Selectivity of 130 mm Mesh Size in Deep Sea Bottom Trawl Fishery in NAFO Regulatory Area

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Abstract

In February 1995 the European Union carried out a selectivity survey on board a Spanish commercial trawler, using the codend-cover method. The objective was to study the selectivity of 130 mm mesh size for the deep sea trawl fisheries in the NAFO Regulatory Area. One hour and four hour hauls were carried out and results obtained for Greenland halibut (*Reinhardtius hippoglossoides*), American plaice (*Hippoglossoides platessoides*), roughhead grenadier (*Macrourus berglax*) and threebeard rockling (*Gaidropsarus ensis*). For the two flatfish species, the proportion of retention increased with the duration of the haul. This increase reflected in a decrease of the corresponding selection factor. It also varied with the size of fish. The selection factor was greater in smaller individuals, and this induced an asymmetry in the selectivity curve. For the groundfish species, data were enough only to fit the four hour selectivity curves, which appeared more symmetrical than the flatfish ones.

Key words: American plaice, Greenland halibut, roughhead grenadier, selectivity, threebeard rockling, trawl

Introduction

Since the late-1980s, EU–Portugal and EU–Spain have developed a deep sea fishery in the NAFO Regulatory Area at depths between 800–1 800 m targeted at Greenland halibut (Junquera *et al*., MS 1992). This new fishery shifted the distribution of the Greenland halibut catches in Northwest Atlantic to the continental slopes in the areas of the nose and tail of the Grand Bank, from the more northern areas in Subareas 2 and 3. Although at present the population structure, exploitation pattern and geographic distribution of Greenland halibut in Subareas 2 and 3 still remain uncertain, the declines recorded in several abundance indices over recent years may point to a decline of this segment of the stock (Anon., 1995).

The management of the Greenland halibut stock in Div. 3LMNO falls under the NAFO Fisheries Commission, Conservation and Enforcement Measures. Based on the Conservation and Enforcement Measures, the trawl mesh size enforced in NAFO Regulatory Area is 130 mm, except for the fishery directed at squid and for nets with polyamide fibres in which a 120 mm mesh is allowed (Anon., MS 1994). To complement these mesh size regulations, NAFO has also established minimum landing sizes for the main commercial species. However, so far this minimum landing size has not been available for Greenland halibut, due to lack of selectivity data for this species. With the purpose of filling this information gap, the European Union supported this mesh selectivity survey, which was undertaken by EU–Spain and EU–Portugal. The results of these studies carried out in February 1995 are presented in this paper.

Materials and Methods

The survey took place from 12 to 22 February 1995 on board the Spanish stern trawler MV *Playa de Sartaxens*. This 2000 hp vessel was constructed in 1987, and is capable of trawling down to 2 000 m depth. It has a gross tonnage of 996 tons, a total length of 75 m, and a width of 13 m. The experiment

followed the codend-cover method (Pope *et al.*, 1975) using one of the commercial trawl gears of the vessel. The mesh size was determined by taking 25 measurements of the codend when the net was wet, with a graduated calliper (CEE TS 21.06 001 made by A/S N.P. UTZON c/ Vejelevej 111, 7000 Fredericia, Denmark).

The codend, 30 m in length, was covered by a 35 mm cover only over the last 15 m. It was so designed because, as pointed out by Beverton (1963) and also confirmed in this experiment, the escapement is mainly from the distal part of the codend. A 2.5 m distance separation was kept between the codend and the cover to allow a normal escapement of fish from the codend into the cover. To prevent damage to either nets, which would invalidate the results, the underside of the uncovered codend and cover was protected with horse tail chafers.

A total of 15 hauls were made, of which 8 were for length sampling for selectivity and the rest for biological sampling and collection of Greenland halibut gonads.

In order to check the impact of trawl duration on mesh selectivity, two sets of hauls were made. One set had trawls of 1 hr in duration and the other 4 hr in duration (the average duration of a commercial trawl).

Four species were analyzed: Greenland halibut (*Reinhardtius hippoglossoides*), American plaice (*Hippoglossoides platessoides*), threebeard rockling (*Gaidropsarus ensis*) and roughhead grenadier (*Macrourus berglax*). All the species were measured to the lower centimetre. For Greenland halibut, American plaice and threebeard rockling, total length was taken from the tip of the nose to the end of the tail, and for roughhead grenadier the measurement was from the tip of the nose to the base of the anal fin (Atkinson, 1981).

In the selectivity hauls, for each of the studied species the respective catches from the codend and cover were weighed and total fish length measured separately. For each species and duration, a retention plot was made for each length. Retention was calculated by dividing the number of fish of a particular length which appeared in the codend by total number of fish of this length which appeared in the cover and the codend. This calculation was made for each haul separately. A total observed retention for each length was also calculated by dividing all the specimens from the codend in all the hauls of the same duration, by the total number of fish at that length caught in those hauls. The

values were plotted in the figures with the "total" label.

The asymmetry observed in the plot of retention against length was better fitted to a generalized logistic curve given by the following retention length relationship (Nelder, 1961):

$$P_i = \left(\frac{1}{1 + e^{a + b L_i}} \right)^m \tag{1}$$

where:

L_i is the mean length of fish within the i th length group.

P_i is the retention of fish of the ith length group, and

a, b and m are parameters of the generalized logistic curve.

The estimation of these parameters was made using the "total" values as observations, by an iterative process that minimizes the function:

$$\phi = \sum W_i \left(P_i - \hat{P}_i \right) \tag{2}$$

where:

$$W_i = N_i P_i \left(1 - P_i \right) \tag{3}$$

and:

W_i is the weighting factor (Paloheimo and Cadima, 1964), which is proportional to the number of observations used to estimate P_i, and

N_i is the number of individuals in the ith length group.

This weighting factor increases as P_i approaches 0.5 and is 0 when P_i equals 0 or 1. For this reason, only lengths in which individuals from the cover and codend were recorded have been taken into account by the fitted method.

Results

The mean mesh size of the codend obtained from 25 measurements of the wet net was found to be 129.24 mm, with a standard deviation of 4.24 mm.

The number of fish measured and taken into account in the logistic curve fit (only length groups in which specimens appeared in the codend and cover were included), split by cover and codend, are presented (Table 1).

For both threebeard rockling and roughhead grenadier, the total number of individuals caught in

TABLE 1.   Number of fish, split by cover and codend, used in the estimation of the logistic parameters.

Species	1 hr trawls		4 hr trawls	
	cover	codend	cover	codend
Greenland halibut	1 463	838	287	866
American plaice	1 154	301	651	467
Threebeard rockling	68	40	309	222
Roughhead grenadier	64	187	369	467

TABLE 2.   Parameters of the generalized logistic curves a, b and m, the lengths at 25, 50 and 75% retention (L_{25}, L_{50}, L_{75}) and selection factor (S.F.) for each species and trawl duration.

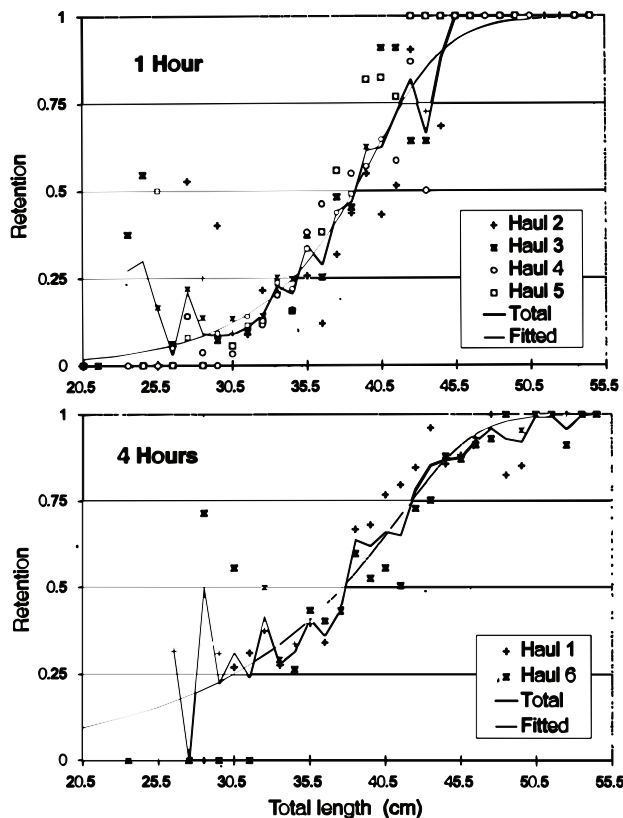|	a	b	m	L_{25}	L_{50}	L_{75}	S.F.
			1 hour				
Greenland halibut	19.631	-0.466	0.389	34.53	38.69	41.93	2.99
American plaice	57.943	-1.582	0.102	28.05	32.34	34.89	2.50
			4 hour				
Greenland halibut	24.226	-0.540	0.178	30.46	37.68	42.26	2.91
American plaice	47.779	-1.375	0.101	24.75	29.75	32.72	2.30
Roughhead grenadier	9.636	-0.599	0.310	8.65	12.55	15.39	0.97
Threebeard rockling	13.538	-0.294	0.447	35.67	41.59	46.40	3.21

Fig. 1.   Greenland halibut trawl selectivity of 130 mm mesh size, estimated using 1 hr and 4 hr duration tows.

1 hr duration hauls were insufficient to make the fit, and for this reason only results for 4 hr are presented.

The logistic curve parameters, as well as the lengths of fish at 25%, 50% and 75% retention, and the selection factor (S.F.) for each species and trawl duration units appear in Table 2.

The fit logistic curves for each species and trawl duration unit, together with the observed values in each individual haul and the "Total" are plotted (Fig. 1–4).

Discussion

The American plaice selection factor obtained for 1 hr and 4 hr duration trawls were 2.3 and 2.5, respectively (Table 2). These values are very consistent with the 2.4 calculated by Walsh *et al*. (1992) using the same mesh size. The length of fish at 25% retention (L_{25}) estimated for this species ranges from 24.75 cm to 28.05 cm (Table 2). This parameter is usually used as a reference to set the minimum landing size. The NAFO Scientific Council has assessed 25 cm as a minimum landing size for American plaice (Anon., 1996) which is in good agreement with the range of L_{25} values obtained in this experiment.

The Greenland halibut selection factor ranged from 2.91 to 2.99 (Table 2), which is a little smaller than the value of 3.19 obtained from Nedreaas *et al*.
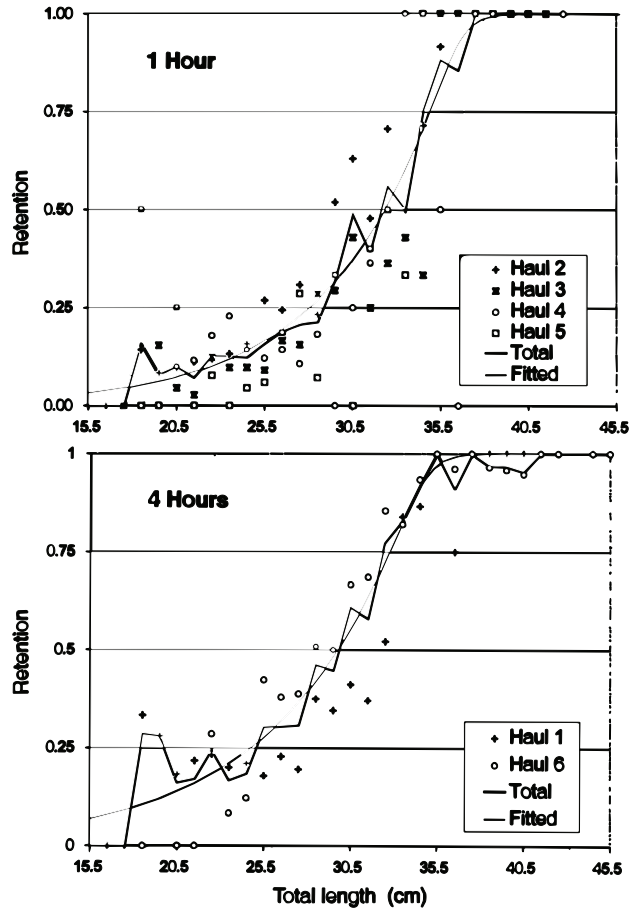
Fig. 2.   American plaice trawl selectivity of 130 mm mesh size, estimated using 1 hr and 4 hr duration tows.
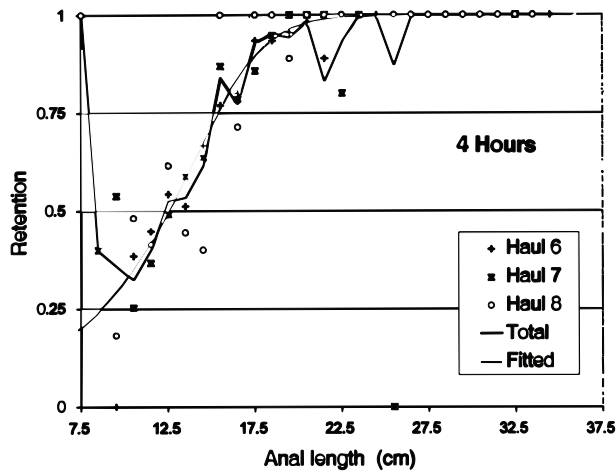

Fig. 3.   Threebeard rockling trawl selectivity of 130 mm mesh size, estimated using 4 hr duration tows.

(1993) in the Baltic Sea, who calculated L_{50} at 43 cm for a 135 mm mesh size. This difference may be
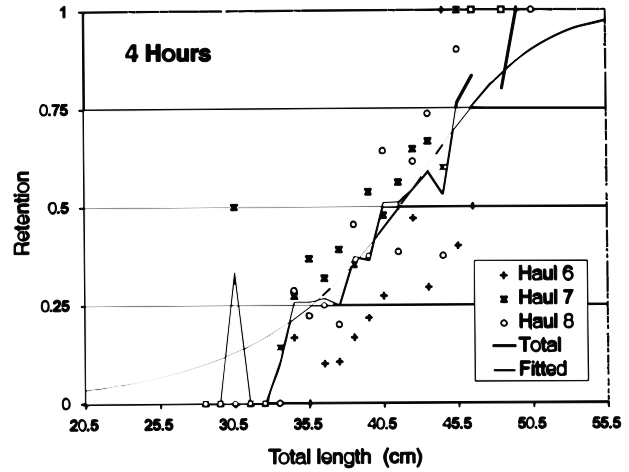

Fig. 4.   Roughhead grenadier trawl selectivity of 130 mm mesh size, estimated using 4 hr duration tows.

due to the fact that an asymmetric logistic model was used in this study, or due to differences in the length composition in the two areas.

As shown in Fig. 1 and 2, both American plaice and Greenland halibut increase in retention with fishing time, and this is reflected in a decrease in the respective selection factors (Table 2). The main cause for this decrease is probably the accumulated catch at the end of the codend, stuffing it progressively. This pattern is more evident in the smaller sizes of fish, as shown by the greater differences observed in L_{25} when compared with those recorded at L_{75} (Table 2). This factor could be related to the greater difficulty that is faced by small fish trying to escape the codend that is progressively stuffing up. This phenomenon induces a greater asymmetry of the logistic curves for 4 hr trawls, as already pointed out in selectivity studies of other flatfishes, for instance megrim (*Lepidorhombus* sp.) in Astudillo and Sanchez (1989).

With respect to threebeard rockling and roughhead grenadier, more symmetrical curves for the 4 hr trawls, which is the average duration of commercial trawls, were observed.

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