Journal of the Persian Gulf
(Marine Science)/Vol. 5/No. 16/June 2014/7/49-56

By-Catch and Discard Composition of Dhow Penaeid Trawl Fisheries in Hormuzgan Province, the Northern Persian Gulf

Kazemi, Seyed Hesam[1*]; Paighambari, Seyed Yousef[1]; Abaspour Naderi, Reza[2]

1- Fisheries Department, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran.
2- Iranian Fisheries Organization, Tehran, IR Iran.

Received: May 2013 *Accepted: March 2014*

Abstract

The present study aims to recognize dhow prawn trawl by-catch from Hormuzgan coastal waters (Northeast Persian Gulf). Sampling was carried out of 36 hauls by using traditionally wooden dhow among prawn fishing season in 2011. The catch composition consisted of 31.66% target species prawns, mainly banana prawn (*Penaeus merguiensis*) and 68.34% by-catch. The total by-catch was 4,622.67kg comprised of 56 species and 37 families. Species composition of by-catch was 81.08% Teleostei, 0.1% Elasmobranchs and 18.8% Invertebrates. Ulmaridae, leiognathidae and Mullidae were the most abundant families with mean CPUE of 10.06, 9.97 and 7.73 kg/hour, respectively. CPUE, Occurrence indices and catch percentage of species (based on Wt %) have been calculated. Prawn-to-by-catch ratio was computed at 1:2.15. It was estimated that annual volumes of the entire fleet dhow prawn trawls in Hormuzgan coastal waters consisted of 5,728 tons of by-catch.. The investigation of the by-catch showed the large pressure on commercial and non-commercial fish stocks in the fishing grounds of northern Persian Gulf; Therefore, fishery managers need to consider other species when determining catch or effort limits, prawn fishing season and area restrictions.

Keywords: *Dhow prawn traw1, By-catch, Hormuzgan, Persian Gulf, Penaeus merguiensis.*

1. Introduction

Bottom trawling is a non-selective method, which changes diversity, community structure, trophic structure and productivity of macrobenthic invertebrate communities (Dyton et al, 1995; Jennings & Kaiser, 1998; Lindeboom & Groot, 1998; Hall, 1999; Collie et al, 2000; Gislason et al, 2000; Kaiser & Groot, 2000). Approximately an average of 27 (range of 17.9 to 39.5) million tons of fish are discarded annually in contrast to annual world prawn landings which is about 1.8 million tons, the annual by-catch and discarded catch of 11.2 and 9.5 million tons, respectively (*Alverson et al., 1994*). Prawn trawls fisheries in tropical waters, has the highest total amount of discards (*Alverson et al., 1996;* Kelleher, 2005; Bellido et al., 2011). By-catch and discarding are one of the most important issues in fisheries management (Ohaus, 1990; Schoning et al.,

* *Email: hesam_pep@yahoo.com*

1992; Alverson et al., 1994; Alverson & Hughes, 1996; Alverson, 1997; Crowder and Murawski, 1998; Costa et al., 2001; Kelleher, 2005; Catchpole & Gray, 2010) because they affect the ecology of a system, the economy of fisheries and management structure and the sociology of a community (Alverson et al., 1994).

The Persian Gulf is lying in sub-tropical climate with an average depth of 36m (*Kampf & Sadrinassab, 2006*). Penaeid prawns are widely distributed in such tropical and sub-tropical areas of the world. Prawn fishing open season is based on estimations on the Catch per Unit Effort(CPUE, kg/h) and carapace length determined through pre-surveys carried out by Ecological Research Center, while time of fishing closure is based on the trend of CPUE (kg/boat-day) during the fishing season and/or a final catch rate (*Niamaimandi et al., 2007*).

Prawn trawling is one of the most important fishing systems in the Persian Gulf and accomplished mainly by employing dhows, wooden or fiberglass vessels less than 30m in length and an average towing speed of 2.5 knots. Fishing trials are concentrated at depth of 8-30m and deployment time is between 1-3 hours depending on fishing area and cod-end catch bulk. Prawns (irrespective of size) are brought to the port for sale. The incidental catch, including certain species are also saved for sale by the fishing fleet. The other part of catch is discarded catch and usually taken to the port to be transformed into flour and fish meal, as practiced commonly in Hormuzgan, Iran (the study area). A concern with the inshore dhow prawn fisheries, however, is its impact on the diverse populations of non-target species on the shallow parts of Iranian waters of the Persian Gulf. Another concern is the volume of the by-catch, including *Aurelia aurita, Leiognathus* Sp., *Sepia pharaonis, Pampus argenteus and Scomberomorus commerson*. Despite such concern, studies on by-catch and discards and investigations on catch composition of prawn trawl fishery in the Persian Gulf are few (*Paighambari et al., 2003; Valinassab et al., 2006*). Therefore, it is the objective of this investigation to estimate by-catch and discards, catch composition in the dhow prawn fishery in the coastal waters of the Persian Gulf in Hormuzgan.

2. Materials and Methods

The area of study expends in prawn's fishing ground of Hormuzgan (northeast of the Persian Gulf), between 56 06 - 57 07 E and 26 25 - 27 07 N (Figure 1). Subsamples were collected at commercial condition from traditionally wooden dhow, bottom trawler with 19.8m length and 2m draft and 405 hp engine which had a bottom trawl net made of polyethylene (PE 3mm diameter – double braided) with 22.3m Head line and 25.1m Fishing line. Mesh size of the net was 25mm (STR) and 40mm (STR) in the cod-end and body, respectively. Average towing duration and trawling depth were 1.5 h (1.3-1.8 h) and 14.5 m (5-22 m). All hauls were done in daylight at an average speed of 2.5 knots (1.8-3.1 knots).

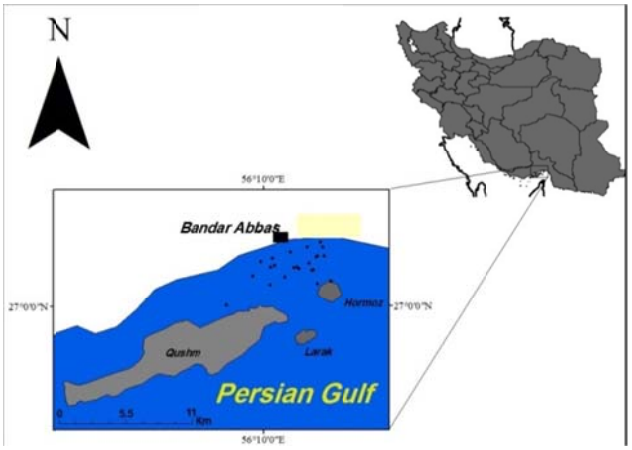

Fig. 1: Map of the study area in the Persian Gulf. The black points show the sampling locations.

Sampling was done at 36 hauls in prawn fishing season on October 2011. After each haul, prawns and incidental catch (commercial fishes) were sorted into species, then counted and weighted. Subsamples were taken from total discard catch (5 - 10 % catch weight), counted and weighed as well. Species were identifed on the basis of scientific references (*Dore & Frimodt, 1987; Tajalipour, 1994; Carpenter et al.,*

1997). CPUE of each species was accounted with the equation below:

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

Where C_w is the weight of catch in kg and h is the tow times (h) (Gulland, 1983). Total portion of each species was estimated based on total weight. Also, the identified species were labeled according to an occurrence index expressed by Dos santos (2002) as below:

$$S_{occ} = \frac{n_i}{N} 100$$

Where S_{occ} is the species occurrence index, n_i is the number of hauls in which the species occurred and N is the total number of hauls. The species were then allocated according to S_{occ} as:

Rare species, caught less than 10% of the times; Uncommon species, caught between 10 and 25% of the times; Common species, caught between 25 and 50% of the times and ;

Very common species, caught more than 50% of the times. Also, the total annual by-catch in dhow prawn trawlers of Hormuzgan, with the assumption that the catch composition of this study was similar to that of other dhow prawn trawlers:

$$\text{Annual By-catch} = \frac{\text{Observed By-catch}}{\text{Observed fishing effort}} \times \text{Annual fishing effort}$$

Where observed by-catch is the amount of total by-catch during sampling trials (kg), observed fishing effort is calculated from: N × (36 × 1.5 hours), where N is the number of dhows that sampling carried out on with, 36 is total hauls and 1.5 hours is the mean time of fishing. The annual fishing effort was estimated as follows:

Annual fishing effort = N × (41 × 12 hours)

Where *N* is the number of dhow prawn trawlers (=136), 41 is the number of duration days of prawn open season, and 12 hours is the legal time for doing prawn trawling.

3. Results

The total catch was composed of 31.66% prawn and 68.34% by-catch (Table1). Incidental catch comprised of 20 commercial fish species and two crustaceans from Portunidae and Sepiidae, and discard catch consisted of one invertebrate, 3 elasmobranches and 30 fish species. In general, four prawn species belonging to penaeidae, 50 teleostei species of 32 families (55.41% from the total catch), 3 elasmobranchs species of 2 families (0.069% from the total catch) and 3 invertebrate species of 3 families (12.85% from the total catch), were identified (Table 2).

Table 1: Total catch (kg) and CPUE (kg/hour per haul) of prawn, discard and incidental catch in a prawn fishing season in Hormuzgan coastal waters (number of hauls = 36).

	Total catch	CPUE	% from total
Prawn	2141.60	39.65	31.66
Incidental catch	562.71	10.42	8.31
Discard	4059.96	75.18	60.03
Total	6764.27	125.25	100

Banana prawn (*Penaeus merguensis*) was dominant prawn species and Sepia pharaonis (2.00%), Pennahia macrophthalmus (1.074%) and *Pampus argenteus* (0.88%) formed the most biomass of incidental catch. Leiognathus Sp. (9.97%) and *Aurelia aurita* (10.06) made the most biomass of Discard catch, and Clupeidae comprised the most frequent species of teleostei fish (5), also Leiognathidae was the most abundant families, representing 9.97% of the whole catch (Table 2).

Many of these small fish mostly (*Ilisha melastoma*) were gillnetted by the net. Overall, there was jelly fish in 12 of 36 sampling hauls with a share of 10.06 % of total catch weight and 12.6 kg mean CPUE in each haul. This part of by-catch, especially when a large bulk is caught in a haul (we have documented more than 400 kg jelly fish in a haul) affected changes in body of the net. It seems that using a size selective BRD (By-catch Reduction Device) such as grid, which could add to a more effective species separation BRD, for example, SMW (Square Mesh Window), is preferred to reduce jelly fish and total by-catch in such multi-species fisheries system.

Table 2.1: The catch composition of dhow prawn fishery in Hormuzgan coastal waters in 2011 (Northeast Persian Gulf)

Order	Family	Species	Total weight (kg)	CPUE ($kg.h^{-1}$ per haul)	% of total catch	Occurrence	Commercial value
Anguilliformes	Muraenesocidae	*Muraenesox cinereus*	0.27	0.005	0.003	Rare	
Aulopiformes	Synodontidae	*Saurida tumbil*	180.74	3.346	2.671	Uncommon	
Clupeiformes	Chirocentridae	*Chirocentrus dorab*	0.37	0.006	0.005	Rare	
	Clupeidae	*Ilisha megaloptera*	224.60	4.159	3.32	Uncommon	
		Ilisha melastoma	570.10	10.557	8.428	Very common	
		Nematalosa nasus	256.40	4.748	3.79	Very common	
		Dussumieria acuta	1.95	0.036	0.028	Rare	
		Anodontostoma chacunda	0.65	0.011	0.009	Rare	
Decapoda	Penaeidae	*Penaeus merguiensis*	1994.48	36.934	29.485	Very common	
		Metapenaeus affinis	134.82	2.496	1.993	Very common	
		Penaeus semisulcatus	10.10	0.186	0.149	uncommon	
		Parapenaeopsis stylifera	2.20	0.040	0.032	Uncommon	
	Portunidae	*Portunus pelagicus*	53.25	0.986	0.787	Common	*
Siluriformes	Ariidae	*Arius dussumieri Arius tenuispinis*	273.50	5.064	4.043	Very common Very common	
Perciformes	Carangidae	*Parastromateus niger*	39.05	0.723	0.577	Common	*
		Scomberoides tol	0.16	0.002	0.002	Rare	
		Atule mate	222.60	4.122	3.29	Very common	
	Drepanidae	*Drepane longimana*	0.20	0.036	0.002	Rare	
	Ephippidae	*Ephippus orbis*	0.35	0.006	0.005	Rare	
	Gerreidae	*Gerres longirostris*	41	0.759	0.606	Common	
	Haemulidae	*Pomadasys stridens*	0.67	0.012	0.009	Rare	*
		Pomadasys kaakan				Rare	*
		Pomadasys maculatum				Rare	*
	Lactaridae	*Lactarius lactarius*	5.58	0.103	0.082	uncommon	
	leiognathidae	*Leiognathus brevirostris*	674.49	12.490	9.971	Very common	
		Leiognathus bindus				Very common	
	Lutjanidae	*Lutjanus johnii*	0.31	0.005	0.004	Rare	*
		Lutjanus russelli				Rare	*
	Mullidae	*Upeneus sulphureus*	523.2	9.688	7.734	uncommon	
	Nemipteridae	*Nemipterus japonicus*	0.40	0.007	0.005	Rare	
	Polynemidae	*Eleutheronema tetradactylum*	1.60	0.029	0.023	Rare	*
	Sciaenidae	*Pennahia macrophthalmus*	72.66	1.345	1.074	Common	*
	Scombridae	*Otolithes ruber*	21.24	0.393	0.314	Very common	*
		Scomberomorus guttatus	1.09	0.020	0.016	uncommon	*
		Scomberomorus commerson	27.02	0.500	0.399	Very common	*
		Rastrelliger kanagurta	0.22	0.003	0.003	Rare	
	Serranidae	*Epinephelus coioides*	3.20	0.059	0.047	Rare	*
	Sillaginidae	*Sillago sihama*	8.24	0.152	0.121	Common	*
	Sparidae	*Acanthopagrus latus*	0.41	0.007	0.006	Rare	
	Sphyraenidae	*Sphyraena putnamiae*	11.47	0.212	0.169	Very common	*
	Stromateidae	*Pampus argenteus*	59.53	1.102	0.880	Very common	*
	Terapontidae	*Pelates quadrilineatus*	1.65	0.030	0.024	Rare	

Table 2.2: The catch composition of dhow prawn fishery in Hormuzgan coastal waters in 2011 (Northeast Persian Gulf)

Order	Family	Species	Total weight (kg)	CPUE ($kg.h^{-1}$ per haul)	% of total catch	Occurrence	Commercial value
	Trichiuridae	*Trichirus lepturus*	383.70	7.105	5.672	Very common	
Mugiliformes	Mugilidae	*Liza dussumieri*	10.75	0.198	0.158	Rare	*
Orectolobiformes	Hemiscylliidae	*Chiloscyllium arabicum*	2.50	0.046	0.036	Rare	
Pleuronectiformes	Cynoglossidae	*Cynoglossus arel*	44.30	0.820	0.654	Common	*
	Psettodidae	*Psettodes erumei*	13.95	0.258	0.206	Common	*
	Soleidae	*Brachirus orientalis*	8.68	0.160	0.128	Uncommon	*
Rajiformes	Dasyatidae	*Dasyatis bennetti* *Himantura uarnak*	2.20	0.040	0.032	Rare Rare	
Scorpaeniformes	Platycephalidae	*Platicephalus indicus* *Grammoplites scaber* *Grammoplites suppositus*	61.11	1.131	0.903	Common uncommon uncommon	*
Semaeostomeae	Ulmaridae	*Aurelia aurita*	680.50	12.601	10.060	Common	
Sepiida	Sepiidae	*Sepia pharaonis*	135.71	2.513	2.006	Very common	*
Tetraodontiformes	Tetraodontidae	*Lagocephalus lunaris* *Chelonodon patoca*	0.35	0.006	0.005	Rare Rare	
	Triacanthidae	*Triacanthus biaculeatus* *Pseudotriacanthus strigilifer*	0.75	0.013	0.011	Rare Rare	

4. Discussion

Valinassab et al. (2006), identified 88 species in traditional prawn dhow trawls, but we isolated only 60 species in our study. From a by-catch perspective, the prawn trawling is the most damaging fishery activity (Vianna & Almeida, 2005), Therefore, having in mind the similarity in sampling methods, the reduction in species numbers may be contributed to stocks depletion after dhows fishing intensive activities in the area for so long. Also, changes in foraging behavior and geographic distribution in reaction to environmental factors can change catchability of organisms from year to year (Tremblay et al., 2006). However, proportion of some discard species (e.*g. Aurelia aurita, Illisha melastoma, Illisha megaloptera, leiognathus Sp*) has been stable nine years after Valinassab sampling in 2002 till our study in 2011indicating that dhow prawn fisheries had maintained sustainable mortality of their stocks.

This research reports that sub-tropical and tropical zones, are the most divers ecosystems and many by-catch species with only a few dominant ones caught in prawn trawl fishery in these area. The most of these species are juvenile and immature fish (Paighambari et al., 2003). So, prawn trawls can destroy the stocks of fish, especially the species that have very common occurrence in the region (Table 2). Returning discard fish into the sea is not common in the study area, so dhow prawn fishery influences on the marine ecosystem by disturbing the sea bottom and killing huge amounts of non-target species and young of springs of commercially valuable species. The annual by-catch which accomplished by dhows at Hormuzgan was calculated as much as 5,728 metric tons.

The method assessed the weight of fish discarded annually by the dhow trawl fleet and generally provided estimates for a given species of the same order of magnitude. However, in some cases effort-based estimate is greatly different from landing-based estimate, particularly for shoaling species (e.g. *Leiognathidae, Clupeidae and Trichiuridae*) that are either absent from a trawl or contribute to a notable proportion of the total catch.

Paighambari and Daliry (2012) reported prawn-to-by-catch ratio 1:7 in stern trawlers. We have shown

prawn-to-by-catch ratio in dhows (1:2.15) is much smaller than stern trawlers as well as smaller than ratio (1:2.67) expressed by Valinassab et al. (2006). However, the use of the BRDs can be profitable to reduce by-catch of prawn trawling (Eayrs et al., 2007). It is essential to recognize the importance of various technical factors (such as mesh size and tow duration of trawl hauls), physical oceanographic factors (such as water depth and region) and biological factors (such as species mix, total catch and year-class strength) in designing management programs to maximize landings and minimize discards from such mixed-species ecosystems (Murawski, 1996). However, more studies on fish behavior and the net structure with underwater cameras could prove useful in better understanding of prawn trawl fishing.

References

Alverson, D. L. 1997. Global assessment of fisheries by-catch and discards: a summary overview, Global Trends. Fisheries Management, (20): 115–125.

Alverson, D.L., Freeberg, M.H., Pope, J.G. and Murawisk, S.A. 1994. A global assement of fisheries by-catch and discards. FAO Fisheries Technical Paper, (339):1‑233.

Alverson, D.L., Freeberg, M.H., Murawski, S.A. and Pope, J.G. 1996. A global assement of fisheries by-catch and discards. FAO Fisheries Technical, pp:339.

Alverson, D.L. and Hughes, S.E. 1996. By-catch: from emotion to effective natural resource management. Review in Fish Biology and Fisheries, (6): 443-442.

Bellido, J.M., Begona santos, M., Grazia pennino, M., Valeiras, X. and Pierse, G.J. 2011. Fishery discards and By-catch: solutions for an ecosystem approach to fisheries management. Hydrobiologia, (670): 317-333.

Carpenter, K.E., Krupp, F., Jones, D.A. and Zajonz, U. 1997. Living marine resources of Kuwait, Eastern Saudi Arabia, Bahrain, Qatar and UAE. FAO Species Identification Field guide for Fishery Purposes, 1-293. Rome, Italy, FAO Publication.

Catchpole, T.L. and Gray, T.S. 2010. Reducing discards of fish at sea: a review of European pilot projects. Journal of Environmental Management, (91): 717–723.

Collie, J.S., Hall, S.J., Kaiser, M.J. and Poiner, I.R. 2000. A quantitative analysis of fishing impacts on shelf sea benthos. Journal of Animal Ecology, (69):785–798.

Crowder, L. B. and Murawski, S.A. 1998. Fisheries bycatch: Implications for management. Fisheries, 23(6):8-17.

Dayton, P. K., Thrush, S. F., Agardy, M.T. and Hofman, R.J. 1995. Environmental effects of marine fishing. Aquatic Conservation, (5): 205–232.

Dore, I. and Frimodt, C. 1987. An illustrated guide to prawn of the world. Ospreybooks. 205P.

Dos Santos, M.N., Saldanha, H.J. and Garcia, A. 2002. Observations on by-catch from a tuna trap fishery off the Algarve (Southern Portugal). ICCAT, 54(5):1726-1732.

Eayrs, S., Hai, N.P. and Ley, J. 2007. Assessment of a juvenile and trash excluder device in a Vietnamese prawn trawl fishery. ICES Journal of Marine Science, (64): 1598-1602.

Gislason, H., Sinclair, M., Sainsbury, K. and O'Boyle, R. 2000. Symposium overview: incorporating ecosystem objectives within fisheries management. ICES Journal of Marine Science, (57):468–475

Gulland, J.A. 1983. Fish stock assessment a manual of basic methods. FAO/Wiley Series on Food and Agriculture. Vol 1. Wiley-Interscience. Chichester. UK. 223P.

Hall, S.J. 1999. The effects of fishing on marine ecosystems and communities. Blackwell, Oxford.

Jennings, S. and Kaiser, M.J. 1998. The effects of fishing on marine ecosystems. Advances in Marine Biology, (34):201–352.

Kaiser, M.J., Groot, S.J. 2000. The effects of fishing on non-target species and habitats: biological, conservation and socio-economic issues. Blackwell, Oxford. 420P.

Kampf, J. and Sadrinasab, M. 2006. The circulation of the Persian Gulf: a numerical study. Ocean Science, (2): 27–41.

Kelleher, K. 2005. Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper No. 470. FAO, Rome: 131 pp.

Lindeboom, H.J., Groot, S.J. 1998. The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. Netherlands Institute of Sea Research, Texel.

Murawski, S.A. 1996. Factors Influencing By-catch and Discard Rates: Analyses from Multispecies/Multifishery Sea Sampling. Journal of Northwest Atlantic Fishery Science, (19): 31–39.

Niamaimandi, N., Arshad, A.B., Daud, S.K., Saed, R.C. and Kiabi, B. 2007. Population dynamic of green tiger prawn, Penaeus semisulcatus (De Haan) in Bushehr coastal waters, Persian Gulf. Fisheries Research, (86): 105-112.

Ohaus, T. 1990. By-catch. Pacific Fishing. November 1990: 44-51.

Paighambari, S.Y. and Daliri, M. 2012. The By-catch Composition of Prawn Trawl Fisheries in Bushehr Coastal Waters, the Northern Persian Gulf. Journal of the Persian Gulf (Marine Science), 3(7): 27-36.

Paighambari, S.Y., Taghavi, S.A., Ghadairnejad, S.H., Seyfabadi, J. and Faghihzade, S. 2003. Comparing the effect of several BRD on reducing commercial species fishing smaller than LM50 in prawn trawls fishery in the Persian Gulf. Iran Journal of Fisheries Science. (12): 13-33. (In Persian).

Schoning, R. W., R. W. Jacobsen, D. L. Alverson, T. H. Gentle, and J. Auyong (eds.), 1992. Proceedings of the National Industry By-catch Workshop, February 4–6, 1992, Newport, Oregon (available from Natural Resources Consultants, 4055 21st W., Seattle, WA 98199).

Tajalipour, M. 1994. Study of systematic and mollusks distribution in Iranian coastal waters of the Persian Gulf. Publication of Kheybar. 403P. (In Persian).

Tremblay, M.J., Smith, S.J., Robichaud, D.A., and Lawton, P., 2006. The catchability of large American lobsters (Homarus americanus) from diving and trapping studies off Grand Manan Island, Canadian Maritimes. Canadian Journal of Fisheries and Aquatic Sciences (63): 1925–1933.

Valinassab, T., Zarshenas, G.A., Fatemi, M.R. and Otobidae, S.M. 2006. By-catch composition of small-scale prawn trawlers in the Persian Gulf (Hormuzgan province), Iran. Iran Journal of Fisheries Science. (15): 129-138. (In Persian).

Vianna, M. and Almeida, T. 2005. Bony fish bycatch in the southern Brazil pink prawn (*Farfantepenaeus brasiliensis and F. paulensis*) fishery. Brazilian Archives of Biology and Technology, 48(4):611‑623.