Assessment of enlarged top sheets in a Nephrops trawl

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Matthew McHugh[a], Martin Oliver[a], Cóilín Minto[b], Shane Murphy[b], and Ronán Cosgrove[a]

[a] Irish Sea Fisheries Board (BIM), Dock Road, Galway, Ireland.

[b] Marine and Freshwater Research Centre, Atlantic Technical University, Galway (ATUG), Dublin Road, Galway, Ireland.

Email: matthew.mchugh@bim.ie

Key Findings

- Increased Nephrops catches with 300 mm top sheet
- Significant reductions in undersize whiting
- Twine area reduced by 8% likely resulting in reduced fuel consumption
- Major scope for implementation as a management measure

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INTRODUCTION

Dublin Bay Prawns or Nephrops (*Nephrops norvegicus*) are one of Ireland's most important species and are typically worth around the same as all other bottom trawled species combined (e.g. BIM 2023). BIM is working with the Irish Fishing Industry to help improve the Nephrops fishery in terms of energy and catch efficiency.

Nephrops trawls are traditionally constructed to target Nephrops and mixed demersal fish species. Typically, Irish Nephrops vessels operate a quad or half-quad configuration, with the standard trawl setup comprising 80 mm diamond mesh trawl body and codend with a (300 mm) square mesh panel (SMP). However, to comply with EU legislation, Irish vessels incorporate gear modifications such as enlarged-mesh escape panels in the codend to reduce or avoid unwanted fish catch (BIM 2014; Tyndall et al. 2017).

While such measures are focused on the trawl's posterior section, increasing mesh size or completely removing sections (e.g. cutaway or coverless trawls) in a trawl's anterior, have also shown reductions in unwanted fish species (Dunlin and Reese 2003; Revill et al. 2006; Briggs 2010; Campbell et al. 2010; Kynoch et al. 2011) but are less common. Increased mesh size in large sections of mesh in the trawls also equates to less twine surface area and lower drag trawls. Increasing top sheet mesh is unlikely to lead to reductions in Nephrops catches because they are known to passively roll along the trawl's lower panel during the catching process (Main and Sangster, 1985, Newland and Chapman,1989; Briggs 2010).

In this trial, we tested enlarged mesh sections in the top sheets of two-panel trawls with modified top sheets. The owner of the trial vessel previously tested 160 mm and was pleased with the results. BIM assisted him in taking this a step further and set up a trial which compared the performance 300 mm with 160 mm mesh top sheets. This work follows on from earlier testing of four-panel trawls with modified top sheets (McHugh et al. 2021 and 2022).

METHODS

The trial was conducted on board MFV Cisemair (S430), a 22.65 m (522 kW) demersal trawler targeting Nephrops in the western Irish Sea (ICES Division 7.a, Nephrops functional unit 15), towing four x two-panel 23 m footrope Nephrops trawls in a quad-rig configuration (Figure 1; Table 1). The control gear was a pair of trawls incorporating 160 mm mesh between the headline and the 300 mm square-mesh panel (Figure 2A). The test gear was a pair of trawls incorporating a 300 mm diamond mesh section in the trawl body before the 300 mm square-mesh panel (Figure 2B). Standard two-panel codends and extensions fitted with a 3 m long 300 mm square-mesh panel installed 9–12 m from the codline were deployed on each trawl.

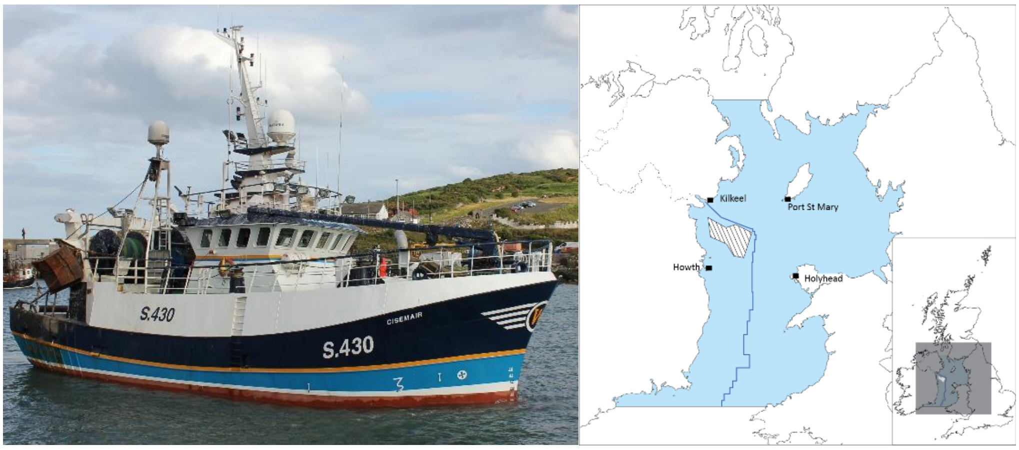

Figure 1. Trial vessel, and Location (hatched area)

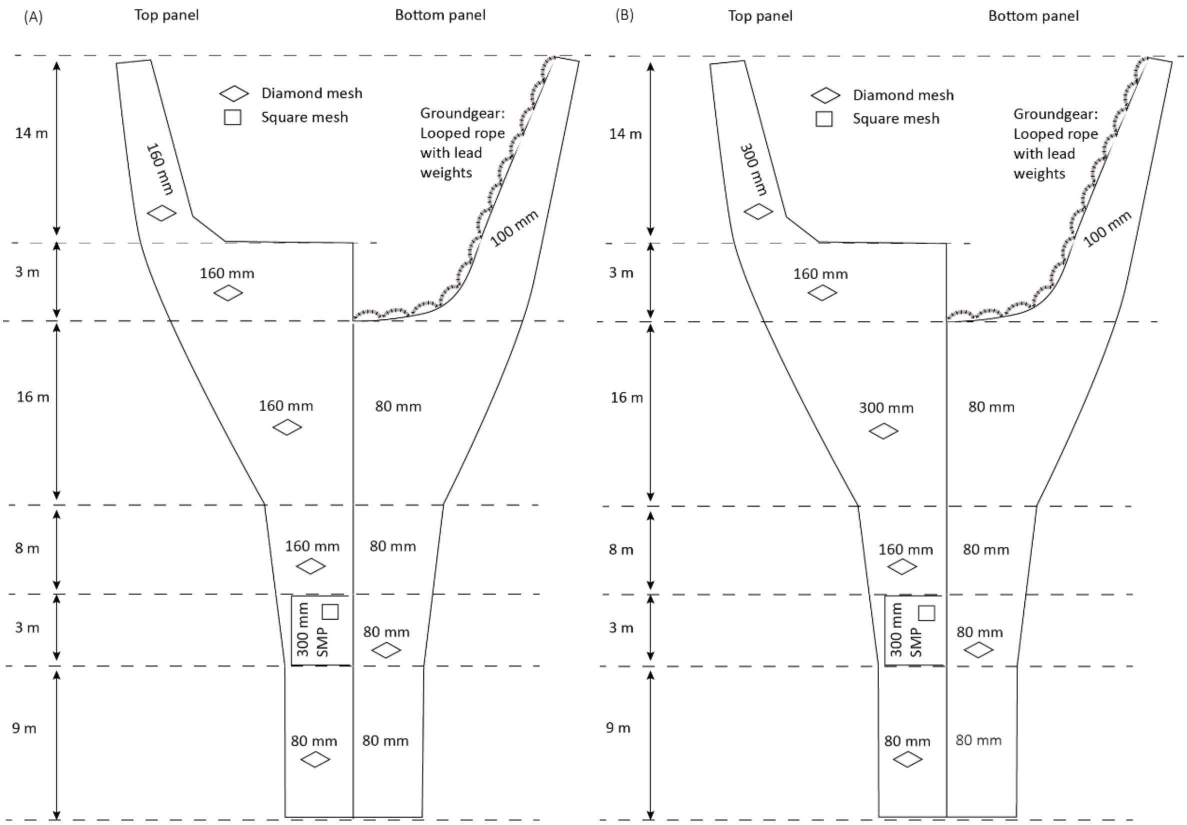

Figure 2. Plans for the trawls with (A) 160 mm control, and (B) 300 mm test

Marport acoustic telemetry sensors were deployed on trawl wing-ends to monitor the spread. The vessels own Marport door sensors were utilised to record the door to clump (port and starboard) distance, and overall door spread. Additionally, loadcells were placed on each pair of nets to record their drag; however, because of technical issues with the loadcells there were no data to analyse. In the absence of load data, twine surface estimates of each net were calculated to estimate potential differences in their drag.

The twine surface area (A) was estimated from:

$A=(N_t+N_b)N_dMd$,

where N_t is the number of meshes on the top row of a panel, N_b the number on the bottom row, N_d the number along the length of the panel, *M* the mesh size, and *d* the twine diameter (Ferro 1981).

Table 1. Vessel and trawl gear characteristics for large mesh top sheets trial

Vessel	Cisemair (S430)
Length (m)	22.65
Engine (kW)	522
Trawl type	*Nephrops*
Trawl manufacturer	Pepe Trawls
Trawl configuration	Quad
Headline length (m)	37
Estimated headline height (m)	1
Footrope length (m)	42
Fishing-circle (meshes × mm)	400 × 80
Number of panels	2
Codend and SMP	
SMP (mm)	300
Mesh size (nominal) (mm)	80
Number of panels	2

Table 2. Mean operational data for the large mesh top sheets with Standard Deviation (StdDev)

Parameter	mean	StdDev
Haul duration (Hr:min)	05:53	0.05
Fishing depth (m)	79.71	26.26
Warp shot (m)	238.57	60.62
Fuel (l/Hr)	79.10	10.10
Load engine (%)	47.30	4.80
Door spread Overall (m)	53.98	2.86
Speed Over Ground SOG (kts)	3.0	0.20

Sampling and analysis

The four trawls were deployed simultaneously in quad-rig configuration with the pairs of control- and test- trawls initially deployed on the starboard and port sides, respectively. Midway through the trial the paired test and control trawls were swapped to the opposite side to account for potential differences in fishing power Combined catches from the paired test and control codends were weighed and sorted to species level from the paired test and control trawls that were kept separate on boarding. Total length (TL) of commercial fish species and carapace length (CL) of Nephrops were measured and recorded to the nearest cm or mm below. Raising factors were applied where subsampling occurred.

We restricted modelling to three key species, Nephrops, haddock, and whiting. We used a Generalise Additive Model (GAM) to predict the proportions 300 mm mesh trawl compared with the 160mm mesh gear. Resulting catch-ratio plots include pointwise confidence intervals on the predicted proportions. The null hypothesis of equal catch efficiency between trawls and compartments was rejected for a given length-class, when the confidence limits associated to the punctual prediction on that length-class did not overlap the reference value of 0.5 (50% catch probability).

The skipper recorded haul data including fishing position, environmental conditions and fishing depth for every haul. The skipper also recorded the vessels fuel consumption (l/hr), engine load (%) and engine revolutions per minute (RPM) several times per haul.

RESULTS

A total of 14 valid hauls were completed during June 2024. Mean haul duration, towing speed and depth fished were 05:53, 3 kt, and 80 m (Table 2). Nephrops was the main commercial species landed with 62% of the total bulk or 83% of total commercial species caught (Table 3). The Nephrops catches were 38% greater in the trawl with the 300 mm mesh (Table 3). However, this increase was not significantly different (Figure 4) likely due to between-haul variability in Nephrops catches.

The main commercial fish species were monkfish and mixed flatfish including, black sole, brill, turbot, megrim, witch and plaice (Table 3). Other species included dogfish and skates and ray (Table 3). Whiting and haddock catches consisted mainly of fish below their respective minimum conservation reference size (MCRS) of 27 and 30 cm (Figures 3 and 4; Table 4). The 300 mm trawl demonstrated a significant reduction for whiting ~< 20 cm (Figure 4). Larger haddock were also reduced but very few large haddock were caught in either net (Table 3).

Twine surface estimates showed that the trawls with 160 mm mesh had a surface area of 67 m^2 while the trawls with 300 mm mesh had a surface area of 62 m^2, that equates to an overall reduction of 8%.

Table 3. Catch weights

Species	Control (kg)	Test (kg)	Difference (%)
Nephrops	2,388	3,291	38
Whiting	69	56	-19
Haddock	59	57	-4
Flatfish$	100	105	4
Monkfish	152	167	10
Ray and skate	247	187	-24
Dogfish*	127	127	1
Non-commercial fish&	311	264	-15
Non-fish catch£	744	697	-6
Other^	7	6	-21
Total bulk	4,204	4,956	18

$Brill, black sole, lemon sole, megrim, plaice, turbot, witch

*Lesser spotted catshark, Bull huss, Spurdog

&Gurnards, dab, pouting; £Seamouse, seaweed, whelks; ^Cod, hake, conger eel, John Dory

Table 4. Catch numbers < and ≥ MCRS

Species	Control (No.)	Test (No.)	Difference (%)
Nephrops all	118,901	178,821	50
≥ MCRS	118,462	178,501	51
< MCRS	439	320	-27
Whiting all	1,320	832	-37
≥ MCRS	16	42	×2.6
< MCRS	1,304	790	-39
Haddock all	507	521	3
≥ MCRS	37	21	-44
< MCRS	470	500	6

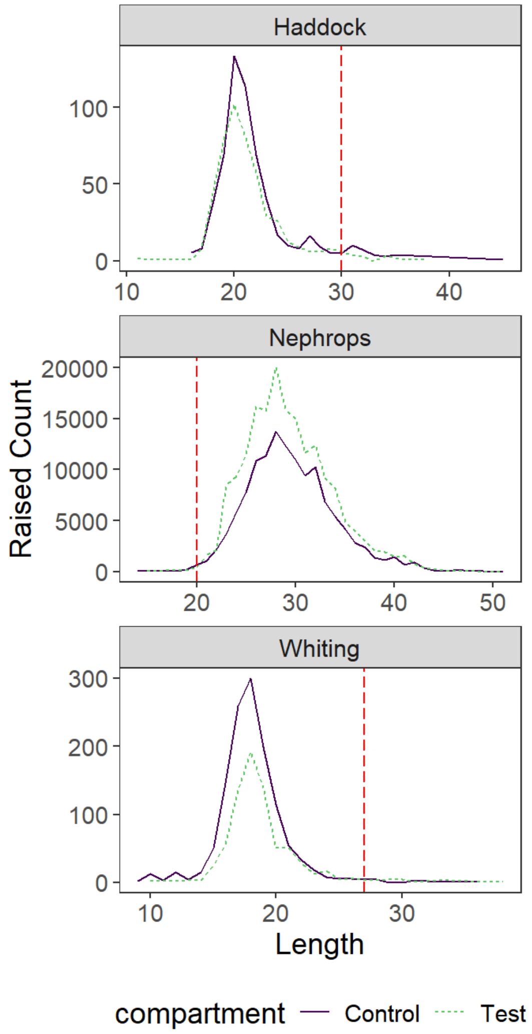

Figure 3. Length frequencies for Haddock, Nephrops, and Whiting caught in the control and test (160 and 300mm top sheet) trawls, Vertical dashed lines represent the respective species MCRS

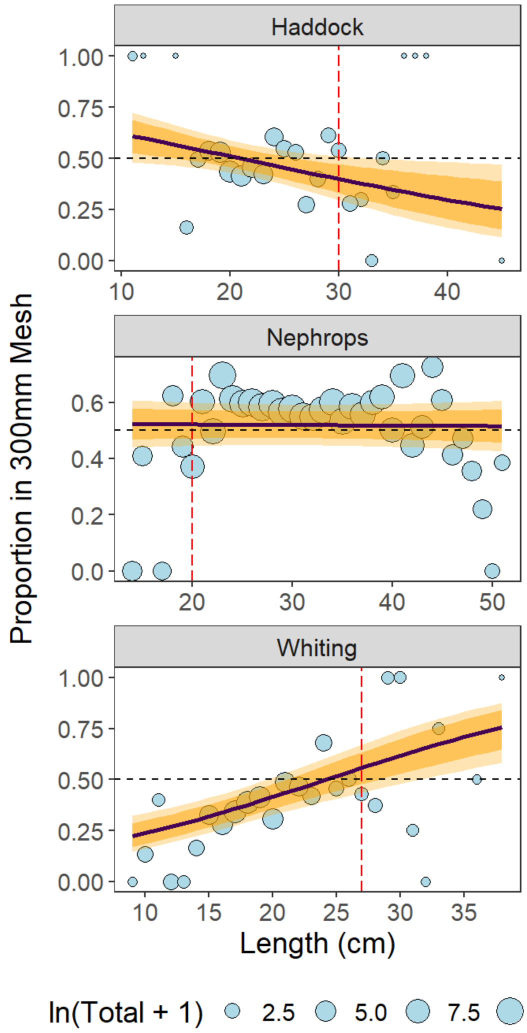

Figure 4. Proportions retained with GAM overlay for Haddock, Nephrops, and Whiting caught in the 300 mm top sheet trawls. Vertical dashed lines represent the respective species MCRS.

Discussion

Although not significant, the overall increase Nephrops catch is a surprising result and may be due to improved ground contact of the trawl associated with increased water flow. Similar results were obtained by Dunlin and Reese (2003) who observed a 20% increase in Nephrops catches in 200 mm compared with 70 mm top sheets. Again the reason for this increase is unknown. We plan to do more testing at sea and possibly in the flume tank next year to further assess and improve knowledge around differences in Nephrops catches in relation to top sheet configuration.

The reduction in undersize whiting is an important result and is in agreement with Dunlin and Reese (2003) who also observed substantial reductions in undersized whiting in 200 mm top sheets. BIM has conducted extensive research on reducing whiting in the Irish Sea Nephrops fishery due to poor stock status and requirements to improve whiting selectivity. Measures such as the Swedish grid and increased codend mesh size have been shown to help in this regard but are also associated with losses in targeted Nephrops. Also, it is not clear how well small whiting survive the process of escaping through diamond mesh codends which raises questions over the efficacy of such a measure in boosting stock conservation.

Incorporating 300 mm mesh panels in the top sheet allows whiting to escape early in the capture process through meshes which are much larger than their body size likely resulting in excellent survival of escapees (Broadhurst et al. 2006).

The reduced twine surface area of 8% bodes well for reduced fuel consumption. While it was not possible to assess fuel consumption during the trial, Niall Connolly also fitted 300 mm top sheets and reported a fuel saving of around 10% compared with 80 mm top sheets over a number of trips targeting Nephrops onboard the MFV Mellifont with skipper Robert Dawe. The increase from 80 mm to 300 mm in the top sheet is likley to decrease the trawl twine surface area by at least 30% which would explain this substantial reduction in fuel use. This reduction in fuel use can lead to improvements in profitability while reducing carbon emissions as part of the energy transition.

Overall, there were no observed operational issues with either of the trawls with 160 or 300 mm top-sheets. The skipper had no problem maintaining the preferred door and wing-end spread throughout the trial.

Observed Improvements in energy and targeted catch efficiency suggest that enlarged mesh top sheets have major potential to become a management measure supporting the sustainable development of the Irish Nephrops fishery.

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