Assessment of Dyneema® floating sweeps and fish scaring ropes in the Irish Sea *Nephrops* fishery

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Assessment of Dyneema® floating sweeps and fish scaring ropes in the Irish Sea *Nephrops* fishery

Daragh Browne, Martin Oliver, Matthew McHugh and Ronán Cosgrove
BIM, New Docks, Galway, Ireland. Email: Daragh.Browne@bim.ie

Key Findings

Neither Dyneema sweeps nor fish scaring ropes directly reduced whiting catches

1

The Dyneema sweeps caught substantially more *Nephrops* than a standard trawl rig and, consequently, may have potential to postpone choking on whiting in the *Nephrops* fishery

2

Changes to codend mesh size and circumference will be assessed as a further potential means of reducing unwanted whiting catches

3

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Introduction

Nephrops norvegicus is currently the most commercially important fishery in Ireland with landings at first point of sale valued at €63 million in 2016.

The Western Irish Sea (functional unit 15, ICES VIIa) is an important area in this fishery with average landings of 2,250 t between 2014 and 2016 contributing around a quarter of national *Nephrops* landings. From 2019, the EU landing obligation will apply to all species subject to catch limits. Whiting in ICES VIIa is likely to be challenging in this regard given the most recent catch estimate of ~ 217 t by Irish *Nephrops* trawlers in 2016 and a quota of just 46 t in 2018 (MI, 2017).

Irish vessels targeting *Nephrops* in ICES VIIa currently employ measures in the rear part of the trawl consisting of a 300 mm square mesh panel (SMP) in two or four panel (SELTRA sorting box) sections to reduce cod catches in compliance with the Irish Sea cod management plan (EC 1342 of 2008). These measures are highly effective in reducing catches of species such as whiting and haddock but are ineffective for very small whiting < 20 cm total length (BIM, 2014a; Tyndall *et al.*, 2017) that can form a major component of the whiting catch (ICES, 2017). Other measures such as the Swedish grid or increasing the codend mesh size to 90 mm may be effective in reducing catches of very small whiting but also result in reduced *Nephrops* catches (Cosgrove *et al.*, 2015; Cosgrove *et al.*, 2016).

Nephrops trawl rigs were traditionally developed to catch *Nephrops* and a range of fish species. *Nephrops* are primarily caught through contact with the ground gear at the trawl mouth, whereas fish are caught through herding by the doors and sweeps which are dragged along the ground ahead of the trawl, creating a plume on the seabed and driving fish towards the trawl mouth. On foot of the cod management plan and landing obligation, fish species no longer form an important catch component for vessels targeting *Nephrops* in the Irish Sea. Hence, measures which reduce herding ahead of the trawl can assist in reducing fish bycatch and compliance with management rules. Catchpole *et al.* (2013) demonstrated reduced whiting catches with "floating" Dyneema® sweeps in the eastern Irish Sea twin-rig *Nephrops* fishery. Dyneema sweeps are thought to be less bottom tending than traditional combination rope sweeps as they are lighter for an equivalent diameter and may float because they have a specific gravity less than water.

Counter-herding devices such as modified sweeps or scaring ropes ahead of the trawl also have potential to reduce fish bycatch. Danish researchers demonstrated that whiting catches were significantly reduced in the Skaggerak (ICES IIIa) *Nephrops* fishery using a counter-herding device, called FLEXSELECT, consisting of ropes designed to scare fish out of the trawl's path (Melli *et al.*, 2017).

While the latter two studies were conducted using twin-rigged trawls, quad-rig trawling is the predominant fishing gear used by Irish vessels to target *Nephrops*. Hence, in this study we aimed to assess the practicalities and feasibility of deploying Dyneema sweeps and scaring ropes ahead of quad-rigged trawls to further reduce whiting catches. The complexity of the changes to the rigging during this trial made it difficult to compare catches from a test gear with a standard trawl using conventional catch comparisons. Instead catches from different gears were compared in order to qualitatively assess measures which had potential for further investigation.

Methods

Fishing operations and gear

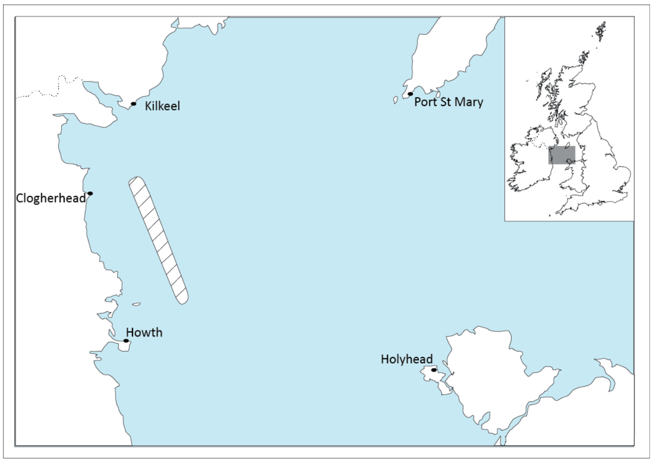

Figure 1. The trial vessel MFV Ocean Breeze (D.96) and trial location (hatched area)

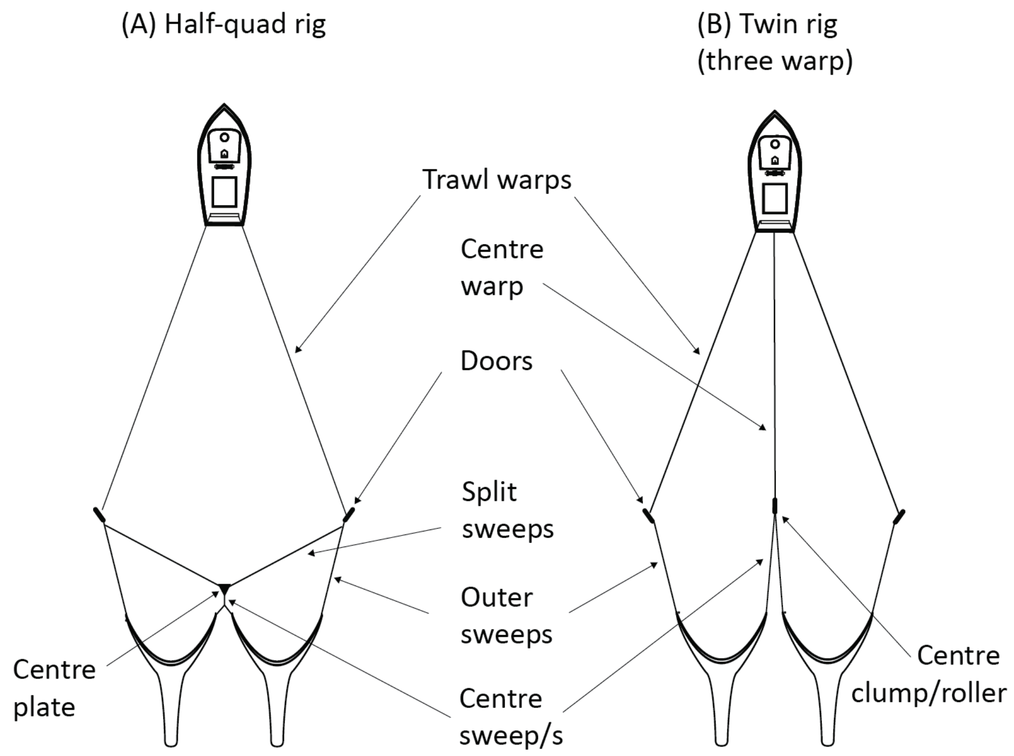

Figure 2. The half quad-rig used in the current study and an example of a twin-rig configuration

A trial was conducted on board the MFV Ocean Breeze (D.96), an 18 m twin-rig vessel in the western Irish Sea (Figure 1) in November 2017. Trawl gear comprised two 36.6 m footrope *Nephrops* trawls with 80 mm mesh throughout, except for 150 mm in the upper wing ends, and an 80 mm four panel SELTRA 300 sorting box and codend (Table 1). The vessel fished a half quad-rig configuration which differs from the typical three-warp twin rig configuration used by Irish vessels in that it utilises two as opposed to three warps and split sweeps between the doors and a centre plate (Figure 2). The split sweeps are in contact with the seabed and this may be an important factor behind increased *Nephrops* catches and reduced fish catches in quad- versus twin-rigged trawls (BIM, 2014b) (Figure 2). A total of 16 tows were carried out over four days with haul durations kept to ~2 h to maximise the number of deployments and facilitate multiple gear modifications. Mean towing speed and depth fished were 2.8 kt and 53.4 m.

Four hauls were initially conducted using a standard rig followed by eight hauls using scaring ropes of different lengths: three lengths of polypropylene (24 mm Ø) scaring ropes measuring 27, 25 and 23 m were deployed for three, one and four hauls, respectively. The scaring ropes were mounted between the centre plate and the outer wingends of both trawls for the 27 and 25 m configurations (Figure 3). For the 23 m configuration, three hauls were completed with only one scaring rope mounted between the centre plate and the outer wingend of the port-side trawl and one haul was completed with the scaring rope mounted to the outer wingend of the starboard-side trawl.

Table 1. Gear specification used during the trial

Characteristic	Description and measurements
Trawl type	*Nephrops*
Trawl manufacturer	Pepe Trawls Ltd.
Headline length (m)	36
Footrope length (m)	40
Fishing-circle (meshes × mm)	380 × 80
Upper wingend mesh size (mm)	150
Sweep material/diameter (mm)	Combination/20
Outer sweep length (m)	2 × 76
Split sweep length (m)	2 × 50
Centre sweep length (m)	20
Warp diameter (mm)	16
Door manufacturer	Dunbar
Door Weight (kg)	280
Engine power (kw)	224
SELTRA mesh size (mm)	80
SELTRA SMP mesh size (mm)	300
SELTRA SMP location (m from codline)	3-6
Codend mesh size (mm)	80

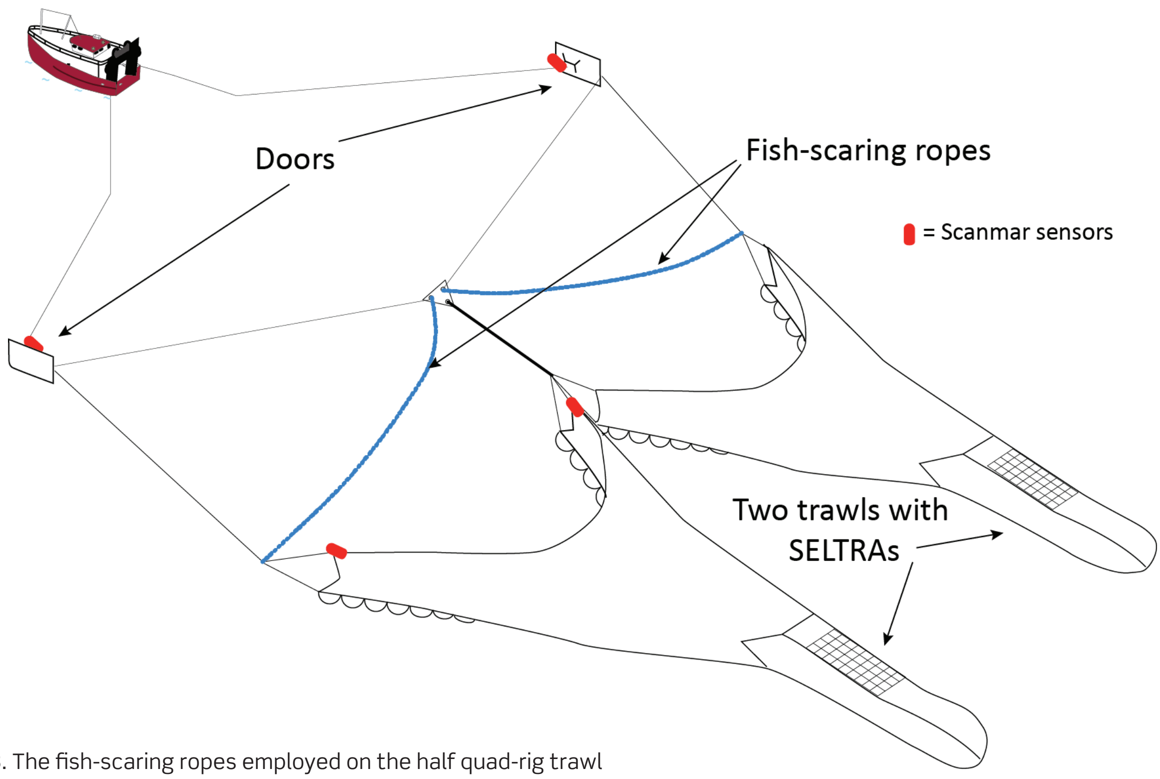

Figure 3. The fish-scaring ropes employed on the half quad-rig trawl

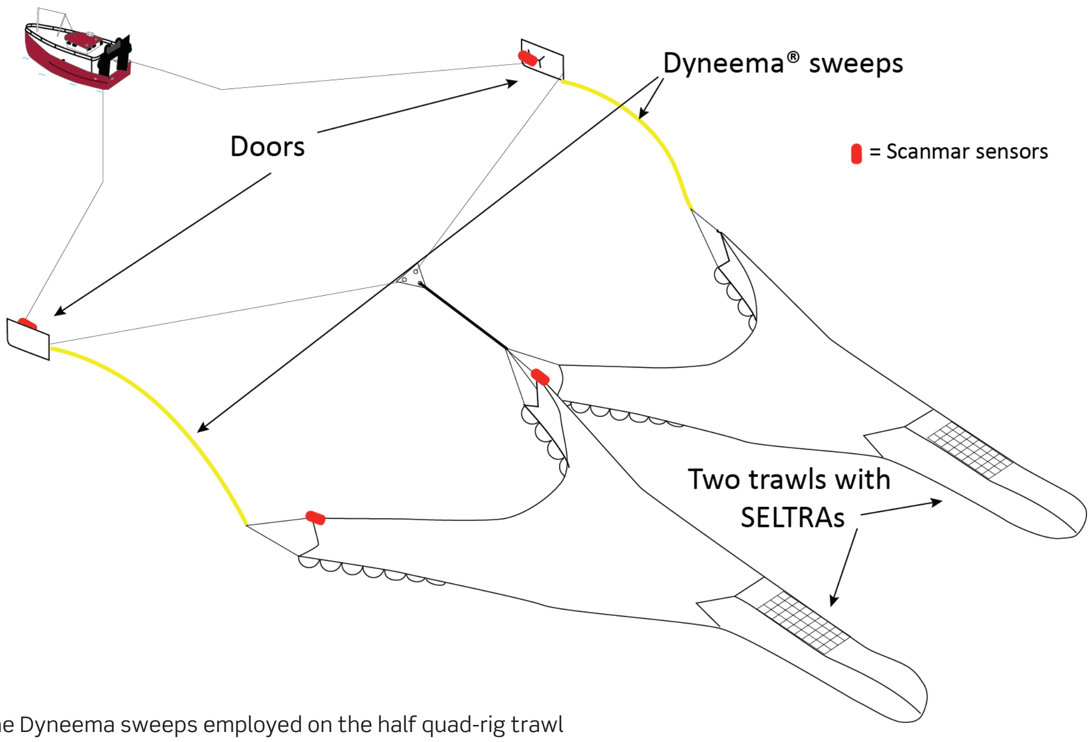

Figure 4. The Dyneema sweeps employed on the half quad-rig trawl

The last four hauls substituted standard 76 m x 20 mm (Ø) combination rope outer sweeps for 20 mm (Ø) Dyneema Dynice SK60 rope with over-braid for abrasion resistance (Figure 4). Each 76 m Dyneema sweep comprised four lengths (i.e. 50 m, 2 × 10 m, and 6 m) in order to facilitate a length change as required. A Dyneema sweep was attached between the door and outer wing-end of the corresponding trawl using hammerlocks, steel swivels, three chain links (90 mm) and shackles. After each haul, Dyneema sweeps and hammerlocks were examined for chafing or polishing due to contact with the sea floor.

Sampling and analysis

The catch was separated to species level, weighed and fish species subject to quotas measured to facilitate length frequency comparison. Qualitative catch comparisons between gears were conducted by standardising species catch rates in each gear according to the quantities caught in each trawl. Raised length frequency count data for whiting were also standardised by trawl to compare the size composition between gears. Choking or early cessation of fishing effort under the landing obligation in relation to a particular species is largely a function of their catch in relation to the target species. Hence, total species catches were also standardised in relation to the quantities of *Nephrops* caught in each gear. Scanmar distance sensors were attached to the doors and the wingends in order to accurately measure their respective spread.

Results

None of the gears reduced whiting catches without associated loss of *Nephrops*: a 32% reduction in whiting catches was observed with the 25 m scaring rope but a 78% reduction in *Nephrops* catches was also observed with that gear. Catch rates of whiting and haddock but also *Nephrops* were substantially higher with the Dyneema sweeps compared to the standard rig (Tables 2 and 3).

Table 2. Mean catch per trawl (kg) for each gear with standard deviation in brackets

	Standard rig	Scaring rope 23 m	Scaring rope 25 m	Scaring rope 27 m	Dyneema sweeps 76 m
Whiting	7.05 (0.49)	7.48 (0.95)	4.80 (–)	8.60 (2.13)	10.34 (1.33)
Haddock	3.29 (0.27)	3.03 (0.32)	2.40 (–)	2.77 (0.18)	7.18 (0.26)
Nephrops	18.94 (1.53)	17.29 (1.68)	4.20 (–)	21.75 (2.13)	44.30 (5.35)
Lesser spotted dogfish	20.37 (2.12)	16.10 (5.06)	24.75 (–)	23.92 (1.44)	17.65 (3.84)
Ray and Skate	11.35 (1.09)	16.28 (4.59)	12.75 (–)	7.62 (0.57)	6.98 (2.23)
Monkfish	3.99 (0.33)	3.78 (0.52)	8.95 (–)	5.25 (0.87)	6.88 (1.17)
Flatfish	3.35 (0.35)	3.53 (0.76)	3.65 (–)	3.78 (0.63)	2.44 (0.40)
Fish discards	22.85 (0.45)	12.43 (0.88)	6.30 (–)	14.73 (0.69)	22.34 (0.32)
Non-fish discards	12.48 (0.80)	27.65 (2.82)	37.35 (–)	7.62 (1.42)	9.68 (1.34)

Table 3. Standardised catches (% weight) for modified gears compared with the standard configuration

	Standard rig	Scaring rope 23 m	Scaring rope 25 m	Scaring rope 27 m	Dyneema sweeps 76 m
Whiting	100	106	68	122	147
Haddock	100	92	73	84	218
Nephrops	100	91	22	115	234
Lesser spotted dogfish	100	79	122	117	87
Ray and Skate	100	143	112	67	61
Monkfish	100	95	224	132	172
Flatfish	100	105	109	113	73
Fish discards	100	54	28	64	98
Non-fish discards	100	222	299	61	78

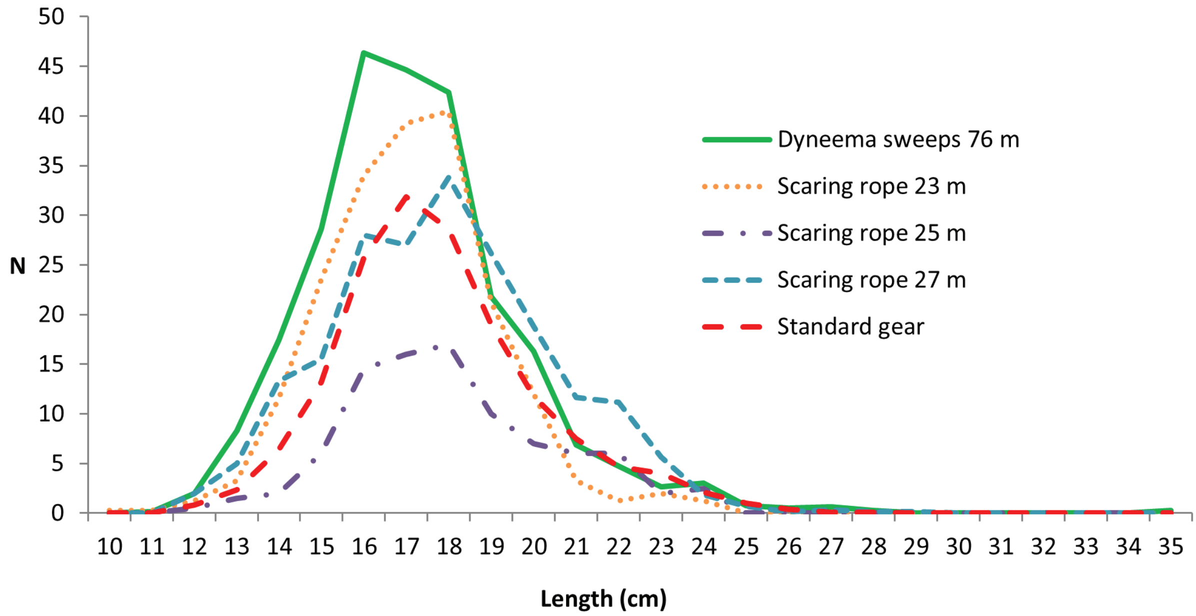

Figure 5. Standardised whiting length frequencies

Standardisation of catches in relation to the target species, *Nephrops*, revealed that the Dyneema sweeps caught proportionately less of all species compared with the standard rig (Table 4). In terms of the practicalities around the different gears, the scaring ropes were inexpensive and relatively easy to deploy. The Dyneema sweeps were more expensive and were found to have stretched by ~ 1.5 m over the course of the trial. The skipper noticed that the centre v-plate was well polished during haul back suggesting good bottom contact of the split sweeps. Deployment of Scanmar distance sensors was essential to monitor performance of all tested gears.

Table 4. Proportional catches (% weight) by species relative to Nephrops catches for each gear

	Standard gear	Scaring rope 23 m	Scaring rope 25 m	Scaring rope 27 m	Dyneema sweeps 76 m
Whiting	37	43	114	40	23
Haddock	17	18	57	13	16
Nephrops	100	100	100	100	100
Lesser spotted dogfish	108	93	589	110	40
Ray and Skate	60	94	304	35	16
Monkfish	21	22	213	24	16
Flatfish	18	20	87	17	6
Fish discards	121	72	150	68	50
Non-fish discards	66	160	889	35	22

Discussion

Study results suggest that the tested gears are ineffective in reducing catches of small whiting in quad-rigged trawling. Nor are they likely to be effective in other rigs: Reductions in whiting catches were achieved using Dyneema sweeps by Catchpole *et al.* (2013) but whiting represented a very small catch component in that trial. Depending on the nature of the fishery e.g. time of year, depths fished, ground type, tides, visibility, towing speeds etc, very small whiting may have different levels of ability to swim clear of fishing gear. BIM (2014b) found no significant difference in catches of small whiting but did find significant reductions in larger haddock and cod in a quad-rigged compared with a twin-rigged trawl. Hence, if contact between the split sweeps and the seabed across the mouth of the quad-rigged trawl has little impact on small whiting, other rigging arrangements ahead of the trawl such as floating Dyneema sweeps or scaring ropes may also be of limited benefit.

On a positive note the Dyneema sweeps caught substantially more *Nephrops* resulting in proportionally less whiting and other fish species compared with the standard rig. It is not known at this stage if these differences in catch rates were due to changes in species abundance or other factors but the results certainly merit further investigation: similar findings through quantitative assessment would suggest this measure has potential to postpone choking on whiting in the *Nephrops* fishery. Reduced ground contact between trawl rigging and the seabed also has further potential benefits in terms of reduced benthic impact and lower fuel consumption. The Dyneema sweeps stretching during the trial was likely to have reduced their effectiveness. Stretching the Dyneema sweeps to achieve their maximum length in advance of any further work should lead to further improvements in their performance.

In terms of other measures to reduce catches of very small whiting, the European Commission recently proposed an increase in codend mesh size from 80 to 90 mm in the Irish Sea (EEC, 2017). Reductions of ~ 60% of whiting < 20 cm and 10% of market sized *Nephrops* were observed in a previous codend mesh size study conducted in the Irish Sea *Nephrops* fishery (Cosgrove *et al.*, 2015). However, major changes in fishing gears have occurred since that study was conducted. Square mesh panels with 120 mm mesh size were employed in Cosgrove *et al.* (2015) whereas square mesh panels with 300 mm mesh are currently predominantly employed by Irish vessels in the Irish Sea. The mesh size employed in square mesh panels has a major impact on the selectivity of gadoid species that come into contact with the panel (Fryer *et al.*, 2016) and a 120 mm SMP is likely to accumulate substantially higher catches compared with a 300 mm SMP. The ability of diamond mesh codends to reduce undersize fish catches depends on the mesh size, codend circumference and the accumulated catch (Herrmann *et al.*, 2007). Hence an appropriate assessment of an increase in codend mesh size must take into account the impact of current gear measures on accumulated catch. BIM plan to address this in an upcoming gear trial. Reduced codend circumference will also be assessed as a further potential means of reducing unwanted whiting catches.

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Bord Iascaigh Mhara
An Cheannoifig,
Bóthar Crofton,
Dún Laoghaire,
Co. Bhaile Átha Cliath.
A96 E5A2

Irish Sea Fisheries Board
Head Office,
Crofton Road,
Dún Laoghaire,
Co. Dublin.
A96 E5A2

T +353 (0)1 214 4100
F +353 (0)1 284 1123
www.bim.ie