<i>Pentaprion longimanus</i>	28.996	0.175	0.279	174.980	1.327	1.122
Nemipteridae	<i>Nemipterus japonicus</i>	275.462	1.663	2.649	451.932	3.427	2.897
	<i>Scolopsis taeniatus</i>	10.150	0.061	0.097	47.511	0.360	0.304
	<i>Eleutheronema tetradactylum</i>	1.450	0.009	0.014	3.476	0.026	0.022
Polynemidae	<i>Polynemus plebeius</i>	0.870	0.005	0.008	-	-	-
	<i>Polynemus sextarius</i>	24.647	0.149	0.237	54.464	0.413	0.349
Scombridae	<i>Rastrelliger kanagurta</i>	2.900	0.017	0.028	-	-	-

Table 3-3. The catch composition of shrimp trawl fisheries in Bushehr coastal waters (Northern Persian Gulf).

Family	Species	First fishing season			Second fishing season		
		Total weight (kg)	%of total catch	CPUE (kg/h)	Total weight (kg)	%of total catch	CPUE (kg/h)
Soleidae	<i>Scomberomorus commerson</i>	217.470	1.313	2.091	129.786	0.984	0.832
	<i>Scomberomorus guttatus</i>	246.466	1.488	2.370	123.992	0.940	0.795
	<i>Euryglossa orientalis</i>	101.486	0.613	0.976	75.322	0.571	0.483
	<i>Solea elongata</i>	86.988	0.525	0.836	11.588	0.088	0.074
	<i>Zebrias synapturoides</i>	10.150	0.061	0.097	-	-	-
Apogonidae	<i>Apogon quadrifasciatus</i>	17.398	0.105	0.167	9.850	0.075	0.063
	<i>Apogon thurstoni</i>	13.048	0.079	0.125	11.588	0.088	0.074
Drepanidae	<i>Drepane longimana</i>	20.297	0.122	0.195	24.335	0.184	0.156
	<i>Drepane punctata</i>	26.096	0.157	0.251	26.652	0.202	0.171
Lethrinidae	<i>Lethrinus lentjan</i>	7.249	0.044	0.070	-	-	-
	<i>Lethrinus nebulosus</i>	-	-	-	22.017	0.167	0.141
Monacanthidae	<i>Alutera monoceros</i>	11.598	0.070	0.111	8.112	0.061	0.052
	<i>Stephanolepis diaspros</i>	-	-	-	11.588	0.088	0.074
Mullidae	<i>Upeneus sulphureus</i>	608.916	3.676	5.855	844.765	6.406	5.415
	<i>Upeneus sundaicus</i>	39.145	0.236	0.376	62.575	0.474	0.401
Muraenesocidae	<i>Congresox talabon</i>	20.297	0.122	0.195	13.906	0.105	0.089
	<i>Muraenesox cinereus</i>	43.494	0.263	0.418	42.876	0.325	0.275
Platycephalidae	<i>Grammoplites suppositus</i>	173.976	1.050	1.673	103.133	0.782	0.661
	<i>Platycephalus indicus</i>	304.458	1.838	2.927	144.85	1.098	0.928
Serranidae	<i>Epinephelus bleekeri</i>	11.598	0.070	0.111	2.3176	0.017	0.015
	<i>Epinephelus coioides</i>	131.932	0.796	1.268	196.996	1.494	1.263
Siganidae	<i>Siganus sutor</i>	8.700	0.052	0.084	3.476	0.026	0.022
Sparidae	<i>Acanthopagrus cuvieri</i>	-	-	-	4.635	0.035	0.03
	<i>Acanthopagrus latus</i>	136.281	0.823	1.310	118.198	0.896	0.758
Tetraodontidae	<i>Chelonodon patoca</i>	10.150	0.061	0.097	11.588	0.088	0.074
	<i>Lagocephalus inermis</i>	13.048	0.079	0.125	15.064	0.114	0.096
	<i>Pseudotriacanthus strigilifer</i>	-	-	-	1.854	0.014	0.012
Triacanthidae	<i>Triacanthus biaculeatus</i>	18.847	0.114	0.181	23.176	0.176	0.148
	<i>Arius spp.</i>	681.406	4.114	6.552	677.898	5.141	4.345
Bothidae	<i>Pseudorhombus elevatus</i>	85.538	0.516	0.822	78.798	0.597	0.505
	<i>Acanthocephala abbreviata</i>	1.160	0.007	0.011	0.927	0.007	0.006
Chaetodontidae	<i>Heniochus acuminatus</i>	0.435	0.003	0.004	0.811	0.006	0.005
Chirocentridae	<i>Chirocentrus nudus</i>	144.980	0.875	1.394	40.558	0.307	0.26
Cynoglossidae	<i>Cynoglossus arel</i>	150.780	0.910	1.450	76.481	0.58	0.490
Echeneidae	<i>Echeneis naucrates</i>	1.160	0.007	0.011	-	-	-
Engraulidae	<i>Thryssa vitirostris</i>	13.048	0.079	0.125	10.429	0.079	0.067
Ephippidae	<i>Ephippus orbis</i>	14.498	0.087	0.139	11.588	0.088	0.074
	<i>Hemiramphus archipelagicus</i>	0.580	0.003	0.005	-	-	-

Table 3-4. The catch composition of shrimp trawl fisheries in Bushehr coastal waters (Northern Persian Gulf).

Family	Species	First fishing season			Second fishing season		
		Total weight (kg)	%of total catch	CPUE (kg/h)	Total weight (kg)	%of total catch	CPUE (kg/h)
Menidae	<i>Mene maculata</i>	14.353	0.087	0.138	8.112	0.061	0.052
Ophichthidae	<i>Ophichthus apicalis</i>	15.948	0.096	0.153	25.494	0.193	0.163
Platacidae	<i>Platax orbicularis</i>	5.80	0.035	0.056	-	-	-
Psettodidae	<i>Psettodes erumei</i>	3.173	1.916	3.051	39.399	0.299	0.252
Scatophagidae	<i>Scatophagus argus</i>	-	-	-	0.579	0.004	0.004
Sillaginidae	<i>Sillago sihama</i>	57.992	0.35	0.558	26.652	0.202	0.171
Stromateidae	<i>Pampus argenteus</i>	146.430	0.884	1.408	57.940	0.439	0.371
Synodontidae	<i>Saurida spp.</i>	292.860	1.768	2.816	193.520	1.467	1.240
Teraponidae	<i>Terapon jabua</i>	11.598	0.070	0.111	28.97	0.22	0.186
Trichiuridae	<i>Trichiurus lepturus</i>	253.715	1.532	2.439	53.305	0.404	0.342
Elasmobranchs							
Dasyatidae	<i>Dasyatis bennetti</i>	817.687	4.937	7.862	716.138	5.431	4.591
	<i>Himantura uarnak</i>						
	<i>Himantura walga</i>						
	<i>Hypolophus sephen</i>						
Myliobatidae	<i>Aetobatus narinari</i>	611.816	3.694	5.883	507.554	3.849	3.253
	<i>Aetomylaeus maculatus</i>						
	<i>Aetomylaeus nichofii</i>						
Rhinobatidae	<i>Rhinobatos annandalei</i>	8.700	0.052	0.084	-	-	-
Rhynchobatidae	<i>Rhynchobatus djeddensis</i>	28.996	0.175	0.279	17.382	0.132	0.111
Carcharinidae	<i>Carcharhinus dussumieri</i>	23.197	0.140	0.223	9.270	0.070	0.059
Hemiscyllidae	<i>Chiloscyllium arabicum</i>	565.422	3.414	5.437	324.464	2.460	2.08
	<i>Chiloscyllium punctatum</i>						
Invertebrates							
Syllaridae	<i>Thenus orientalis</i>	2.900	0.017	0.028	2.318	0.017	0.015
Portunidae	<i>Portunus pelagicus</i>	1290.322	7.791	12.407	489.014	3.708	3.135
Squillidae	<i>Squilla mantis</i>	27.546	0.166	0.265	32.446	0.246	0.208
Loliginidae	<i>Loligo duvacei</i>	7.249	0.044	0.070	4.635	0.035	0.03
Sepiidae	<i>Sepia pharaonis</i>	26.096	0.157	0.251	9.270	0.070	0.059
Octopodidae	<i>Octopus spp.</i>	-	-	-	0.579	0.004	0.004
Stromboidae	<i>Tibia curvirostris</i>	23.197	0.140	0.223	18.541	0.140	0.119
Scyphozoa		797.39	4.814	7.667	123.992	0.940	0.795
Echinoidea		24.647	0.149	0.237	10.429	0.079	0.067
Asteroidae		11.598	0.070	0.111	5.794	0.044	0.037
Holothurioidae		-	-	-	3.476	0.026	0.022
Hydrophidae	<i>Hydrophis pelamis</i>	17.398	0.105	0.167	23.176	0.176	0.148
Chelonidae	<i>Chelonia mydas</i>	-	-	-	79.957	0.606	0.512

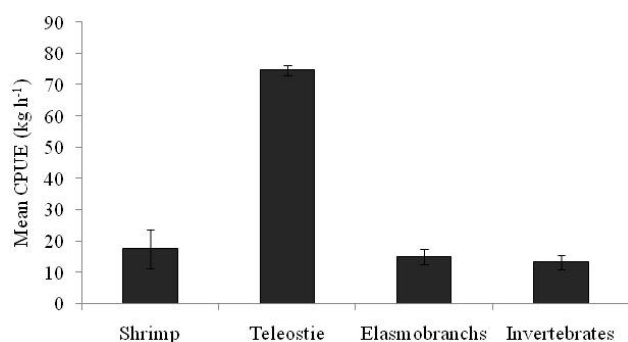


Fig. 1: Mean CPUE (kg h<sup>-1</sup>) of shrimp, teleostie, elasmobranchs and invertebrates in bottom trawls of Bushehr coastal waters (N. Persian Gulf)

Of the teleostei species, Carangidae had the most species (16), followed by the Clupeidae and Haemulidae (8), 19 families were represented by one species (Table 3). The families of Carangidae, Clupeidae and Haemulidae contributed over 19.22% of the weight of the total catch (Table 3).

Of the Elasmobranchs species, Dasyatidae had the most species (4) followed by the Myliobatidae (3). Three families were represented by one species (Table 3).

#### 4. Discussion

The subtropical and tropical zones, such as the Persian Gulf, are the most diverse ecosystems (Table 3). This research was a comprehensive study of the shrimp trawl By-catch from Bushehr coastal waters (N. Persian Gulf). Our study indicated that shrimp trawls generally produced large catches of fishes in the Persian Gulf. Since, there are many demersal fish species of the Persian Gulf that spawn from late winter to early summer or in autumn (Houde et al., 1986), shrimp trawl fisheries threaten these species assemblages by catching the adults and immature fishes. Many demersal fish species are protected, listed or endangered (IUCN, 2011). The catch data of fishes indicated 21% reduction in fish landing from 110,000 tonnes in 2002 to 87,240 tonnes in 2003 in the Persian Gulf (Valinassab et al., 2006, Planning and Development Department, 2003). Asadi (1990) has suggested that proportion of juvenile commercial fine

fish is 59.2% in the catch composition of shrimp trawls from Hormuzgan waters (N. Persian Gulf). Also, Azar (1981) has cited contribution of fine fish from total catch is 50% in the shrimp fishing grounds of Bushehr waters. These results indicated that shrimp trawl fishery was very destructive and could change species composition and populations structure of a region in the long term (Schratzberger, 2002).

If we assumed that the catch composition of this study was similar to other steel trawlers, the total annual By-catch could be estimated in Bushehr coastal waters as follows:

$$\text{annual By - catch} = \frac{\text{observed By - catch}}{\text{observed fishing effort}} \times$$

annual fishing effort

In recent years on average, shrimp fishing season in Bushehr province has been opened for 33 days. In this period, fishing has been carried out day and night. Therefore:

$$\text{Annual fishing effort} = N \times (33 \times 24 \text{ hours})$$

N: The number of steel trawlers (= 12)

$$\text{Annual By - catch} = \frac{26.086 \text{ tonnes}}{2 \times (33 \times 24 \text{ hours})} \times$$

$$9504 \text{ hours} = 141.7 \text{ tonnes}$$

$$\text{Total annual By - catch} = 141.7 \text{ tonnes} \times 2 = 283.4 \text{ tonnes}$$

(Steel trawlers are outriggers).

Also, in this investigation the value of discards was great. It is worrisome because (i) it directly affects the species diversity and balance in the Persian Gulf ecosystems (ii) and it potentially led to loss of income of fisheries (Bellido et al., 2011).

The catch composition of Penaeid shrimps consisted of: 71.45% *Penaeus semisulcatus*, 15.89% *Metapenaeus affinis* and 12.66% *Parapenaeopsis stylifera*. *Penaeus semisulcatus* contributed the highest share in the catch composition of Penaeid shrimps of Bushehr coastal waters, but this species are declining by over-exploitation (Niamaimandi et

al., 2007). Overfishing of *P. semisulcatus* is mostly due to illegal catch in the closure seasons, or also in the nursery grounds. It is concerned and if fisheries authorities do not attempt to reduce the fishing pressure on *P. semisulcatus*, the stocks of this species will be damaged in future.

By-catch-to-shrimp ratio can be used for estimating By-catch without presence of monitors aboard commercial trawlers and cruises. Alverson et al. (1994) calculated By-catch-to-shrimp ratio 4.17:1 in the Persian Gulf, also Valinassab et al. (2006) computed By-catch-to-shrimp ratio 2.67:1 for wooden traditional vessels in Hormuzgan coastal waters (N Persian Gulf). In our study, By-catch-to-shrimp ratio did not differ significantly between shrimp fishing seasons (Chi-square test;  $P > 0.05$ ), and the average By-catch-to-shrimp ratio was obtained 7:1. This is the first report for By-catch-to-shrimp ratio in steel trawlers of Iranian waters from the Persian Gulf. This ratio could cause ecological ill-effects on ecosystem and reduce fish stocks of the Persian Gulf in future. Results indicated that because of the critical condition of fish resources in Bushehr coastal waters, using of the BRDs<sup>1</sup> could be useful to decline By-catch and discards as a result of shrimp trawling.

### Acknowledgment

The authors thank the captains and crew of C/Vs Saber and Jahanara for their cooperation.

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