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A short-term economic assessment of incentivised selective gears

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ABSTRACT

An economic analysis of the impact of introducing more selective fishing gears and how their uptake is incentivised is carried out. The study focusses on some of the selective gears and the additional fishing opportunities used to encourage their uptake that are available as part of the Scottish Conservation Credit Scheme, which was set up to support the EU cod (*Gadus morhua*) recovery plan. We first demonstrate that the classification of the gears in the scheme is appropriate in relation to how they select for cod. We then evaluate the short-term direct and indirect financial impacts related with the different gear options. The analysis is carried out in relation to five different fleet segments of the Scottish whitefish fleet which are identified on the basis of the vessel size, engine power and gear fished and shows that with appropriate incentives, it is possible to introduce more selective gears without reducing profitability. The degree to which this can be achieved, however, will vary by fleet segment and will depend on the incentives on offer, the catch composition of the economically important species and the selective performance of the modified gear over this range of species. We also demonstrate that what incentivises one segment may not encourage another.

1. Introduction

Discarding occurs when part of the catch is deemed unsuitable for landing and is thrown back into the sea (Bergmann, 2002). It has long been a problem in fisheries and there are a variety of reasons why it occurs. The species caught may be unmarketable, of poor quality or below the minimum landing size (MLS) (Catchpole et al., 2005). In mixed fisheries, fish can be discarded when the quota for that species has been reached but fishermen continue fishing to catch their quotas of other species (Graham and Kynoch, 2001). A type of discarding known as 'high grading' can also occur when otherwise legally landable fish are discarded in favour of more profitable (e.g. larger, fresher) fish or to save quota for later on in the year (Campbell et al., 2010).

Many gear modifications have been made to reduce discarding and to improve the size and species selectivity in fisheries worldwide. Changes of the codend design parameters of mesh size, mesh shape, twine thickness and the number of meshes in circumference (He, 2007; Krag et al., 2011; Sala and Lucchetti, 2010; O'Neill and Herrmann, 2007) and the removal of attachements such as lifting and strengthening bags (Kynoch et al., 2004) have been effective in a range of fisheries at improving size selection, whereas methods such as square mesh panels, exclusion grids, raised footropes and separator panels have been shown to improve the species selectivity of a trawl gear (Hamabe et al., 2010; Macbeth et al., 2012; Grimaldo et al., 2008; Broadhurst et al., 2002; Drewery et al., 2010; Chosid et al., 2012; Campos and Fonseca, 2004). In general the devices used and/or the modifications made to improve gear selectivity will depend on the target species and the species to be selected and one design will not be a solution for every fishery. Studies of fish behaviour in relation to fishing gears have shown that fish react differently to different parts of the gear (Beutel et al., 2008; Main and Sangster, 1985) and that understanding fish behaviour is crucial for increasing selectivity of trawls (Jones et al., 2008).

The Scottish Conservation Credits Scheme (SCCS), which was set up in 2008 to support the EU cod (*Gadus morhua*) recovery plan, uses a range of management measures to reduce the fishing mortality and discarding of cod. It has introduced a system of real time, seasonal and permanent closures to reduce fishing effort on grounds where the abundance of cod is high and encourages the use of fishing gears that are more selective for cod (Holmes et al., 2011; Needle and Catarino, 2011; Kynoch et al., 2011a,b). While the scheme is compulsory, the elements in relation to the use of more selective gears are optional, and participating skippers are rewarded with additional fishing opportunities (i.e. extra days at sea). For those

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Table 1
The selective gear options belonging to each gear category and the additional fishing days per annum rewarded for their use under the initial scheme (2009–2011) and the present scheme (since 2012). Our analysis has only considered the large mesh options in the belly and forward sections and only includes the gears in bold font.

Category	Gear	Initial scheme (days)	Present scheme (days)
1	130 mm codend	8	15
2	**300 mm belly panel**	**12**	**30**
3	**300 mm forward section** **600 mm belly panel** 200 mm SMP	**20**	**50**
4	**800 mm belly panel** **600 mm forward section**	**24**	**70**

not taking part in the scheme the median number of days at sea available is 91 which can be increased by up to an additional 70 (initially 24) if the most selective gear option is used.

Recent catch comparison trials in Scotland have shown that cod will escape through large mesh (300–800 mm) panels that are fitted in the belly section or in the whole of the forward section (belly panel and all netting sections above and forward of it) of a trawl gear while maintaining catches of haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*) (Kynoch et al., 2009, 2011a,b; Campbell et al., 2010). Other authors have also shown how the selectivity of cod can be improved by increasing the mesh size of the forward sections of the gear or by inserting large mesh panels at different positions in the trawl (Beutel et al., 2008; Holst and Revill, 2009; Madsen et al., 2006; Thomsen, 1993).

The standard gear used in the Scottish demersal whitefish fishery is a single or twin trawl with forward sections made of 120–160 mm netting and with 120 mm mesh size codends and extension sections. The gear options available as part of the SCCS include increasing codend mesh size, fitting a square mesh panel in the extension section, fitting large mesh size belly panels (behind the footrope) and increasing the mesh size of the whole of the forward section (the belly panel and all netting above and forward of it). They are categorised according to how selective they are thought to be for cod and the number of days extra fishing that is offered as an incentive depends on which category they are in. The gear details, their category and the associated additional fishing days per annum rewarded for their use under the initial scheme (2009–2011) and the more generous present scheme (since 2012) are detailed in Table 1 and Fig. 1.

This study examines the gears options where large mesh panels have replaced the belly panel or the entire forward section of the trawl gear. In particular, we look at: (i) the 300 mm belly panel; (ii) the 300 mm forward section; (iii) the 600 mm belly panel; (iv) the 600 mm forward section; and (v) the 800 mm belly panel. The first of these is in gear category 2, the second and third in category 3 and the fourth and fifth in category 4 (Table 1). Catch comparison fishing trials have been carried out for these types of gears where the catch rate of the gear in question was compared with that of a standard commercial gear (Kynoch et al., 2009, 2011a,b; Campbell et al., 2010). Here we first combine the results from these studies, and analyse the catch rates of these gears to identify whether they have been sensibly categorised by the SCCS, i.e. we investigate whether the selective performance of gears in the same category are similar and hence justify rewarding vessels the same amount of additional fishing days.

We then consider the economic implications of fishing these gears. An often overlooked issue in many selectivity studies is the likely uptake of new measures by the fishing industry. Fishing is an economic activity and in order to make informed decisions, fishermen must understand the economic costs and benefits of using a more selective gear. They need to take into account factors such as the loss of catch, the costs of installing and maintaining the gear, the effect on the market price of fish and running costs such as fuel and crew etc. A number of studies of the biological and/or economic impact of more selective gears have been carried out. Generally these have considered the longer term implications taking into account the expected increases of biomass and yields that would be expected from the new measures. Raveau et al. (2012) and Macher et al. (2008) analysed the long- and short-term biological and economic effects of different selective devices on hake (*Merluccius merluccius*) and nephrops (*Nephrops norvegicus*) in the Bay of Biscay and showed that while they could be beneficial to the stocks, the economic benefit would vary between fleet segments and that to be effective fishing effort must also be controlled. Similarly, O'Neill et al. (2008) showed that the benefits of improving the selectivity of the North Sea whitefish fleet may not be evenly distributed across fleet segments and to produce a more equitable solution a combination of technical measures and effort control may be required. Kronbak et al. (2009) examine the bio-economic effect of using more selective gears on the Danish trawl fisheries in the Kattegat and Skagerrak and found that there was a trade-off between short term losses and longer term gains.

Jennings and Revill (2007) stress that new or modified gears need to be promoted with strong incentives and/or enforcement pressures as, otherwise, voluntary uptake can be expected to be low. In practice individual skippers are often more likely to be concerned with the short term impact of reduced landings rather than the uncertain longer term, collective benefits to the fishery. If they anticipate economic losses, they may be less willing to deploy more selective gears and/or possibly fish them in a way which reduces their selective performance. Hence, in this study we focus on the short term economic consequences of fishing the large mesh gear options that are available as part of the SCCS and investigate the attractiveness of the incentives on offer. In particular, we compare the incentives of the old scheme with those on offer at present and consider the likely uptake of the selective gears. As the impact of the different gear options will depend on the catch profile of a given vessel, the economic analysis is carried out in relation to five different fleet segments of the Scottish whitefish fleet which are identified on the basis of the vessel size, engine power and gear fished. The analysis evaluates the short-term direct and indirect financial impacts related with the different gear options. The direct impacts come from using the more selective gear, and are the expected loss in revenue due to reduced catch and possible changes in fuel efficiency due to the reduced drag associated with using gears with larger meshes. The indirect impacts arise solely from the additional days at sea rewarded to incentivise the use of the more selective gears.

2. Materials and methods

2.1. Catch comparison data

Cod, haddock, whiting, monkfish (*Lophius piscatorius)* and megrim (*Lepidorhombus whiffiagonis*) data collected from four sets of experimental trials which tested the selective performance of the large mesh panel/section gear options specified above are used in the analysis here. A 800 mm belly panel was tested on the MFV Caspian in 2008; a 300 mm forward section was tested on the MFV Russa Taign in 2008; 300 and 600 mm forward sections were tested on the MFV Resilient in 2009; and the 300, 600 and 800 mm belly panels were tested on the MFV Genesis in 2010 (Kynoch et al., 2009, 2011a,b; Campbell et al., 2010). These four vessels are twin-rig whitefish trawlers and in each case the test gear was compared with the standard gear used by that vessel normally. The forward sections of the standard gear were made from 160 mm mesh size 4 mm