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FISH-4230; No. of Pages 10
ARTICLE IN PRESS
Fisheries Research xxx (2015) xxx–xxx
Contents lists available at ScienceDirect
Fisheries Research
journal homepage: www.elsevier.com/locate/fishres

Reducing flatfish bycatch in roundfish fisheries

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ARTICLE INFO

Article history:
Received 26 January 2015
Received in revised form 19 August 2015
Accepted 28 August 2015
Available online xxx

Keywords:
FRESWIND
Selectivity
Mixed fishery
Flatfish
Roundfish
Contact probability
Discard ban
Choke species
Baltic Sea

ABSTRACT

Flatfish bycatch is a concern in many demersal trawl fisheries around the world, especially for fisheries operating under discard-ban regulations. We introduce and assess the performance of FRESWIND (Flatfish Rigid EScape WINDows), a concept for a selection device that reduces flatfish bycatch in roundfish-directed fisheries. The new concept was tested for the first time in the Baltic cod-directed fishery, using a commercial twin trawler. The vessel was rigged with two trawls; one standard trawl gear and one incorporating the experimental FRESWIND. Comparison of the catches from both trawls exhibited up to ~68% reduction in flatfish bycatch for the trawl with FRESWIND mounted. In addition, the catch of undersized cod was reduced by ~30%, whereas losses of marketable cod were relatively minor (~7%). Further simulations predicted that, in the commercial fishery, a reduction of more than 50% in flatfish bycatch could be achieved if FRESWIND were adopted. Given these promising results, FRESWIND may also provide a method that significantly reduces flatfish bycatch in other fisheries.

1. Introduction

Discarding is an ethically and ecologically undesirable fishing practice of global concern. It wastes natural resources and severely challenges the sustainability of fisheries (Hall et al., 2000). It decreases the efficiency of fishing operations and changes the trophic flows in foodwebs and entire ecosystems (Catchpole et al., 2005; Greenstreet et al., 1999).

Societal interest groups have discussed the consequences of discarding and potential solutions intensively for decades (Catchpole et al., 2005; Alverson and Hughes, 1996). To date, different strategies have been implemented around the world to reduce or avoid unwanted catches (Condie et al., 2014). For example, one of the main aims of the upcoming European Commission Common Fisheries Policy reform (EU regulation 1380/2013) is to phase out discards by obliging fishermen to keep all catches of species with quota on board, land them, and count them against their quotas. The new policy is controversial because it puts the economic viability of the industry at risk, especially fleets engaged in mixed fisheries, where the bycatch of species with low quota can alter or even stop the normal fishing activities focused on species with less constraining quotas (STECF, 2014). It is a fishing industry priority to reduce and/or avoid the catch of such choke species (those species that can prematurely close a mixed fishery due to the exhaustion of their limited quotas).

Flatfish bycatch contributes substantially to the volume of discards in many demersal trawl fisheries around the world (Storr-Paulsen et al., 2012; Anon, 2011; Branch, 2006; Borges et al., 2005). This is often the result of a mismatch between the selectivity properties of the gear and the specific characteristics of flatfish morphology. For example, flatfish bycatch often occurs in fisheries targeting roundfish species (Wienbeck et al., 2014; Milliken and DeAlteris, 2004). Attempts to improve the selectivity in these fisheries often involve codend modifications in order to improve the size selectivity of the target species. These modifications include strategies like increasing codend mesh size or using meshes with square geometry (Guijarro and Massutí, 2006; Ordines et al., 2006; Fonteyne and M'Rabet 1992). Square mesh geometry facilitates escapement for roundfish species, while the effect on flatfish selectivity is unclear or negative (Guijarro and Massutí, 2006; Fonteyne and M'Rabet, 1992; Robertson and Stewart, 1988). These obser-

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http://dx.doi.org/10.1016/j.fishres.2015.08.025

vations indicate that alternative technological methods should be applied to reduce flatfish bycatch in roundfish fisheries.

This paper introduces a new concept for a selection device specifically developed for flatfish species. The FRESWIND (Flatfish Rigid EScape WINDows) uses the special morphology of flatfish to optimize selectivity (i.e., to largely avoid flatfish catches) without compromising the catchability of marketable sizes of the roundfish target species. FRESWIND is designed to be mounted ahead of the codend, to create a sequential selection process in which flatfish selection is achieved mainly by FRESWIND and roundfish size selection is achieved in the codend.

FRESWIND was tested for the first time in the western-Baltic-cod-directed trawl fishery, with catches composed primarily of the target species (*Gadus morhua*), with a mix of flatfish species taken as bycatch. To date, most research efforts in Baltic Sea trawl fisheries have concentrated on improving the size selectivity of cod through codend modifications (Madsen, 2007). As a result, two cod-selective codends are mandatory in the area (T90 and BACOMA; EU 686/2010). Although these codends present good size-selective properties for cod, flatfish selectivity is an increasing concern in the fishery, because species with limited quotas, such as plaice (*Pleuronectes platessa*), can disrupt normal fishing strategies due to the landing obligation rules stated in the new European policy (STECF, 2014; Wienbeck et al., 2014).

This study assesses the performance of a FRESWIND design, developed specifically for the Baltic cod-directed fishery, on the targeted cod and two common flatfish species in the area, plaice and flounder (*Platichthys flesus*). Plaice is the most valuable flatfish bycatch, regulated by total allowable catches (TACs) and a minimum landing size (MLS) of 25 cm. Estimates from the German catch sampling program in commercial fisheries yielded discard ratios ranging from10% to 100% between trips, with mean values from 10% to 40% in the cod directed-trawl fishery. Flounder is the most widely distributed flatfish species in the Baltic Sea, regulated by a MLS of 23 cm (ICES Subdivisions 22–25). It is mainly a bycatch species (ICES, 2012), and the German catch sampling program estimates discard ratios with high variation between trips (0–100%) and mean discard values between 5 and 40%.

This paper will investigate the performance of FRESWIND in the Baltic cod-directed trawl fishery. Further, we predict the consequences of the commercial fishery adopting FRESWIND.

2. Material and methods

2.1. The FRESWIND concept

The FRESWIND concept relies on the differences in flatfish and roundfish species morphology to optimize species selectivity. It was proposed originally by Swedish fisherman Vilnis Ulups, and further developed into the device presented here. The experimental gear design consists of rigid windows mounted on each side of a four-panel extension piece connected forward to the codend. The windows are constructed as grid-like sections with horizontal bars of steel to ensure well defined escape outlets, allowing the body shape of flatfish to pass in natural swimming orientation (Fig. 1). The windows were made of bars 10 mm in diameter with 38 mm barspacing. For this barspacing, the FISHSELECT method (Herrmann et al., 2009) predicted escapement possibilities for a wide range of flatfish sizes, while enabling only escapements for undersized cods (below Minimum Landing Size, MLS = 38 cm). The extension piece where the FRESWIND was mounted was cut in a way that induced ~45° angle of attack of the windows in relation to the towing direction. By using this specific design, it is intended to produce a tapering zone, which should enhance the probability for a fish to come into contact (attempt made by the fish to escape (Sistiaga et al., 2010)) with the side windows when swimming or drifting towards the codend. The extension piece was made with four net panels of 4 mm double twine and diamond mesh netting. The mesh size was 120 mm, and the number of meshes around was 4 × 25. A V-shape guiding device 860 mm high and 200 mm wing length, was mounted in the centerline of the extension piece ahead of the windows, with the aim of directing fish from the central path of the extension towards the windows. Wires were inserted into the vertical edges of the guiding device to increase its stiffness.

The codend used after the extension piece was the mandatory BACOMA codend (EU 686/2010) provided by the fishers. With this combination of FRESWIND and the codend, a stepwise selection process along the gear is intended, in which flatfish selection is achieved mainly by FRESWIND and cod size selectivity is achieved by the codend.

2.2. Sea trials

Sea trials were carried out on the German commercial twin trawler FV "Crampas" (18 m, 219 kW) during daytime. The cruise was conducted in the western Baltic, west of the island of Bornholm (ICES Subdivision 24), 15–25 March 2013, during the major cod fishing period. The skipper chose the fishing ground and fishing tracks based on his normal fishing strategies, to ensure the fish populations available for the gears were representative of the commercial trips. Two trawls model *ballontrawl 260,* constructed with 120 mm diamond mesh size netting, and with 260–144 meshes in circumference (from the square to the last section of the belly) were provided by the vessel. The groundrope of the trawls were equipped with rubber discs, and the doors used were Thyborön Type 11, weighting 451 kg. The trawls were equipped with the mandatory BACOMA codend and extension pieces. The extension pieces were identical, except that one included the FRESWIND device. The combination of the FRESWIND device and the BACOMA codend is denoted hereafter as the *test* selection system; the setup with the simpler extension piece (without FRESWIND) and the BACOMA codend is denoted as the *reference* selection system. The trials were conducted as a catch comparison experiment (Krag et al., 2014). The test and reference gear were twin trawled for each haul, and the position of each gear were swapped after completing half of the planned experimental hauls, to remove effects from side. Catches from each experimental haul were weighted by species, and the total length of all fish was measured with electronic measuring boards (0.5 cm below).

2.3. Data analysis

2.3.1. Estimation of catch comparison (CC) curves

The number of individuals of each length class caught in each of the trawls was used to evaluate the length-dependent relative catching efficiency of the two trawls for each species separately. For each of the species considered, the proportion of catches in the test system to the total in a haul i was given as:

$$CC_{il} = \frac{nt_{il}}{nt_{il} + nr_{il}} \quad (1)$$

where, nt_{il} is the number of fish of length class l caught by the test system in haul i, and nr_{il} represents the same number for the reference system. The experimental CC_{il} data are commonly used in catch-comparison analyses to estimate the gain/loss of catchability of the test gear, assuming that the observed trend is caused by the introduction of a selection device in the reference gear (Krag et al., 2014). In catch comparison studies, it is of main interest to assess any potential length dependency on the observed catch proportions. This assessment is carried out by estimating the most likely functional form of the catch comparison curve $CC(l)$.