

Scottish Industry Science Partnership Report



Report no. 02/11

SISP project 003/10

Trials to assess the potential for nephrops trawls with low headline heights (<1m) in reducing whitefish by-catches

R J Kynoch, A Edridge, J Drewery and F G O'Neill



April 2011

marinescotland
science

© Crown copyright 2011

Scottish Industry Science Partnership Report Number 02/11

**TRIALS TO ASSESS THE POTENTIAL FOR *NEPHROPS* TRAWLS WITH LOW
HEADLINE HEIGHTS (<1M) IN REDUCING WHITEFISH BY-CATCHES**

R J Kynoch, A Edridge, J Drewery and F G O'Neill

April 2011

Marine Scotland Science
375 Victoria Road
Aberdeen
AB11 9DB

TRIALS TO ASSESS THE POTENTIAL FOR *NEPHROPS* TRAWLS WITH LOW HEADLINE HEIGHTS (<1M) IN REDUCING WHITEFISH BY-CATCHES

R J Kynoch, A Edridge, J Drewery and F G O'Neill

Marine Scotland Science, Marine Laboratory
375 Victoria Road, Aberdeen, AB11 9DB

Summary

Trials were held to assess whether whitefish by-catch could be reduced in the *Nephrops* trawl fishery by using low headline *Nephrops* trawls.

There was no significant reduction in the quantities of cod caught when using the *Nephrops* trawl with a headline height no greater than 1 m.

For whiting there was no significant difference between the two trawls for fish below 27 cm and for haddock below 30 cm. However, for larger whiting and haddock there were significant differences in relative catch rates in lengths >28 cm and >31 cm respectively.

For *Nephrops*, the control gear appear to fish better than the test with significant differences in the catch rates found for *Nephrops* above 36 mm carapace length. However, overall catch rates for this species was very low with none of the hauls being representative of commercial catches.

Introduction

Since February 2008, the Scottish Conservation Credit Scheme has rewarded fishermen with additional days at sea for adopting conservation measures which allow non-target species to escape. Under the scheme the Scottish Government has encouraged fishermen to come forward with their own initiatives to improve gear selectivity. In an effort to support fishermen in developing new selective gear the Scottish Industry/Science Partnership (SISP) programme was established to provide funding for scientific projects. In early 2010 the Mallaig & North West Fishermen's Association (MNWFA) and the Scottish Whitefish Producers Association (SWFPA) successfully submitted a project proposal for SISP funding to investigate the potential for low headline *Nephrops* trawls to reduce the impact on non-target species.

Traditionally trawls used to target *Nephrops* on offshore grounds in Scotland have incorporated headline heights of up to ~2.5 m. However, there is no evidence that *Nephrops* move far from the seabed when encountering a trawl and therefore much of this headline height impacts only on fish catches. The main aim of this project was to test a new design of *Nephrops* trawl incorporating a headline height of ~1 m. The intention was to compare the catches of this net design against those from a more traditional higher headline trawl. This

report presents the results of these trials, carried out on a Scottish twin trawl *Nephrops* trawler during November 2010.

Vessel and Fishing Grounds

The Favonius (PD17), a 480kW twin rig stern trawler was chartered for the experimental trials. The charter ran for 10 days from 9 to 18 November 2010. The catch comparison trials were carried out on commercial *Nephrops* grounds in the North Sea (ICES area IVa). Two different areas were targeted, one approximately 40 nautical miles east of Peterhead (F & F) and the other approximately 90 nautical miles North East of Fraserburgh (Tommy Raes). The species mix encountered at both grounds consisted of haddock, whiting, cod and limited numbers of *Nephrops*.

Fishing Gear

Both experimental and control trawls were supplied by Faithlie Trawls International Limited, Fraserburgh. The same ground gear configuration was attached to both trawls with a total length of 61 m. It consisted of 250 mm hopper discs in the centre reducing down to 200 mm hopper discs at the wing ends. Both nets were fished with a bosom tickler chain constructed from 10 mm mid-link chain.

The control trawl was of a recent design which has been supplied to a number of Scottish vessels targeting offshore *Nephrops* grounds and incorporated a 480 x 80 mm mesh fishing circle. The low headline trawl had a slightly smaller fishing circle of 400 x 80 mm mesh and was similar to an experimental design which has already undergone flume tank trials. The netting used to construct the upper and lower wings of both trawls was 156mm (nominal) and 80 mm (nominal) respectively. During the previous flume tank trials it was noted that reducing the number of meshes across the wing sections could be used to control the overall headline height of the trawl. The control trawl incorporated 45 meshes across the top wing and 73 meshes across the lower wing (Figure 1). For the experimental trawl the number of meshes across the top and lower wings was reduced to 23 and 33 meshes respectively (Figure 2). It should be noted that the wing lengths were similar for both trawls, but the test trawl had 40 more mesh across fishingline centre to enable it to be rigged to the 61 m ground-gear. Both trawls had a 19.5 mesh deep square or cover constructed from 156 mm netting.

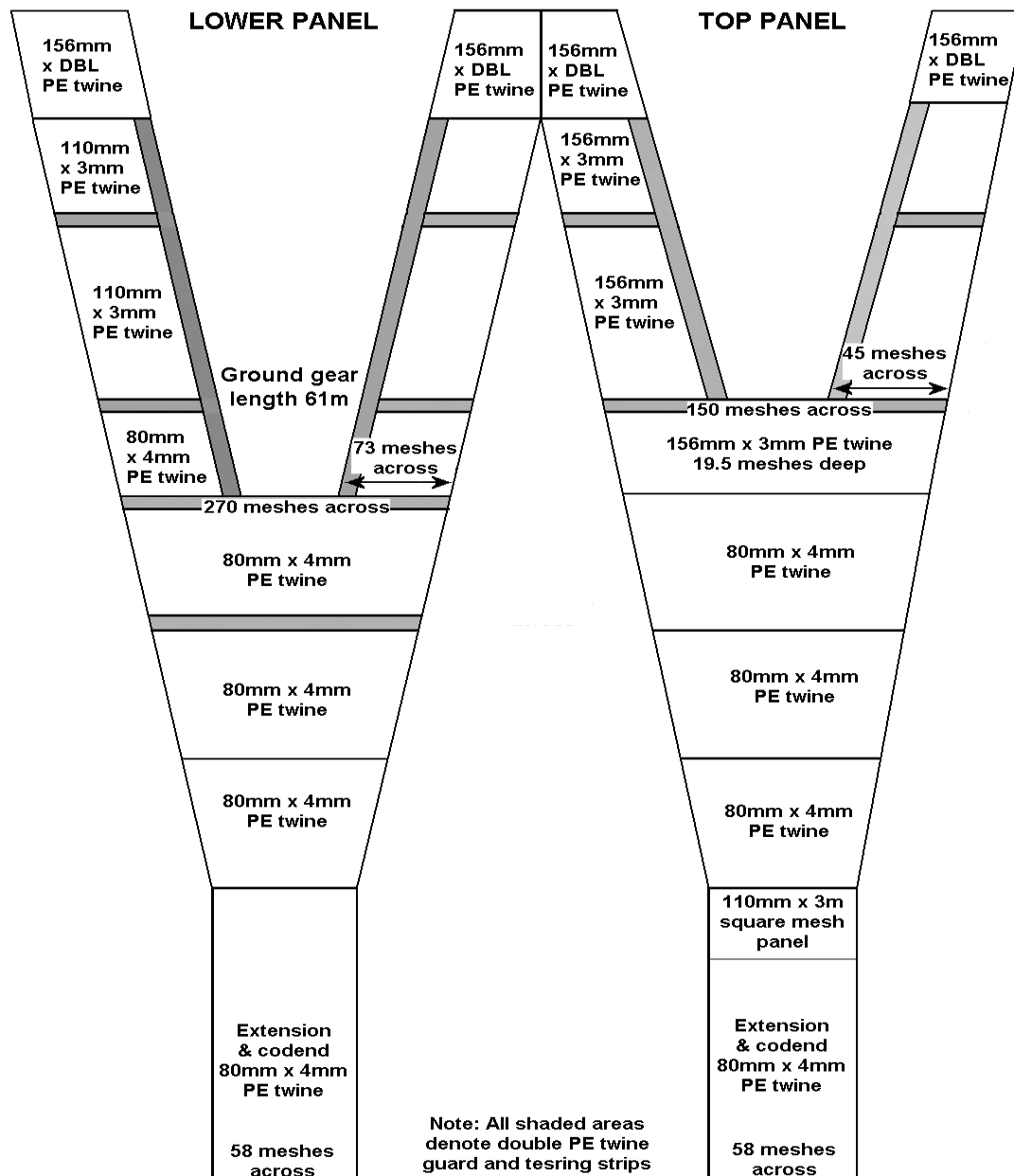


Figure 1: Net plan control trawl

Similar 80 mm (nominal) cod-ends were rigged to both trawls each constructed from 4 mm (nominal) single compact twine and incorporated 160 mm lifting bags. Both extensions were rigged with 110 mm (nominal) x 3 m long square mesh panels constructed from 3 mm knotted high tenacity twine and positioned at 12-15 m from the cod-line. The square mesh panel dimensions were 19 bars across by 55 bars deep and the joining ratio of diamond to square mesh bar was 2.7:1. The overall stretched length of each extension and cod-end was 15.1 m. The cod-end end and square mesh panel mesh sizes were measured, whilst the netting was wet, using an OMEGA gauge with a 125N measuring force (Table 1).

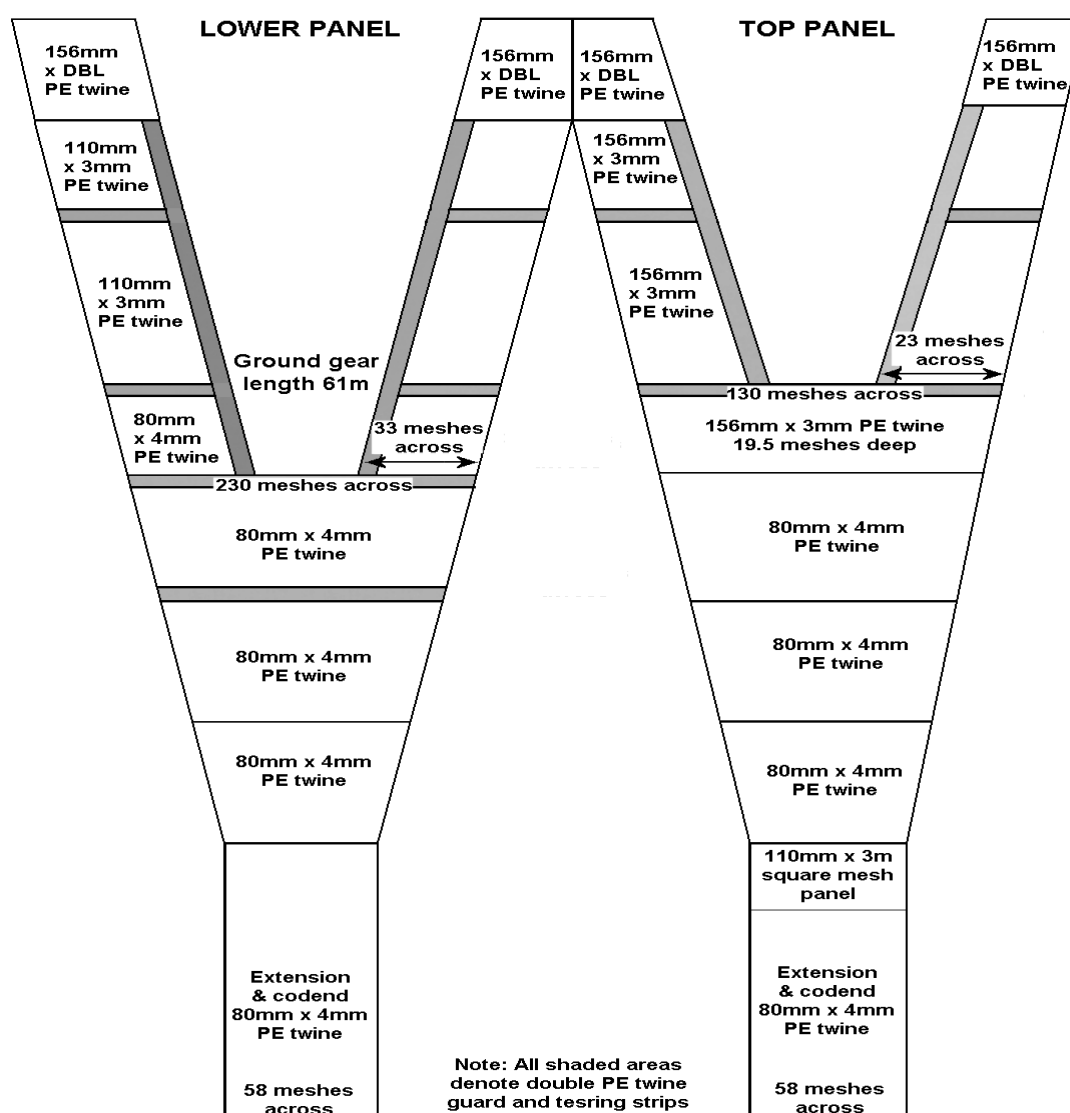


Figure 2: Net plan low headline experimental trawl

Table 1

Mesh measurements using the OMEGA gauge set to 125N measuring force

Description	Mesh size (Stand Dev)
Test trawl 80 mm cod-end	80.8 mm (0.65)
Test trawl 110 mm square mesh panel	111.4 mm (0.50)
Control trawl 80 mm cod-end	81.0 mm (0.73)
Control trawl 110 mm square mesh panel	111.5 mm (0.62)

The trawls were fished using the vessel's own wire rig which consisted of a three warp towing system attaching to 550 kg Thyberon doors and 1000 kg roller clump. The overall sweep-line length was 121 m and consisted of a 113.4 m long sweep (combination wire, chain and rubber leg) and 7.6 m double bridles (top – combination wire and lower – combination wire rubber leg).

Fishing Trials Procedure

The tow duration for all the catch comparison hauls was 3 hours. Towing speed over the ground varied from 2.8 to 3.0 knots, the vessel's normal range when fishing commercially for *Nephrops*. During each haul the vessel's Notus net monitoring system was used to monitor trawl door to clump spread for both sides of the twin rig system (Table 2). Periodically during the cruise Scanmar height units (min/max range 0.6 m/150 m) deployed to monitor headline height of both trawls.

The twin trawl technique (Wileman *et al.*, 1996) was used to assess the relative catch rates of the test gears. This involves towing two trawls in parallel, with the test gear fished on one side of the twin trawl system and the unmodified control trawl fished on the other side. As standard practice aboard Favonius, the starboard trawl's cod-end was always emptied into the vessel's fish hopper first followed by the port cod-end. At all times the cod-end catches were kept separate in the fish hopper by means of a divider running down its centre. The intention was to fish the test trawl on both sides of the twin trawl system to reduce any port/starboard bias however, there was insufficient time during the cruise to carry this out and therefore the test trawl was only fished on the port side.

At the end of each haul the cod, haddock, and whiting from the test and control cod-ends were separated into baskets and then measured. The catch weights of these species were subsequently calculated using length-weight relationships (Coull *et al.*, 1989). However, all *Nephrops* catches were separated into baskets, weighed and then measured. Where larger catches of fish were encountered and for most *Nephrops* catches a sub-sample of the baskets were taken. The fish and *Nephrops* in the sub-sample were then measured and raised to the total number caught in that particular cod-end. A full summary of catch data for these species can be found in Table 3.

Table 2

Haul summary table for catch comparison hauls

Haul No	Water depth (m)	Warp Aft (m)	Area worked	Mean Speed Made Good (kts)	Mean Door spread Port – clump (Test side) (m)	Mean Door spread Stbd – clump (Control side) (m)
F10/1	111	320	F & F	2.9	68	65
F10/2	111	320	F & F	2.9	73	64
F10/3	108	320	F & F	2.8	69	66
F10/4	129	366	Tommy Raes	2.9	69	64
F10/5	136	366	Tommy Raes	3.0	72	66
F10/6	124	366	Tommy Raes	2.9	72	65
F10/7	130	366	Tommy Raes	2.9	72	65
F10/8	133	366	Tommy Raes	2.8	73	66
F10/9	131	366	Tommy Raes	3.0	73	67
F10/10	128	366	Tommy Raes	2.9	71	65
F10/11	134	366	Tommy Raes	2.9	69	65
F10/12	126	366	Tommy Raes	2.9	73	65
F10/13	112	320	F & F	3.0	72	64
F10/14	110	320	F & F	2.8	70	62

Table 3

Summary of catch data for cod, haddock, whiting and *Nephrops* by weight and number.

Haul	Cod				Whiting				Haddock				<i>Nephrops</i>			
	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test
	Total weight (kg)		Total Number		Total weight (kg)		Total number		Total weight (kg)		Total number		Total weight (kg)		Total number	
1	7	5	8	7	30	19	116	92	136	120	712	666	32	34	967	1039
2	10	10	7	12	14	9	66	43	89	108	470	645	4	2	70	41
3	9	10	12	10	36	14	151	69	159	93	805	533	69	30	2116	957
4	80	68	77	66	171	63	428	142	52	33	232	122	70	67	2046	1943
5	75	60	94	82	35	15	90	48	34	63	146	346	2	1	46	22
6	109	102	91	91	194	86	487	197	56	30	240	112	18	27	534	872
7	94	133	82	98	114	91	297	234	43	57	190	286	74	54	2450	1758
8	103	103	95	110	8	12	25	47	47	88	226	521	1	1	7	5
9	266	284	228	242	156	69	375	161	77	44	350	201	13	11	428	382
10	101	91	92	84	156	74	447	194	72	54	350	260	74	57	2491	1963
11	61	41	72	61	36	32	126	126	65	79	326	459	2	1	49	29
12	132	105	131	134	252	123	254	349	124	83	585	409	33	31	1331	1285
13	12	5	8	7	55	95	257	459	145	188	732	1091	63	61	1972	1966
14	4	5	6	6	36	38	171	192	97	184	495	1179	6	5	152	108

Results

Gear Performance

Headline height readings for the low headline trawl indicated a range from 0.8 m to 1.1 m, which were confirmed by underwater observations of this trawl (Figure 3). The headline height of the control trawl was found to range from between 1.8 to 2.1 m. During two observation tows at Tommy Raes wingend and door-clump spreads were recorded for both trawls. Mean wing-end and door-clump spreads for the low headline trawl were found to be 2 m and 5 m respectively more than the corresponding values for the higher headline trawl. This possibly indicated that the reduction in wing netting surface area in the test trawl reduced drag and made it easier to tow. From the limited observations obtained during the cruise it was found that the test trawl had good ground gear contact. To further back this up short dropper chains were attached to both ground gear centres after haul 5 to act as bottom contact indicators. It was found that the chain attached to the control trawl polished approximately 3 hauls sooner than the test trawl's. It was noted that the mudding up of the larger wing surface area of the control trawl was possibly helping it to bed-in quicker than the test trawl.

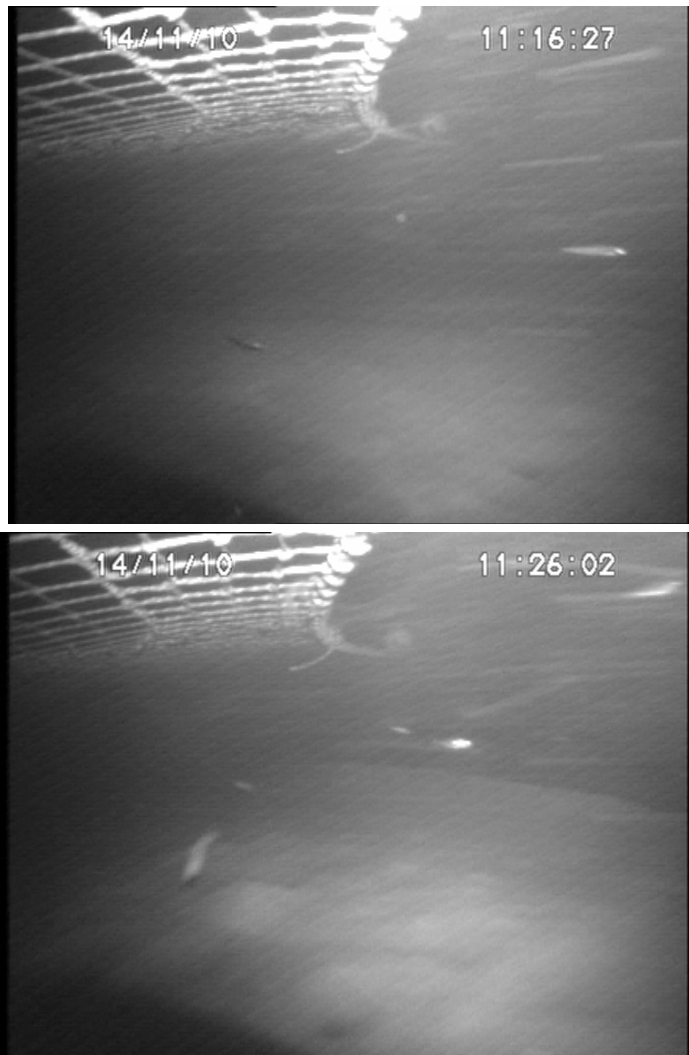


Figure 3: underwater footage of opening of low headline test trawl.

Catch Comparison

A total of 14 catch comparison hauls were completed during the cruise; 5 at F & F and 9 at Tommy Raes. The predominant species encountered during the trials were whiting and to a lesser extent haddock. At F & F the size range of whiting retained by the control trawl was between 21 to 39 cm (mean ~27 cm), but at Tommy Raes larger fish were encountered giving a larger range from 22 to 51 cm (mean ~34 cm). A similar size range of haddock was encountered on both grounds but high concentrations of cod were found only at Tommy Raes. Catches of *Nephrops* during the trials were very small with the largest quantities usually caught during the dawn haul.

The catches retained in the test and control trawl cod-ends were analysed using the smoother based methodology of Fryer *et al.* (2003). The analysis is in three stages:

1. A smoother was used to model the log catch rate of the test gear relative to the control gear for each haul;

2. The fitted smoothers were combined over hauls to estimate the mean log relative catch rate;
3. Bootstrap hypothesis tests using the statistic T_{\max} were used to assess whether the mean log relative catch rates depended on gear or area fished, and to compare the mean log relative catch rates to zero (or equivalently the mean relative catch rates to unity).

The analysis was on the logistic scale, but the results have been back-transformed for presentation. The results are presented in figure 4 where the relative catch rate is shown as the proportion of fish retained in the test gear at each length as compared to the control net. A value of less than one indicates that the test gear caught fewer fish at that length and a value greater than one indicates more fish were caught in the test gear compared to the control. A dashed line indicates where the relative catch rate did not differ significantly from one, whereas an unbroken line indicates there is point-wise significance at the 5% level.

Due to no significant evidence that the relative catch rate of any of the species depended on either of the two fishing grounds both areas have been combined in the final analysis.

Cod: The relative catch rate of the low headline test gear did not differ significantly from that of the higher headline control gear ($p=0.334$).

Whiting: There were no significant differences in catch rates between the test and control gears for whiting below 27 cm. The test gear caught significantly less whiting from 28 cm (35%) to 45cm (45%). The bootstrap analysis result indicates an overall significant difference between the two gears ($p<0.001$).

Haddock: There were no significant differences in catch rates between the test and control gears for haddock below 30 cm. The test gear caught significantly less haddock from 31 cm (20%) to 43 cm (31%). Overall the two gears differed significantly ($p=0.022$).

Nephrops: There were no significant differences in catch rates between test and control gears for *Nephrops* with carapace lengths of below 36 mm. The control gear caught significantly more *Nephrops* with carapace length from 37 mm (18%) to 50 mm (32%). The bootstrap analysis indicated that overall the two gears did differ significantly ($p=0.029$).

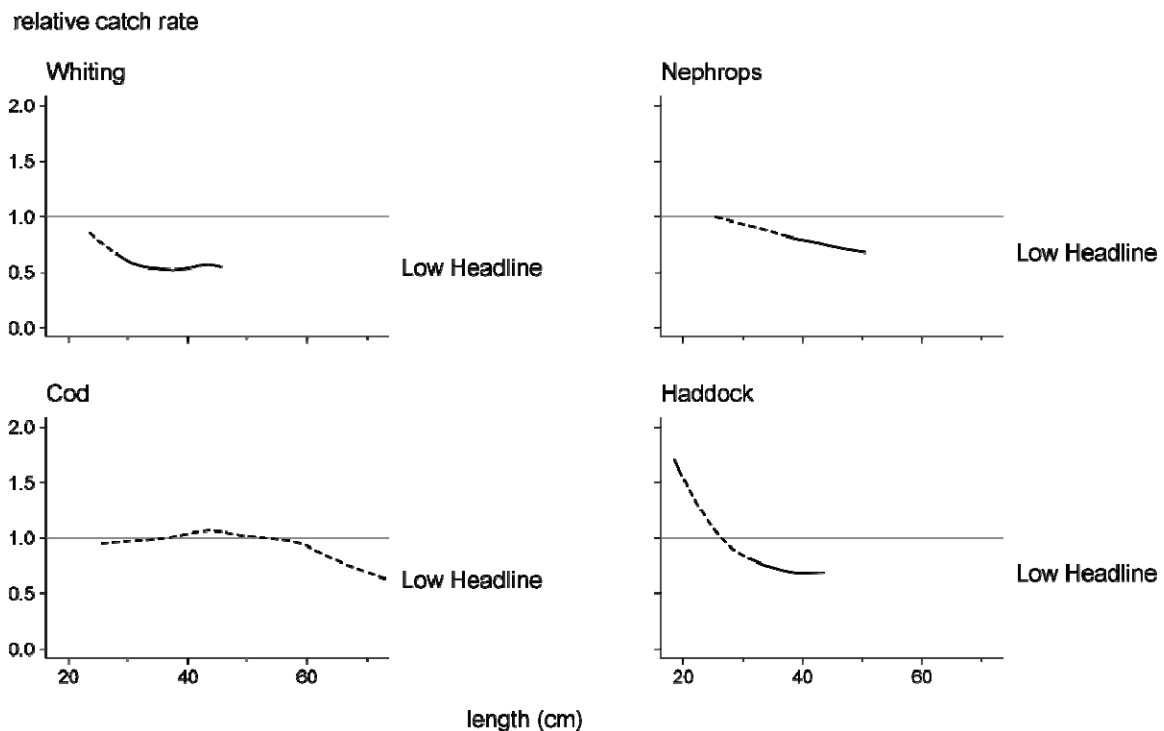


Figure 4: Estimated catch rates for each species for the low headline test gear relative to the higher headline control gear. The lines are solid when the catch rate is significantly different from unity at the point-wise 5% significance level and dashed otherwise

Discussion

From the results obtained during these trials it appears that *Nephrops* trawls with headline heights no greater than 1 m will still retain significant quantities of cod. This is similar to results obtained from previous trials on whitefish trawls (Ferro *et al.*, 2007) which showed that the majority of cod enter the trawl low down, less than 1m above the groundrope.

For whiting and haddock these results show that avoidance or escape from the mouth of the low headline trawl is length dependent. For whiting there was no significant difference between the two trawls for fish below 27 cm and for haddock below 30 cm. However, for larger whiting and haddock there were significant differences in relative catch rates in lengths >28 cm and >31 cm respectively. This suggests that the smaller fish approach or enter the gear close to the seabed or do not have the swimming ability to evade or escape over the headline.

For *Nephrops* the control gear appear to fish better than the test with significant differences in the catch rates found for *Nephrops* above 36mm carapace length. However, it should be noted that overall catch rates for this species was very low with none of the hauls being representative of commercial catches. Anecdotally commercial *Nephrops* skippers suggest

that an old trawl will fish stronger than a new one until it has been fished for some hauls and beds-in. As mentioned previously it was noted that the control trawl appeared to bed-in quicker than the test possibly due to the larger wing netting surface area and therefore may be a reason for the differences in *Nephrops* catch rates.

Acknowledgments

The authors would like to thank the skipper Andrew Buchan and crew of the fishing vessel Favonius, Willie Hepburn (Faithlie Trawls Int Ltd) along with their colleague Jim Mair for their technical help and expertise during the cruise.

References

- Coull, K. A., Jermyn, A. S., Newton, A. W., Henderson, G. I., Hall, W. B., 1989. Length/weight relationships for 88 species of fish encountered in the North East Atlantic. Scottish Fisheries Research report, No. 43.
- Ferro, R.S.T., Jones, E.G., Kynoch, R.J. and Buckett, B-E, 2007. Separating species using a horizontal panel in the Scottish North Sea whitefish trawl fishery. ICES Journal of marine Science, 64:1543-1550.
- Fryer, R. J., Zuur, A. F., Graham, N., 2003. Using mixed models to combine smooth size-selection and catch-comparison curves over hauls. Canadian Journal of Fisheries and Aquatic Sciences 60: 448-459.
- Wileman, D. A., Ferro, R. S. T., Fonteyne, R., Millar, R. B., 1996. Manual of methods of measuring the selectivity of towed fishing gears. ICES Coop. Res. Rep. 215,p.126.