

Catch Comparison trials using a 400mm Square Mesh Panel

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Summary:

- The 400mm SMP alone is unlikely to result in the required Cod weight reduction of 60% for Marine Scotland to classify this gear as highly selective.
- The 400mm SMP reached the required 60% reduction in Cod capture when tested with the modified Flip Flap or Faithlie Cod Avoidance Panels.
- Further trials using the 400mm SMP with the modified Flip Flap and the modified FCAP are recommended.

Introduction:

The Cod Recovery Plan aims to increase Cod stocks so that they are within safe biological limits but its implementation has negatively influenced the Scottish TR2 fleet (NSFAC 2011). At the December EU Agriculture- Fisheries Council meetings in 2011 substantial cuts in effort were agreed under the Cod Recovery Plan (Armstrong 2012). Furthermore the less than 5% Cod buy back derogation is being removed as Marine Scotland Science believe that Cod mortality attributed to the TR2 sector was not consistent with the Cod recovery plan, despite good compliance. Therefore to ensure economic viability the Scottish TR2 fleet urgently needs to adopt conservation measures, which allow them to continue fishing in a way that is not detrimental to Cod stocks. To this end the industry has agreed to universally adopt highly selective gear in TR2 vessels in return for a suitable days at sea allocation (Armstrong, 2012). Marine Scotland Science have defined highly selective gear as fishing gear which has demonstrated a 60% reduction in the weight of Cod caught (Marine Scotland 2012). Industry is working closely with Marine Scotland Science to develop such gears with a variety of options at differing stages of development. At present Marine Scotland Science has only accepted one selective gear and therefore the development of alternatives is required to give industry a range of practical solutions.

Net Design:

In these trials the effectiveness of a 400mm Square Mesh Panel (SMP) at reducing Cod capture was investigated. The 400mm SMP was tested in a standard Nephrops trawl and in conjunction with a modified Flip Flap net and a modified Faithlie Cod Avoidance Panel (FCAP).

The standard Flip Flap net was developed by Gamrie Bay Trawls and underwent SFF observer trials in June 2011. Following the success of these trials Marine Scotland carried out full scientific

trials in July and November 2011. Based on the results of the scientific trials Marine Scotland has classified the specific Flip Flap arrangement that was tested as highly selective. The key features of the accepted Flip Flap design include a large mesh (200mm) vertical panel which is attached to the top sheet, 0.5m away from the end of the taper (Drewery *et al.* 2011). The bottom half of this panel swings free inside the net and is held in a vertical position by a weighted leadline (Drewery *et al.* 2011). A triangular hole immediately in front of the vertically hanging panel allows the fish to escape (Drewery *et al.* 2011). In these trials this Flip Flap arrangement was altered so that the Flip Flap vertical panel was placed in the middle of the 400mm SMP, with the 400mm SMP replacing the escape hole. This altered Flip Flap arrangement is referred to as the “400mm SMP Flip Flap” during this report and was tested in hauls 7 – 11.

The FCAP consists of an inclined panel that is attached to the top sheet. Immediately in front of the FCAP a hole in the top sheet allows fish to escape. The inclined panel is attached to the bottom sheet to maintain its angle but a gap between the bottom sheet and the FCAP allows anglers and other commercial fish species to enter the net (Jones 2012¹). The FCAP has already undergone testing in a flume tank and two rounds of SFF observer trials, both which showed positive reductions in Cod capture (Jones 2012^{1 & 2}). The latest trials on the Rebecca showed a 70.98% reduction in the weight of Cod caught after gear alterations when the FCAP was placed in a standard Nephrops trawl (Jones 2012¹). In these trials the FCAP was placed in the middle of the 400mm SMP, which replaced the escape hole that was present in the previous trials. The FCAP with the 400mm SMP has been referred to as the “400mm SMP FCAP” during this report and was tested in hauls 22 – 28.

This report investigates the effects the 400mm SMP, the 400mm SMP Flip Flap and the 400mm SMP FCAP have on Cod capture. No previous testing has been carried out with these gear configurations. Supplementary information on the effects the 400mm SMP and the 400mm SMP Flip Flap had on Haddock, Whiting and Saithe capture was also recorded. Only the results for Haddock and Whiting are shown as there were not sufficient numbers of Saithe encountered to produce any meaningful results.

Methods:

The 400mm Square Mesh Panel (SMP) was tested on the twin rig Nephrops trawler, the Rebecca Jeneen (PIIn = OB38) as part of a commercial fishing trip between 12/03/2012 – 23/03/2012. All fishing took place in ICES Area VIAI in statistical rectangle E343 with a total of 28 valid hauls being completed. The twin trawl method was used with four different gear configurations being tested. Hauls 1 -3 consisted of the test gear comprising of a 400mm SMP being towed on both the port and starboard sides to make sure that the selective gear was fishing effectively. The 400mm SMP's was 4.5m x 1.2m in size and was fitted 12m from the cod end strings. After haul three the 400mm SMP in the starboard net was covered over using 100mm regular mesh. The starboard net was then used as the control and remained in this configuration for the duration of the trials. The 400mm SMP alone was tested in the portside net in hauls 4 – 6. After haul 6 the 400mm SMP Flip Flap was fitted to the portside test net and remained in place for hauls 7 – 11. This gear arrangement appeared to be having little influence on Cod capture and there were concerns that Nephrops were lost by the vertical panel becoming blocked. Therefore the skipper decided to remove the 400mm SMP Flip Flap for hauls 12 – 21 and revert back to fishing with only the 400mm SMP fitted. Before haul 22 the 400mm SMP FCAP was fitted to the test net and remained in place until the last haul. The summary table below illustrates the gear changes made in this trial.

Table 1: A summary of the different gear configurations tested during these trials.

Hauls	Gear Configuration
1 -3	400mm SMP in test and control net
4 – 6	400mm SMP in test net only
7 – 11	400mm SMP Flip Flap test net only
12 – 21	400mm SMP in test net only
22 - 28	400mm SMP FCAP test net only

The catch from the test and control nets was kept separate in the hopper by a divider. All cod from all hauls was retrieved and put in baskets for recording. All Haddock and Whiting were retrieved in hauls 1 -9. It was not possible to record all Haddock and Whiting for all hauls due to time constraints. Standard length – weight relationships were then used to determine the weight of all sampled fish (Coull *et al.* 1889).

Data Analysis:

The catches of Cod from the test nets and the control net were analysed using the smoother based methodology of Fryer *et al* (2003). First the log catch rate of the test gear, compared to the control net was modelled for each haul using a smoother. The fitted smoothers were combined over hauls to estimate the mean log relative catch rate for each gear type. Bootstrapping, using the statistic Tmax was used to assess if the mean relative catch rates depended on the fishing gear and to compare the mean log relative catch rates to zero. The analysis was completed on a logistic scale but the results have been back transformed for presentation (Drewery *et al.*, 2011). The relative catch rates are shown as a proportion of fish retained at each length in the test nets, compared to the control net. A value of one indicates that all fish were retained in the test net and a value of zero indicates all fish were released. A continuous line indicates that at these lengths, there was a significant difference between the number of fish in the test gear and the control net, a dashed line indicates the difference was statistically insignificant.

Results:

A total of 470 Cod was caught and sampled during these gear trials. The 400mm SMP was incorporated into both nets for hauls one to three to ensure that the selective gear was fishing adequately. Thirty three Cod were recorded in each net in these hauls, with an average weight difference of 22.45%. Relatively minor differences in the number and weight of Haddock and Whiting were recorded in these hauls demonstrating that the gear was working effectively. Therefore trials commenced with haul 4.

Statistical analysis showed a significant difference between the overall number of Cod caught in 400mm SMP ($p = < 0.01$), the 400mm SMP Flip Flap ($p = < 0.01$) and the 400mm FCAP ($p = < 0.01$), compared to the control gear. No significant difference between the selective gear types was observed ($p = 1.0$). A statistically significant difference was also observed between the number of Haddock and Whiting caught in the 400mm SMP ($p = < 0.01$ for both species) and the number of whiting caught in 400mm SMP and the 400mm SMP Flip Flap ($p = < 0.015$, $p = 0.013$ respectively), compared to the control gear.

Table 2: The quantity and weight of Cod caught per haul by the control and test net. Test net = 400mm SMP, number of Hauls = 13.

Haul	The number of Cod		% difference in the number of Cod caught	The live weight of Cod (Kg)		% difference in the weight of Cod caught (Kg)
	Trial Net	Control Net		Trial Net	Control Net	
4	7	14	50.00	11.38	12.24	7.03
5	6	8	25.00	10.09	13.63	25.97
6	8	13	38.46	6.08	17.05	64.34
12	6	16	62.50	7.47	15.31	51.21
13	4	11	63.64	3.86	13.76	71.95
14	5	9	44.44	5.48	9.28	40.95
15	6	22	72.73	9.96	29.05	65.71
16	4	8	50.00	4.19	11.08	62.18
17	8	12	33.33	9.49	8.7	-9.08
18	5	16	68.75	5.11	22.08	76.86
19	10	9	-11.11	9.98	8.96	-11.38
20	5	5	0.00	3.84	4.92	21.95
21	4	8	50.00	3.53	8.85	60.11
Total	78	151	48.34	90.46	174.91	48.28

Table 3: The quantity and weight of Cod caught per haul by the control and test net. Test net = 400mm SMP Flip Flap, number of Hauls = 5.

Haul	The Number of Cod		% difference in the number of Cod caught	The live weight of Cod (Kg)		% difference in the weight of Cod caught (Kg)
	Trial Net	Control Net		Trial Net	Control Net	
7	9	15	40.00	8.91	10.22	12.82
8	1	9	88.89	0.21	13.36	98.43
9	3	9	66.67	1.47	7.25	79.72
10	7	14	50.00	7.12	14.31	50.24
11	3	13	76.92	4.12	17.86	76.93
Total	23	60	61.67	21.83	63.00	65.35

Table 4: The quantity and weight of Cod caught per haul by the control and test net. Test net = 400mm SMP FCAP, number of hauls = 7.

Haul	Number of Cod		% difference in the number of Cod caught	The live weight of Cod (Kg)		% difference in the weight of Cod caught (Kg)
	Trial Net	Control Net		Trial Net	Control Net	
22	0	8	100.00	0	8.56	100.00
23	0	4	100.00	0	4.17	100.00
24	2	7	71.43	6.18	7.87	21.47
25	3	14	78.57	3.81	16.31	76.64
26	7	16	56.25	12.6	24.14	47.80
27	1	9	88.89	1.28	8.85	85.54
28	7	14	50.00	5.51	14.77	62.69
Total	20	72	72.22	29.38	84.67	65.30

Table 5: The quantity and weight of Haddock caught per haul by the control and test net. Test net = 400mm SMP, number of hauls = 3.

Haul	Number of Haddock		% difference in the number of Haddock caught	Live weight of Haddock (Kg)		% difference in the weight of Haddock caught (Kg)
	Test Net	Control Net		Test Net	Control Net	
4	61	141	56.74	20.08	47.58	57.80
5	37	49	24.49	13.11	18.5	29.14
6	77	186	58.60	24.56	59.47	58.70
Total	175	376	53.46	57.75	125.55	54.00

Table 6: The quantity and weight of Haddock caught per haul by the control and test net. Test net = 400mm SMP Flip Flap, number of hauls = 3.

Haul	Number of Haddock		% difference in the number of Haddock caught	Live weight of Haddock (Kg)		% difference in the weight of Haddock caught (Kg)
	Test Net	Control Net		Test Net	Control Net	
7	37	127	70.87	12.72	45.92	72.30
8	19	42	54.76	6.98	12.75	45.25
9	49	124	60.48	15.08	38.83	61.16
Total	105	293	64.16	34.78	97.5	64.33

Table 7: The quantity and weight of Whiting caught per haul by the control and test net. Test net = 400mm SMP, number of hauls = 3.

Haul	Number of Whiting		% difference in the number of Whiting caught	Live weight of Whiting (Kg)		% difference weight of Whiting caught (Kg)
	Test Net	Control Net		Test Net	Control Net	
4	45	219	79.45	4.88	19.99	75.59
5	31	74	58.11	2.64	10.63	75.16
6	99	209	52.63	12.01	24	49.96
Total	175	502	65.14	19.53	54.62	64.24

Table 8: The quantity and weight of Whiting caught per haul by the control and test net. Test net = 400mm SMP Flip Flap, number of hauls = 3.

Haul	Number of Whiting		% difference in the number of Whiting caught	Live weight of Whiting (Kg)		% difference in the weight of Whiting caught (Kg)
	Test Net	Control Net		Test Net	Control Net	
7	73	181	59.67	7.44	16.62	55.23
8	53	68	22.06	3.98	5.97	33.33
9	88	164	46.34	7.75	16.58	53.26
Total	214	413	48.18	19.17	39.17	51.06

Figure 1: The relative catch rate of Cod by the selective gears in comparison to the control standard Nephrops net.

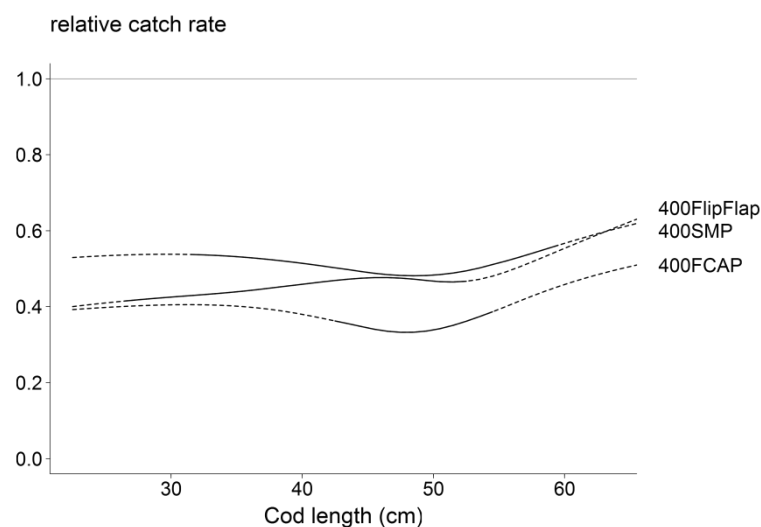


Figure 2: The relative catch rate of Haddock by the selective gears in comparison to the control standard Nephrops net.

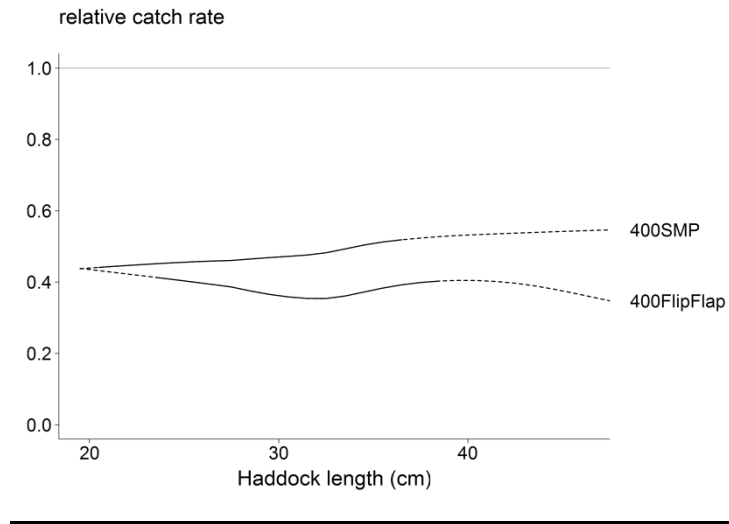
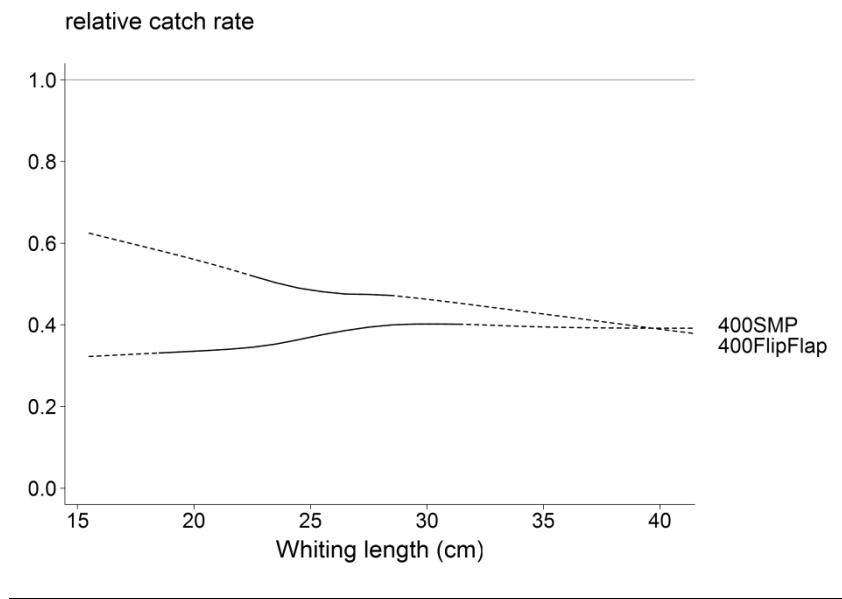


Figure 3: The relative catch rate of Whiting by the selective gears in comparison to the control standard Nephrops net.



Conclusions:

400mm SMP:

All gear configurations demonstrated a marked reduction in the number and weight of Cod caught in the test net, compared to the control gear. The 400mm SMP was tested for the majority of the hauls (Haul total = 13, total number of Cod caught = 229) with an observed reduction in the number of cod caught of 48.34% and a reduction in weight of 48.28%. The similar reductions in the percentage differences indicate that the 400mm SMP is not retaining juveniles or the larger fish but allowing Cod of all sizes to escape. This is supported by the relatively flat relative catch rates at length shown in figure 1. As figure one illustrates there is a significant difference in the relative catch rate between the 400mm SMP and the control net for Cod approximately 26 to 52cm in length. The relative catch rate between the 400mm SMP and the control gear becomes statistically insignificant for larger fish. This could be because few larger fish were encountered during these trials, or the 400mm SMP is not adequately facilitating their escape.

These results suggest that although the 400mm SMP alone is capable of almost halving the weight of Cod caught this gear is unlikely to achieve the 60% reduction required by Marine Scotland for 'highly selective gear' classification. However the observed reduction in Cod weight is lower than the observed reduction in the weight of Haddock (54%) and Whiting (64.24%) with the same gear configuration (See tables 5 & 7). Clearly the 400mm SMP is capable of reducing bycatch of these three important commercial species and therefore its use could be encouraged as fisheries management moves towards a multispecies approach.

400mm SMP Flip Flap, 400mm SMP FCAP:

Greater reductions in the quantity of Cod caught were observed whilst trialling the 400mm SMP Flip Flap and the 400mm SMP FCAP. The addition of either panel further reduced the average weight of Cod caught by approximately 17%, raising the average percentage reduction in weight to 65.35% and 65.3% respectively (See tables 3 and 4). Therefore these gear combinations can reduce the weight of Cod caught by the required 60% and should be considered for further development and SFF observer trials. Previous SFF and Marine Scotland led trials of the standard Flip Flap and FCAP arrangements support these results (Drewery *et al.* 2011, Jones 2012^{1 & 2}), suggesting that different variations of these selective measures are capable of reaching the Cod reductions required by Marine Scotland.

The percentage difference in the weight of Cod caught between the 400mm SMP Flip Flap and the 400mm SMP FCAP in these trials is minimal (Tables 3 & 4). However the length range in which a significant difference has been detected differs between these two selective measures, potentially indicating that these selective gears work effectively for different sized Cod. As figure one shows the relative catch rate of Cod is lower for the 400mm SMP FCAP, but the length range over which a significant difference was detected is narrower than that of the 400mm SMP Flip Flap. This indicates that although the overall percentage differences in the weight of Cod caught between these two test gears is small, the size composition of retained fish in the test net differs.

The 400mm SMP Flip Flap was the only selective gear combination trialled which produced a meaningful, statistically significant difference in the number of Cod caught under the minimum landing size (35cm). Further trials testing the selectivity of the 400mm SMP Flip Flap and the 400mm SMP FCAP combinations would be beneficial because if this is the case then these gears could have the potential to provide TR2 fishermen with selective gear options that could be utilized, depending on the size of Cod they are likely to encounter. Caution is needed however, as the inter

haul variation within these trials is high. Although the standard Flip Flap has already been classified as highly selective by Marine Scotland the classification of alternatives based on the same design principles would be beneficial to industry as not all nets can be easily adapted to incorporate the classified Flip Flap design.

Haddock and Whiting:

1392 Haddock and 1887 Whiting were sampled during the first 9 hauls of this trip. It was not possible to sample all hauls due to time constraints. The 400mm SMP alone reduced the weight of Haddock and Whiting caught by 54% and 64.24%, showing that this gear configuration is also capable of reducing bycatch of these two species. The number and weight of Haddock caught decreased further during the testing of the 400mm SMP Flip Flap, suggesting that this gear configuration encourages escape. As table 8 shows this was not the case for Whiting. The percentage difference of the weight of Whiting caught decreased after the Flip Flap arrangement had been incorporated into the test net. These results are reflected in the relative catch rates shown in figures 2 and 3. Both the 400mm SMP and the 400mm SMP Flip Flap showed significant reductions in the relative catch rates of Haddock and Whiting under their minimum landing sizes and therefore the use of these selective gear variations for reducing Cod capture could have positive benefits for these fish stocks. These conclusions are tentative in nature as Haddock and Whiting was only measured in three hauls, when the 400mm SMP and the 400mm SMP Flip Flap was being trialled. Further trials in which other key species such as Haddock and Whiting were fully accounted for would be beneficial to ensure that selective gear developed to reduce Cod capture is not having an intentional, adverse effect on other key species.

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