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**Scottish Marine and Freshwater Science Vol 8 No 3**

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# **Trials to Assess the Effect of Bobbin Groundgear and a 200mm Square Mesh Panel to Reduce Unwanted By-catches in the Commercial *Nephrops* Fishery**

M Kinghorn, J Dooley, A Edridge, RJ Kynoch and FG O'Neill  
Marine Scotland Science

## **Summary**

The Gear Innovation and Technology Advisory Group (GITAG) funded trials to assess whether the unwanted by-catch of round and flatfish could be reduced in the *Nephrops* trawl fishery using a modified *Nephrops* trawl incorporating 200mm bobbins and a 200mm square mesh panel.

Catches of *Nephrops* and monkfish remained consistent with that of a standard commercial *Nephrops* trawl.

There were significant reductions in relative catch rates of cod and larger haddock (>25cm) and whiting (>28cm). There was no significant difference between the two trawls for haddock below 24cm and for whiting below 27cm.

There was a significant reduction in the quantities of smaller common dab (<19cm) and long rough dab (<21cm) that were caught when using the modified trawl. However, significantly more larger plaice above 30cm were retained by the modified trawl.

## Introduction

As the full implementation of the Landing Obligation in 2019 nears ever closer, the Scottish Fishermen's Federation established the Gear Innovation and Technology Advisory Group (GITAG) in August 2015 to stimulate innovation in fishing gear development to address issues that the industry will face as the Landing Obligation is progressively introduced.

GITAG encourages applications from all sectors of the industry and, to date a number of gears have been developed and trialled. Here we report on trials of a *Nephrops* trawl from Faithlie Trawls International Limited, a net manufacturer from Fraserburgh.

Their proposal centred around the partial use of plastic bobbins in the bosom of the ground gear in conjunction with a larger Square Mesh Panel (SMP) at the end of the tapered section in a standard *Nephrops* trawl. Traditionally, trawls used to target *Nephrops* in the Scottish Fishery have ground gear consisting of small hoppers or discs. The modifications to this trawl have been designed with an aim to retain the catches of *Nephrops* but reduce the unwanted by catch of round and flat fish alike.

## Vessel and Fishing Grounds

The Zenith BF106, a 24.85m 500kW, twin rig stern trawler was chartered for the selectivity trials. The charter ran for 7 days from 24<sup>th</sup> to 31<sup>st</sup> of May 2016. Catch comparison trials, using the twin trawl method, were carried out on commercial fishing and *Nephrops* grounds 50 miles north of Fraserburgh in the North Sea (ICES area IVa). The species mix at the fishing grounds consisted of haddock, whiting, cod, a variety of flatfish and *Nephrops*.

## Fishing Gear

Faithlie Trawls International Limited constructed and supplied both the experimental and control trawls used during the trials. Both are 200ft low headline trawls designed to target *Nephrops* with the control trawl currently being used by the Zenith and a number of other Scottish vessels to fish commercially for *Nephrops*.

Broadly similar in design, both trawls incorporated 160mm mesh in the upper wings and 110mm mesh in the lower wings, intended to reduce the catches of round and flat fish respectively. The upper and lower belly panels of both trawls were constructed with 80mm mesh of 3mm PE twine on the top and 4mm on the bottom.

The control net (Figure 1) is a conventional *Nephrops* trawl. The groundgear comprised a 15.24m centre section of 8" rubber discs spaced 12" apart by 3" discs (Figure 3) and 22m sections along each wing of 6" discs separated by 2" spacers. It was fitted with a flip-up rope and behind the headline there are 2.5 meshes of 170mm double followed by 13 meshes of 160mm single. A 3.1m 110mm SMP is inserted at the end of the tapered section 14m from the codline. The codend was 100mm double and fitted with a 4m cover.

The test trawl (Figure 2) differed from the control in the following ways

- the 15.24m centre section of ground gear consisted of 8" plastic bobbins spaced 4" apart by 3" discs (Figure 3).
- there was no flip-up rope.
- behind the headline there are 4 meshes of 145mm (ISK) double followed by 15 meshes of 160mm single.
- A 200mm SMP was inserted 9m from the codline. The codend was 100mm double and fitted with a 3.5m cover.

The trawls were fished using the vessel's own wire rig which consisted of a three warp towing system attached to 500kg Thyboron doors and a central 1200kg roller clump. Behind the doors, two 4.5m lengths of 16mm chain are at either end of 128m of sweep, 91.4m of which was combination wire and 36.6m of rubber leg. At the end of the sweep a triangle split the bridles which consisted of two 4.6m lengths, the top being 22mm combination wire and the bottom a rubber leg with 2" discs.

## **Fishing Trials Procedure**

The tow duration for all the catch comparison hauls was 3 hours. Towing speed over the ground varied from 2.4 to 2.8 knots, the vessel's normal range when fishing commercially for *Nephrops*. During each tow, the vessel's Notus net monitoring system was used to monitor net geometry, namely the trawl door to clump spread for both sides of the twin rig.

The twin trawl technique (Wileman *et al.*, 1996) was used to assess the relative catch rates of the test gears. This involves towing two trawls in parallel, with the test gear fished on one side of the twin trawl system and the unmodified control trawl fished on the other. In order to reduce any port/starboard bias, the test trawl was fished on both sides of the twin trawl system. 24 valid hauls were split evenly with the test net on the port side for 12 hauls and the starboard side for 12.

At the end of each haul, as standard practice aboard the Zenith, the starboard trawl's codend was always emptied into the vessel's fish hopper first. The port codend was lifted from the water and secured to prevent any fish escaping while the catch from the starboard codend was sorted. In turn, the catches from both codends were separated into baskets before being measured. Length-weight relationships were subsequently used to calculate the catch weights of the fish species (Coull et al., 1989). Where larger catches of certain species was encountered, a sub-sample was measured and raised to the total weight of that particular species in that respective codend. *Nephrops* were on the other hand, collectively weighed after sorting to ascertain simply whether the test net was retaining the same volume as that of the control.

## Data Analysis

For each species, the percentage difference between the bulk weight of the test gear, summed over a trip, and that of the control gear was also calculated. 95% confidence intervals were estimated by carrying out 1000 bootstrap repetitions and calculating the Efron 95% confidence limit, where on each repetition the haul data were selected with replacement.

A length based assessment was also carried out for each species (except *Nephrops*). The catches retained in the test and control codends were analysed using the smoother based methodology of Fryer et al. (2003). This analysis is in three stages:

- A smoother was used to model the log catch rate of the test gear relative to the control gear for each haul;
- The fitted smoothers were combined over hauls to estimate the mean log relative catch rate;
- Bootstrap hypothesis tests using the statistic  $T_{max}$  were used to assess whether the mean log relative catch rates depended on gear and to compares the mean log relative catch rates to zero (or equivalently the mean relative catch rates to unity).

The analysis was on the logistic scale, but the results are back-transformed for presentation.

## Results

### Gear Performance

The average spread of the gear from door to clump was as expected when fishing in 100m -150m of water. In the majority of hauls the test gear was spread marginally more than that of the control gear as shown in Table 1. The test gear had not been fished prior to the trip and had therefore, not yet had sufficient time to bed-in. Both gears maintained good bottom contact throughout the trials as confirmed by the mudding up of the ground gears and the wings of both nets respectively.

### Catch Comparison

25 hauls were completed during the trials, 24 of which were valid and used for catch comparison analysis with no port/starboard bias being detected. The predominant species encountered during the trials were cod, haddock and monkfish and to a lesser extent whiting, saithe, hake and various species of flat fish. The numbers of each fish species and corresponding calculated weight from each valid haul are shown in Tables 2 - 5 and are presented graphically for an overview in Figures 4 and 5.

There were significant reductions in the capture of many of the species caught. Catches of haddock were reduced by 56%, whiting by 63%, cod by 25%, hake by 61%, saithe by 88%, long rough dab by 54% and megrim by 24%. There were no significant differences in the bulk catches of monkfish, *Nephrops*, common dab, lemon sole, plaice or witch (Table 6).

The results of the length based analysis are presented in Figures 6 and 7 where the relative catch rate is shown as the proportion of fish retained in the test gear at each length as compared to the control net. A value of less than one indicates that the test gear caught fewer fish at that length and a value greater than one indicates more fish were caught in the test gear compared to the control. A dashed line indicates where the relative catch rate did not differ significantly from one, whereas an unbroken line indicates there is point-wise significance at the 5% level.

This analysis shows that smaller haddock, whiting, hake and saithe are more likely to be retained in the test gear than larger fish. However, it is the opposite for long rough dab, common dab, lemon sole, plaice and witch, as the length based analysis demonstrates that fewer smaller fish of these species were caught by the test gear. There was no length dependency for cod, monkfish or megrim.



## Discussion

The test trawl had been designed to retain the same *Nephrops* as the traditional prawn trawl and reduce the by-catch of all other fish species. Although there was a small reduction in the catch of *Nephrops* that were retained, this difference is not significant. The slight discrepancy in total weight could be due to the rubber discs in the bosom of control net digging in to the ground a little more than that of the plastic bobbins on the test net. However, it should be noted that overall catch rates for this species were quite low and that few hauls were representative of commercial catches.

There were also no differences in the bulk catches of monkfish, common dab, lemon sole, plaice or witch. However, there were significant reductions in the capture of haddock, whiting, cod, hake, saithe, long rough dab and megrim. The length based analysis shows that smaller haddock, whiting, hake and saithe are more likely to be retained in the test gear than larger fish. For long rough dab, it is the opposite, and more smaller fish are likely to escape. There was no length dependency for cod, monkfish or megrim.

As the test trawl differed from the control trawl in a number of ways it is not possible to be certain which modification (or combination of modifications) leads to these changes in relative catch rates. However, it is probably reasonable to assume that the larger haddock, whiting, hake and saithe are escaping through the larger SMP in the test trawl, perhaps also aided by the shortened straight section. Correspondingly, the reduced retention of smaller long rough dab, common dab, witch, plaice and lemon sole is probably attributable to increased numbers of smaller fish passing under the lighter spherical plastic bobbins of the groundgear and to the likelihood that the plastic bobbins had no effect on the larger flatfish.

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**Table 1:** Haul summary for catch comparison hauls.

<b>Haul Number</b>	<b>Water Depth (m)</b>	<b>Warp Aft (m)</b>	<b>Average Towing Speed (kts)</b>	<b>Average Door Spread Port - clump (m)</b>	<b>Average Door Spread Stbd - clump (m)</b>	<b>Test Configuration</b>
Z16002	104	320	2.4	65	64	Stbd
Z16003	102	320	2.5	60	66	Stbd
Z16004	109	320	2.5	65	68	Stbd
Z16005	126	320	2.4	71	62	Stbd
Z16006	122	320	2.6	62	69	Stbd
Z16007	122	320	2.8	63	69	Stbd
Z16008	144	320	2.7	65	67	Stbd
Z16009	128	365	2.7	69	73	Stbd
Z16010	138	365	2.7	65	69	Stbd
Z16011	153	365	2.7	62	65	Stbd
Z16012	128	320	2.6	64	69	Stbd
Z16013	128	365	2.7	64	74	Port
Z16014	128	365	2.6	71	67	Port
Z16015	109	320	2.6	71	64	Port
Z16016	118	320	2.8	67	63	Port
Z16017	109	320	2.7	65	67	Port
Z16018	118	320	2.6	69	65	Port
Z16019	128	320	2.7	69	64	Port
Z16020	118	320	2.6	65	62	Port
Z16021	109	320	2.7	67	65	Port
Z16022	118	320	2.9	65	62	Port
Z16023	118	320	2.7	67	64	Port
Z16024	109	320	2.6	67	64	Port
Z16025	109	320	2.6	64	69	Stbd

**Table 2:** Summary of catch data of haddock, whiting, cod and monkfish by weight and number.

Haul	Haddock				Whiting				Cod				Monkfish			
	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test
	Total Weight (kg)		Total Number		Total Weight (kg)		Total Number		Total Weight (kg)		Total Number		Total Weight (kg)		Total Number	
2	99	21	514	121	10	2	27	6	15	3	6	2	31	30	18	24
3	62	53	316	277	6	4	16	10	14	5	13	5	35	48	29	32
4	142	64	667	341	27	10	65	31	17	21	20	29	42	27	26	22
5	131	65	570	298	21	10	49	24	11	12	10	8	54	31	35	25
6	34	31	182	209	12	10	32	39	6	7	5	7	39	25	27	16
7	82	49	344	264	24	6	60	19	7	8	12	6	41	82	25	48
8	55	29	253	166	36	15	104	57	10	7	7	6	62	56	34	28
9	51	20	288	124	29	7	78	23	320	346	204	211	120	70	58	36
10	57	21	247	138	13	5	35	18	257	174	147	113	72	92	37	44
11	58	22	268	157	20	8	54	22	150	95	79	34	63	74	30	36
12	12	3	62	14	7	4	22	11	84	85	55	54	83	63	49	37
13	40	11	227	77	43	3	125	11	200	234	108	105	67	40	34	17
14	77	32	415	255	20	9	63	29	370	152	210	68	60	45	31	23
15	2	3	12	16	1	0	2	0	187	143	102	84	60	52	28	28
16	20	15	89	74	5	2	12	7	451	264	223	125	74	64	35	33
17	145	43	670	227	34	12	81	36	25	8	18	10	50	77	35	48
18	55	25	245	127	19	8	47	32	43	29	27	17	103	82	61	48
19	57	28	247	132	6	5	17	19	9	24	12	18	65	76	36	41
20	109	41	508	233	6	2	20	8	8	3	7	4	64	51	36	32
21	120	44	566	275	23	10	61	26	9	16	14	16	63	55	32	35
22	19	14	95	78	13	8	38	23	7	6	8	10	36	33	20	19
23	14	9	66	49	19	1	50	5	6	3	4	4	29	16	22	15
24	46	16	219	88	32	16	76	38	4	7	5	4	21	25	14	17
25	30	11	145	59	17	5	37	13	4	4	5	3	33	26	18	18
<b>Totals</b>	<b>1517</b>	<b>670</b>	<b>7213</b>	<b>3799</b>	<b>443</b>	<b>161</b>	<b>1171</b>	<b>507</b>	<b>2212</b>	<b>1656</b>	<b>1301</b>	<b>943</b>	<b>1365</b>	<b>1241</b>	<b>770</b>	<b>722</b>

**Table 3:** Summary of catch data of hake, saithe, common dab and long rough dab by weight and number.

Haul	Hake				Saithe				Common Dab				Long Rough Dab			
	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test
	Total Weight (kg)		Total Number		Total Weight (kg)		Total Number		Total Weight (kg)		Total Number		Total Weight (kg)		Total Number	
2	27	14	27	15	5	0	3	0	6.7	4.1	108	54	0.5	1.1	12	32
3	24	21	18	18	1	0	1	0	4.2	4.3	63	47	1.4	1.2	49	33
4	37	20	24	12	1	5	1	3	3.1	2.8	46	45	6.1	2.3	199	69
5	8	0	8	1	11	2	7	1	7.2	6.1	111	73	15.7	10.6	543	256
6	8	2	8	3	21	0	12	0	3.3	2.5	59	37	4.6	4.7	150	162
7	11	12	12	9	38	4	23	3	1.8	1.9	26	21	9.2	3.0	254	87
8	18	11	15	7	27	12	15	5	2.2	1.7	31	26	14.3	9.0	551	252
9	48	10	24	8	47	3	30	2	0.8	0.7	14	8	5.0	2.6	143	65
10	34	5	18	6	80	5	43	3	0.0	0.4	0	6	0.9	1.3	20	26
11	3	4	3	3	96	8	57	5	0.3	0.3	4	4	2.2	4.0	54	109
12	66	15	46	11	16	4	8	2	0.4	0.6	7	6	4.8	2.4	122	62
13	52	10	35	9	29	0	14	0	2.4	2.4	41	32	6.3	6.7	188	166
14	44	0	29	0	10	0	5	0	3.4	7.8	69	154	7.2	5.9	186	179
15	67	29	37	15	15	0	8	0	0.7	0.4	10	4	2.9	0.8	75	22
16	72	20	43	19	15	4	9	2	0.3	0.5	4	7	1.0	0.4	29	15
17	77	40	43	28	7	0	3	0	1.8	1.4	21	17	2.4	1.0	71	33
18	56	18	34	17	9	0	7	0	0.9	0.2	11	2	0.6	0.2	22	5
19	48	25	35	17	18	1	11	1	0.5	0.2	7	5	0.8	0.4	28	10
20	18	6	16	7	4	0	2	0	0.5	1.0	4	13	0.3	0.7	7	23
21	22	16	19	10	3	0	2	0	8.7	4.9	149	82	6.3	2.5	185	91
22	8	7	5	4	13	6	9	5	2.5	1.3	43	23	30.1	4.3	1025	122
23	5	3	4	2	0	0	0	0	3.2	2.1	60	35	12.3	5.2	462	182
24	12	9	5	6	11	4	8	2	2.5	0.8	45	15	20.1	3.4	679	94
25	5	3	5	4	4	0	3	0	1.7	1.3	32	21	23.2	7.9	762	240
<b>Totals</b>	<b>771</b>	<b>300</b>	<b>513</b>	<b>231</b>	<b>481</b>	<b>58</b>	<b>281</b>	<b>34</b>	<b>59</b>	<b>50</b>	<b>965</b>	<b>737</b>	<b>178</b>	<b>81</b>	<b>5815</b>	<b>2334</b>

**Table 4:** Summary of catch data of lemon sole, plaice, witch and megrim by weight and number.

Haul	Lemon Sole				Plaice				Witch				Megrim			
	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test	Control	Test
	Total Weight (kg)		Total Number		Total Weight (kg)		Total Number		Total Weight (kg)		Total Number		Total Weight (kg)		Total Number	
2	6	5	36	32	21	27	133	157	1.8	1.6	11	11	3.0	0.5	9	2
3	4	8	26	48	25	21	155	129	1.7	2.2	13	13	2.7	5.5	6	12
4	12	9	108	67	13	15	73	71	2.9	2.1	18	14	4.4	4.2	12	11
5	16	18	138	111	23	20	176	118	4.2	4.0	40	26	1.8	0.5	8	3
6	6	7	53	51	7	7	47	43	1.7	1.0	15	6	0.2	0.4	2	2
7	8	7	50	43	13	13	73	69	2.3	1.7	17	10	3.6	0.8	7	3
8	6	4	52	28	12	9	72	48	1.8	1.4	13	12	0.0	0.2	0	2
9	9	12	39	47	1	0	2	2	10.7	9.5	45	42	8.7	8.2	27	24
10	9	11	37	38	0	1	0	2	8.4	5.7	42	28	7.7	5.0	18	12
11	4	4	17	15	0	0	0	2	11.1	9.8	46	40	2.4	3.5	6	10
12	6	9	23	33	2	3	6	6	9.7	10.2	41	40	9.6	8.7	32	23
13	3	5	11	20	0	2	1	4	7.7	8.1	38	35	22.6	21.5	54	42
14	4	1	14	4	3	2	5	5	7.9	4.2	35	14	19.1	12.6	43	32
15	5	5	16	22	2	2	4	5	8.2	6.7	32	28	30.7	18.7	82	52
16	1	1	4	4	5	3	11	9	0.9	1.7	3	5	13.0	12.9	37	30
17	5	7	33	35	24	17	131	89	3.7	2.9	23	15	6.7	5.0	23	15
18	3	4	13	17	2	2	12	8	4.9	3.2	31	20	7.0	3.3	23	11
19	2	5	12	21	4	1	20	8	6.0	6.0	41	38	9.3	8.8	32	23
20	1	6	6	29	10	11	52	52	2.8	3.3	15	17	12.5	9.5	29	25
21	9	7	73	43	66	73	474	442	1.5	3.7	10	25	6.9	1.0	15	5
22	5	3	37	19	8	6	51	40	2.4	1.2	25	13	0.0	0.0	0	0
23	4	4	36	22	4	4	28	22	1.2	1.7	10	11	0.3	0.0	1	0
24	7	4	58	24	9	8	54	42	1.6	0.5	14	4	0.3	0.1	1	1
25	8	4	65	25	7	9	46	48	2.8	3.7	18	21	0.5	0.8	3	4
<b>Totals</b>	<b>144</b>	<b>148</b>	<b>957</b>	<b>798</b>	<b>261</b>	<b>257</b>	<b>1626</b>	<b>1421</b>	<b>108</b>	<b>96</b>	<b>596</b>	<b>488</b>	<b>173</b>	<b>132</b>	<b>470</b>	<b>344</b>

**Table 5:** Summary of catch data for *Nephrops* by weight.

<b>Haul</b>	<b>Total weight (kg)</b>	
	<b>Control</b>	<b>Test</b>
<b>2</b>	1.2	1.2
<b>3</b>	2.5	4.5
<b>4</b>	43	34.4
<b>5</b>	61.6	65.6
<b>6</b>	36	32.5
<b>7</b>	35	34
<b>8</b>	71.6	67.5
<b>9</b>	1.8	1.8
<b>10</b>	0	0
<b>11</b>	0.4	1
<b>12</b>	0	0
<b>13</b>	0	0
<b>14</b>	0	0
<b>15</b>	0	0
<b>16</b>	0	0
<b>17</b>	15	13
<b>18</b>	1.2	0.8
<b>19</b>	0.8	0.8
<b>20</b>	0.8	0.8
<b>21</b>	113	100
<b>22</b>	106.5	81
<b>23</b>	42	32
<b>24</b>	44	44
<b>25</b>	78	76
<b>Total</b>	<b>654</b>	<b>591</b>

**Table 6:** Total weights of each species in kg (all hauls combined) retained by test and control net. The % reduction is the amount by which the test gear reduces catches of that species. The values in brackets are bootstrapped estimates of the lower and upper 95% confidence limits of the percentage difference between the test and control weights and negative percentages imply a percentage increase.

	test (kg)	control (kg)	% reduction
haddock	670	1517	56 (49, 62)
whiting	162	443	63 (56, 72)
cod	1656	2214	25 (1, 42)
hake	300	770	61 (50, 70)
saithe	58	481	88 (79, 93)
long rough dab	82	178	54 (34, 67)
megrin	132	173	24 (9, 37)
monk	1240	1367	9 (-4, 21)
nephrops	591	654	10 (-5, 23)
common dab	50	59	16 (-9, 33)
lemon sole	150	143	-5 (-24, 11)
plaice	256	261	2 (-16, 16)
witch	96	108	11 (-1, 22)



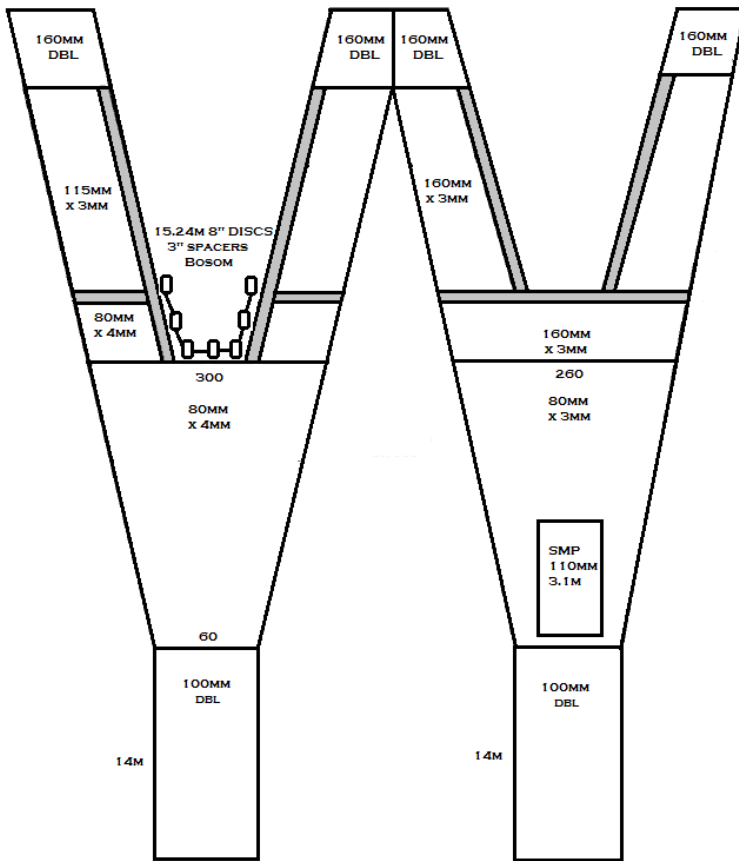


Figure 1: Net plan control trawl

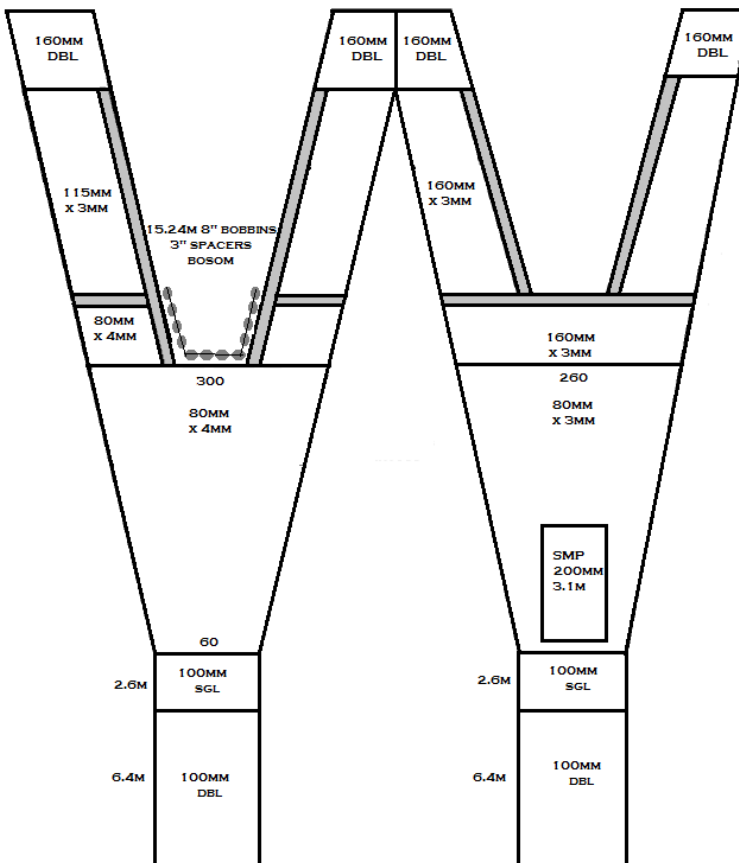
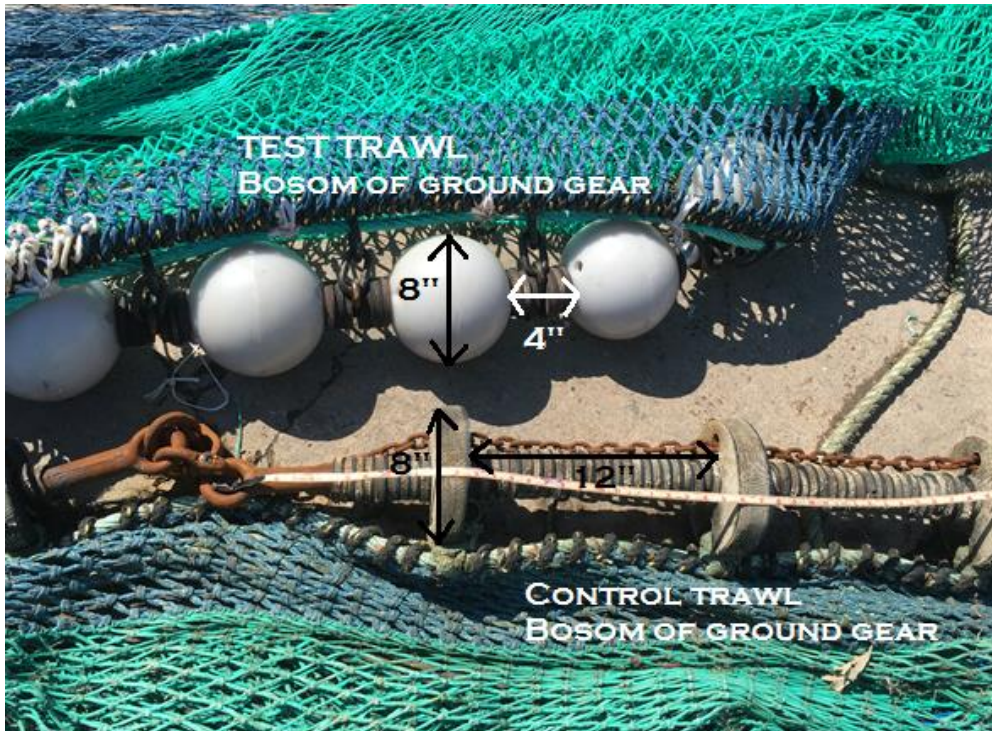
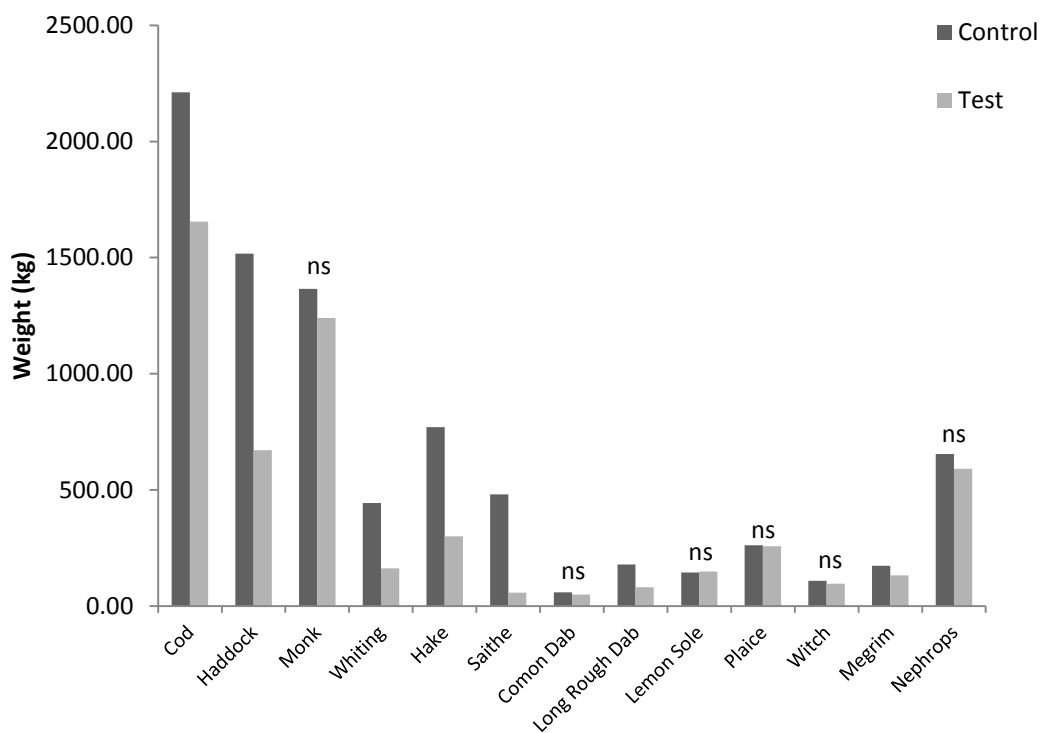


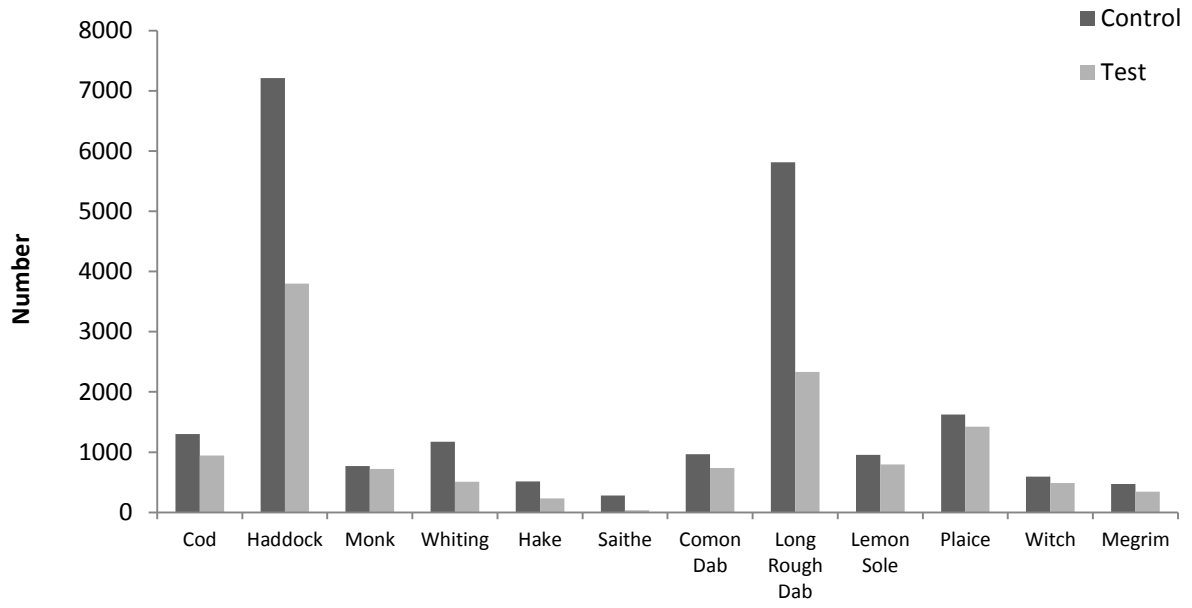
Figure 2: Net plan test trawl



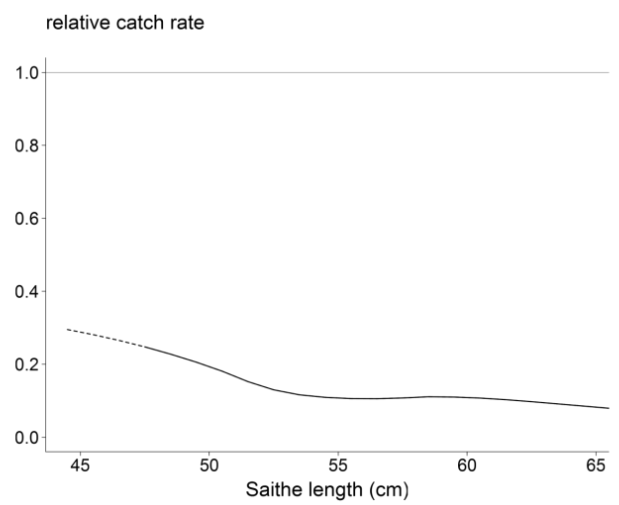
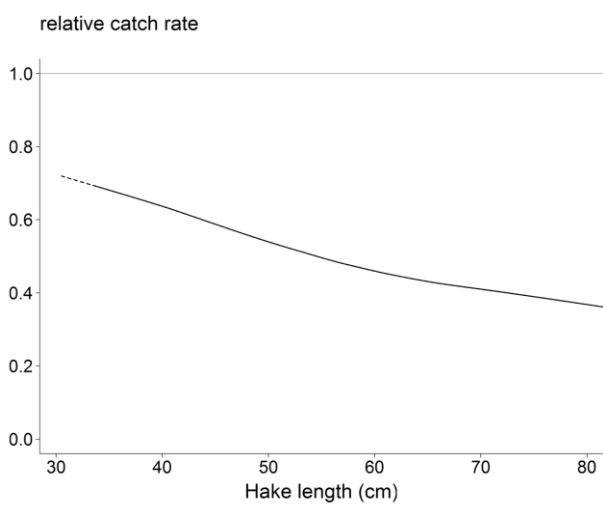
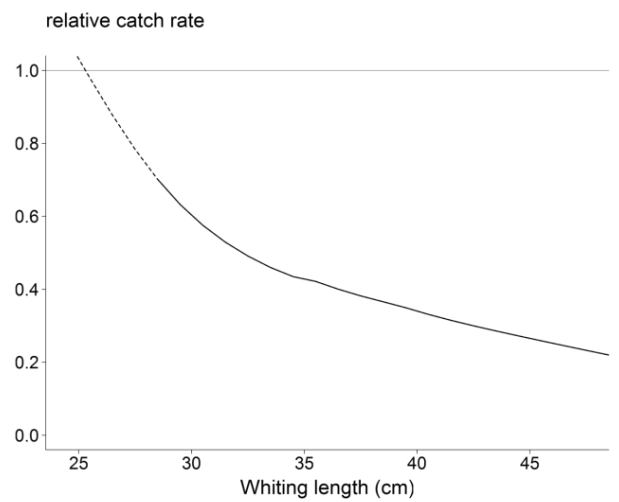
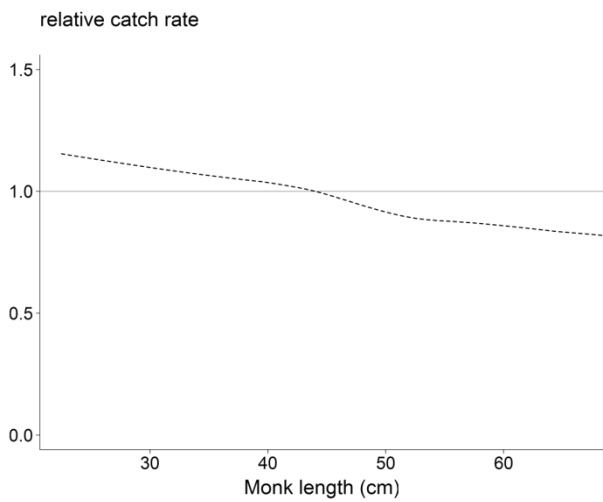
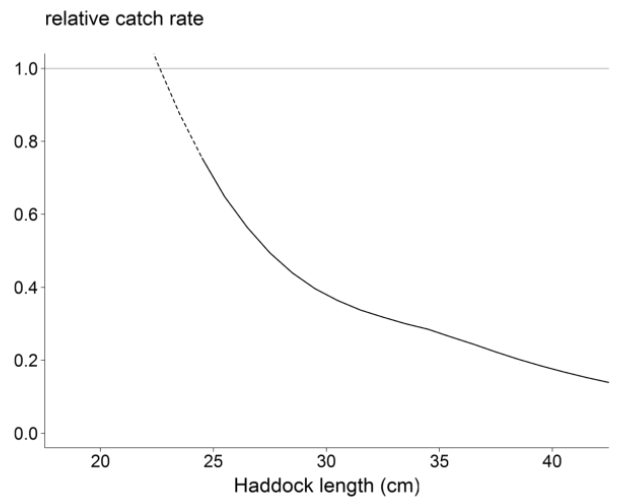
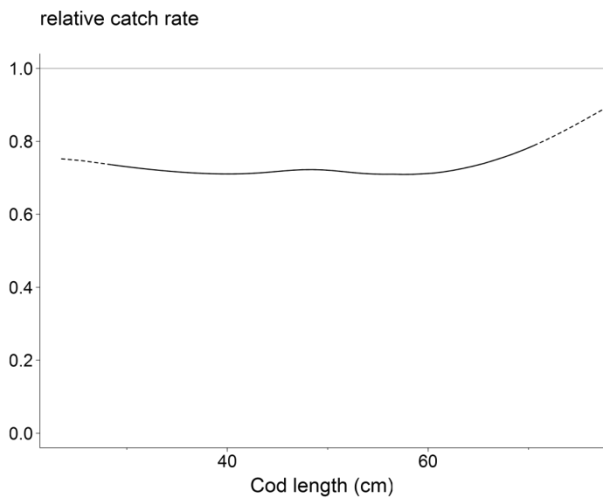
**Figure 3:** Bosom sections of the contrasting ground gear.



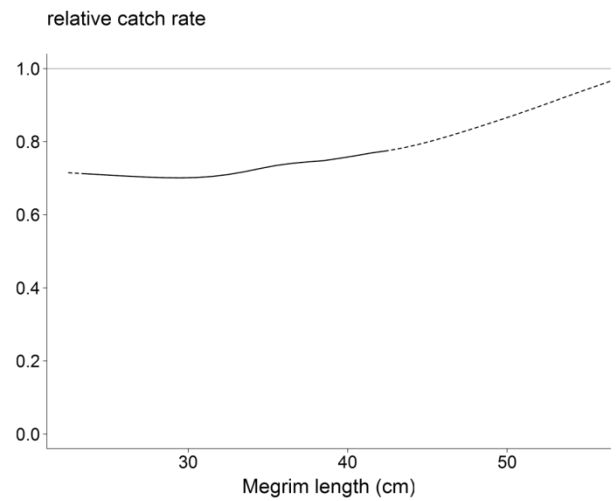
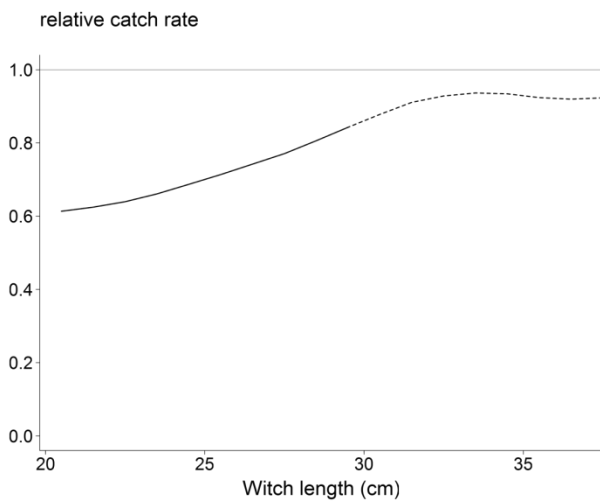
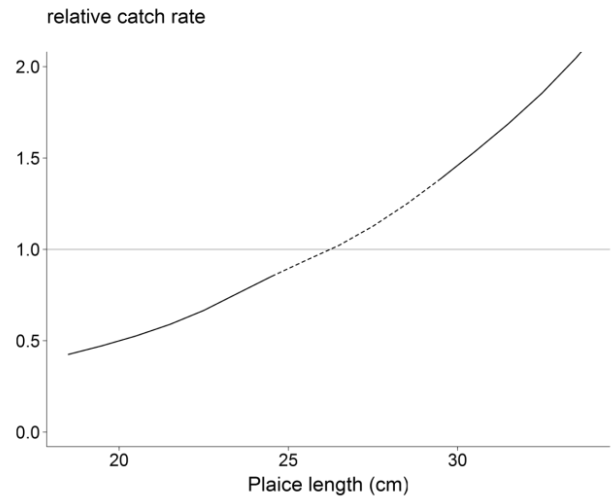
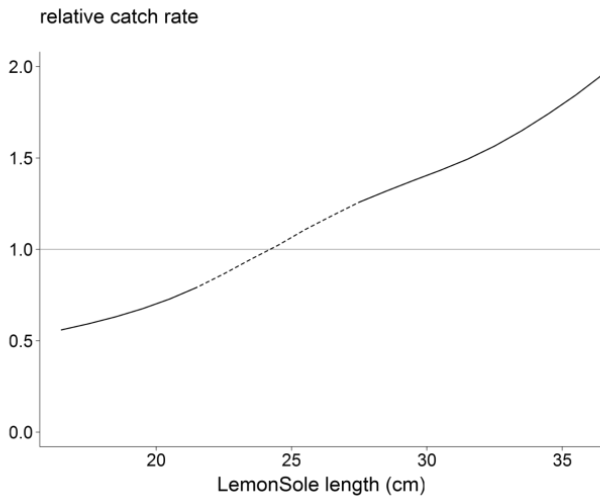
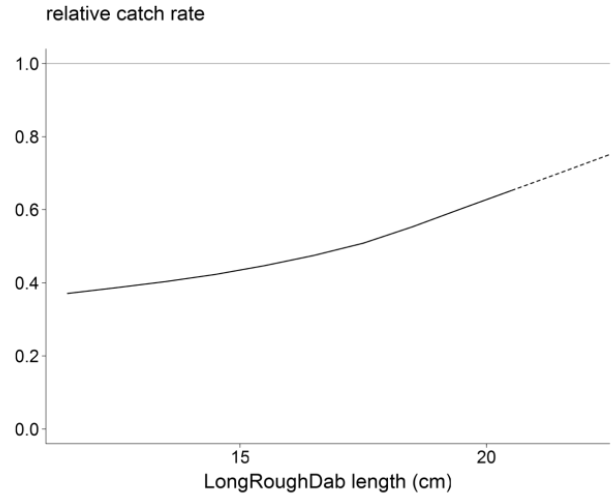
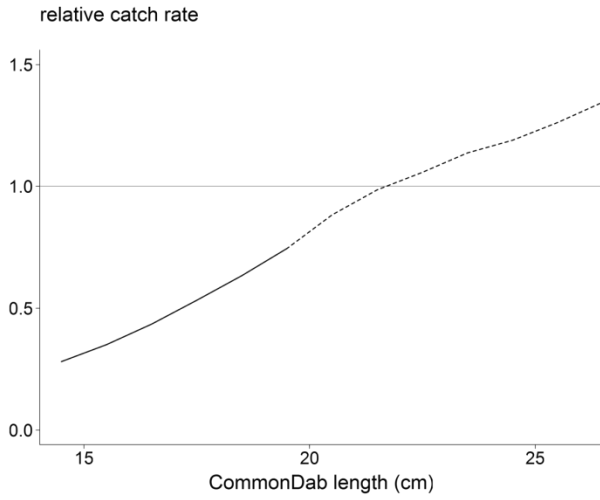
**Figure 4:** Total catch weight (kg) for each species in the control and test gear respectively. ns denotes that there was no significant difference in the catches between the gear for that species.



**Figure 5:** Total number of each of the species sampled during the trial from the control and test gear respectively.



**Figure 6:** Estimated catch rates for each round fish species for the test gear relative to the control gear. The lines are solid when the catch rate is significantly different from unity at the point-wise 5% significance and dashed otherwise.



**Figure 7:** Estimated catch rates for each flat fish species for the test gear relative to the control gear. The lines are solid when the catch rate is significantly different from unity at the point-wise 5% significance and dashed otherwise.