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Performance of a Square Mesh Panel in Capturing Immature Indian Halibut in Shrimp Trawlers in the Persian Gulf

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Abstract

The performance of a square mesh panel (90 mm stretched mesh size) on reducing the catch of immature *Psettodes erumei* Bloch and Schneider, 1801 smaller than Lm50% value was tested in a small-scale shrimp-trawl fishery along Hormuzgan coasts in the The Persian Gulf. During shrimp season, 25 trawl hauls were carried out and a total of 371 *P.erumei* was caught in the codend and cover net. Length ranges of Indian halibut caught in the codend and cover net were 8-35.2 cm and 9-25 cm and their mean lengths were 24.58±5.8 cm and 15.29±3.5 cm, respectively. Two sample Kolmogorov-Smirnov tests detected significant difference in the size-frequency distribution of *P.erumei* between codend and codend plus cover net (Dks= 2.464; P< 0.001). The results of two-sample t-tests detected a significant difference (P<0.001) in the mean length of *P.erumei* caught in the codend and cover net. The escape rate, based on number was 28.8%. The length of 50% retention (*L50*) was 17.2 cm and differed greatly from the Lm50% (37.3 cm). The square mesh panel efficiency was not so acceptable. An increase in mesh size of codend or mesh size of square mesh panel during shrimp fishing season will be required to delay capture until fish is reached Lm50% and Lm value. It is more likely that samples of immature Indian halibut were influenced by the spatial and temporal distribution of the species as well as mesh size of panel, weak swimming capability of *P.erumei* and body form of species.

Keywords: *Psettodes erumei, Square mesh panel, Immatur, Shrimp trawl, Hormuzgan coasts*

1. Introduction

Indian halibut (*Psettodes erumei* Bloch & Schneider, 1801) is the single species belonging to Psettodidae family that lives in the Persian Gulf and Oman Sea. It`s body is oval-shaped and flat but fairly thick (Hensley, 1997). Indian halibut is highly predacious and predominantly a piscivorous fish and often swims in an upright position (Das and Mishra, 1990). This species which mostly lives in muddy-sandy substrates up to 25 m depths (Ramamathan and Natarjan, 1980) is one of commercial species mainly caught with bottom trawl in the Persian Gulf. Reported Lm50% of Indian halibut was 37.3 cm (Kamali et al., 2006; Farahani et al., 2005).

Total catch of demersal species in the world reached about one million tons in 2001 (Fishery

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Statistics Year Book; FAO, 2002). In Iran, catch of Indian halibut was 2149 tons in 1997 and 1858 tons in 2002 (Planning and Development Department of Iran Fisheries Company, 2003). Indian halibut is considered as bycatch in the shrimp trawl in the Persian Gulf (Valinassab et al. 2006; Paighambari and Daliri, 2012; Eighani and Paighambari, 2013).

In tropical shrimp fisheries, shrimps are generally part of a species assemblage where the size of the target shrimp overlaps with the size of the juvenile fish that need to be excluded from the net (Eighani and Paighambari, 2013). The fishermen prefer to reduce only the catches of undesirable fish and shrimp sizes and retain larger valuable specimens for local consumption or export.

The Persian Gulf is in the subtropical zone lying between 24° and 30° latitude and has a vast area of shallow water which is known to be a preferred habitat for demersal species (Sheppard et al. 1992; Reynolds, 1993). Major target species in the Persian Gulf include shrimps, mackerels and various perciform fishes (Valinassab et al. 2006). An average of about 70 to 75% of the total catch weight per haul was recorded as bycatch in the Persian Gulf shrimp fishery (Valinassab et al. 2006; Paighambari and Daliri, 2012).

The reduction problem of juvenile stocks in commercial species by shrimp trawl net is a global concern. Shrimp trawling is generally regarded as one of the least selective fishing methods since the bycatch may consist of over several hundred teleost species (Clucas, 1997; Kelleher, 2005; Eayrs, 2007). No other fishing method comes close to matching such discarding and wastage of marine resources.

A suite of management regulations should be implemented in the fishery to protect the juvenile of commercial species and minimize the physical impacts of fishing on the environment. Many of the valuable commercial species live in the shrimp fishing grounds of the Persian Gulf, and shrimp trawling threatens immature specimens that are smaller than the length at first maturity (Lm50%) (Paighambari et al., 2002). The most common management strategy to reduce bycatch from shrimp trawling is to install physical devices, collectively termed “bycatch reduction devices” (BRDs) (Broadhurst, 2000; Eayrs, 2007). The first experiments done for SMP in shrimp trawl in the Persian Gulf were done with a SMP of 10 cm stretched mesh located in the top panel of extension excluded 26% of the bycatch and 4% of the shrimp by weight (Kahfizadeh, 1994). The SMP reduce the bycatch of juvenile flounder and trash fish in shrimp beam trawls in the Inland sea of Japan (Tokai and Kitahara, 1991). Many studies in the Mediterranean (Sarda et al., 2006; Ozbilgin et al., 2012) and Australia (Brewer et al. 1998) have shown that the use of SMP in the trawl codends reduces the bycatch of juvenile fish. Since, it was acceptable achievement in the small fish exclusion, in this study, we assessed the performance of a square mesh panel to reduce the catch of juvenile Indian halibut smaller than Lm50% (the length at which 50% of fish are mature) in the shrimp-trawl fishery along Hormuzgan coasts in the Persian Gulf.

2. Materials and Methods

2.1. Sea trails

Sampling operations were performed using two wooden fishing dhows (bottom shrimp trawlers with 19.80 m in long, and 405 horsepower for engines) during October and November 2011 and 2012. Overall, 25 trawl hauls were carried out at a towing speed of ~ 2.2 knots and in tow duration of 90 min. Fishing depth was 8-25 m. The study area was divided into two regions: Hormuz-Keshtisoukhte (56° 27′ E, 27° 07′ N) to (56° 18′ E, 27° 06′ N) and Keshtisoukhte-Toola (56° 18′ E, 27° 06′ N) to (55° 58′ E, 26° 58′ N). (Figure 1).

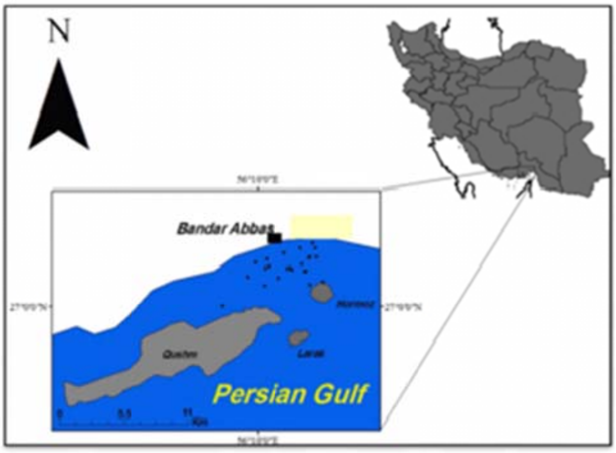

Fig 1: The study area for shrimp-trawl experiments in Hormozgan waters, north of the the persian Gulf. Black circles show trawling positions.

3. Gear specification

The shrimp trawl had a headrope length of 44.2 m and was constructed from polyethylene twisted knotted netting with stretched mesh sizes ranging from 40 mm in the body of the trawl to 25 mm in the codend. Bottom trawl nets and their covers were made from twine No: 210 D / 36. The square mesh panel was made from 90 mm stretched mesh of twisted knotted polyethylene netting with 19 mesh bars in width and 35 mesh bars in length. A square mesh panel is a panel of square mesh netting located in the top panel of the codend, so they remain open during the towing (Figure 2).

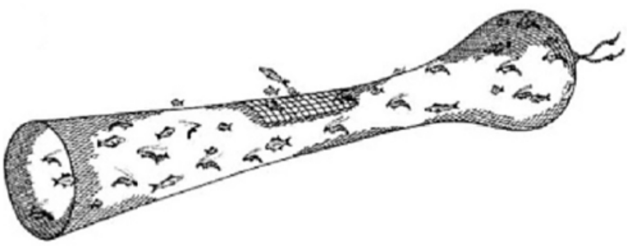

Fig 2: Square mesh panel for the escape of small fish from the codend (Source: Eayrs, 2007).

As fish pass through the trawl, they orientate directionally toward the device and swim through the square escape opening. A cover net constructed according to the specifications in Wileman et al (1996). An ending in the codend, constructed from 15 mm polyethylene twisted knotted diamond mesh netting, was placed above the escape hole to collect the individuals excluded by the BRDs. To separate the cover net from the escape hole, plastic hoop was attached to the cover net.

4. Data Analysis

At the end of each haul, the total catch from the cover and the codend was emptied onto separate sorting areas onboard the vessel. Indian halibuts were removed from the remaining catch and then, counted and weighed for codend and cover net separately. The total length was measured to the nearest millimeter. Data analysis was done by SPSS19 and Excel softwares. To analyze normality of the data and homogeneity of variances, Kolmogorov-Smirnov and Levene tests were used (Zar, 1999). These test indicated the length data were distributed normally and variances were homogeneous. The mean length was compared for the codend and codend plus cover net using two-sample t-tests ($P<0.05$). Size frequency distribution of Indian halibut were compared between codend and codend plus cover net using two-sample Kolmogorov-Smirnov tests ($P<0.05$).

The rate of escapement by number attributed to the square mesh panel was calculated by the following equation (Dickson, et al., 2004):

$$E = (Ncn / (Ncn + Nce)) \times 100$$

Where E is escapement rate by number (%), N_{cn} is catch in cover net (number) and Nce is catch in codend (number).

Selectivity parameters were calculated by maximizing the log-likelihood function based on the logistic model curve according to the Excel file described by Tokai (1997). The selection parameter L50 is the length at which a fish has a 50% probability of being retained in the codend. The selection range (SR) is difference in length between the 25 and 75% retention points.

5. Results

The data from 25 trawl hauls, (371 samples) were analyzed. In the trawl nets equipped with the SMP, 4837.383 kg of shrimp and bycatch were caught in the codend and cover net combined. 49.826 kg (1.03%) of the total catch belonged to Indian halibut. CPUE index (Catch per Unit Effort) for Indian halibut was calculated 1.328 (Kg/h). A total of 264 Indian halibut with 43.359 kg weight and 107 Indian halibut with 6.467 kg weight were retained in the codend and cover net, respectively. Length range and mean length of Indian halibut caught in the codend and cover nets were measured 8-35.2 cm and 9-25 cm and 24.58±5.8 cm and 15.29±3.5 cm, respectively. Weight ranges and mean weight of these species caught in the codend and cover nets were measured 9.5-350 g and 12-130 g, 164.23±105.0 g and 60.43±25.9 g, respectively.

Length frequency distributions of Indian halibut caught in codend and cover net are shown in Figure 3. The catch of small individuals by length was greatest in the cover net. Two sample Kolmogorov-Smirnov tests detected significant difference in the size-frequency distribution of Indian halibut between codend and codend plus cover net (Dks= 2.464; P< 0.001).

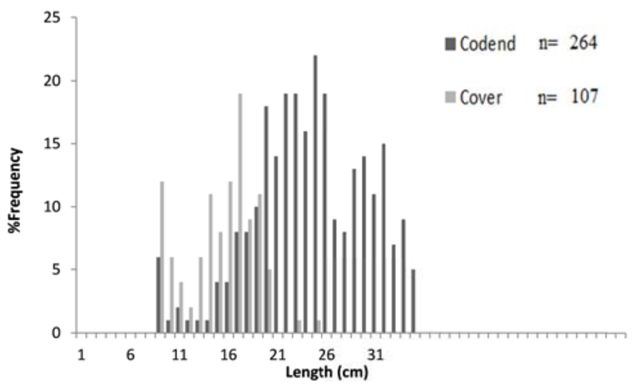

Fig 3: Length frequency distributions of the total number of Indian halibut caught in the codend and released through the square mesh panel.

Indian halibut caught in codend and codend plus cover net had mean length of 24.53±2.45 cm and 21.90±2.31 cm, respectively. A significant difference in the results of two-sample t-tests (P<0.001) in the mean length of Indian halibut caught in the codend and cover net was also detected. Also, the escape rate based on number was calculated at 28.8%.

Selectivity curve showed the 50% retention length (*L50*) was 17.2 cm and selection range was 5.8 cm (Fig. 4). Selectivity curve of Indian halibut indicated that fish length at 50% retention (*L50*) differed greatly from the Lm50% value.

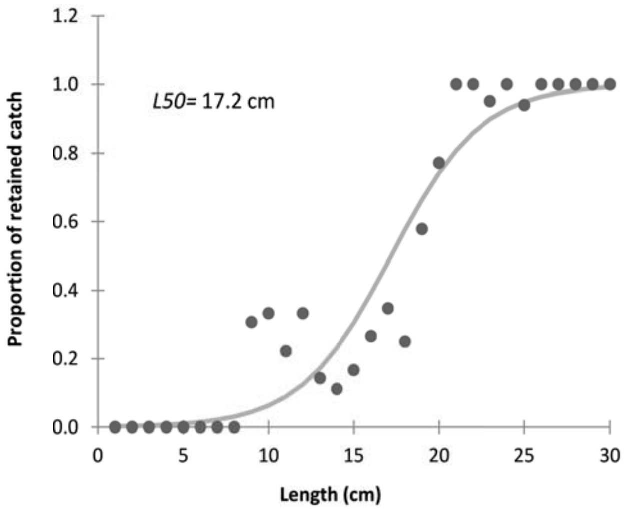

Fig 4: Selectivity curve for Indian halibut using a square mesh panel with a 90 mm stretched mesh size

6. Discussion

The sole fishes are one of the commercial species in coastal water and shelf areas (Farahani et al., 2005). During the study on occasion approximately 42% of juvenile fish of Indian halibut was discarded by number.

The square mesh panel has proven to maintain catches of shrimps and reduce bycatch of juvenile fish from several different designs of trawls over a range of commercial conditions in Australia (Broadhurst et al. 1999; Broadhurst and Kennelly, 1996). The results of these experiments showed that codend with square mesh panel had the potential to reduce bycatch of non-target individuals (Fonteyne and M`Rabet., 1992; Broadhurst and Kennely., 1994; Broadhurst, 1996).

Length composition of Indian halibut caught in the codend was significantly larger than that caught in the codend plus cover net. Two sample Kolmogorov-Smirnov tests detected significant difference in the size-frequency distribution of Indian halibut between codend and codend plus cover net, accordingly some of small Indian halibut (smaller than Lm50% value) might be able to escape through the square mesh panel.

Broadhurst et al. (1996) reported that trawl with square mesh panel caused juvenile red spot whiting (*sillago flindersi*, Mckay 1985), an important commercial finfish, to escape from the square mesh panel. Maartens et al. (2001) found that use of bycatch reduction device in codend of a commercial monkfish (*Lophius vomerinus*, Valenciennes 1873) and sole (*Austroglussus microlepis*, Bleeker 1863) improved the selected size and released juveniles of this species. Dickson et al. (2004) reported that 31.8% of commercial fishes escaped from square mesh panel in Philippines shrimp trawl fishery. O`Neill et al. (2005) found that trawl with 90 mm square mesh panel for haddock (*Melanogrammus aegelfinus*, L.1758) and whiting (*Merlangius merlangus*, L. 1758) were more selective than the net with no panel. Grimaldo et al. (2009) found that the percentages of fish escaping at the depth from the diamond-mesh codend were significantly lower than estimated for the square mesh panel.

Normally, a small selection range is desirable. In this study, the selection range was fairly large. Selectivity curve of pooled data for Indian halibut indicated that fish length at 50% retention (*L50*) substantially was smaller than Lm50% and an increase in mesh size of codend or mesh size of square mesh panel would be required to delay capture until fish had reached Lm50% value. This would have a positive effect upon the yield of Indian halibut. From an ecological perspective, codend equipped with square mesh panel was relatively preferable because it retained fewer under-sized Indian halibut.

All the individuals caught in the codend and cover net were smaller than Lm50% value. This could be due to the temporal and spatial distribution of the species. Several studies have also reported temporal or spatial changes in bycatch assemblages in tropical regions (Gallaway and Cole, 1999; Tonks et al., 2008). It is also notable that the individuals larger than 20 cm were valuable and they could be income source for small-scale fishermen.

The escape rate based on number for Indian halibut was calculated at 28.8%. This rate was not acceptable, but various factors influenced the bycatch reduction device efficiency. These factors included: BRD location, the size of BRD, the size of escape opening, hauling speed, weather condition, vertical distribution of shrimp and bycatch, behavior of bycatch and mesh size and configuration. A variety of factors have probably contributed to the use of bycatch reduction device; first vessel operators have become more experienced with BRDs (Hannah and Jones, 2006). The square mesh panel efficiency could be related to everyone of above mentioned factors. At sea, testing the effects of these factors was beyond the scope of this study and remains a possibility for a future work. However, in this study it might be related to weak swimming capability of Indian halibut. Advantages of square mesh panel were its relatively simple design and easy usage which reduced sorting times as well as including features that allowed small fish bycatch to escape, From an ecological perspective, the application of the BRD seems to be a step forward towards reduced fishing impact (Eayrs et al., 2007).

The catch data confirmed clearly multi-species nature of Hormuzgan shrimp trawl fishery, where a large fraction was composed of bycatch species (Valinassab et al. 2006; Paighambari and Daliri, 2012) that created both management (capture of commercial fish species) and ecological (high discard rates) problems. These problems could be partially addressed via the adoption of appropriate gear modifications, such as the use of square mesh panel.

It has been argued (Anon, 1994) that reducing bycatch of juvenile fish would benefit other regional fisheries, including artisanal (small-scale) fisheries. The capture and discarding of juvenile commercial fishes are a waste of food sources. These animals are usually dead or dying when landed and therefore, do not have the opportunity to reproduce or grow to a size more suitable for human consumption. Giving the opportunity to grow and become adults, these fish would contribute better to overcoming the problem of food security in developing countries. In addition, the capture of these fish is clearly a threat to reproductive capability of each species and the sustainability of the ecosystem.

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