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Short Communication

Development of catch control devices in the Barents Sea cod fishery

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ABSTRACT

Four catch control devices were tested in the Barents Sea cod fishery. Three of the devices were codends that close and partially detach from the rest of the trawl when they have filled up with the desired amount of fish. Each of these three systems had a different release mechanism (based on an acoustic releaser or a weak link). The fourth prototype was a codend with two side splits along the gear in the N-direction. For each prototype, the simplicity of the device, its cost, and its operational reliability in securing the desired catch size while releasing excess fish at fishing depth were evaluated.

1. Introduction

In recent years, the cod (*Gadus morhua*) fishery in the Barents Sea has shown exceptionally high stock levels that have led to large quota allocations for fishing vessels. These vessels are factory vessels that fish very efficiently when the availability of fish is high. In this scenario, trawl hauls often exceed the production capacity of the vessels (i.e., 50 tons of fish in just a few minutes of towing). High densities of fish mean that large quantities of fish can enter the trawl within minutes, and this process is difficult to control even with electronic monitoring sensors attached to the trawl. Large catches sometimes result in poor quality of the catch and burst codends, as well health, safety, and environment issues (Fig. 1).

A limited number of studies have focused on developing catch control devices for trawls. For example, Goudey and Randazzo (2001) and Pol and Chosid (2012) developed the stretch-mesh concept and the self-closing codend, respectively, to reduce the waste of resources associated with regulatory discards in the New England groundfishery. Icelandic trawlers occasionally use zipper lines in the upper panel of the extension piece in mackerel trawls to prevent the occurrence of unwanted big catches (pers. comm., H. Einarsson, Institute of Marine Research, Iceland). These zipper lines break and unzip when the codend fills up. Several prototypes of catch control devices have been tested in the Norwegian ground fishery in the last two years as discussed at the Working Group on Fishing Technology and Fish Behavior of the International Council for the Exploration of the Sea in May 2013 (ICES, 2013), including: (1) semi-detachable codends; (2) thin twine that breaks due to drag of the catch or expansion of the codend; (3) side splits along the gear in the N-direction in the foremost part of the codend; (4) large meshes that open as the codend fills up; (5) a motorized gate that opens upon a signal from an operator so that excess fish are guided out of the trawl; and (6) a hatch in the upper panel of the codend that opens when the codend fills up. This last device is based on a hole in the upper panel of the codend that is covered with a rubber flap. The flap stays closed until the flow dynamic in the swelling codend opens the flap and releases the excess fish. Although some of these devices have been shown to be very effective at controlling catch size, fishermen are still not allowed to use any of them in the Barents Sea cod fishery at present.

This paper describes in detail the development and functioning of some of the devices described above that were developed by the authors. Important features that were taken into account when evaluating these devices include the simplicity of the device, the equipment cost, and the operational reliability in securing the desired catch size while gently releasing the excess of fish at fishing depth.

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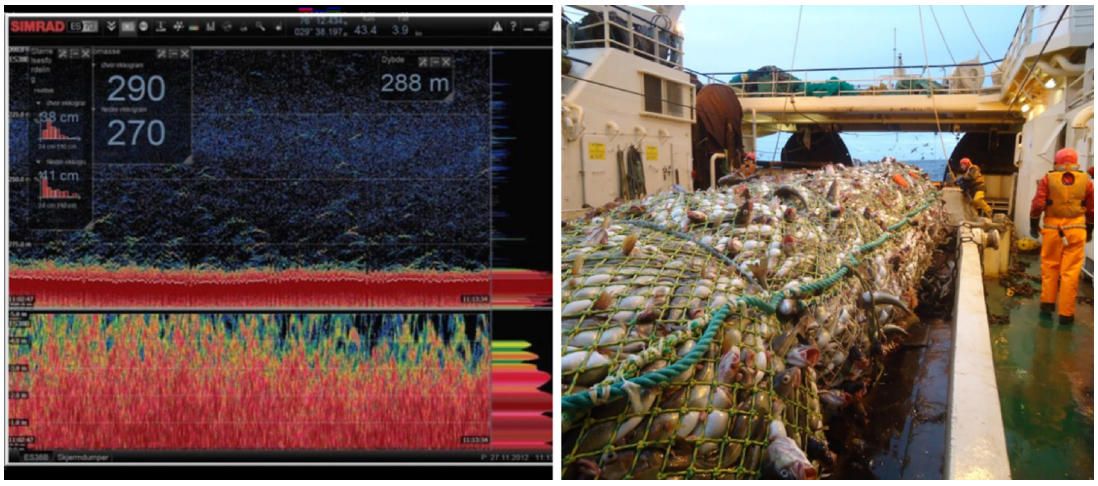

Fig. 1. A photograph that illustrates the screen of an echo sounder with the 5-m expansion zone showing dense registration of cod (left) and a codend with the resulting catch after a 10-min tow (right).

2. Materials and methods

Four different catch control devices were designed, fabricated and tested: three devices with semi-detachable codends and one device based on two splits cut in the N-direction in the foremost part of the codend. The working principle of the semi-detachable codends was based on a codend that partially detached from the extension piece after a certain (desired) catch level was reached. In this system, once the codend was detached from the extension piece, the fish that remained inside the trawl had the chance to escape unharmed at the fishing depth. Information about when the codend was full, closed, and detached was provided by Scanmar catch sensors mounted on the codend (Fig. 2A). Once the sensor indicated that the codend was full to the desired limit, and it had detached, the retrieving process could begin. The working principle of the codend with the side splits was based on side openings (10 meshes in the N-direction) that progressively opened as the catch accumulated and the codend swelled (Fig. 2B). Scanmar sensors were used in the same way as for the semi-detachable codend.

2.1. Semi-detachable codend prototypes

Three semi-detachable codend prototypes were developed, each with a different release mechanism:

(1) In the first prototype (Fig. 3A), an acoustic signal was sent to an acoustic releaser that released a 1 m^2 sea anchor. Due to the hydrodynamic force created by the towing of the vessel, the sea anchor pulled on an 8 mm nylon rope that laced together the codend and the extension piece. When the codend was detached, two 16 mm spectra ropes that were braided around the codend mouth closed it immediately as it fell backwards. The codend then hanged closed from the two spectra ropes (Fig. 2A). A similar technique for detaching the codend from the extension piece was shown by Soldal and Engås (1997). Initial small-scale testing of this prototype was performed in a flume tank (Hirtshals, Denmark) in April 2011 with an IXSEA acoustic releaser (Model: OCEANO 2500 Universal Acoustic Release, IXSEA Ltd., UK).

(2) The second prototype combined the use of an acoustic releaser, two supporting ropes that held the tension of the selvedges, and a piece of thin (Ø 1.8 mm) PE twine. The thin twine was braided around the whole circumference of the gear between the extension piece and the codend so that it held them together (Fig. 3B). When the catch sensors indicated that the desired catch size had been reached, an acoustic signal was manually sent to the acoustic releaser, which released the supporting ropes. Once these ropes were released, the load of the codend was transferred to the thin PE twine. Because the load exceeded the breaking force of the thin twine, the codend was released from the extension piece. As the detached codend fell backwards, two 16 mm spectra ropes closed it immediately. The codend then hanged closed from the spectra ropes.

(3) The third prototype used two pieces of thin (Ø 1.8 mm) PE twine as the release mechanism (i.e., a weak link) (Fig. 3C). In this prototype, the codend was attached to the extension piece by only two thin twines (one per selvedge) that linked together the selvedges of the extension piece with the selvedges of the codend. An even thinner twine (Ø 1.2 mm) was braided between the extension piece and the codend to ensure that the hydrodynamic forces in the gear did not create gaps in the gear. When the codend was loaded and the breaking strength of the twines in the selvedges was reached, the weak link broke and released the codend from the extension piece. The twine braided between the extension piece and the codend broke easily, as its breaking strength was lower than that of the weak links in the selvedges. As the detached codend fell backwards, two 16 mm spectra ropes closed it immediately. The codend then hanged closed from the spectra ropes.

All three prototypes had three free meshes in the aft part of the extension piece that acted as a skirt and guaranteed that no gaps were created between the two pieces of the gear during the fishing process (see Fig. 3A–C).

2.2. Non-detachable codend prototype

In this prototype, the catch control mechanism was based on modifications in the codend. The modifications consisted of two side cuts along the codend in the N-direction and a funnel installed inside the codend just after the cuts (Fig. 3D). The function of the side cuts was to release excess fish once the codend was full, whereas the function of the funnel was to prevent the fish that had already entered the codend from moving forward and escaping through the side openings. The position of the funnel and the cuts can be adjusted depending on the catch volume desired. In this prototype, we cut 10 meshes on each side of the codend, and the funnel was placed 2 meshes behind the cuts. To keep the cuts from opening too much before the codend was full, an 8 mm nylon rope that ended in a 20.3 cm diameter float was braided through the cuts