Cefas

Fisheries Science Partnership 2013/14

North East Coast Net Grid Trials

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Executive Summary

This work was carried out as part of the Fisheries Science Partnership (FSP) programme. The twin rig trawler *Aquarius II* was chartered for ten days in September and October 2013 to undertake fishing trials in the *Nephrops* fishery off the North east coast of England. The aim of the work was to significantly reduce cod catches in this fishery through collective action with local fishing skippers. The practical approach taken was to insert a design concept under development known as the Net Grid into a trawl and to evidence changes in selectivity towards cod and other commercial species under normal fishing conditions. The objective of the work was to further develop this design with the aim of developing a trawl that reduces catches of cod in the English NE *Nephrops* trawl fishery without losing the target species of *Nephrops*. The Net Grid is comprised of a four panel box section inserted into a standard two-panel trawl into which an inclined sheet of netting is laced. On the top of the box section in front of netting grid is a fish escape hole. The netting grid acts as a physical barrier and guides fish out of the escape-hole while *Nephrops* pass through the netting to the cod end. The vessel's own commercial twin-rig trawl was used for the trials; one rig was modified by including a version of the Net Grid, the other was left in its standard commercial configuration to provide a direct comparison. Twenty four tows were conducted during the trials and two experimental versions of the Net Grid were tested.

Both versions demonstrated that they had minimal effect on the retention of *Nephrops*. Of the total *Nephrops* landed from the first trial, 53% came from the trawl with the Net Grid, and in the second trial, 49% came from the trawl with the Net Grid. The contribution of cod to the catch was calculated from relatively few hauls (n=20). Nonetheless, the Net Grid design demonstrated a catch of cod that was less than 5% of total catch. Version one of the Net Grid delivered 2.6% of cod in the total catch by weight which represented a 74.9% reduction by weight of cod, whilst version two delivered 1.9% representing a 60.8% reduction in cod. The design shows that cod catches can be reduced whilst retaining catch levels of *Nephrops*; however, there remains no means to target *Nephrops* while avoiding cod without reducing the catch of other marketable fish. Discards were reduced by both versions of the Net Grid, achieving a 63% reduction and a 36% reduction by weight respectively.

It was evident that the insertion of these Net Grids into a *Nephrops* trawl reduces cod catches to less than 5% and significantly reduces discards and landings of all fish. Modifications, of the type described here, that are effective in reducing catches of unwanted cod and other gadoid species, may be of practical and economic benefit to the industry when operating under the anticipated catch quota and landing obligation.

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1 Introduction

1.1 The Fisheries Science Partnership

The Fisheries Science Partnership (FSP) is a Defra-funded collaborative research programme of scientific research between the UK fishing industry and scientists. Since it was established in 2003 the programme has undertaken around 100 projects, covering annual time-series surveys of stocks subject to traditional assessments and *ad hoc* projects on, e.g., gear selectivity, discard survival, tagging and migration, and fishery development. A full description of the aims and all completed reports of the FSP programme can be found on the Cefas website (www.cefas.defra.gov.uk). Charter of suitable fishing vessels for projects approved by Defra and its FSP steering committee is arranged through an open tendering procedure and scientific and operational work plans are developed in line with the agreed and commissioned project, between Cefas and the selected vessel.

Fishing gear selectivity has featured highly in the FSP programme and both scientists and industry continue to seek ways of improving gear design to minimise discarding. As with previous FSP projects, this work investigates the selectivity of demersal trawls by exploring design features that take advantage of behavioural trends of fish species.

1.2 Background

The fishermen of the English NE *Nephrops* fishery initiated the study when they proposed a project, as part of the Cefas Fisheries Science Partnership Programme, to improve on a previously tested selective trawl design. The design under development is known as the Net Grid and the objective of the work was to further develop this design concept with the aim of producing a trawl that significantly reduces catches of cod in the fishery without losing the target species of *Nephrops*. The Net Grid is comprised of a four panel box section inserted into a standard two-panel trawl into which an inclined sheet of netting is laced. On the top of the box section in front of the inclined sheet of netting is a fish escape hole. The netting acts as a physical barrier and guides fish out the escape-hole while *Nephrops* pass through the netting to the cod end.

The Net Grid was an industry driven alternative to the Swedish grid, and was originally tested within an ambitious timetable which achieved positive but limited results in 2012. The rigid construction of the Swedish grid design was considered inappropriate for vessels working in the English NE *Nephrops* fishery, due to handling difficulties with net drums and power blocks. One of the concerns from the fishermen after initial testing was that the Net Grid design, although highly effective at reducing cod catches, also indicated losses of *Nephrops*. Results from these earlier trials of the Net Grid were presented to STECF in 2012[1].

The objective of the initial testing in 2012 was to assess whether the design could deliver a catch weight for cod of 1.5% of the total catch weight and be applicable to Articles 11 and 13 Council Regulation (EC) No 1342/2008. However, the trials demonstrated that when substantial numbers of fish escape a selective trawl, fewer cod can make up a much higher percentage contribution of the total catch. In the previous study, delivering 1.5% cod could be dependent on whether one cod was caught or two. Moreover, the Net Grid design retained more 'age 0' small cod than the standard trawl. This was also the finding from the trial of the Swedish grid undertaken in the Farne Deeps

[1] Trials of a Net Grid for the UK Nephrops trawl fisheries; Tom Catchpole, Frank Armstrong, Stuart Masson, Dave Price, Peter Clark, Steven Moss, Mark O'Brien, Kevin Duggan, Mike Manser, Ana Ribeiro Santos & John Hingley, Cefas Report; November 2012.

fishery in 2006[1] twice as many small cod were retained when using the Swedish grid owing to changes in the selectivity of the cod end when fewer fish overall were retained. Therefore, neither the Swedish grid nor the Net Grid was considered a practical solution to deliver 1.5% cod catches.

The aim of this study was to achieve the maximum reduction in cod catches while not reducing catches of *Nephrops* by modifying the Net Grid design. Following discussions with skippers and CEFAS staff, Seafish gear technologist Mike Montgomerie drew up netting plans for two versions of a modified Net Grid.

1.3 Objective

The overall objective was to develop a modified *Nephrops* trawl that delivered a catch weight for cod of no more than 5% of the total catch. It was agreed that the Net Grid concept was the most likely to achieve this. Two versions of the Net Grid were tested both with an inclined sheet of netting of 200mm turned on the square and laced inside a four-panel section of the trawl. This mesh size was considered to be small enough reduce cod catches, but large enough to ensure no loss of *Nephrops*.

The specific objectives were to record the catch composition of twin *Nephrops* otter trawls, one with a Net Grid inserted and one without, to examine the effects of two different methods of inserting the Net Grid into a trawl.

[1] Catchpole, T.L., Revill, A.S., Dunlin, G., 2006. An assessment of the Swedish grid and square mesh cod end in the English (Farne Deeps) Nephrops fishery. Fisheries Research, 81, 118-125.

2 Material and Methods

2.1 Vessel

Following an open tendering process, the fishing vessel *Aquarius II* (BH 456) (Figure 1) was awarded a contract to undertake the survey work associated with this project over a period of 10 days. MFV *Aquarius II* is a 14.94 m steel-hulled trawler based at Amble, in the northeast of England.

Figure 1 Aquarius II, LOA 14.94 m, GT 36.23 t, 216 kW.

2.2 Gear

The vessel's own commercial trawls were used for the trial. With the exception of the experimental modification, both trawls were of identical construction; the trawls had a 400 mesh x 80 mm fishing circle, with ground gear of 37m constructed from 15cm and 22cm rubber discs. The starboard trawl was altered by including the Net Grid modification which had a 200mm square mesh panel; the other was left in its standard commercial configuration with a 90mm square mesh panel to provide a direct comparison. The trawls complied with existing technical regulations and for the purpose of these trials were fitted with new, identical 85 mm cod ends. The trawls were towed simultaneously as a twin rig, using a 3-warp towing system with a 450 kg clump centre weight and spread using ThyborØn® 55 doors.

To reduce any port/starboard bias it has been common practice for gear trials of this type to have the test trawl fished on both sides. Time and weather constraints did not allow for this but observations made on a catch sampling trip carried out prior to any gear modification indicated that both nets fished comparably.

The Net Grid
The Net Grid is comprised of a four panel box section inserted into a standard two-panel trawl into which an inclined sheet of netting is laced. On the top of the box section in front of the inclined sheet of netting is a fish escape hole. The netting acts as a physical barrier and guides fish out the escape-hole while *Nephrops* pass through the netting to the cod end.

Two versions of the Net Grid were tested. The "long" version (Version 1) (Figure2) was operated for 14 tows and the "short" version (Version 2) (Figure 3) for 10. (See Annex 2 for detailed net plans).

Modifications to the previously tested Net Grid designs included:

- positioning the Net Grid ahead of the square mesh panel
- constructing the inclined netting in 200mm stretched mesh in square configuration
- increasing the height of the side panels
- removing the poles used to give height
- moving the floats from around the escape hole to the top selvages of the four panel section
- adding leaded rope to the bottom selvages of the four panel section.

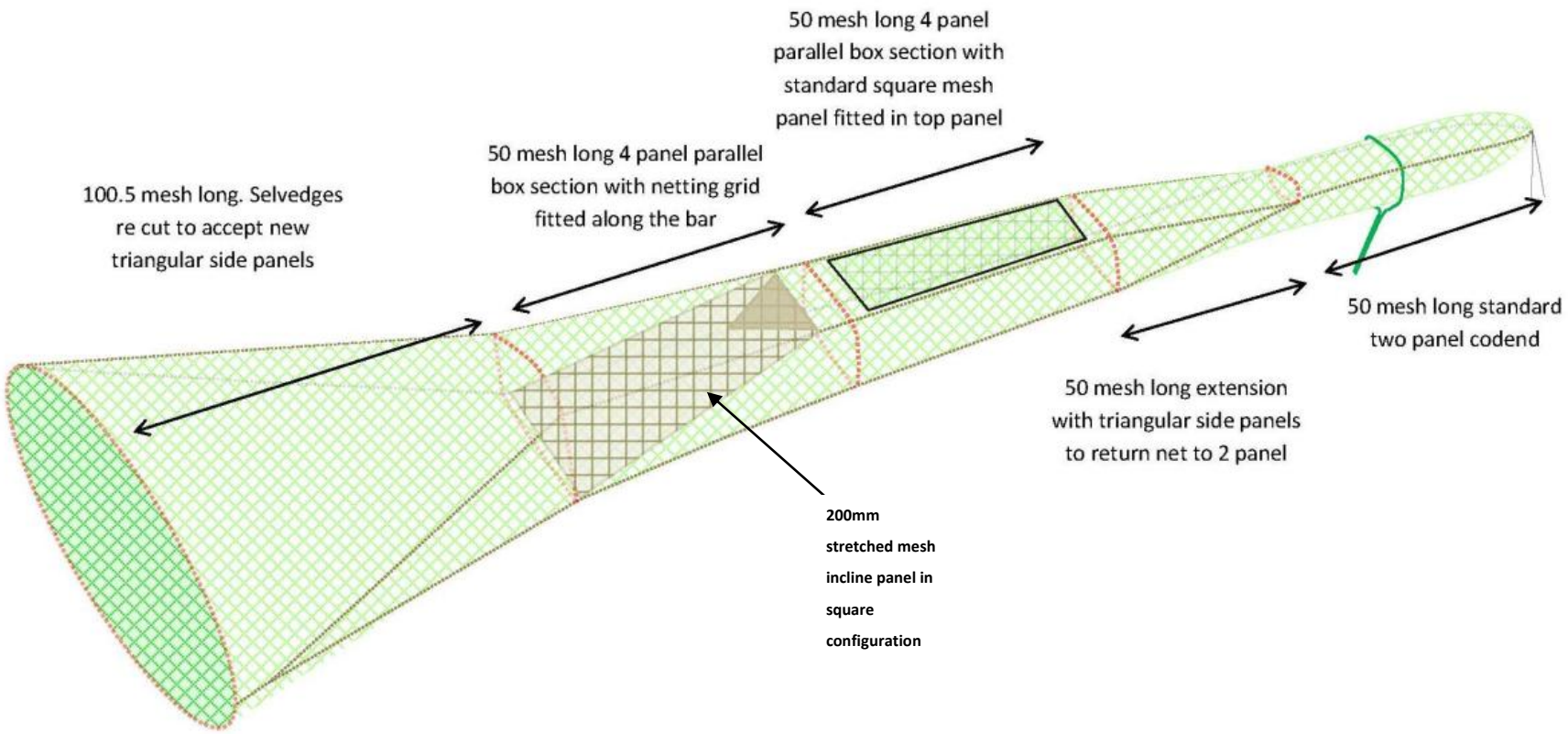


Figure 2 Net Grid modified design 1 long version (illustration by Mike Montgomerie, Seafish).

The four panel box section includes the inclined netting, escape hole and the square mesh panel in version 1. The escape hole is ahead of the square mesh panel and the taper back to two panels begins after the end of the square mesh panel.

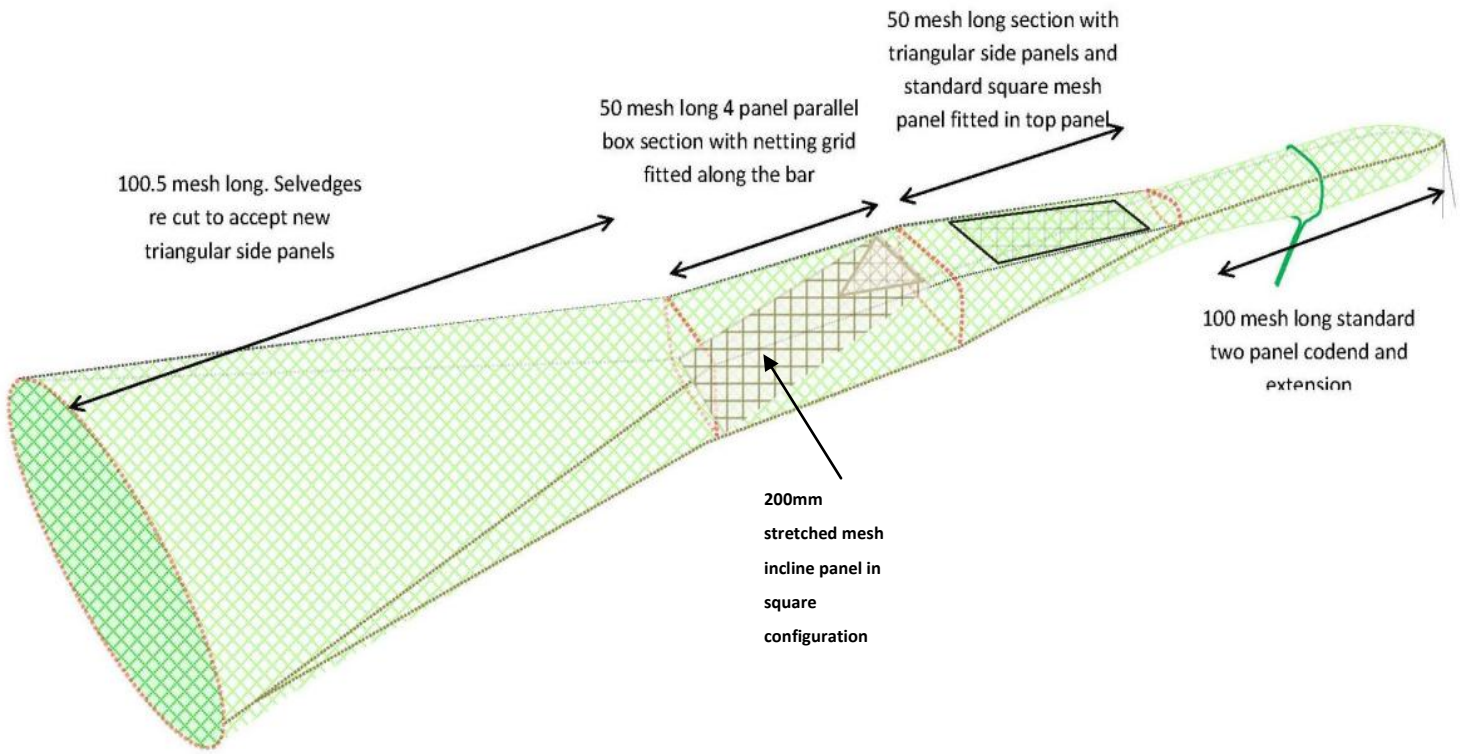


Figure 3 Net Grid modified design 2 short version (illustration by Mike Montgomerie, Seafish).

The four panel box section includes the inclined netting and the escape hole in version 2. The taper back to two panels begins after the escape hole and includes the square mesh panel.

2.3 Gear monitoring

The vessel had both Notus® and Scanmar® gear monitoring systems onboard. Notus® was used to monitor door spread, with sensors on both doors and the clump. Both nets had Scanmar® flow sensors attached to the centre point of the headline. A Scanmar® pitch and tilt monitor was attached at various positions around the Net Grid modification over the period of the study. This indicated the angle of the netting to which it was attached, both in the direction of travel and at 90°to it.

2.4 Area and period of survey

Tows of 3-5 hours duration, i.e. typical of normal commercial practice, were conducted in the Farne Deeps fishing grounds off the North East coast of England. Towing speed was on average between 2.0 and 2.7 knots. The area of the main *Nephrops* fishing grounds within the Farne Deeps is classed as Functional Unit 6 (FU6) in the North Sea *Nephrops* stock assessment and is very small and highly localised. All fishing took place in the statistical rectangles 38E9 and 39E9 in ICES area IVb, bottom depths ranged between 55 and 101 m. (Figure 4) Fishing took place during daylight and darkness, however because *Nephrops* catches were negligible during darkness, priority was placed on achieving daylight tows.

Version 1 of the Net Grid was operated from 23rd till the 26th of September and resumed on the 8th of October after a spell of South-easterly gales, till a period of Northerly gales interrupted trials after the 9th. Version 2 was operated in one continuous period between the 15th and 18th of October.

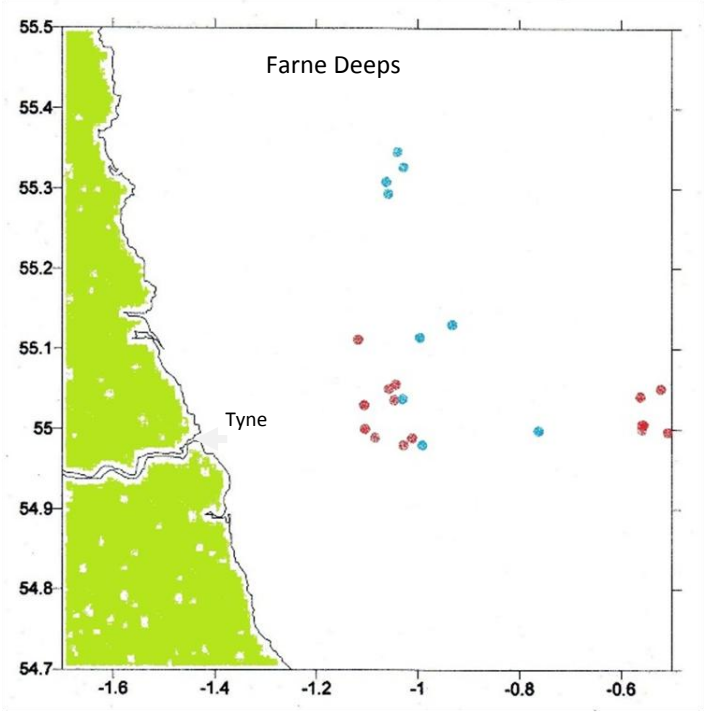


Figure 4 Hauling positions, (Version 1 red, Version 2 blue). IVb (38E8, 39E8)

(See Annex 3 for shooting and hauling depths, times and exact positions.)

2.5 Experimental Design

The aim of the experimental trials was to look at the effect of using 200mm netting turned on the square as the incline panel. Two Net Grids were constructed by Fidelis Ship Supplies to designs by Seafish gear technologist Mike Montgomerie. (Figures 2&3) The principle variation between them was the length of the 4-panel section. In the "long" version the 4 panels continue to include the square mesh section, whilst in the "short" version the taper back to 2 panels begins after the inclined netting section. (Annex 4.2) Initially the study was expected to be conducted over two 5 day periods, with the first period expected to demonstrate that the Net Grid would release finfish and in the second that it would retain *Nephrops*. Unfortunately, as a result of unforeseen delays in issuing the tender, the first emergence of *Nephrops* for the winter season coincided with the beginning of the study.

Following discussions with the skipper, the experimental plan was agreed:

- the survey would be of one 10 day period
- start with the “long” version and complete a sufficient number of tows to identify any effects on the catch
- then change to the “short” version and complete a sufficient number of tows to compare effects on the catch with those observed (if any) using the “long” version.

Figure 5 Skipper and Cefas SIC inserting Net Grid.

Figure 6 Escape hole and incline panel.

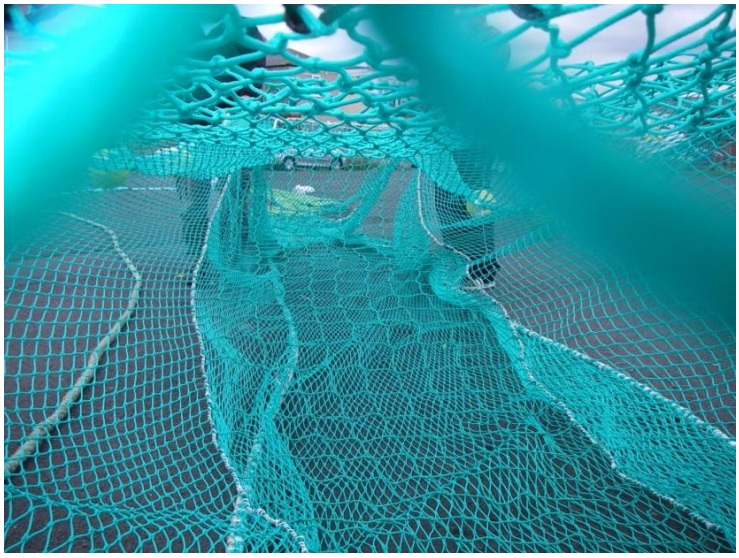


Figure 7 Escape hole and incline panel interior of net view.

2.6 Sampling Plan

A fixed routine for handling and sorting the catch was maintained throughout the trials. Catches from the test and control nets were kept separate. The cod-ends of both trawls were drawn up to the vessel's stern and the starboard trawl's cod end was delivered into the vessel's hopper and removed to baskets on the deck. The port trawl's cod-end was then delivered into the empty hopper and sorted first.The crew sorted the catch as they would normally, with the exception that all material usually discarded was retained in baskets for sampling as the "discard fraction". On completion of sorting the port cod end all retained fish and *Nephrops* were stored in another area of the deck and the baskets containing the contents of the starboard cod end were then processed.

Figure 8 Crew sorting port net contents from hopper, starboard net contents removed to baskets.

Cefas observers sampled using standard techniques. For each haul all fish species caught were measured to the nearest cm below, the *Nephrops* carapace length was measured to the nearest mm below. All Cod caught were measured. Sub sampling was necessary for *Nephrops* and on occasions when the fish (other than Cod) catch was large, but sub samples reflected the total catch composition and raising factors were calculated. Length-weight relationships were applied to generate estimates of the catch weight of each species and therefore its weight in the total catch. For each of the main commercial species, the catches from the standard and Net Grid trawl were compared using a catch comparison statistical analysis method (Holst etal, 2009[1]) This analysis used a generalised linear mixed model (GLMM) which provides comparisons of fish catch at length by the two trawls through a continuous curve with a realistic confidence band. The analysis was applied to the catch data from all hauls considered valid (Annex 3).

Figure 9 Measuring the catch.

[1] Holst, R., and Revill, A., 2009. A simple statistical model for catch composition studies. Fish. Res. 95, 254-259

3 Results

3.1 Catch composition

A total of 24 tows were conducted during the trials, representing 85 hours 20 minutes of fishing time. There were 20 tows considered to be valid for comparison, resulting in data being collected from 72 hours 50 minutes fishing effort. Data from the "long" version were collected from 11 tows representing 41 hours 5 minutes effort. One haul was discounted as the vessel developed hydraulics problems on hauling. In 2 tows, (representing 7 hours 45 minutes effort) it was considered that the Scanmar® monitor had adversely affected net performance (see 3.5).

Data from the "short" version were collected from 9 tows representing 31 hours 45 minutes effort. One haul was invalid as the port net became fouled on the sea bed after 1 hour 45 minutes and standard procedures could not be followed. Clearing the hopper to keep port and starboard net contents separate added 5-10 minutes extra to the time between hauling and shooting.

3.1.1 Total catch

The contribution to the catch from the 10 largest contributors for each version of the Net Grid and the control trawls is shown (Figures 10 & 11). It can be seen that *Nephrops* and whiting dominate the catch in both trials. The *Nephrops* catch was unaffected by either version of the Net Grid but the catches of whiting and all other fish was significantly reduced.

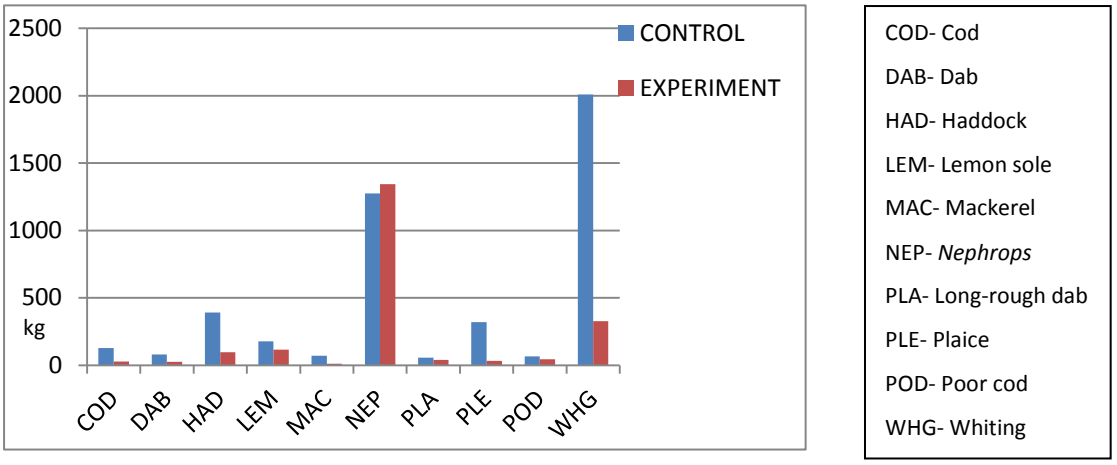


Figure 10 Version 1 Contribution by weight to total catch (10 largest contributors), blue= standard trawl, red=Net Grid.

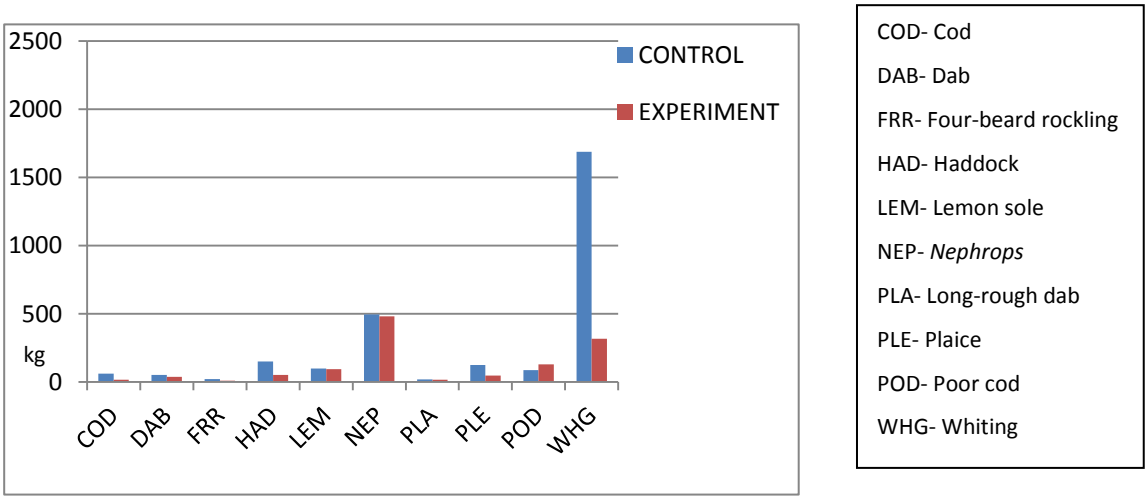


Figure 11Version 2 Contribution by weight to total catch (10 largest contributors), blue= standard trawl, red=Net Grid.

3.1.2 Landings

Landings of fish were significantly less when using the Net Grid, in Version 1 there was 85% less whiting, 74% less haddock, 90% less plaice and 66% less lemon sole by weight (Figure 12). Version 2 showed similar results. (Figure 13) Landings of *Nephrops* from the control configuration were the same as from the Net Grid trawls for both versions. Of the total *Nephrops* landings in trial one, 53% came from the Net Grid trawl and in trial two, 49% of *Nephrops* landings came from the Net Grid trawl (Annex 4.5).

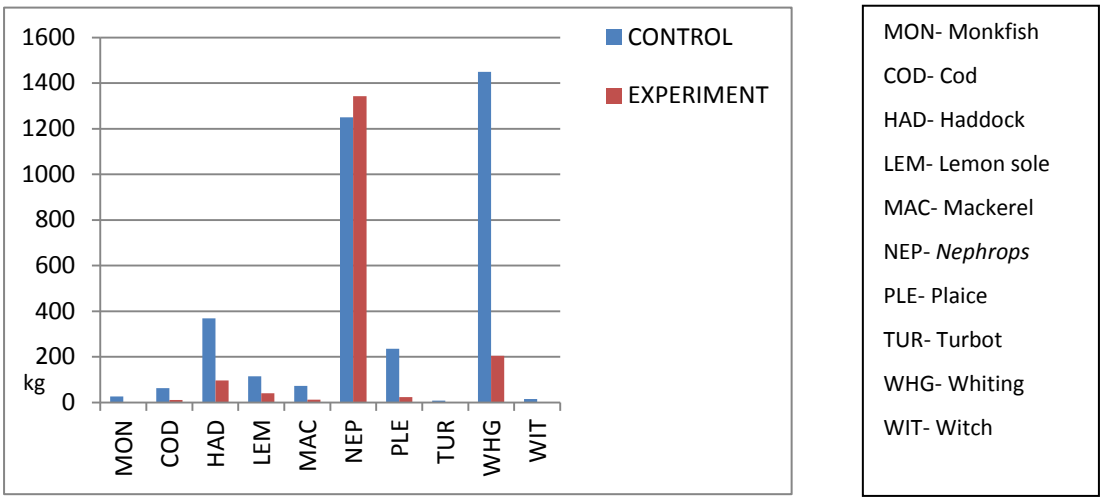


Figure 12 Version 1 Contribution by weight to total landings. (10 greatest contributors), blue= standard trawl, red=Net Grid.

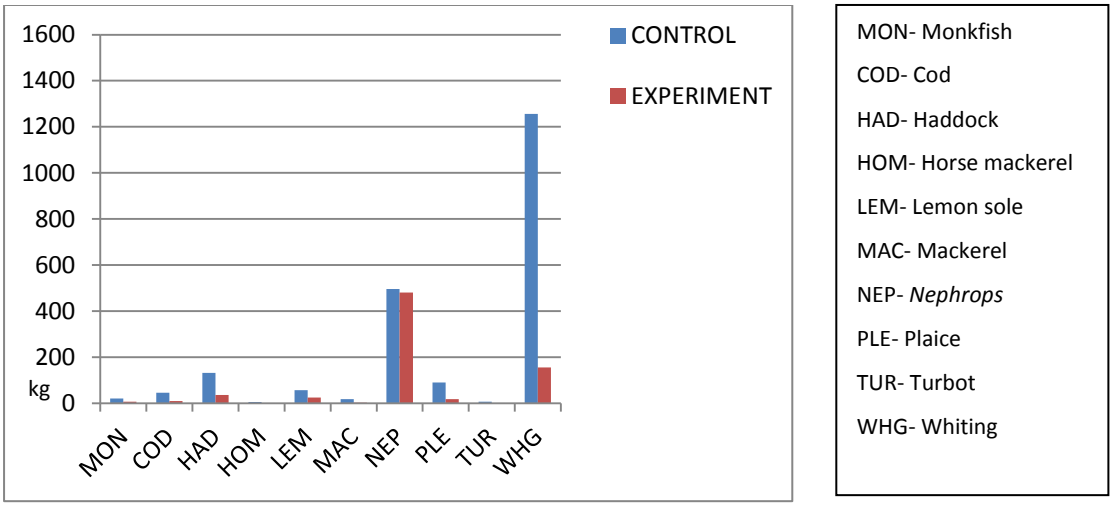


Figure 13 Version 2 Contribution by weight to total landings. (10 greatest contributors), blue= standard trawl, red=Net Grid.

3.1.3 Discards

Discards of fish were significantly less when using the Net Grid. In Version 1 there was a 63% reduction in discarded fish by weight, whilst Version 2 achieved a reduction of 36%. There was no difference to the 10 greatest contributing species to the discards between the two versions (Figures 14&15).

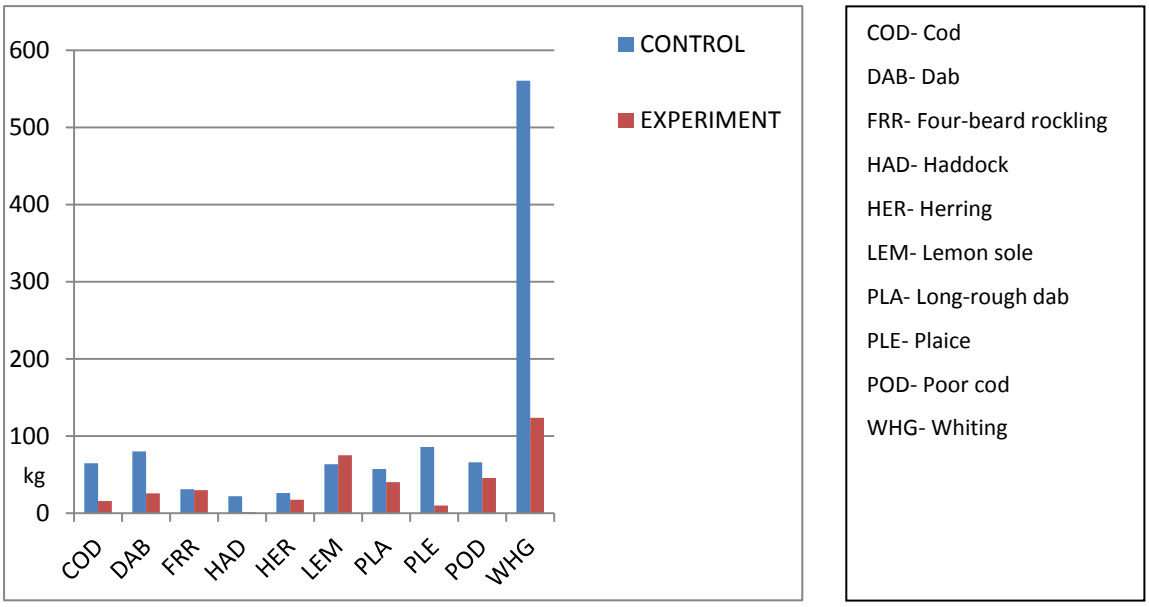


Figure 14 Version 1 Contribution by weight to discards. (10 greatest contributors), blue= standard trawl, red=Net Grid.

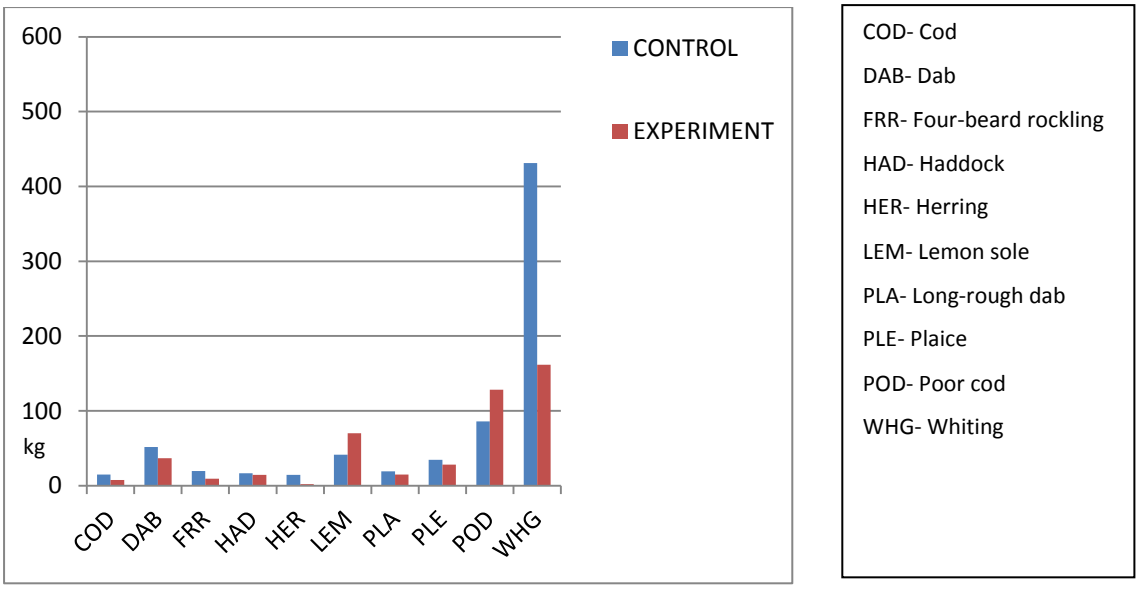


Figure 15 Version 2 Contribution by weight to discards. (10 greatest contributors), blue= standard trawl, red=Net Grid.

3.2 Cod

Cod catches during the trials were low reflecting the scarcity of cod in the area at the time. There was a mean catch weight of 9kg of cod per haul in the 20 control hauls. Using version 1, cod made up 2.9% of the total catch in the control trawl and 2.6% in the Net Grid trawl. Using version 2, cod made up 2.1% of the total catch in the control trawl and 1.5% in the Net Grid trawl.

Version 1

CONTROL	EXPERIMENT		Reduction
5.7%	10.6%		-46.4%
2.2%	4.4%		-52.5%
1.8%	0.6%		-74.1%
4.8%	4.4%		-71.9%
4.1%	1.5%		-87.6%
5.0%	0.8%		-91.5%
1.3%	0.1%		-95.7%
3.1%	7.4%		-0.9%
0.4%	0.0%		-100.0%
2.3%	0.3%		-94.5%
2.2%	1.4%		-84.0%
1.4%	0.0%		-99.7%
MEAN			
2.9%	2.6%		-74.9%

Version 2

CONTROL	EXPERIMENT		Reduction
2.4%	3.1%		-23.3%
2.2%	1.0%		-87.1%
1.3%	1.3%		-36.4%
1.6%	2.6%		1.6%
1.0%	0.3%		-83.8%
2.4%	0.0%		-99.4%
4.3%	2.3%		-81.6%
1.1%	1.0%		-74.0%
2.2%	2.1%		-63.0%
MEAN			
2.1%	1.5%		-60.8%

Table 1 Percentage contribution of cod by weight in the whole catch.

There was a significant reduction in the catch of cod using both versions of the Net Grid. A reduction of 75% by weight was achieved when using Version 1 and 61% when using Version 2 (Table1, Figure 17). The length frequencies of cod catches taken with the standard and Net Grid designs are given in Figure 16. Statistical analysis using General Linear Mixed Model (GLMM) demonstrated that significantly fewer cod were caught across the length range with both Net Grid designs. The results indicated that Version 1 was the most efficient at releasing cod but again small percentages of cod in the total catch must be considered (Annex 4.1).

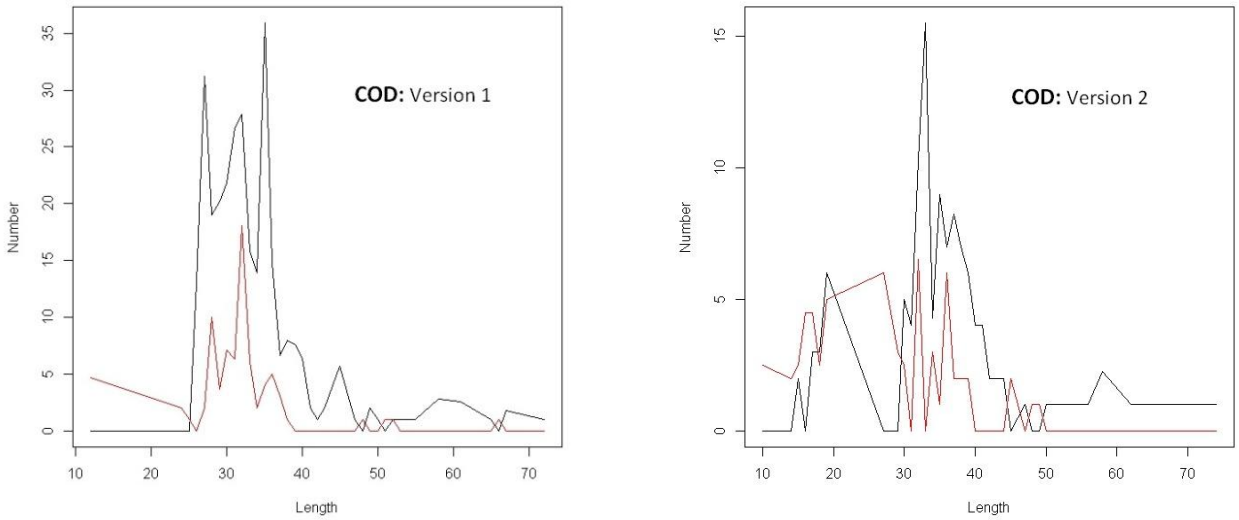
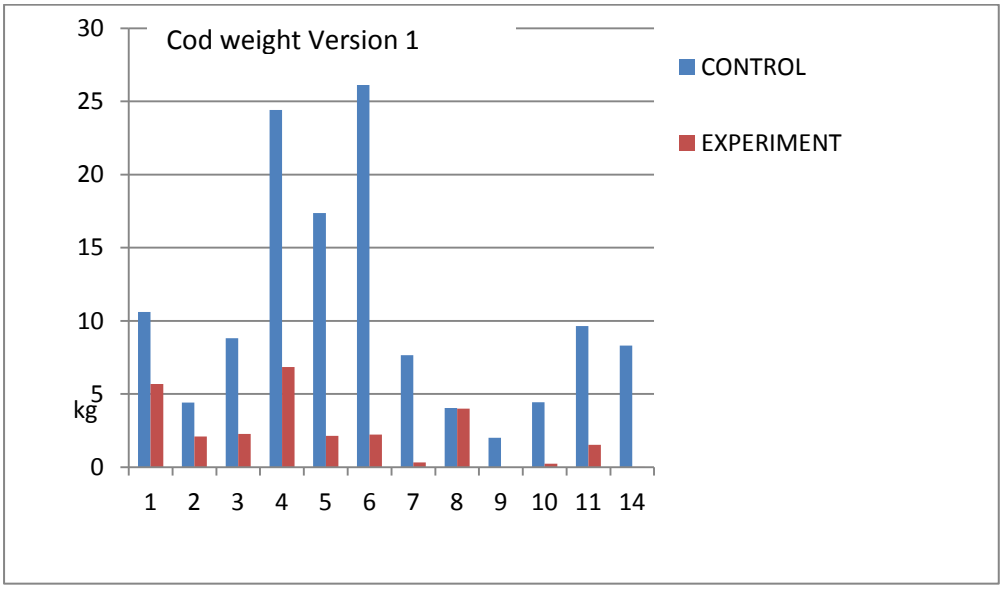


Figure 16 Numbers of cod caught at length in the control (black) and test (red) trawls



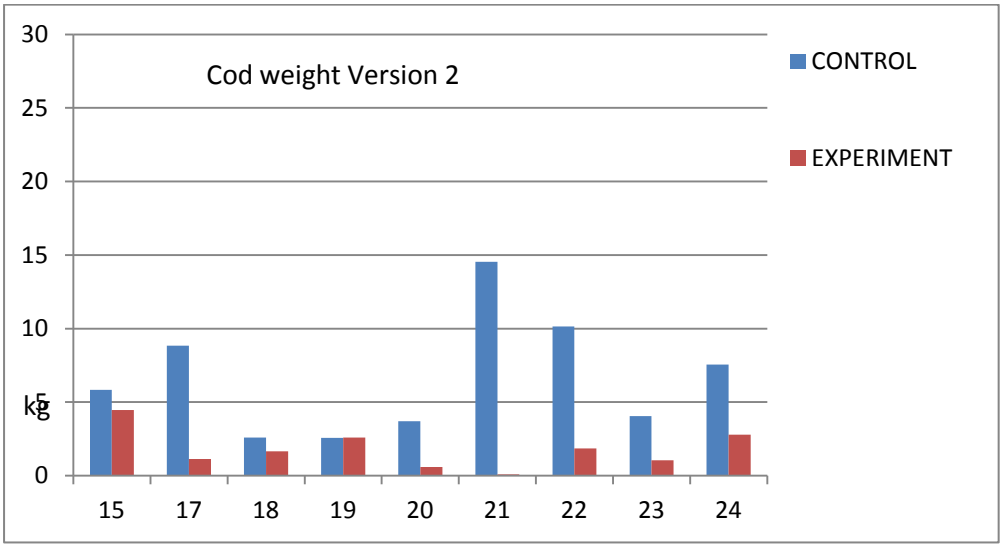


Figure 17 Weight of cod caught per haul in the control and experimental trawls for Net Grid versions 1 and 2.

3.3Nephrops

Nephrops catches were not significantly different between the control trawl and the Net Grid Trawl in the tows used for data analysis. Of the total *Nephrops* landings when using Version 1, 53% came from the Net Grid trawl and when using Version 2, 49% came from that trawl (Annex 4.5) This would indicate that both versions allowed *Nephrops* to pass through unhindered to the cod end and had no effect on total *Nephrops* catch. There was no difference in the total weight of *Nephrops* caught. However, GLMM statistical analysis indicated that there were fewer small *Nephrops* retained in the catch when using Version 1 of the Net Grid and slightly more large *Nephrops* (Annex 4.4 Figure 18). This effect has been observed in one previous trial of the Net Grid[1] but possible reasons for this are as yet unexplained. Also unexplained was the indication of a slight reduction in the largest *Nephrops* (>45mm carapace length) when using Version 2 (Annex 4.4).

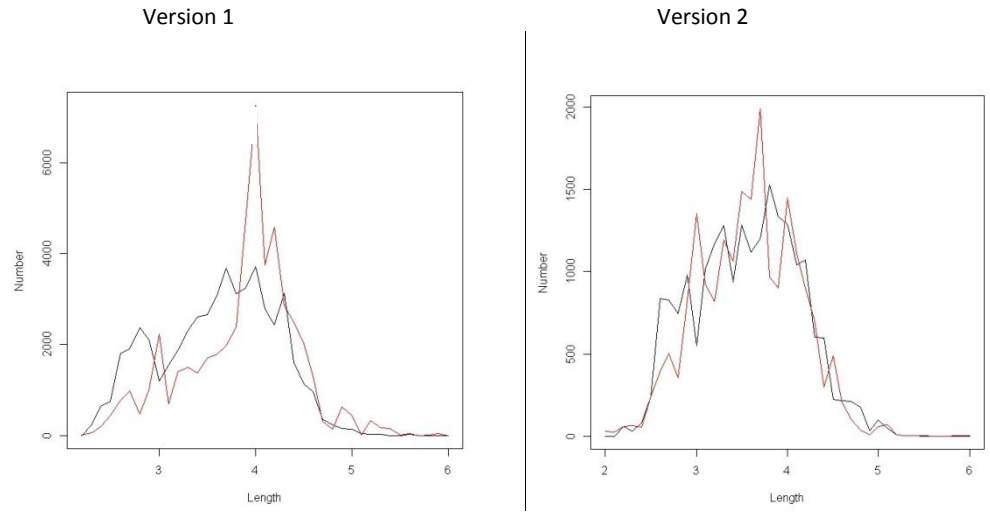


Figure 18 Numbers of Nephrops caught at length in the control (black) and test (red) trawls

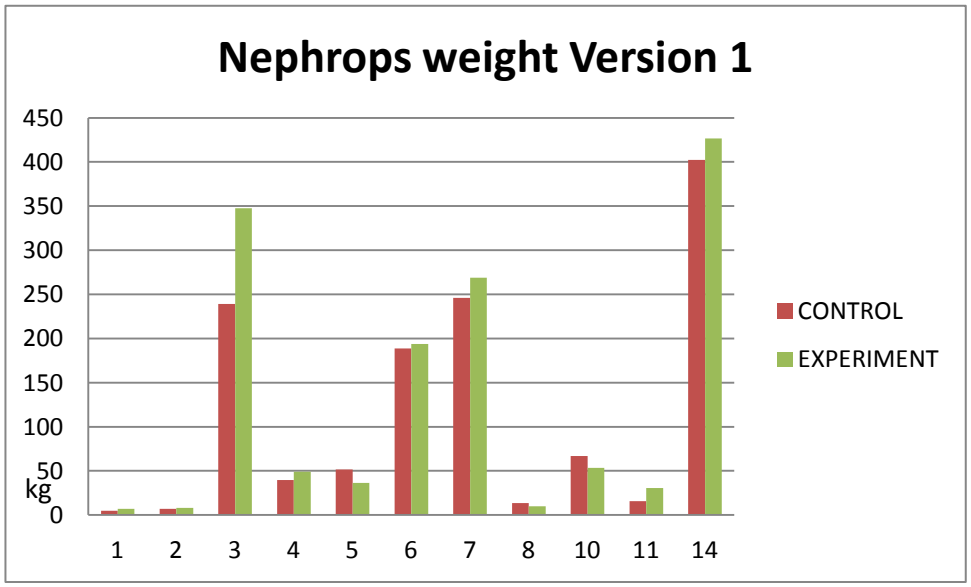


Figure 19 Version 1 Comparison by haul of *Nephrops* catch

[1]Trials of a Net Grid for the UK Nephrops trawl fisheries; Tom Catchpole, Frank Armstrong, Stuart Masson, Dave Price Clark, Steven Moss, Mark O'Brien, Kevin Duggan, Mike Manser, Ana Ribeiro Santos & John Hingley, Cefas Report; No 2012.

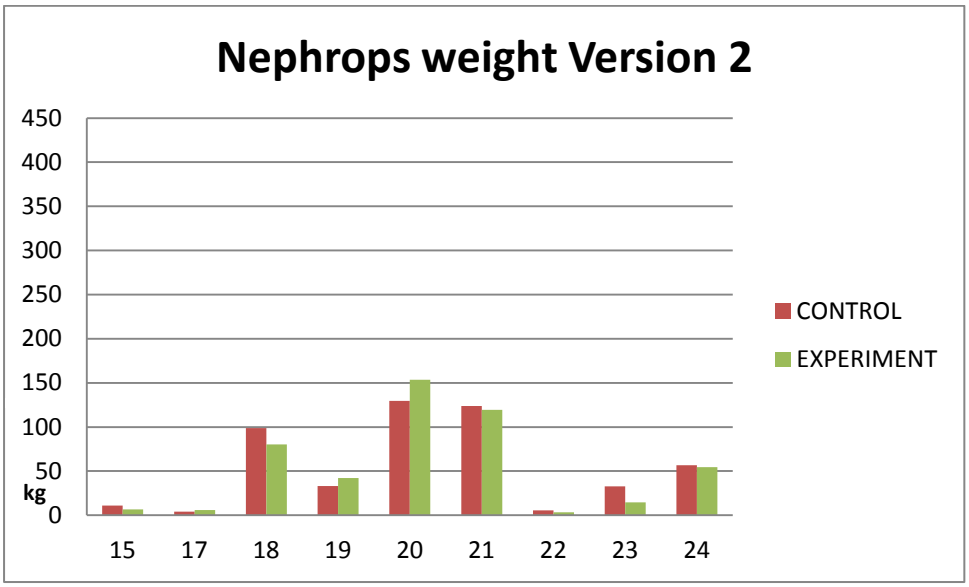


Figure 20 Version 2 Comparison by haul of *Nephrops* catch

3.4 Whiting

Whiting dominated the fish catch. When using Version 1 of the Net Grid whiting accounted for 43% of the total catch weight of the control trawl and 15% of the catch of the Net Grid trawl. When using Version 2 the figures were 60% for the control trawl and 26% for the Net Grid trawl. The catch of whiting was reduced by 163% when using Net Grid Version 1 and 188% when using Net Grid Version 2, but under GLMM analysis version 1 performed slightly better. (Annex 4.3) Numbers at length were similar for both versions of the Net Grid (Figure 21).

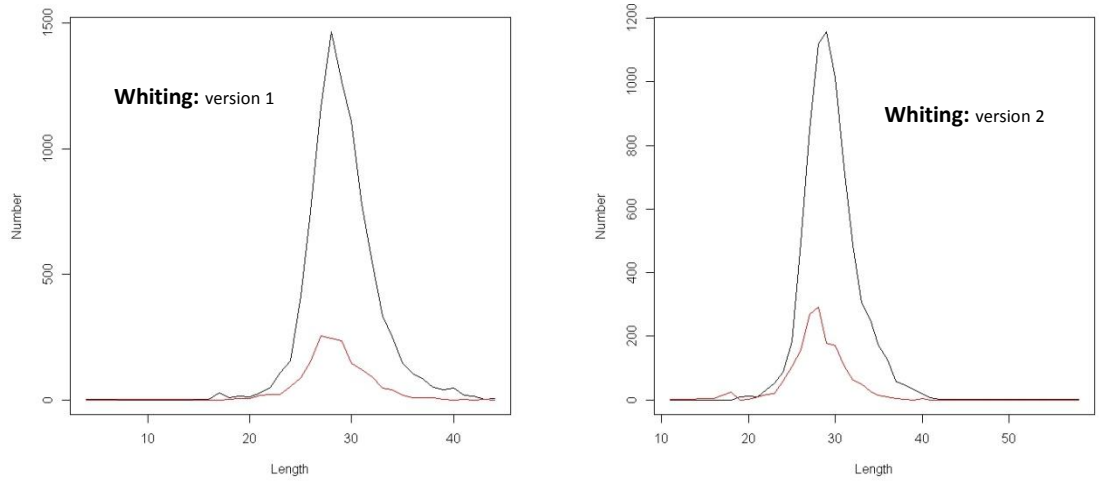


Figure 21 Numbers of whiting caught at length in the control (black) and test (red) trawl

3.5 Gear Monitoring

The Notus® and Scanmar® gear monitoring systems were operated on all tows. By monitoring the readings from these and adjusting the middle towing warp, the skipper was able to ensure that the ideal towing symmetry was maintained for both nets. The Scanmar® pitch and tilt monitor was attached at various positions in front of and behind the Net Grid modification in both versions. The constancy of readings from this sensor indicated that the trawl was stable around the area of the Net Grid insertion.

When this monitor was placed on the cod-end in the "long" version in tows 12 and 13 no signal was received and both tows showed there were substantial losses of *Nephrops* retained in the Net Grid trawl. It was thought that the net had twisted the cod-end under the weight of the sensor so that the top had in fact been towed on the sea bed. *Nephrops* meshed in the extension, also not seen before, appeared to confirm this. When the sensor was removed for tow 14 there were no meshed *Nephrops* and the modified net fished better than the control, to support this observation. Data recorded for tows 12 and 13 were not included for comparison.

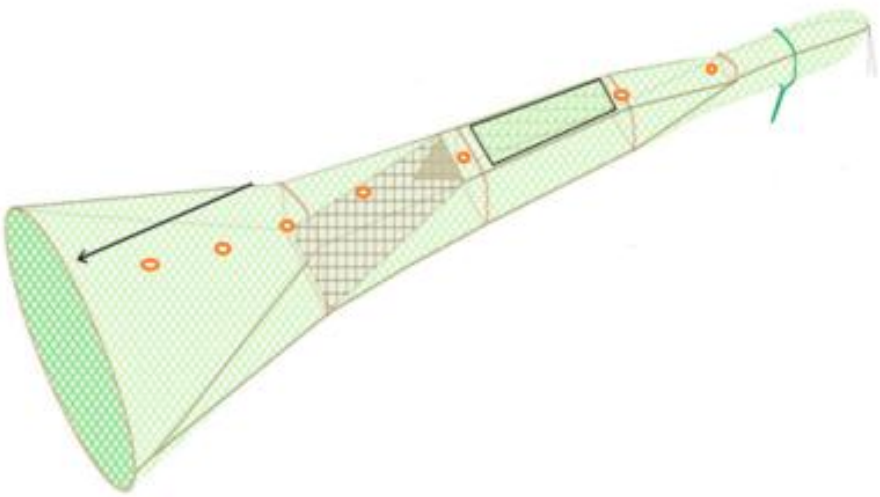


Figure 22 Positions of Scanmar® pitch and tilt sensor placement (orange circle)

4 Discussion

4.1 Conclusions

The Net Grid used in these trials can be inserted into a standard *Nephrops* trawl without hindering the retention of *Nephrops*, delivering a catch weight for cod of no more than 5% of the total catch weight.

Although there were few cod in the area at the time of the trials, statistically relevant results were achieved. The Net Grid designs were effective in reducing catches of fish species across all lengths, in particular for whiting, which dominates the fish catch in this fishery. The Net Grid designs may therefore, be of practical and economic benefit to the industry, when operating under the anticipated catch quota and landing obligation, when fish species have restricted quotas.

Examining the contribution to the *Nephrops* landings from the modified trawls showed that both versions of the Net Grid did not affect the retention of marketable *Nephrops*. Statistical analysis of the *Nephrops* catch showed a difference in the way the two grids appeared to affect them. Using Version 1, slightly fewer small and slightly more large Nephrops were retained, whilst using Version 2, fewer of the largest (>45mm carapace length) were retained. However, whilst this effect has been seen in a previous trial of another version of the Net Grid[1], the reasons for it still remain unexplained.

Whilst both versions were equally effective in retaining *Nephrops* and reducing cod catches, Version 1 appeared to be more efficient in reducing discards. The skipper of the charter vessel, without access to the data, preferred this version i.e., the long version (Figure 2), based on his observations of the net when deploying and retrieving it.

The following conclusions can be drawn from this study

- The industry-led Net Grid design inserted into a conventional *Nephrops* trawl allows fish to escape without affecting the passage of *Nephrops* to the cod end.
- Both designs tested performed comparably in retaining *Nephrops*.
- The insertion of the Net Grid into a *Nephrops* trawl demonstrated the potential to reduce cod catches to less than 5% of the total catch.
- The Net Grid significantly reduces the catch of all fish, both marketable and discards.
- There remains no means to target *Nephrops* while avoiding cod without reducing the catch of other marketable fish.
- The Net Grid modification to a *Nephrops* trawl presents no problems to its deployment and retrieval.
- The Net Grid has the potential to assist skippers in adjusting their catch compositions when the catch quota and landing obligation regulations are introduced.
- Both versions of the Net Grid investigated here demonstrated that they meet the objective of minimising cod catches to less than 5% of the total catch weight without affecting Nephrops catches.
- It is recommended that these Net Grid designs be made available as options to skippers as part of the Cod Recovery Scheme.

[1] Trials of a Net Grid for the UK Nephrops trawl fisheries; Tom Catchpole, Frank Armstrong, Stuart Masson, Dave Price, Peter Clark, Steven Moss, Mark O'Brien, Kevin Duggan, Mike Manser, Ana Ribeiro Santos & John Hingley, Cefas Report; November 2012.

4.2 Future work

There is little further work that can be done to develop the Net Grid design. Skippers feel that if a Net Grid is used, the square mesh panel is redundant; experiments could be carried out to investigate this as it is a legal requirement to have a square mesh panel in a *Nephrops* trawl.

The focus of future work should be on reducing discards, while maintaining catches of marketable fish; and, with a view to preparing for the landing obligation, avoiding species for which catch quotas are expected to be restrictive. For this fishery the main species of concern are whiting and plaice.

5 References

Holst, R., and Revill, A., 2009. A simple statistical model for catch composition studies. Fish. Res. 95, 254-259

Catchpole, T.L., Revill, A.S., Dunlin, G., 2006. An assessment of the Swedish grid and square mesh cod end in the English (Farne Deeps) Nephrops fishery. Fisheries Research, 81, 118-125.

Trials of a Net Grid for the UK Nephrops trawl fisheries; Tom Catchpole, Frank Armstrong, Stuart Masson, Dave Price, Peter Clark, Steven Moss, Mark O'Brien, Kevin Duggan, Mike Manser, Ana Ribeiro Santos & John Hingley, Cefas Report; November 2012.

6 Acknowledgements

David Gair and the crew of the Aquarius II are warmly thanked for their bonhomie, cooperation and cuisine throughout the project; they were a pleasure to work with.

Special mention is also made of Stuart Buchan at Fidelis Ship Supplies and Mike Montgomery of Sea Fish. The former responded rapidly to construct the Net Grids to plans drawn up by the latter.

Chris Barrett and Kevin Duggan are thanked for sharing the sampling work.

Input from numerous fishers before the fishing trials is gratefully acknowledged, as is the assistance and support provided by the FSP team (Mike Fox and Sarah Walmsley) within Cefas.

Defra are also thanked for supporting this project.

7 Annexes

Annexe 1 Detailed Operations Plan

THE CENTRE FOR ENVIRONMENT, FISHERIES AND AQUACULTURE SCIENCE
(Lowestoft Laboratory, Suffolk, NR33 0HT, England)

FISHERIES SCIENCE PARTNERSHIP 2013-14 North East Net Grid Trials

Detailed Operations Plan for North Sea *Nephrops* gear trials

This plan is based on the results from previous trials on MFVs: Avocet, Luc and Green Pastures.

Meeting held in Amble on 17/08/2013.

Attendees:

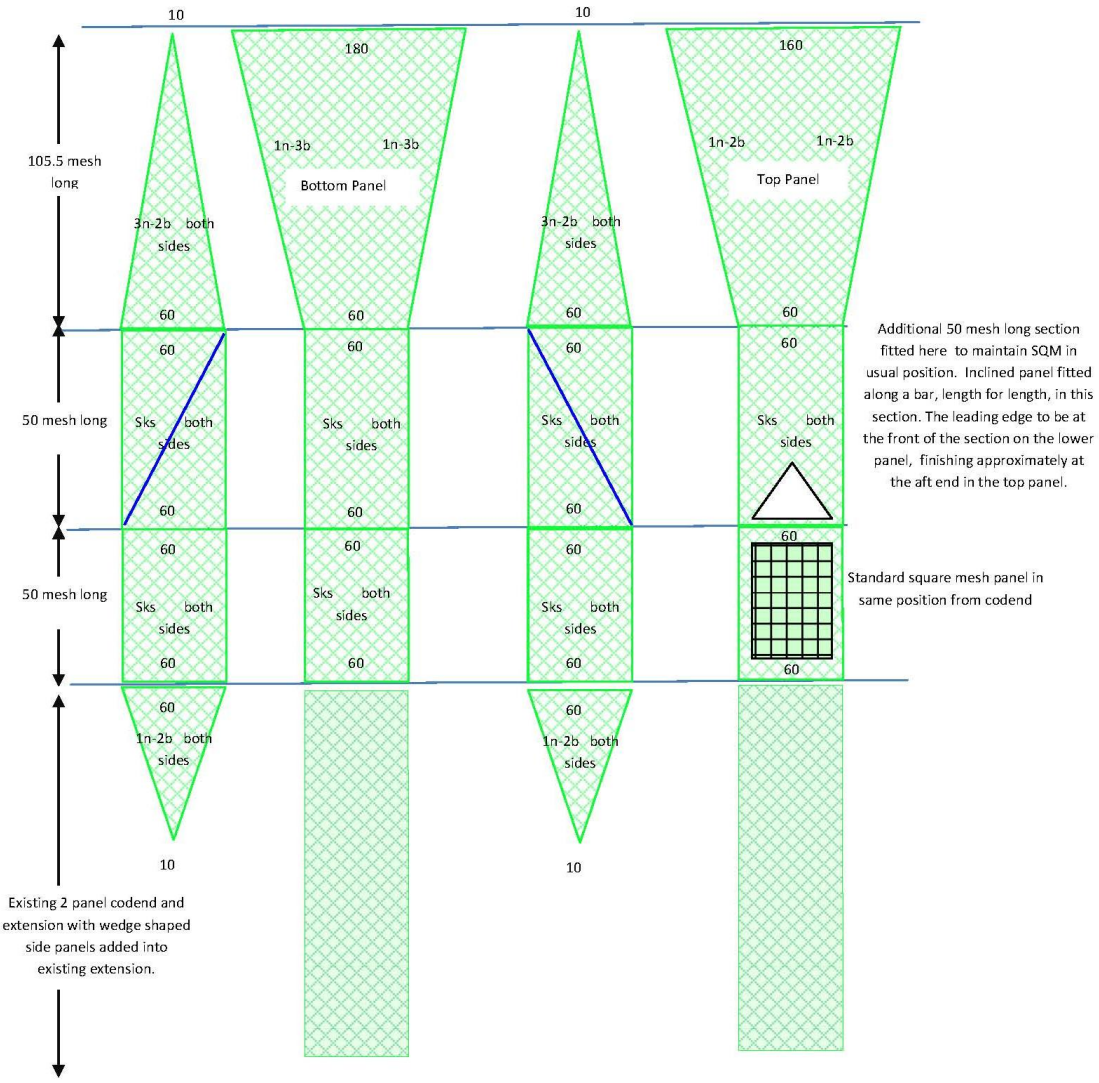
F. Armstrong (CEFAS SIC)

D. Gair (Skipper Sophie Louise II SSS678) *Note vessel will be named Aquarius II BH456 at the time of trials.

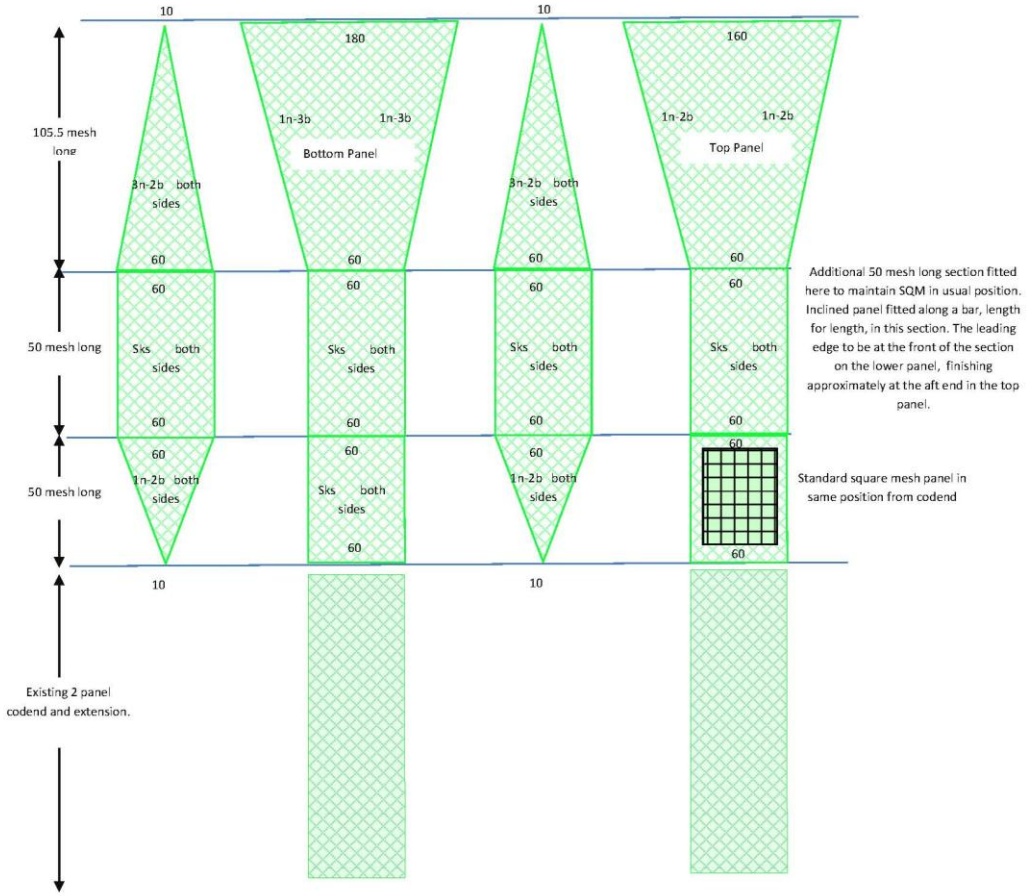
- The vessel will be Twin rigging using identical 20 fm 400 Pisces nets.
- The long version of the panel will be the first modification.
- Modifications will be made to the Starboard net.
- The first phase of the trials is to begin on 18/09/2013 and consist of 5 fishing days with 3, 3 to 4 hour tows each day. It is envisaged that weather permitting these days will be consecutive. The expectation is to achieve 12-15 tows showing that the modification releases finfish.
- The second phase of the trials is to begin on 13/10/2013 and consist of 5 fishing days with 3, 3 to 4 hour tows each day. It is envisaged that weather permitting these days will be consecutive. . The expectation is to achieve 12-15 tows showing that the modification does not hinder the retention of *Nephrops*.
- The vessel is working off quota and days regulations within the dispensation requirements.
- The object is to investigate the results of using modified cod avoidance nets in a *Nephrops* fishery.
- The departure and arrival port will be Amble and it is expected that landings will be made daily. Weather and tidal constraints may necessitate that some trips are extended or the landing port changed to Blyth.
- The vessel's agent is Alliance Amble.
- CEFAS scientists Frank Armstrong and Christopher Barratt will be onboard the vessel.
- All Cod and *Nephrops* catches will be measured and catches of other commercial species will also be sampled.
- Discarded species will be retained in baskets to ensure the accuracy of quantities before discarding.
- The conditions and details of the ITT, contract and dispensation will be upheld.

Annex 2 Detailed Net Plans

Version 1



Version 2


10
10
180
160
105.5 mesh long
1n-3b
1n-3b
Bottom Panel
1n-2b
1n-2b
Top Panel
3n-2b both sides
3n-2b both sides
60
60
60
60
60
60
60
60
50 mesh long
Sks both sides
Sks both sides
Sks both sides
Sks both sides
60
60
60
60
60
60
60
60
50 mesh long
1n-2b both sides
Sks both sides
1n-2b both sides
60
60
10
10
Existing 2 panel codend and extension.
Additional 50 mesh long section fitted here to maintain SQM in usual position. Inclined panel fitted along a bar, length for length, in this section. The leading edge to be at the front of the section on the lower panel, finishing approximately at the aft end in the top panel.
Standard square mesh panel in same position from codend

Annexe 3 Shooting and hauling times,depths and positions

Hauls highlighted in red were considered invalid and excluded from data analysis.

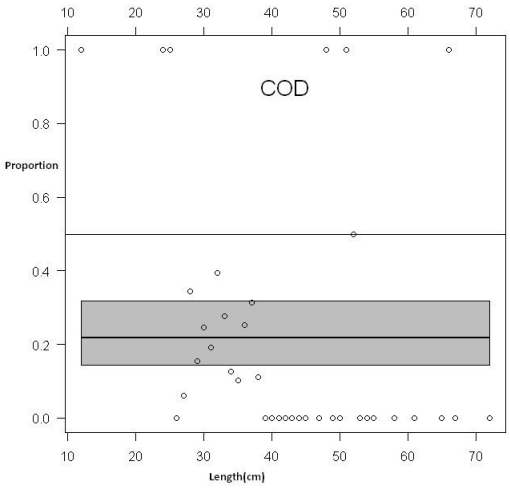
	Haul	Shot Date	Time	Depth (m)	Lat. Deg	Lat. Min	Lon. Deg	Lon. Min	Haul Date	Time	Depth	Lat. Deg	Lat Min	Lon. Deg	Lon. Min	Tow duration
T1	1	23/09/2013	18:20	90	55	12	-1	8	23/09/2013	21:20	88	55	6	-1	1	03:00
T1	2	23/09/2013	22:20	82	55	7	0	-5	24/09/2013	01:50	84	55	6	0	-5	03:30
T1	3	24/09/2013	07:00	82	55	13	-1	12	24/09/2013	10:10	75	55	5	-1	10	03:10
T1	4	24/09/2013	11:15	77	55	6	-1	9	24/09/2013	15:00	86	55	14	0	-56	03:45
T1	5	24/09/2013	15:50	86	55	14	-1	50	24/09/2013	19:20	82	55	5	0	-56	03:30
T1	6	25/09/2013	07:00	79	55	13	-1	12	25/09/2013	10:40	77	55	4	-1	9	03:40
T1	7	25/09/2013	11:50	77	55	4	-1	10	25/09/2013	16:00	82	55	11	-1	11	04:10
T1	8	25/09/2013	17:40	92	55	11	-1	2	25/09/2013	20:40	79	55	4	0	-56	03:00
T1	9	26/09/2013	06:25	81	55	6	0	-22	26/09/2013	09:35	86	55	1	0	-11	03:10
T1	10	08/10/2013	06:30	75	55	13	-1	13	08/10/2013	09:30	77	55	6	-1	11	03:00
T1	11	08/10/2013	10:15	75	55	5	-1	9	08/10/2013	13:10	60	54	59	-1	7	03:00
T1	12	08/10/2013	14:00	59	54	59	-1	8	08/10/2013	18:00	62	55	7	-1	14	04:00
T1	13	09/10/2013	06:30	57	55	6	-1	14	09/10/2013	10:15	55	54	57	-1	8	03:45
T1	14	09/10/2013	11:00	55	54	57	-1	14	09/10/2013	15:10	55	55	7	-1	16	04:10
T2	15	15/10/2013	13:15	79	55	19	-1	10	15/10/2013	16:15	86	55	13	-1	0	03:00
T2	16	15/10/2013	17:00	81	55	13	-1	0	15/10/2013	18:45	81	55	9	-1	6	01:45
T2	17	15/10/2013	20:10	81	55	11	0	-55	15/10/2013	23:15	86	55	15	0	-47	03:00
T2	18	16/10/2013	06:40	92	55	28	-1	3	16/10/2013	09:15	101	55	35	-1	6	02:35
T2	19	16/10/2013	09:50	101	55	35	-1	7	16/10/2013	13:15	90	55	27	-1	11	03:25
T2	20	17/10/2013	07:00	57	55	6	0	-14	17/10/2013	12:00	59	54	54	-1	4	05:00
T2	21	17/10/2013	12:35	59	54	54	-1	5	17/10/2013	18:10	68	55	7	-1	11	05:35
T2	22	17/10/2013	18:45	70	55	7	-1	11	18/10/2013	00:01	88	55	15	0	-54	05:15
T2	23	18/10/2013	06:45	92	55	26	-1	2	18/10/2013	10:00	97	55	26	-1	5	03:15
T2	24	18/10/2013	10:50	97	55	35	-1	7	18/10/2013	14:30	82	55	26	-1	13	03:40

Annex 4 Statistical analysis

The following diagrams show a graphic representation of a General Linear Mixed Model (GLMM) for species for each trial; the data are summarised by the proportion of fish retained in the test trawl (of those retained in both trawls) pooled over hauls for each trial. The effect of length on relative catch rates is captured by the fitted linear logistic functions of length (solid lines); with 95% confidence bands (shaded grey). The horizontal line bisecting at 0.5 shows the length at which there is an equal number of fish in each trawl, i.e. where there is no statistical difference in catches between the test and control trawls.

4.1. Cod

Version1



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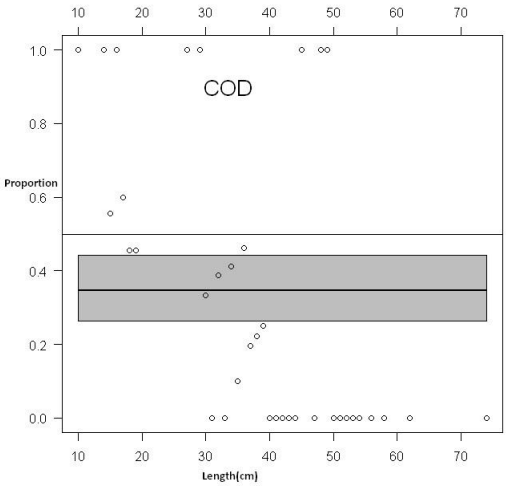
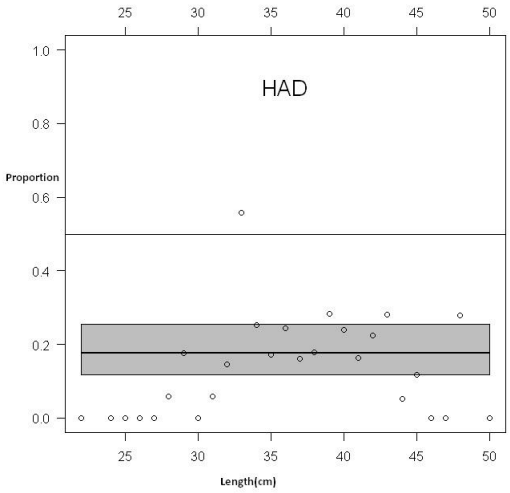


4.2Haddock

Version1



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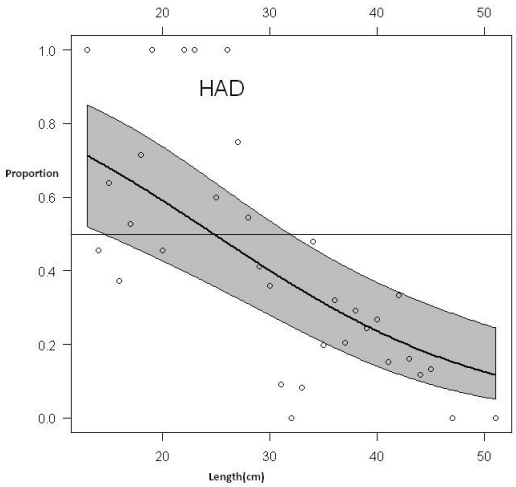
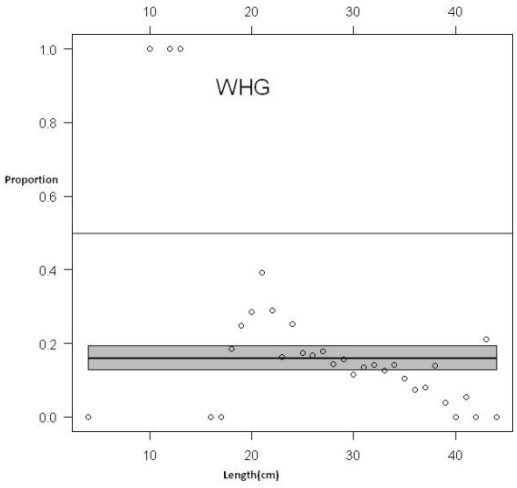


4.3Whiting

Version1



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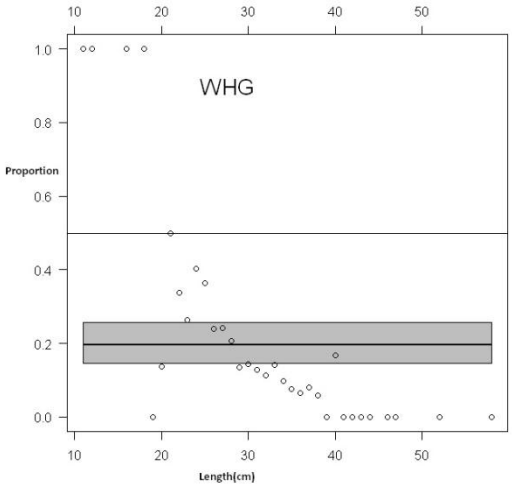
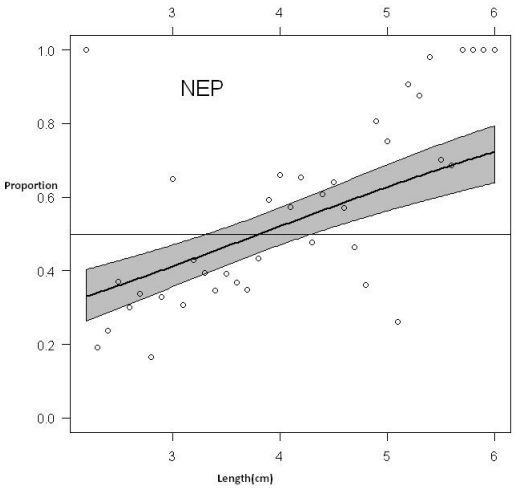


4.4Nephrops

Version1



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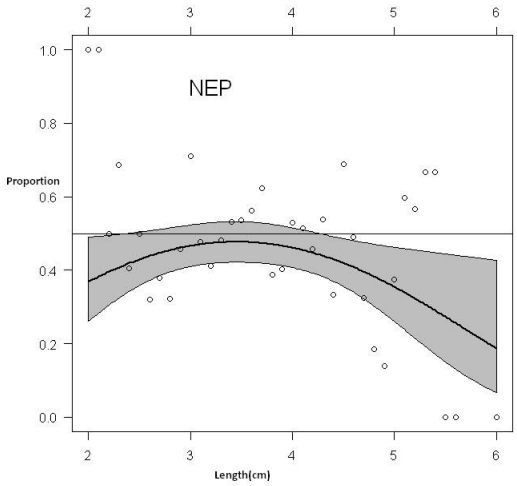
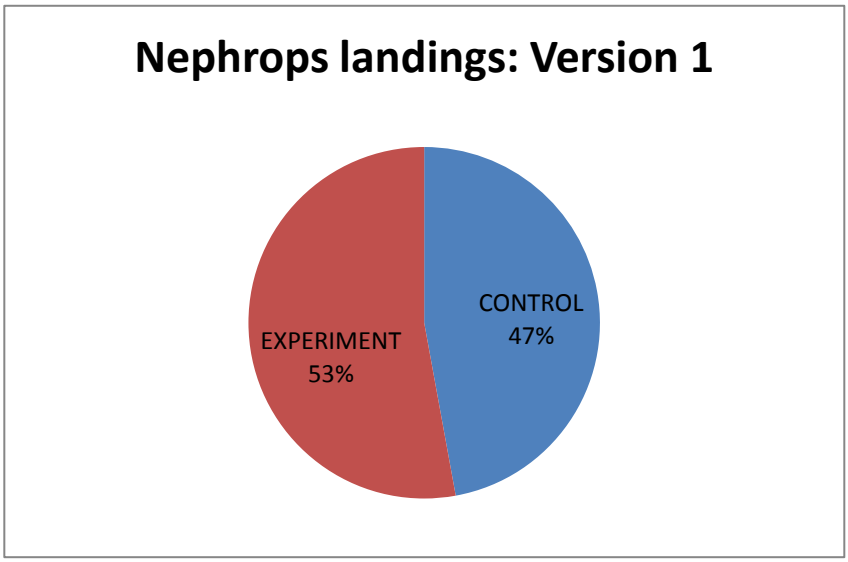
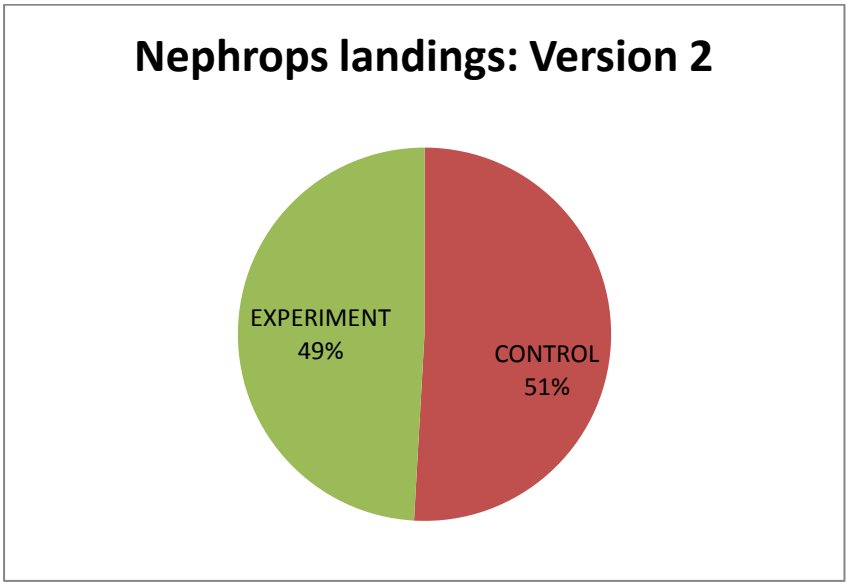


4.5 Total *Nephrops* landings by weight during study





Annex 5

NORTH EAST COAST NED GRID TRIALS

SKIPPER'S COMMENTS/REPORT ON REPORT OF FRANK ARMSTRONG AND TOM CATCHPOLE

DATED DECEMBER 2013

Equipment Used during both long and short grid panel trials.
Notus door and clump sensors were used to measure and alter spread of the fishing gear;
2 x Scanmar flow/symmetry sensors (one on each net) were used to measure and alter symmetry of nets.
1 x Scanmar tilt/catch sensor was used to check grid stability (we did not use the catch element of the sensor as it was irrelevant for these trials).
1 x Scanmar trawl sounder sensor used to check the height of the trawls.

Long Grid Panel Trial

The long grid panel trial commenced on the 23rd September 2013. We placed Scanmar tilt/catch sensor on the top of the panel above where the inclining panel starts. The panel and the net where the sensor was placed was very stable.

The panel was stable where ever the tilt sensor was used above the square mesh panel (SMP). We placed the tilt sensor on the cod end and observed a reduction in the catch in the test net. Once towing began the cod end tipped ninety degrees to starboard and then lost signal as it went below the net. My opinion is that the weight of the sensor tipped the bag on its side thus the SMP was tipped onto its side letting the prawns out. I have observed this before working the sensor in the TR1 (125 mm) nets but with no SMP. As the cod end fills with fish it re-emerges on top of the cod end. As there was no fish going into the cod end this did not happen, as fish were escaping from the escape hole and the prawns must have been escaping from the SMP. My opinion is that maybe more trials should be done with the grid panel but not use a SMP to see how stable the cod end is using the grid panel only. Once we removed the tilt sensor from the lower end bag (cod end) the catch rate for prawns returned to a rate similar to the control net.

The Short Grid Panel Trial

The short grid panel trial commenced on the 15th October 2013. This showed very similar results to the long grid panel trial. I did observe crabs stuck in the incline netting and this was not observed in the long grid panel trial. Also on haul number 17 on the 15th October 2013, there was a 28-32 degrees twist in the panel, this was possibly due to towing across the tide so was thought to be somewhat irrelevant to the performance of the grid. I have continued to use this sensor after the trial and have observed this again in a standard net when towing across the tide. This panel also

seemed to get muddier than the long grid panel. This could possibly due to an increase in vessels towing across the same fishing grounds.

Conclusion

In my opinion I think there is potential in these panels to eliminate discards. Due to the lack of cod during the period of the trials limited data was achieved on cod escaping from the panels, but as for the escaping of other species it was encouraging. My only concern was the lack of ground fish i.e plaice, lemon sole, dover sole, monkfish, turbot etc, that was present in the control net but not in the test net. Further development in the way the incline netting is positioned or tensioned could help these species be retained whilst still discarding round fish i.e. cod, haddock, whiting etc.
As for hauling and shooting the fishing gear, both panels were no problem to work but I still favoured the longer panel as it seemed more selective. The larger panel would also, in my opinion, be easier and less complicated to fine tune to retain the ground fish. As both panels showed potential in discarding fish it would be interesting to do more trials to see how much fish were actually escaping from the escape hole and how much were escaping from the SMP. Converting one or both panels by removing the SMP would not take a lot of work.
I hope you find my comments useful but should you wish to clarify or discuss any points, please do not hesitate to contact me.

David Gair
Skipper
Gair Trawlers Limited (Aquarius II BH 456)
29 December 2013

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