



# Raising the fishing line to reduce cod catches in demersal trawls targeting fish species

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# Raising the fishing line to reduce cod catches in demersal trawls targeting fish species

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## Key Findings

The raised fishing line is a relatively inexpensive gear modification which generally increases catches of targeted demersal fish species while reducing unwanted catches.

1

Cod catches were reduced by 39% by weight in the raised fishing line compared with a standard fishing line.

2

Whiting and haddock catches increased by 87% and 37% by weight respectively in the raised fishing line. This led to an increase in total catch value of 14% offsetting loss in catches of commercial species such as flatfish and monkfish in the modified gear.

3

Catches of skates and rays were also reduced by 80% by weight in the raised fishing line.

4

Under a fully implemented landing obligation scenario, the raised fishing line postponed choking on cod from 8 to over 11 hauls but had little effect on haddock.

5

Major scope exists to further develop the raised fishing line approach with relevant gear modifications eligible for grant aid under the BIM sustainable fisheries scheme.

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## Introduction

The Fisheries Conservation team in BIM develops and tests gear modifications to reduce unwanted catches, boost fishery sustainability and meet legislative requirements such as the EU landing obligation (LO).

Cod is a species which is likely to raise significant challenges when it is phased in under the LO, primarily due to quota mismatch with other demersal species. For example, the total allowable catch for whiting in the Celtic Sea is over 10 times greater than cod. At a finer scale, Irish vessels were generally subject to a catch limit of 33 tonnes of whiting compared with just 1 tonne of cod in the Celtic Sea in March 2017. Previous LO simulation studies demonstrated how it is possible to avoid early cessation of fishing effort or “choking” on cod in the *Nephrops* fishery by using selective gears. However, vessels targeting whiting found it difficult to reduce catches of cod and other choke species without substantial reductions in profitability (Cosgrove *et al.*, 2015; Calderwood *et al.*, 2016).

Studies on fish behaviour in trawls have shown that cod remain close to the bottom sheet while whiting and haddock

rise vertically after initial contact with the fishing gear (Main and Sangster, 1981; Krag *et al.*, 2010). This study aimed to take advantage of these behavioural differences by raising the trawl's fishing line up to 1 m above the ground gear to allow cod escape while maintaining whiting and haddock catches.

## Methods

### Fishing operations and gear

A catch comparison trial was conducted on board a 24.7 m twin-rig vessel targeting mixed demersal fish species in ICES Division VIIg in the Celtic Sea during March 2017. (Figure 1) Eleven valid hauls were carried out over a four-day period with average haul duration, depth and towing speed of ~2 hours, 75 m and 3 knots, respectively.

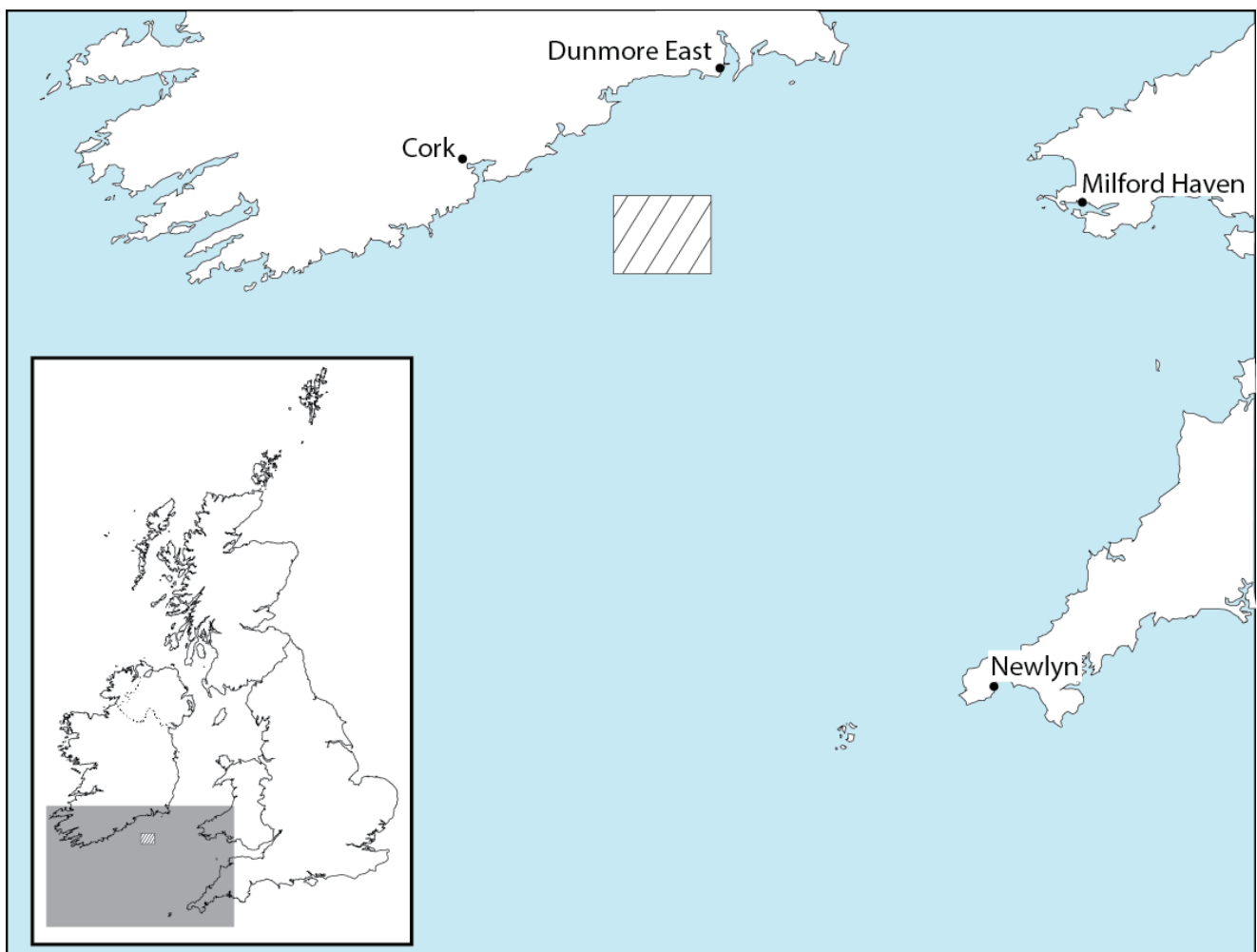


Figure 1. Location of raised fishing line trial (hatched area), and inset the location between Ireland and the United Kingdom



Characteristic	SFL	RFL
Trawl type	Twin-rig whitefish	
Fishing-circle (meshes × mm )	620 × 80	
Sweep length (m)	2 × 83 (37 + 46)	
Warp diameter (mm)	20	
Door manufacturer	Thyborøn	
Door weight (kg)	800	
Clump (roller) weight (kg)	900	
Nominal mesh size (mm)	80	
Cod end circumference (mesh no.)	120	
120 mm SMP location from codline (m)	9-12	
Headline floats (no.)	30	
Measured Mesh size (mm)	83	89
Standard Deviation (mm)	1.95	2.53
Fishing line height from ground gear (m)	0	1
Headline height (m)	5.4	6.4

Table 1. Gear specification of standard (SFL) and raised fishing line (RFL) gear

The fishing gear was provided by the vessel with one trawl rigged as normal with a standard fishing line (SFL) and the other modified with a raised fishing line (RFL) (Table 1). Using the protocol from Fonteyne *et al.* (2007), the Omega gauge provided average codend mesh measurements of 83 mm for the SFL and 89 mm for the RFL trawl. Square mesh panels in line with current legislative requirements were included in both gears. The gears were rotated once during the trial so that potential differences in fishing power associated with net position could be assessed. Further rotations were not possible due to the complex arrangement of the gear.

Raising the fishing line involved lengthening the droppers (toggles) between the fishing line and ground gear to 1 m (Figure 2). Droppers were constructed from 8 mm polysteel rope, double looped between the fishing line and ground gear with the exception of the two wing-end droppers which were made from chain. An additional length of chain was attached between the first dropper (where it was connected to the fishing line) and the footrope's chain extension, just behind the bunt bobbin. This assisted in maximising the distance between the fishing line and ground gear by pulling the fishing-line forward and keeping the chain dropper vertical. A Scanmar headline height sensor was deployed on a number of hauls on the SFL and RFL trawls to assess differences in headline height.

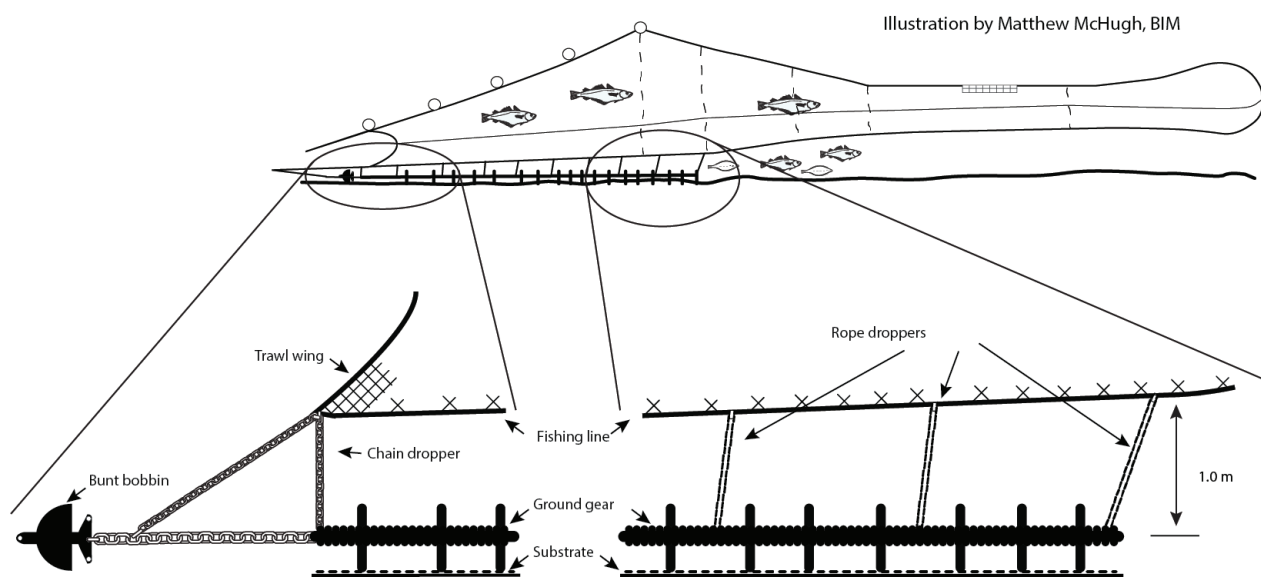


Figure 2. Raised fishing line configuration: (a) trawl showing species likely escape route, (b) configuration that holds the fishing line forward and, (c) rope droppers connected between the fishing line and ground gear

## Sampling and Analysis

Total catches were weighed and sorted at haul level for commercial species. Due to relatively low catch rates, commercial flatfish species were weighed, combined and categorised as commercial flatfish. Non-commercial species such as mixed flatfish, small pelagic species and crabs were combined as 'other species'. Random representative subsamples were weighed and measured for commercial species. Total lengths (TL) of commercial fish species were measured to the nearest cm below. Tables and raised 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 weight at length for comparative purposes.

Vertical separation of catches in fishing gears is known to vary diurnally (during day and night) (Krag *et al.*, 2010). Seven and four hauls were conducted during day and night time respectively so catches of all species were standardised by the numbers of hauls to facilitate comparison of diurnal catches. A general additive mixture model (GAMM) was used to statistically assess proportional differences in catches of key species in the two gears taking diurnal effects into account. Sales note data related to the trip were used to assess differences in catch value between the gears under business as usual (BAU) and landing obligation (LO) scenarios. Quotas used in this analysis were obtained from the Department of Agriculture, Food and the Marine fisheries management notice for March 2017. The plaice quota was assumed to be 1% of total landings under both scenarios.

## Results

Table 2. Quantities of species caught during the trial

Species	Standard fishing line (kg)	Raised fishing line (kg)	Difference (%)
Whiting	2,706	5,069	87
Haddock	1,975	2,713	37
Pollock	35	43	23
Hake	78	72	-8
Cod	798	488	-39
Other species	568	328	-42
Commercial flatfish*	584	250	-57
Ling	28	10	-64
Monkfish	202	57	-72
Mixed ray\$	124	25	-80

\*lemon sole, plaice, megrim, witch, turbot, black sole and brill

\$spotted and blonde ray

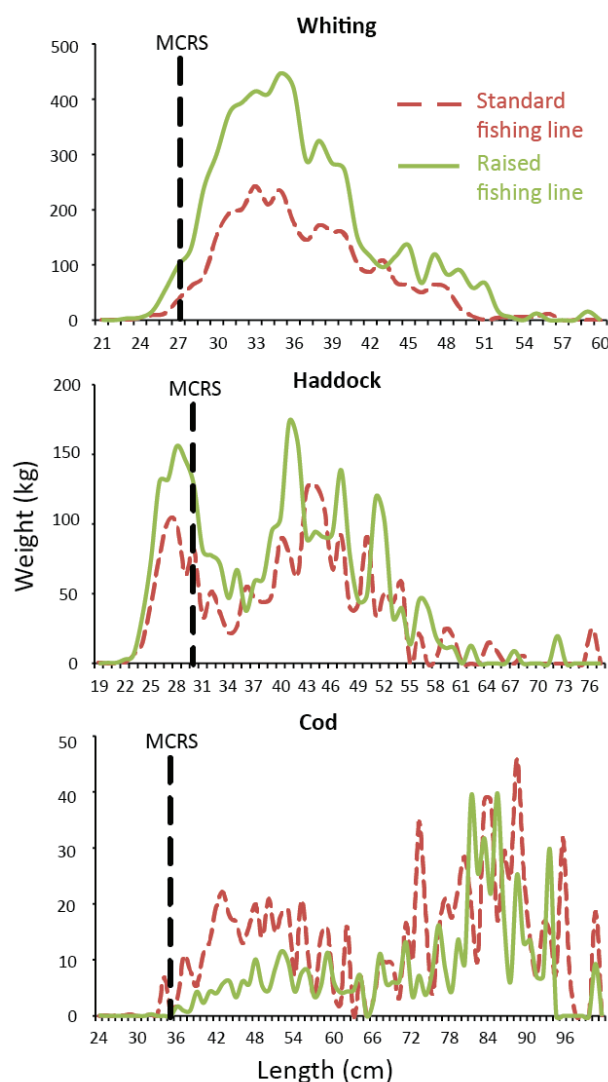


Figure 3. Raised length frequency distributions of key species

Substantial reductions in catches of cod (-39%) and other species such as commercial flatfish (-67%), and skates and rays (-80%) were observed in the RFL compared with the SFL. Whiting and haddock catches increased by 87% and 37% respectively in the RFL (Table 2). Observed reductions in cod catches in the RFL predominantly related to smaller cod (< 65 cm). Increased whiting and haddock catches were observed to occur across all size classes (Figure 3). Headline height was approximately 1 m higher on the RFL compared with the SFL.

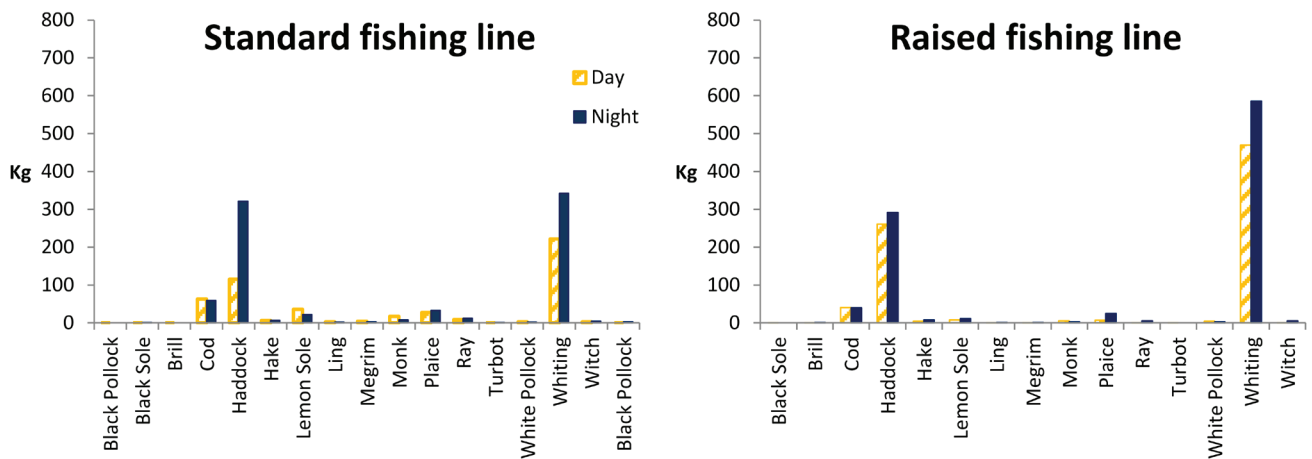


Figure 4. Species catch per haul

Major differences in diurnal catch rates of haddock were observed between the two gears. Haddock catches were 2.8 times higher in the SFL at night compared with day time. In contrast, the RFL caught approximately the same amount of haddock during day and night time (Figure 4). GMM modeling of proportional catch at length in the two gears taking into account diurnal effects revealed: significantly higher catches of whiting in the RFL; higher (not significant) catches of haddock in the RFL; lower catches of smaller cod and higher catches of larger cod in the RFL (again not significant) (Figure 5).

Total catch value was 14% higher in the RFL gear compared with the SFL under BAU. Assuming all quota species were subject to the LO, the vessel choked on cod after 8 hauls in the control gear but remained all clear after 11 hauls with the raised fishing line. The plaice choke was postponed by 2 hauls with the RFL but the haddock choke occurred one haul earlier due to increased haddock catch rates (Figure 6). However the total catch value was slightly higher at the end of haul 5 in RFL compared with haul 6 in SFL.

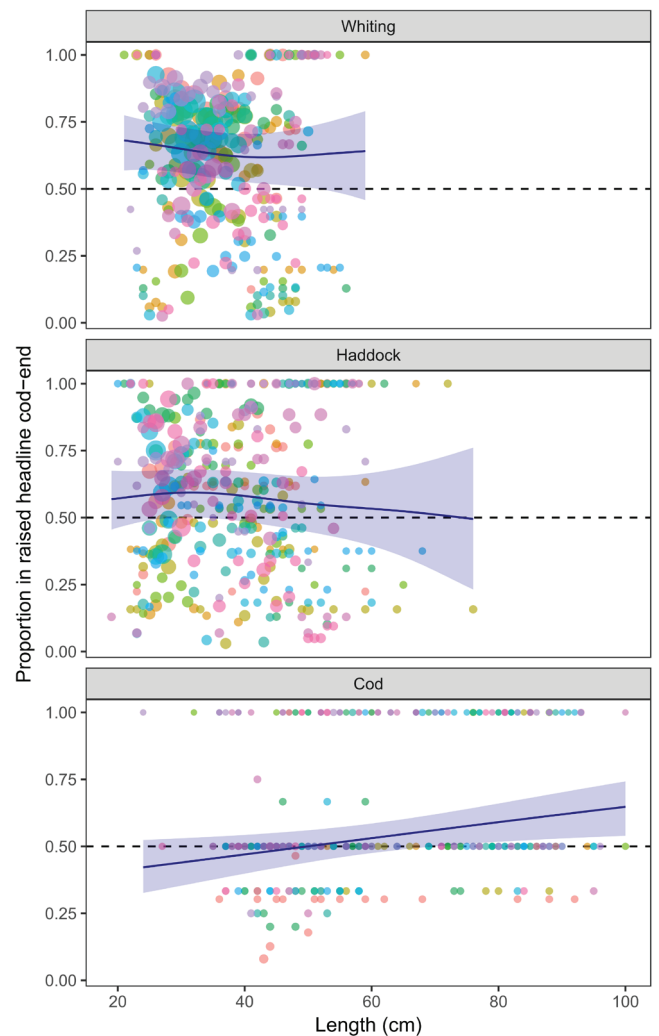


Figure 5. Predicted GMM proportion (assuming an equal number of day and night hauls) and approximate 95% confidence intervals in the raised headline cod-end. Points are coloured by haul with point size proportional to the total raised count.

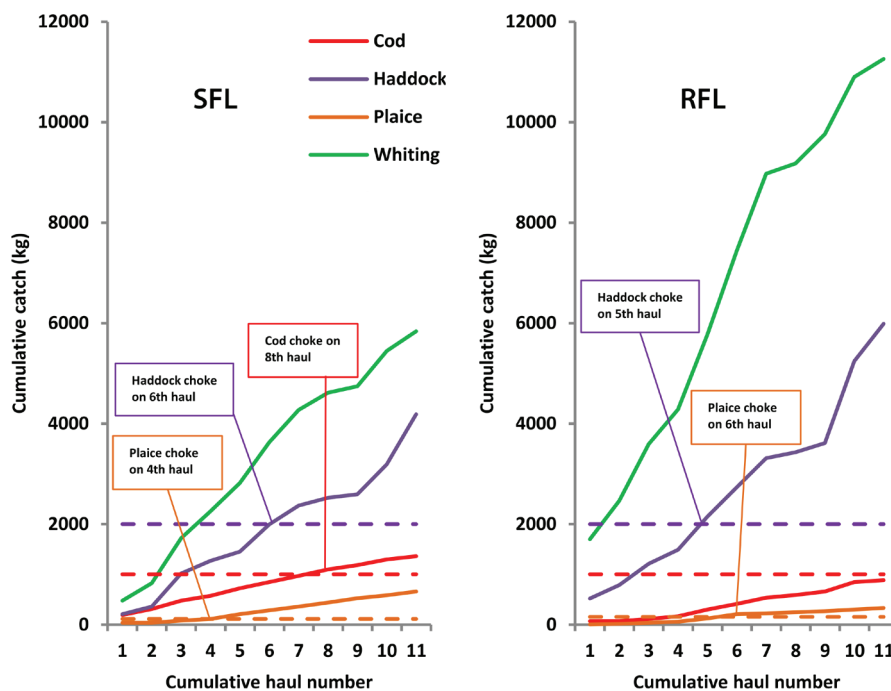


Figure 6. Landing obligation chokes for the standard (SFL) and raised fishing line (RFL) gear

## Discussion

Study results demonstrate the utility of this type of gear modification under the current predominantly landings based management system, and when cod is phased in under the LO. The 14% increase in catch value under BAU demonstrated how increased whiting catches more than made up for the loss of cod and other commercial species in the RFL. The delayed choke on cod combined with increased catches of the target species are also likely to boost vessel profitability under the LO scenario. However, the vessel would still have choked on cod at the end of one fishing trip using the RFL which suggests that this type of gear modification does not represent a comprehensive solution to the cod quota mismatch. Furthermore, the RFL had relatively little impact in terms of postponing chokes on plaice and haddock due to low quotas and higher catch rates of haddock. Gear modifications are unlikely to solve the haddock issue and, as outlined in previous LO simulation studies (Cosgrove *et al.*, 2015; Calderwood *et al.*, 2016), additional management measures will likely be needed to avoid choking on low quota species when vessels target whiting in the Celtic Sea.

Reduced catches of cod and flatfish species were likely due to escape between the RFL and ground gear. Significantly higher catches of whiting and higher catches of haddock in the RFL may have been due to the reduced ability of fish to escape the path of the trawl. For example, with both trawls traveling at the same speed (3 kts or 1.5 m s<sup>-1</sup>) and the ~1 m height difference, fish in front of the RFL trawl would need to increase their swimming speed by ~1.5 m s<sup>-1</sup> before they could clear its headline.

Substantially higher haddock catches in the RFL compared with the SFL during day time may be caused by higher species vertical distribution in the water column during daytime. Preliminary examination of diurnal catch rates from previous trials reveal: similar diurnal haddock catch rates in a trial conducted in April 2016 in the Celtic Sea (Browne *et al.*, 2016); an opposite trend with twice as much haddock caught during day compared with night time in a standard *Nephrops* twin-rig trawl in the Celtic Sea in December 2016 (Tyndall *et al.*, 2017). These findings suggest that tactical changes in fishing behaviour in relation to day and night time may offer some potential to address LO challenges in relation to haddock. However, such measures would need to be altered in relation to time of year and possibly area in order to be effective.

## Conclusion

The RFL is a relatively simple inexpensive modification which generally increases catches of target species while reducing unwanted catches of low quota species. This gear has potential to improve efficiency and reduce discarding under the current management regime and to reduce choking on cod when that species is phased in under the LO. Major reductions in ray species are an additional conservation benefit of this gear which could be useful in the development of management measures for skates and rays. Scope exists for further development of the RFL approach, for example with semi-pelagic or sweepless (i.e. no ground gear) trawls. In addition to reducing unwanted catches, these gears have potential to reduce fuel consumption and benthic impact. Relatively major changes in rigging may be required but such modifications are eligible for grant aid under BIM's sustainable fisheries scheme.

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