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Evaluation of a simple means to reduce discard in the Kattegat-Skagerrak *Nephrops* (*Nephrops norvegicus*) fishery: Commercial testing of different codends and square-mesh panels

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Abstract

Discarding of fish species in the Kattegat-Skagerrak *Nephrops* directed fisheries remains at high levels. In this work we have tested four sets of codends pair-wise with the catch comparison technique under full commercial conditions to assess their potential in reducing the catch of undersized commercial species, in particular cod. We investigate the position of a 90 mm square-mesh panel (SMP), the effect of increasing the mesh size from 90 to 120 mm in the SMP, the effect of inserting a 90 mm SMP in an 80 mm codend and the effect of increasing the codend mesh size from 90 to 120 mm in a total of 89 hauls. Inserting the SMP 3–6 m from the codline compared to 6–9 m from the codline, reduced catches of cod above the minimum landing size (MLS) and *Nephrops* above and below the MLS. Increasing the mesh size in the SMP from 90 to 120 mm increased the catch of cod above the MLS in weight with an overall increase of 12% in the revenue. The effect of installing a 90 mm SMP 6–9 m from the codline in a nominal 80 mm codend had no effect on the catch of cod. Increasing the nominal codend mesh size from 90 to 120 mm reduced the catch of all species below the MLS, except monkfish. Catches of *Nephrops* above the MLS were, however, reduced by approximately one third and the total loss in revenue was 21%.

Keywords: Species selectivity; *Nephrops norvegicus*; Trawl; By-catch; Discard; Kattegat; Skagerrak; Square-mesh panel

1. Introduction

Discard sampling programmes have identified a high discard rate of commercial species in the Kattegat-Skagerrak *Nephrops (Nephrops norvegicus)* directed fishery (Anon., 2003). By-catch and discard of cod (*Gadus morhua*) call for particular attention because the stock is at a critically low level (ICES, 2006). In parts of the North Sea, the selectivity for cod has been improved by introducing a 120 mm codend in the legislation for selected fisheries (EC Reg. No. 2056/2001). The actions in the Kattegat-Skagerrak area have been less dramatic and at the onset of the present experiment, a codend mesh size of 70 mm was allowed in combination with an 80 mm square mesh panel (SMP) (EC Reg. No. 850/98). However, reports from Danish fishermen and results from discard sampling (unpublished) indicated that this measure was not sufficient to solve the severe discard problems in the *Nephrops* directed fishery.

Although SMPs are used in several *Nephrops* fisheries, relatively few selectivity studies have been published on this subject (Briggs, 1992; Armstrong et al., 1998; Madsen et al., 1999). The published studies show data mainly on whiting (*Merlangius merlangus*) (Briggs, 1992; Armstrong et al., 1998; Madsen et al., 1999) and haddock (*Melanogrammus aeglefinus*) (Madsen et al., 1999), while only sparse data are accessible on cod (Madsen et al., 1999) and no data have been published on other by-catch species.

Furthermore, a better understanding is needed of fundamental technical parameters that might influence the effectiveness of an SMP. Studies conducted in *Nephrops* (Armstrong et al., 1998) and whitefish fisheries (Graham and Kynoch, 2001; Graham et al., 2003; O'Neill et al., 2006) indicate that the SMP position influences the selectivity. The effect of a SMP, the mesh size in the SMP, the position of the SMP and the effect of increasing the codend mesh size were investigated in this study.

The acceptance of a new gear by the industry is influenced by the economic consequences for the vessel owner and this aspect has not been sufficiently attended to in the past (Tschernij et al., 2004). The Kattegat-Skagerrak *Nephrops* directed fishery

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is characterised by the importance of the by-catch species. In evaluating the economic consequences of a change in gear, it is therefore important to assess the effect on all economically important species. As prices are strongly size-dependent, even a small loss of larger size groups may have a severe impact on the economics of a gear. On the other hand, a considerable loss of small size groups may be compensated for by a minor increase in catches of larger individuals. It is therefore important to take the size composition of the catch into account when evaluating the economic consequence of a gear change.

Improvement of the selectivity will benefit fish stocks in the Kattegat-Skagerrak because mortalities of discards are typically much greater than escapees (Broadhurst et al., 2006). The overall objective of this study is to reduce the discard in the *Nephrops* directed fishery in Kattegat-Skagerrak by improving the species and size selectivity by simple means that are more likely to be implemented in the legislation, if successful, than more complicated designs. To meet the overall objectives, the focus of this study is: to evaluate the effect of gear change on all species of commercial interest to this fishery, with particular attention to cod; to assess basic parameters that influence the selectivity of an SMP; to investigate the effect of an increase in codend mesh size as an alternative strategy to the SMP, and to evaluate the economic effect. Comparative experiments were chosen using a twin trawl set-up. This allows the experiments to be conducted under full commercial towing and hauling conditions while avoiding using a cod-end cover, which might influence the results (Madsen and Holst, 2002) and is more difficult to handle under full commercial conditions.

2. Materials and methods

2.1. Experimental set-up

Different codend designs were tested and pair wise compared in a series of catch comparison experiments as described by Wileman et al. (1996). The twin trawl set-up had one vessel towing two similar trawls side by side. This set-up allows comparison of two different codends fished under full commercial conditions with regards to towing time and towing speed as well as shooting and hauling practices, which can be a problem when handling codend covers. In this work, a selective codend with either an SMP or a larger codend mesh size was tested against a reference codend. The reference codend had either no SMP or an SMP that, due to its position or mesh size, was expected to be less selective than the selective codend.

2.2. Sea trials

All experimental tows were conducted in August and September 2003 onboard the 294 kW commercial vessel FN 234 *Canopus*. The vessel's own trawls were used. The two identical trawls were combined fish and *Nephrops* trawls, using a nominal mesh size of 90 mm and 336 meshes in circumference was used. A three-warp towing system, with a 630 kg roller clump and two 173 cm long *Skagen* otter boards, was used to tow the gear. The towing rig behind the otter boards consisted of 6 m back strops and 90 m single sweeps. Scraper chains were used in most tows but were removed in areas where the bottom was too soft. The headline height of the trawls was around 2 m and the spread of the wings of each trawl was about 30–35 m.

The codends were shifted between the starboard and port side every 6th tow to compensate for any side effects.

2.3. Experimental codends

An 80 mm codend mesh size and a 90 mm SMP mesh size were chosen as a baseline in the SMP experiments as 90 mm codends already were used by some of the larger vessels on a voluntary basis. A 90 mm codend was chosen as baseline when

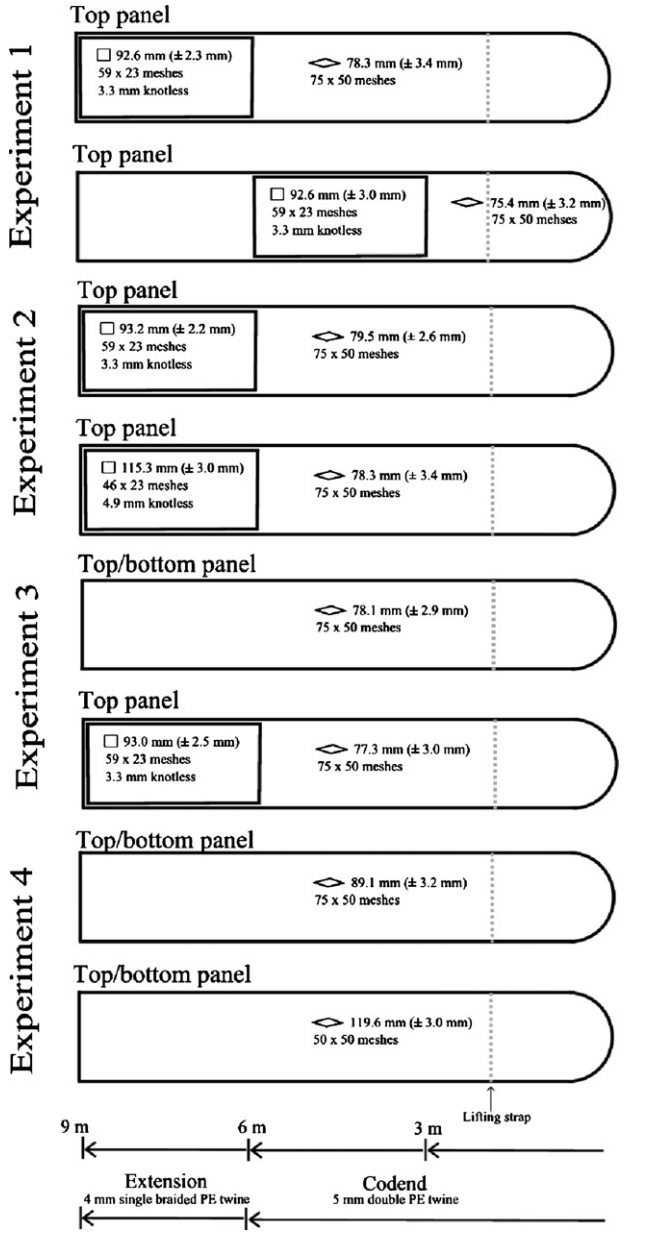

Fig. 1. Top panels of the eight cod-ends used during the experiments. The rectangle indicates where the SMP's are placed. Bottom panels are identical but without windows. The measured mesh sizes (ICES 4 kg wedge) with standard deviation are indicated.