REPORT TO STECF ON AREA VII HADDOCK ENGLISH SELECTIVITY TRIALS:

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This report was prepared by Tom Catchpole (thomas.catchpole@cefas.co.uk from Centre for Environment, Fisheries and Aquaculture Science, UK) for the Scientific, Technical and Economic Committee for Fisheries (STECF). The report presents summary findings from the recent industry/science partnership projects investigating improvements in selectivity towards haddock for the demersal otter trawl fishery in ICES Area VII. Summary reports on a series of fishing gear trials are presented here.

In this report a trial refers to a set of experiments conducted on one vessel. Three vessels each conducted a trial between 29th July and 24th September 2014:

1. Testing 100mm square mesh panels in the cod-end onboard MFV Crystal Sea (two experiments undertaken). This design demonstrated a **72-79% reduction** in haddock catches.
2. Testing 200mm diamond-mesh escape panels in the wings, square and back sections of the trawl onboard MFV Valhalla (one experiment undertaken). This design demonstrated a **22% reduction** in haddock catches.
3. Testing square mesh panels (112mm and 155mm) in the body of the trawl onboard MFV Our Olivia Belle (four experiments undertaken). This design demonstrated a **7-64% reduction** in haddock catches.

A total of 81 hauls were completed in the three trials. Sufficient haddock were caught to enable a robust statistical analysis of the data. When accounting for the loss of marketable fish, and the changes in selectivity towards haddock, the design incorporating a 100mm square-mesh panel in the code-end was the most effective design tested. Full reports of these trials will be published in due course but summary findings are presented here.

The results from two further trials of a low headline trawl design (MFV Imogen) and of a vertical separator trawl (MFV Guiding Light III) are planned for completion before the end of this year.

BACKGROUND

Following conclusion of the negotiations at December Council 2013, these studies were initiated by the UK to meet the requirements laid out in the statement by the Council (13th January 2013) with regard to Celtic Sea haddock.

This stated: *Fishing mortality on the Celtic Sea haddock stock is too high and needs to be reduced in order to ensure sustainable exploitation of the stock. The stock is decreasing due*

to reduced recruitment, so a substantial reduction in TAC is required. To contribute to the required reduction in fishing mortality, an increase in selectivity for adult fish will also be required. The Council encourages the Member States engaged in the whitefish fishery in the Celtic Sea to introduce additional selectivity measures to those already in place under Commission Regulation 737/2012, so as to reduce catch rates of adult haddock, such as the use of a large diamond mesh panel in the top panel of demersal trawls. These additional measures should be in place by end of July 2014 at the latest.

Recruitment of this species is characterised by sporadic events; when there is a large recruiting year-class, catches increase and so do discards. Catching and discarding juvenile and undersized haddock reduces the reproductive potential of the stock and its resilience during years of poor recruitment with knock-on effects to the future economic potential of the fishery. Improved selectivity of otter trawls towards haddock is considered to be an effective means to reduce discarding and promote stock rebuilding when sporadic events of strong year-classes arise. Since the Council statement it has been identified that the 2013 year-class is relatively high, the first since 2009 [1] (Figure 1a). Therefore, there is a motivation to protect this year class by improving trawl selectivity.

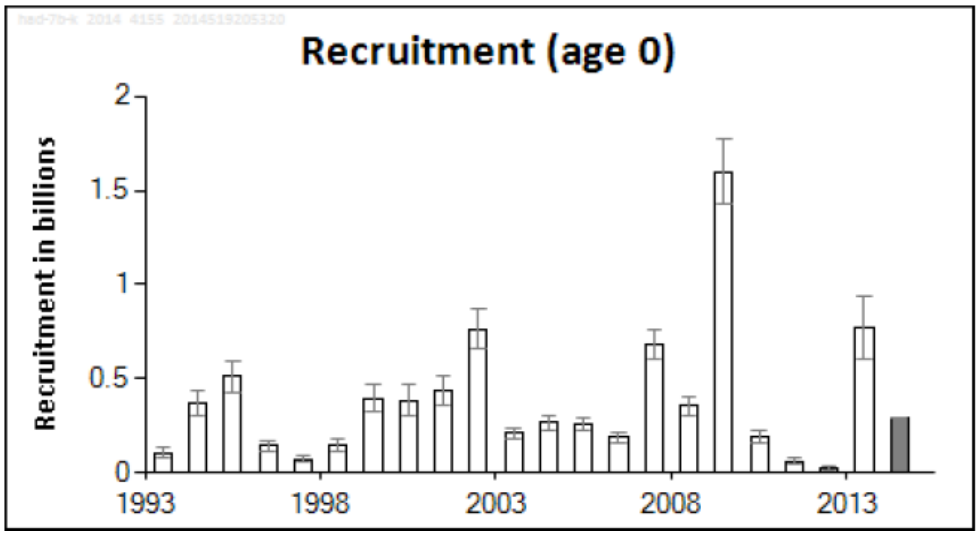


Figure 1a Haddock in Divisions VIIb–k. Predicted recruitment values are shaded. Standard errors are indicated by the error bars.

Meetings were held with vessel operators in the main ports for this fishery in September 2013 (Newlyn, Mevagissey, Plymouth and Brixham). These were part of a series of meetings to set out the principles of the landing obligation. At these meetings it was identified that haddock was considered to be the mostly likely *choke* species during the transition to the landing obligation under the Reformed CFP.

[1] ICES, 2014, Advice June 2014, 5.3.11 Celtic Sea and West of Scotland, Haddock in Divisions VIIb–k, Advice for

A further meeting was arranged by the Cornish Fish Producers Organisation (CFPO) on 7th February 2014 in response to the significant reduction in the Division VIIb-k haddock TAC for 2014 (reduced by 33% from the agreed TAC in 2013). It was noted that this followed a 15% reduction in the 2013 TAC relative to the agreed TAC in 2012. These reductions had already had significant implications for management of the mixed fisheries in the South-West and caused serious concerns, particularly with regard to the landings obligation.

It was agreed that CFPO and Cefas would work collaboratively on the design and immediate implementation of industry/science partnership projects to define gear adaptations which would reduce catches of size grades 4 and 5 (small but mature fish) as well as any catches of haddock below minimum landing size (MLS). This would build upon the work already conducted in 2013 and previously reported to STECF in 2013. It was underlined that it was vitally important to assess and take into account the effect of any gear adaptations on other economically important species in the catch. The outputs were expected to reduce the fishing mortality on small haddock and so help conserve the stock (by reducing discard mortality), as well as minimise the economic impact in the move towards the landing obligation.

AIM

Three trials were conducted using three commercial fishing vessels, and seven different trawl modifications (experiments). Funding was sourced from three research programmes, each managed independently, but the results have been compiled here into one report. In all cases, the trawl modifications were developed collectively by vessel operators, scientists and net makers.

The aim of these studies was to improve the size selective performance of demersal otter trawls by reducing unwanted catches of undersized and small grade haddock in ICES Area VII. Commercial fishing trips sampled as part of the Data Collection Framework (DCF) - Cefas observer programme, demonstrated high catches of juvenile haddock and cod in the first part of 2014 (Annex 1). Therefore, the effect of the modified trawls on improving selectivity towards cod was also investigated.

THE TRIAL DESIGNS

In each of the three trials, the vessel's own commercial trawls were used; one trawl was modified, the other left in its standard commercial configuration to provide a direct comparison. With the exception of the experimental modification, both trawls were of identical construction. The design of the modified trawls and summary of the results are described in Table 1 and shown in the figures below.

For trial one and three, both vessels fished with a twin-rigged trawl. For these trials, the standard and modified trawls were towed simultaneously using a 3-warp towing system.

Here, the catches from each tow could be directly compared. In trial two, the vessel used a single-rigged trawl and the standard and modified net was alternated after each tow.

A consistent routine for handling and sorting the catch was maintained throughout the trials. Catches from the standard and modified nets were kept separate. The crew sorted the catch as they would handle catches normally with the exception that all material that would usually be discarded was separated out and retained for sampling as the "discard fraction".

Once the crew had finished sorting the catch, Cefas observers began sampling using standard techniques. For each haul Cefas observers measured all fish species caught to the nearest cm below. Subsampling was necessary on occasions when the total catch was large, but subsamples reflected the total catch composition and raising factors were calculated and applied.

ANALYSIS

The haul positions for each trial are presented.

For each experiment in each trial, the length frequencies of the catches of haddock and cod, pooled for all hauls, were constructed and presented. Length-weight relationships were applied to the length data to calculate catch weights. A simple figure showing the percentage change in landed catches, by weight, when using the modified trawls compared with the standard trawl is presented for each experiment. A simple assessment of the economic performance of the modified gear is given in Annex 3; a fuller analysis will be conducted and presented in the final reports. The landings were influenced by the availability of quota, specifically for haddock, so do not represent all of the catch that could have been landed had quota not been restricted.

A General Linear Mixed Model (GLMM) catch comparison analysis was applied to the catch data from haddock and cod for each experiment (Holst *et al*., 2009)[2]. The data were fit using a quadratic, linear and constant relationships and the model of best fit is presented in each case. The effect of length on catch rates is presented 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 standard and modified trawls.

In Trials 1 and 3 the catches taken from each of the two rigs from each tow were compared. In Trial 2, where a single-rig was used, each tow with a modified trawl was paired with a tow

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

using a standard trawl. Because day and night catches were so different, see below, the standard and modified tows were paired as sequential day and night tows.

The modified trawl investigated in Trial 1 was the culmination of a series of trials conducted by the MFV Crystal Sea prior to the Cefas project. The vessel took part in the Marine Management Organization (MMO) Catch Quota scheme[3], whereby it has been operating under a landing obligation for ICES Division VIIb-k haddock. The vessel was monitored using electronic monitoring and CCTV (EM) and over 10% of fishing operations were audited by on-shore observers. As part of the scheme, the vessel voluntarily undertook gear trials. The data generated by the skipper from the gear trials was partly corroborated through electronic monitoring and CCTV. Results from these gear trials conducted prior to the Cefas trials are shown in Annex 2.

It was not possible to make statistical comparisons between trials (the standard trawls varied between vessels). The proportions of haddock caught at each length for the seven modified trawls are presented (Figure 1b) to provide a visual comparison of the catch profiles of the different designs.

There is strong anecdotal evidence that the catches of haddock are substantially different between the day and night time hauls. Skippers at a number of meetings have highlighted this fact, and some have modified their fishing behaviour to fish more of the time during the day and less at night to avoid catching haddock for which they have no quota to land and so have to discard. As part of this analysis we looked at the day-night differences in catch rates for these three trials. Only catches taken with standard trawls were included. Hauls were designated as either having occurred during the day or night (most of the tow occurring before 06:00 and after 22:00). The numbers of fish caught at length from all tows from each of the three trials were summed and standardised using the total tow duration. This provided total numbers of fish per minute per length caught during the day versus the night for each trial. Length frequency plots present the output.

RESULTS

A summary of the results is presented in Table 1. The catch profiles for haddock for each of the modified trawls are shown in Figure 1b. Detailed results are presented below for each of the experiments within each trial along with an analysis of day versus night catch patterns.

In the first experiment in Trial 1, haddock reductions were 79% by number when comparing a coverless trawl with no square mesh panels with another coverless trawl with two square mesh panels, one in the statutory portion of 9-12m, the other in the cod-end, both of 100mm mesh size (stetched). There were some losses of landed commercial species but also some gains.

[3] Catch Quota Trials 2013: Western haddock interim report. Marine Management Organization, 2013.

In the second experiment in Trial 1, the aim was to assess the effect of the square mesh panel in the codend relative to the effects of the panel in the statutory position and the absence of a cover. When the only difference between the two trawls was the 100mm square mesh panel in the codend, the reduction in haddock was 72%. This indicates that it was the codend 100mm panel rather than the absence of a cover or the 100mm panel in the statutory position that was releasing haddock from the trawl. There were similar losses and gains of commercial species as with experiment 1 in this trial.

In the second trial there was only one experiment conducted. A trawl with 200mm diamond sections in the wings, square and part of the back net was compared against a trawl with 115mm diamond mesh throughout. There was a 22% reduction in haddock numbers with the modified trawl, this reduction was significant for the larger fish only. This suggests that haddock did not readily escape from the front end of the trawl, the mouth of the net.

In trial three, four experiments were conducted with 155mm and 112mm square mesh panels. In three of the experiments, the standard trawl had a 112mm square mesh panel inserted in the statutory position. The high catch rates of small haddock with this standard net indicated that the 112mm square mesh panel was not effective at avoiding the capture of small haddock.

The experiments in trial three showed that when inserted closer to the mouth of the net the 155mm square mesh panel was less effective than when positioned close to the codend. When in the position closet to the mouth of the trawl, substantial numbers of small haddock were caught even when using a 155mm square mesh panel. When located near to the codend at 2.5-5.5m from the codline, the reduction in haddock catches was 64% by number and was significant across the length range, compared with a trawl with no square mesh panel. However, the large reduction in haddock catches was coupled with unacceptable loss of marketable catches of other species.

Table 1 Summary of results of selectivity gears trials for haddock, % change in haddock total catch by number

Trial	Exp.	Standard trawl	Modified trawl	Hauls	Results relative to the standard trawl - haddock	% change in haddock
Trial 1	Exp. 1	No cover; 100mm cod-end	no cover; 100mm SMP in cod-end; 100mm SMP @ 9-12m; 100mm codend	11 (twin-rig)	Almost all abundant small fish avoided. Significant reduction of haddock below 46cm with modified trawl; higher reductions with decreasing size of fish. Analysis indicates increasing catches of larger fish with modified trawl.	**79% reduction**
Trial 1	Exp. 2	No cover; 100mm SMP above cod-end; 100mm cod-end	no cover; 100mm SMP in cod-end; 100mm SMP @9-12m; 100mm cod-end	7 (twin-rig)	Almost all abundant small fish avoided. Significant reduction of haddock below 45cm with modified trawl; higher reductions with decreasing size of fish. Analysis indicates increasing catches of larger fish with modified trawl.	**72% reduction**
Trial 2	Exp. 1	115mm throughout, 100mm cod-end	200mm wings, square and lower back; 115mm elsewhere, 100mm cod-end	18 (single-rig); 9 tows each	Reductions of haddock across the length range but not significant in analysis below 50cm. Substantial numbers of small fish haddock still caught.	**22% reduction**
Trial 3	Exp. 1	115mm SMP @ 6-9m from codline; 87mm cod-end; 115mm elsewhere	115mm SMP @ 6-9m from codline; 155mm SMP @ 9.5-12.5m from codline; 87mm cod-end	11 (twin-rig)	No reduction in overall haddock catches, analysis indicates marginal reduction in fish over 50cm. Substantial numbers of small haddock still caught.	**7% reduction**
Trial 3	Exp. 2	115mm SMP @ 6-9m from codline; 87mm cod-end; 115mm elsewhere	115mm SMP @ 6-9m; 155mm SMP @ 9.5-12.5m; 155mm SMP @ 2.5-5.5m from codline; 87mm codend	12 (twin-rig)	Substantial numbers of small haddock still caught. Significant reduction in catches of haddock above 25cm. Increasing reductions in catches with increasing size. Large reduction in catches of larger haddock. caught.	**25% reduction**
Trial 3	Exp. 3	115mm SMP @ 6-9m from codline; 87mm cod-end; 115mm elsewhere	115mm SMP @ 6-9m; 155mm SMP @ 2.5-5.5m from codline; 87mm cod-end	12 (twin-rig)	Substantial numbers of small haddock still caught. Significant reduction in catches of haddock above 27cm. Increasing reductions in catches with increasing size. Substantial reduction in catches of larger haddock.	**38% reduction**
Trial 3	Exp. 4	87mm cod-end	155mm SMP @ 2.5-5.5m from codline; 87mm cod-end	10 (twin-rig)	Significant and substantial reduction in catches of haddock at all sizes.	**64% reduction**

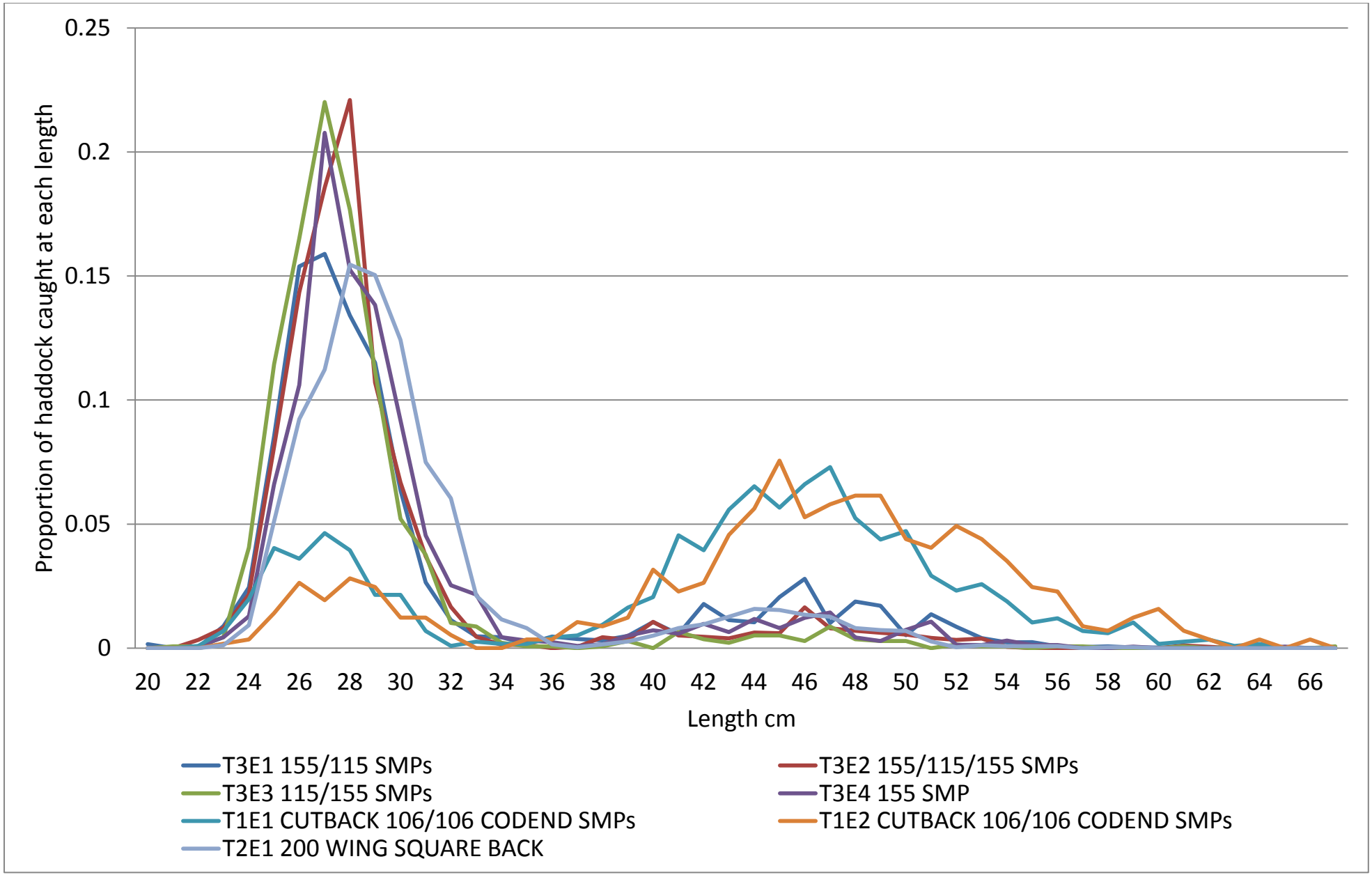


Figure 1b Catch profiles of haddock caught using the seven modified trawl designs T = Trial, E = Experiment

CONCLUSIONS

- **A total of 81 hauls were completed by three commercial fishing vessels testing seven modified trawl designs to improve the selectivity towards haddock in the English mixed demersal fishery in ICES Area VII.**
- **The modified trawls were of three types: i) large diamond mesh sections in the top of the trawl near the mouth of the net (22% reduction in haddock), ii) 100mm square mesh panels in the cod-end (72-79% reduction in haddock), and iii) combinations of 112mm and 155mm square mesh panels in the main body of the trawl (7-64% reduction in haddock).**
- **There were substantial numbers of small (22-30cm) haddock caught during the trials supporting the reported relatively high 2013 year-class.**
- **A square mesh panel of mesh size 100mm in the cod-end was the most effective design at reducing haddock catches (72-79%), particularly for small haddock, whilst retaining marketable catches.**
- The result is supported by data generated in previous trials conducted by the MMO under a Catch Quota Scheme, which estimated that catches of haddock below 30cm were reduced by up to 90% by inserting a 100mm square mesh panel in the cod-end coupled with a square mesh panel that conforms to Celtic Sea technical measures further forward in the trawl.
- Inserting large meshes in the top of the net, at the mouth of the trawl, demonstrated a limited reduction in haddock (22%), significant only for large fish (>50cm). The coverless trawl, when used without escape panels, also caught substantial quantities of small haddock. This indicates that small haddock, of the length range most abundant, were not stimulated to escape from the front section of the trawl.
- From the configurations of the square mesh panels tested, it can be inferred that the closer to the cod-end the panel was positioned the more haddock escaped from the trawl. For example, inserting a 155mm square mesh panel at 9-12.5m into a trawl with a 112mm at 9-12m did not reduce haddock catches. Inserting the 155mm panel at 2.5-3.5m reduced haddock catches by 38%.
- A trawl with a square mesh panel of 112mm, positioned at the statutory position of 9-12m from the codline caught substantial numbers of small haddock (22-30cm). From these trials, there is no evidence that a panel in this position, even with a mesh size of 155mm, would avoid catching substantial numbers of small haddock.

- Smaller haddock (22-30cm) appeared not to utilize escape opportunities before they are close to, or inside, the cod-end, whereas larger haddock were observed to escape more readily from the main body of the trawl.

- A square mesh panel of mesh size of 155mm in a position that is effective for releasing haddock near to the cod-end also resulted in the considerable loss of marketable fish, making this design unviable for commercial use.

- Catches of cod were considerably lower than for haddock in these trials making the analysis less robust. The 100mm square mesh panels in the cod-end and statutory position showed a change in cod catches of a 7% increase and a 35% decrease. The effectiveness of this design for cod is therefore unclear.

- The catch profile for night time catches was similar for all trials, with high numbers of small, juvenile haddock caught. In Trial 2 catches of haddock were less by 91% by number during the day compared with night and in Trial 3 76% less. In Trial 1 there was only 2% less haddock in the day.

- The location of hauls in the three trials suggests that the diurnal vertical behaviour of haddock could be stronger in the more northerly, shallow areas that were fished, compared with the southerly deeper waters.

- Further data is needed to explore this hypothesis. However, this observation does provide another potential tool for vessel operators to avoid catching haddock; i.e. by shifting effort to areas and times when haddock are not available to demersal otter trawls. Some vessel operators are already reporting that they are expending a higher proportion of their fishing effort in the day to avoid haddock.

Trial 1 – 100mm square mesh panels in and adjacent to codend combined with coverless trawl

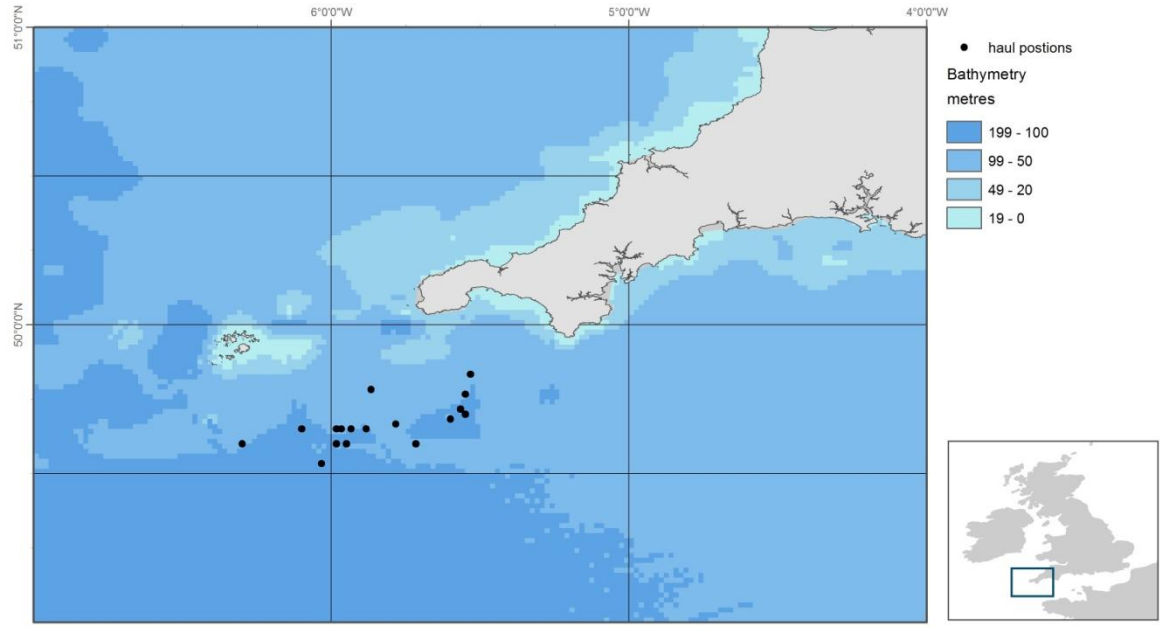


Figure 1 Position of hauls in Trial 1

Figure 2

Standard trawl

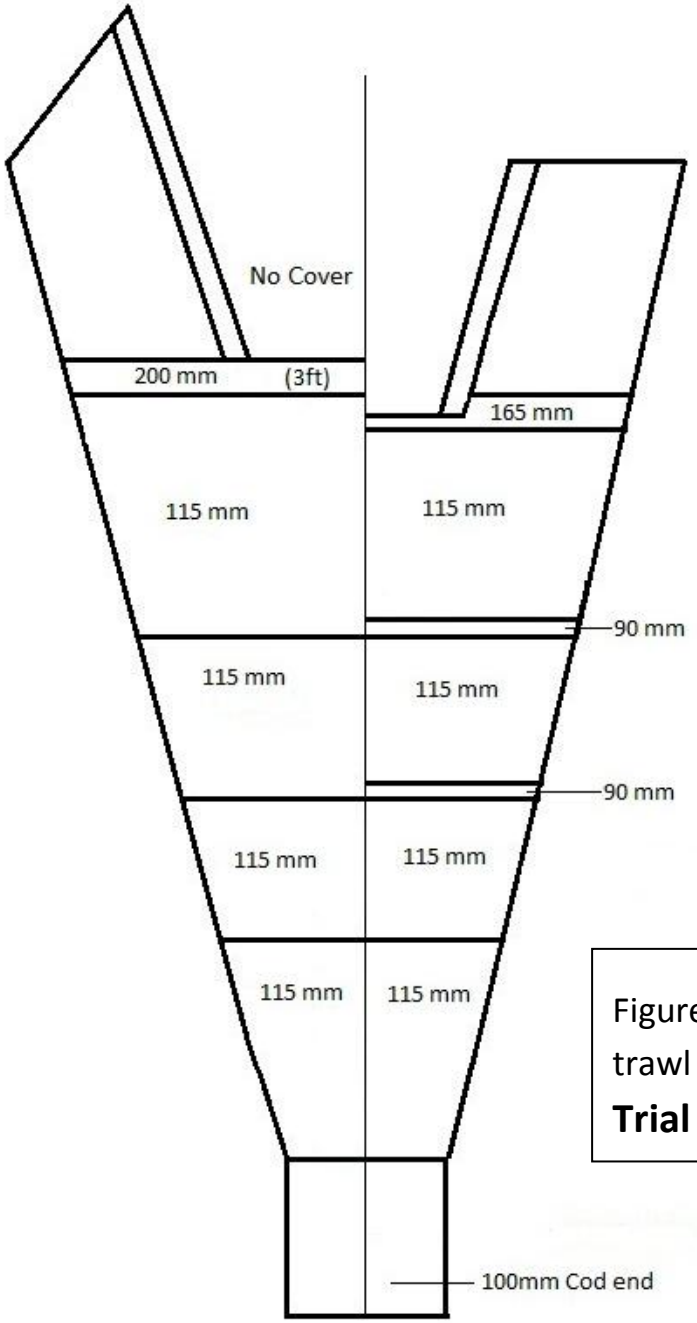
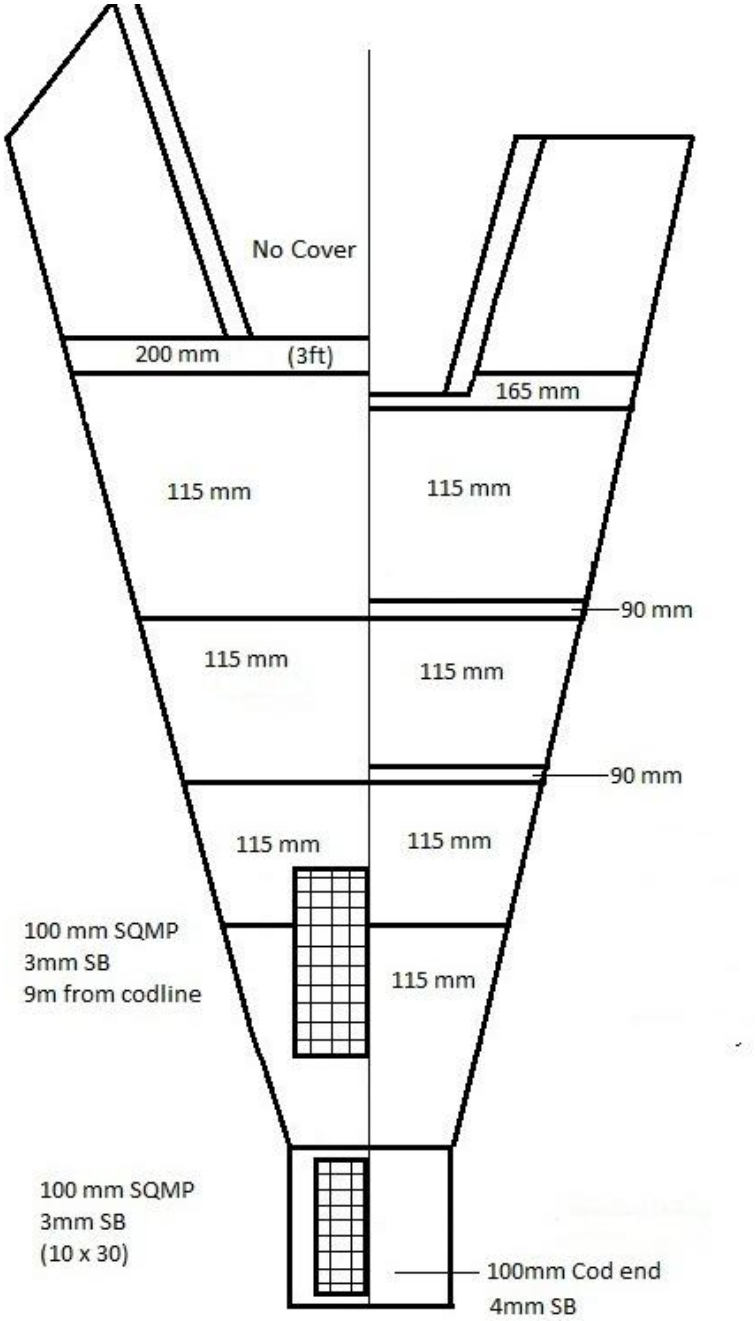


Figure 3a Illustrative trawl plans

Trial 1, Experiment 1

Experimental Trawl



Trial 1 Experiment 1 Haddock

Almost all abundant small fish avoided. Significant reductions in haddock below 46cm, higher reductions with decreasing size of fish. Glmm also indicates increasing catches of larger fish with modified trawl.

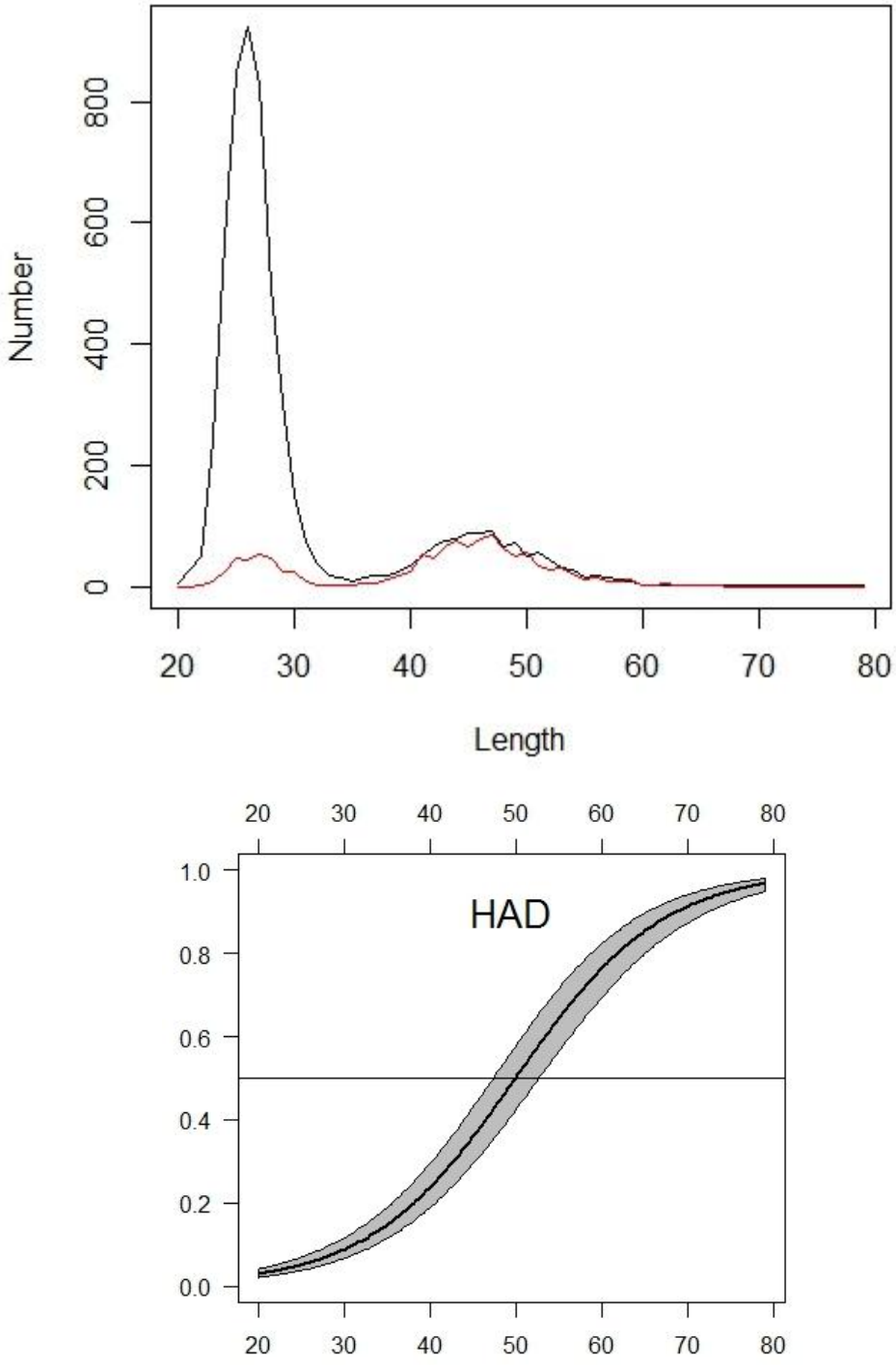


Figure 3 For Trial 1 Experiment 1, numbers haddock caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Trial 1 Experiment 1 Cod

A statistically significant, but small, reduction in cod across the full length range.

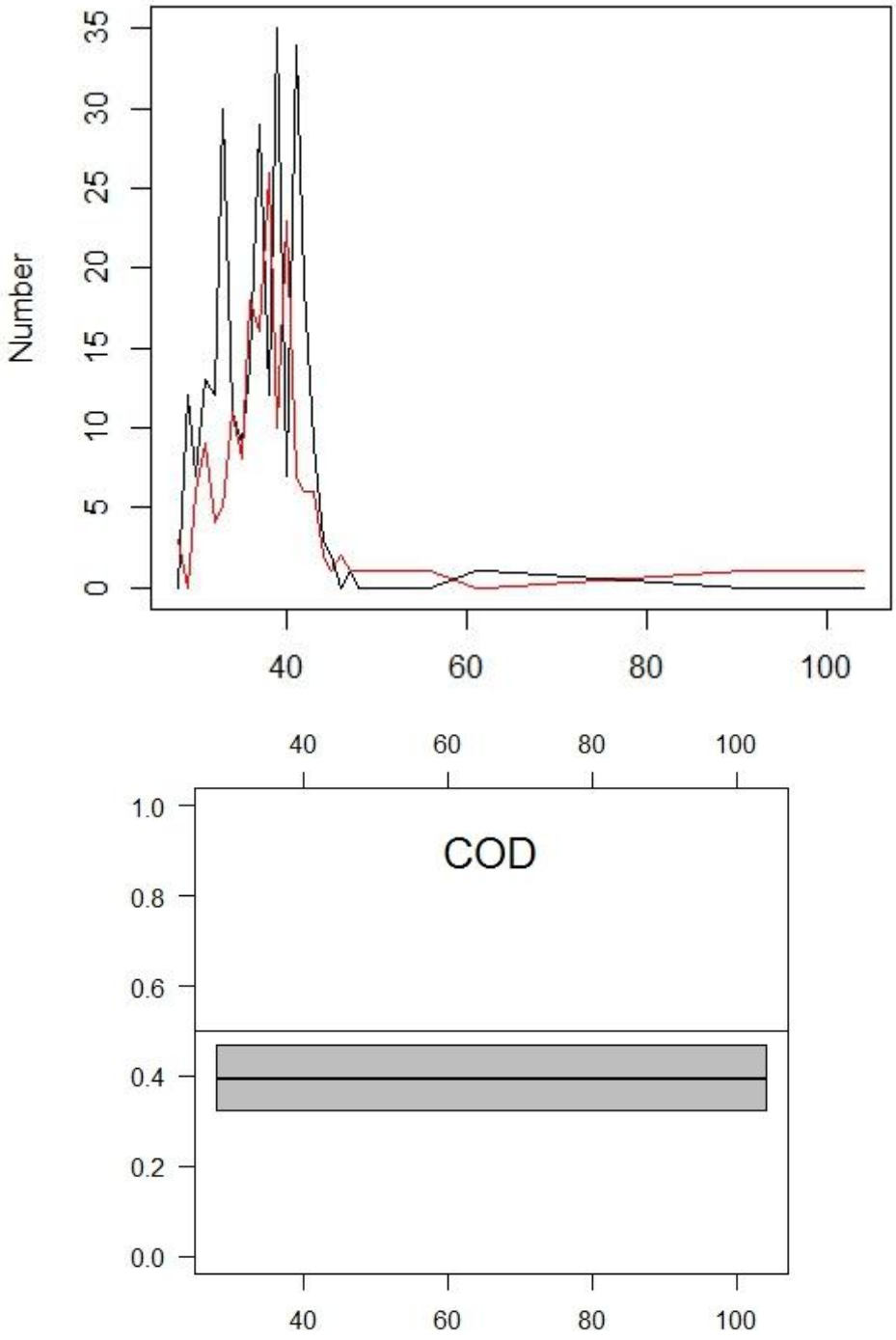


Figure 4 For Trial 1 Experiment 1, numbers cod caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Figure 5 Trial 1 Experiment 1 percentage difference in weight of landed catches (top 10 by weight) with the modified trawl (haddock landings influenced by quota availability)

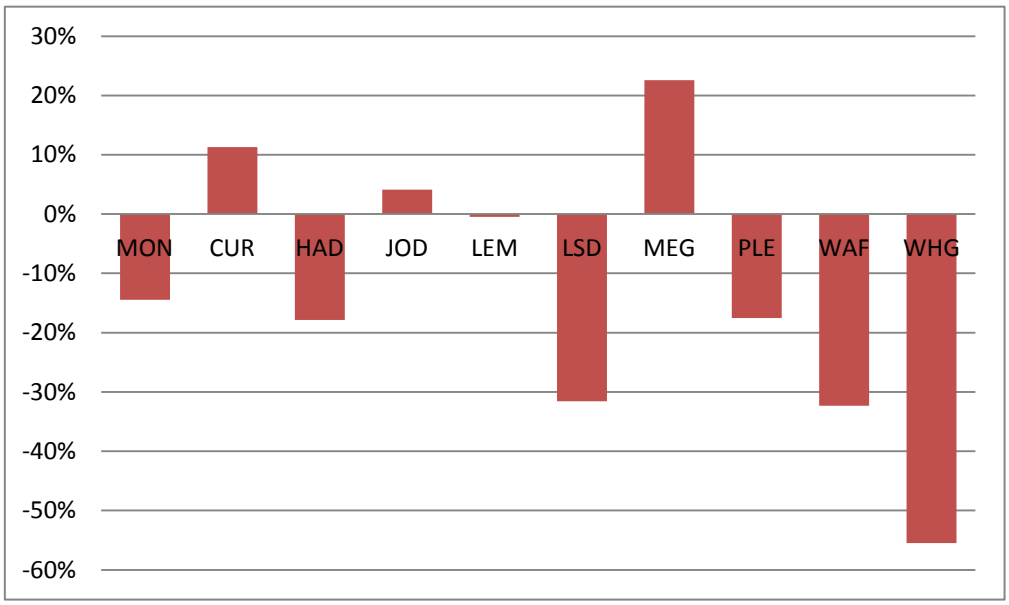
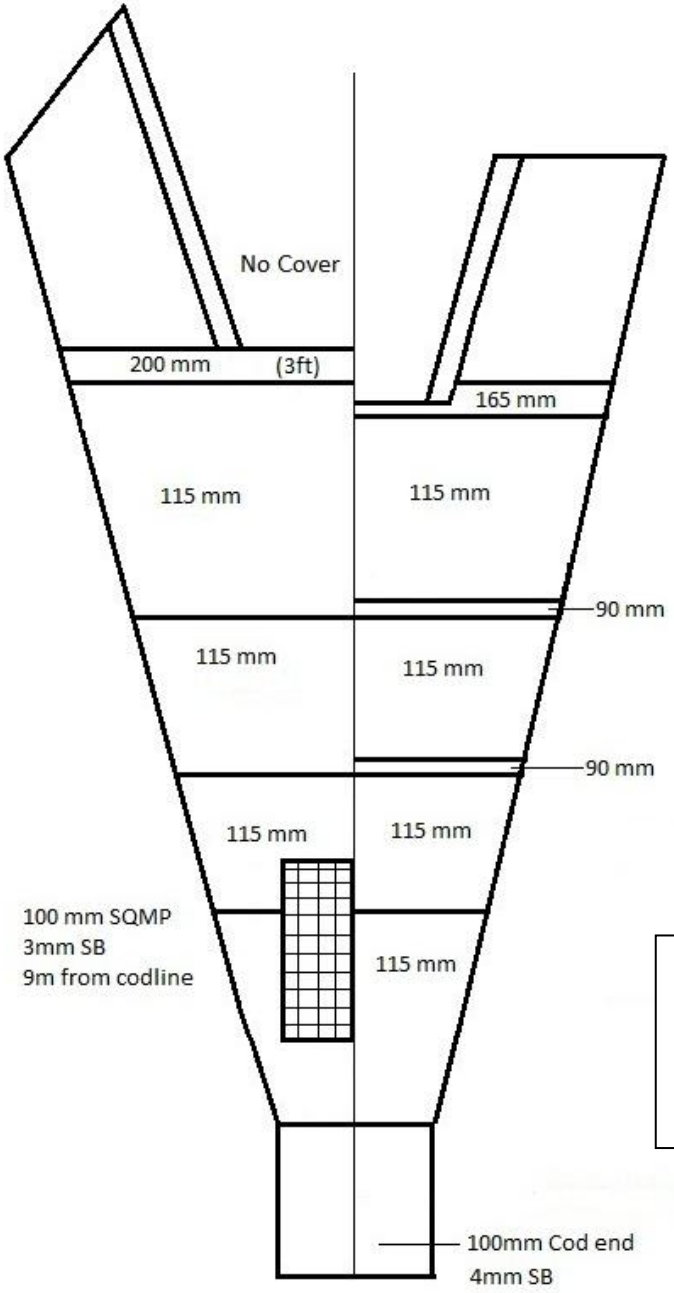


Table 2 Summary of Trial 1 Experiment 1

Trial	Trial 1
Experiment	Experiment 1
Standard trawl	100mm codend
Modified trawl	no cover (cut back headline); 100mm SMP in codend; 100mm SMP @ 9-12m from codline; 100mm codend
Hauls	11 (twin-rig)
Days fishing	4
Period	29/7/2014-1/8/2014
Results relative to the standard trawl - Haddock	Significant reduction of haddock below 46cm with modified trawl; higher reductions with decreasing size of fish. Almost all abundant small fish avoided. Analysis indicates increasing catches of larger fish with modified trawl.
% change in haddock number (number in standard trawl)	79% reduction (5660)
Results relative to the standard trawl - Cod	A statistically significant, but small reduction in cod across the full length range.
% change in cod number (number in standard trawl)	35% reduction (256)
Effect on other marketable fish	Loss of marketable fish (whiting, monkfish , plaice) and some gains (megrim).

Standard trawl



Experimental Trawl

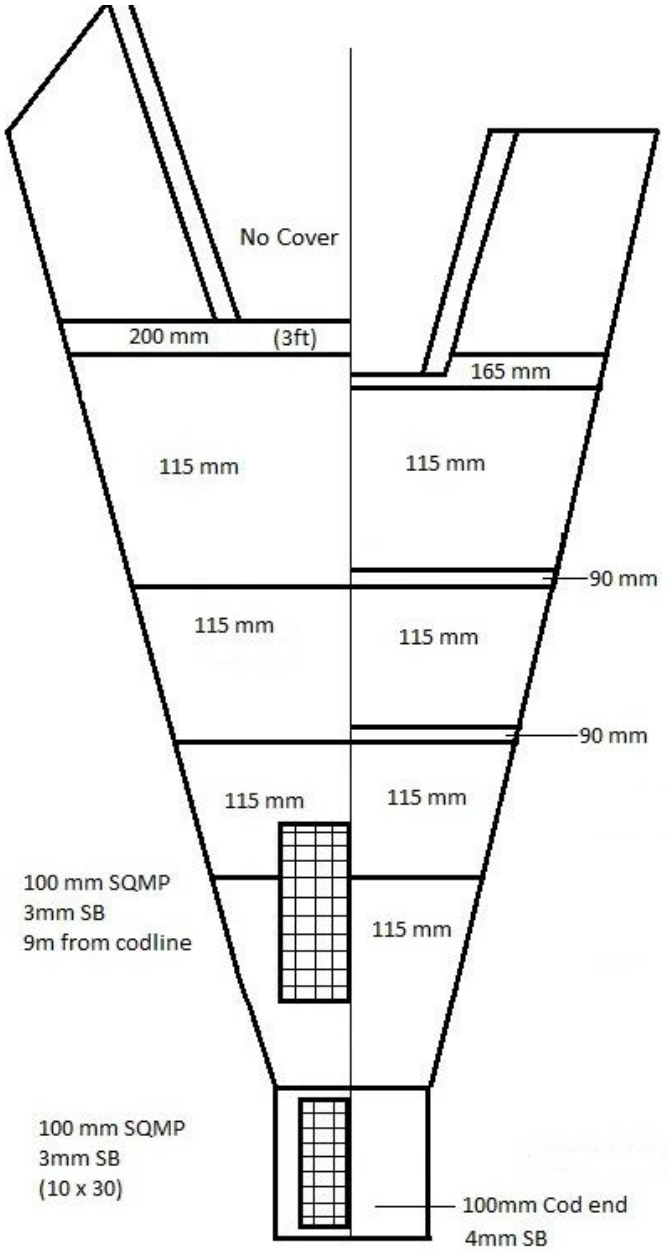


Figure 6a Illustrative trawl plans

Trial 1, Experiment 2

Trial 1 Experiment 2 - Haddock

Almost all abundant small fish avoided. Significant reductions of haddock below 45cm with modified trawl; higher reductions with decreasing size of fish. Analysis indicates increasing catches of larger fish with modified trawl.

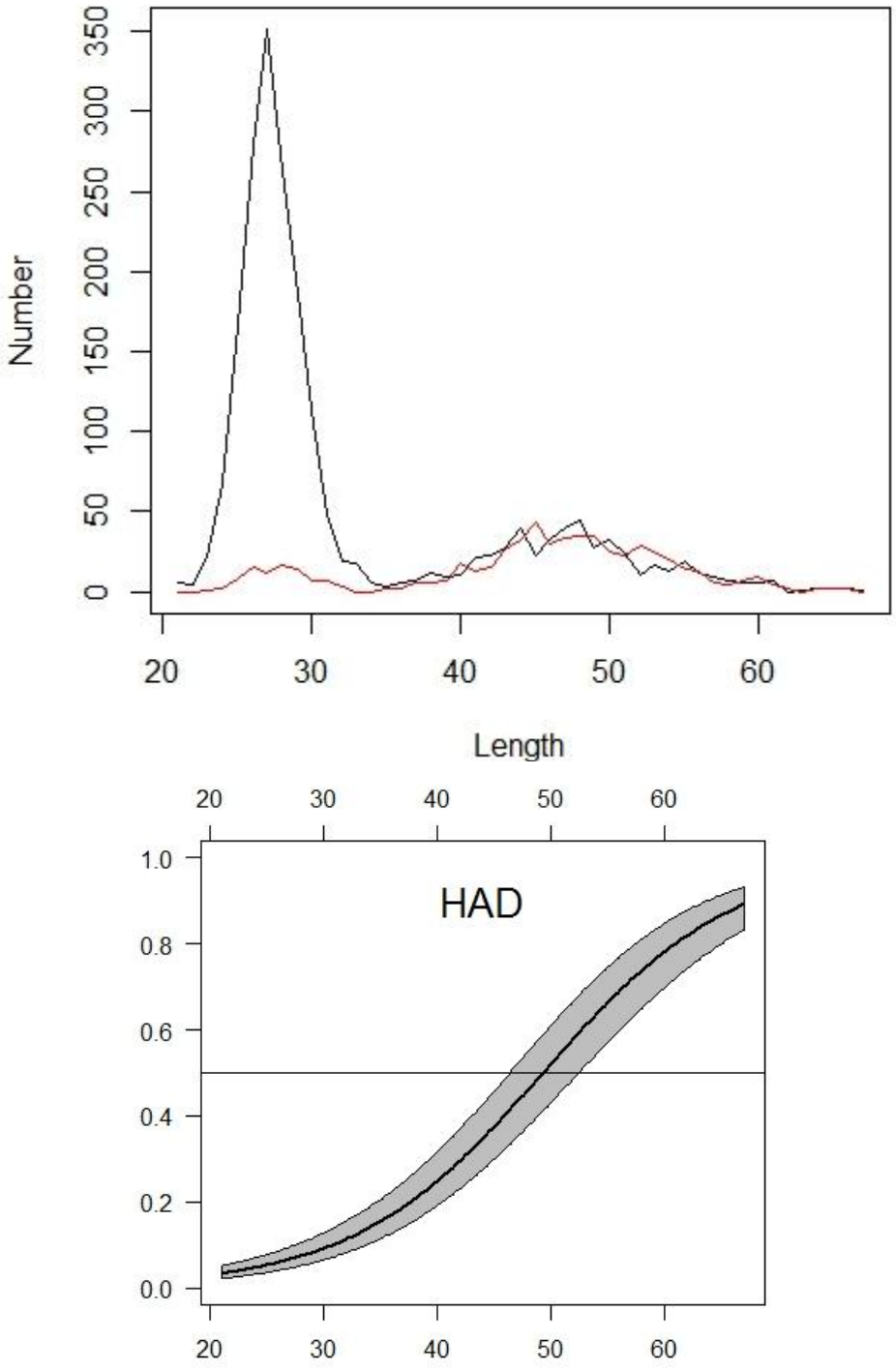


Figure 6 For Trial 1 Experiment 2 numbers of haddock caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Trial 1 Experiment 2 - Cod

No statistically significant difference.

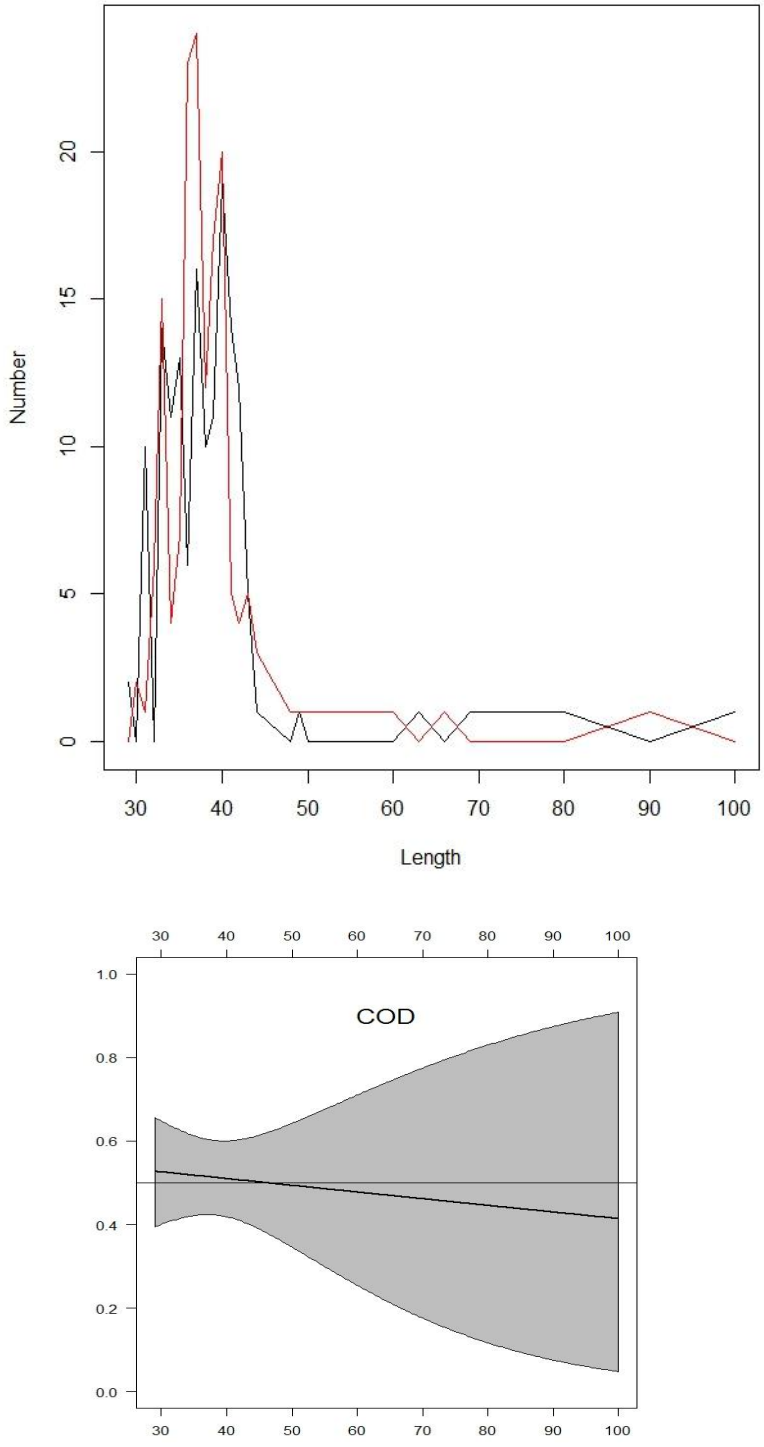


Figure 7 For Trial 1 Experiment 2, numbers cod caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Figure 8 Trial 1 Experiment 2 percentage difference in weight of landed catches (top 10 by weight) with the modified trawl (haddock landings influenced by quota availability)

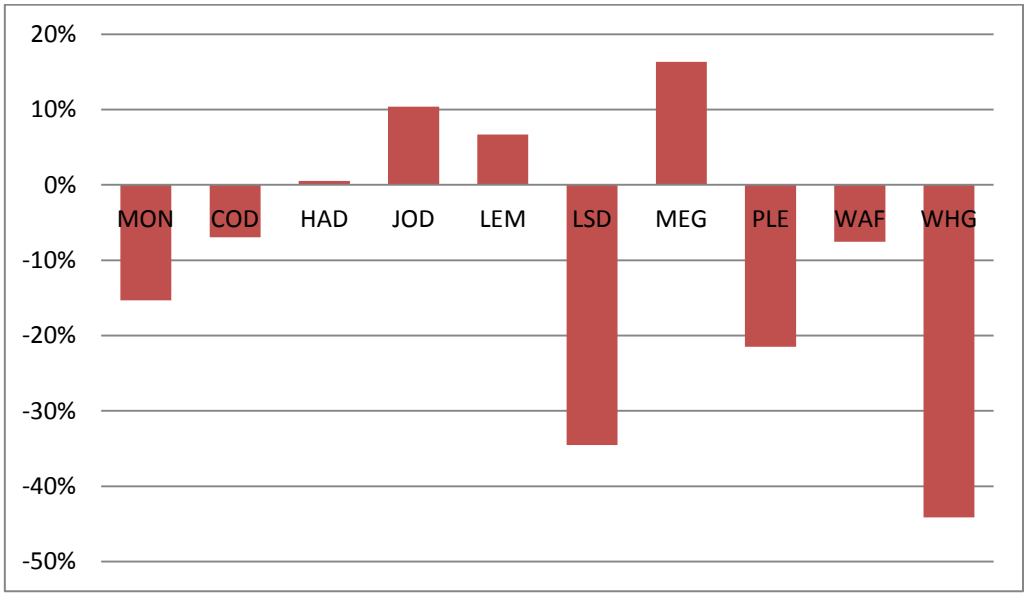


Table 3 Summary of Trial 1 Experiment 2

Trial/vessel	Trial 1 MFV Crystal Sea
Experiment	Experiment 2
Standard trawl	100mm SMP above codend; 100mm codend
Modified trawl	no cover (cut back headline); 100mm SMP in codend; 100mm SMP @ 9-12m from codline; 100mm codend
Hauls	7 (twin-rig)
Days fishing	3
Period	02/08/2014-4/8/2014
Results relative to the standard trawl - Haddock	Almost all abundant small fish avoided. Significant reduction of haddock below 45cm with modified trawl; higher reductions with decreasing size of fish. Analysis indicates increasing catches of larger fish with modified trawl.
% change in haddock number (number in standard trawl)	72% reduction (2033)
Results relative to the standard trawl - Cod	No statistically significant change.
% change in cod number (number in standard trawl)	6% increase (149)
Effect on other marketable fish	Loss of marketable fish (whiting, monkfish, plaice) and some gains (megrim, John Dory, lemon sole).

Trial 2 – 200mm diamond mesh in wings, square and back sections

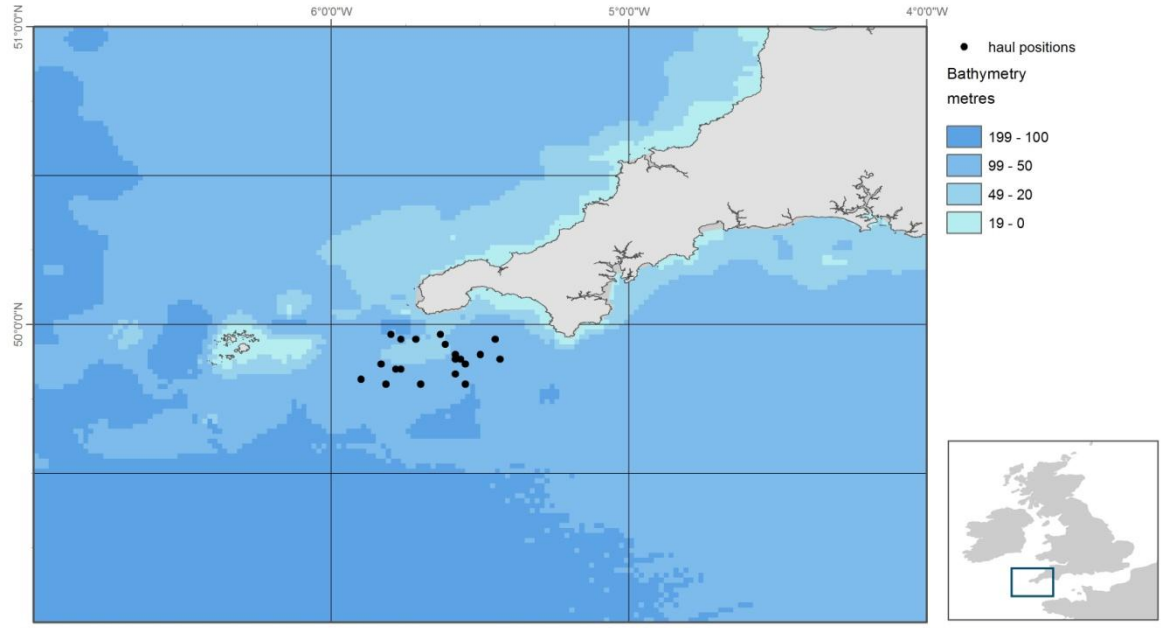
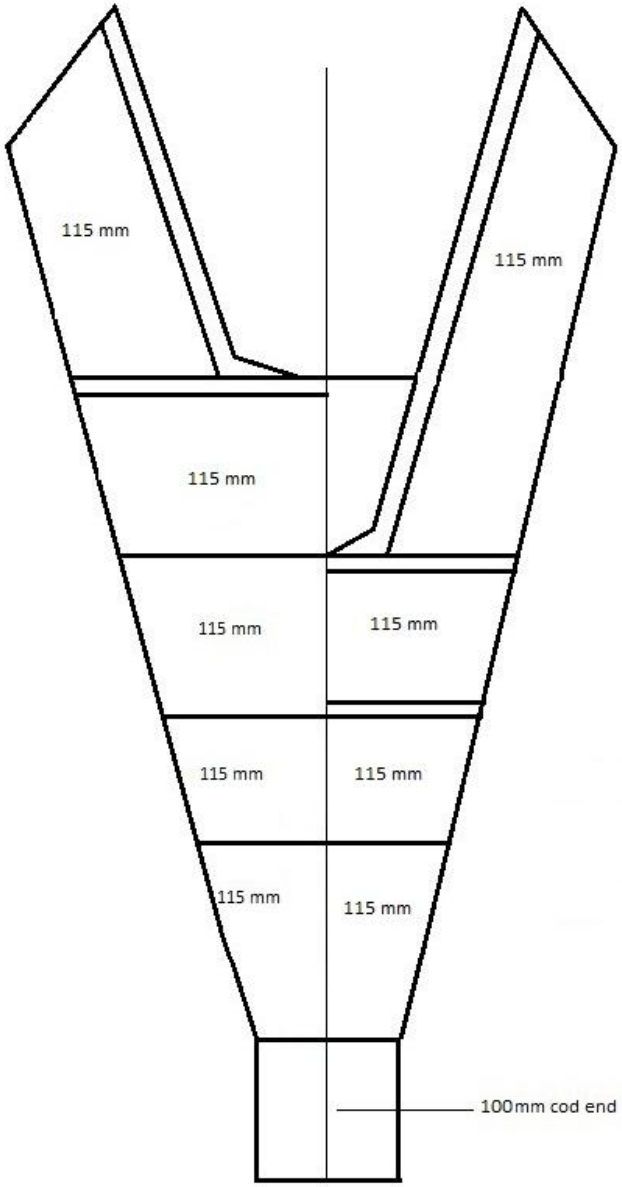


Figure 9 Position of hauls in Trial 2

Figure 10 MFV Valhalla (home port Mevagissey)

Standard trawl



Experimental Trawl

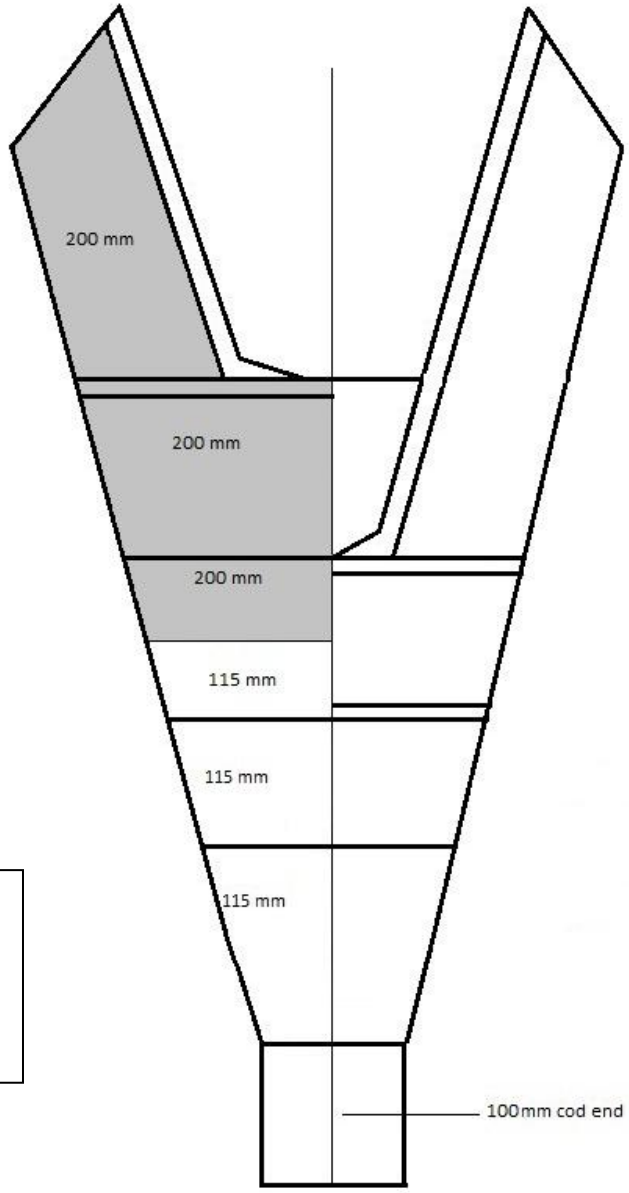


Figure 11a Illustrative trawl plans

Trial 2, Experiment 1

Trial 2 Experiment 1 Haddock

Reductions of haddock across the length range but not significant in analysis below 50cm. Substantial numbers of small fish haddock still caught.

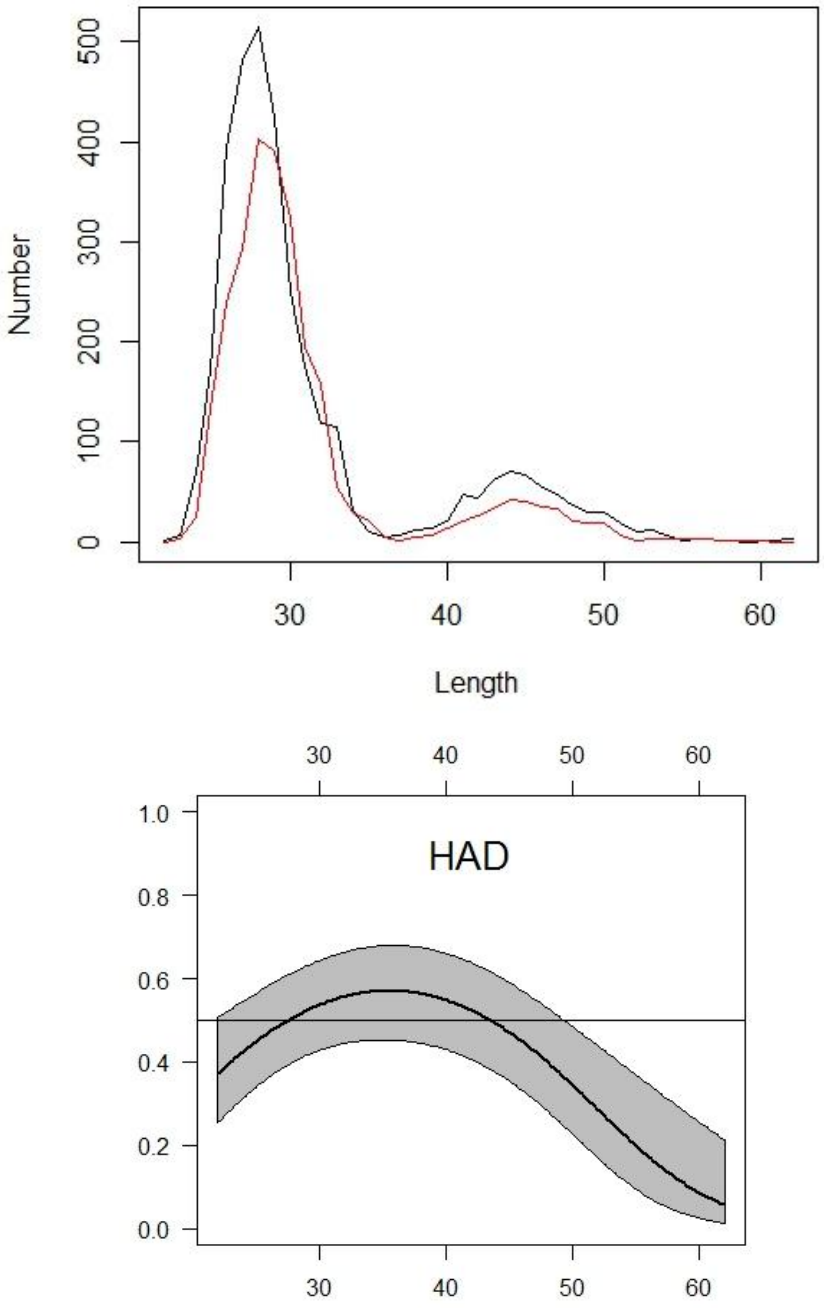


Figure 11 For Trial 2 Experiment 1 numbers of haddock caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Trial 2 Experiment 1 Cod

No statistically significant change

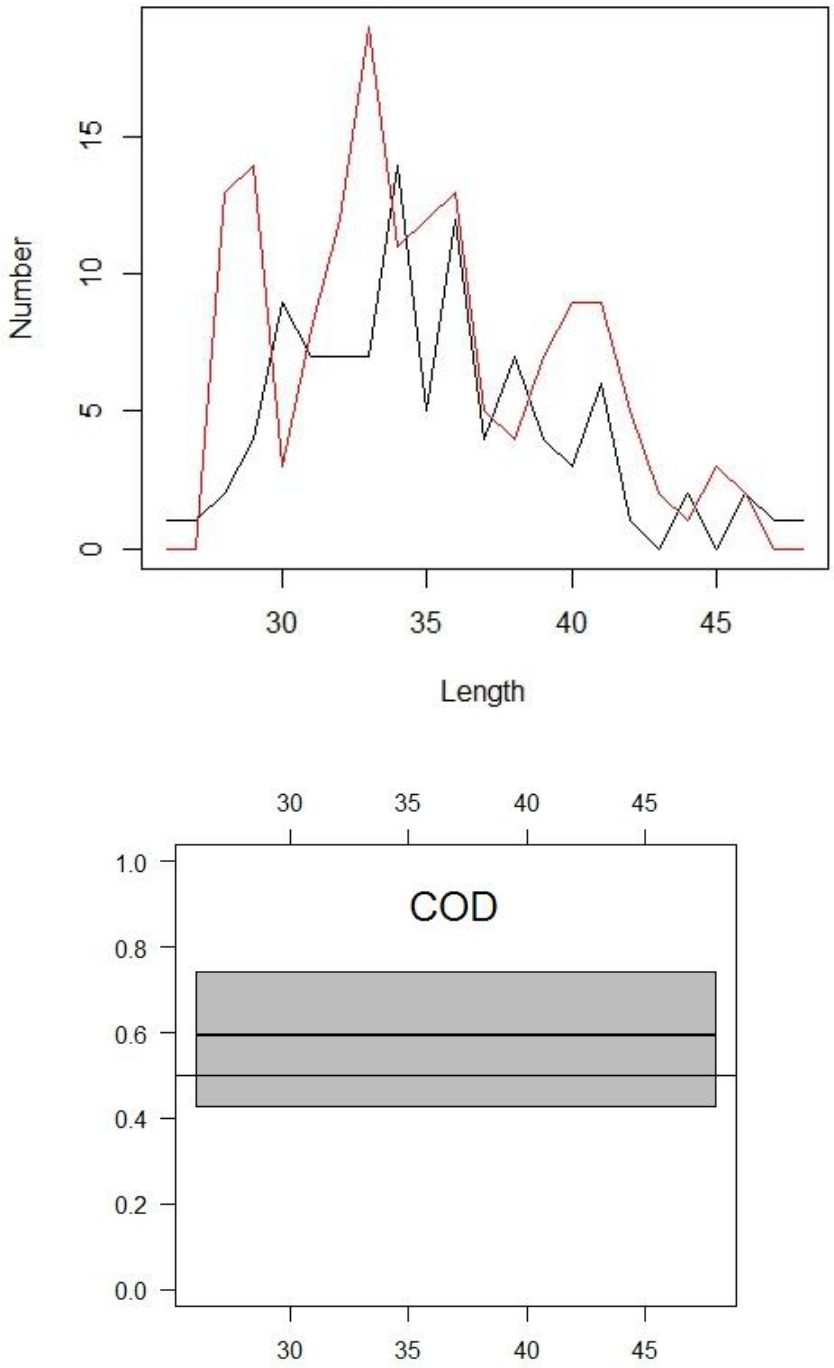


Figure 12 For Trial 2 Experiment 1, numbers cod caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Figure 13 Trial 2 Experiment 1 percentage difference in weight of landed catches (top 10 by weight) with the modified trawl (haddock landings influenced by quota availability)

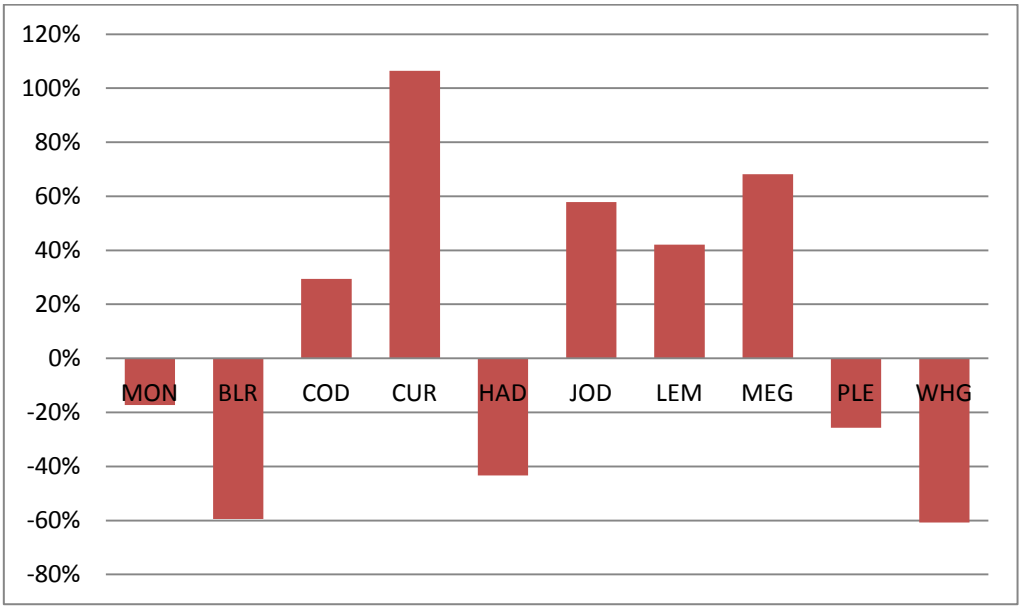


Table 4 Summary of Trial 1 Experiment 2

Trial/vessel	**Trial 2 MFV Valhalla**
Experiment	Experiment 1
Standard trawl	115mm throughout, 100mm codend
Modified trawl	High lift trawl, 200mm wings, square and lower back; 115mm elswhere, 100mm codend
Hauls	18 (single-rig); 9 tows with each
Days fishing	7
Period	19/8/2014-24/9/2014
Results relative to the standard trawl - Haddock	Reductions of haddock across the length range but not significant in analysis below 50cm. Substantial numbers of small fish haddock still caught.
% change in haddock number (number in standard trawl)	22% reduction (3342)
Results relative to the standard trawl - Cod	No statistically significant change
% change in cod number (number in standard trawl)	52% increase (100)
Effect on other marketable fish	Losses (whiting, plaice) and gains of other marketable fish (John Dory, lemon sole megrim).

Trial 3 – 155mm square mesh panels

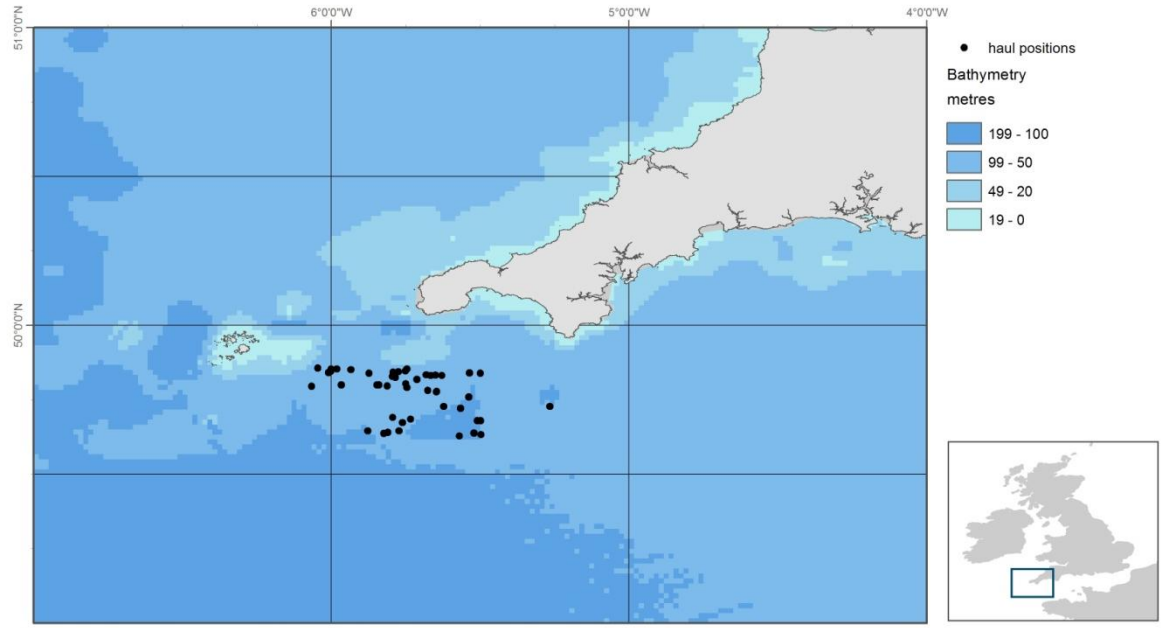
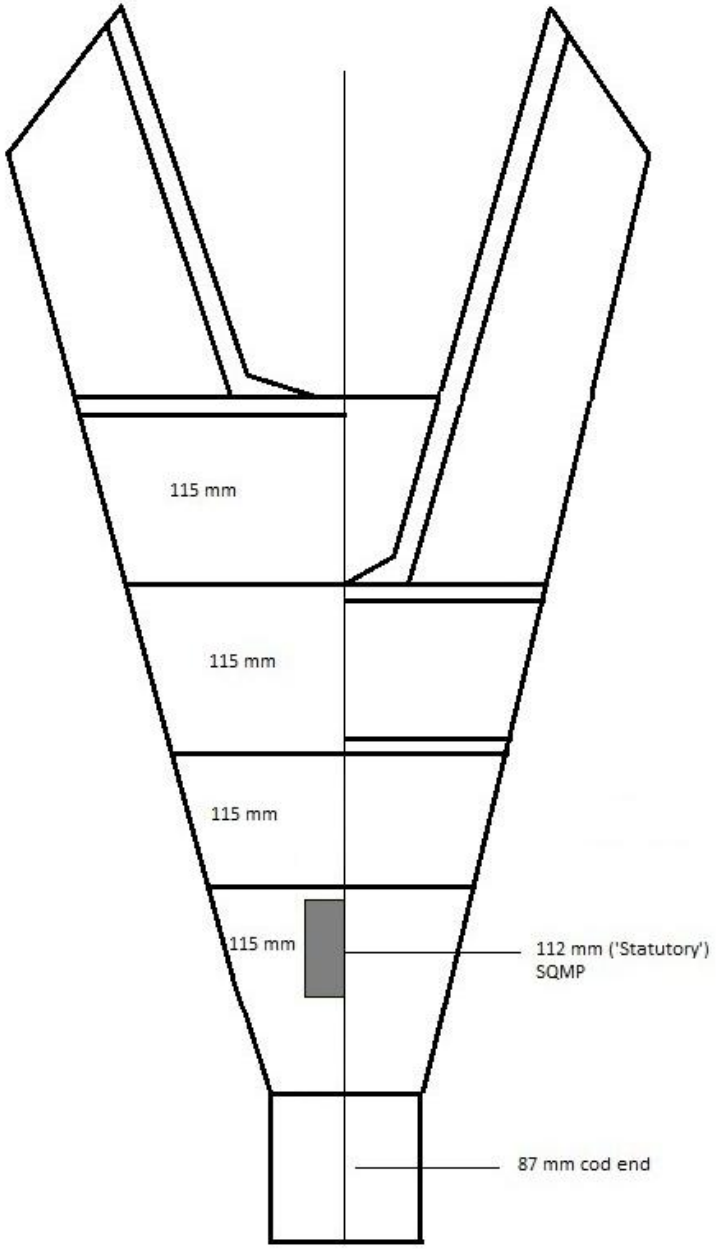


Figure 14 Position of hauls in Trial 2

Figure 15 MFV Our Olivia Belle (home port Ilfracombe)

Standard trawl



Experimental Trawl

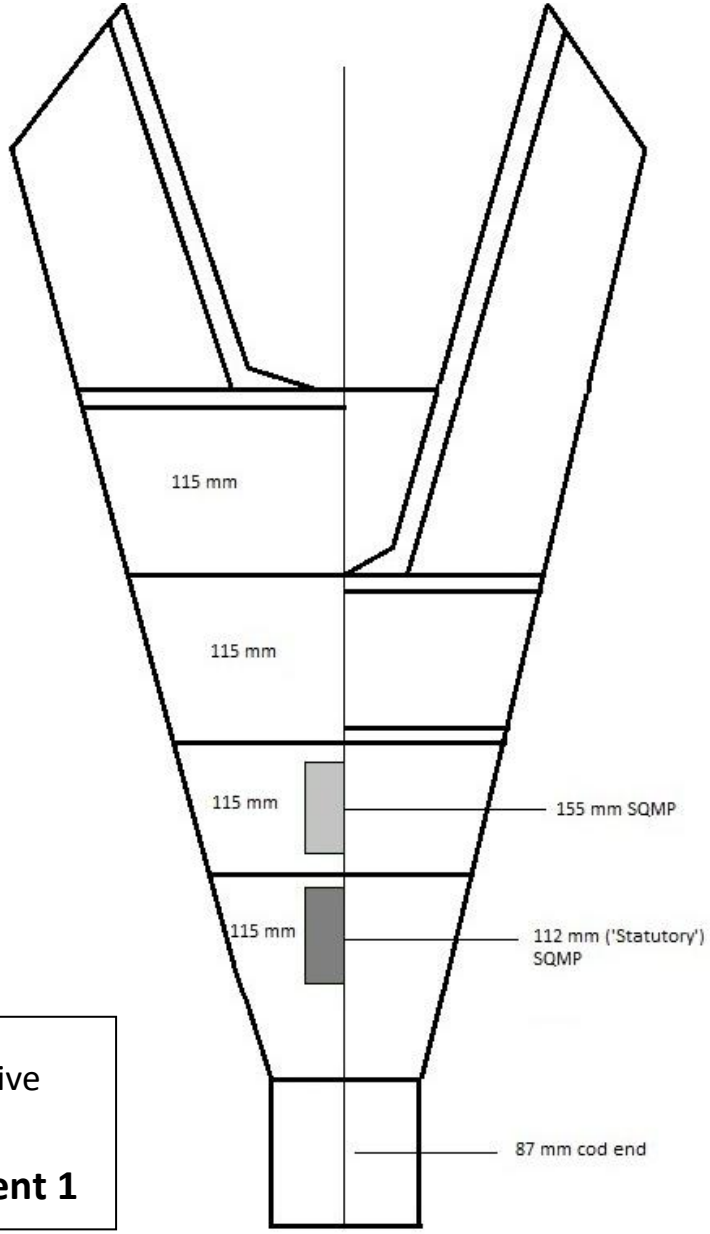


Figure 16a Illustrative trawl plans

Trial 3, Experiment 1

Trial 3 Experiment 1 Haddock

Analysis indicates only marginal reduction in haddock over 50cm in length. Substantial numbers of small haddock still caught.

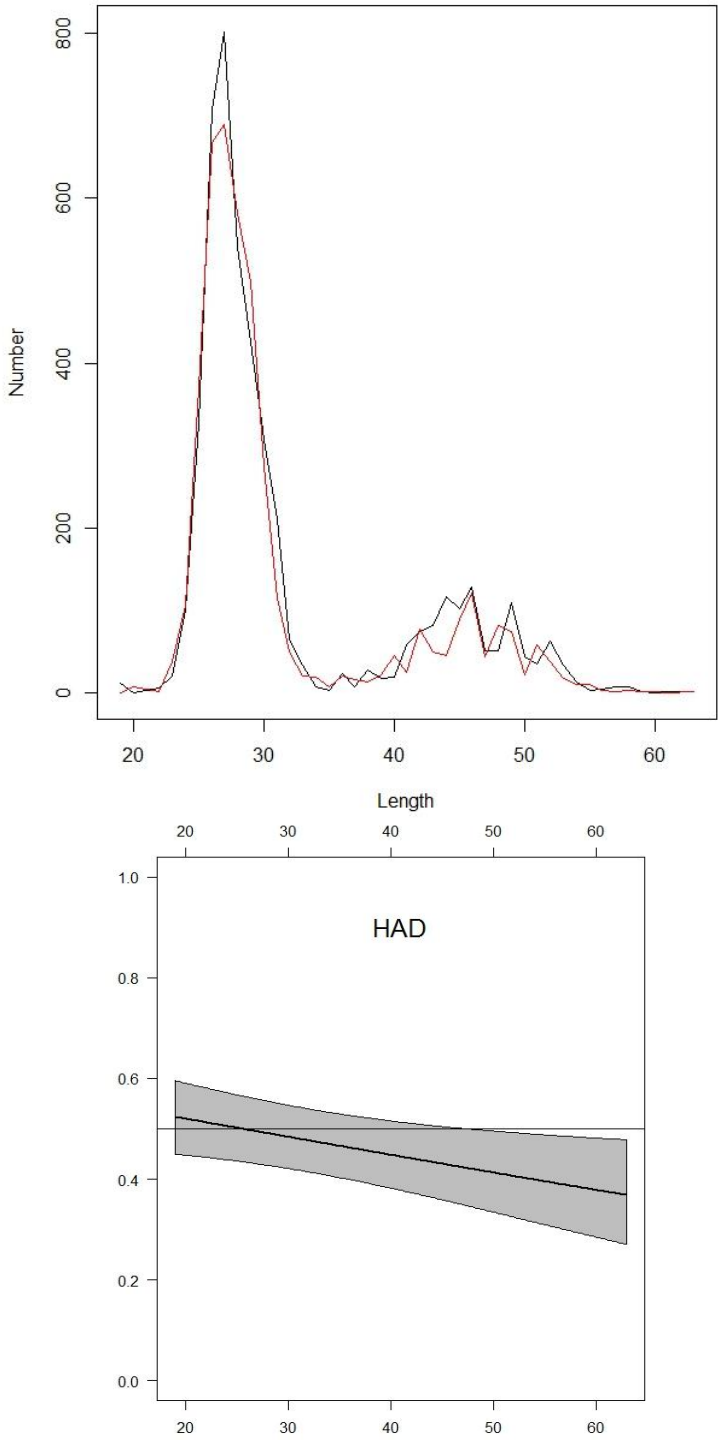


Figure 16 For Trial 3 Experiment 1 numbers of haddock caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Trial 3 Experiment 1 Cod

A statistically significant increase in cod with the modified trawl across the full length range.

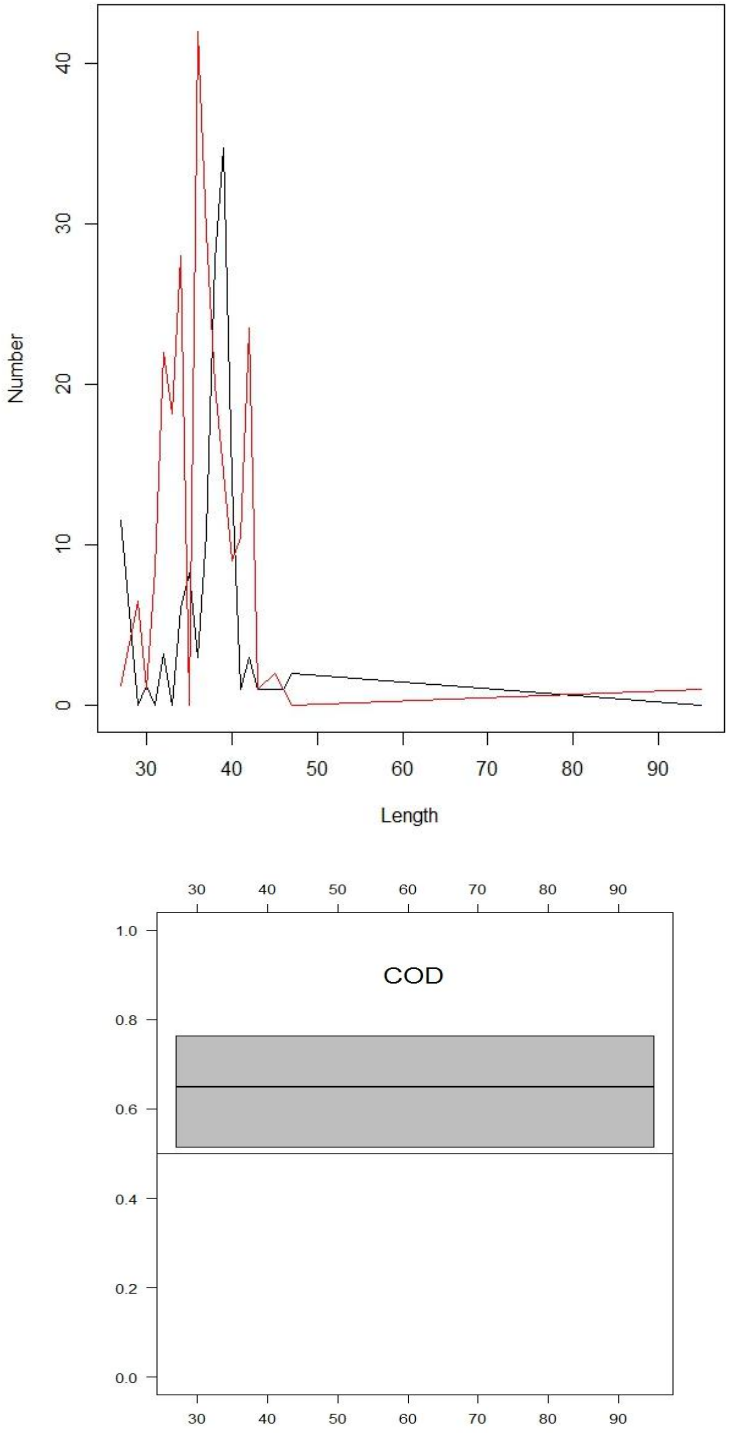


Figure 17 For Trial 3 Experiment 1, numbers cod caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Figure 18 Trial 3 Experiment 1 percentage difference in weight of landed catches (top 10 by weight) with the modified trawl (haddock landings influenced by quota availability)

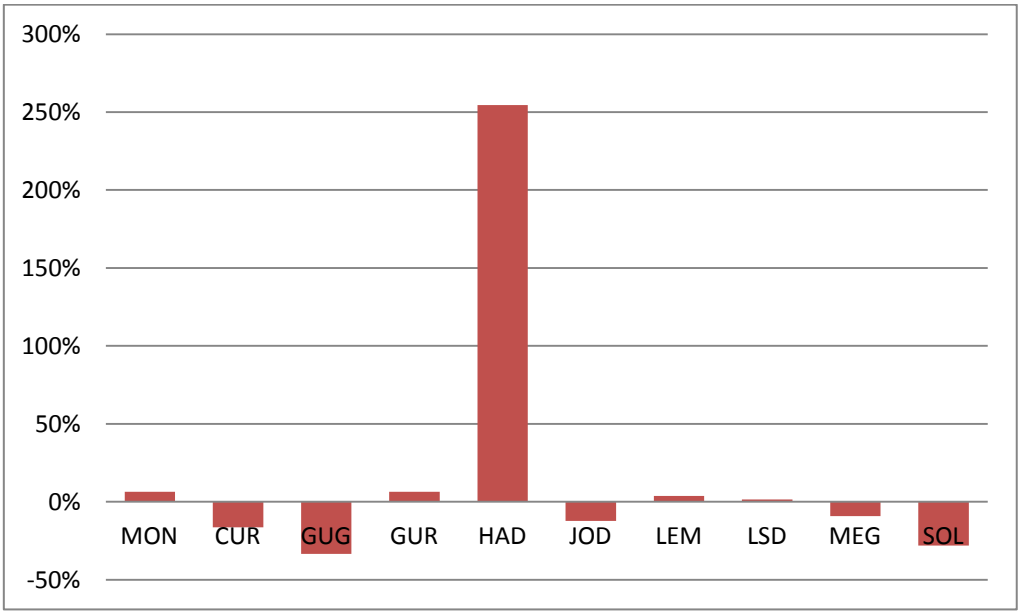
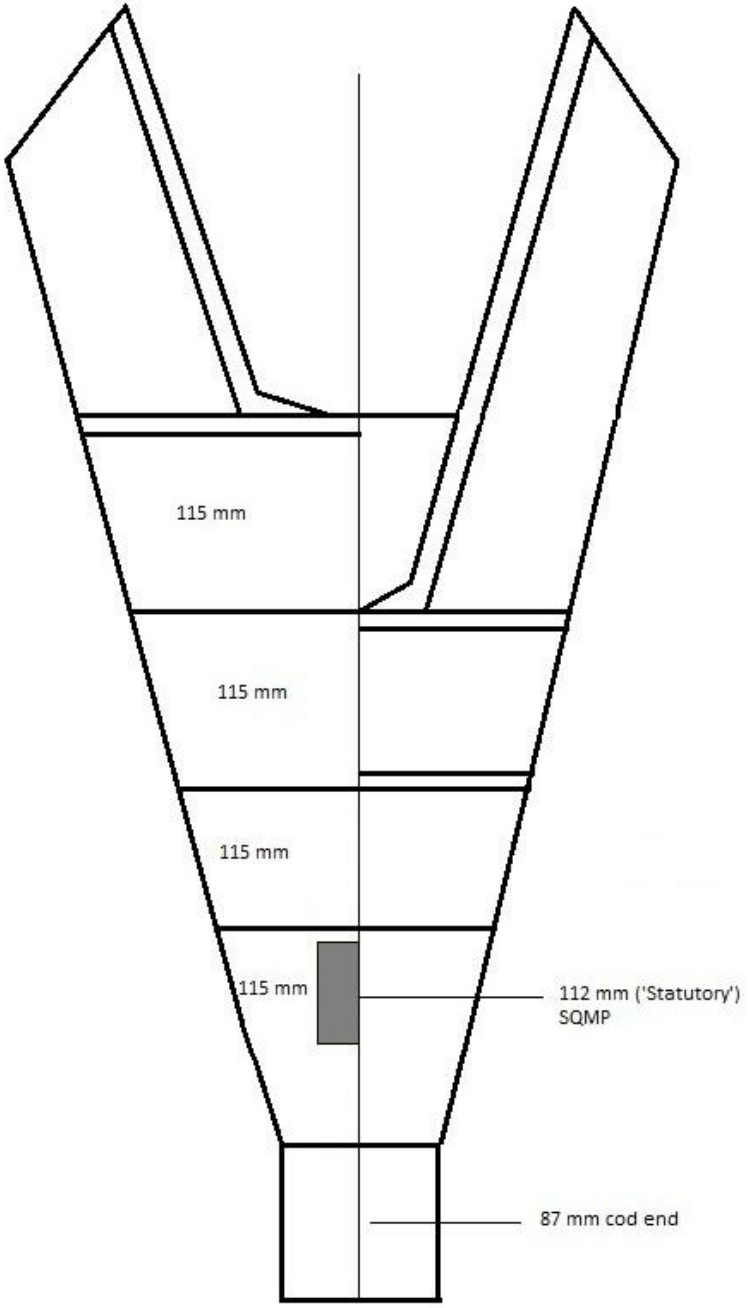


Table 5 Summary of Trial 3 Experiment 1

Trial/vessel	Trial 3 MFV Our Olivia Belle
Experiment	Experiment 1
Standard trawl	115mm SMP @ 6-9m from codline; 87mm codend; 115mm elsewhere
Modified trawl	115mm SMP @ 6-9m from codline; 155mm SMP @ 9.5-12.5m from codline; 87mm codend
Hauls	11 (twin-rig)
Days fishing	4
Period	15/8/2014-18/8/2014
Results relative to the standard trawl - Haddock	No reduction in overall haddock catches, analysis indicates marginal reduction in fish over 50cm. Substantial numbers of small haddock still caught.
% change in haddock number (number in standard trawl)	7% reduction (4651)
Results relative to the standard trawl - Cod	A statistically significant increase in cod across the full length range.
% change in cod number (number in standard trawl)	85% increase (130)
Effect on other marketable fish	Losses (sole) and gains of other marketable fish (monkfish).

Standard trawl



Experimental Trawl

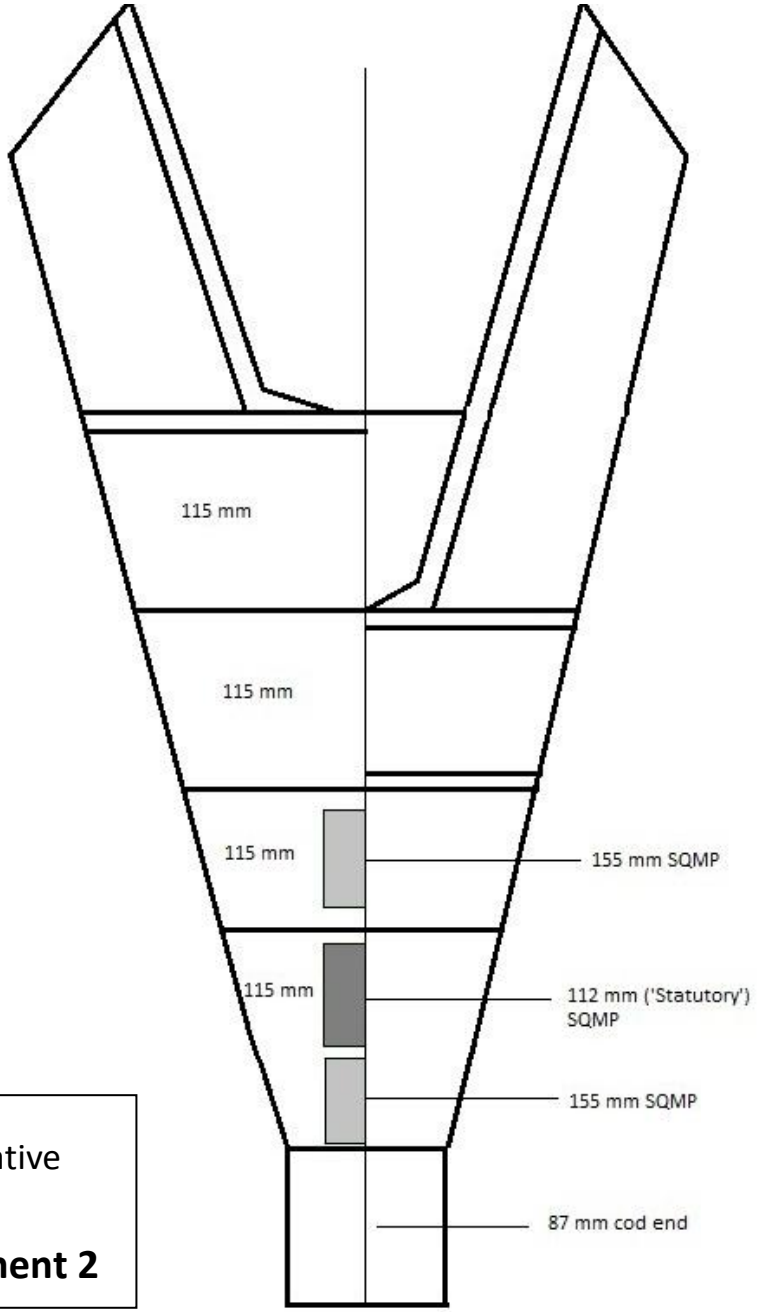


Figure 19a Illustrative trawl plans

Trial 3, Experiment 2

Trial 3 Experiment 2 Haddock

Substantial numbers of small haddock still caught. Significant reduction in catches of haddock above 25cm. Increasing reductions in catches with increasing size. Large reduction in catches of larger haddock.

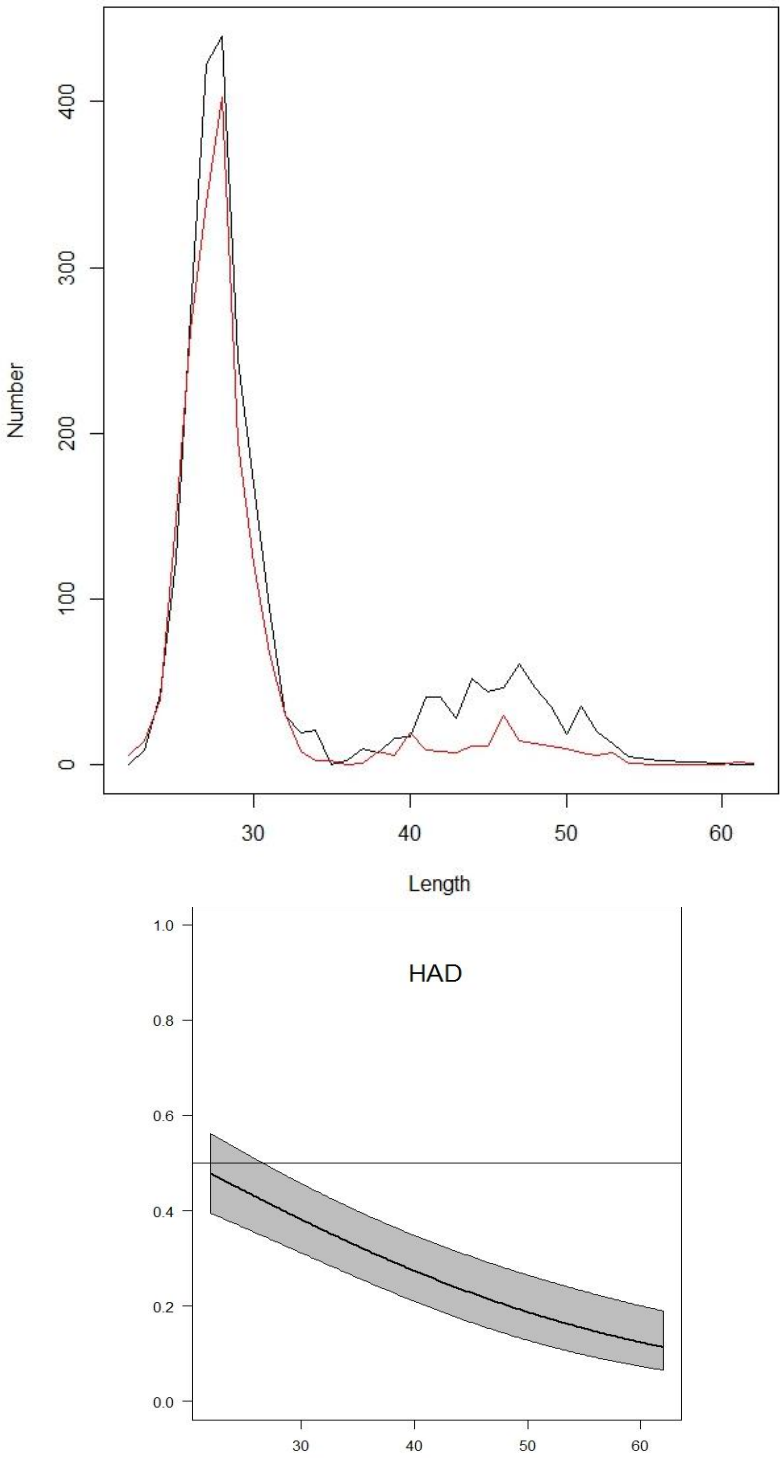


Figure 19 For Trial 3 Experiment 2 numbers of haddock caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Trial 3 Experiment 2 Cod

A significant and substantial reduction in cod catches across the full length range.

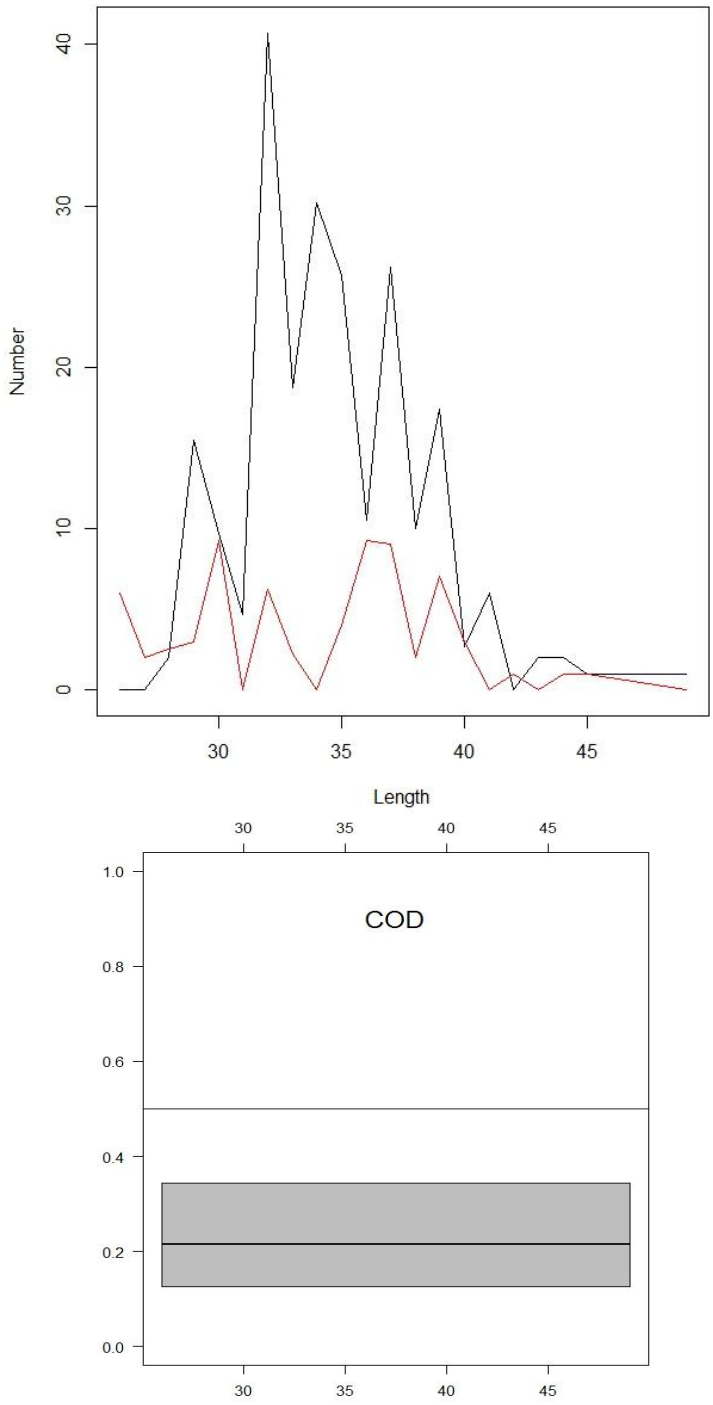


Figure 20 For Trial 3 Experiment 2, numbers cod caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Figure 21 Trial 3 Experiment 2 percentage difference in weight of landed catches (top 10 by weight) with the modified trawl (haddock landings influenced by quota availability)

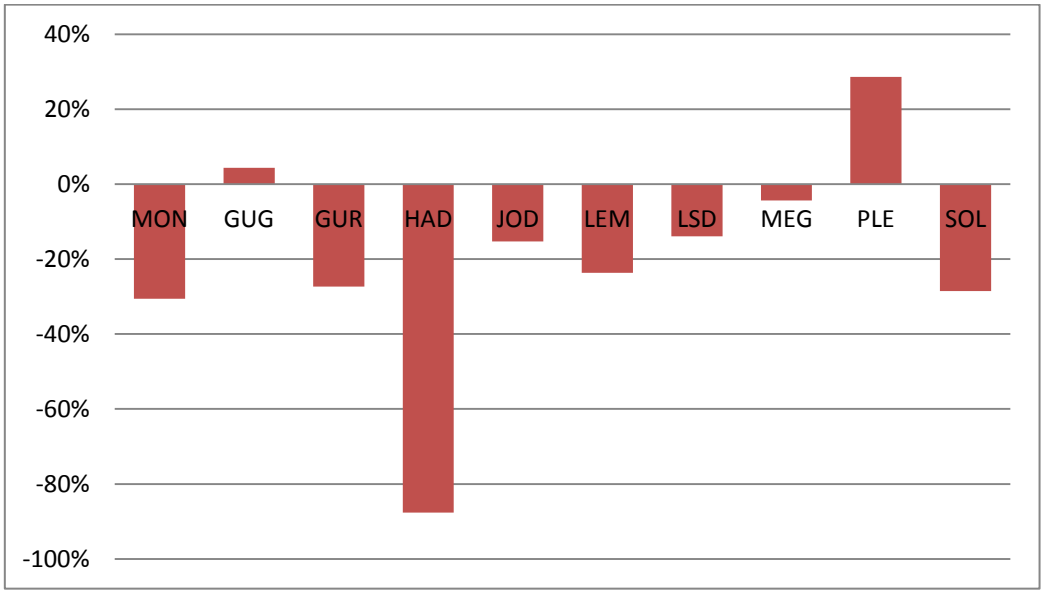
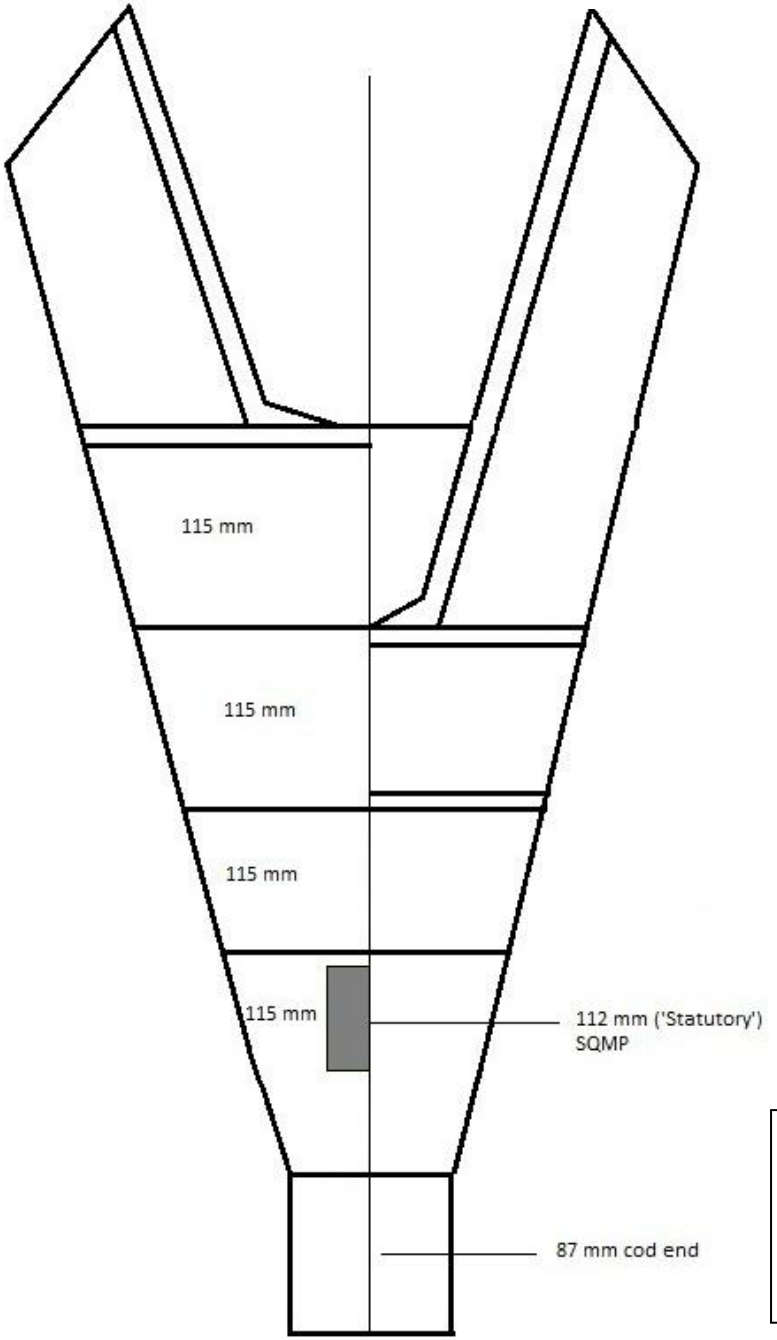


Table 6 Summary of Trial 3 Experiment 2

Trial	Trial 3 MFV Our Olivia Belle
Experiment	Experiment 2
Standard trawl	115mm SMP @ 6-9m from codline; 87mm codend; 115mm elsewhere
Modified trawl	115mm SMP @ 6-9m; 155mm SMP @ 9.5-12.5m; 155mm SMP @ 2.5-5.5m from codline; 87mm codend
Hauls	12 (twin-rig)
Days fishing	5
Period	18/8/2014-22/8/2014
Results relative to the standard trawl - Haddock	Substantial numbers of small haddock still caught. Significant reduction in catches of haddock above 25cm. Increasing reductions in catches with increasing size. Large reduction in catches of larger haddock.
% change in haddock number (number in standard trawl)	25% reduction (2428)
Results relative to the standard trawl - Cod	A significant and substantial reduction in cod catches across the full length range.
% change in cod number (number in standard trawl)	70% reduction (226)
Effect on other marketable fish	Loss of other marketable fish (sole, lemon sole, John Dory, monkfish) and some gains (plaice).

Standard trawl



Experimental Trawl

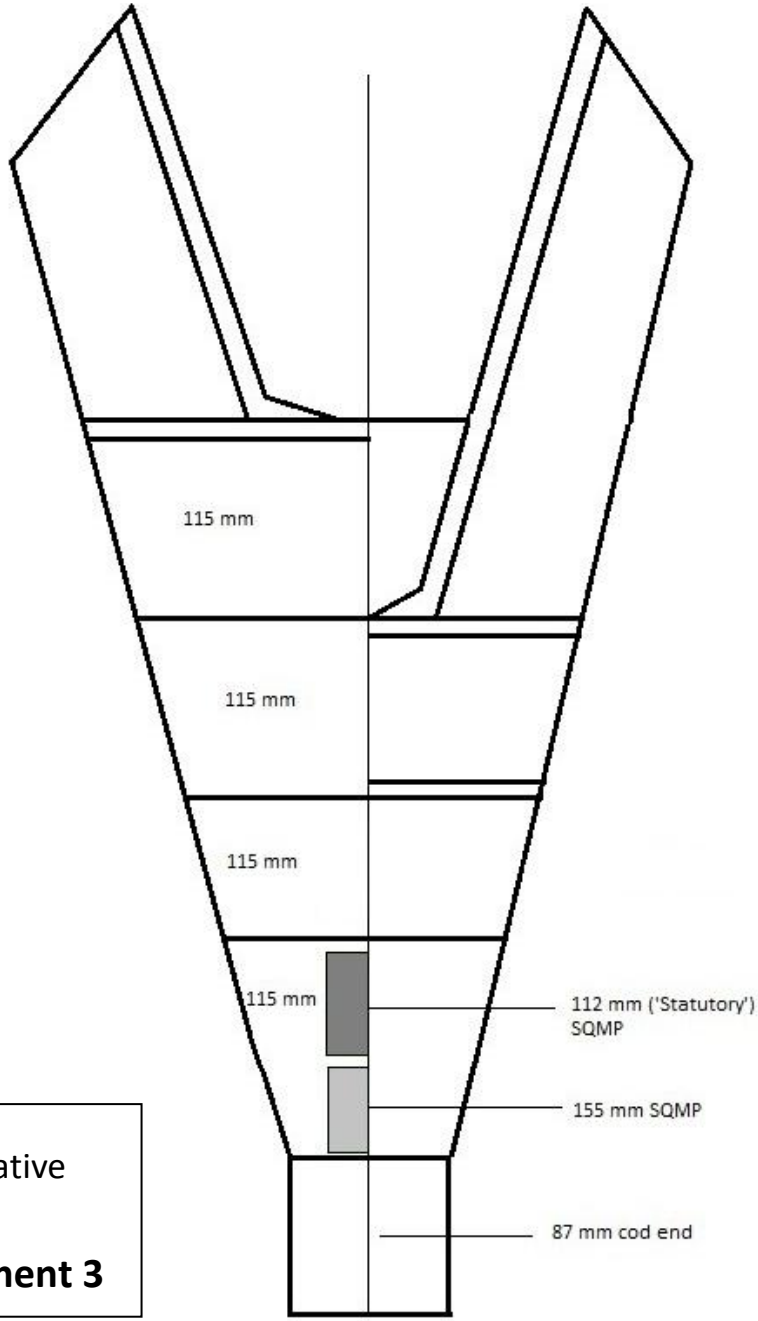


Figure 22a Illustrative trawl plans

Trial 3, Experiment 3

Trial 3 Experiment 3 Haddock

Substantial numbers of small haddock still caught. Significant reduction in catches of haddock above 27cm. Increasing reductions in catches with increasing size. Substantial reduction in catches of larger haddock.

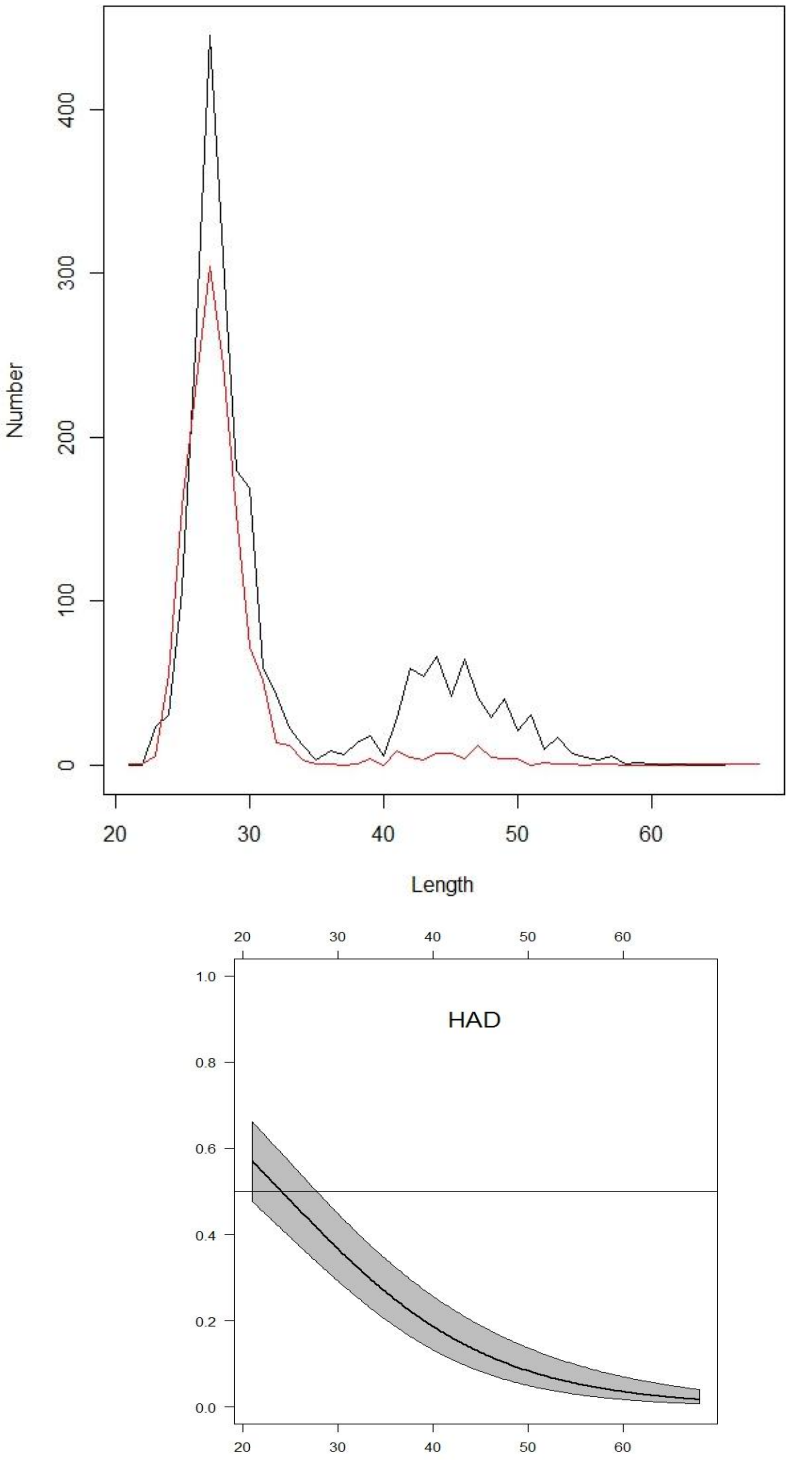


Figure 22 For Trial 3 Experiment 3 numbers of haddock caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Trial 3 Experiment 3 Cod

A significant and substantial reduction in cod catches across the full length range.

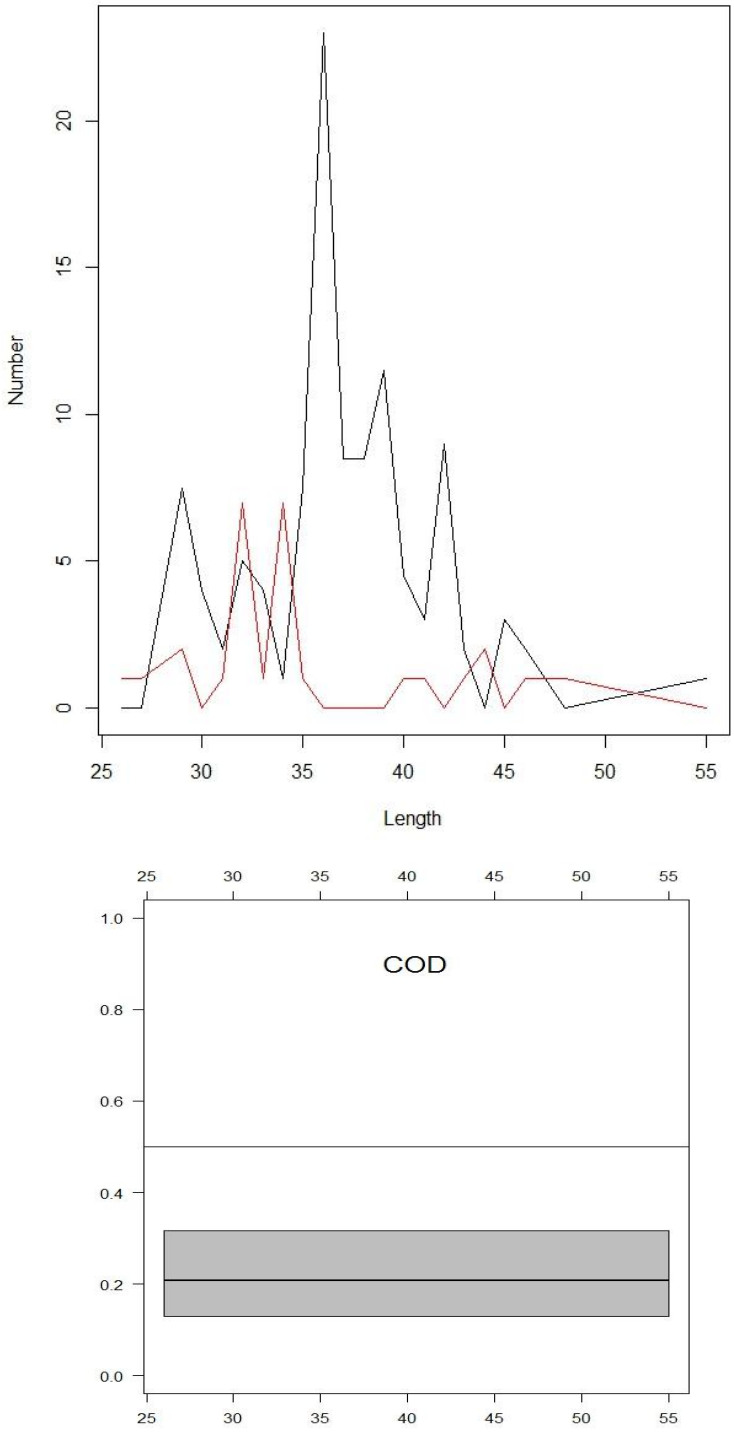


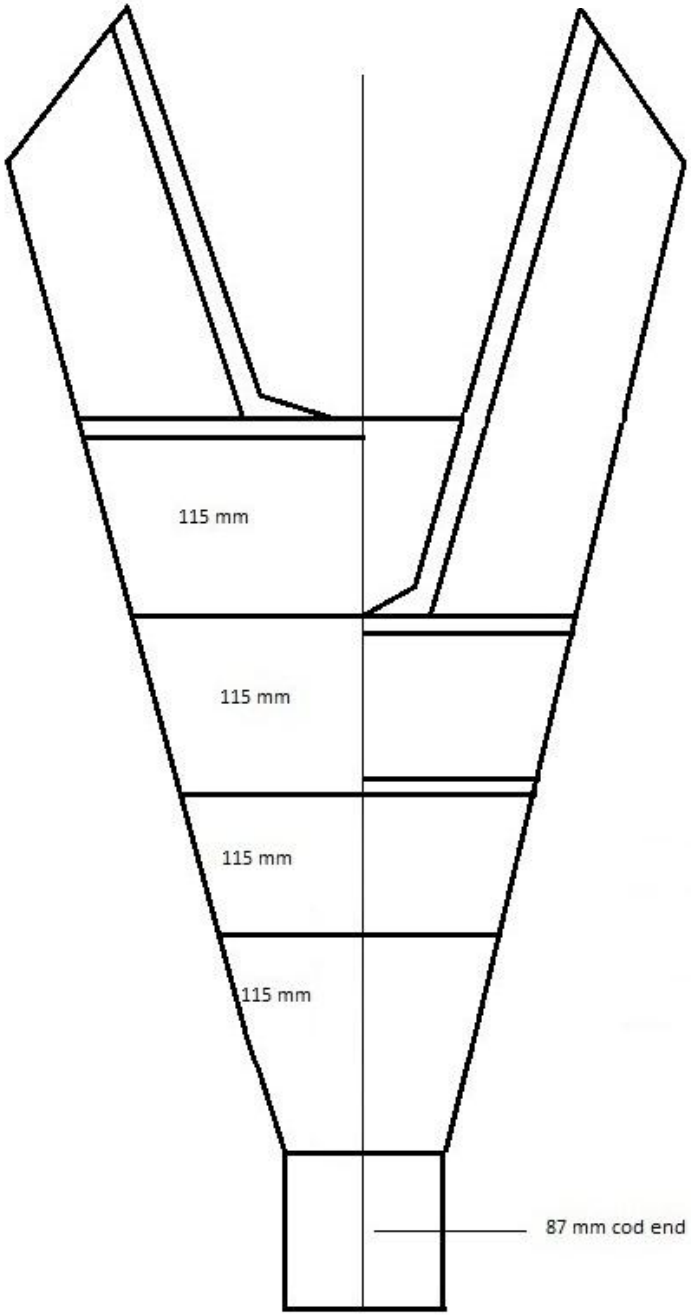
Figure 23 For Trial 3 Experiment 3, numbers cod caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Figure 24 Trial 3 Experiment 3 percentage difference in weight of landed catches (top 10 by weight) with the modified trawl (haddock landings influenced by quota availability)

Table 7 Summary of Trial 3 Experiment 3

Trial	Trial 3 MFV Our Olivia Belle
Experiment	Experiment 3
Standard trawl	115mm SMP @ 6-9m from codline; 87mm codend; 115mm elsewhere
Modified trawl	115mm SMP @ 6-9m; 155mm SMP @ 2.5-5.5m from codline; 87mm codend
Hauls	12 (twin-rig)
Days fishing	4
Period	22/8/2014-1/9/2014
Results relative to the standard trawl - Haddock	Substantial numbers of small haddock still caught. Significant reduction in catches of haddock above 27cm. Increasing reductions in catches with increasing size. Large reductions in catches of larger haddock.
% change in haddock number (number in standard trawl)	38% reduction (2241)
Results relative to the standard trawl - Cod	A significant and substantial reduction in cod catches across the full length range.
% change in cod number (number in standard trawl)	74% reduction (107)
Effect on other marketable fish	Substantial loss of other marketable fish (sole, lemon sole, gurnards, plaice).

Standard trawl



Experimental Trawl

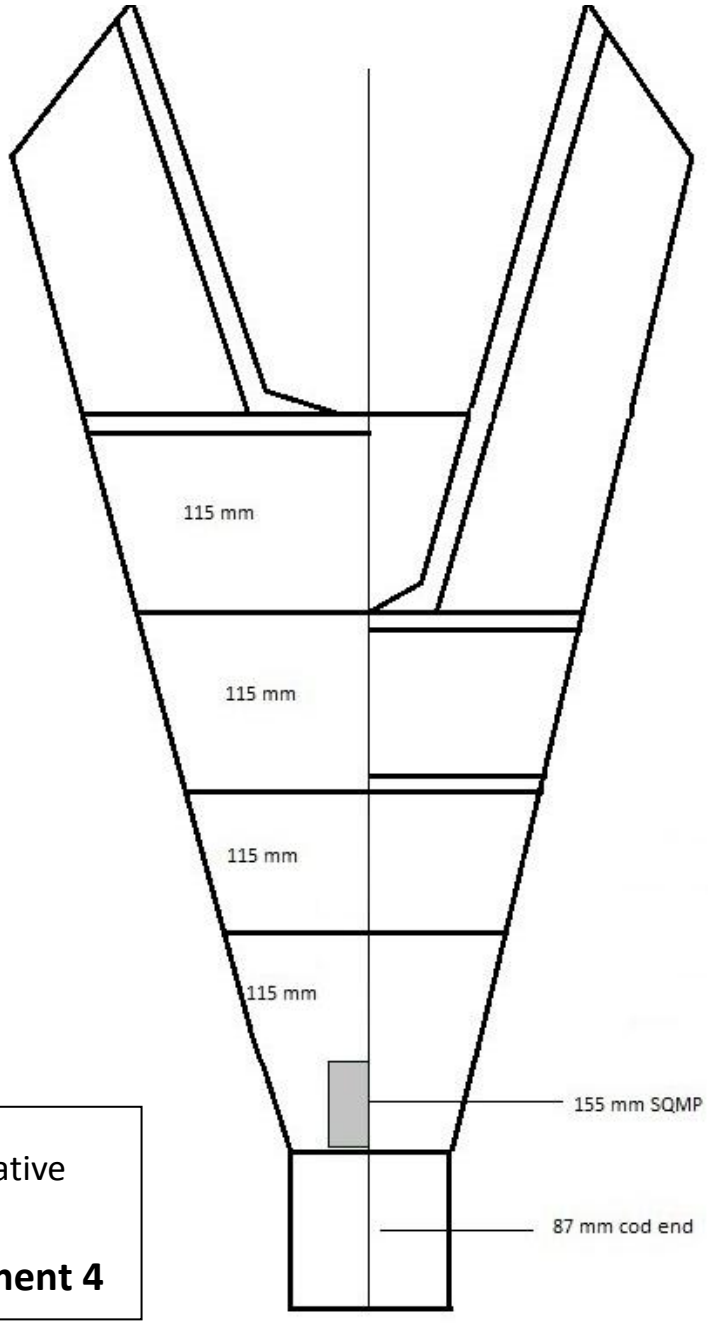


Figure 25a Illustrative trawl plans

Trial 3, Experiment 4

Trial 3 Modified Trawl 4 Haddock

Significant and substantial reduction in catches of haddock at all sizes.

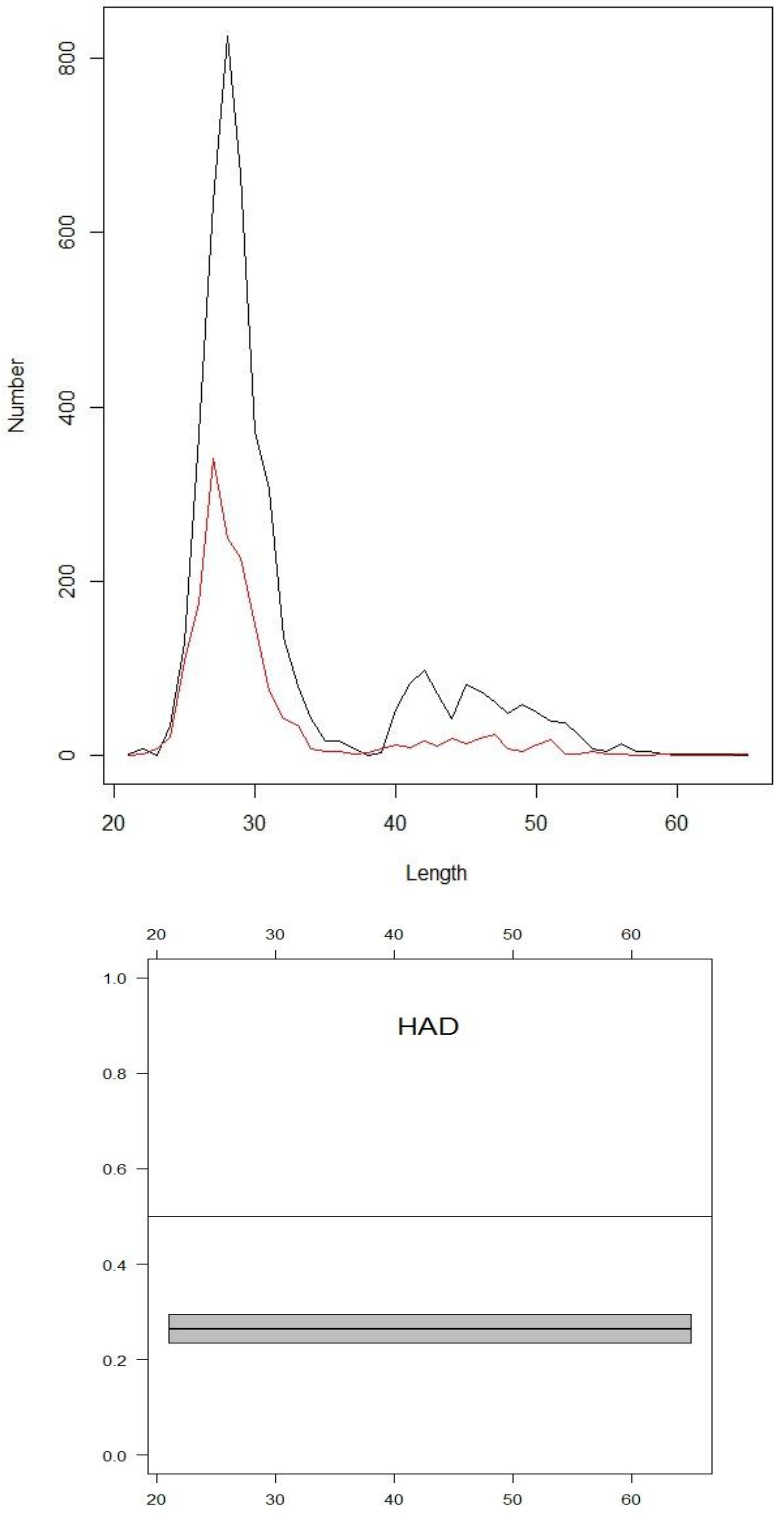


Figure 25 For Trial 3 Experiment 4 numbers of haddock caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Trial 3 Modified Trawl 4 Cod

Almost all cod avoided. A significant and substantial reduction in cod catches across the full length range.

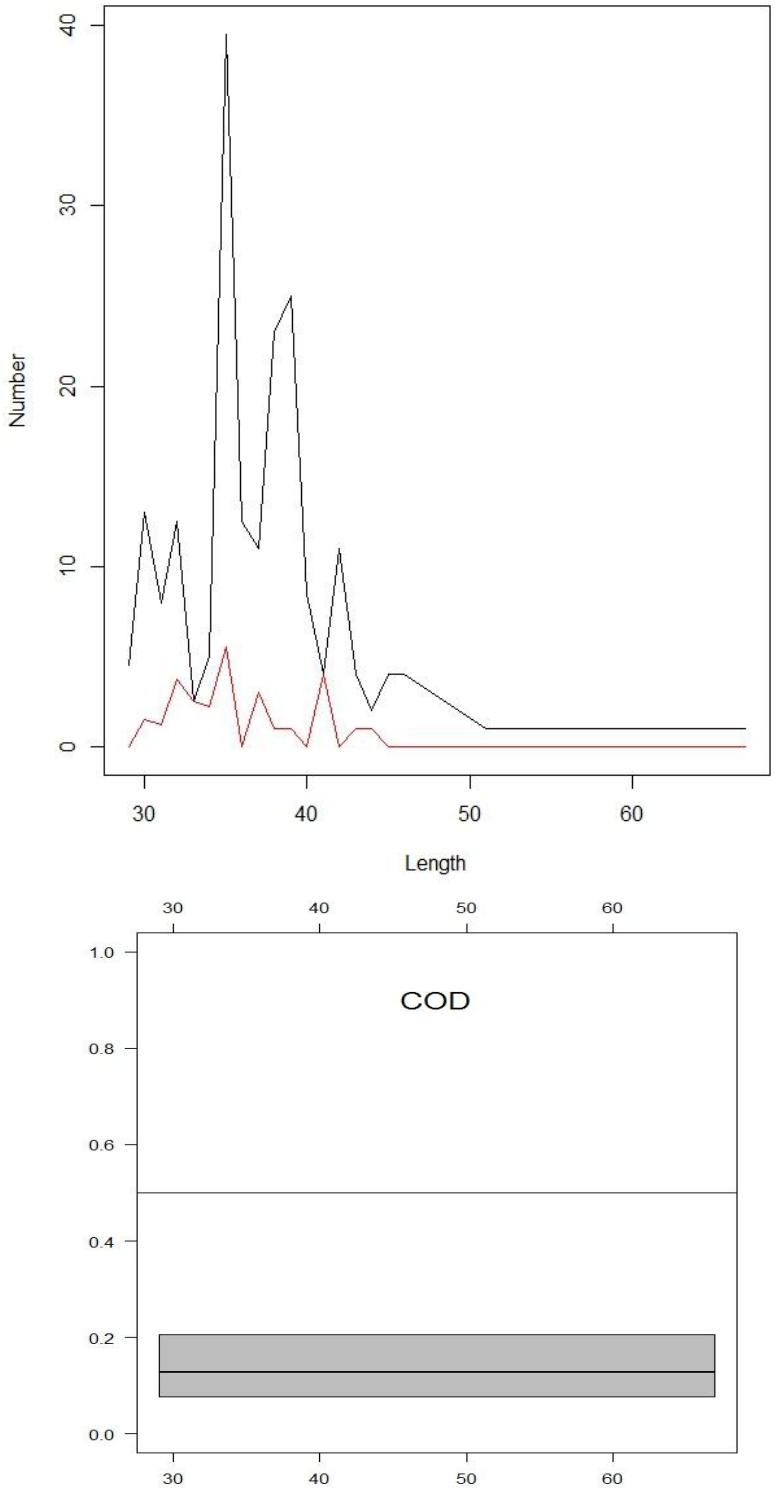


Figure 26 For Trial 3 Experiment 4, numbers cod caught at length in standard trawl (black) and modified trawl (red) and output from catch comparison analysis (below).

Figure 27 Trial 3 Experiment 4 percentage difference in weight of landed catches (top 10 by weight) with the modified trawl (haddock landings influenced by quota availability)

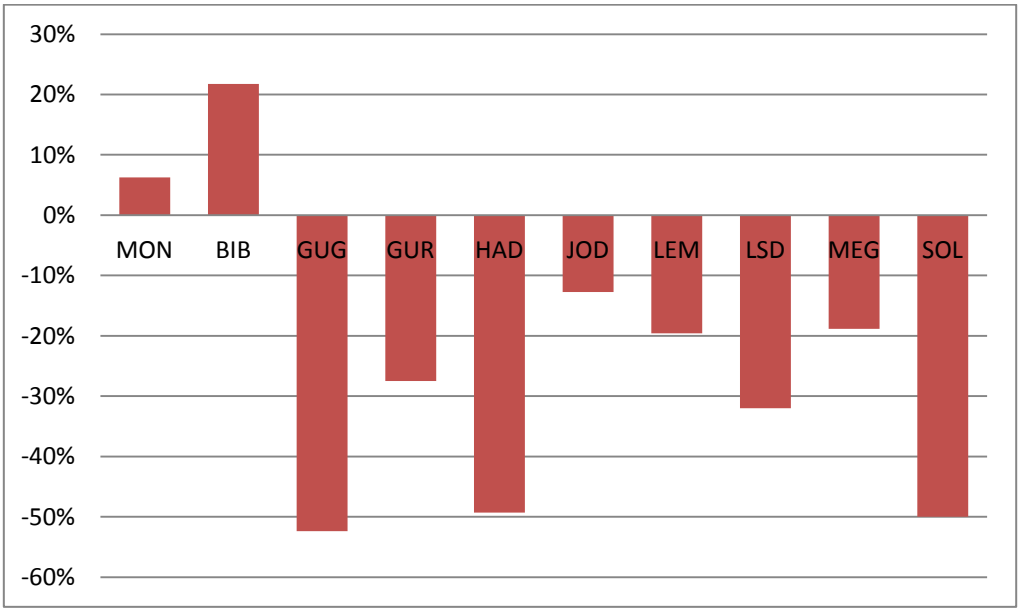


Table 8 Summary of Trial 3 Experiment 4

Trial	Trial 3 MFV Our Olivia Belle
Experiment	Experiment 4
Standard trawl	87mm codend
Modified trawl	155mm SMP @ 2.5-5.5m from codline; 87mm codend
Hauls	10 (twin-rig)
Days fishing	4
Period	1/9/2014-4/9/2014
Results relative to the standard trawl - Haddock	Significant and substantial reduction in catches of haddock at all sizes.
% change in haddock number (number in standard trawl)	64% reduction (4509)
Results relative to the standard trawl - Cod	Almost all cod avoided. A significant and substantial reduction in cod catches across the full length range.
% change in cod number (number in standard trawl)	86% reduction (197)
Effect on other marketable fish	Substantial loss of other marketable fish.

DAY VERSUS NIGHT CATCH ANALYSIS FOR HADDOCK

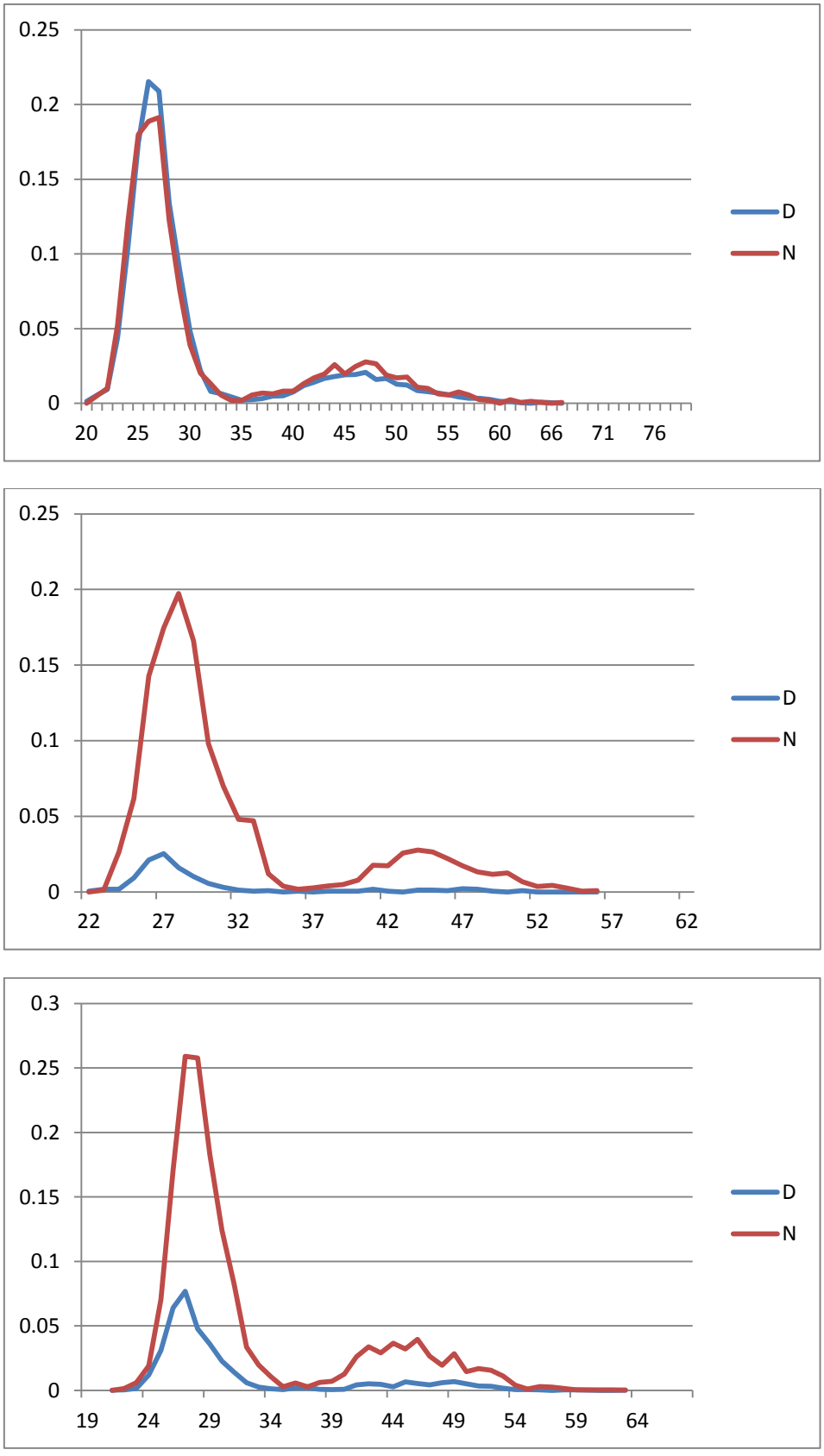


Figure 28 Numbers of haddock at length caught per hour from standard trawls only in day (blue = D) versus night (red = N) tows; top = Trial 1, middle = Trial 2, bottom = Trial 3.

The analysis of day versus night catches indicates that in Trial two and three there was a substantial difference between haddock catches during the day compared with the night, supporting the observations of fishing vessel operators. For Trial one, there was a 2% less haddock caught during the day compared with night.

The catch profile for night time catches was similar for all trials, with high numbers of small, juvenile haddock caught. In Trial 2 catches of haddock were less by 91% by number during the day compared with night. In Trial 3, haddock catches were 76% less during day time hauls.

When looking at the location of hauls, Trial 1 was conducted more southerly and in deeper water, Trial 2 had the most northerly hauls in the shallower water and Trial 3 hauls were conducted mostly in the northerly shallow water but some in the southern deeper water. Therefore, there is an indication from these trials that haddock diurnal vertical behaviour could be occurring more strongly in the northerly, shallow areas, which were fished in these studies, compared with the southerly deeper waters.

Further data, perhaps from observer programmes and other gears trials, is needed to explore this hypothesis. However, this observation does provide another potential tool for vessel operators to avoid catching haddock; by shifting effort to areas and times when haddock are not on available to demersal otter trawls. Some vessel operators are already communicating that they are expending a higher proportion of their fishing effort in the day to avoid haddock.

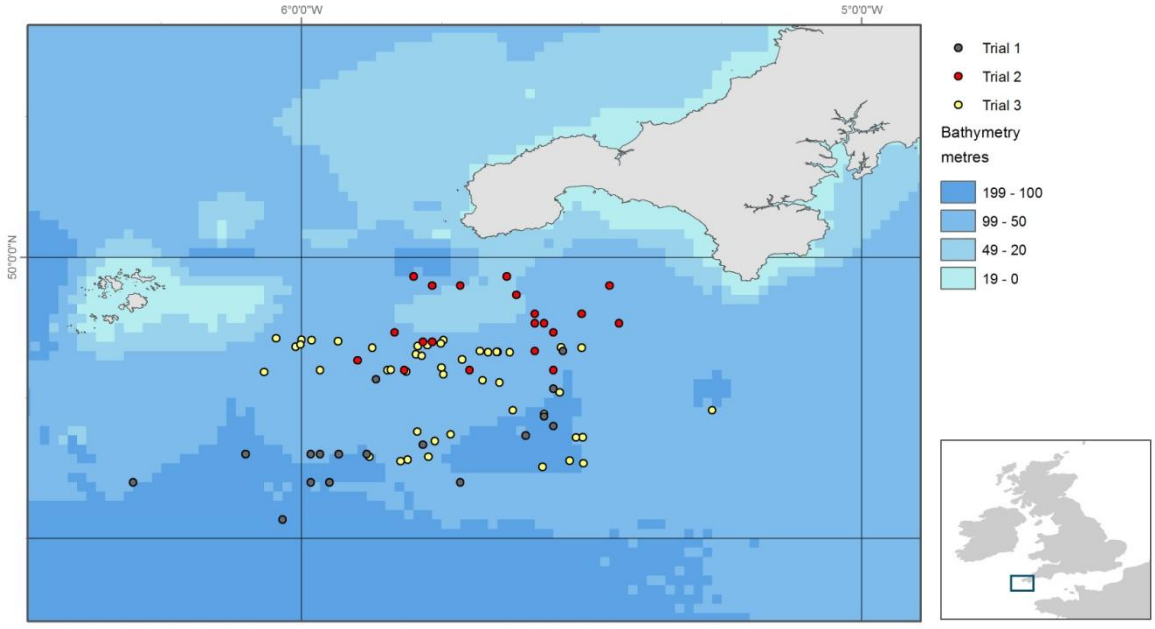


Figure 29 Location of hauls from the three trials

ANNEX 1

ANALYSIS ON HADDOCK AND COD CATCHES IN ICES DIVISIONS VII E,F AND G IN 2014

ANA RIBEIRO SANTOS AND TOM CATCHPOLE, CEFAS, 18 JULY 2014

SUMMARY

- 17 trips were sampled onboard of otter and beam trawlers, in ICES VIIe, f and g, in 2014.

- On average, in each trip, 46% and 40% (in weight) of cod and haddock were discarded, respectively.

- Overall, 86% and 85% (in number) of cod and haddock discards were under MLS.

DATA ANALYSIS

The data used for this analysis were collected by Cefas Observer programme in 2014, on board of beam and otter trawlers operating the ICES VII e, f and g. The objective was to analyse the catch composition of cod and haddock in those trips. For each trip, numbers-at-length were raised to the haul, based on an estimated proportion of the total catch volume sampled. Then data were raised to the trip level, based on the proportion of sampled to fished hauls. The length data were converted to biomass, using length-weight relationships. Length frequency graphs were constructed for each species and gear type.

RESULTS

In 2014, 17 observer trips were made on otter and beam trawlers in VIIe, f and g. See Table 1 for a summary of cod and haddock catches in each trip. Overall, the data showed great variability of cod and haddock catches among the trips, varying between 0.82 – 741 kg for cod and 5 – 2034 kg for haddock. The discards rates varied between 0 and 100% for both species. Two out of the six trips sampled in the beamers, comprised 90% of the total discards of cod and haddock. For the otter trawlers, 3 of the 11 trips sampled contributed with 90% of total discards for cod and haddock. On average, the beam trawlers caught and discarded more fish, with 53% and 48% of cod and haddock being discarded, respectively. The otter trawlers discarded, on average, 42% and 36% of cod and haddock, respectively.

The length frequency distributions show that 86% and 85% (in number) of cod and haddock discards are under MLS (Figure 1). 15% of the discarded fish was over the MLS. Only the biggest fish were retained.

The catches profiles showed that in some of the sampled trips, the populations of cod and haddock being caught are dominated by small, undersized fish.

Table 1. Summary of cod catches, from beam and otter trawlers in ICES VIIe, f and g, in 2014.

				COD							
Gear	Trip Code	Date	ICES area	Discards		Retained		Total catch		Cod Discard rate (%)	
				Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Beam trawls	**BM114BT**	25-Mar-14	VIIe	0.88	3.18	0.00	0.00	0.88	3.18	100%	100%
	BM214BT	01-Jun-14	VIIe	34.70	76.67	10.14	1.67	44.84	78.33	77%	98%
	NN414BT	17-May-14	VIIf and VIIg	69.98	185.06	332.86	74.94	402.84	260.00	17%	71%
	NN514BT	20-May-14	VIIe and VIIg	13.18	56.67	18.06	5.00	31.24	61.67	42%	92%
	NN614BT	23-Jun-14	VIIe	8.23	22.10	23.96	5.52	32.18	27.62	26%	80%
	PH114BT	25-Mar-14	VIIf	429.97	1282.34	311.98	59.32	741.95	1341.66	58%	96%
	TOTAL			**556.95**	**1626.01**	**696.99**	**146.45**	**1253.94**	**1772.46**	**44%**	**92%**
	Average per trip			**92.82**	**271.00**	**116.17**	**24.41**	**208.99**	**295.41**	**53%**	**89%**
Otter trawls	**BM214OT**	04-Apr-14	VIIe	0.00	0.00	10.42	2.00	10.42	2.00	0%	0%
	LE114OT	29-Jan-14	VIIe	0.00	0.00	53.65	5.00	53.65	5.00	0%	0%
	LE214OT	25-Feb-14	VIIe	0.00	0.00	32.20	3.00	32.20	3.00	0%	0%
	NN114OT	09-Apr-14	VIIe	6.62	18.00	7.85	1.50	14.47	19.50	46%	92%
	NN214OT	19-May-14	VIIe	64.02	212.00	16.64	3.00	80.66	215.00	79%	99%
	PH114OT	03-Apr-14	VIIe	5.44	18.00	7.52	1.00	12.96	19.00	42%	95%
	PH214OT	08-Apr-14	VIIe	48.51	32.22	103.95	12.22	152.47	44.44	32%	73%
	PH414OT	10-Apr-14	VIIe	1.88	11.00	0.00	0.00	1.88	11.00	100%	100%
	PH514OT	13-May-14	VIIe	20.49	68.00	11.36	0.00	31.86	68.00	64%	100%
	PH614OT	11-Jun-14	VIIe	0.82	1.25	0.00	0.00	0.82	1.25	100%	100%
	PH714OT	23-Jun-14	VIIe	0.00	0.00	1.47	2.00	1.47	2.00	0%	0%
	Total			**147.78**	**360.47**	**245.06**	**29.72**	**392.85**	**390.19**	**38%**	**92%**
	Average per trip			**13.43**	**32.77**	**22.28**	**2.70**	**35.71**	**35.47**	**42%**	**60%**
	Overall Total			**704.73**	**1986.48**	**942.06**	**176.17**	**1646.79**	**2162.65**	**43%**	**92%**

Table 2. Summary of haddock catches, from beam and otter trawlers in ICES VIIe, f and g, in 2014.

				HAD							
Gear	Trip Code	Date	ICES area	Discards		Retained		Total catch		Haddok Discard rate (%)	
				Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number
Beam trawls	**BM114BT**	25-Mar-14	VIIe	0.00	0.00	18.70	9.54	18.70	9.54	0%	0%
	BM214BT	01-Jun-14	VIIe	0.00	0.00	5.08	5.00	5.08	5.00	0%	0%
	NN414BT	17-May-14	VIIf and VIIg	237.89	1818.47	182.34	215.65	420.23	2034.12	57%	89%
	NN514BT	20-May-14	VIIe and VIIg	15.52	176.67	0.00	0.00	15.52	176.67	100%	100%
	NN614BT	23-Jun-14	VIIe	47.34	317.62	7.64	8.29	54.98	325.90	86%	97%
	PH114BT	25-Mar-14	VIIf	240.19	769.40	259.36	251.23	499.55	1020.64	48%	75%
	Total			**540.94**	**3082.16**	**473.13**	**489.70**	**1014.07**	**3571.86**	**53%**	**86%**
	Average per trip			**90.16**	**513.69**	**78.85**	**81.62**	**169.01**	**595.31**	**48%**	**60%**
Otter trawls	**BM214OT**	04-Apr-14	VIIe	2.18	26.00	1.16	2.00	3.34	28.00	65%	93%
	LE114OT	29-Jan-14	VIIe	0.00	0.00	113.52	55.42	113.52	55.42	0%	0%
	LE214OT	25-Feb-14	VIIe	0.00	0.00	25.93	17.52	25.93	17.52	0%	0%
	NN114OT	09-Apr-14	VIIe	7.17	42.00	198.54	199.50	205.71	241.50	3%	17%
	NN214OT	19-May-14	VIIe	210.78	759.50	52.46	44.00	263.25	803.50	80%	95%
	PH114OT	03-Apr-14	VIIe	1.03	7.00	10.51	8.00	11.54	15.00	9%	47%
	PH214OT	08-Apr-14	VIIe	25.67	242.22	31.31	16.67	56.98	258.89	45%	94%
	PH414OT	10-Apr-14	VIIe	0.25	3.00	4.62	3.00	4.87	6.00	5%	50%
	PH514OT	13-May-14	VIIe	32.57	227.00	30.13	20.00	62.70	247.00	52%	92%
	PH614OT	11-Jun-14	VIIe	85.81	503.75	29.37	16.25	115.17	520.00	75%	97%
	PH714OT	23-Jun-14	VIIe	33.99	190.00	21.42	16.00	55.41	206.00	61%	92%
	Total			**399.44**	**2000.47**	**518.96**	**398.35**	**918.40**	**2398.83**	**43%**	**83%**
	Average per trip			**36.31**	**181.86**	**47.18**	**36.21**	**83.49**	**218.08**	**36%**	**61%**
	Overall Total			**940.38**	**5082.63**	**992.09**	**888.06**	**1932.47**	**5970.69**	**49%**	**85%**

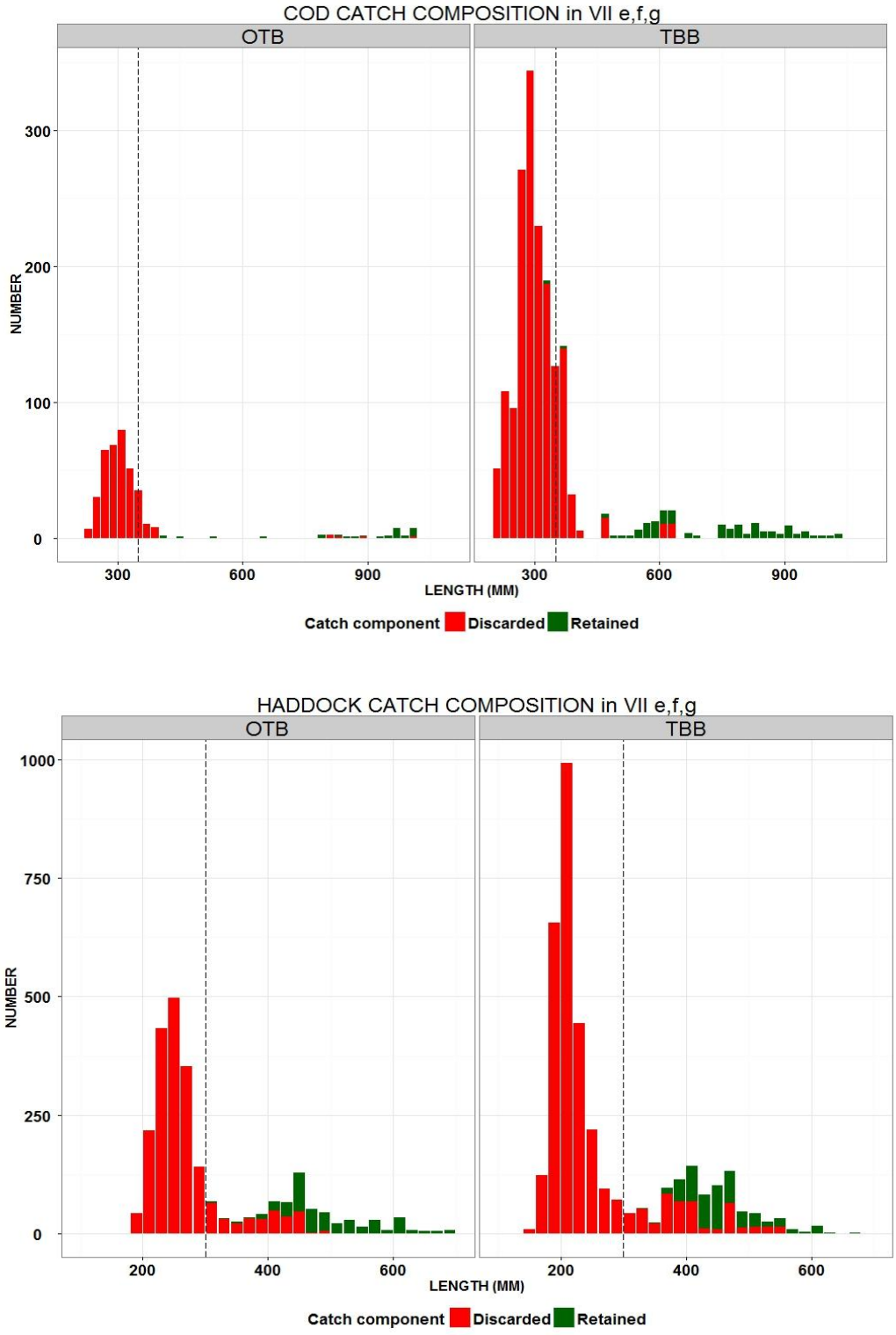


Figure 1. Length-frequency distribution of discarded and retained cod and haddock caught in ICES VIIe, f and g, in 2014. Vertical dashed line – MLS (35 cm for cod and 30 cm for haddock).

ANNEX 2 GRADE COMPOSITION AND SELECTIVITY OF ICES VII B-K HADDOCK IN THE SOUTHWEST OTTER-TRAWL FISHERY SEPTEMBER 2014

Marine Management Organisation

Grade Composition and Selectivity of ICES VII b-k Haddock in the Southwest Otter-Trawl Fishery

September 2014

Marine Management Organisation

Grade Composition and Selectivity of ICES VII b-k Haddock in the Southwest Otter-Trawl Fishery

September 2014

Report prepared by: Julian Roberts and Grant Course on behalf of the Marine Management Organisation and David Stevens, vessel owner and skipper.

Cover photograph courtesy of David Stevens.

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Contents

Figures

Tables

Executive summary

ICES area VIIb-k haddock has high discard levels and has suffered erratic recruitment in recent years. The scientific advice is for reduced fishing mortality and improved selectivity.

This report looks at landings by size grade into English ports in the south west, which is considered to be indicative of a high level of discarding through quota restriction. It also provides the results of a series of innovative selectivity trials of different trawls designs.

The participants have trialled trawl configurations that dramatically reduce overall haddock catches across all size ranges. They have also taken other avoidance measures which include refitting the vessel when haddock is most abundant and reducing fishing effort during hours of darkness when catches tend to be at their highest levels.

By reducing the cover of the top sheet of the trawl, total haddock catches were reduced by 37%. Total juvenile (those below the minimum landing size of 30cm for the purpose of this report) haddock catches were reduced by up to 90% by inserting a 100mm square mesh panel in the codend coupled with a square mesh panel that conforms to Celtic Sea technical measures further forward in the trawl.

The results suggest that the modifications to the trawl are able to reduce overall fishing mortality of juvenile and mature haddock whilst maintaining a profitable catch of other quota species although further evidence is required to fully assess the commercial impact of such measures.

The vessel is fitted with remote electronic monitoring with CCTV (REM) equipment as a prerequisite of the current catch quota trials. The configuration of the cameras have not been best suited to corroborating the results of the selectivity trials although a further trip has been subsequently carried out with observers on board; the results of this trip is being published by the Centre for Environment, Fisheries and Aquaculture Science (Cefas).

The selectivity trials provide an excellent example of fishing industry initiative, which builds on recent collaboration with fisheries managers and scientists. In order to achieve cost effective means of corroborating the results of such trials it is considered that the remote electronic monitoring system can be configured corroborate self-reported data and to augment data gathered by scientific observers.

Acknowledgements

The Marine Management Organisation (MMO) is grateful to David and Alec Stevens for their dedication and innovation in carrying out these trials and the provision of the selectivity data.

Introduction

ICES area VII b-k (Celtic Sea) haddock forms a significant by-catch in mixed demersal trawl fisheries in the South West Approaches. Erratic recruitment to this stock coupled with high fishing mortality has resulted in scientific advice for reduced total allowable catches and improved selectivity to preserve new recruitment cohorts in order to bring fishing mortality within maximum sustainable yield (ICES 2014).

English trawlers have engaged in scientific trials over recent years to improve the selectivity of trawls in relation to gadoid species such as haddock and recent mandatory technical measures have been introduced in part of the stock area (Commission Implementing Regulation (EU) No 737/2012). However, it is considered that further technical measures are necessary to align catches with available quota in the context of the demersal landing obligation.

Article 15 of Council Regulation (EU) No 1380/2013 prohibits the discarding of demersal quota species in a phased approach from 2016 to 2019. At the point when haddock becomes subject to the landing obligation all catches will have to be landed and counted against quota (subject to any flexibilities and exemptions prescribed in discard plans). No longer would fishermen be able to discard to remain within quota limits and continue fishing.

This report analyses the landings by size grade of haddock into ports in the South West of England and compares the data to one vessel participating in catch quota trials under which all catches of haddock must be retained and landed. This data provides a degree of insight into the level of high grading and discarding that is typical of the fleet as a whole.

Gear trials have also been carried out by the participant vessel both on a voluntary basis and as part of the Fisheries Science Partnership between industry and Cefas. The results of the voluntary gear trials have been provided to the MMO and are summarised in this report. The purpose of the gear trials is to explore measures to protect recent recruitment to the stock as well as to reduce total haddock catches whilst maintaining profitable landings in the context of a landing obligation.

The results in this report relate to catches from the western part of ICES area VIIe. In this area the technical measures require 100mm codends for catches exceeding 30% haddock and other whitefish. ICES VIIe is outside the scope of Commission Implementing Regulation (EU) No 737/2012 which requires square mesh panels to be inserted into otter trawls within 9m of the codline; the mesh size of the panel is dependent on the vessel engine power and codend mesh size and must be fitted in accordance with Council Regulation 850/98.

The data provided in this report is partly corroborated through electronic monitoring and CCTV, which is fitted to the vessel as a prerequisite for its simultaneous participation in the MMO catch quota trial. The results of the catch quota trials will be reported separately.

Analysis of haddock landings by grade

Landed weights of VIIb-k haddock by size grade were taken from the electronic reporting system (ERS). For the purpose of the analysis landings into Plymouth, Brixham, Newlyn and Torquay by otter trawl vessels were used. Benchmark data from the catch quota participant vessel was used to compare to other vessels on the basis that there were no discards of haddock by this vessel.

The ERS landings data uses the European grade structure for fish size. However on some UK markets these grades are split into further grades. This data has been adjusted to fit the ERS requirements. For example in Plymouth the two larger grades used locally are merged together to form the grade 1 haddock on the ERS system (Table 1). This report uses the official European grades converted back into local market grades.

Table 1: Table showing the grades used on local markets and how they map into the ERS system grade structure

Market grades	ERS Equivalent Grades	Weight at grade
1	1	>2kg
2	1	1-2kg
3	2	0.57-1kg
4	3	0.3-0.57kg
5	4	0.17-0.3kg

Landings by grade for non-catch quota (CQ) vessels and the CQ vessel were examined to determine what percentages of their landings were at the different grades. Table 2 shows the landings for the CQ vessel, a comparative non-CQ vessel and the Cornish Fish Producers' Organisation (CFPO) vessels, split by grade using the percentage contributions at grade.

The comparative non-CQ vessel was selected on the basis that it has a similar fishing pattern (see Figures 1 and 2) to the CQ vessel and because it was also one of the other highest individual catchers of haddock (VIIb-k) in 2013. This vessel is not a member of the CFPO.

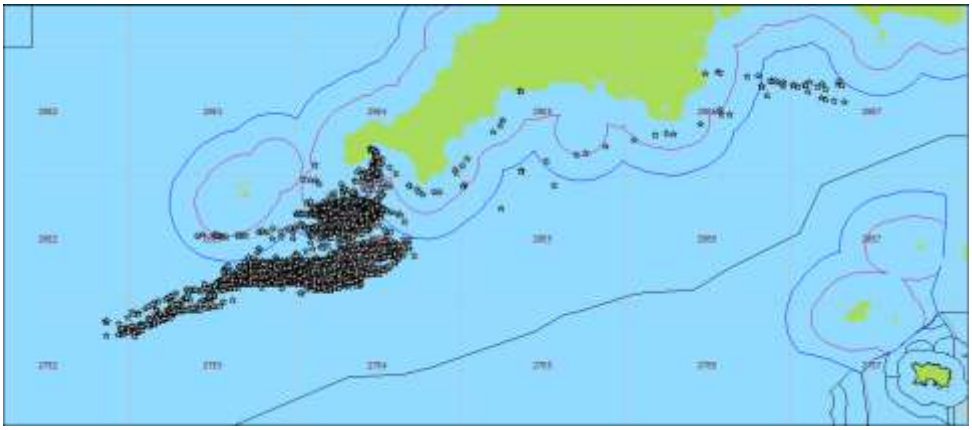


Figure 1 The VMS plot for the CQ vessel in 2013.

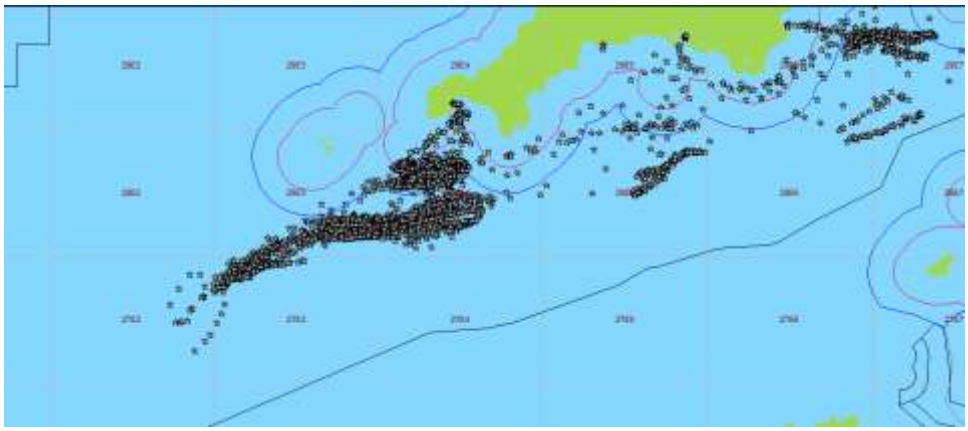


Figure 2 The VMS plot for the non-CQ comparison vessel in 2013.

Table 2: The calculated percentage split across the different size grades for Celtic Sea haddock (VIIb-k).

Also shown are the weights landed by the CQ vessel, a similar non-CQ vessel and the CFPO (excluding the CQ vessel).

Market Grade	% by Grade CFPO non-CQ Vessels	% by Grade non-CQ Comparison Vessel	% by Grade CQ Vessel	CFPO Landed Weights (excluding CQ vessel)	Comparison Vessel Landed Weights	CQ Vessel Landed Weight
1/2	32.5	21	12	162,963	19,260	26,493
3	55	61	56	275,784	55,946	123,633
4	12	18	30	60,171	16,509	66,232
5	0.5	0	2	2,507	0	4,415
Total				**501,426**	**91,715**	**220,774**

Overall, the CQ vessel landed more than twice as much haddock as the non-CQ comparison vessel with approximately 221 tonnes compared to 92 tonnes. This 221 tonnes was also equivalent to 44% of the CFPO's total landed weight of 501 tonnes of haddock.

When these total landed weights are split between the grades there is a difference between how these total landings are made up. For example, the CQ vessel landed 4.4 tonnes of grade 5 and 66.2 tonnes of grade 4 haddock, whereas the whole of the rest of CFPO only landed 2.5 tonnes of grade 5 and 60.2 tonnes of grade 4 haddock, despite having a total landing more than twice the size of the CQ vessel. Grade 3 haddock are very similar across the 3 different vessel groups with about 55-61% of the landings being made up of this grade. However there is a large difference in the percentage contribution made by grade 1/2 haddock to the total landings, with CFPO non-CQ vessels having 32.5%, the non-CQ comparison vessel having 21% and the CQ vessel having only 12% grade 1/2 haddock.

Both individual vessels examined fished in similar areas in 2013. The CQ vessel landed more than twice as much haddock overall than the non-CQ vessel, yet the non-CQ vessel landed catch was 82% grades 1-3, whilst the CQ vessel's catch was 68% grades 1-3. The CFPO non-CQ vessels had 87.5% of their catch as grades 1-3.

Table 2 shows that the main differences between the landings of these vessels is that those which are not on the CQ scheme land a higher percentage of grades 1-2 and considerably less grade 4/5 haddock.

Selectivity Trials

The data summarised below has been provided by the skippers of the trial vessel who have sought to reduce overall haddock catches as well as ensure catches of juveniles (those below the minimum landing size) are minimised.

The standard twin-rig otter trawl has diamond codend mesh size of 100mm joined to a diamond 100mm extension piece which merges to a 16 foot cover with 200mm diamond mesh. The main purpose of the large meshes in the headline cover is to eliminate small whitefish, which have a tendency to swim upwards to escape. It is thought that the selectivity through the cover is effective for smaller grades of adult fish but less so for juvenile fish. The trawl configurations used in 5 trials are set out schematically in Figure 3.

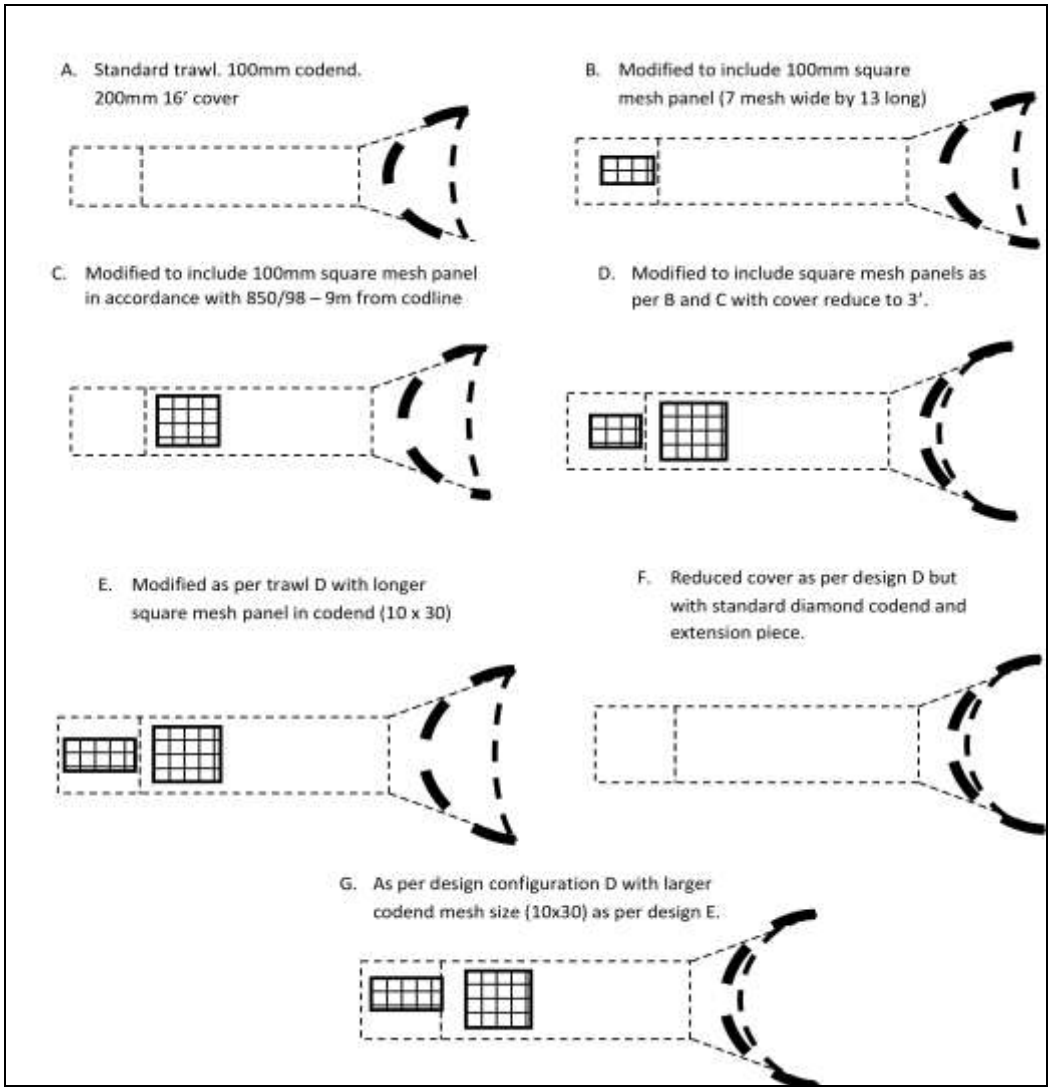


Figure 3 Schematic of gear configurations

The different net configurations were trialled as set out in Table 3.

Table 3: Gear configurations trialled across 12 trips

	e-log trip serial number	Gear comparison
Trial 1	B1065420140161 B1065420140162 B1065420140163 B1065420140164 B1065420140165 (hauls 1-3)	Port side codend 100mm diamond mesh. TYPE A Starboard side codend 100mm diamond with 100mm square meshes (7x15 meshes) in codend top sheet. TYPE B
Trial 2	B1065420140165 (hauls 4 onwards) B1065420140166 B1065420140167	Port side codend 100mm diamond with 3.1m x 1.1m 100mm square mesh panel 9m from the codline. TYPE C Starboard side codend 100mm diamond with 100mm square meshes (7x15 meshes) in codend top sheet. TYPE B
Trial 3	B1065420140168	Starboard side – reduced cover (3') trawl with square mesh panels in codend and further SMP 9m from codline (as per 737/2012). TYPE D Port side – original net with diamond mesh and 200mm 10' cover. TYPE A
Trial 4	B1065420140169 B1065420140170	Port side codend 100mm diamond mesh. TYPE A Starboard side codend 100mm diamond with 100mm square meshes (10 x30 meshes) in codend top sheet and further SMP 9m from codline. TYPE E
Trial 5	B1065420140171 B1065420140172	Starboard side – reduced cover (3') trawl with square mesh panels in codend (10x30) and further SMP 9m from codline (as per 737/2012). TYPE G Port side reduced cover (3') trawl with standard diamond meshes. TYPE F

Figure 4 square mesh panel (7x15 meshes) inserted in codend

Figure 5 Codend square mesh panel (10x30 meshes)

In each of the comparison trials the crew processed the catch from each codend separately and weighed the catch components on motion compensated scales. The different weights of undersize haddock caught from each codend were recorded on paper log sheets that were submitted to MMO.

Records were maintained throughout each fishing trip to take account of any diurnal influence on catches and selectivity although this effect is not analysed in this report.

Results from trial 1

Figure 6 shows the catches by weight of juvenile haddock from an unmodified diamond mesh codend compared with that from a modified codend with a square mesh panel inserted into the top sheet. The results show a consistent reduction in retained juvenile haddock catch with the modified gear.

Across all 61 hauls in this comparison trial there was a total of 358kg (average 6kg per haul) of juvenile haddock caught with the modified gear compared to 1451kg (average 24kg per haul) caught by the modified gear which gives a reduction of juvenile haddock catch in the modified gear of 75%.

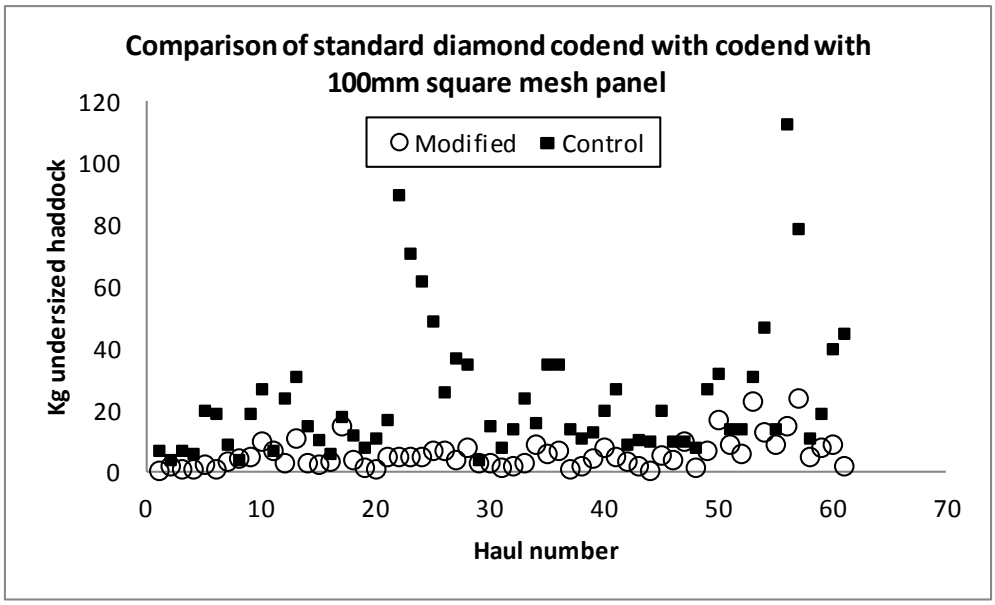


Figure 6 Comparison of standard diamond mesh codend with a codend fitted with 100mm square mesh panel

Results from trial 2

Figure 7 shows the catches by weight of juvenile haddock from a diamond mesh codend and square mesh panel in the extension piece compared with that from a modified codend with a square mesh panel inserted into the top sheet. The results show a consistent increase in selectivity by the codend square mesh panel in comparison to the square mesh panel sited 9m from the codline.

Across all 47 hauls in this comparison trial there was a total of 451kg (average 10kg per haul) of juvenile haddock caught with the square mesh panel mounted in the codend compared to 1044kg (average 22kg per haul) in the gear with the square mesh panel sited 9m from the codline.

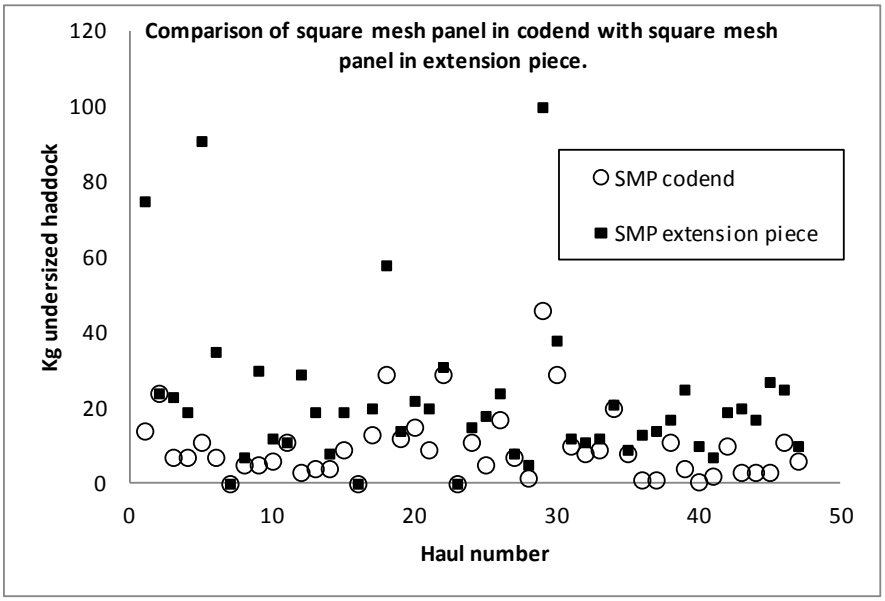


Figure 7 Comparison of square mesh panel in the codend with square mesh panel in the extension piece

The average catch rate in the unmodified gear in trial 1 was 24kg compared to 22kg using the square mesh panel sited in the extension piece in trials 2 with a very similar distribution range. The results do not show a comparison between a standard net and one with a square mesh panel in the extension piece although the indirect comparison across trials 1 and 2 suggest this configuration is not effective at selecting out juvenile haddock.

Trials 1 and 2 shows consistently high selectivity where the square mesh panel is sited in the codend with an average catch rate per haul of 6kg in trial 1 and 10kg in trial 2.

Results from trial 3

Trial 3 used an unmodified net compared to a trawl with the headline cover reduced to 3 feet ahead of the footrope together with square mesh panels in the codend and 9m from the codline.

Figure 8 shows the comparison in relation to catch of juvenile haddock. The unmodified gear shows a similar range of catches of juveniles to that in trial 1with an average catch rate of 20kg (24kg in trial 1).

The coverless trawl gave a catch rate of 4kg per haul which is lower than the modified gear in trials 1 and 2 which may suggest selectivity is improved again by the reduced cover which selection of small haddock occurring from the cover and the square mesh panels.

The overall reduction of catch of juvenile haddock in the modified gear in trial 3 was 82%.

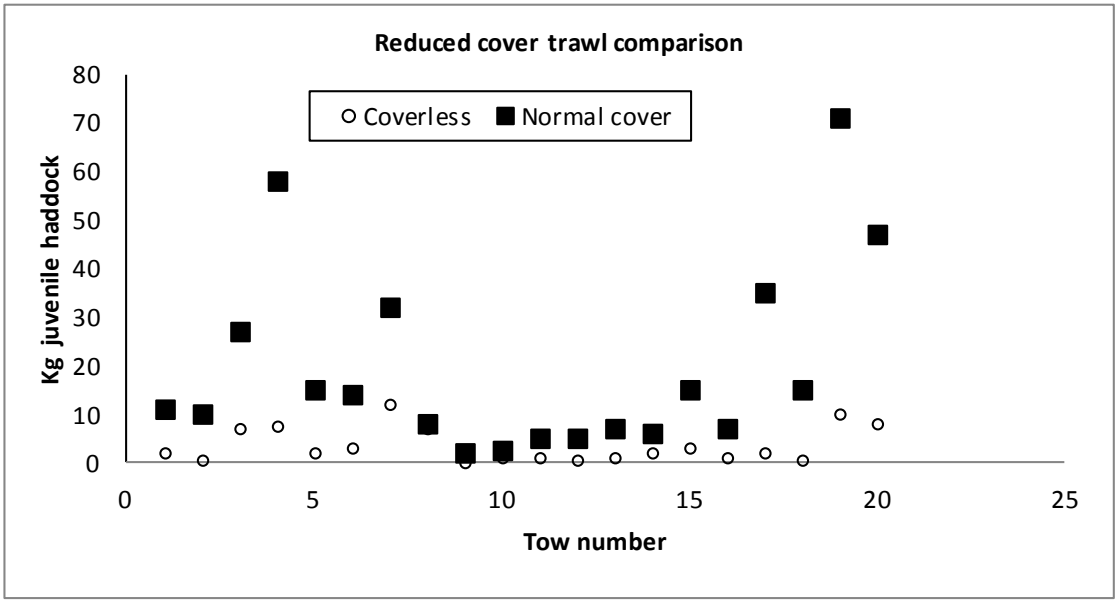


Figure 8 Comparison with reduced cover trawl with standard cover trawl

Figure 9 shows the data from trial 3 incorporating 20 hauls over 5 days comparing the coverless trawl with square mesh panels to the full cover trawl shows a marked reduction of total whitefish catch and a negligible reduction in the catch of john dory. Total catch of haddock was reduced by 37%, whiting by 30%, hake by 58%. The John Dory catch was higher overall in the coverless trawl by 7% and is indicative that the gear modification does not impact on the selectivity for this species which is a high value component of the catch.

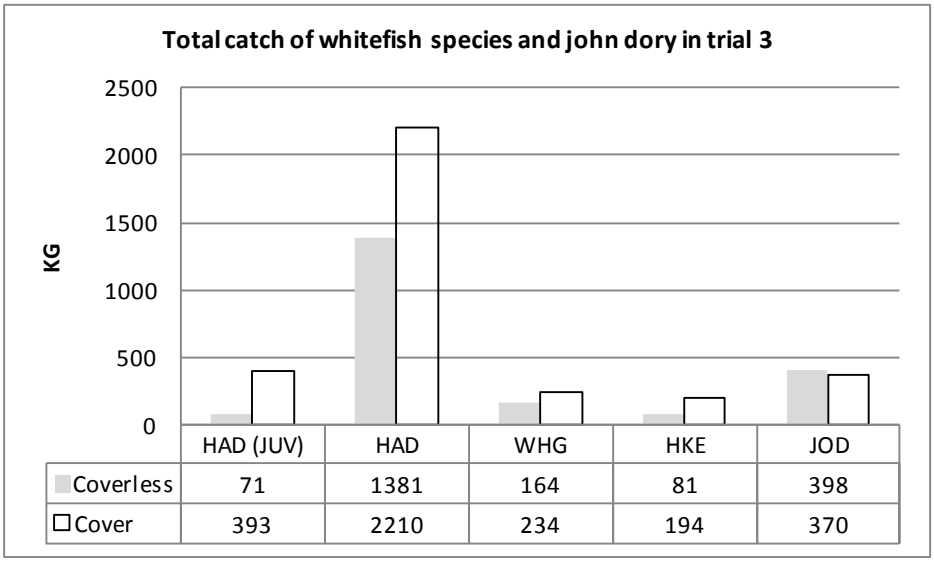
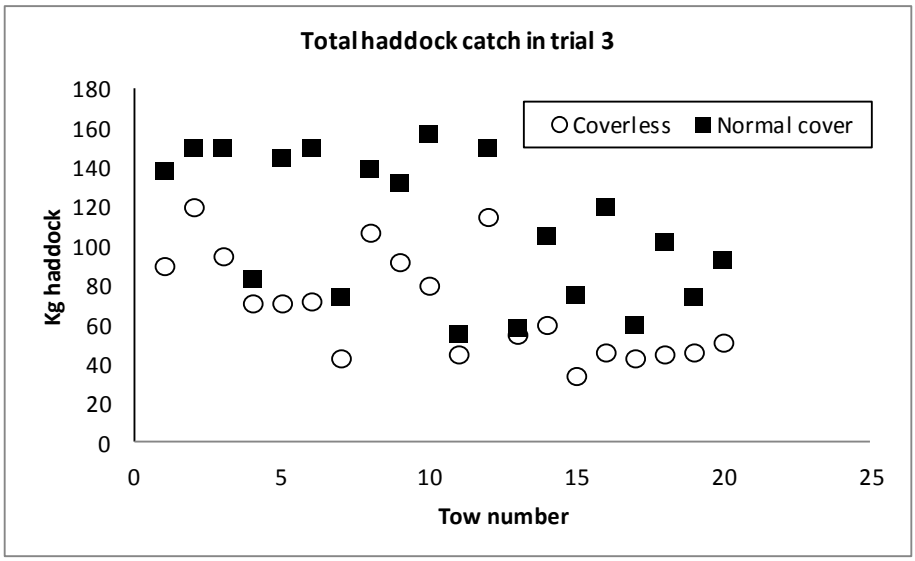
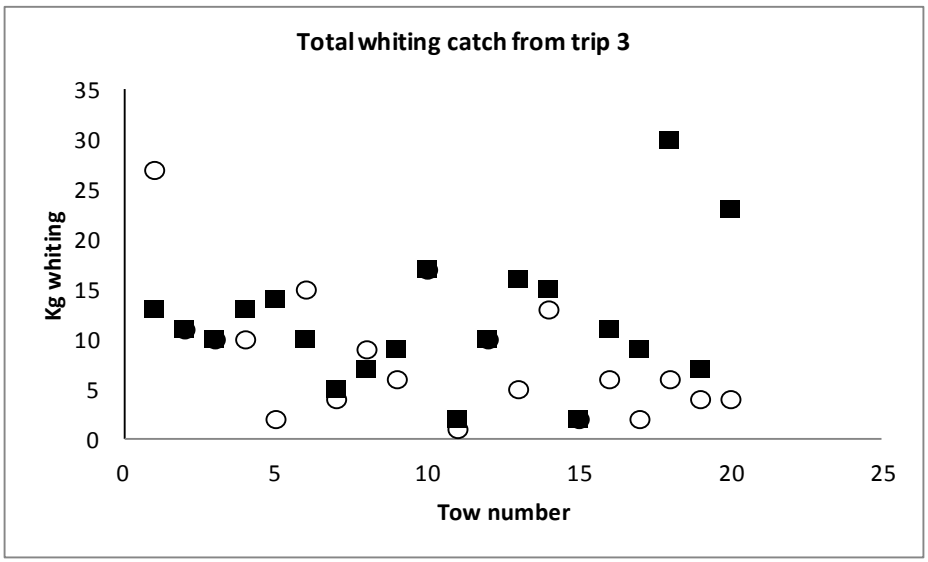
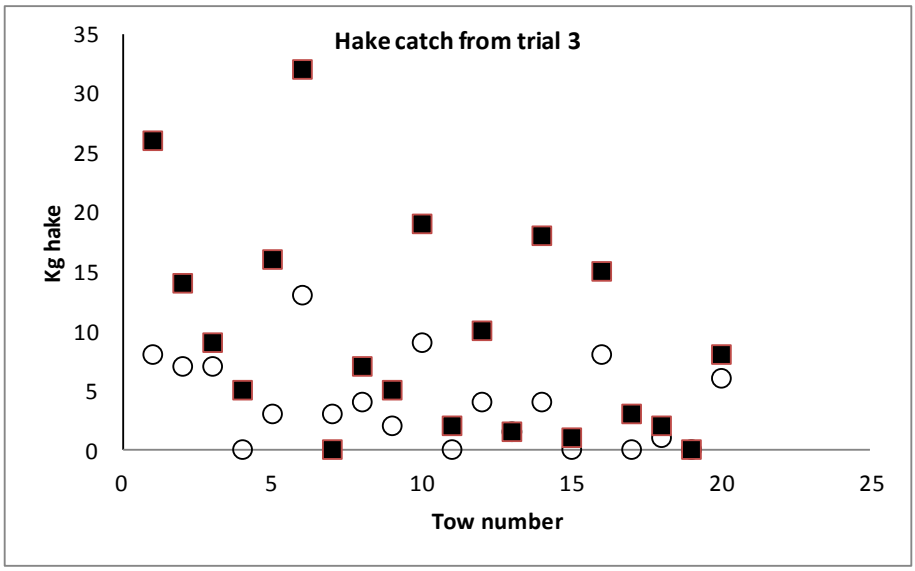


Figure 9 Comparison of total catches of key species in trial 3

Figure 10 shows the results of total catches at individual haul level for haddock, whiting, hake and John Dory. The catches of haddock and hake are consistently lower in the modified gear across all hauls. Catches of whiting suggest a similar pattern although with less difference on some hauls while the catch of John Dory does not appear to be impacted by the gear modification.







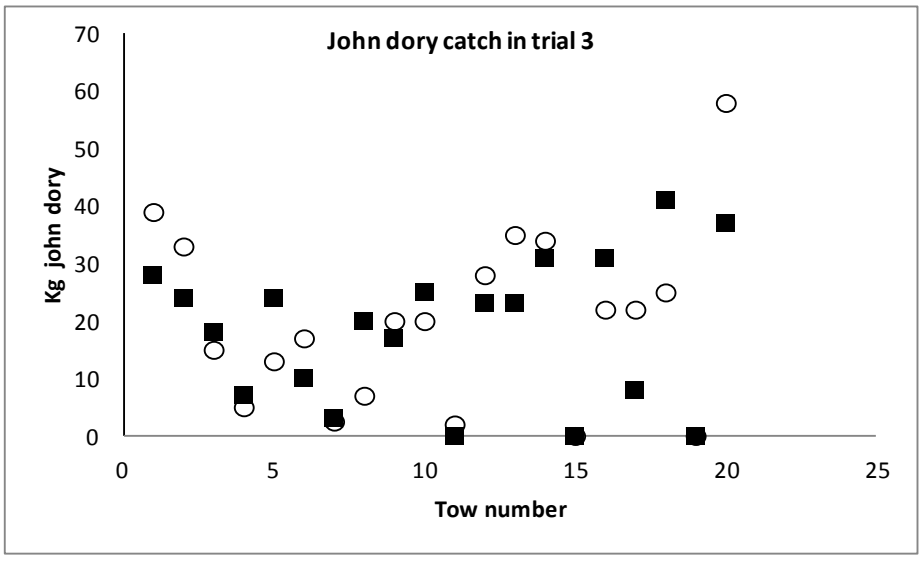


Figure 10 Comparison of catches at individual haul level in trial 3

Results from trial 4

Figure 11 shows the results of a comparison of a standard net with one fitted with a larger square mesh panel in the codend coupled with a square mesh panel 9m from the codline. Over a total of 38 hauls the average catch of juvenile haddock in the modified trawl was 9kg compared to 59kg in the standard trawl giving an overall reduction of 85%.In comparison to trial 2 this gives a further 10% increase in selectivity over the design with a smaller 100mm square mesh panel in the codend with no panel higher in the trawl.

In trial 4 the average catch rate of juvenile haddock in the standard gear (59kg per haul) was considerably higher than in trials 1 (24 kg) and 3 (20kg) where a standard trawl was also used. This suggests that there was a higher abundance of small haddock on the grounds during trial 4.

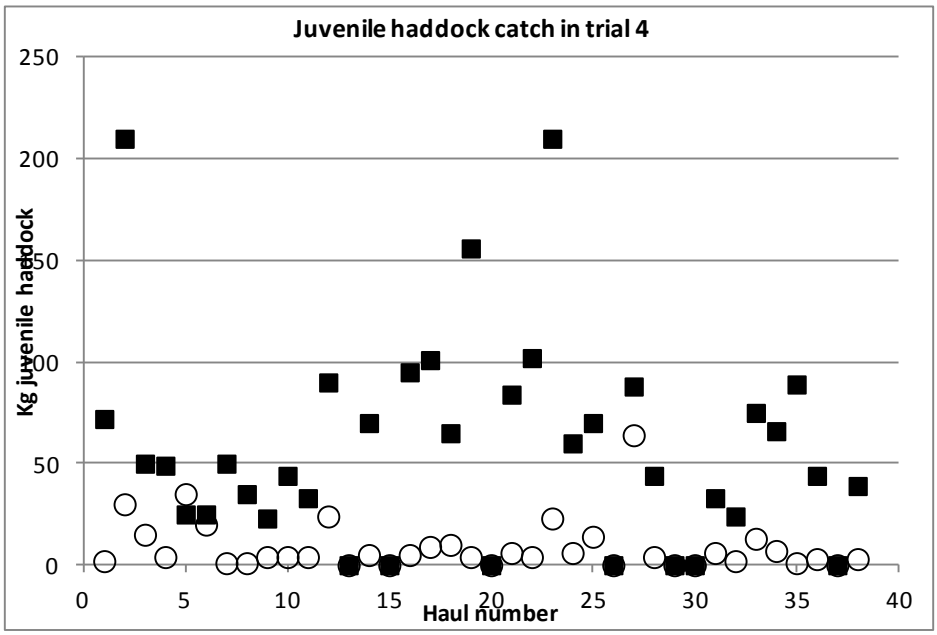


Figure 11 Comparison of juvenile haddock catch in a standard trawl (black squares) with one fitted with square mesh panels in the codend and extension piece

Results from trial 5

Results from trial 3 demonstrate a large reduction in total haddock catch in a modified trawl in which the headline cover is reduced further back towards the footrope. This modification including two square mesh panels also shows a large reduction in juvenile haddock catch. In order to determine the point at which juvenile haddock escapes the trawl a further trial was carried out with two reduced cover trawls, with and without square mesh panels.

The results are shown in Figure 12; in total the reduced cover trawl with square mesh panels retained 157kg of juvenile haddock compared with 1609kg in the trawl without square mesh panels. The square mesh panels therefore account for a 90% reduction in the retention of juveniles. Results from trials 1 and 2 would suggest that

the selectivity for juvenile haddock is achieved mainly by the square mesh panel sited in the codend.

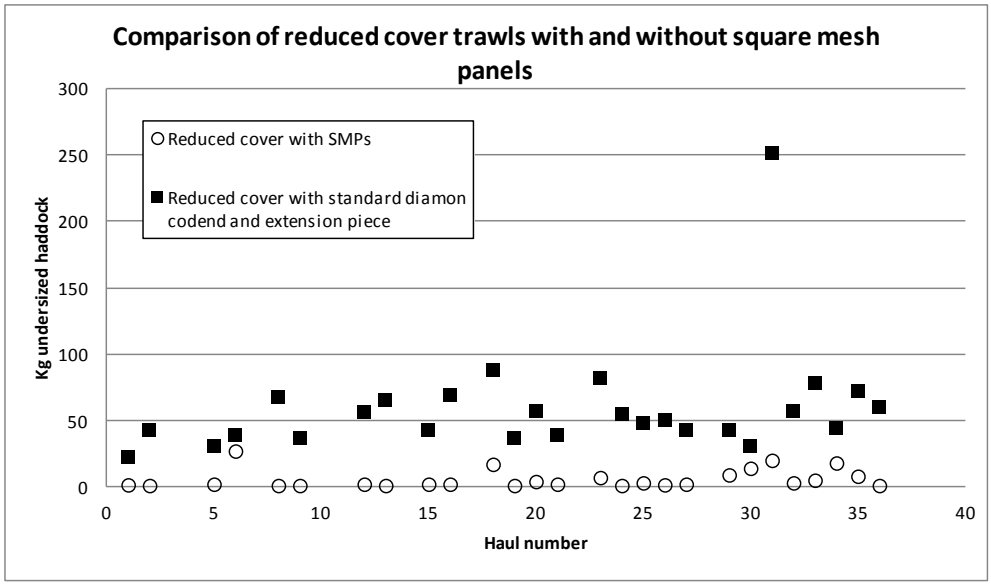


Figure 12 Comparison of reduced cover trawls, one fitted with square mesh panels in the codend and extension piece

Impact of the modified gear on other target species

The results do not provide for an economic assessment of the viability of the modified gears other than the evidence that catches of John Dory are not impacted. The vessel owner has reported that there may be little impact on catches of angler and megrim or possibly a slight improvement in catches. The trial has not coincided with significant squid catches and further evidence would be required to assess the impact for this species.

An alternative low headline trawl could reduce catches of whitefish species even further although this design is likely to reduce catches of a range of target species including John Dory.

Corroboration using REM

The selectivity results are those reported by the Master during the trips and all trips are subject to REM CCTV and sensor data recording, which is currently archived. Catches from each codend were separated in the hopper to allow comparisons on catch to be made (Figure 13). The skipper obtained his estimate by weighing the catch at sea on motion compensated scales, whilst the analyst obtained theirs by viewing the volume of catch in a basket and assigning an estimated weight to this volume (see example CCTV camera views in Figure 14).

Figure 13 Catch from port and starboard codends separated in the hopper (photo courtesy of David Stevens)

The CCTV footage from small number of hauls from were analysed including two trips in which trial results are not covered in this report. The analysis is limited to estimating the catch of juvenile haddock from modified gear. The results of the comparison between the skipper reported weights and the analyst observed weights is shown in Table 4. It can be seen that on all hauls sampled the amount of undersize haddock caught was low, generally less than 7kg, with the exception of Haul 15 on trip B1065420140164, where 23kg were reported. The percentage difference the analyst's estimate and the skipper's reported estimate was calculated. This produced a range between 80% under reported and 33% over reported (-80% to +33%). The high variance in estimates is considered to be a result of the very small quantities observed although the cumulative comparison amounts to only 2%.

Table 4: Comparison between the skipper's and the analyst's estimate of undersize haddock caught

Elogbook number	Haul	Skipper estimate (kg)	Analyst estimate (kg)	% difference from analyst	Confidence rating
B1065420140159	2	2	2	0	MEDIUM
B1065420140160	6	4	3	33	POOR
B1065420140160	18	1	5	-80	POOR
B1065420140161	9	5	5	0	MEDIUM
B1065420140161	11	7	7	0	GOOD
B1065420140162	4	7	7.5	-7	GOOD
B1065420140163	3	1.5	2	-25	POOR
B1065420140164	10	1.5	1.5	0	MEDIUM
B1065420140164	15	23	20	15	GOOD
B1065420140165	3	2	2	0	GOOD
B1065420140165	9	7	7	0	MEDIUM
	Total	**61**	**62**	**-2**	

The analyst's view of the undersize catch was often difficult because of the way that it was handled and because the camera positions were not optimal (the configuration is primarily aimed at monitoring discards). Estimates on hauls were given a "confidence rating" depending on how well the analyst could see the catch and how confident they felt their estimate was. "Good" and "Medium" confidence was only selected on eight of these hauls and on seven the catch estimates matched, with only one haul having a 15% difference. "Poor" was selected on 3 occasions and on all hauls there was a large percentage difference.

Figure 14 REM CCTV image of catch from each codend sorted with juvenile haddock separated from the marketable catch (orange basket at far right)

Discussion

The UK fishing industry reported high catches of haddock in the first half of 2014, which were problematic because of the restrictive quota which did not cover bycatch for many vessels (ICES 2014).

Whilst there are many variables to take into account such as local fishing practices, areas and seasonality, this analysis is consistent with the official STECF 2012 discard rates of 58% for TR1 gears (100mm + codends) and 76% for TR2 gears (<100mm codends).

Against this backdrop there is clearly a need for major improvements to selectivity and catch avoidance both to support harvesting within maximum sustainable yield and reduce the potential for quota exhaustion to effect an early fishery closure under the landing obligation.

Despite the potential to improve selectivity, the MMO suggests that in the absence of total avoidance measures, marketable haddock is likely to continue to form a significant proportion of the catch in this fishery (MMO interim report 2013). There have been anecdotal reports of vessels discarding very large volumes of haddock because of a lack of quota, often catches constituting large grades of haddock, particularly in the hours of darkness. The larger catches of small grade 4/5 haddock appear to be taken in the more offshore areas where angler and megrim are targeted along with important quota and non-quota commercial species.

We understand that some smaller vessels have stopped fishing at night to avoid high haddock discards. Larger vessels have more limited scope to reduce fishing at night although the trial vessel has done this during the summer of 2014. Increased avoidance measures may be viable to a point by using more selective trawl configurations such as the reduction of top sheet cover and/or reducing headline lift, although it is not clear what impact this might have on the reduction of catch of other species.

Further analysis of the grades of marketed haddock bears out the fact that through 2013, the SW otter trawl fleet were discarding marketable haddock whilst retaining the larger more valuable grades as a means obtaining best value for money for the available quota. Significantly the trial vessel landed the same quantity of small grade 4/5 haddock as the entire remaining CFPO fleet. A comparative vessel to the trial vessel not in CFPO membership landed approximately half the grade 4/5 haddock compared to the trial vessel.

The vessel in the trial uses standard gear that is relatively selective (as demonstrated by a very small percentage of juvenile catch in catch quota trials in 2013) whilst remaining viable in terms of catches of other species. This has been achieved through the use of large (200mm) meshes in the headline panel. Recent trials by CEFAS (Smith and Catchpole 2013) have shown that nets incorporating a 400 mm diamond mesh square section and 200 mm diamond mesh in part of the back net section yielded a reduction in haddock below 46 cm; equating to a reduction of 41% by number overall.

Other selectivity studies have focussed on the use of square mesh panels to reduce the catch of whitefish below the minimum landing size. Kynoch R J et al (2008) found that 120mm square mesh panels were effective at reducing juvenile haddock catch in Nephrops trawls when placed up to 18m from the codline although the results are confined to fish above 20cm in length.

In these selectivity trials the lowest catch rates of juvenile haddock were seen in the Type B, D, E and G trawls, which incorporate a square-mesh panel in the codend. The Type E and G trawls are most effective overall as a result of the larger square mesh panel in the codend compared to the Type B and D trawls. The type E and G trawls reduced juvenile haddock catches by 85-90%.

The selectivity for juvenile haddock by the square mesh panel situated 9m from the codline and in accordance with technical rules for the Celtic Sea (Type C) appears to be less effective. A direct comparison between Types B and C confirm this although there was no comparison between the Type C and a standard Type A trawl.
Based on the catch rates alone the Type C trawl does not appear to be more selective than the standard Type A trawl but this remains inconclusive as there were varying quantities of small haddock across different trips.

The Type D and G trawls with the reduced cover appear to be effective at reducing the total catch of haddock, whiting and hake and therefore represents a possible method of reducing quota usage for these stocks under a landing obligation. Further work is required to assess the potential loss of other key species when using this gear and whether this might be influenced by the type and power of vessels. The loss of hake and potentially other species such as squid may be significant and further analysis of catches from the reduced cover trawls may provide a means of assessing this.

The gear modifications are effective at reducing juvenile haddock cohorts as they appear on the grounds. The vessel owner considers that the abundance of juveniles reduces east of 5^{o} West and the introduction of further technical measures may therefore only be relevant west of this line.

The square mesh panels in the codend, although effective in terms of selectivity, do not comply with Article 7 of Council Regulation 850/98, which sets out the basic requirements for fitting such panels. Article 7 requires no more than 5 open diamond meshes between the selvedge and the square mesh panel (to ensure a reasonable width of panel) whereas the trial configuration has up to 10. The skipper has reported that extending the size of the panel from 10x30 meshes to cover more of the codend would result in unacceptable loss of other commercial species.

The vessel has operated under a dispensation from Article 7 of 850/98 for the purpose of the trials. This does highlight an example of where technical rules can reduce the flexibility of operators to fish more selectively. The proposed overhaul of the EU technical measures would need to take account of this type of scenario whilst maintaining clarity for inspecting officers. Where a vessel is engaged in fully documented fishing and where monitoring allows for confidence that all catches of key species are being retained and counted against quota, it is considered that operators should be afforded flexibility in gear design to suit their particular fishery.

Innovations such as gear type approval and tagging may assist with a more flexible system.

Forward Look

The participant vessel operators are continuing with catch quota trials in 2014 in relation to three key species: haddock, megrim and angler. The operators are seeking to adapt their fishing practices and to continually assess the ability to operate under the landing obligation from 2016 in terms of catch avoidance where necessary and maximising profit under a catch quota system.

It is considered that expanded participation in schemes such as this should be encouraged as a means of maximising evidence prior to the implementation of the demersal landing obligation.

The use of REM has shown potential to provide a means of corroborating industry-sourced data and to augment scientific observer studies. There is also a need to ensure that such trials are able to feed in to revision of regional technical measures and the compilation of discard plans.

References

Smith, S and Catchpole, T; CEFAS 2013. Area VII Haddock Discard Eliminations using Technical Measures.
http://www.cefas.defra.gov.uk/media/625804/mf056%20report_final.pdf

Kynoch R J, Ferro R S and Fryer R J. 2008 The effect of 120mm square mesh panels on the release of cod, haddock and whiting from Scottish Nephrops trawls. Fisheries Research Services Internal Report No 27/08

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ANNEX 3

SUPPLEMENTARY NOTE ON THE ECONOMIC PERFORMANCE OF THE MODIFIED GEARS

Aim

This supplementary note should be read together with the report by Centre for Environment, Fisheries and Aquaculture Science (Cefas, UK) to the Scientific, Technical and Economic Committee for Fisheries (STECF) on selectivity trials towards haddock in the demersal otter trawl fishery in ICES Area VII. The aim is to provide information relating to whether the changes in the composition of the overall catch in the modified trawls affects its overall value. Rough estimates of the total value of the catches from the standard trawls in each experiment have therefore been compared with those from each modified trawl to provide indicative figures on the relative economic performance of the trawls.

Methods

The price per kilogram for each commercial species caught in the standard and modified trawls was obtained from the Fishing Activity Database (FAD) and applied to the retained catch to estimate the value of the catch from each experiment. For popular species such as haddock, cod, megrim and sole, the price statistics were based on the size grades used at key ports (Plymouth, Brixham and Newlyn) in South West England. Given that the aim of the trials was to avoid haddock, the total value of the retained catch from each experiment in each trial was completed with the total values including or excluding haddock (Table 1).

Results

Results indicate that for Trial 1, both experiments showed minimal reductions in the overall value of the catch when using the modified trawl ranging from 2–8% when haddock catches are included to 3-5% when haddock catches are removed from the analysis. Similar results were evident for Trial 2 when haddock catches were included. When haddock catches were removed however, the total value of the catch from the modified trawl was 22% less than that from the standard trawl. The experiments in Trial 3 varied with reduction in value of between 4 and 42% when the modified trawl was used and haddock included in the analysis to between 10 and 38% when haddock is excluded from the analysis.

Conclusions

Despite variations in the total value of the catch between the standard and modified trawls in the different experiments, overall the differences were minimal. The mean total value of the retained catch with haddock in the standard trawls was around £4,839 while the mean value of the catch from the modified trawls was ~£4,232, a reduction of £607 or 13%. The

modified trawl incorporating a 100mm square-mesh panel in the cod-end was the most effective design in reducing haddock while at the same time maintaining the overall value of the catch.

Table 1: Comparison of the value (£) of catch from the standard and modified trawls for each experiment in each trial showing the total value with and without haddock.

Trial	Experiment	Species	Standard trawl	Modified trawl	Difference (modified - standard trawl)	Difference as a %
Trial 1	Experiment 1	MON	2340	2019	-321	-16
		HAD	2280	1894	-386	-20
		LEM	1651	1688	38	2
		JOD	1418	1476	58	4
		MEG	774	919	145	16
		SOL	380	208	-171	-82
		BLL	140	209	69	33
		WHG	217	116	-101	-87
		Others	836	750	-86	-11
		Total with HAD	10036	9281	-755	-8
		Total minus HAD	7756	7386	-369	-5
	Experiment 2	LEM	1437	1474	37	3
		MON	1292	1106	-186	-17
		HAD	1170	1188	18	2
		JOD	797	879	82	9
		MEG	693	799	106	13

		SOL	341	164	-177	-108
		WAF	160	148	-12	-8
		PLE	174	129	-45	-35
		COD	102	86	-16	-18
		WHG	102	65	-37	-57
		Others	222	309	87	28
		Total with HAD	6488	6346	-142	-2
		Total minus HAD	5319	5158	-161	-3
Trail 2	Experiment 1	HAD	1026	584	-442	-76
		LEM	308	450	141	31
		MEG	186	320	134	42
		MON	254	206	-48	-23
		JOD	92	146	54	37
		BLL	38	136	99	72
		PLE	64	45	-20	-44
		Others	218	180	-38	-21
		Total with HAD	2187	2067	-120	-6
		Total minus HAD	1161	1483	322	22
Trial 3	Experiment 1	LEM	956	1000	44	4
		SOL	546	401	-145	-36
		MEG	488	414	-73	-18
		MON	370	394	24	6
		JOD	354	310	-44	-14
		GUG	292	193	-99	-51
		HAD	74	250	177	71
		GUR	114	121	7	6
		BLL	129	67	-62	-93
		Others	182	206	23	11
		Total with HAD	3504	3356	-148	-4
		Total minus HAD	3430	3106	-324	-10
	Experiment 2	LEM	843	644	-199	-31

	SOL	768	531	-237	-45
	MEG	483	483	0	0
	MON	436	301	-135	-45
	JOD	287	242	-44	-18
	GUG	180	189	9	5
	LSD	113	97	-16	-16
	HAD	163	22	-141	-629
	Others	343	276	-67	-24
	Total with HAD	3616	2786	-830	-30
	Total minus HAD	3452	2763	-689	-25
Experiment 3	LEM	1131	827	-305	-37
	MON	558	584	26	4
	SOL	709	295	-414	-141
	MEG	492	403	-89	-22
	GUG	433	252	-181	-72
	JOD	206	234	28	12
	HAD	222	83	-139	-167
	GUR	154	116	-38	-33
	Others	503	318	-185	-58
	Total with HAD	4408	3111	-1298	-42
	Total minus HAD	4186	3027	-1159	-38
Experiment 4	LEM	795	616	-178	-29
	MON	679	722	43	6
	SOL	443	218	-225	-103
	MEG	357	287	-70	-24
	HAD	321	159	-163	-102
	JOD	227	198	-29	-15
	GUG	276	131	-144	-110
	GUR	149	108	-41	-38
	Others	385	237	-148	-62
	Total with HAD	3632	2678	-954	-36

	Total minus HAD	3310	2519	-791	-31