

A preliminary assessment of the Swedish grid in the English *Nephrops* fishery (Farne Deeps)

T.L.Catchpole¹, A.S.Revill² and G.Dunlin³

^{1,2} Centre for Environment Fisheries & Aquaculture Science (Cefas), Pakefield Road, Lowestoft, NR33 0HT, UK

³ Sea Fish Industry Authority, Seafish House, St Andrews Dock, Hull, HU3 4QE, UK

Introduction

Cod is an important commercial species in the North Sea and Irish Sea, the stocks of which are categorised as currently being outside safe biological limits (ICES, 2003). Due to the currently critical status of these cod stocks it is necessary to reduce the overall fishing effort exerted on cod of all ages/sizes (Anon., 2001); scientific advice in recent years has been to reduce the fishing effort exerted on cod to zero.

Further to reductions in cod quotas and limiting the number of days that vessels spend fishing for cod, changing the structure of trawls, so that the cod encountered by the trawl are not retained, offers another way to reduce effort on cod. There are several ongoing studies to develop species-selective gear for the three prominent mixed-species demersal trawl fisheries (otter, beam and *Nephrops* trawling) in the North and Irish Seas, where cod is an important catch component (Anon., 2001). In this study, the potential for one design, the Swedish grid, in reducing cod catches in an English *Nephrops* fishery is assessed.

The North Sea English *Nephrops norvegicus* trawl fishery, adjacent to the Farne Deeps, is one fishery in which cod is caught as bycatch. The main port for the fishery is North Shields situated on the mouth of the River Tyne. Other ports from which most vessels come to fish on this fishery are Blyth, Amble and Hartlepool. The fishing area extends between 0° to 2°W and 54° to 56°N. As defined by ICES (International Council for the Exploration of the Seas) the fishery is within management area (MA) I, which contains functional units (FU) 6 and 8, the Farne Deeps and Firth of Forth *Nephrops* fisheries respectively. The English (Farne Deeps) fishery is seasonal and runs from September to May; the season is dictated by the emergence behaviour of the *Nephrops* (Evans et al., 1994; Macer and Brown, 1987).

The bycatch of commercial fish makes up an economically important component of the landings in this fishery. In the 2001/02 season, 900 tonnes of mostly whiting, haddock and cod were landed (Catchpole et al., 2005), worth an estimated £1.4 million (market values from (Lee, 2001). In the same season an estimated total (landings and discards) of 288 tonnes of cod were caught (Catchpole, 2005; Catchpole et al., 2005).

Unlike haddock and whiting, which rise to the top of the trawl, cod remain on the bottom of the trawl during the catching process, as do the target species, *Nephrops*. To avoid any loss of *Nephrops*, research into reducing cod catches in *Nephrops* fisheries has focussed on using structures within the trawl to encourage the physical separation of cod from *Nephrops*. Trawls that have been developed in other *Nephrops* fisheries include the inclined separator panel (Rihan and McDonnell, 2003) and the Swedish grid.

The use of the Swedish grid is now mandatory in Swedish national waters. In the same fishery but outside Swedish waters, vessels are heavily restricted in the number of allocated fishing days unless the grid is used. The grid allows *Nephrops* to pass through the bars of the grid, which are too narrow to allow larger fish to pass. Instead these fish are guided upward to an escape hole (Figure 1). The grid, therefore, works to reject all large fish bycatch, essentially making the Swedish *Nephrops* fishery a single species fishery. When comparing the trawls used in the English and Swedish *Nephrops* fisheries, the other main difference is in the codends used. English *Nephrops* trawls use an 80 mm diamond mesh codend (single-rig), while Swedish trawls use a 70 mm square mesh codend.

The Swedish grid design has not been tested previously in this *English Nephrops* fishery. This work is a preliminary assessment of the potential use of the grid and its ability to reduce fishing effort exerted on cod and other species. The importance of collaborative research between fishermen and scientists on gear technology is well recognized (Melvin, 2003), as is the need to evaluate the socio-economic effects of new gears. This work was conducted on board a commercial vessel with the full involvement of its crew and included the collection of social data and an economic evaluation.

Method

A twin-rig vessel was chartered (Table 1), the skipper of which had extensive knowledge of this English *Nephrops* fishery. The twin-rig catch-comparison method was employed to assess the potential of the Swedish grid system in reducing the bycatch of cod and other species (Figure 2). Two trawls were towed simultaneously, one, the 'standard trawl', was a trawl comparable to those used by most vessels in this fishery (80 mm single-rig) (Catchpole et al., 2005). The other was the 'grid trawl', which differed only in the insertion of a section containing a Swedish grid into the extension piece (Figure 2 and 3).

The grid was fitted into an 8 m long, non-tapered section of the trawl. The grid dimensions were 150 cm in height by 85 cm in width. The grid was hinged horizontally and required floatation from six 20 cm floats. The angle of the grid was 45° and the spacing between the bars of the grid was 35 mm. Both the standard and grid trawl had a square mesh panel (90 mm) in the extension piece and a large diamond-mesh panel (159 mm) in the headline in accordance with current legislation.

Trials took place between 6th and 11th November 2005. Twelve replicate tows were successfully completed; the grid trawl and standard trawl were swapped sides after 7 tows to negate any side bias. New and identical codends (85.4 mm), extensions pieces (85.8 mm) and lifting bags (174.4 mm) were fitted to each trawl to minimise unwanted differences between the trawls. Tows were conducted in the area of the fishing grounds used by commercial vessels (54°53.75N to 55°6.71N and 001°06.15W to 001°17.23W) and lasted for a mean of 2:08 hours (2:00–2:36). Tows speeds were 2.3 –3.2 knots and took place between 07:10 and 15:45; all tows were trawled on a straight course.

The skipper was asked to fish in an area where he knew there would be both *Nephrops* and fish. It was recognized that because of this, along with the absence of any quota restrictions during the trials and the presence of researchers, the catching patterns might not accurately reflect normal commercial practices. However, all tows were conducted on previously towed tracks and in close proximity to other vessels fishing commercially, therefore, the trawls were considered to be characteristic of normal practice.

On hauling, the grid trawl was emptied into the hopper and the crew of the vessel were asked to sort the catch as they would normally, with the only exception that all material that would be discarded back to the sea was retained (this is subsequently referred to as the 'discard' fraction). The codend of the standard trawl was suspended over the hopper during this time to prevent any loss from the trawl.

During the sorting process, trained scientists measured the lengths of the main commercial fish species selected as marketable (subsequently referred to as 'landed' fraction) and those in the discard fraction. The main commercial fish species caught were whiting (*Melanogobius merlangus*), lemon sole (*Misocrostomus kitt*), plaice (*Pleuronectes platessa*), haddock (*Melanogrammus aeglefinus*), cod (*Gadus morhua*) and Dover sole (*Solea solea*).

All the fish of these species were measured when possible; sub-samples were taken when time was restricted. The number of baskets of *Nephrops* selected for tailing (subsequently referred to as '*Nephrops* for tails') and to be sold whole; and the number of baskets of discards of non-commercial fish species and of the total discard fraction were recorded. Thus, total discards and landings (in quantity and/or number) were obtained with length frequencies for the six main commercial fish species for both components. Once the sorting of the grid trawl was completed, the same procedure was used for the standard trawl.

T-tests were performed on total numbers landed and discarded per tow for the six main fish species and on the quantity of discards for each tow. The data allowed for one-way ANOVAs to be performed on the quantity of *Nephrops* for tails and whole *Nephrops* landed per trawl. Length frequencies of landings, discards and total catch, using data from all tows, were generated for the six main fish species.

Landings from the grid and standard trawls were sold separately. An assessment of the economic consequence of using the Swedish grid for the duration of the trials was determined from the difference in revenues generated from each trawl using sales invoices. Landings in weight were also recorded separately for each trawl and for each tow in the vessel logbook.

At the commencement of the trials, a meeting was held with the skipper to explain the rationale behind the trials. On completion of the trials, the skipper completed a feedback form designed to determine his opinions on the success of the trials, what the consequences would be of adopting the gear and his ideas for improving the gear.

Results

On hauling the first tow, the extension piece of the grid trawl had become twisted which meant nothing could pass through the grid; no data were gathered from this tow. All subsequent tows were completed without incident. There were no blockages of the grid.

There were no cod landed from the trawl with the grid compared to 325 with the standard trawl. Landings of whiting, haddock and plaice were all significantly less ($p < 0.05$) from the grid trawl than from the standard trawl (Table 2). Landings (in number) were a mean of 68% higher for whiting, 71% higher for plaice and a total of 99% higher for haddock with the standard trawl than with the grid trawl.

Discards of whiting (in number) were significantly lower when using the grid ($p = 0.004$) but discards of cod were significantly higher with the grid ($p = 0.033$) (Table 2). Whiting discards were a mean 60% lower with the grid; cod discards were a mean 53% lower without the grid. With the grid there was a reduction in the capture across the full length-range for whiting and it prevented the capture of marketable sized cod. However, small cod in the length range 13-20 cm were retained more effectively when using the grid than with the standard trawl (Figure 4).

There were more *Nephrops* for tails (mean 7%) and whole *Nephrops* (mean 22%) from the trawl with the grid in all but two of the trawls; however, this difference was not significant (Table 3). Similarly, the weight and value of *Nephrops* (data from sales invoices) did not differ significantly between hauls ($p > 0.15$). There was also no significant difference in the quantity (in baskets) of total discards between the two trawl designs (Table 3).

The sales invoices showed that, for the duration of the trials, when using the grid, landings were reduced by 51% in weight and 40% in value. The most valuable species landed from both trawls was *Nephrops*, which accounted for 76% of the landings value from the grid trawl and 41% from the standard trawl. Whiting accounted for the largest reduction in value of landings when using the grid followed by squid and cod. At first sale, fish and squid worth £441 were landed from the grid trawl compared to £1,777 from the standard trawl, equating to a 75% reduction (Table 4).

Feedback from the skipper highlighted the loss of marketable fish and consequent economic costs. The skipper did not believe that the grid had any potential use in this fishery. Also mentioned was the potential difficulty in handling the gear, although he and the crew were able to work with the grid safely and competently during the trials in sometimes poor conditions. The grid did not pass through the power-block (Figure 3); however, this did not affect the fishing process onboard this vessel.

Discussion

The Swedish grid was effective at reducing the capture of whiting of all sizes and haddock and cod of marketable sizes. However, more cod under the MLS, mostly in the length range 13-20 cm, were retained by the trawl with the grid. This result could only be attributed to the different selection properties of the grid trawl and standard trawl codends. With identical codend, extension piece and lifting bag specifications the difference in selection properties towards small cod is likely to be a consequence of the different quantities and composition of the catches retained by each codend. More fish were retained in the standard trawl and this was considered to improve the selective properties of the codend toward small cod.

As a means to reduce fishing effort on cod, on its own the grid does not provide a complete solution. With the grid, catches of marketable cod were reduced by 325 (or 100%) but catches of cod below MLS were increased by 1409 (or 114%). Improved codend selection could reduce the retention of these small cod but further research would be required to test this (e.g. investigating larger diamond-mesh or square-mesh codends in conjunction with the grid).

It is also recognised that the relative importance of fishing mortality and natural mortality on cod in the size range 13-20 cm is different to that on cod above the MLS, however, the relevance of this is beyond the scope of this study. Furthermore, it is unknown what proportion of the small cod on the fishing grounds that were encountered by the two trawls was retained. To establish this would necessitate some selectivity studies on the trawls.

The economic impact of introducing the grid to the English *Nephrops* fishery would likely be considerable. A previous estimate in 2001/02 of the contribution that fish bycatch make to the total landings value was ~20% (Catchpole, 2005). During this study, the fish landed from the standard trawl made up 58% of the total value of landings. The quantities of landings of all commercial fish species were lower when using the grid. An immediate significant reduction in landings revenue would therefore result from the introduction of the grid. Consequently, there is unlikely to be any industry support for its use in this English *Nephrops* fishery.

Conclusions

- 1) Cod of a marketable size were not retained when using the Swedish grid
- 2) Significantly more cod below marketable size were retained when using the Swedish grid
- 3) There was considerable loss of other marketable fish and squid with associated economic costs when using the grid
- 4) There was no significant difference in *Nephrops* landings between the standard trawl and trawl with the grid
- 5) There was no significant overall reduction in discards (all species combined) when using the grid

References

Anon., 2001. Quality of life and management of living resources - Research on effective cod stock recovery measures - Project QRLT-2001-00935 RECOVERY Technical Annex 1.

Catchpole, T., 2005. A Multidisciplinary study of discarding in North Sea fisheries. School of Marine Science and Technology and School of Geography, Politics and Sociology. University of Newcastle-upon-Tyne, Newcastle-upon-Tyne, p. 210.

Catchpole, T.L., Frid, C.L.J., Gray, T.S., 2005. Discarding in the English north-east *Nephrops norvegicus* fishery: the role of social and environmental factors. Fisheries Research 72, 45-54.

Evans, S.M., Hunter, J.E., Elizal, Wahju, R.I., 1994. Composition and fate of the catch and bycatch in the Farne Deep (North Sea) *Nephrops* fishery. ICES Journal of Marine Science 51, 155-168.

ICES, 2003. ICES Advisory Committee on Fishery Management Working Group Advice for 2003.

Lee, D., 2001. National Statistics - UK Sea Fisheries Statistics 1999 and 2000. DEFRA - Department for Environment Food and Rural Affairs, London.

Macer, C.T., Brown, C.G., 1987. A note on estimation of discards in the fishery for *Nephrops* off the north-east coast of England.

Melvin, E.P., J., 2003. Focusing and Testing Fisher Know-How to Solve Conservation Problems: A Common Sense Approach. Putting Fisher's Knowledge to Work, pp. 224-226.

Rihan, D.J., McDonnell, J., 2003. Protecting Spawning Cod in the Irish Sea through the use of Inclined Separator Panels in *Nephrops* Trawls.

Table 1. Details of twin-rig vessel and fishing gear used in the trials

| | |
|------------------|--------------------------------------|
| Engine | 215 kW |
| LOA | 14.95 m |
| Year built | 2003 |
| Trawls | 2 x Gamrie Bay |
| Ground rope | 45 m grass rope |
| Codend mesh size | 85.4 mm |
| Bridles | 100 m |
| Centre clump | 450 kg |
| Doors | 2 x 2.3 m Dunbar Vee (400 kg) |
| Door spread | 2 x ~45 m (from Trawlmaster sensors) |

Table 2. T-test results from a comparison in numbers of landings and discards of the six main commercial fish species between a standard trawl (S) and a trawl with Swedish grid (G) (there were no discards of Dover Sole during the trials).

| | Trawl type | Mean number per trawl n = 12 | SE | P-value |
|-----------------|------------|------------------------------|-----|---------------|
| Landings | | | | |
| Whiting | G | 151 | 19 | 0.006 |
| | S | 497 | 72 | |
| Cod | G | 0 | 0 | n/a |
| | S | 27 | 3.9 | |
| Haddock | G | 0 | 0.1 | 0.016 |
| | S | 6 | 1.9 | |
| Plaice | G | 8 | 1.5 | 0.0096 |
| | S | 28 | 6.3 | |
| Lemon sole | G | 9 | 2.2 | 0.054 |
| | S | 20 | 4.6 | |
| Dover sole | G | 5 | 0.8 | 0.1 |
| | S | 8 | 1.5 | |
| Discards | | | | |
| Whiting | G | 81 | 9.2 | 0.0004 |
| | S | 217 | 27 | |
| Cod | G | 220 | 33 | 0.013 |
| | S | 103 | 23 | |
| Haddock | G | 37 | 9.2 | 0.49 |
| | S | 28 | 8.9 | |
| Plaice | G | 15 | 3.5 | 0.16 |
| | S | 26 | 6.6 | |
| Lemon sole | G | 3 | 1.2 | 0.52 |
| | S | 4 | 1.7 | |

Table 3. Comparison of quantity of *Nephrops* landed and discards generated from a standard trawl (S) and trawl with Swedish grid (G). Quantity is in units of baskets, whereby one basket of *Nephrops* selected for tailing ~18 kg; one basket of *Nephrops* landed whole ~16 kg; one basket discards ~25 kg.

| | Trawl | Mean number of baskets per trawl (n = 12) | SE | P-value |
|---|--------|--|------------|---------|
| <i>Nephrops</i> selected for tailing (ANOVA) | G S | 4.4 3.9 | 0.7 0.6 | 0.53 |
| <i>Nephrops</i> landed whole (ANOVA) | G S | 3.8 2.9 | 0.5 0.4 | 0.14 |
| Total discards (T-test) | G S | 3.8 2.9 | 0.1 0.3 | 0.14 |
| Non-commercial discards (T-test) | G S | 0.3 0.4 | 0.1 0.1 | 0.68 |

Table 4. Total numbers landed (data from on board sampling) of the main fish species caught and weight and value of landings (data from sales invoices) when using a standard trawl and a trawl with Swedish grid.

| Landings | Number | Grid | | Standard | | |
|-----------------|--------|----------------|--------------|----------|----------------|--------------|
| | | Weight (kg) | Value (£) | Number | Weight (kg) | Value (£) |
| <i>Nephrops</i> | - | 732 | 1391 | - | 672 | 1262 |
| Cod | 0 | 0 | 0 | 325 | 222 | 232 |
| Haddock | 1 | 0 | 0 | 67 | 29 | 30 |
| Whiting | 1813 | 275 | 128 | 5968 | 939 | 658 |
| Lemon sole | 112 | 17 | 19 | 240 | 47 | 63 |
| Plaice | 97 | 14 | 10 | 337 | 100 | 78 |
| Dover sole | 57 | 14 | 52 | 93 | 20 | 66 |
| Squid | - | 85 | 193 | - | 192 | 450 |
| Others | - | 17 | 39 | - | 136 | 200 |
| Total | | 1154 | 1832 | | 2357 | 3039 |

Figure 1 A typical grid used in the Swedish fishery. Large fish are guided out of the trawl by the grid while smaller fish and *Nephrops* pass through the grid and enter the codend. The grid is made of aluminum and is jointed to facilitate winding the trawl on to the net drum



Figure 2. The twin-rig trial method: twin-rigged trawling with a standard trawl on the portside and a Swedish grid on the starboard side



Figure 3. Using the power block to manoeuvre the Swedish grid during hauling, note the grid does not pass through the power block



Figure 4. Length frequencies for all cod and whiting caught with grid trawl and standard trawl

