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# Improving selectivity of the Baltic cod pelagic trawl fishery: Experiments to assess the next step

Niels Madsen[a,*,1], Vesa Tschernij[b,1,2], Renè Holst[a,1]

[a] DTU Aqua, National Institute of Aquatic Resources, North Sea Science Park, P.O. Box 101, DK-9850 Hirtshals, Denmark
[b] Institute of Marine Research, Sweden

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ABSTRACT

Due to declining cod (*Gadus morhua*) stocks, the Baltic Sea was one of the first areas regulated by the European Communities where selective escape windows were implemented to improve the exploitation pattern. Increasing discard rates and the potential for a significant increase of the spawning stock and the yield of the fishery are important reasons to further improve the selectivity of the fishery and to asses the potential next step in this process. In this study, we tested three relatively different design concepts, in the Baltic cod pelagic trawl fishery, that are relevant to past or present legislation and that were developed to meet requirements of increased selectivity performance. A standard nominal 135 mm diamond mesh codend, a codend with two nominal 125 mm bottom windows, and a codend with a nominal 125 mm nominal top window were tested using the covered codend method. A Danish and a Swedish commercial vessel were used for the sea trials to account for potential differences between vessels. Potential differences among the three gear variants were assessed by a two-step mixed effects model. The codend catch weight was found to have a significant effect on the selectivity in some cases. We assessed the actual effect of the selectivity performance on the immediate reductions of the proportions of cod being retained below and above the present minimum landing size (MLS) and a potential increased MLS.



## 1. Introduction

The Baltic Sea cod (*Gadus morhua*) fishery was one of the first fisheries regulated by the European Communities, where the use of selective escape windows (henceforth windows) were introduced in legislation to improve the selectivity of trawl gear (Madsen, 2007). Several amendments were made over the few years from 1995 until the Bacoma codend was implemented in 2003.

Mortality of Baltic cod escaping from trawl codends during towing is generally estimated to be low (Suuronen et al., 1996, 2005), and escapees that return to the population will benefit the stock. The Baltic cod fishery is a single species fishery and improving the selectivity further from today's level would highly benefit the long-term yield, discard rates, and spawning stock (Madsen, 2007). Furthermore, discard rates have increased during recent years (ICES, 2008). This problem is believed to be caused by capture of individuals below the minimum landing size (MLS) (Anon, 2008). Several Baltic countries (ICES, 2009), the European Union Commission and the Baltic Sea Regional Advisory Committee recommend improving the selectivity further (Anon, 2008) and assess new ways to improve the selectivity (ICES, 2009). However, very few experiments on improving size selectivity in the Baltic cod fishery have been reported in international ISI (Institute of Scientific Information) indexed journals (Madsen, 2007). There is particularly limited information on gears that can be used in the future, having a substantially higher selectivity than the Bacoma codend used today (Madsen, 2007; ICES, 2009). Additionally, there are problems with the length of the Bacoma codend window not allowing cod to escape at high catch rates that have not been assessed by experiments (ICES, 2009).

Although fisheries that use pelagic trawls are important in the Baltic Sea (ICES, 2008), selectivity experiments have been focused on the demersal bottom trawl fishery (Madsen, 2007). Cod are mostly caught with pelagic trawls that are fished semi-pelagically from the seafloor up to the upper water layers. This fishery mainly targets aggregating spawning cod, thus high catch rates are likely to occur, which might influence the trawl selectivity. Furthermore, fishermen report that pelagic cod reacts by moving towards the bottom when targeted by a trawl. This means that placement of the window in the top or the bottom panel of the codend might affect selectivity.

* Corresponding author. Tel.: +45 33963200; fax: +45 33963260.
*E-mail address:* nm@aqua.dtu.dk (N. Madsen).
[1] Authorship equal.
[2] Present address: Iconex Ltd., P.O. Box 40, Pargas 21 601, Finland.

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When assessing and comparing the selectivity between different gears it is important to consider that the codend selectivity is prone to a vessel effect (Tschernij and Holst, 1999), and that the amount of catch in the codend can have an effect on the selectivity (Madsen, 2007). Furthermore it is important to compare the immediate reductions of the proportions of cod being retained below and above the present minimum landing size (MLS), and in relation to a potentially larger MLS. This evaluation is important because a successful implementation of codends that will improve selectivity will depend on short-term losses and the fishermen's acceptance (Tschernij et al., 2004; Suuronen et al., 2007).

The experiments described in this paper were designed to be able to take the next step in improving the selectivity of Baltic cod trawls by addressing several relevant issues that have not yet been assessed concerning gear design, fishery patterns, experimental design and interpretation of the results. To sum up, the overall objectives are to: make further improvements in the size selectivity of trawl codends to reduce discards levels; test alternative concepts to the Bacoma codend currently used; estimate the selectivity in the Baltic cod pelagic trawl fishery using commercial vessels fishing on commercial conditions; get estimates of the selectivity of gears that are likely to be used in the future; estimate if the codend catch has a significant effect on the selectivity of the new codend designs; use a replicate setup to assess differences between the vessels, including the trawls, which potentially influence the results; assess the actual effect on the retention of cod below and above the current minimum landing size and the effect of increasing the MLS also when compared to the currently used Bacoma codend.

## 2. Methods

### 2.1. Vessel and fishing gear

The Swedish commercial trawler Kungsö (166 tons, 650 kW) was hired to conduct the Swedish sea trials and the Danish commercial trawler Lis-Hansa (73 tons, 385 kW) was hired to conduct the Danish sea trials. In practice, both trawlers are a mixture of side and stern trawlers. The net drums sit on the aft deck but the codend(s) are first hauled close to the aft end of the vessel, where they are attached to a wire that drags them to the side before being hauled on board. The vessels each used their own commercial Baltic Sea pelagic cod trawl. The trawl used by the Danish vessel was spread by 4.6 $m^2$ pelagic otterboards. The trawl had no wings. In the upper panels the mesh size (nominal size of full mesh opening) was 1600 mm, in the side panels 140 mm and in the lower panel 105 mm. In the aft part of the trawl and in the trawl extensions the mesh size was 105 mm. The extension was made of 3 untapered sections each 11 m long (stretched length) having a circumference on 200, 160 and 120 meshes, respectively, going towards the rear end. Scanmar equipment measured the trawl opening (height) to vary between 14.6 and 16.4 m. The Swedish trawl was spread by 11 $m^2$ pelagic otterboards. In the upper and side panels the trawl had a mesh size of 3200 mm in the wings and in the front part of the trawl, but decreasing to 1600 mm in the mid-part of the trawl and 120 mm in the aft trawl. In the lower sections the mesh size is 3200 mm in the wings, 800 mm in the aft wings, 200 mm in the front section just behind the trawl opening and furthers backwards the mesh size is 105–120 mm. The extension is 38 m long and 100 meshes in circumference with a mesh size of 120 mm. The trawl opening was measured (Scanmar) to be about 30 m during the sea trials.

### 2.2. Codend designs

The codends used by the Danish and Swedish vessels were exactly the same. Codend designs and specifications are provided in Fig. 1. We tested three basically different concepts: a top window codend, a bottom windows codend, and a standard diamond mesh codend. The windows have netting turned 45°, relative to standard netting, to give the mesh opening a squared configuration.

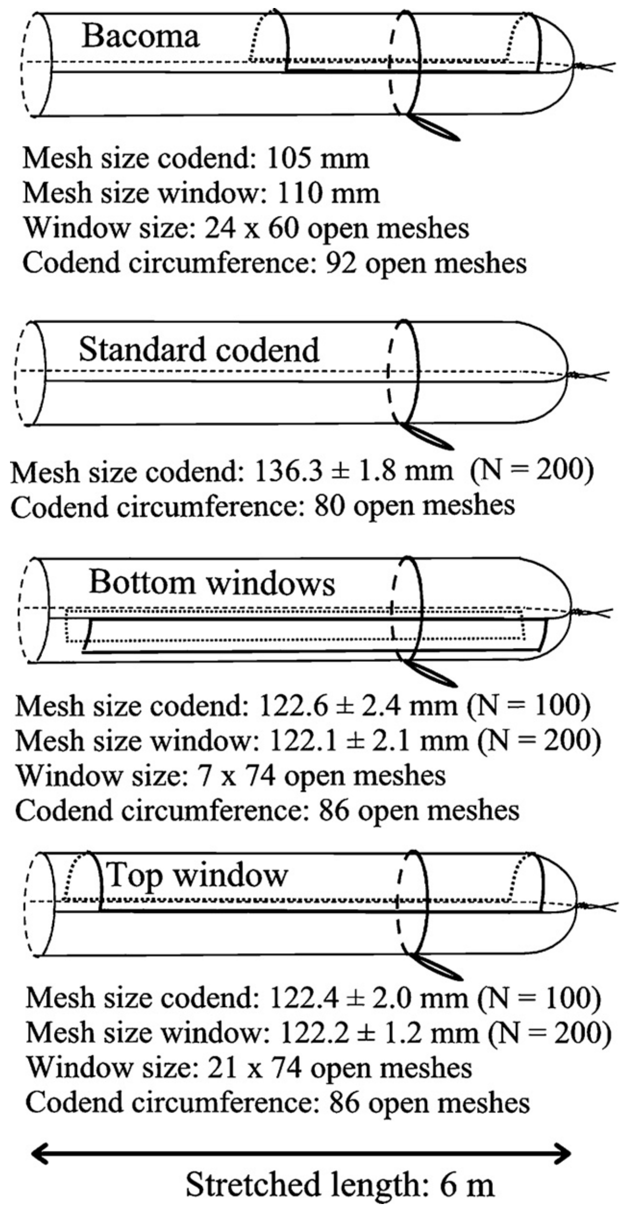


**Fig. 1.** Specifications of a conventional Bacoma codend as used by most fishermen and made in accordance with legislation. Specifications of the three test codends below. Mesh size is provided along with the standard deviation. All codends have 4 meshes in each selvedge.

To produce comparable results we aimed at reaching *L*50-values (*L*50 = 50% retention length) of the same magnitude for all three codends. The reason is that the *SR* (selection range) can be positively correlated with *L*50 (Madsen et al., 2002; Madsen, 2007). Therefore, the inside nominal mesh size was chosen to be 125 mm for the top and bottom windows codends and 135 mm for the standard codend. To assure that selectivity results would be comparable, the same net material, 4 mm double twine PE (polyethylene), was used in all codends except for the window in the top window codend, because twine net material can affect the selectivity (Lowry and Robertsen, 1995; Wileman et al., 1996; Herrmann and O'Neill, 2006). The netting used in the top window was braided black knotless Ultra Cross PE single twine of 4.9 mm thickness, which is well suited for window netting material (Madsen et al., 2002). Today the use of knotless braided netting is required in the Bacoma codend