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The selectivity of the gill-nets used to target hake (*Merluccius merluccius*) in the Cornish and Irish offshore fisheries

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Abstract

The North European gill-net fishery targeting hake (*Merluccius merluccius*) is mostly prosecuted using gill-nets with a mesh size of 120 mm. Fishers from both the UK and Ireland are active in this fishery using this particular gear type.

A study was undertaken aboard a commercial gill-netter off the coast of Cornwall (UK) in 2005 to estimate the selectivity parameters of this particular fishing gear, as little published information was available. We found that the 120 mm gill-net caught mostly larger hake, catching few fish below 60 cm. The modal selectivity length for hake using gill-nets with this mesh size was close to 80 cm.

The study indicates that the 120 mm gill-fishery off Cornwall and Ireland is a highly size-selective component of the international fishery exploiting the northern hake stock, a stock in which international landings at length peaked at around 30 cm (2004).

Keywords: Gill-net; Selectivity; Hake; *Merluccius merluccius*; SELECT

1. Introduction

Cornish gill-net fishermen in the UK believe their gear (120 mm gill-net) to be selective for large hake (*Merluccius merluccius*), catching relatively few small hake in the process. The same nets are also used in the Irish gill-net fishery, but as we could find no published selectivity data on this type of gear, we conducted a series of trials to estimate the selectivity parameters. The hake gill-nets used by both the Cornish and Irish fishermen are typically made up from sheet monofilament netting of 120 mm mesh size and about 50 meshes deep. They are rigged onto a floated head-rope and lead-cored footrope (Cosgrove et al., 2005).

Hake off Cornwall and Ireland form part of the northern hake stock, a stock which is spread from the continental shelf from Norway to the Bay of Biscay. This hake stock is fished by international fleets using a wide variety of gears including trawls, gill-nets and long-lines. The spawning stock biomass of the northern hake reached a low level in the 1990s (ICES, 2006), and emergency measures were introduced in 2001 to conserve the stock (Council Regulations 1162/2001, 2602/2001 and 494/2002). This has been replaced by EC Regulation 811/2004 which implements measures for the recovery of the northern hake stock, with the objective of rebuilding the spawning stock biomass. Fishing gear selectivity is an important aspect for hake conservation, and the use of gears that have minimal catches of young, immature hake will assist stock recovery.

This paper presents the results from sea trials to determine the selectivity of the 120 mm hake gill-nets used by the Cornish and Irish fishermen. The sea trials were conducted aboard a commercial gill-netter during the periods 8–15 October, 22–29 October and 7–14 November 2005.

2. Method

2.1. Experimental design

The experiment was carried out on the hake fishing grounds off Cornwall (Fig. 1) aboard the FV Carol H (WY 379), a

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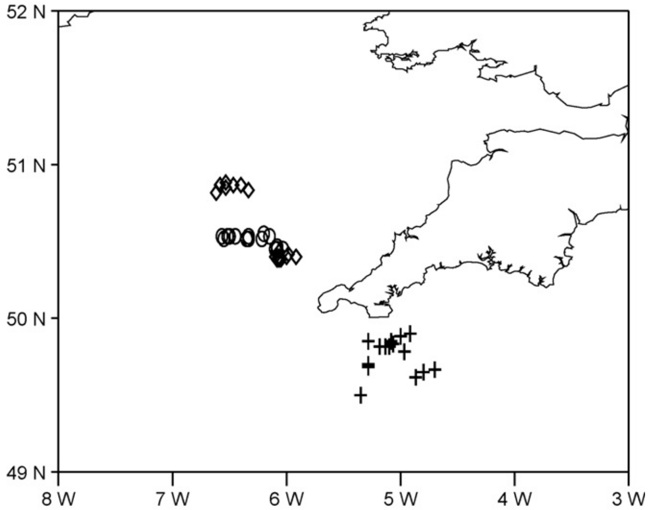

Fig. 1. Shooting positions of the gill-nets during the selectivity trials. Circles, trip 1 (8–15 October); crosses, trip 2 (22–29 October); diamonds, trip 3 (7–14 November).

steel-hulled netter of 17.5 m reg. length and with a 195 kW engine. Twenty-four gill-nets (bottom setting type) were constructed using materials which closely matched the type used commercially in the Cornish and Irish hake gill-net fisheries. The gill-nets were all newly made for the study and differed from each other only in terms of their mesh size. Four different mesh-sizes were used, with six gill-nets of each mesh-size (i.e. 80 mm, 100 mm, 120 mm and 140 mm (full stretched mesh length)). Each gill-net was 5.5 m high × 107 m long when set.

Gill-net mesh sizes, both smaller and slightly larger than the commercial mesh size of 120 mm were used in order to estimate the selectivity parameters of the commercial mesh size. Meshes larger than 140 mm were not considered because of the low expectations of any catches, and meshes smaller than 80 mm were not used because they were expected to become fouled with excessive amounts of weed, etc.

To allow a valid comparison of the catch rates and size compositions of the different mesh sizes, all nets were made with the same type and diameter (0.65 mm) monofilament nylon, and all the mesh sizes were fished at the same time and place and for the same soak time. (Intended soak times were 24 h but these had to be adjusted according to weather and other practical reasons.) The hanging ratios of all nets were set to 0.6 in all cases, and floats of 113 g buoyancy were set every 180 cm. The lead-line was 10 mm 3× strand heavy leaded.

Each day, all 24 gill-nets were retrieved after soak times which ranged between 12 and 36.5 h with an average of 23.3 h, which was close to the intended 24 h. On retrieval the catches were removed and each net was cleaned and redeployed. This process was repeated for 7 days, whereupon the vessel returned to port to land the catch. Three netting trips were made within a 6-week period in 2005: 8–15 October, 22–29 October, and 7–14 November. This provided repetition of the trials to assist the statistical analysis. Fig. 1 shows the positions where fleets were shot for each of the three trips. The first and third trips fished grounds to the North of Cornwall, whilst the second fished to the south of Cornwall.

It was commented by the skipper of the commercial vessel that new gill-nets do not fish as efficiently as older nets. We therefore deployed some extra older commercial 120 mm gill-nets (belonging to the vessel) in the vicinity of the selectivity experiments. The catches from these older commercial 120 mm nets were compared to the catch compositions from the new experimental 120 mm nets.

All fish species caught were measured to the cm below, and no sub-sampling of the catch took place. For hake, a record was kept of whether each fish was caught by the gills or by the teeth, as this may affect selectivity.

2.2. Data analysis using the SELECT method

Millar and Holst (1997) demonstrated how the SELECT method model reduces to a log-linear model for a range of (uni-modal) selectivity curves. This facilitates easy estimation with most statistical software packages. Uni-modal curves have however often appeared inadequate for modelling the selectivity. Fish are often caught in gill-nets by more than a single mechanism. A typical pattern is a dominant mechanism, e.g. gilling, which accounts for the majority of the catch and span a relatively narrow length interval for a given mesh size, whereas other catch mechanisms (e.g. entangling, or caught by the teeth) act on a wider length range. If the selectivity curve corresponding to each catch process is described by a Gaussian-shaped curve, the resulting selectivity curve describing the total selectivity will be a mixture of these with the individual components scaled according to relative efficiency of the corresponding catch mechanism. In practice it is however often not possible to identify more than two components. These can then be referred to a main process and secondary processes accounted for by a single component. Such curves are commonly denoted ‘bi-modal’ curves, but it may be more appropriate to call them ‘mixture-curves’, since they do not necessarily show more than a single mode. Estimation of such curves requires a general purpose optimiser to maximise the log-likelihood function or customised software such as the Gill-Net program (ConStat, Denmark). In general the selectivity curves are estimated by maximising the log-likelihood function:

$$L(\theta|n) = \sum_{\ell}\sum_{j} n_{\ell,j} \cdot \log(\phi(\ell, m_j; \theta))$$

A given choice of the selectivity curve function is incorporated in the expression of ϕ. See Millar and Holst (1997) for the parameterisation of four uni-modal curves. These are all two-parameter curves whereas the bi-modal curve uses five-parameters and is given by

$$\begin{aligned}\phi(\ell, m; \theta) &= \varphi(\ell, m; a_1, a_2) + \omega \cdot \varphi(\ell, m; b_1, b_2)\\ &= \exp\left(-\frac{(\ell - a_1 \cdot m)^2}{2(a_2 \cdot m)^2}\right)\\ &\quad + \omega \cdot \exp\left(-\frac{(\ell - b_1 \cdot m)^2}{2(b_2 \cdot m)^2}\right)\end{aligned}$$