Assessment of a SELTRA sorting box with 90 mm codend mesh size in the Irish Sea *Nephrops* fishery

Fisheries Conservation Report

October 2018

BIM
Ireland's Seafood Development Agency

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Key Findings

1. Catches of small whiting were reduced by 78%.
2. Reductions in *Nephrops* catches mainly occurred for tail grades with a total loss in *Nephrops* catch value of 11%.
3. The SELTRA 90 is the least prohibitive gear modification in terms of reduced *Nephrops* catch value.
4. Increases in codend mesh size are unlikely to be of benefit in improving whiting conservation in the Irish Sea.

Ireland's EU Structural and Investment Funds Programmes 2014 - 2020
Co-funded by the Irish Government and the European Union

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

EUROPEAN UNION
This measure is part-financed by the European Maritime and Fisheries Fund

Introduction

BIM and the Irish Fishing Industry have tested a range of gear modifications aimed at reducing catches of whiting, a major potential choke species in the Irish Sea *Nephrops* fishery. Gears such as the 300 mm square mesh panel (SMP) and SELTRA sorting box with 80 mm mesh size codends achieve large reductions in catches of whiting and haddock but are ineffective for very small whiting (< 20 cm) which can form a major component of the catch (BIM, 2014; ICES, 2017; Tyndall et al., 2017). Floating Dyneema sweeps and fish scaring ropes mounted ahead of the trawl with a view to counter acting the herding effect of the sweeps failed to reduce catches of very small whiting (Browne et al., 2017). The Swedish grid can be effective in this regard but can also be associated with handling difficulties (Graham and Fryer, 2006).

A proposal by the European Commission to increase codend mesh size from 80 to 90 mm in the Irish Sea (EC, 2017), lead to the North Western Waters Advisory Council requesting BIM to examine the issue. The resulting study, employing gears currently in use by the Irish fleet, observed a 60 % reduction in < 20 cm whiting but also a 33% reduction in market sized *Nephrops* by increasing the codend mesh size from 80 to 90 mm. This is in contrast to Cosgrove et al., (2015) who observed a reduction of ~ 60 % of whiting < 20 cm and an 11% reduction in market sized *Nephrops* by increasing the codend mesh size from 80 to 90 mm. However, the latter trial employed 120 mm SMPs and restricted the mesh size increase to the codend whereas the former employed 300 mm SMPs and the same mesh size in the extension piece and codend as currently used by Irish vessels. Results of these studies suggested that restricting the mesh size increase to the codend and not the extension piece might assist in maintaining *Nephrops* catches while reducing whiting catches.

A further trial was conducted in May 2018 to address this issue. This involved comparing catches from a trawl with 80 mm mesh in the codend and extension piece with: a trawl with 90 mm mesh in the codend and extension piece; a trawl with 90 mm mesh restricted to the codend. These trawls had 300 mm SMPs mounted 9 – 12 m from the codline to be consistent with the gear used by Irish vessels. The ground was extremely soft during the trial and it was difficult to maintain door spread and obtain reliable results. It was observed, however, that restricting the mesh size increase to 90 mm in the codend and not the extension piece did not improve *Nephrops* retention. Different mesh size ranges have different permitted maximum codend circumferences and this type of measure would in any case be technically difficult to implement and enforce. A SELTRA with a 300 mm SMP and 90 mm was also tested with promising results but required further investigation given the operational issues encountered.

This study aimed to compare catches from a SELTRA sorting box with 90 mm codend, with a standard two panel trawl with a 300 mm SMP and 80 mm codend. The pros and cons of relevant gear modifications in reducing whiting bycatch in the Irish Sea *Nephrops* fishery are discussed.

Methods

Fishing vessels and gear

A catch comparison trial was conducted in the western Irish Sea (Figure 1) in June 2018 on board an 18 m vessel. Trawl gear comprised 2 x 37 m footrope *Nephrops* trawls towed using two warps in a half quad-rig configuration (Figure 2). The mesh size used in the trawls was 160 mm in the upper wings with 80 mm used for the remaining top and bottom panels. The test gear consisted of a four-panel 90 mm SELTRA sorting box with a 300 mm SMP mounted 3.7 m metres from the codline (henceforth, SELTRA 90). The standard gear consisted of a two-panel aft section with a 300 mm SMP and 80 mm codend (henceforth, Standard 80) (Figure 3). Both gears complied with the maximum legal circumference of 120 meshes round for 80 mm and 100 meshes round for 90 mm mesh size codends. A lifting strap was present on both gears while a cover bag was only present on the Standard 80 gear in line with Industry practice in the area. Test gears were rotated once halfway through the trial to permit any potential difference in fishing power between the trawls to be accounted for in subsequent analyses.

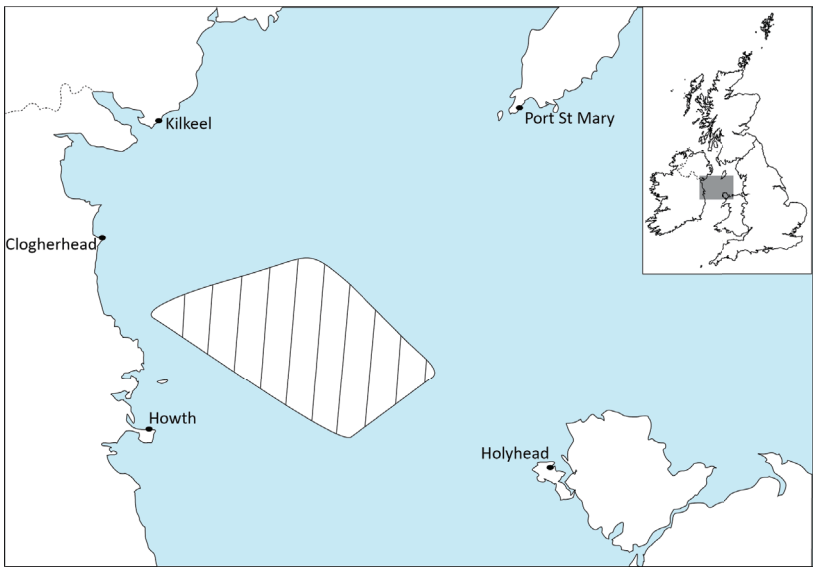

Figure 1. Location of trial (hatched area) within the western Irish Sea (FU 15, ICES 7a)

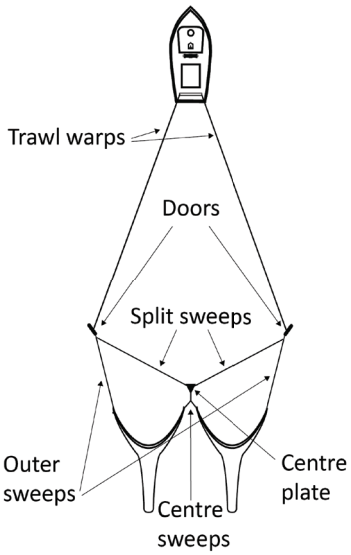

Figure 2. The half quad-rig trawl configuration

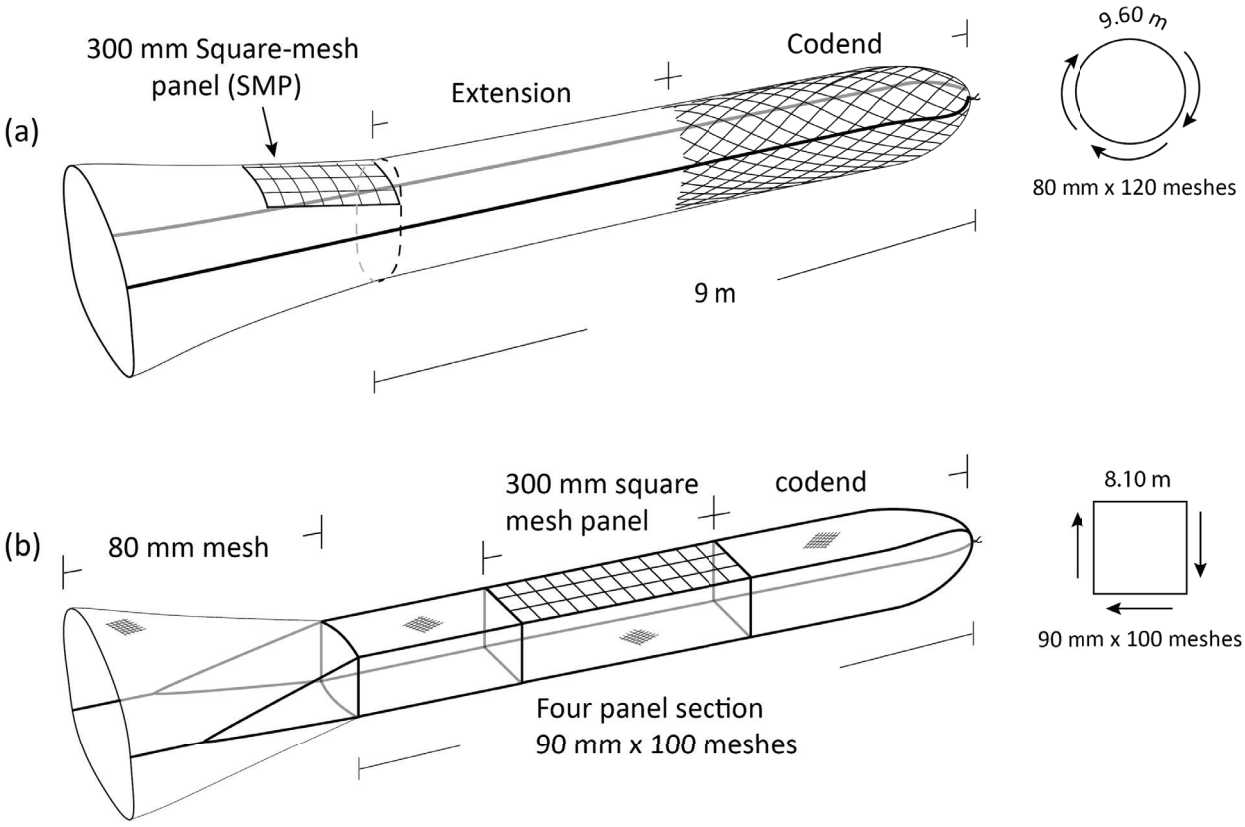

Figure 3. The Standard 80 (a) and SELTRA 90 (b) gears with their respective mesh sizes and codend circumferences.

Sampling and analysis

Total catches were weighed and sorted at haul level for key species with random representative subsamples also taken for *Nephrops* in order to facilitate length-frequency comparison. Total length (TL) of commercial fish species was measured to the nearest cm below and *Nephrops* carapace length (CL) was measured to the nearest mm below. The exploitation rate is similar between male and female *Nephrops* in the Western Irish Sea (MI, 2017), and hence, the length-weight relationship used for males in Briggs et al., (1999), $X = 0.00032CL^{3.21}$, was applied to obtain estimated *Nephrops* weight at length values for comparative purposes. Length-weight relationships for whiting and haddock, $X_{WHI} = 0.0060TL^{3.1070}$ and $X_{HAD} = 0.0080TL^{3.0669}$, from Silva et al., (2013) were also applied to allow comparison of estimated weight at length for these species. A Generalised Additive Model (GAM) was used to predict the proportion of overall whiting, haddock and *Nephrops* catches at length retained in the SELTRA 90 compared with the standard 80 gear. Measured mesh sizes were obtained with an Omega gauge (Fonteyne et al., 2007) and are presented in Table 1. Price data from Browne et al., (2018) was used to estimate the value of *Nephrops* catches and facilitate comparison between trials.

Results

A total of 12 hauls were carried out over four consecutive days. Mean haul duration, towing speed and depth were 04:00 h, 2.8 kt and 73 m respectively. The weather was exceptionally calm with wind speeds of 1 to 11 km/h or Beaufort Force 0 to 2. The main fish species caught during the trial were whiting, haddock and lesser-spotted dogfish. Catches (kg) of these key fish species were substantially reduced by 61% to 72% in the SELTRA 90. *Nephrops* catches were also reduced by 20% (Table 2).

The SELTRA 90 was highly effective in reducing catches of very small gadoid fish with 78% and 69% reductions by weight respectively for whiting and haddock < 20 cm (Table 3 and 4, Figure 4). Reductions in *Nephrops* were more evident for smaller *Nephrops* with a 34 % reduction by weight in *Nephrops* < 25 mm. The total loss in commercial value of *Nephrops* was 11%. Broken down by size grade, the largest reduction in value occurred for tail grade *Nephrops* (28%). Larger whole grade *Nephrops* were reduced by 8% in value (Table 5). The GAM model confirmed significant reductions in ~ < 30 cm whiting, ~ < 40 cm haddock and ~< 35 mm CL *Nephrops* (Figure 5).

Table 1. Vessel and gear specification

Engine power (kW)	224
Warp diameter (mm)	16
Door manufacturer	Dunbar
Door weight (kg)	320
Outer sweep length (m)	70
Split sweep length (m)	50
Centre sweep length(m)	20
Trawl manufacturer	Pepe trawls Ltd.
Trawl type	Half quad-rig
Headline length (m)	36
Footrope length (m)	40
Fishing circle	380 x 80
Measured 80 mm codend mesh size (mm)	84.4
Measured 90 mm codend mesh size (mm)	92.3

Table 2. Total species catch weights (kg) and % difference in test gears

Species	Standard 80	SELTRA 90	Difference (%)
Bulk catch	2364	1481	-37
Nephrops	1163	896	-23
Haddock	280	90	-68
Whiting	59	16	-72
Cod	39	4	-90
Monk	30	42	41
Flatfish	93	45	-51
Lesser spotted dogfish	226	88	-61
Fish discards	163	99	-40
Non fish discards	180	122	-32

Table 3. Counts (N) and estimated weights (kg) of whiting in test gears

	Standard 80	SELTRA 90
Whiting total count (N)	1155	280
Δ 80 mm (%)		-76
≥ 27 cm TL (N)	15	8
Δ 80 mm (%)		-47
< 27 cm TL (N)	1140	272
Δ 80 mm (%)		-76
< 20 cm TL (N)	987	223
Δ 80 mm (%)		-77
Whiting total weight (kg)	58	15
Δ 80 mm (%)		-74
≥ 27 cm TL (kg)	4	2
Δ 80 mm (%)		-56
< 27 cm TL (kg)	54	13
Δ 80 mm (%)		-75
< 20 cm TL (kg)	42	9
Δ 80 mm (%)		-78

Table 4. Counts (N) and estimated weights (kg) of haddock in test gears

	Standard 80	SELTRA 90
Haddock total count (N)	3364	1077
Δ 80 mm (%)		-68
≥ 30 cm TL (N)	64	21
Δ 80 mm (%)		-67
< 30 cm TL (N)	3300	1056
Δ 80 mm (%)		-68
< 20 cm TL (N)	2219	765
Δ 80 mm (%)		-66
Haddock total weight (kg)	318	96
Δ 80 mm (%)		-70
≥ 30 cm TL (kg)	29	11
Δ 80 mm (%)		-62
< 30 cm TL (kg)	289	85
Δ 80 mm (%)		-70
< 20 cm TL (kg)	166	51
Δ 80 mm (%)		-69

Table 5. Estimated counts (N), weights (kg) and value of *Nephrops* in test gears

	Standard 80	SELTRA 90
Total Count (N)	58991	44817
Δ 80 mm (%)		-24
≥ 25 mm CL	52560	40658
Δ 80 mm (%)		-23
< 25 mm CL	6432	4159
Δ 80 mm (%)		-35
Total Weight (kg)	1057	845
Δ 80 mm (%)		-20
≥ 25 mm CL (kg)	1009	814
Δ 80 mm (%)		-19
< 25 mm CL (kg)	48	31
Δ 80 mm (%)		-34
Total value (€)	4966	4405
Δ 80 mm (%)		-11
≥ 25 mm CL (€)	4875	4344
Δ 80 mm (%)		-11
< 25 mm CL (€)	92	61
Δ 80 mm (%)		-33
> 31 mm CL - whole (€)	4051	3745
Δ 80 mm (%)		-8
≥ 20 ≤ 31 mm CL - tails (€)	915	660
Δ 80 mm (%)		-28

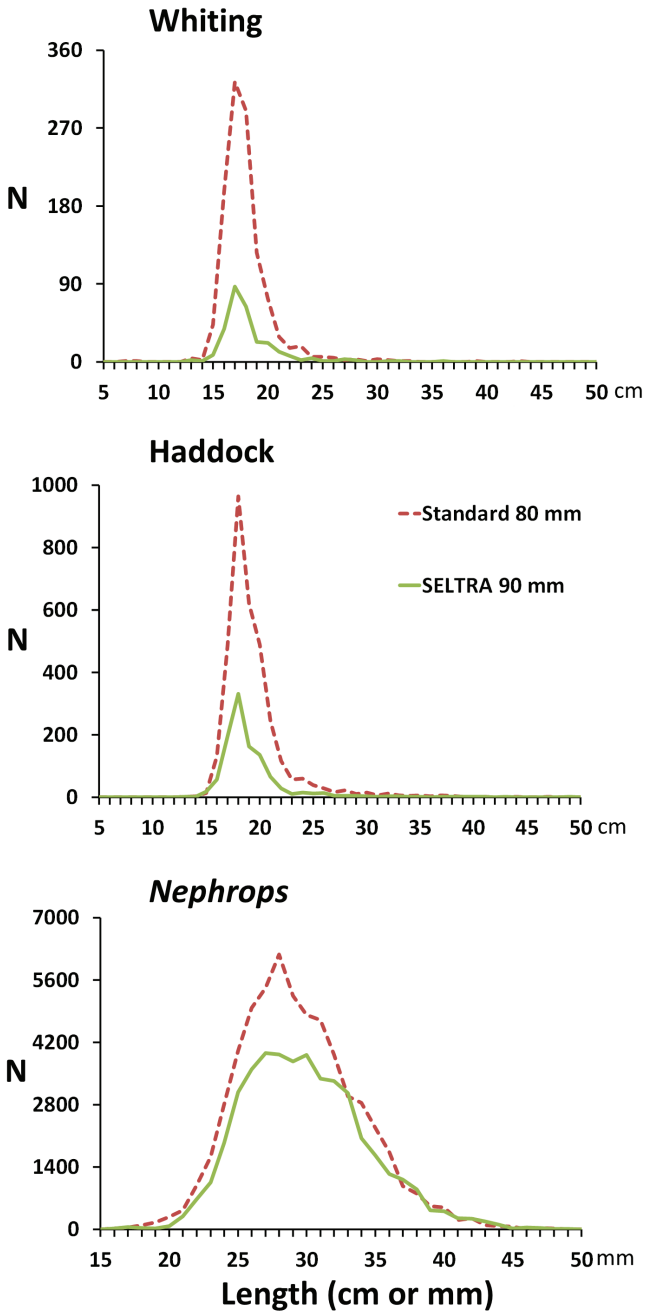

Figure 4, Length frequency plots for key species retained in test gears.

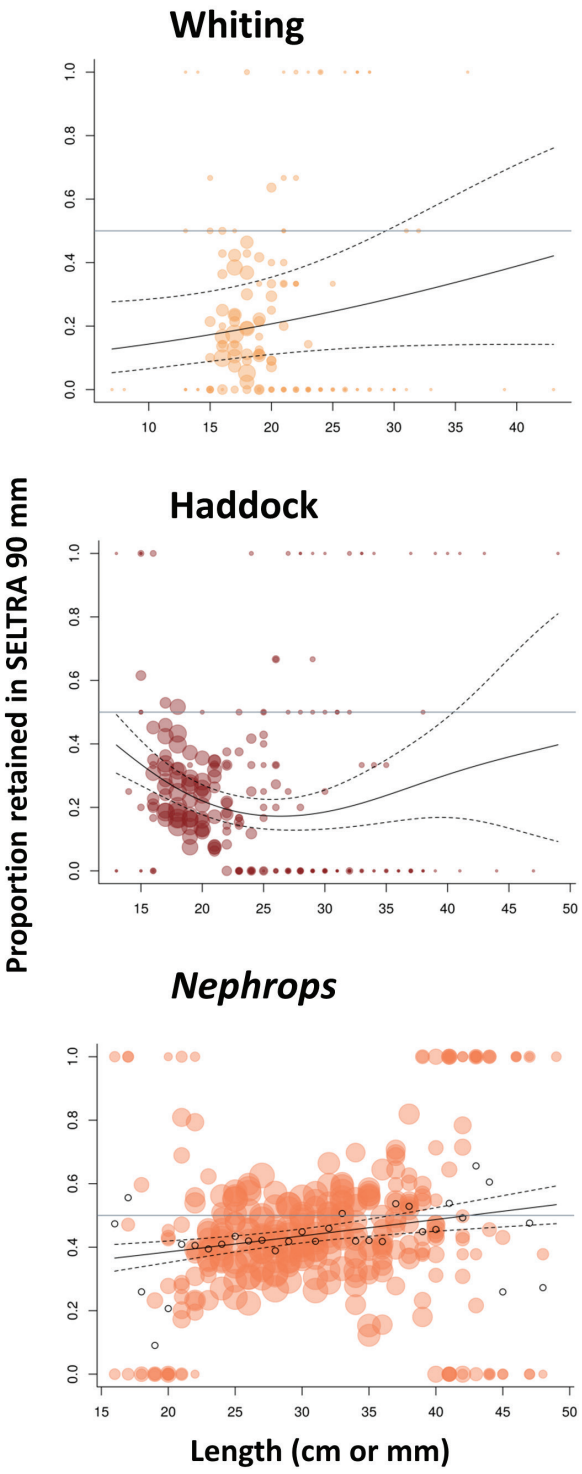

Figure 5. Overall raised proportions of catch at length for key species retained in the SELTRA 90 mm (points) and predicted overall mean proportions from the GAM (solid line). Dotted lines represent the upper and lower 95% confidence intervals. Equal proportions are shown as dashed horizontal lines at 0.5. Proportions > 0.5 indicate higher retention in the experimental SELTRA 90 mm gear and < 0.5 indicates higher retention in the control Standard 80 mm gear

Discussion

Substantial reductions in catches of both whiting and haddock < 20 cm in the SELTRA 90 compared with the Standard 80 are likely due to the increase in codend mesh size and superior attributes of the SELTRA in reducing fish bycatch. Browne et al., (2018) achieved a 60% reduction in < 20 cm whiting in a comparison of standard 300 mm SMPs with 90 and 80 mm codends which is lower than the 78% reduction in the current study. In general, the closer to the codline the escape panel is located, the higher the escapement of whiting in *Nephrops* trawls (Catchpole and Revill, 2008); the SELTRA escape panel is located 3.7 m from the codline whereas the standard 300 mm SMP panel is located 9 m from the codline. Also, the four-panel design stabilises a relatively narrow vertical opening between the escape panel and bottom sheet which further enhances fish escapement (Tyndall et al., 2017).

The SELTRA 90 did lose *Nephrops* but these were mostly smaller less valuable *Nephrops* and the 20% reduction is substantially lower than the 33% reduction observed in the comparison of standard 300 mm SMPs with 90 and 80 mm codends (Browne et al., 2018). The stable vertical opening and reduced contact with the escape panel partly explains higher *Nephrops* retention in the SELTRA. In addition, 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, lower bulk catch weights in the SELTRA compared with the 300 mm SMP (Tyndall et al., 2017) may have contributed to higher *Nephrops* catches in the SELTRA. It should be noted that this trial was completed during a period of exceptionally fine weather which is likely to have minimised losses of both *Nephrops* and whiting through the codend meshes (O'Neill et al., 2003).

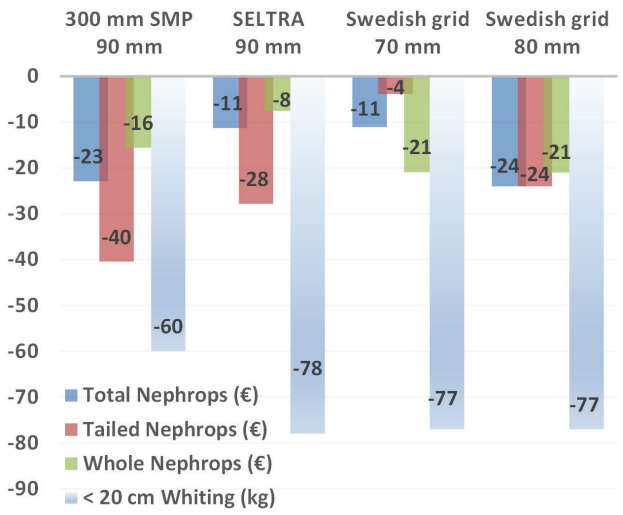

Figure 6. Comparison of estimated reductions in *Nephrops* value (€) and whiting weight (kg) from the current trial with the results of previous BIM trials.

Increases in codend mesh size and the Swedish grid have proven to be the most effective gear modifications for reducing < 20 cm whiting catches to date but are also associated with losses in *Nephrops* catches and value (Figure 6). A previous trial with a Swedish grid and 70 mm codend (Cosgrove et al., 2016) was conducted prior to the introduction of a regulated codend mesh size increase to 80 mm in 2017 for multi-rig or over 12m vessels (S.I.510 of 2016). Hence, most *Nephrops* in the Irish Sea are currently caught using 80 mm codends. Cosgrove et al., (2015) assessed the effects of an increase in codend mesh size from 70 to 80 mm and found a substantial reduction in the value of tailed *Nephrops*, no reduction in whole *Nephrops* and no reduction in < 20 cm whiting. Applying the same *Nephrops* price data across trials, an estimated total reduction in the value of tail grade *Nephrops* of 24% would have occurred in the Swedish grid if an 80 mm codend was used. This estimate should be treated with caution as reduced bulk catches associated with the Swedish grid would likely counteract this reduction to some extent. However, this simple scenario demonstrates that the SELTRA 90 would likely be the least prohibitive gear modification in terms of reduced *Nephrops* catch value.

Measures which reduce unwanted catches should aim to improve the sustainable exploitation of marine biological resources and marine ecological resources (EC, 2013). The impact of mesh size increases on whiting conservation may be hampered by technology creep in relation to twine stiffness, and poor survival of escapees through codend meshes. O'Neill et al., (2016) found that increasing twine stiffness reduced selectivity of fish species and stiffer twines are known to be used in response to regulated mesh size increases. This is evident in Irish *Nephrops* fisheries where stiffer twines have been introduced since a regulated codend mesh size increase in 2017. Smaller fish are likely to make fewer escape attempts and sustain greater damage and stress in a trawl (Broadhurst et al., 2006). Assessing mortality of escapees through codend meshes can be problematic (Breen et al., 2002) but Sangster et al., (1996) found that most whiting and haddock < 20 cm died following escape through codends with mesh sizes ranging between 70 and 110 mm. Results from BIM research suggest that most of the reduction in < 20 cm whiting from 90 mm codends is occurring through the codend meshes which raises serious doubts regarding the utility of a mesh size increase in improving whiting conservation. Fish should generally be allowed to escape before they enter into the codend, where the risk of damage is highest (Suuronen, 2005) so gear modifications which permit escapement of < 20 cm whiting earlier on in the capture process would be more beneficial from a conservation perspective.

Acknowledgements

BIM would like to thank, the owners, skipper and crew of the trial vessel, which we have refrained from naming due to the use of economic data, for their assistance during the trial. This work was funded by the Irish Government and part-financed by the European Union through the EMFF Operational Programme 2014-2020 under the BIM Sustainable Fisheries Scheme.

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