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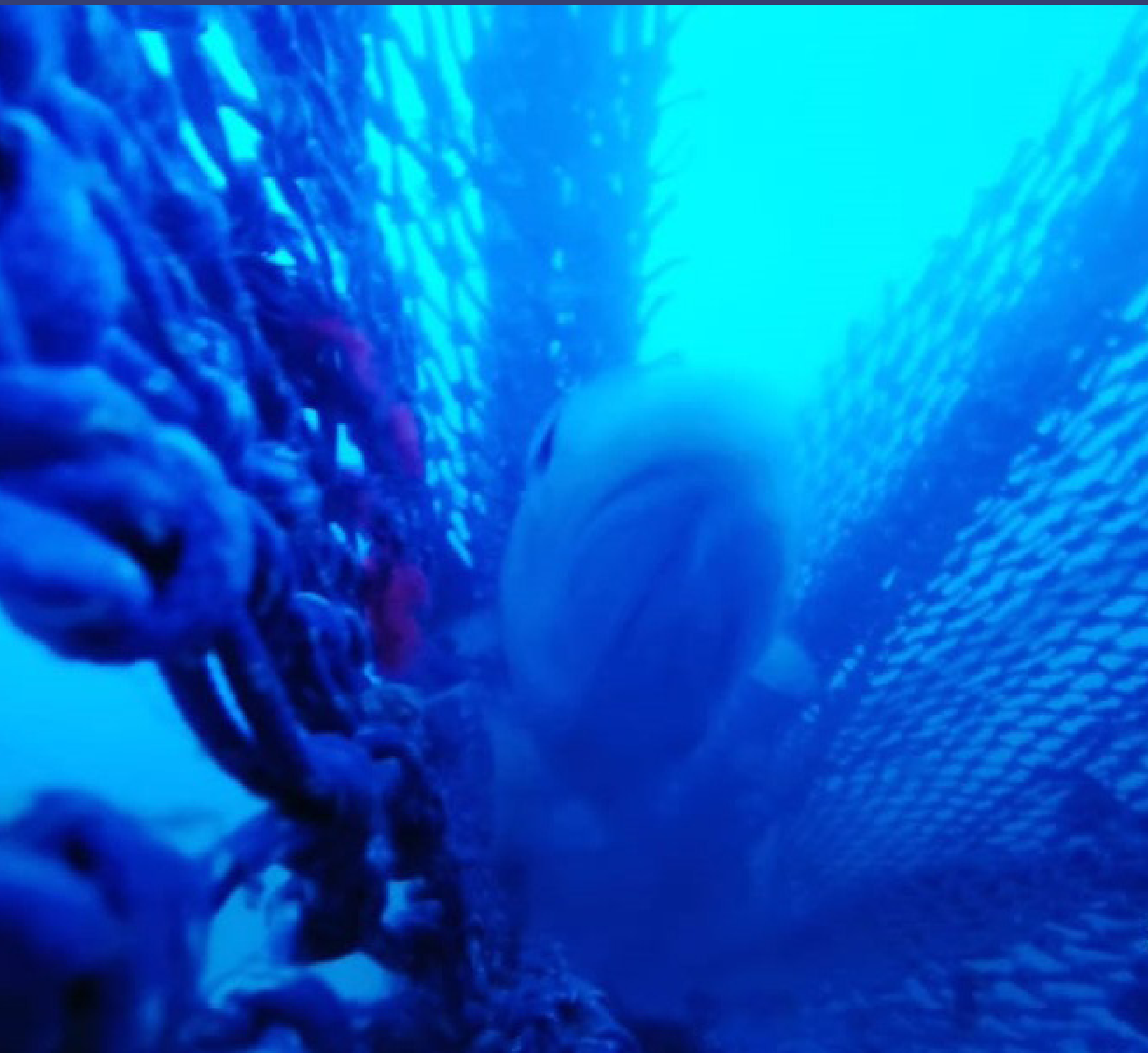
Jordan Feekings, Tiago Malta, Maria Sokolova and Valentina Melli

DTU Aqua Report no. 380-2020



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Cruise report from Havfisken, September 2020

By Jordan Feekings, Tiago Malta, Maria Sokolova and Valentina Melli

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Key Findings

A covered codend experiment was conducted onboard R/V Havfisken to look **at the catch efficiency of a diamond opening and diamond opening + flip flap net grid in relation to the SELTRA 300 3-6 and 4-7 m.**

1

The results from the trial show that **both test gears** (diamond opening and diamond opening + flip flap net grid) **were equally efficient as the SELTRA 300 4-7 m at avoiding catches of cod.**

2

Both test gears (diamond opening and diamond opening + flip flap net grid) **retained significantly more *Nephrops*** across a large length range **compared to both SELTRA 300 designs**.

3

The **SELTRA 300 3-6 m retained significantly less large cod** when compared to the other three gears tested.

4

Both test gears (diamond opening and diamond opening + flip flap net grid) **retained significantly more plaice** across a large length range **compared to both SELTRA 300 designs**.

5

The **position of the SELTRA 300 was found to influence selectivity**, with the SELTRA 300 3-6 m retaining the least amount of cod but also leading to a significant loss of the target species, *Nephrops*.

6

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Introduction

Cod (*Gadus morhua*) stocks within EU waters (North Sea, eastern English Channel, Skagerrak and Kattegat) are in poor condition. Consequently, new management regulations have been introduced in the Kattegat, Skagerrak, North and Baltic Seas. Among others, the main technical measures introduced have been in relation to gear designs, namely demersal trawls.

In the Kattegat, new technical measures were introduced in August 2020 to protect the cod stock (BEK nr 1249 af 24/08/2020). The traditional SELTRA 270 diamond mesh panel has been replaced with a SELTRA 300 square mesh panel, and its placement moved 1 meter closer to the codline (3-6 m rather than the previous 4-7 m). Additionally, a modified version of the scaring floats design that was developed under Fast Track II together with FN 459 M Jerup was also introduced into legislation. Here, the scaring floats with small grid in the bottom was combined together with a SELTRA 300 square mesh panel placed 4-7 m from the codline.

In the Skagerrak and North Sea, a new national cod plan was implemented in August 2020 (BEK nr 1204 af 12/08/2020), where a suite of additional gears were introduced, including a SELTRA 300 square mesh panel and a modified version of the scaring floats design. Both designs are however slightly different from what has been introduced into the Kattegat. In the Skagerrak and North Sea, the SELTRA 300 is placed 4-7 m from the codline and the scaring floats do not have a small grid mounted in the bottom.

The scaring floats design that was developed under Fast Track II together with FN 459 M Jerup consisted of three rows of floats and a small grid in the bottom in combination with a large diamond opening in the SELTRA 270 panel (Figure 1).

Figure 1. The modified SELTRA codend with floats and grid.

The results from the trial on FN 459 M Jerup showed that catches of cod were reduced by approximately 70 % in relation to a SELTRA 270. Based on these results, modified versions of the scaring floats have been introduced into legislation. The version introduced into the Skagerrak (SELTRA 300 4-7m + scaring floats) was tested on board Havfisken in June 2020 and showed little improvement in selectivity for fish species when compared to a SELTRA 300 4-7m. This result led us to question the effect of the scaring floats and wonder whether the large opening in the top panel was the cause for the reduction in cod catches. Furthermore, the national cod plan introduced into the Skagerrak and North Sea allows for developing and testing additional selective gears. Here, one of the gears mentioned is the flip flap net grid that has been part of the Scottish national cod plan since 2010. A flip flap net grid is a panel of netting installed vertically inside a trawl, where the top half of the panel is attached and the bottom half is weighted along its perimeter, but free to ‘flap’. Following consultation with the industry, it was decided that both the large opening and flip flap net grid were of interest and worth testing. Therefore, this trial aimed to test the following 4 gears in the demersal Norway lobster (*Nephrops norvegicus)* fishery:

1. A large diamond opening 4-7 m
2. A large diamond opening 4-7 m in combination with a flip flap net grid
3. A SELTRA 300 3-6 m
4. A SELTRA 300 4-7 m

Material and Methods

Fishing operations and gear

The trial was carried out on board R/V Havfisken, a 17 m research vessel built to fish with twin-rig trawls (Figure 2) operating in ICES Divisions IIIa (Figure 3). A total of 18 valid hauls were carried out from Sept 1st to Sept 8th 2020. All hauls were carried out on commercial fishing grounds in the Skagerrak and Kattegat. Small-meshed covers were used to capture individuals that escaped the codend, consequently hauls durations were shorter than what is typically observed in the *Nephrops* fishery. During the trial, average haul duration was 2 hours 15 minutes. The vessel engaged in twin-rig trawling, where the test gears (diamond opening with and without the flip flap net grid) and SELTRA codends were towed in parallel.

Figure 2. The vessel, R/V Havfisken.

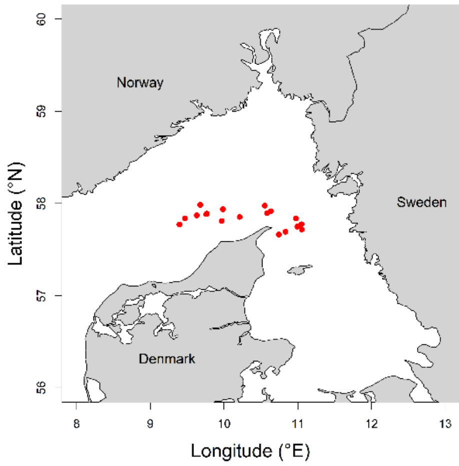

Figure 3. Trial location (18 valid hauls).

The aim of the project was to determine how selectivity changes when 1) the SELTRA 300 panel is replaced with a large diamond opening and a flip flap net grid and 2) the placement of the SELTRA panel is moved closer to the codline.

The standard SELTRA 300 codend consisted of four panels with a total circumference of 100 meshes, a nominal mesh size of 90 mm diamond mesh and a 3 meter long panel with a nominal mesh size of 300 mm placed at either 4-7 meters (Skagerrak) of 3-6 meters (Kattegat) from the codline (Table 1). The codend with the large diamond opening had the same specifications as the standard SELTRA codend, except that the panel was replaced with a large diamond opening that had a total stretched length of 2.7 m and went from seam to seam at its widest (Figure 4). The flip flap net grid consisted of 90 mm diamond netting turned 45 degrees and was fastened along the top panel and half way down (12 meshes) in the side panels (Figure 4). There was a small metal chain mounted along the net grid's bottom edge to weigh it down.

The codend covers had a nominal mesh size of 39.68 mm (SD = 1.16 mm) and a series of kites, weights and floats were used to keep the covers from contacting the codends (Figure 5).

Table 1. The technical specifications of the gears tested.

	Characteristic	Standard (SELTRA 300)	Modified (Diamond opening)
Codend	Mesh type	Diamond	Diamond
	Nominal mesh size (mm)	90	90
	Measured mesh size ± SD (mm)	96.1 ± 1.9	93.9 ± 2.4
	Codend circumference (mesh no.)	100	100
	Twine thickness	3 mm double	3 mm double
	Material	Polyethylene (PE)	Polyethylene (PE)
	Codend stretched length (m)	5.3/ 6.3	5.3
	Extension piece stretched length (m)	2.5	2.7
	No. of selvedges	4	4
	Number of meshes in selvedge	2	2
Panel	Panel stretched length (m)	3	2.7
	Nominal mesh size (mm)	300 mm	-
	Number of meshes across (length x width)	16 x 3	24 x 24*
	Distance from the codline to the panel (m)	3 / 4	4
Flip flap	Dimension (length x width) (mesh no.)	-	19 x 12
	Nominal mesh size (mm)	-	90
	Mesh type	-	T45 (diamond mesh turned 45 degrees)

*number of meshes at the diamond openings widest and longest points.

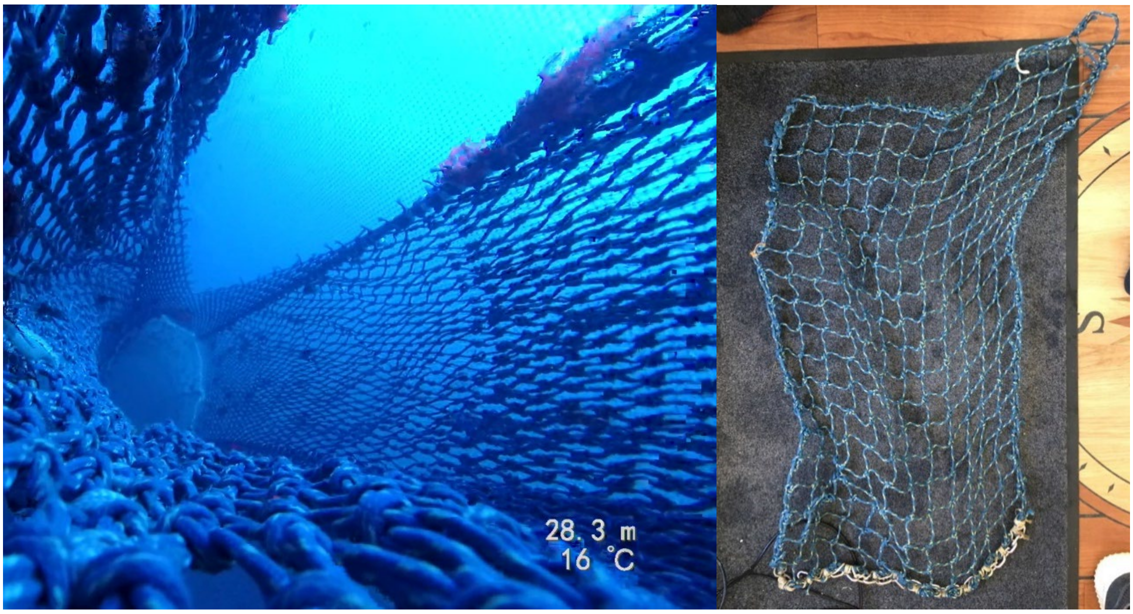

Figure 4. The large diamond opening in the top panel (left) and the flip flap net grid (right).

Figure 5. The codend covers.

Sampling and Analysis

Fishing was conducted following full commercial conditions in terms of towing speed and fishing areas. The use of covers typically results in large numbers of small fish being caught. To avoid damage to the covers, the haul durations during the trial were shorter than what is typical for this fishery. The total catch, in weight, of each trawl codend and cover was recorded prior to sorting. All catches of the target species *Nephrops*, as well as cod and plaice (*Pleuronectes platessa*) were length-measured. Carapace length of Norway lobster and total length of fish were rounded down to the nearest millimetre and centimetre, respectively. To prevent any systematic effects between the trawls and their position (side of the vessel) on the catch, the codends were shifted from one trawl to the other halfway through the experiment. For a given species, only hauls with a total of ten individuals for both gears were included.

The covered codend method implies that all individuals that entered the trawl were caught in either the codend or the cover. We were interested in estimating the length-dependent probability for an individual to be retained in the codend. Therefore, for each species and each trawl separately, we used the count data for the different length groups and tested different parametric models to estimate the retention rate at length, r(*l*, ***v***), where ***v*** is a vector consisting of the parameters of the model. We chose the model with the lowest individual Akaike information criterion (AIC) value (Akaike, 1974). 95% Efron confidence intervals (Efron, 1982) accounting for between and within hauls variation in selectivity were estimated using a double bootstrapping method with 1000 iterations. To fully exploit the experimental design with two trawls towed simultaneously and in parallel, for each experiment we synchronized the hauls selection during the bootstrap procedure. This increased the power of the analysis in determining the effect of adding the scaring floats, at each SELTRA position. The analyses were performed using the software SELNET (Herrmann, 2012).

Results

During the trials, a total of 18 valid hauls were carried out. The towing time varied from 1.5 to 3.2 hr with an average and standard deviation of 2.2 ± 0.53 hr. The depth varied from 22.5 to 164.0 m with an average and standard deviation of 73.5 ± 41.3 m. The total estimated catch weight varied between 20 and 163 kg with an average and standard deviation of 80 ± 45 kg.

Here we examine the selectivity of the large diamond opening and a flip flap net grid for the main commercial species in relation to the two legislated versions of the SELTRA 300 (Figure 6). We also examine the results for the SELTRA 300 codends in relation to those previously collected during the June 2020 cruise.

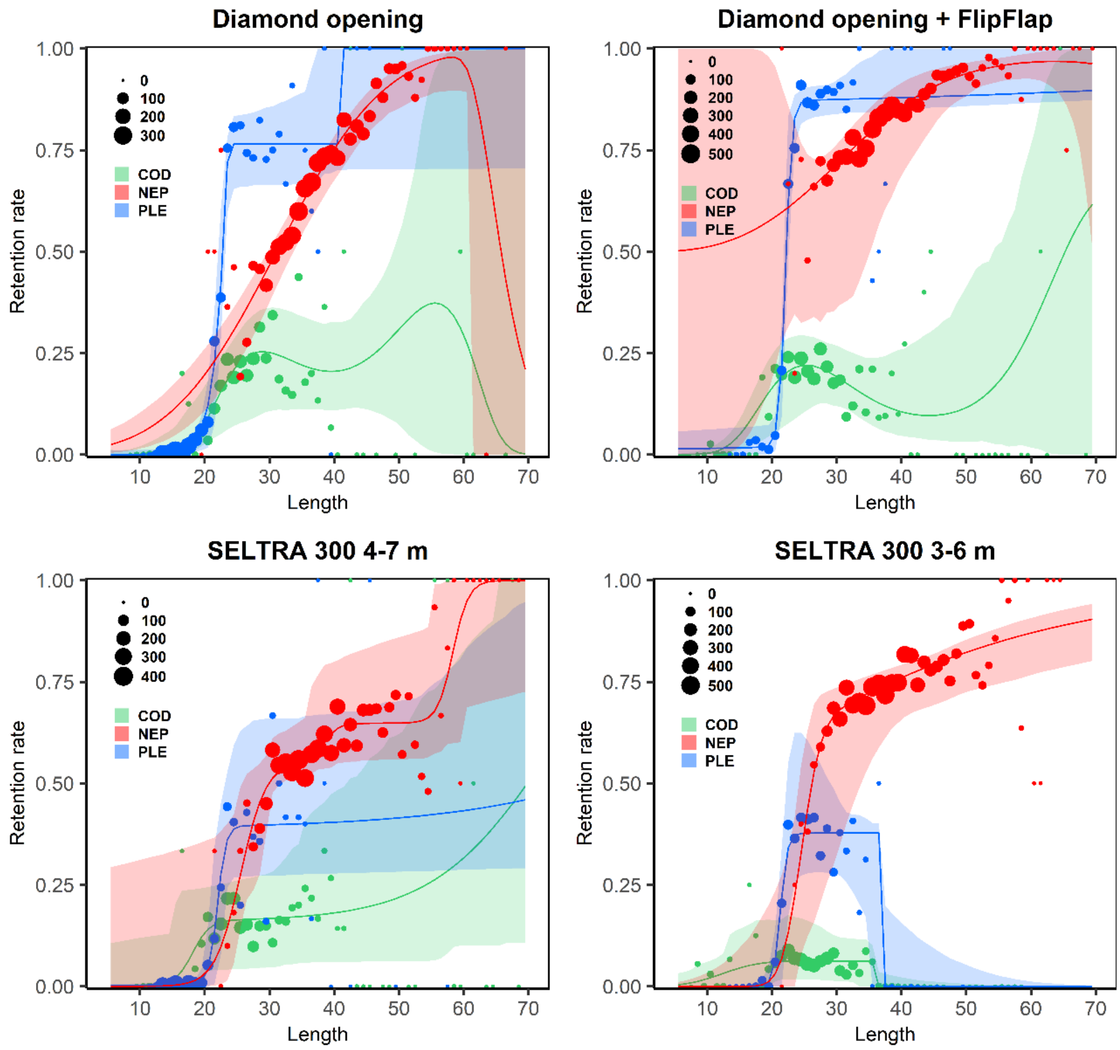

Figure 6. Absolute selectivity curves for cod, plaice and *Nephrops* in each of the four gears tested; Diamond opening (upper left), Diamond opening + Flip Flap net grid (upper right), SELTRA 300 4-7 m (lower left) and SELTRA 300 3-6 m (lower right). The 95% confidence intervals are represented by the shaded areas. The solid lines represent the mean retention rates for each of the gears and the dots represent the observed data.

Effect of the large opening and flip flap net grid in relation to the two legislated SELTRA 300 designs on the selectivity of cod, plaice and *Nephrops*

When comparing the selectivity curves for cod from the diamond opening and the diamond opening with the flip flap net grid it appears that the addition of the flip flap net grid may have improved the selectivity for cod, however, no significant differences can be observed across all length classes (Figure 7). A similar result can be observed when comparing the selectivity curves for the two test gears against that of the SELTRA 300 4-7 m. However, the three above mentioned gears all appear to catch significantly more large cod than the SELTRA 300 3-6 m.

For plaice, both versions of the diamond opening retained significantly more individuals across a large span of length classes (Figure 7). The SELTRA 300 3-6 m caught significantly less large plaice when compared to the SELTRA 300 4-7 m.

The retention of *Nephrops* appears to be highest for the large diamond opening with the flip flap net grid. When compared to both SELTRA 300 designs, the diamond opening with the flip flap net grid retained significantly more *Nephrops* (length classes 45-61 mm; Figure 7). Retention for *Nephrops* was lowest in the SELTRA 300 4-7 m and can be attributed to the poor weather conditions experienced during the second half of the cruise when this codend was trialed. In several hauls, large losses of *Nephrops* were observed due to the bad weather conditions.

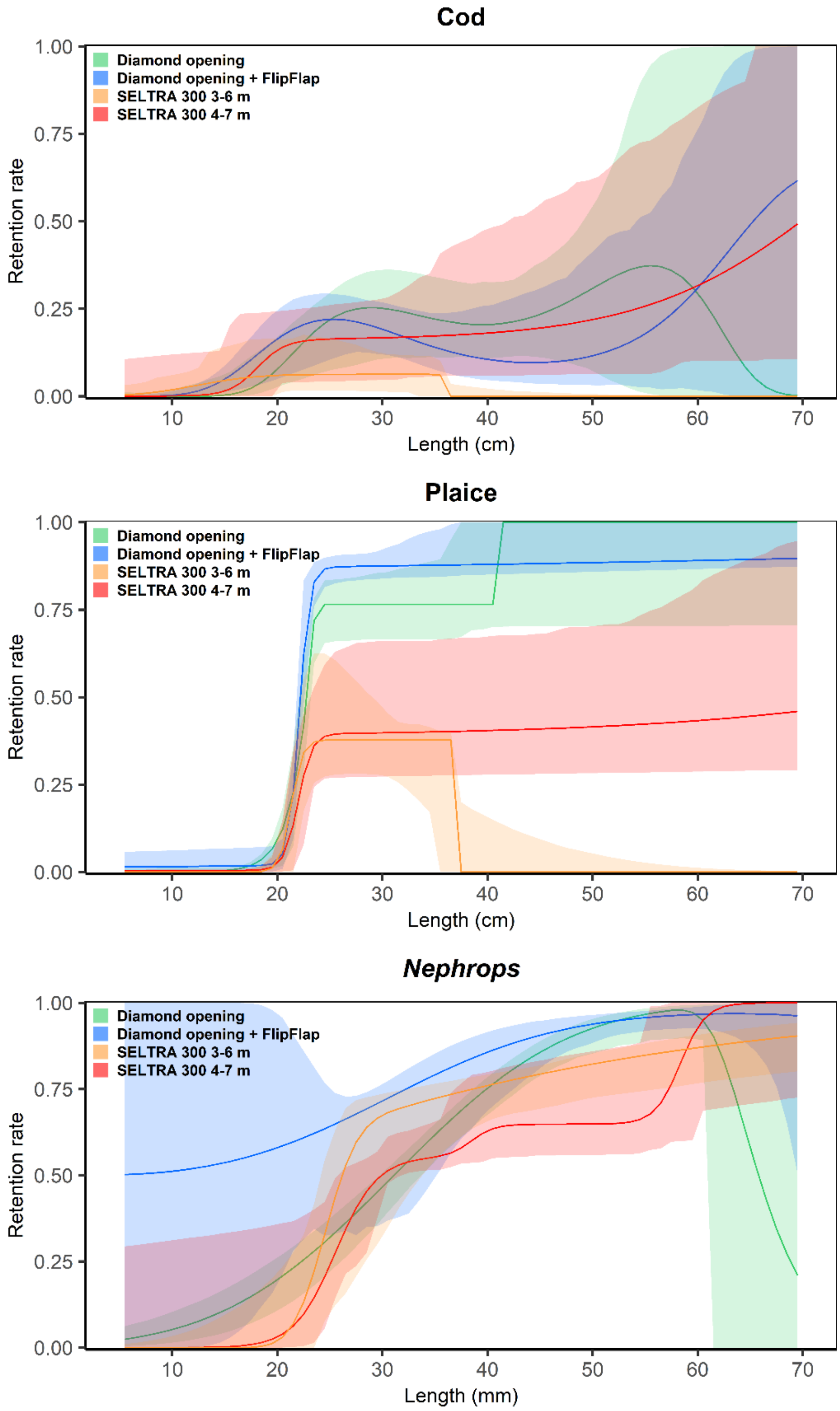

Figure 7. Absolute selectivity curves for cod (top) plaice (middle) and *Nephrops* (bottom) comparing the selectivity for the three species in the four gears tested. The 95% confidence intervals are represented by the shaded areas. The solid lines represent the mean retention rates for each of the gears; Diamond opening (green), Diamond opening + Flip Flap net grid (blue), SELTRA 300 3-6 m (orange) and SELTRA 300 4-7 m (red).

Effect of panel placement on selectivity of cod, plaice and *Nephrops*

Here we use the SELTRA 300 3-6 m panel placement and look at its position in relation to the panel placements tested during the June 2020 Havfisken cruise; 4-7 m and 7-10 m. We chose to exclude the SELTRA 300 4-7 m data from the September cruise as the weather conditions during the second half of the September cruise, when testing the 4-7 m placement, were rather different (i.e strong winds and rough sea state)from those in the first half of the September cruise and the June cruise. In several hauls, large losses of *Nephrops* were observed which resulted in lower than expected retention rates and large confidence intervals (Figure 8). The weather conditions during the first half of the September cruise and the June cruise were more similar. The results here are absolute selectivity estimates, meaning that the populations encountered, despite potentially being different, should not affect the results. However, differences in sea state are more likely to influence the performance of the SELTRA 300 and potentially lead to differences in the results.

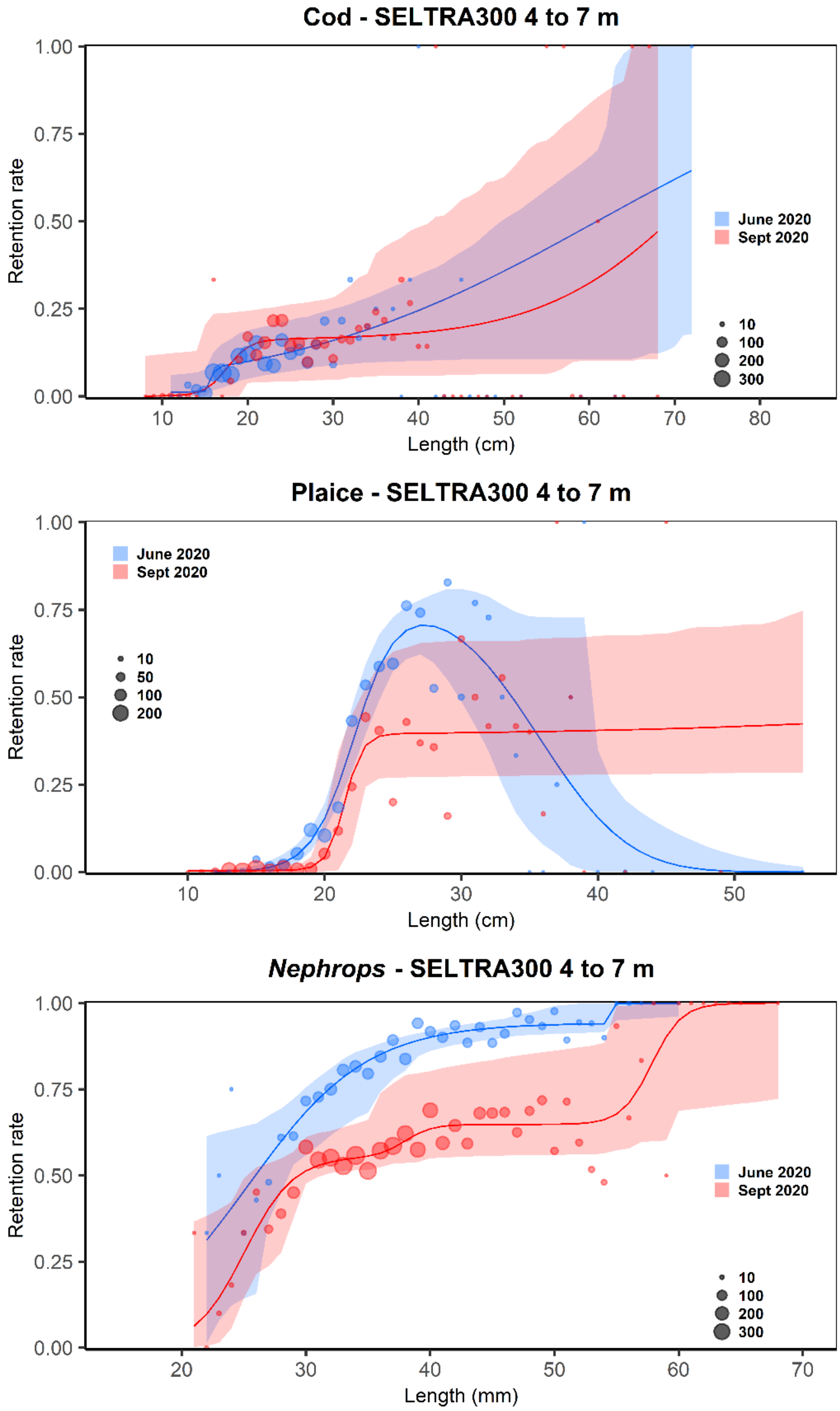

Figure 8. Absolute selectivity curves for cod (top) plaice (middle) and *Nephrops* (bottom) comparing the selectivity for the SELTRA 300 4-7 m from the June and September trials. The 95% confidence intervals are represented by the shaded areas. The solid lines represent the mean retention rates for each of the two trials.

For cod and *Nephrops*, no significant differences were observed across all length classes when the position of the panel was changed from 4-7 to 7-10 meters from the codline (Figure 9). However, when the panel was moved closer to the codline there was a significant reduction in the retention of large individuals.

For plaice however, there is an indication that more large individuals are retained in the gear when the panel is placed further from the codline (Figure 9). When the SELTRA 300 panel was placed at 3-6 m there was an overall reduction in the retention of plaice, with the reduction being significant for length classes 25-32 cm when compared to the SELTRA 4-7 m, and for individuals above 28 cm when compared to the SELTRA 7-10 m.

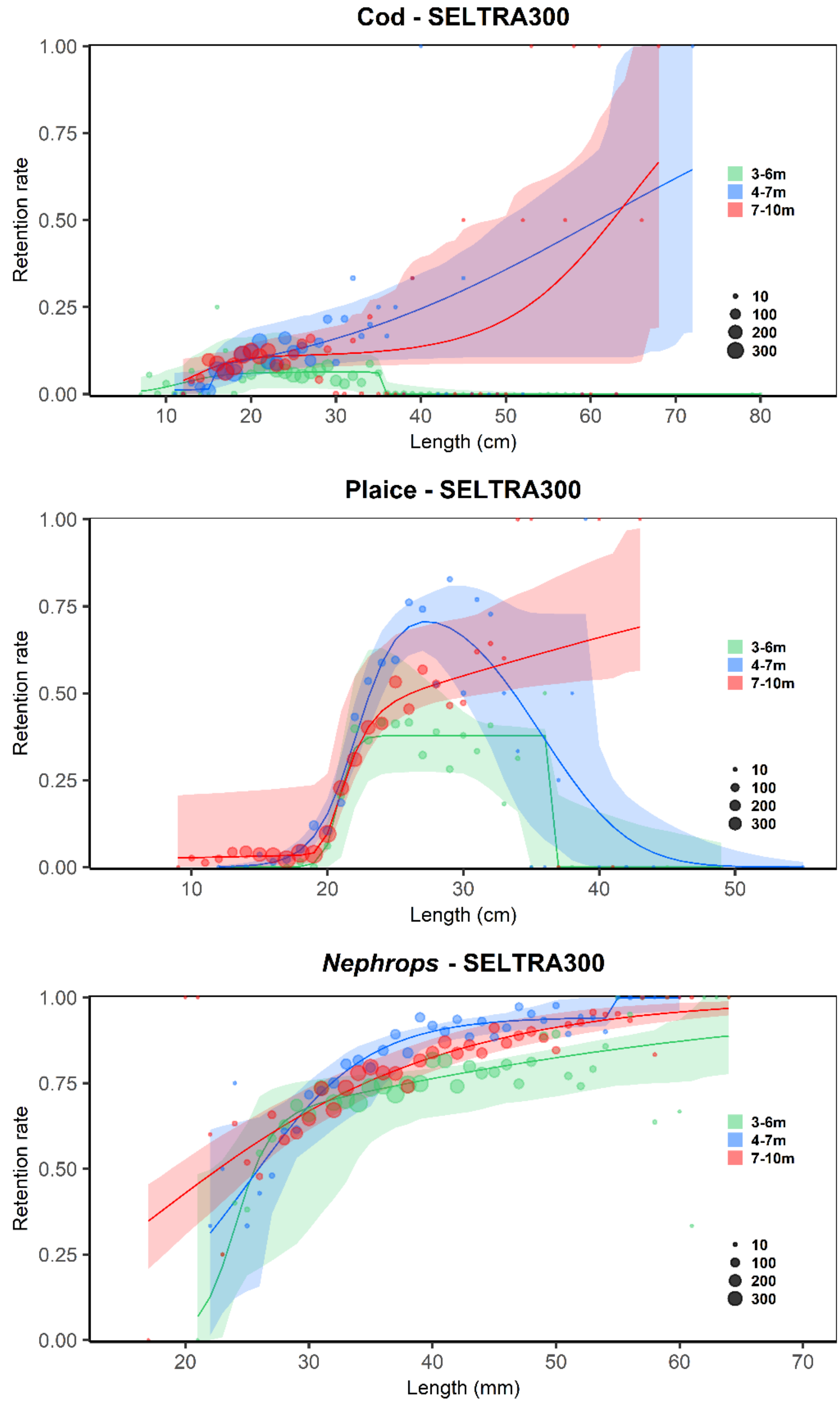

Figure 9. Absolute selectivity curves for cod (top) plaice (middle) and *Nephrops* (bottom) comparing the selectivity for the three species when the position of the panel is changed. The 95% confidence intervals are represented by the shaded areas. The solid lines represent the mean retention rates for each of the three positions; green (3-6 m), blue (4-7 m) and red (7-10 m).

Discussion

The results from the trial show that a large diamond opening in the top panel had a high retention for the target species (*Nephrops*) and important bycatch species (plaice) while having a low retention for cod. The addition of the flip flap net grid appears to result, while not significantly, in a further reduction of cod. In relation to the SELTRA 300 4-7 m, both versions of the diamond opening appear to have a better overall selectivity, retaining more *Nephrops* and plaice while having a similar selectivity for cod. In relation to the SELTRA 300 3-6 m, both versions of the diamond opening retain more cod, plaice and *Nephrops* above the minimum conservation reference size (MCRS).

The flip flap net grid tested here was slightly different to the one described in the Scottish national cod plan (Drewery, 2012). Here, 90 mm T90 netting was used as opposed to 200 mm square mesh. This was done to prevent catch from escaping out of the opening once already in the codend, for example, during haul back. Based on visual observations collected from underwater recordings, it appears as though the flip flap net grid achieved its objective, and also worked as a stop net, preventing catch from escaping out of the diamond opening during haul back (Figure 10). The underwater recordings also showed that the chain mounted along the net grid's bottom edge was potentially too light. A heavier chain may have helped hold the bottom edge of the flip flap down and possibly further improve selectivity.

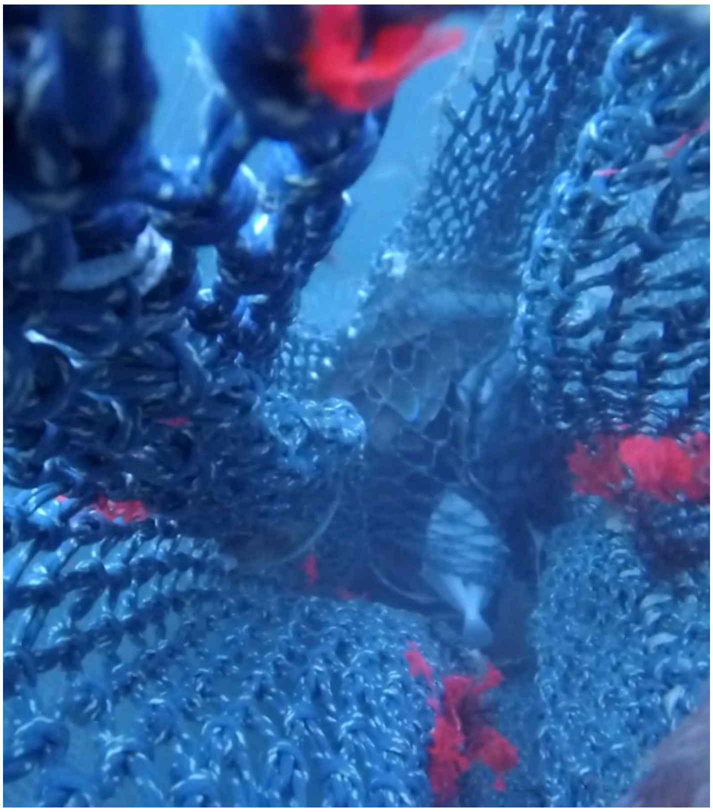

Figure 10. The flip flap net grid acting as a stop net during haul back.

The diamond opening appears to be more stable in terms of selectivity on a haul-by-haul basis. This can be seen in the narrower confidence bands around the mean curves for these two gears. It is also supported by the fact that the loss of *Nephrops* observed in the SELTRA 300 4-7 m in bad weather conditions was not observed during the same hauls for the diamond opening.

The position of the SELTRA 300 panel 3-6 m from the codline was found to have a lower retention for all three species compared to the results from the previous trial where the panel was placed at 4-7 m and 7-10 m from the codline. For cod and *Nephrops*, the retention in the 3-6 m was significantly lower for large individuals. For plaice, we have a bell shaped size selection at 3-6 m, as was also observed when the panel was placed at 4-7 m. This further supports the idea that plaice stay closer to the bottom netting when they are far away from the catch accumulation zone but can rise vertically once in proximity of the codline, with larger plaice being more likely to rise and contact the escape panel. The loss of target species (*Nephrops*) may lead to an increase in effort to catch the quota. Therefore, the benefit deriving from the significant reduction in retention of large cod may be smaller than expected. Furthermore, despite the SELTRA 300 tested during the trial being designed according to legislation, many fishermen add floats along the selvedges of the panel to ensure the panel section does not collapse and result in a loss of target catch. The height of the panel section is known to influence the selectivity for a number of species. For example, Krag et al. (2016) found that changing the height of the panel section from approximately 20 to 50 cm resulted in a significant increase in the retention of cod, saithe and plaice, while no effect was observed for *Nephrops*. Therefore, it may be that a SELTRA 300 with floats mounted along the selvedges would retain more of the fish species. During this trial, depth sensors were used to determine the height of the panel section. Unfortunately, there were problems with the sensors and these data were not able to be used.

Based on the results obtained during this trial, the diamond opening appears to be a good alternative to the SELTRA 300 codends. The diamond opening's simple design not only makes it interesting for the fishing industry, but also easy to describe in legislation and to control. Furthermore, it is a cost efficient alternative to the SELTRA as the diamond opening is simply cut out of existing netting and no expensive knotless netting and additional attachments, such as floats, are needed. Finally, the addition of the flip flap net grid showed to be an easy and cost effective solution, with the potential to improve the efficiency of the diamond opening.

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