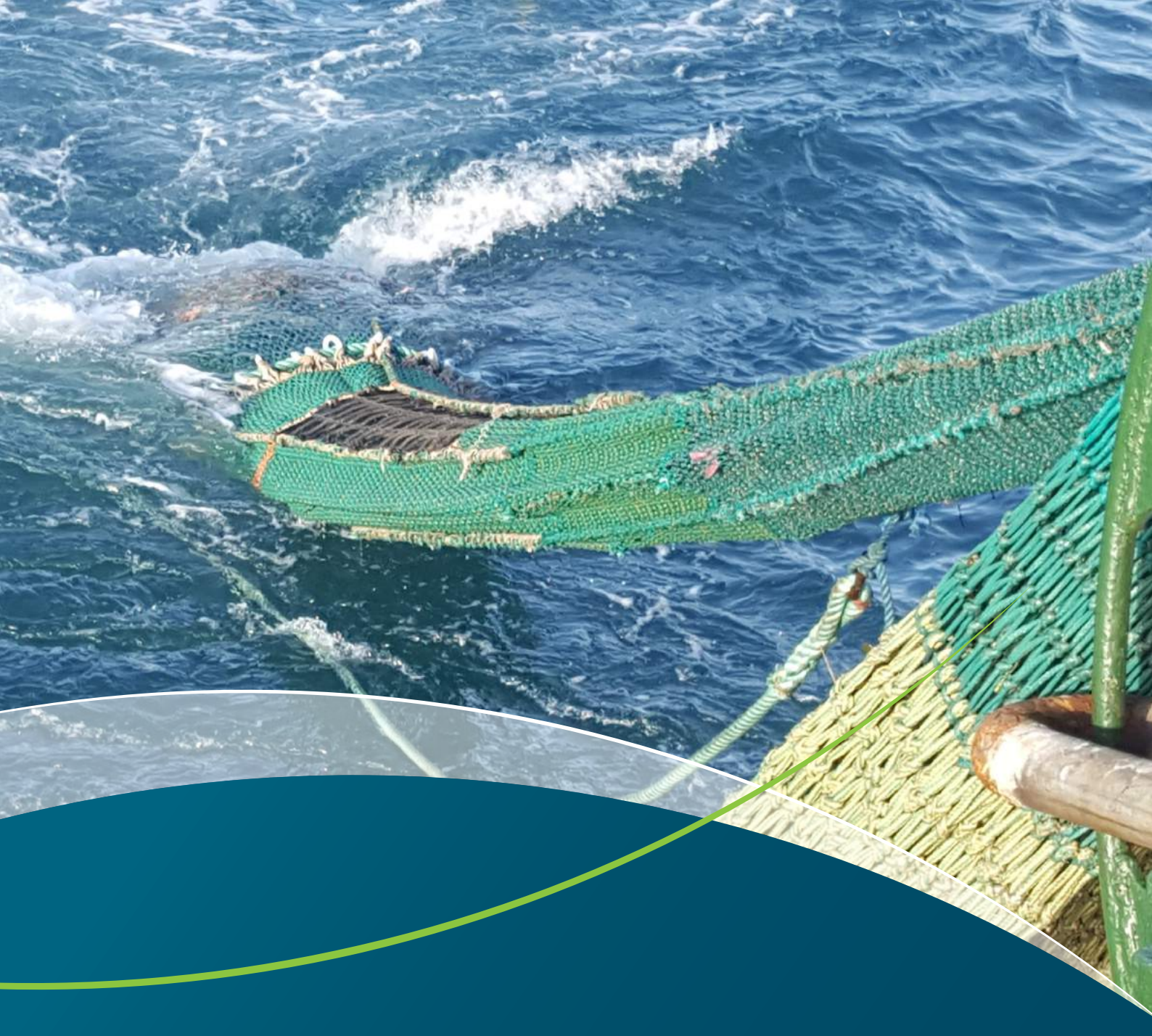

The SELTRA sorting box: A highly selective gear for fish in the Irish *Nephrops* fishery

Fisheries Conservation Report

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BIM Ireland's Seafood Development Agency

The SELTRA sorting box: A highly selective gear for fish in the Irish *Nephrops* fishery

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Key Findings

1. A preliminary trial of a SELTRA with a modified adapter was successful on board a quad-rig *Nephrops* vessel.
2. A full scale trial of a SELTRA with further modifications to the adapter was successful on board a twin-rig vessel.
3. Substantial reductions in fish catches in the SELTRA compared with a standard 300 mm square mesh panel e.g. 24% of whiting, 51% of haddock, 81% of cod and 74% of dogfish.
4. Nephrops catches improved by 19% in the SELTRA compared with a standard 300 mm square mesh panel.
5. Substantial reductions in catches of fish species in the SELTRA minimises catch sorting times leading to further improvements in catch quality and working conditions for the crew.
6. Any vessel which predominantly aims to catch *Nephrops* can benefit from using a SELTRA.
7. The SELTRA meets current legislative requirements and is fully eligible for grant-aid from BIM.

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Introduction

The Fisheries Conservation team in BIM assesses a range of gear modifications to reduce unwanted catches and address requirements under the EU landing obligation.

With a value of €49m at first point of sale in 2015, *Nephrops norvegicus* is Ireland's most commercially important demersal species. Unwanted fish bycatch is a major issue in *Nephrops* trawl fisheries (Catchpole *et al.*, 2005; Catchpole and Revill, 2008; Ungfors *et al.*, 2013; Nikolic *et al.*, 2015). New requirements to restrict discarding of demersal species raise challenges for the Irish fishing Industry to reduce catches of species such as whiting in the Irish Sea (Poseidon, 2013) and haddock in the Celtic Sea (Cosgrove *et al.*, 2015) in order to avoid negative economic consequences associated with the landing obligation.

A range of measures have recently been assessed by BIM to reduce unwanted fish catches in *Nephrops* trawls. A trial of a 300 mm square mesh panel (SMP) in the Irish Sea resulted in reductions across all size classes of haddock and whiting of 52% and 70% respectively with marginal increases in *Nephrops* and reductions in flatfish catches compared with a standard trawl (BIM, 2014). A standard rigid sorting grid achieved major reductions in all size classes of all fish species with a small loss (4%) of market sized *Nephrops* (Cosgrove *et al.*, 2016a). A dual codend with net separator panel effectively provided a means of separating fish from *Nephrops* catches, facilitating improved selectivity and significant reductions of undersize whiting (84%) and haddock (49%) while retaining marketable *Nephrops* and fish (Cosgrove *et al.*, 2016b). The dual codend has great potential to deal with a range of challenges posed by the landing obligation but some financial investment and legislative change will be required before widespread uptake occurs.

The SELTRA sorting box (henceforth, the SELTRA) consists of a four panel extension piece with a 300 mm SMP / escape window located in the top sheet 3 – 6 m from the codline. The codend is also four panels. The four panel design stabilises the vertical opening between the escape window and the bottom sheet, and this enhances *Nephrops* retention as they move passively along the bottom sheet. The vertical opening is also kept relatively narrow to optimise fish escapement as they actively swim into the codend. Designed to reduce cod catches in *Nephrops* trawl fisheries in the Kattegat and Skagerrak, the SELTRA has also achieved substantial reductions in flatfish and roundfish such as haddock (Madsen *et al.*, 2010). The device meets current legislative requirements in Ireland, is relatively simple in terms of construction, and requires minimal financial investment. Hence, the SELTRA has major potential to address issues with unwanted catches and challenges posed by the landing obligation in *Nephrops* fisheries.

In 2014 BIM tested different SELTRA configurations based on requirements under the Irish Sea cod management plan. Major reductions in whiting, haddock and cod were achieved but unacceptable losses ranging from 23 to 44% of market sized *Nephrops* also occurred. In 2015, a SELTRA was obtained directly from a Danish net maker who manufactured the device for commercial use in his locality. A short preliminary trial of this SELTRA was conducted in September 2015 on board the 24 m quad-rig vessel the MFV Stella Nova to assess if the gear was fit for purpose. A two panel adaptor section (16 x 60 meshes, length x width in each panel), constructed from 4.5 mm polyethylene (PE) twine was used to stabilise the connection between the SELTRA and the trawl body (Figure 1a). Collated catch weights revealed ~ 90% reductions in whiting and haddock with no loss in marketable *Nephrops* in the SELTRA compared with a standard trawl. Hence, the new gear was considered fit for purpose and a follow up full scale scientific trial was arranged on the 18 m twin-rig vessel MFV Ocean Breeze in September 2016. After 5 hauls during that trial it was observed that ~ 20% reductions of market sized *Nephrops* were occurring in the SELTRA compared with standard gear. The losses were attributed to a potential reduction in the vertical opening between the escape window and bottom sheet in the twin-rig gear. Hence, the SELTRA was further modified by expanding the two panel netting section ahead of the device with a view to maximising water flow and stabilising the vertical opening (Figure 1b). A further four hauls were conducted using the modified SELTRA as part of the MFV Ocean Breeze trial with good results both in terms of reducing fish catches while maintaining and even boosting *Nephrops* catches. A further successful trial was conducted on board the MFV Ocean Breeze in December 2016 to test the modified SELTRA against a trawl with a 300 mm SMP, a popular selectivity device used by Irish vessels under the cod management plan in the Irish Sea. Here, we outline the results from the latter two successful trials using the modified SELTRA in the Irish Sea.

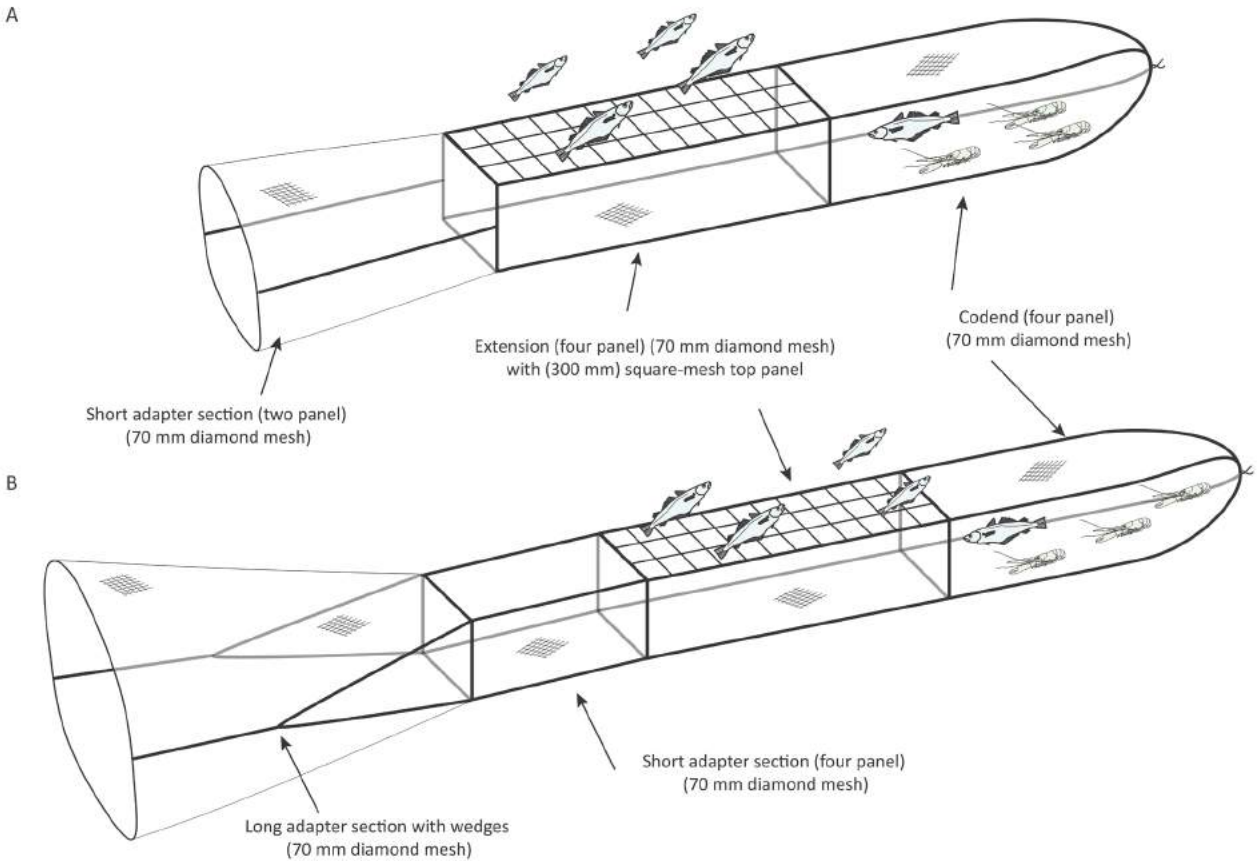

Figure 1. (A) The SELTRA with two panel adapter used in a preliminary trial on board a quad-rigger and (B) the SELTRA with a short four panel adapter and a longer adapter with wedge used successfully in trials 1 (T1) and 2 (T2) on board a twin-rigger.

Methods

Fishing operations and gear

Full scale trials were carried out on board the MFV Ocean Breeze (D.96), an 18m twin-rig vessel (Figure 2) in the Irish Sea (Figure 3). Trial one (T1) occurred during September and trial two (T2) during December 2016. Following onshore modification of the SELTRA, a total of 4 hauls were conducted in T1 during the latter half of a chartered gear trial. A total of 12 hauls were conducted during T2. Mean haul durations, towing speed and depth fished were ~ 4 h, 2.8 kt, and 55 m during both T1 and T2.

The two trawls were towed using a two-warp system that split into four, where the outer two split warps were attached to the trawl doors (Dunbar), and the inner two split warps were attached to a centre plate. The trawls were fished using 50 m single combination sweeps and 20 m double bridles giving 70 m overall sweep line length (Table 1). The mesh size in the top and bottom panels behind the headline and in the lower wing ends of the trawl was 80 mm while meshes in the upper wing ends were 150 mm. Trawls were rotated once during T2 so that potential differences in fishing power associated with net position could be assessed.

No SMP was used in the control gear during T1. In T2 the control had a 300 mm SMP mounted 9 - 12 m from the codline, an approved selectivity device commonly used in the Irish Sea. A four panel SELTRA sorting box with a 300 mm SMP located 3 – 6 m from the codline was used as the test gear in T1 and T2 (Table 2, Figure 4).

Using the protocol from Fonteyne *et al.* (2007), the Omega gauge was used to measure codend mesh sizes (Table 2). The codend in the control gear in T1 and T2 consisted of a standard two panel 70 mm (nominal) diamond mesh codend, where each panel was constructed using single 6 mm (nominal) braided compact PE twine with 50 × 60 meshes (length × width). The SELTRA extension piece was constructed using three identical diamond mesh panels (50 × 34 meshes of 70 mm, 6 mm PE) and one square-mesh (17 × 3 meshes, 300 mm, 8 mm PE). The SELTRA codend was constructed using four identical panels (31 × 30 meshes, 70 mm, 6 mm PE).

Following initial teething problems with the SELTRA on board the MFV Ocean Breeze, the connection between the SELTRA and the trawl was further modified: a short four panel adapter section (16 x 30), constructed from 4.5 mm PE twine, was used to transition from a long adaptor section to the SELTRA. The long adapter section was 3.5 mm PE twine, 90 meshes long with a wedge allowing a more stable connection between the two panel trawl and the short four panel adaptor (Figure 1b). For a detailed net plan of the SELTRA (and adaptor sections), please see Appendix I.

Figure 2. The trial vessel (T1 and T2), MFV *Ocean Breeze* (D.96)

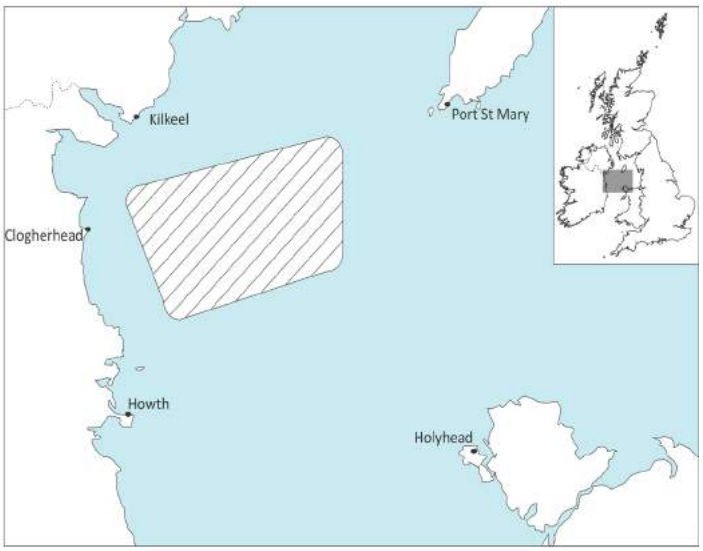

Figure 3. Location of trials T1 and T2 (hatched area).

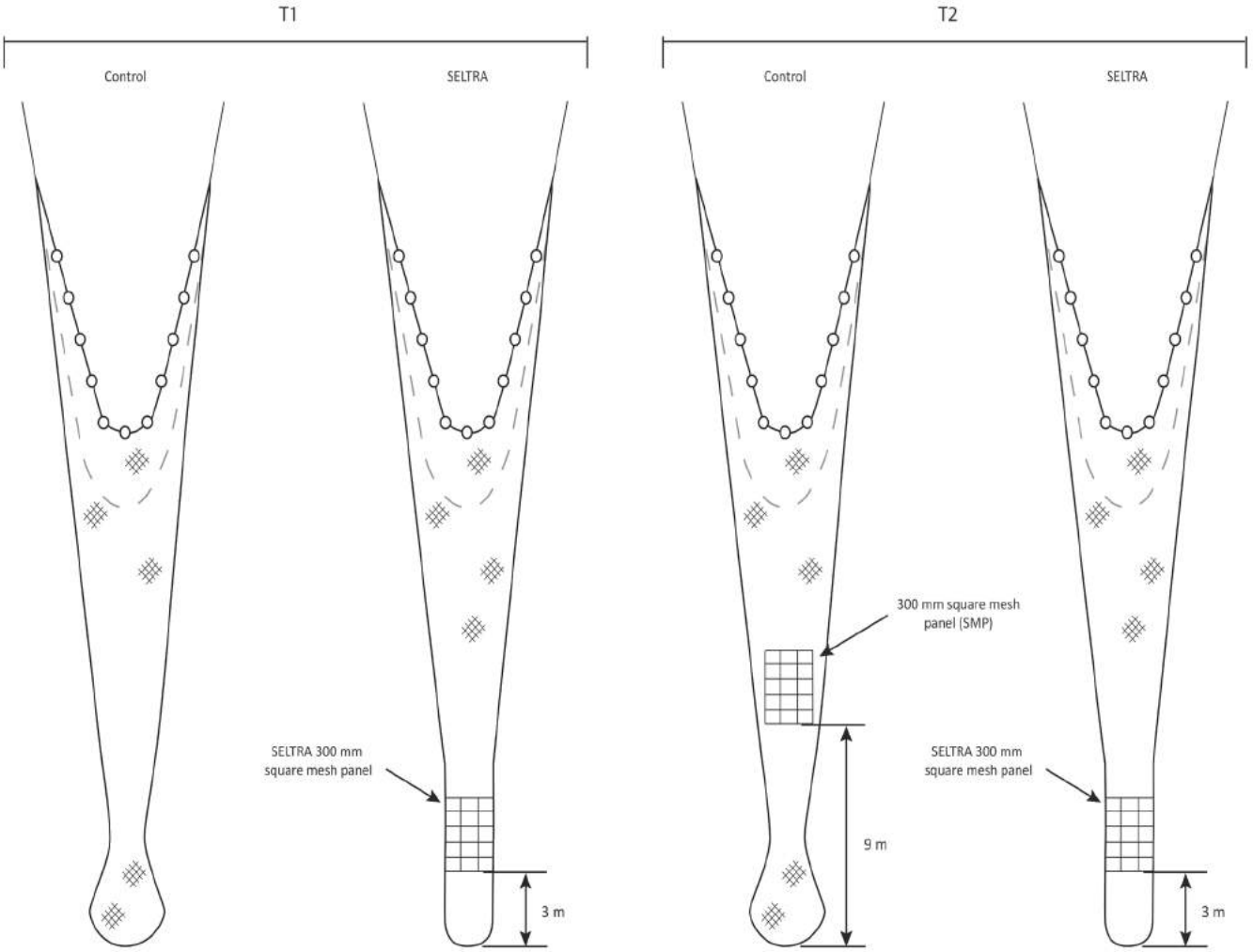

Figure 4. Locations of the square mesh panels (SMP) in T1 and T2 viewed from above.

Sampling and analysis

Total catches were weighed and sorted to species level. The total weight of each commercial species was recorded in addition to a random representative subsample. Cumulative total weight of non-commercial species such as mixed flatfish, small pelagic and crabs was also obtained and categorised as discards. The weights of commercial flatfish species were obtained separately but subsequently combined due to relatively low quantities. Total lengths (TL) of commercial fish species were measured to the nearest cm below while *Nephrops* carapace lengths (CL) were measured to the nearest mm below. Digital callipers linked wirelessly to a Toughbook pc were used to measure the *Nephrops*. Tables and length frequency distributions were constructed for total numbers and weights of key species caught during the trial. Length weight relationships available from the Marine Institute and Fishbase.org were used to estimate key species catch weights ≥ or < minimum conservation reference size (MCRS) for comparative purposes. Multinomial modelling of proportional catch at length (Browne *et al.*, 2017) was used to statistically assess differences in catches of key species in the SELTRA compared with the 300 SMP control gear in T2. Length, catch weight per codend, net position, and day/night were included as covariates in the models.

Table 1. Gear Specification in T1 and T2

Trawl type	Twin-rig *Nephrops*
Trawl manufacturer	Pepe Trawls Ltd.
Headline length (m)	36
Footrope length (m)	40
Fishing-circle (meshes × mm)	380 x 80
Sweep length (m)	2 × 70 (20 + 50)
Warp diameter (mm)	16
Door manufacturer	Dunbar
Door weight (kg)	280
Engine power (kw)	224

Table 2. Characteristics of codends, SELTRA, and square mesh panels (SMP)

Characteristic	T1 Control	T1 SELTRA	T2 Control	T2 SELTRA
Nominal mesh size (mm)	70	70	70	70
Measured mesh size (mm)	77	75	76	73
Standard deviation (mm)	1.32	1.54	1.69	2
Cod end circumference (mesh no.)	120	120	120	120
300 mm SMP location from codline (m)	—	3–6	9–12	3–6

Results

The SELTRA achieved substantial reductions in catches of most fish species compared with the standard control gear in T1 and the 300 mm SMP control gear in T2 (Table 3). This did not apply to monkfish or ray which are generally too big to pass through the SELTRA escape window. Greater reductions in fish catches occurred in T1 due to the absence of a SMP in the control gear in that trial. *Nephrops* catches in the SELTRA increased by 9% and 19% in T1 and T2, respectively, compared with control gears. A total of 3 cod were caught in T1 which was insufficient to produce a proportional difference in catches between the two gears. An 81% reduction in cod catches occurred in the SELTRA compared with the 300 mm SMP control gear in T2. Catches of commercial flatfish species were reduced by 55% and 69% respectively in T1 and T2 but these species formed a relatively minor component of marketable catches which predominantly consisted of *Nephrops*. Relatively large catches of lesser spotted dogfish occurred, particularly in T2 where there were almost 3 times more of this species than any other species in the control gear. A 74% reduction in lesser spotted dogfish catches in T2 demonstrated that the SELTRA is considerably more effective in reducing catches of this species compared with a standard 300 mm SMP. Mean bulk weights per haul were significantly higher in the SELTRA compared with the control gear in both trials (Paired t-test, $P < 0.05$).

Categorisation of key species in relation to MCRS revealed that catches of the main commercial fish species, whiting and haddock were mostly below MCRS. A larger reduction in undersize whiting occurred in T1 due to the absence of a SMP in that trial (Table 4, Figure 5). Little difference in catches of very small whiting (~ <20 cm) occurred in either trial but substantial reductions, significantly so in T2, were evident for larger whiting (~ ≥ 20 cm) in both trials (Figure 5 & 6). Major reductions in catches of haddock ≥ and < MCRS occurred in both trials. Larger scale reductions were evident in T1 due to the absence of a SMP in the control gear. Similar to whiting, no significant difference in catches of very small haddock (~ <15 cm) occurred in the SELTRA compared with the 300 mm SMP control gear in T2 (Figure 6). Over 95% of the *Nephrops* catches by weight in all gears were > MCRS. The SELTRA retained significantly more midsized *Nephrops* (~ 20 - 30 mm CL) compared with the 300 mm SMP control gear in T2 (Figure 6).

Multinomial modelling of proportional catches in T2 revealed that net position was not significant. Catch weight and fish/*Nephrops* length were significant for all species. Day/night was significant with the SELTRA retaining proportionally less whiting and haddock during night and day time compared with the 300 mm SMP control gear.

Table 3. Total quantities of species and percentage differences (Δ) between the control and SELTRA gears in T1 and T2

Species	T1 Control (kg)	T1 SELTRA (kg)	T1 Δ (%)	T2 Control (kg)	T2 SELTRA (kg)	T2 Δ (%)
Whiting	152	66	-57	362	277	-24
Haddock	126	12	-91	639	314	-51
Nephrops	362	396	9	610	725	19
Cod	—	—	—	43	8	-81
Commercial flatfish	20	6	-69	118	53	-55
Lesser spotted dogfish	351	25	-93	1617	419	-74
Monkfish	5	9	72	123	107	-12
Ray	—	—	—	129	103	-20
Discards	264	142	-46	575	432	-25
Bulk catch	1308	688	-47	4229	2578	-39
Mean bulk catch per haul	327	172	-47	352	215	-39

Table 4. Estimated total quantities of key species in relation to minimum conservation reference sizes (MCRS)

Species	Category	T1 Control (kg)	T1 SELTRA (kg)	T1 Δ (%)	T2 Control (kg)	T2 SELTRA (kg)	T2 Δ (%)
Whiting	< 27 cm	118	55	-53	329	271	-18
	≥ 27 cm	27	5	-83	31	8	-74
Haddock	< 30 cm	89	10	-89	401	183	-54
	≥ 30 cm	38	1	-98	268	151	-44
Nephrops	< 20 mm	16	11	-33	9	8	-16
	≥ 20 mm	327	389	19	565	700	24

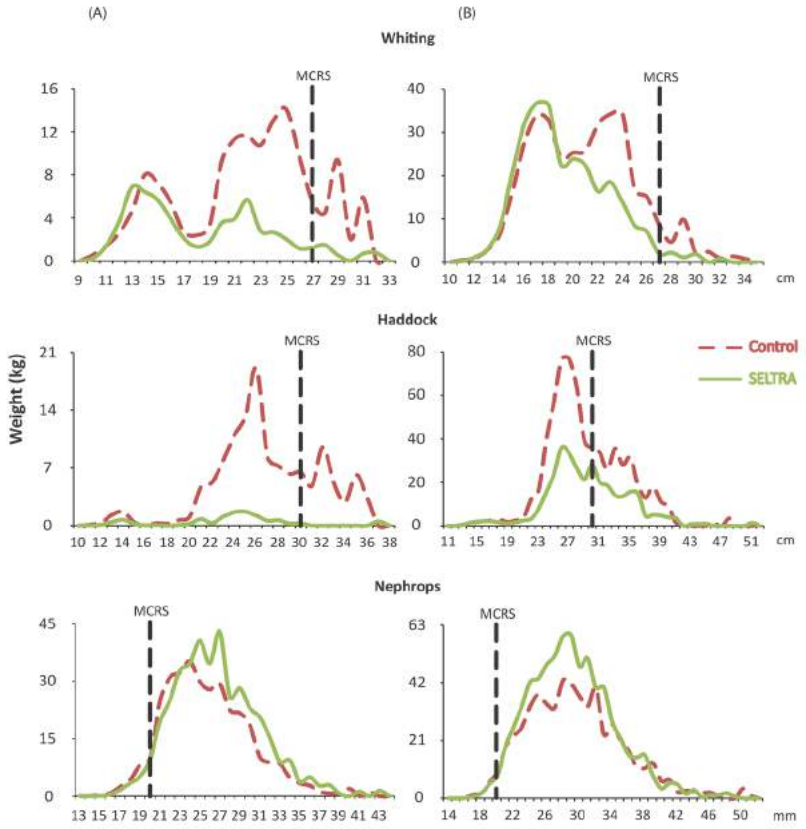

Figure 5. Length frequency distributions of the three main species (whiting, haddock and *Nephrops*) from (A) T1 and (B) T2 for the control and SELTRA codend configurations.

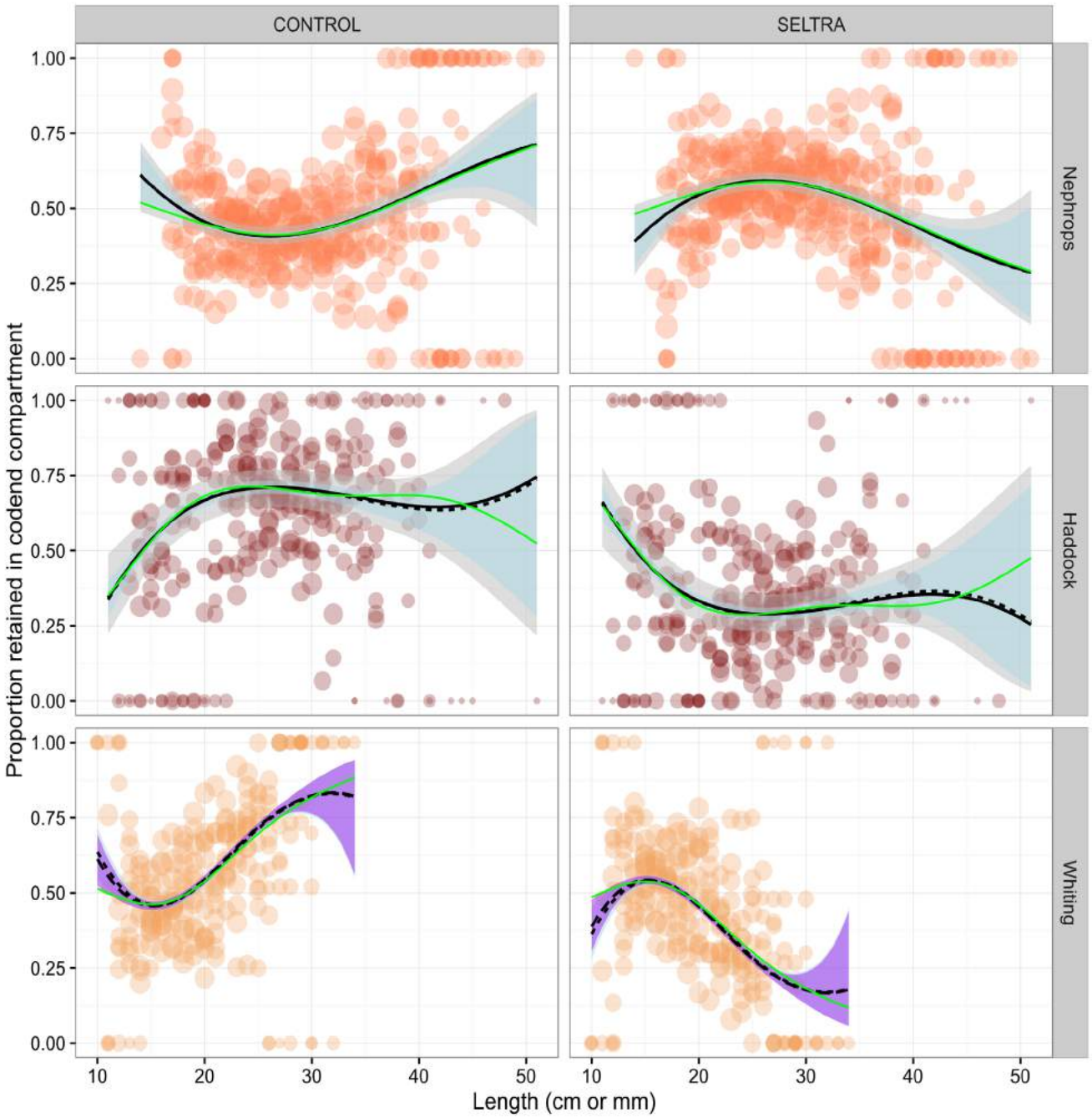

Figure 6. Proportion of catch per length-class retained in the test and control compartments. Points represent the data and lines and bands the fitted and 95% confidence intervals on the fitted proportions, respectively. Predictions from the best fitting models as judged by AIC and BIC are plotted along with a straightforward GAMM for comparison. The size of the point is proportional to the log of the count.

Discussion

The results of this study demonstrate that the SELTRA is highly effective at reducing fish catches in *Nephrops* trawls. Any vessel which predominantly targets *Nephrops* can benefit from this gear which is eligible for BIM grant aid. The dual codend remains a good option for vessels that want to catch *Nephrops* and fish, while the latter or a Swedish grid can be used as fish exclusion devices when required.

A two panel adapter worked well on a 24 m quad-rig vessel while further modification of the connection between the SELTRA and the trawl was required on board an 18 m twin-rig vessel. Towing speeds were similar during operations on both of these vessels but longer wing-ends and higher opening trawls on board the quad-rigger may have assisted in improving water flow and effectiveness of the original SELTRA.

The four panel SELTRA with SMP located 3 – 6 m from the codline was considerably more effective at reducing fish catches and retaining *Nephrops* compared with a standard two panel cod end with a 300 mm SMP located 9 – 12 m from the codline. In general, the closer to the codend the escape window is located, the higher the rate of escapement of whiting and haddock in *Nephrops* trawls (Catchpole and Revill, 2008). This explains the substantial reductions in fish catches in the SELTRA compared with the 300 mm SMP control gear in T2. The SELTRA was comparable to other gears in its effectiveness at reducing catches of very small whiting (~ <20 cm) and haddock (~ <15 cm). This was likely due to the failure of such fish to actively pass through the escape window in the SELTRA. Simple measures such as attaching cable ties, streaming upwards from the bottom sheet (NOAA, 1993) or a net flapper hanging from the top sheet at the rear of the SELTRA could assist in stimulating such small fish to swim upwards and out through the escape window. Alternatively, gear measures such as the dual codend with net separator panel or Swedish grid are also highly effective at reducing whiting catches across all size classes (Cosgrove *et al.*, 2016a; Cosgrove *et al.*, 2016b).

Greater *Nephrops* retention in the SELTRA provides a major additional incentive to use the gear and was likely primarily caused by greater trawl stability resulting in fewer *Nephrops* passing through the escape window. The four panel codend and extension piece in the SELTRA provides a more stable vertical opening between the top and bottom sheets compared with the two panel designs used in standard 300 mm SMP gear (Madsen *et al.*, 2015). Reduced vertical opening in the two-panel gear likely assists in fish escapement but may also result in *Nephrops* passing through the 300 mm SMP, particularly when net geometry changes during manoeuvres such as altering course. Anecdotal reports from Irish fishermen about losing *Nephrops* in standard 300 mm SMP gear support this suggestion. Bulk catch weight is known to influence codend mesh openings and has been shown to be negatively correlated with *Nephrops* retention in the codend (Browne *et al.*, 2017). Hence, significantly lower mean bulk catch weights in the SELTRA compared with the 300 mm SMP control gear may have also contributed to higher *Nephrops* catches in the SELTRA.

Major reductions in cod catch in the SELTRA compared with the 300 mm SMP control gear suggest that the SELTRA is a superior option for cod conservation. Substantial reductions in catches of lesser spotted dogfish in the SELTRA compared with the 300 mm SMP control gear have major potential to boost the quality and value of the catch. Substantial reductions in catches of all fish species in the SELTRA can greatly reduce catch sorting times, further boost catch quality, and improve working conditions for the crew.

References

BIM. 2014. Assessment of a 300 mm square-mesh panel in the Irish Sea *Nephrops* fishery. Irish Sea Fisheries Board (BIM), Fisheries Conservation Report. 5 pp.

Browne, D., Minto, C., Cosgrove, R., Burke, B., McDonald, D., Officer, R., and Keatinge, M. 2017. A general catch comparison method for multi-gear trials: application to a quad-rig trawling fishery for *Nephrops*. ICES Journal of Marine Science. doi: 10.1093/icesjms/fsw236.

Catchpole, T., Frid, C., and Gray, T. 2005. Discards in North Sea fisheries: causes, consequences and solutions. Marine Policy, 29: 421-430.

Catchpole, T., and Revill, A. 2008. Gear technology in *Nephrops* trawl fisheries. Reviews in Fish Biology and Fisheries, 18: 17-31.

Cosgrove, R., Graham, N., Moore, S.J., Kelly, E., Curtin, R., and Keatinge, M. 2015. At sea simulation of the operational and economic impacts of the landing obligation on Irish demersal fisheries. Report to the Discard Implementation Group. 13 pp.

Cosgrove, R., Browne, D., and McDonald, D. 2016a. Assessment of rigid sorting grids in an Irish quad-rig trawl fishery for *Nephrops*. Irish Sea Fisheries Board (BIM), Fisheries Conservation Report, February 2016. 9 pp.

Cosgrove, R., Browne, D., Tyndall, P., McHugh, M., Oliver, M., Minto, C., Burke, B., *et al.* 2016. Assessment of a dual codend with net separator panel in an Irish *Nephrops* fishery. Irish Sea Fisheries Board (BIM), Fisheries Conservation Report, December 2016. 12 pp.

Fonteyne, R., Buglioni, G., Leonori, I., and O'Neill, F. G. 2007. Review of mesh measurement methodologies. Fisheries Research, 85: 279-284.

Madsen, N., Frandsen, R. P., Holst, R., and Krag, L. A. 2010. Development of new concepts for escape windows to minimise cod catches in Norway lobster fisheries. Fisheries Research, 103: 25-29.

Madsen, N., Hansen, K., and Madsen, N. A. 2015. Behavior of different trawl codend concepts. Ocean Engineering, 108: 571-577.

Nikolic, N., Diméet, J., Fifas, S., Salaün, M., Ravard, D., Fauconnet, L., and Rochet, M.-J. 2015. Efficacy of selective devices in reducing discards in the *Nephrops* trawl fishery in the Bay of Biscay. ICES Journal of Marine Science: Journal du Conseil, 72: 1869-1881.

NOAA. 1993. Technical Memorandum, NMFS SEFC 327, Status report on the potential of gear modifications to reduce finfish bycatch in shrimp trawls in the southeastern United States 1990 - 1992. 131.

Poseidon. 2013. A case study review of the potential impact of proposed CFP discard reform. Poseidon report to Seafish UK. 55 pp.

MI. 2015. The Stock Book 2015 : Annual Review of Fish Stocks in 2015 with Management Advice for 2016. Galway, Ireland, 624 pp.

Poseidon. 2013. A case study review of the potential impact of proposed CFP discard reform. Poseidon report to Seafish UK. 55 pp.

Ungfors, A., Bell, E., Johnson, M. L., Cowing, D., Dobson, N. C., Bublitz, R., and Sandell, J. 2013. Chapter Seven - *Nephrops* Fisheries in European Waters. In Advances in Marine Biology, pp. 247-314. Ed. by L. J. Magnus, and P. J. Mark. Academic Press.

Acknowledgements

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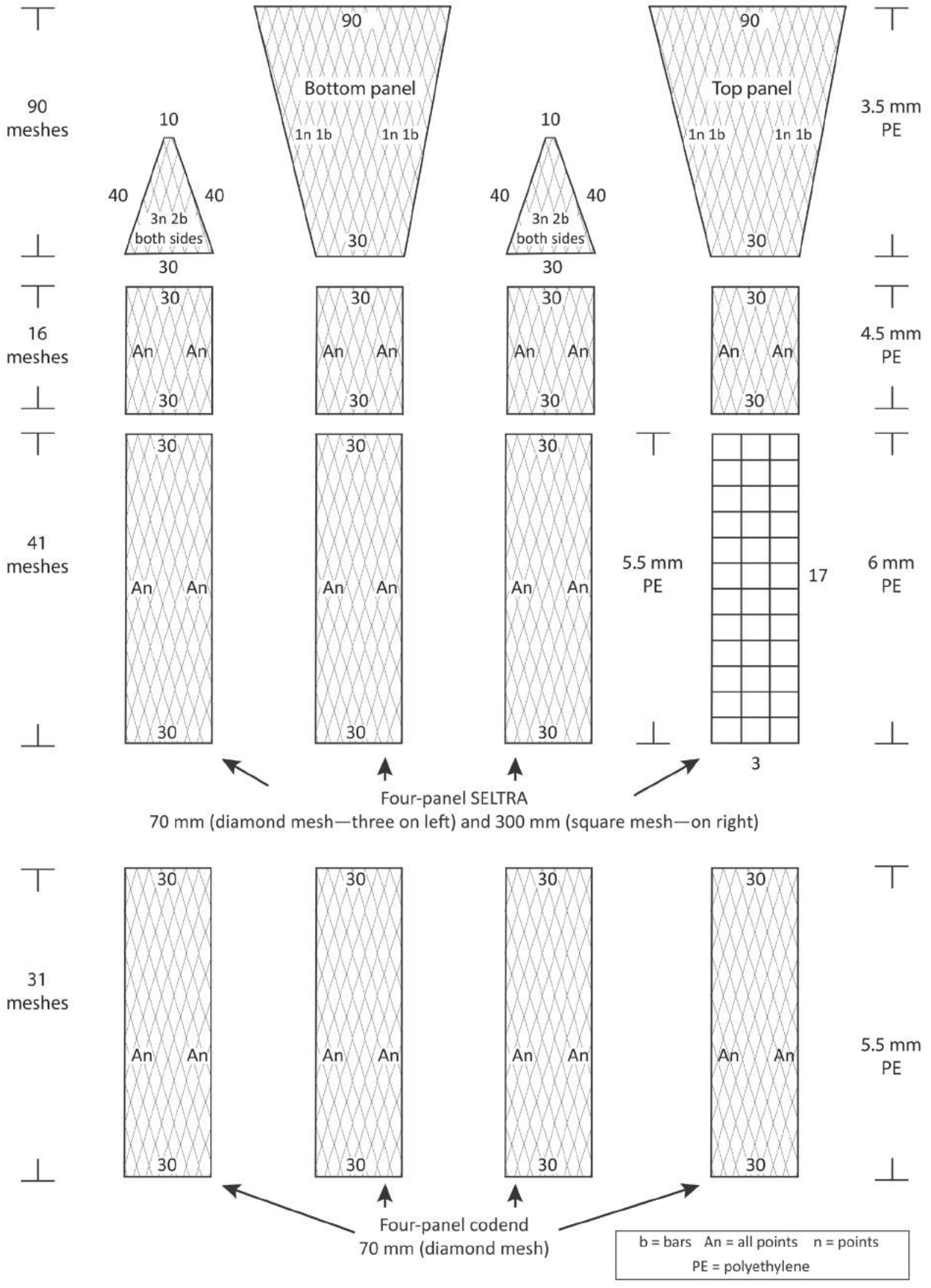
Appendix I

Net plan of SELTRA used in trials on board the MFV Ocean Breeze



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