Bord Iascaigh Mhara
Irish Sea Fisheries Board

Assessment of T90 mesh in a fishery targeting whiting in the Celtic Sea

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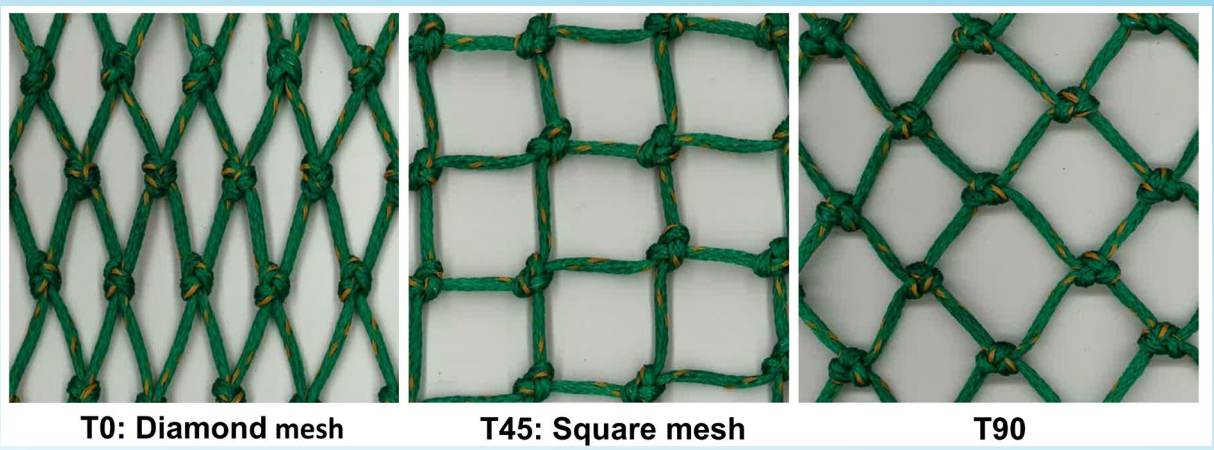

Figure 1. Outline of mesh orientations

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Key findings:

- **Whiting catches below the minimum conservation reference size of 27 cm were reduced by 60% using the 80 mm T90 mesh. Taking into account current market preferences, whiting catches below 32 cm were reduced by 67% while catches of market sized fish increased by 16%.**
- **The quality of the catch was greatly improved in the T90 according to the skipper and crew of the trial vessel.**
- **A larger T90 mesh size will be required to optimise reductions in below minimum conservation reference size haddock.**
- **Substantial increases in catches of haddock in the T90 could be problematic when that species is phased in under the Landing Obligation in the Celtic Sea. A bioeconomic assessment of optimal gear design and economic return from the mixed demersal species fishery targeting whiting and haddock in the Celtic Sea would assist in addressing this issue.**

Introduction

Ireland has a quota of 6,333 tonnes of whiting in the Celtic Sea in 2016 which is worth approximately €8.6m at first point of sale, making it the second most commercially important demersal fish species after monkfish in that area. Whiting catches in the Celtic Sea are predominantly made by vessels which target a range of finfish species and *Nephrops* with otter trawls. Landings by Irish vessels targeting mixed finfish from 2011 to 2014 were dominated by whiting, with the majority of landings attributed to less than 20 vessels which specifically targeted that species (Anon, 2015). Current minimum mesh sizes in the Celtic Sea depend on catch composition, with Irish vessels targeting whiting required to use a minimum mesh size of 80 mm.

The landing obligation raises major challenges for vessels targeting whiting in the Celtic Sea. The discard plan for demersal species in north western waters[1] requires that any vessels with landings in 2013 and 2014 consisting of more than 25% of cod, haddock, whiting, and saithe combined, are required to land all whiting catches in 2016. Vessels meeting that threshold can avail of a de minimis exemption of 7% of total annual catches. However, the whiting discard rate was 27% for all fleets in the Celtic Sea in 2015, including those targeting species such as haddock and monkfish using larger mesh sizes. The discard rate for vessels using 80 mm cod-ends was > 30% (MI, unpublished data). Although the de minimis exemption can provide some assistance, such relatively high levels of unwanted catches are likely to cause negative economic impacts for Irish vessels targeting whiting unless selectivity can be improved.

In terms of available measures to improve selectivity, increasing mesh size from 80 to 90 mm will likely lead to major reductions in catches of whiting > minimum conservation reference size (MCRS) of 27 cm (BIM, unpublished data). Although 120 mm square mesh panels were introduced in 2012, the volume of discards has remained high and there is no evidence yet of improvements in selectivity in the fishery (MI, 2015). T90 mesh is produced from diamond mesh netting turned 90° so that the main direction of the run of the netting is parallel to the towing direction resulting in improved mesh openings compared with diamond mesh (Figure 1). Previous assessments of T90 mesh as a measure to improve size selectivity include: a study on cod in otter trawls in the Baltic (Herrmann et al., 2013), haddock in otter trawls in the Barents Sea (Digre et al., 2010), and commonly encountered roundfish in the Belgian beam trawl fishery (Bayse et al., 2016).

Previous work in Ireland on alternative mesh orientation in otter trawl codends is limited to a recent BIM assessment of square mesh cod-ends in an Irish *Nephrops* fishery (Cosgrove et al., 2016).

1 Commission Delegated Regulation (EU) 2015/2438 of 12 October 2015 establishing a discard plan for certain demersal fisheries in north-western waters

Square mesh is produced by mounting diamond netting with a 45° deviation from the normal direction (Figure 1) and has been tested as a means of improving *Nephrops* selectivity in countries such as Denmark and Sweden. Cosgrove et al. (2016) observed 66% and 60% reductions in < MCRS whiting and haddock respectively using a 65 mm square mesh codend constructed from 3.5 mm single braided polyethylene (PE) twine. Based on the results of previous research, legal mesh size and landing obligation requirements, a trial was conducted to assess if similar improvements could be achieved by using T90 in a fishery targeting whiting in the Celtic Sea.

Methods

Fishing operations

Figure 2. The trial vessel, the MFV Foyle Fisher

The trial was carried out on board the MFV Foyle Fisher (G497) (Figure 2) a 24.7 m twin-rig trawler targeting whiting in ICES division VIIg (Figure 3). A total of 14 hauls were carried out over a 6 day period commencing on the 4th of April 2016. Fishing operations approximating normal commercial hauls were carried out with haul duration, towing speed and depth of ground fished averaging 3:21 hours, 2.9 knots and 77 m respectively. Fishing gear consisted of twin–rigged whitefish hopper trawls set up using a triple warp and centre clump arrangement. Mesh size in each trawl was 80 mm with 160 mm in the upper wings and cover, and 120 mm in the bottom wings. Ground gear was constructed with 36 cm (14 inch) discs. The extension piece and codend of both test gears were constructed from two panels of 80 mm (nominal) double 4 mm compact braided PE twine. Double 4 mm twine is commonly used in this fishery. Twine thickness and number are known to be negatively correlated with fish size selection (Herrmann et al., 2013) so it was hoped that the double 4 mm twine would produce similar reductions in < MCRS whiting to the single 3.5 mm twine used in Cosgrove et al. (2016). The length of the extension piece and codend of both gears was 150 meshes. A cover or strengthening bag and a 120 mm square mesh panel were also present in both test gears as is required by EU law.

Wienbeck et al. (2011) conducted an experiment with both diamond and T90 mesh cod-ends of varying circumference in the Baltic Sea and found that the combined effect of turning meshes 90° and reducing circumference yielded the highest mean L50 values. We used the maximum legal circumference of 120 meshes and a reduced circumference of 80 meshes for the diamond and T90 gears respectively. Using the protocol of Fonteyne et al. (2007), the Omega gauge provided measurements of 83.2 and 81.6 mm in the T90 and diamond mesh codends respectively. Experimental and control codends were rotated daily so that potential differences in fishing power depending on net configuration could be accounted for in subsequent analyses.

Table 1. Gear specification

Trawl type	Twin-rig hopper
Trawl manufacturer	Foyle Warrior Ltd.
Head-line length (m)	23
Foot-line length (m)	21
Fishing circle	550 x 80 mm
Sweep length (m)	55 + 51
Warp diameter (mm)	20
Door spread (m)	112
Door manufacturer & model	Thyboron Type II
Door weight (kg)	259
Clump weight (kg)	750 (roller)

Sampling and analysis

Total catches were weighed and sorted to species level. The total weight of each commercial fish species was recorded in addition to the weight of a random representative subsample. Commercial fish species were measured to the nearest cm below (Total Length (TL)). Tables and length frequency distributions were constructed for total numbers and weight of key fish species caught using both test gears. A recently developed multinomial modelling approach which facilitates comparison of catches in more than two gears (Browne et al., 2015) was initially used to statistically examine differences in the proportional catches of key fish species across size classes between different gears. A general additive mixed effects model (GAMM) was subsequently used to plot the predicted proportions of catches per length class retained in the T90 as it better reflected local length dynamics in the tails of length distributions compared with the multinomial model. It was not possible to include the explanatory variables net configuration and catch weight per codend in the GAMM but these variables accounted for relatively little difference in predicted proportions (< 1.5%) between the two modeling approaches.

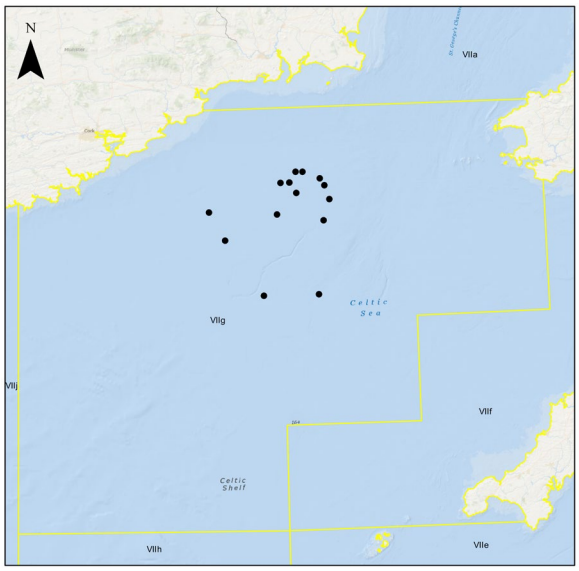

Figure 3. Haul locations

Table 2. Quantities (kg) of species caught during the trial

Species	Diamond	T90	Δ Diamond (%)
Whiting	6579	5163	-22
Haddock	2948	6282	113
Lesser Spotted Dogfish	937	1194	27
Cod	625	752	20
Other non-commercial species	574	713	24
Lemon Sole	543	941	73
Pollack	329	82	-75
Plaice	279	352	26
Hake	272	358	32
Monk	187	167	-11
Ray	168	201	20
Mixed flats	135	161	19
Ling	87	168	94

* Δ = Difference from

Results

Quantities of species caught in the test gears are outlined in Table 2. Whiting and haddock were the main species caught during the trial accounting for over 70% of total catches by weight. Total catches of whiting were lower while total catches of haddock were substantially higher in the T90. Catches of flatfish species such as lemon sole and plaice were also higher in the T90. Length frequency distributions and estimated counts of three key species in relation to minimum conservation reference sizes (MCRS) and market requirements are outlined in Table 3 and Figure 4 respectively. Whiting catches below the minimum conservation reference size (MCRS) of 27 cm were reduced by 60% using the T90. Taking into account current market preferences, whiting catches below 32 cm were reduced by 67% while catches of market sized fish increased by 16%. Relatively few small haddock were caught during the trial but catches of larger haddock were ~ 200% higher in the T90 gear. Increased catches of plaice in the T90 were mostly attributed to small fish, with a 54% increase in plaice catches below the MCRS of 27 cm in that gear. Model predicted proportions of overall catch at length retained in the T90 show a significant reduction in catches of small whiting; a significant reduction in catches of small haddock and a significant increase in catches of large haddock; and a significant increase in catches of small plaice in the T90 (Figure 5).

Table 3. Estimated total counts of key fish species in relation to minimum conservation reference and market sizes

Species	Category	Diamond	T90	Δ* Diamond (%)
Whiting	Total count	9319	8631	-7
	< 27 cm	139	56	-60
	> = 27 cm	9180	8575	-7
	< 32 cm	2628	857	-67
	> = 32 cm**	6691	7774	16
Haddock	Total count	3670	10650	190
	< 30 cm	238	223	-6
	> = 30 cm	3432	10427	204
Plaice	Total count	956	1476	54
	< 27 cm	394	837	113
	> = 27 cm	562	639	14

* Δ = Difference from

**Market minimum size

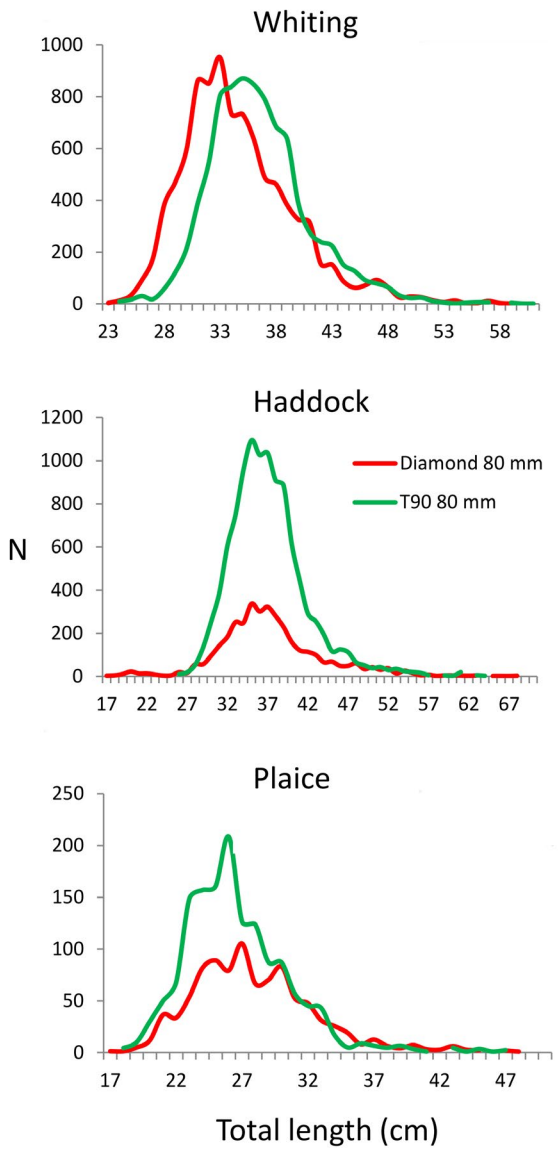

Figure 4. Length frequency distributions of three key species

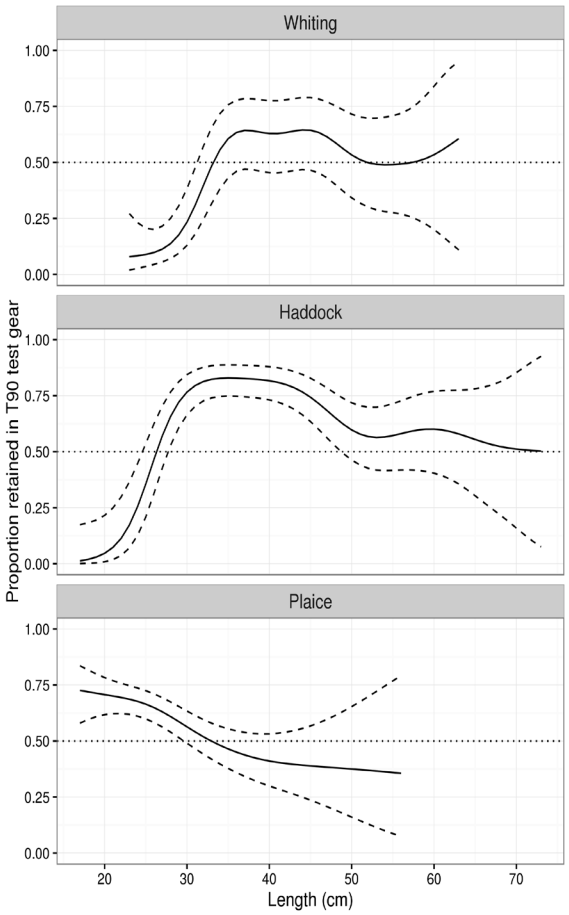

Figure 5. Predicted proportion of overall catch at length retained in the T90 test gear. Predictions are from generalized additive mixed models per species. Solid lines represent the predicted mean proportion and dashed lines the upper and lower 95% confidence intervals. Equal proportions are shown as dotted horizontal lines at 0.5.

Discussion

Study results were extremely positive in relation to whiting with significant reductions in catches of small whiting, and observed increases in market sized whiting achieved with the 80 mm T90 gear. Increased catches of market sized whiting and haddock were likely related to increased water flow through the gear associated with greater opening of the T90 meshes. This gear characteristic was also probably responsible for the greatly improved quality of the catch reported by the skipper and crew, an additional benefit of the T90 gear.

Lower observed reductions in < MCRS haddock compared with whiting in the T90 can be explained by a larger minimum size of 30 cm for haddock compared to 27 cm for whiting, and poorer selectivity of haddock compared with whiting in the 80 mm mesh size. Similar to current management measures which require larger sized mesh for vessels targeting haddock compared with whiting, a larger T90 mesh will be required to achieve further reductions in catches of < MCRS haddock.

Although not currently an issue, substantial increases in catches of marketable haddock in the T90 gear could cause problems when that species is phased in under the landing obligation. The total allowable catch (TAC) of haddock for Irish vessels in the Celtic Sea in 2016, 1613 t, equates to ~ one quarter of the whiting TAC. Haddock and whiting generally behave the same way in trawls so it is difficult to separate the two species using gear measures (Catchpole and Revill, 2008). Hence, the ~ doubling of the haddock catch observed with the T90 in the current study could increase the propensity of vessels targeting whiting to choke on haddock. A bioeconomic assessment of optimal gear design and economic return from the mixed demersal species fishery targeting whiting and haddock in the Celtic Sea would assist in addressing this issue.

Diamond mesh is considered optimal for maximising selectivity of flat fish species. Hence, reduced selectivity of flatfish such as plaice and lemon sole in the T90 was not unexpected. Alternative gear measures such as escape panels in the bottom of the trawl can, however, assist in minimising flatfish catches while maintaining whiting and haddock catches when required.

Given that the landing obligation currently applies to whiting in the Celtic Sea, it was imperative that the test gear could be readily adopted by Industry without the need to go through a potentially lengthy process of seeking legislative changes to minimum mesh size or other gear characteristics. The tested T90 gear fits that bill, and provides an excellent option to substantially improve the length composition and quality of the whiting catch on board vessels targeting that species.

Acknowledgements

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