Escape response of juvenile seabream with rockfish from the separating model codend in tank experiments

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Most grid sorting has been used to sort out flatfish in shrimp fisheries, while double grid systems have been tested to separate smaller shrimp. The escape of juvenile red seabream through separating panels made with steel grids or large mesh tested for masking effects in a two-species system. Fish behavior was observed in a circulating water tank. The escape rate was 20% greater with the separating codends than with the normal codend in the single-species experiments. The rates in the two-species experiments were 30% or 20% greater than the single-species rates for the normal or separating codends, respectively. The seabream retention rates in the grid separator codend decreased as rockfish retention increased, possibly due to a threat effect. Conversely, the retention rate of both species increased concurrently in the net separator, possibly due to a masking effect. The escape rates of juvenile red seabream varied by compartment in the mesh separating codend. These results suggest that grid separating codends can be used in the field as towed fishing gear to reduce juvenile catch.

Keywords : Model codend, Grid and mesh separator, Juvenile fish, Retention rate

Introduction

Optimizing catch size while minimizing discarded bycatch in towed fisheries is both economically and environmentally desirable. Bycatch reduction devices (BRDs) such as square mesh windows, sorting grid systems, and separator panels have been tested and adapted for various species, gear, and regions (Broadhurst, 2000; Matsushita, 2000; Madsen and Valentinsson, 2010). The most effective and simplest way to reduce bycatch in passive static fishing gear is to use a larger mesh size. However, in towed fishing gear, optomotor and panic responses (Kim et al., 2008) of fish exhausted by the towing speed are the main escape behaviors from the codend, which may be complicated by masking effects as catch accumulates (Hannah and Jones, 2012). Many BRDs have been adapted to different species, gear, and regions in accordance with local regulations. However, each BRD has shortcomings for reaching optimum catch while minimizing discard (Madsen and Valentinsson, 2010). Furthermore, international guidelines for bycatch reduction are difficult to agree upon (Chopin and Suuronen, 2009; Sea Grant. 2014).

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Recently, active stimulating devices (ASDs) have been tested as BRDs in tank experiments, including a fluttering net panel inside the codend (Kim and Whang, 2010; Kim, 2011) and a shaking codend (Kim, 2015). Pulsing codends (O’Neil et al., 2003) and fluttering windows (Grimaldo et al., 2007) have also been shown to reduce bycatch. Observational studies have revealed that fish near codends may behave erratically (Kim et al., 2008) or are behaviorally impaired as they try to escape the codend (Hannah and Jones, 2012). Therefore, an alternative method to decrease bycatch may be an active stimulating BRD using flow around and in the codend to create a filtering or sieving effect on juvenile fish.

The grid sorting method has been tested in trawl nets (Issksen et al., 1992), followed by many improvements in materials, such as rope grids (He and Balzano, 2011) or flexible synthesis grids (Massuti et al., 2009), and design changes such as horizontal bars (Ohata et al., 2008). Generally, most grid sorting has been used to separate flatfish from shrimp catches. The double grid system uses a front grid to sort flatfish while the rear grid sorts out small shrimps like in a typical grid BRD (He and Balzano, 2007). However, sorting grids have not yet been used to separate smaller fish from a target fish catch.

The escape of juvenile fish through both grid and mesh separating panels investigated the effectiveness of these BRDs in multi-species catches. In addition, the separating codends were compared to a normal codend without a BRD. Then the codend retention rates were compared by codend type, compartment, and species.

**Materials and Methods**

The experimental fish were juvenile red seabream, Pagrus major, which are common in Korean waters. Approximately 5,000 juvenile red seabream with a mean total length of 6.1 ± 0.7 cm, mean girth of 3.9 ± 0.6 cm, and mean body weight of 3.7 ± 1.0 g (Fig. 1) were purchased from a fish hatchery in Tongyoung, Korea, on May 25, 2015. The relationships between total body length (BL, in cm) and girth (G, in cm)/weight (W, in g) from a sample of 300 red seabream were as follows:

\[
G = 0.67BL - 0.21 \quad (n = 300, r = 0.82)
\]

\[
W = 0.094BL^{2.02} \quad (n = 300, r = 0.83)
\]

![Fig. 1. Relationship between total body length and girth/weight from a sample of 300 red seabream.](image)

To observe the escape behavior of juvenile fish when bigger fish were present in the codend, 160 rockfish Sebastiscus marmoratus were purchased from a live fish shop in Tongyoung, Korea, after they were caught on the inshore seabed of the southern Sea of Korea. They had a mean total length of 15.7 ± 2.7 cm, mean girth of 10.6 ± 1.5 cm, and mean body weight of 68.2 ± 26.7 g. The relationships between total body length (BL, in cm) and girth (G, in cm)/weight (W, in g) from a sample of 138 rockfish are shown in Fig. 2.

\[
G = 0.612BL+1.3 \quad (n = 138, r = 0.81)
\]

\[
W = 0.124BL^{2.28} \quad (n = 138, r = 0.85)
\]

The fish were reared in a 3 m diameter water tank that formed the central part of a 5 m diameter blue FRP circular tank (Kim and Whang, 2010) located at the