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The selectivity of the Swedish grid and 120 mm square mesh panels in the Scottish *Nephrops* trawl fishery

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ABSTRACT

Two sets of trials were conducted, on the west and east coasts of Scotland, to estimate the selectivity of an 80 mm diamond mesh codend fitted with (i) a 35 mm Swedish grid, (ii) a 120 mm square mesh panel (SMP) at 6–9 m from the codline and (iii) a 120 mm SMP at 12–15 m from the codline. The main results can be summarised as follows:

- the Swedish grid gear retained all *Nephrops* < 40 mm carapace length and between 75 and 90% of *Nephrops* ≥ 41 mm;
- the SMP gears retained between 70 and 88% of *Nephrops* below about 37 mm and all *Nephrops* ≥ 40 mm;
- the grid gear retained fewer whitefish than the SMP gears. No cod > 34 cm, haddock > 35 cm, whiting > 38 cm and hake > 41 cm were retained by the grid gear;
- and the position of the SMP had no significant effect on the retention of *Nephrops,* cod, haddock, or whiting.

1. Introduction

The *Nephrops* (*N. norwegicus*) trawl fisheries in Europe are often mixed and can catch a broad range of species. To the West of Scotland and in the North Sea the codend mesh in a *Nephrops* trawl can be as small as 70 and 80 mm respectively. This can result in the retention and discarding of many fish under the minimum landing size, such as cod (*G. morhua*), haddock (*M. aeglefinus*) and whiting (*M. merlangus*). There may also be discarding of species for which there is no quota or high grading of species (i.e. discarding of fish that can be landed legally) to maximise quota value over a year.

Measures are in place in various fisheries to reduce discarding and unwanted by-catch. These include large diamond mesh headline panels, coverless or cut-back headline trawls, square mesh panels (SMPs) in the extension, inclined separator panels and Swedish grids. The Swedish grid is an adaptation of the Nordmøre grid that was developed to reduce fish by-catch in shrimp (*P. borealis*) trawls (Isaksen et al., 1992). It is used routinely in the Swedish *Nephrops* fishery, but its uptake has been resisted elsewhere in Europe due to concerns regarding handling and the loss of marketable by-catch (Valentinsson and Ulmestrand, 2008).

Catch comparison trials using Swedish grids have been conducted in the Swedish and English *Nephrops* trawl fisheries (Valentinsson and Ulmestrand, 2008; Catchpole et al., 2006). The Swedish trials compared different combinations of 35 mm grid, diamond mesh codend (DMC) and square mesh codend (SMC). The landings of *Nephrops* (minimum landing size is a carapace length of 40 mm) did not differ significantly between any of the gear pairs compared, but there were large reductions in the quantities of haddock, cod and whiting landed and discarded in the gears with the grid. The English trials compared (i) a Swedish grid (35 mm bar spacing) with an 85 mm DMC to an 85 mm DMC and (ii) a Swedish grid (35 mm bar spacing) with a 70 mm square mesh codend (SMC) to an 85 mm DMC. The grid with an 85 mm DMC increased the landings of tailed and whole *Nephrops* (minimum landing size is a carapace length of 25 mm) and reduced the catches of larger (>30 cm) cod and haddock. At smaller lengths however, the catches of haddock and cod increased. Whiting catches reduced across all lengths. The grid with a 70 mm SMC reduced the landings of tailed and whole *Nephrops* and the catches of haddock, cod and whiting across all lengths.

Selectivity trials using modified Nordmøre and Swedish grids have been carried out in the Portuguese crustacean-trawl fishery (Fonseca et al., 2005) and the Danish Skagerrak and Kattegat *Nephrops* fishery (Frandsen et al., 2009). In the Portuguese trials, the covered codend method was used to assess the selectivity of a grid with 25 mm bar spacing and a 0.2 m gap at the bottom. Between 8

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and 15% of *Nephrops* escaped and these were mainly the larger individuals. In the Danish trials, the twin trawl method was used with a 40 mm control codend to obtain selectivity curves for (i) a 90 mm DMC, (ii) a 90 mm DMC with a 120 mm square mesh panel (SMP) at 6–9 m and (iii) a 90 mm DMC with a modified Swedish grid that had a 35 mm bar spacing over the lower three quarters and an 80 mm bar spacing over the top quarter. The three gears retained similar quantities of *Nephrops* of carapace length < 40 mm, but the grid lost 11% of *Nephrops* in the range 40–44 mm and about 40% of those with carapace length > 60 mm. The grid reduced catches of cod, haddock, whiting, plaice (*P. platessa*), and saithe (*P. virens*) above the minimum landing size, but the catches of cod and haddock below the minimum landing size increased.

Square mesh panels are used to reduce discarding in several *Nephrops* fisheries. Catchpole and Revill (2008) review the literature and conclude that inserting an SMP typically reduces catches of whiting and haddock, and that in general improved selection is associated with an increase of mesh size and the panel being positioned closer to the codline. They also conclude that SMPs do not release *Nephrops* although a recent study by Krag et al. (2008) indicate that some *Nephrops* may escape through the SMP.

Here, we present the results of two trials, on the west and east coast of Scotland, to estimate the selectivity of an 80 mm DMC fitted with (i) a 35 mm Swedish grid, (ii) a 120 mm SMP at 6–9 m from the codline and (iii) a 120 mm SMP at 12–15 m from the codline. We use the twin trawl method, with a small mesh control net, and produce, as far as we are aware, the first estimates of the selectivity of an unmodified Swedish Grid for *Nephrops*, hake (*M. merluccius*), cod, haddock, whiting, plaice and witch (*G. cynoglossus*).

2. Materials and methods

The west coast trials were in March 2009 between Coll and Barra in the South Minch. The Ocean Trust (OB 38), a 375 kW twin-rig *Nephrops* trawler, towed twin John Noble *Nephrops* Discer nets, each with a fishing circle of 400 × 80 mm diamond meshes. The overall groundgear length was 30 m with 304 mm hopper discs in the centre and 250 mm out to the wings. The trawls were towed using a three-warp system with a 409 kg centre clump and spread using 1.5 m/140 kg Morgere doors.

The east coast trials were in July 2009 on the Fladen *Nephrops* grounds. The Fruitful Bough (PD 109), a 522 kW twin rig stern trawler, towed a matched pair of scraper nets (Pisces design), each with a fishing circle of 520 × 80 mm diamond meshes. The overall groundgear length was 55 m with 200 mm hopper discs in the centre and 150 mm out to the wings. The trawls were towed using a three-warp system with a 1000 kg roller clump and spread using 1.7 m/700 kg Type 11 Thyboron doors.

The twin trawl method was used to estimate the selectivity of the three test gears, where one net of the twin-rig fishes a test gear while the other fishes a 40 mm diamond mesh codend (control gear) to estimate the population of *Nephrops* and fish available on the grounds. At the start of both trials the twin rig gears were hauled ashore, checked to confirm that they were matching and mended where necessary.

The 80 mm diamond mesh codends and extensions were made from netting of 4 mm single polyethylene (PE) twine. They had 120 open meshes around the circumference and were fitted with 160 mm diamond mesh lifting bags made from 5 mm double PE twine with 54 open meshes. The combined codend and extension lengths were 18 m. The square mesh panels were 3.1 m long, 1.0 m wide and made from 120 mm diamond mesh netting of 4 mm single knotted PE turned on the square. They were inserted two meshes in from the selvedge and, when used, were positioned at either 6–9 m or 12–15 m from the codline (Fig. 1). For simplicity, the gears are labelled SMP6 and SMP12.

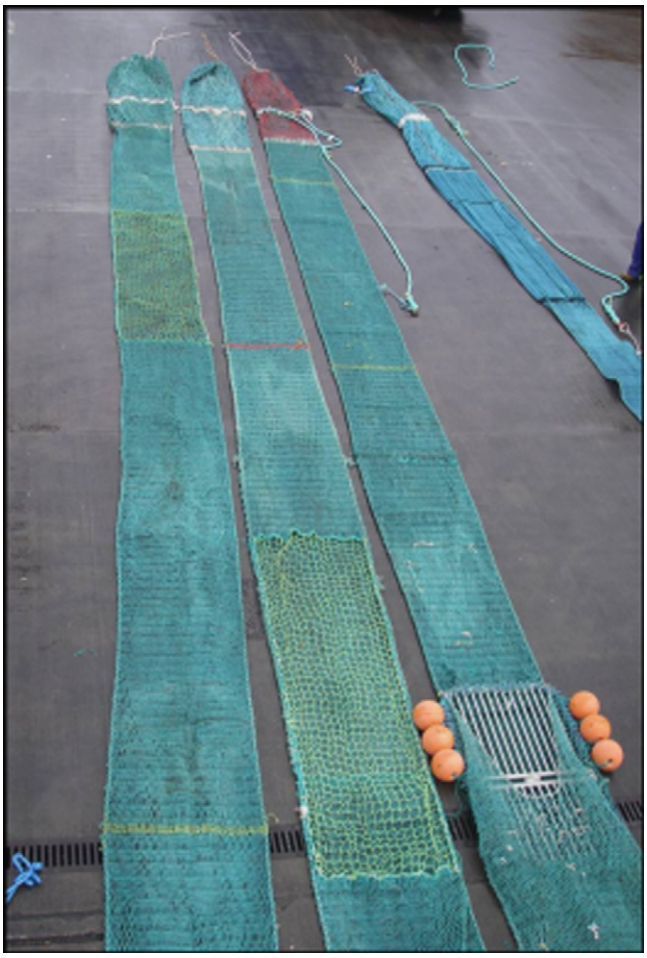

Fig. 1. The codends and extensions of the three gears examined. From left to right, the SMP6 gear, the SMP12 gear and the Swedish grid gear. The small mesh control is on the far right.

The Swedish grid was made from aluminium tubing and hinged at the midpoint along its length. It was 1.52 m long and 0.86 m wide and had a bar spacing of 35 mm, giving 14 bars in the top and bottom of the grid and a mass of 22 kg. It was positioned in the extension, 13 m from the codline, so that it inclined backwards at a 45° angle to the selvedge. A triangular, fish-release vent hole was cut out of the top sheet in front of the grid and three 8″ floats attached on each side, above the hinge, to support the grid weight (Fig. 1). No guiding panel was used and a chaffing strip of netting was attached to the bottom sheet to protect the grid lacing.

Most hauls lasted between 3 and 3½ h. In practise haul duration varies from fishery to fishery, and at different times during the year; it can range from 2–3½ h, up to 4–6 h. The vessels towed at their normal fishing speed of between 2.3 and 2.5 kts on the Ocean Trust and 2.6 and 2.8 kts on the Fruitful Bough. Wingend spreads, door spread and headline height were measured using Scanmar instrumentation. When the grid was used, a tilt sensor measured the angle of the upper or lower sections of the grid on alternate hauls. To minimise tidal effects on the twin rig geometry, hauls were conducted either directly with or against the tide. To minimise the risk of washout, the catch from the test gear was taken aboard before that from the control gear.

Nephrops, cod, haddock, whiting, saithe, hake, megrim (*L. whiffiagonis*), lemon sole (*M. kitt*), plaice, witch and all species of skate were sorted from the catch, subsampled where necessary and mea-