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Rope Grid: A new grid design to further reduce finfish bycatch in the Gulf of Maine pink shrimp fishery

Pingguo He[a,*], Vincent Balzano[b]

[a] School for Marine Science and Technology, University of Massachusetts Dartmouth, 706 South Rodney French Boulevard, New Bedford, MA 02744, USA
[b] FV "North Star", 31 Vines Road, Saco, ME 04072, USA

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ABSTRACT

The pink shrimp (*Pandalus borealis*) is an important commercial species for the Gulf of Maine inshore fleet with annual landings exceeding 5500 metric tons in 2010. Due to the small codend meshes used in the trawl, bycatch of juvenile finfish has been an issue. The adoption of the Nordmøre Grid since the early 1990s has significantly reduced finfish bycatch in the fishery, but a small portion of juvenile fish continues to be caught and discarded. To further reduce finfish bycatch, flume tank tests and sea trials were carried out on a radically modified Nordmøre-style grid. The new design cut away two-thirds of the netting surrounding a traditional Nordmøre Grid, and replaced the netting with four ropes, hence called "Rope Grid". A trouser trawl with two identical codends was used for sea trials on board F/V "North Star", a 14 m shrimp trawler, comparing the codend equipped with the new Rope Grid to the codend with a regular Nordmøre Grid. Four major bycatch species with mean catch rates greater than 0.4 kg h^{-1} were silver hake (*Merluccius bilinearis*), red hake (*Urophycis chuss*), American plaice (*Hippoglossoides platessoides*) and witch flounder (*Glyptocephalus cynoglossus*). The results indicate that the new Rope Grid significantly reduced all four major bycatch species by 36–50% ($P < 0.001$) with no significant reduction on the targeted pink shrimp (105 kg h^{-1} vs. 102 kg h^{-1}, $P > 0.1$) or the size of the shrimp (number of shrimps in 1 kg, RNG: 109.3 ± 1.96; ROPE: 110.0 ± 1.70; $P = 0.62$). The reduction of finfish bycatch was length related for all four major species with an increased rate of escape for larger fish from the Rope Grid. The Rope Grid was practical to handle and easy to modify, and has potential for adoption in this fishery as well as possible application in other shrimp and prawn fisheries around the world.

1. Introduction

Shrimp trawl fisheries, especially tropical shrimp (prawn) fisheries, are notorious for bycatch and discards due to the small mesh sizes used in the codend and a variety of fish mixing with the targeted shrimps (Kelleher, 2005). Even in coldwater shrimp fisheries which are relatively "clean", bycatch can still be substantial (Harrington et al., 2005). Mandatory or voluntary use of the Nordmøre Grid since early 1990s has greatly reduced finfish bycatch in many coldwater shrimp fisheries (Isaksen et al., 1992; Broadhurst, 2000; Richards and Hendrickson, 2006; He and Balzano, 2007).

In the Gulf of Maine, an inshore shrimp trawl fishery targets pink shrimps (*Pandalus borealis*) when they move into shallow waters to spawn. The fishery is mainly prosecuted by vessels from Maine, New Hampshire and northern Massachusetts. Before 1992, large quantities of juvenile fish of commercial importance were discarded by small mesh shrimp trawlers (Howell and Langan, 1992). Since 1980s, several studies were carried out to reduce finfish bycatch in the shrimp fishery including the testing of square mesh codends, large mesh panels, escape panels, exit openings, and the Nordmøre Grid (Averill, 1989; Kenny et al., 1992). The Nordmøre Grid was first developed in northern Norway and is one of the most successful devices for reducing fish bycatch without a significant reduction of shrimps in a number of fisheries (Isaksen et al., 1992; Broadhurst, 2000). The use of the Nordmøre Grid became mandatory in the Gulf of Maine shrimp fishery in the 1992 fishing season and was an overnight success in terms of its ability to reduce bycatch and maintain shrimp catch, and was quickly adopted by industry and mandated by management (Kenny et al., 1992; Clark et al., 2000; Richards and Hendrickson, 2006). However, the Nordmøre Grid cannot eliminate small fish that can pass through the 25 mm spacing which is the maximum bar space allowed in the fishery (Clark et al., 2000). Small fish such as Atlantic herring (*Clupea herangus*), blueback herring (*Alosa aestivalis*), silver hake, red hake, flounders, and juveniles of Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) are often caught as bycatch in various quantities (He et al., 2007). In a shrimp trawl

* Corresponding author. Tel.: +1 508 910 6323.
E-mail address: phe@umassd.edu (P. He).

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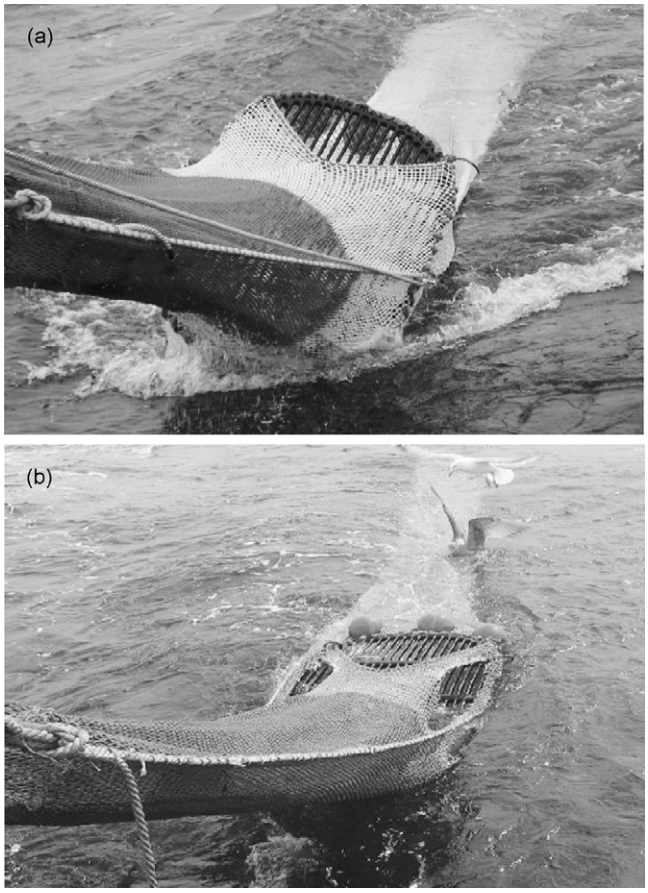

Fig. 1. The regular Nordmøre Grid (a) and a modified grid preceding the new Rope Grid (b).

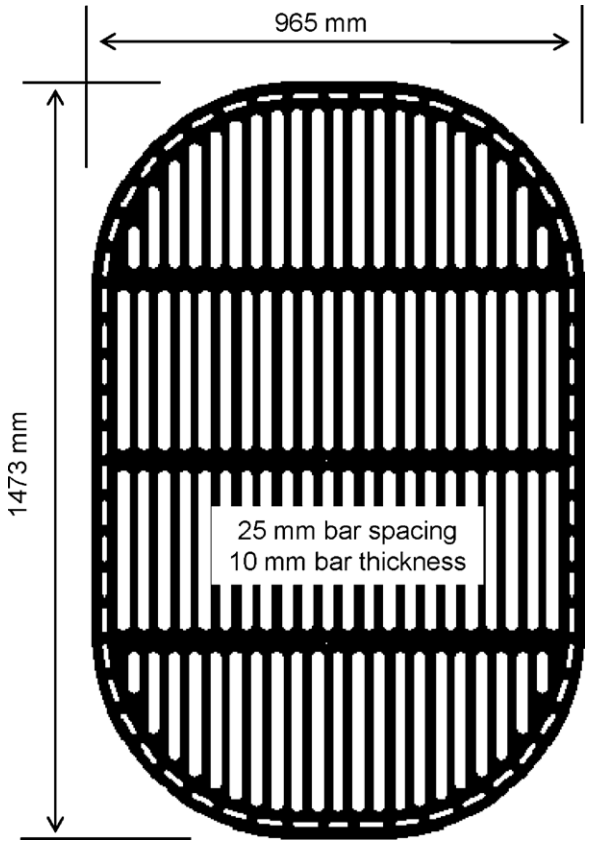

Fig. 2. The specifications of the high-density polyethylene (HDPE) grid used for both regular Nordmøre Grid and the new Rope grid. The black grid was 25 mm thick.

research carried out by the first author and his colleagues during the 2006 shrimp season, an average of 30.7 kg per half-hour tow of Atlantic herring was caught in a commercial trawl fitted with a regular Nordmøre Grid (He et al., 2007). In research carried out in April 2004, bycatch of silver hake of as much as 400 kg h^{-1} was recorded, in comparison to about 100 kg h^{-1} of targeted pink shrimp (He et al., 2008). Even though these high bycatch occurrences are not common, and quite rare in the early months of the season (December to February), bycatch typically increases as season progresses from

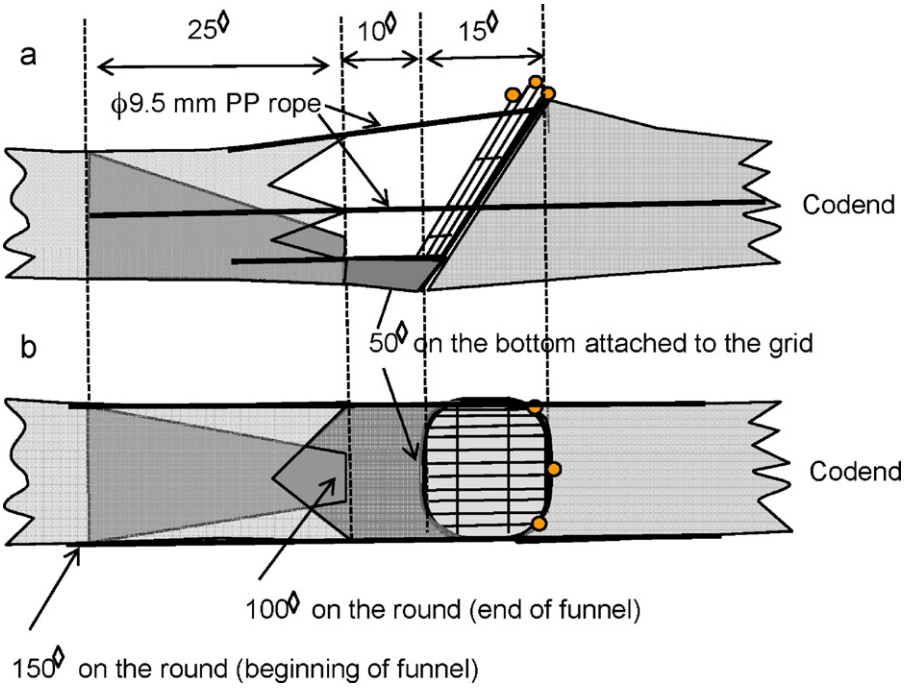

Fig. 3. The detailed design of the new Rope Grid with (a) side view and (b) top view. Drawing not to scale. (◊) Number of meshes.