Journal of Sea Research 202 (2024) 102550

Contents lists available at ScienceDirect

Journal of Sea Research

journal homepage: www.elsevier.com/locate/seares

The challenge of harvesting common sole (*Solea solea*) in highly selective trawl fisheries

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ARTICLE INFO

Keywords:
Fisheries management
Technical measures
Size selection
Escape panel
Sustainable fisheries

ABSTRACT

Common sole (*Solea solea*) is an economically important species in several European trawl fisheries, yet little is known about the size selective properties of codends used in bottom trawl fisheries targeting sole. This study presents results from a sea trial conducted in the inner Danish waters where common sole is fished in a seasonal trawl fishery using a 90 mm diamond mesh codend with a mandatory large mesh escape panel. To improve understanding of the selectivity in this gear, we in addition tested a plain 90 mm diamond mesh codend without an escape panel. This combination of codend mesh size and large mesh escape panel is part of an ambitious management plan aimed at eliminating bycatch of cod (*Gadus morhua*) in trawl fisheries in the inner Danish waters. In the fishery for common sole, we found a severe mismatch between gear regulations and minimum conservation reference size of the target species. The outcome is a highly inefficient fishery in which only 22 % (CI: 18–27 %) by weight of the marketable sole is retained in the 90 mm diamond mesh codend. Further, we estimated that 25 % (CI: 16–35 %) of the sole entering the codend would contact the mandatory escape panel and escape, resulting in a total loss of 83 % (CI: 79–87 %) of marketable sole through the mandatory gear. The inefficiency in this fishery demonstrates the need for other means than gear specifications to regulate this type of fishery.

1. Introduction

Common sole (*Solea solea*) (henceforth sole) is a high value species that constitutes an economically important fishery in its entire geographical distribution from Norway in the north to Senegal in the south (Howell and Dinis, 2019). In addition to having a relatively small cross-section size, sole has the shortest (24 cm) minimum conservation reference size (MCRS) (Regulation (EU) 2019/1241) of any flatfish species caught in Danish waters. From a management point of view, exploitation of sole is at a biologically sustainable level in the study area (ICES Subdivision 20–24) (ICES, 2023).

Kattegat is part of the inner Danish waters and is bordered by Sweden and Denmark. In this area, the targeted trawl fishery for sole is a seasonal fishery conducted at night and fished when sole aggregate during autumn and winter at depths of 20–40 m. In Kattegat, the value of sole landings constituted 3.9 mill. Euro on an annual basis corresponding to 28 % (range: 23–30 %) of all demersal fish landings over the 5-year period from 2019 to 2023, while the fraction by weight was 8 % (range: 5–14 %) (Danish Fisheries Agency, 2024). Approximately 20 vessels participate in this fishery.

In directed sole fisheries in the North Sea south of 56°, the minimum codend mesh size allowed in beam trawls is 80 mm (Regulation (EU) 2019/1241). In the demersal otter trawl fisheries in Kattegat and Skagerrak, minimum mesh sizes have increased over the last two decades, and additional selective devices have been implemented in legislation. Both measures were introduced to reduce unintended bycatch of juvenile round fish, in particular cod (*Gadus morhua*) (Krag et al., 2015, 2008; Madsen and Valentinsson, 2010). Currently, the targeted autumn/winter fishery for sole in Kattegat use a 90 mm codend with one of the following large mesh escape panels mounted in the upper panel: i) a 270 mm diamond mesh or a 180 mm square mesh escape panel located 4–7 m from the codline or ii) a 120 mm square mesh panel located 3–6 m

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https://doi.org/10.1016/j.seares.2024.102550
Received 13 June 2024; Received in revised form 24 October 2024; Accepted 24 October 2024
Available online 28 October 2024

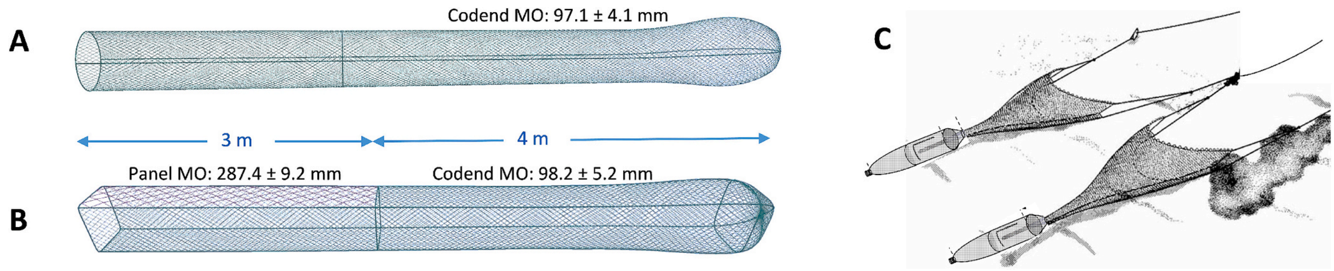

Fig. 1. Drawings of (A) the 90 mm diamond mesh codend (DIA) and (B) the 90 mm codend with a 270 mm diamond mesh panel (DMP) inserted 4–7 m from the codline. Drawing of the DMP is turned 45 degrees to better visualize the panel. Mesh sizes are reported as mean ± 2 standard deviations. The two codends were tested simultaneously using the covered codend methodology (C) (modified drawing from Crimond Enterprises Ltd).

from the codline (only allowed during October–December)(DK-BEK no. 1659/11/12/2023). Panel ii was introduced specifically to allow for a smaller mesh size in the escape panel during the prime season for sole. However, when using either of these gears in the demersal otter trawl fishery for sole in Kattegat, fishers argue that a large fraction of the valuable catch is lost through the 90 mm codend meshes, and they also experience unintended losses of sole through the mandatory escape panels.

However, despite the economic significance of the sole fishery, no scientific documentation for this exists. Furthermore, only few studies have documented selectivity of sole in commercial mesh sizes (Bayse et al., 2016; Fonteyne and M'Rabet, 1992; van Beek et al., 1981), and none of these studies have focused on otter trawls. Furthermore, the effect of the mandatory escape panel used in the Kattegat fishery on size selectivity of sole is unknown.

The aims of this study were to estimate size selectivity for sole in commercial fishing gears used in Kattegat and Skagerrak. Specifically, we i) estimate size selectivity for the 90 mm diamond mesh codend, ii) investigate how a large mesh escape panel near the codend affected size selection of sole in otter trawls, and iii) evaluate the catch efficiency for sole in the mandatory trawl gear used in Kattegat.

2. Materials and methods

2.1. Sea trials

We conducted a dedicated 10 day fishing trial in southwestern Kattegat in November 2017. A 16 m long, 340 kW twin trawler that is part of the Kattegat sole fishery was chartered for the trial. Fishing followed commercial practices for targeting sole, with relatively short tows (2−3*h*) conducted only at night (from sunset to sunrise). We used the vessel's own trawls (400 meshes in circumference (80 mm) and 30.5 m ground gear). On one side, we mounted a plain nominal 90 mm diamond mesh codend (DIA) made of two panels (Fig. 1a). On the other side, we mounted a four panel 90 mm diamond mesh codend with a 270 mm Diamond Mesh Panel (DMP) (Fig. 1b). This panel was chosen because it is used throughout the year by most of the fleet. For the DMP, the joining ratio between the 90 mm codend meshes and 270 mm panel meshes was 4:1 as specified in current legislation (DK-BEK no. 1659/11/12/2023). In each fraction, 50 meshes were measured in dry condition after the trial using an Omega gauge (Fonteyne et al., 2007). Both codends had 96 open meshes in circumference and were made of double twine netting with a twine thickness of 4 mm. The two codends were fished simultaneously in a three-wire towing rig using the covered codend setup (Wileman et al., 1996) to collect individuals escaping the codends (Fig. 1c). The last 10 m of each trawl were therefore fitted with a small mesh cover made from 35 mm (nominal) Dyneema® netting with a twine thickness of 1.8 mm. The two covers were identical, and they were kept open by kites and weights following the design described in Krag et al. (2016).

Total catch in codends and covers was estimated by eye of the skipper and the entire catch of sole was length measured. No other species was measured but landings of all commercial species were recorded.

2.2. Estimation of selection curves and parameters

We analyzed size selection in the two gears independently as covered codend data following the principles set forth in Wileman et al. (1996). The size selection $r_{av}(l, \boldsymbol{v})$ averaged over hauls m was estimated based on the number of sole caught in each length class l in the codend nC_{lj} and in the cover nCC_{lj}, in each haul j, by minimizing the following expression with respect to selection parameters $\boldsymbol{v}$:

$$-\sum_{j=1}^{m}\sum_{l}\{nC_{lj}\times ln(r_{av}(l\boldsymbol{v}))+nCC_{lj}\times ln(1.0-r_{av}(l\boldsymbol{v}))\}\quad(1)$$

Minimizing (1) with respect to the parameter $\boldsymbol{v}$ is equal to maximizing the likelihood for the observed experimental data under the assumption that the size selection model can describe the length dependent probability for retaining a common sole with length l in the codend conditioned it enters the net. The ability of the applied model to describe the experimental data, was evaluated based on the *p*-value, model deviance versus degrees of freedom, and by inspection of how the modelled size selectivity curve represented the length-based trend in the experimental data. The *p*-value quantifies the probability to obtain, by coincidence, at least as big deviation between the observed experimental data and the fitted size selection curve. Therefore, for the model to be acceptable in describing the data, the *p*-value should be at least 0.05 corresponding to at least 5 % probability that the observed deviation is coincidental (Wileman et al., 1996). Size selectivity of trawl codends with no additional selective device is most often described by the logistic model (Wileman et al., 1996):

$$r_{logistic}(l, L50, SR)=\frac{exp(ln(9)\times(l-L50)/SR)}{1.0+exp(ln(9)\times(l-L50)/SR)}\quad(2)$$

The logistic size selection model is described by two parameters $\boldsymbol{v} = (L50, SR)$: length at 50 % retention (*L50*) and selection range (*SR* = *L75*-*L25*). If fit statistics allows it, we will use this model to explain retention of sole in both codends. In the DMP, sole can potentially be subjected to a more complex sequential selective process; they can either escape through the large meshes in the panel, or they can escape through the smaller codend meshes. Previous studies have found the logistic model to be unable to explain this process whereas a dual selection model is applicable to codends with such a device (e.g. Cuende et al., 2020; Herrmann et al., 2013; Krag et al., 2017; O'Neill et al., 2006; Zuur et al., 2001):

$$r_{dual}(l, C_{DMP}, L50_{DMP}, SR_{DMP}, L50_{Codend}, SR_{Codend}) = (1.0 - C_{DMP} + C_{DMP} \times r_{logistic}(l, L50_{DMP}, SR_{DMP})) \times r_{logistic}(l, L50_{Codend}, SR_{Codend}) \quad (3)$$

The first selection process takes place when a sole encounters the DMP section where it can be size selected if it contacts the escape panel. The parameter C_{DMP} quantifies the fraction of sole entering this section and contacts the escape panel. If a sole contacts the escape panel, the probability that it passes through it, is described by a logistic model with parameters $L50_{DMP}$ and SR_{DMP}.

For sole that do not escape during the first selection process, a second process will take place in the diamond mesh codend. For this process model (3) assumes a logistic size selection model with parameters $L50_{Codend}$ and SR_{Codend}. However, due to the large mesh size in the panel we additionally considered a special case of Eq. (3) where all individuals that contacted the large mesh panel were modelled escaping independent of fish size. For such case model (3) simplifies to:

$$r_{dualC}(l, C_{DMP}, L_{50Codend}, SR_{Codend}) = (1.0 - C_{DMP}) \times logistic(l, L_{50Codend}, SR_{Codend}) \quad (4)$$

This simplified version of the dual model has three parameters $\boldsymbol{v} = (C_{DMP}, L50_{Codend}, SR_{Codend})$. In case of the two dual selection models (Eq. (3) or (4)) the combined selection parameters $L50_{combined}$ and $SR_{combined}$ considering both the large mesh escape panel and the codend were obtained using the numerical method described in Sistiaga et al. (2010).

The choice between the simple logistic model (Eq. (2)) and the two more complex models described by Eq. (3) and (4), was based on Akaike's Information Criterion (AIC) values (Akaike, 1974) with the model providing the lowest value to be selected.

We used a double bootstrap method when estimating the 95 % confidence intervals (CIs) of parameter values and of the selection curves (Herrmann et al., 2012; Millar, 1993). We used 1000 bootstrap repetitions for each codend design and estimated and reported the Efron percentile 95 % CIs (Efron, 1982).

Difference between retention ($\Delta r(l)$) of sole in the two codend designs was estimated by subtracting the retention at length (Herrmann et al., 2018; Larsen et al., 2018):

$$\Delta r(l) = rDMP(l) - rDIA(l) \quad (5)$$

where *rDMP(l)* and *rDIA(l)* are the size selection curves for sole in the DMP and the DIA, respectively obtained by the method described above. The bootstraps group of results (1000 repetitions) obtained when estimating the 95 % CI for the retention rates for each codend were used to generate a new set of bootstraps for $\Delta r(l)$ to obtain 95 % CIs for $\Delta r(l)$ following the approach described in Larsen et al. (2018).

2.3. Estimation of performance indicators

We used performance indicators (Wienbeck et al., 2014) to provide an overview of the performance of the two codends in the specific fishery situation. These quantify the retention efficiency in percentage below and above MCRS ($nP-$ and $nP+$) and should be low (close to 0.00 %) and high (close 100.00 %), respectively, for the gear to be well adjusted to the size distribution of the species in question. The discard ratio (*ndRatio*) quantifies the fraction of the catch (in percentage) that consists of undersized sole. Ideally, the *ndRatio* should be as low as possible. Following Wienbeck et al. (2014) $nP-$, $nP+$ and *ndRatio* are estimated directly from the collected covered codend size selectivity data for the specific codend:

$$\begin{aligned}
nP- &= 100 \times \frac{\sum_{j=1}^{m} \sum_{l<MCRS} \{nC_{lj}\}}{\sum_{j=1}^{m} \sum_{l<MCRS} \{nC_{lj} + nCC_{lj}\}} \\
nP+ &= 100 \times \frac{\sum_{j=1}^{m} \sum_{l\geq MCRS} \{nC_{lj}\}}{\sum_{j=1}^{m} \sum_{l\geq MCRS} \{nC_{lj} + nCC_{lj}\}} \\
dnRatio &= 100 \times \frac{\sum_{j=1}^{m} \sum_{l<MCRS} \{nC_{lj}\}}{\sum_{j=1}^{m} \sum_{l} \{nC_{lj}\}}
\end{aligned} \quad (6)$$

Similarly, indicator values of weights (*wP-*, *wP+*, and *wdRatio*) (Sala et al., 2015; Melli et al., 2020) were estimated based on conversion of length *l* to weight *w* of individual fish (Coull et al., 1989):

$$\begin{aligned}
wP- &= 100 \times \frac{\sum_{j=1}^{m} \sum_{l<MCRS} \{nC_{lj} \times a \times l^{b}\}}{\sum_{j=1}^{m} \sum_{l<MCRS} \{(nC_{lj} + nCC_{lj}) \times a \times l^{b}\}} \\
wP+ &= 100 \times \frac{\sum_{j=1}^{m} \sum_{l\geq MCRS} \{nC_{lj} \times a \times l^{b}\}}{\sum_{j=1}^{m} \sum_{l\geq MCRS} \{(nC_{lj} + nCC_{lj}) \times a \times l^{b}\}} \\
dwRatio &= 100 \times \frac{\sum_{j=1}^{m} \sum_{l<MCRS} \{nC_{lj} \times a \times l^{b}\}}{\sum_{j=1}^{m} \sum_{l} \{nC_{lj} \times a \times l^{b}\}}
\end{aligned} \quad (7)$$

We used the double bootstrapping method described above to estimate the Efron 95 % percentile CIs for the indicator values (Eq. (6) and (7)) to account for uncertainty induced by between-haul and within-haul variation. In contrast to estimation of the population-independent selection curves and parameters described above, these indicators give an estimate of the direct consequences of the different gear choices in this specific area and season. The indicators use the size structure in the population at the time of the of sea trial, and they are therefore not applicable to other areas or seasons (Wienbeck et al., 2014).

2.4. Software

All analyses described in sections 2.2 and 2.3 were performed using the software tool SELNET (Herrmann et al., 2012).

3. Results

3.1. Trawl catch data

We obtained 18 valid hauls during the trial. There was no subsampling, and 17,814 individuals in the size range between 10 and 45 cm were caught, and length measured (Table 1). The average haul duration was 2.3 (range: 2.0–2.7) h with an average speed of 2.32 (range: 2.30–2.33) knots. Depth ranged from 13 to 32 m. Total catch weight ranged from 60 to 220 kg and catch composition in this targeted fishery was restricted to a few species, and 95 % of the landings by weight consisted of sole with 55 % and plaice (*Pleuronectes platessa*) with 40 %. The remaining 5 % consisted of brill (*Scophthalmus rhombus*),

Table 1
Catch data for each haul *j*. nc_j is number of soles in codend and ncc_j is number of individuals in the cover surrounding the codend (see Fig. 1c).

	DIA		DMP	
Haul ID *j*	Codend nc_j	Cover ncc_j	Codend nc_j	Cover ncc_j
1	27	692	16	717
2	55	852	40	621
3	12	543	6	437
4	19	685	14	809
5	33	763	16	824
6	25	768	17	742
7	21	317	20	276
8	35	319	27	294
9	22	340	11	320
10	25	238	30	311
11	41	244	32	195
12	23	260	20	244
13	29	245	22	279
14	41	827	25	818
15	40	590	32	516
16	37	311	24	336
17	37	303	29	315
18	51	234	35	240
Total	573	8531	416	8294

turbot (*Scophthalmus maximus*), common dab (*Limanda limanda*) and witch flounder (*Glyptocephalus cynoglossus*).

3.2. Size selection curves and parameters

The length-dependent retention probability for sole in the DIA was well explained by the logit model (*p*-value >0.05 and deviance resembled value of DOF (Table 2)) (Fig. 2). Retention data from the DMP, on the other hand, reflected the more complex selection process of this type of codend where larger fish can either i) escape through the panel or ii) be retained by the codend (Fig. 2). A logistic curve was unable to explain selection in this codend (P-value <0.0001 and deviance = 127.03, DOF = 33) (Table 2), whereas both dual selection models provided acceptable *p*-values. Based on AIC-value, the model of choice was DualC implying a length independent process where all sole that come into contact with the large mesh panel, will escape regardless of their size (Table 2). We estimated that 24.6 % of the sole contacted the large mesh escape panel and escaped through it (Table 3).

The population structure obtained during the sea trial shows a single peak around the MCRS. At this length, both gears retained very few fish (0.8–1.2 %) (Fig. 2). The low retention of the most frequent length classes illustrates the challenge of obtaining sufficient numbers of sole in the selective size range of the commercial gears during sea trials. However, the high number of valid hauls in this directed sea trial resulted in a strong data set, which allowed us to estimate size selection with narrow CIs, particularly for the 90 mm codend (Fig. 2).

When comparing the two tested codends, the retention of sole above 27 cm was significantly lower in the DMP than in the DIA, which demonstrates a significant effect of the large mesh panel on the selection of sole (Fig. 3).

Table 2
Fit statistics for the different size selection models considered for DIA and DMP respectively. Model selected for each codend is marked in bold.

Codend	DIA		DMP	
Selection model	**Logistic**	Logistic	Dual	**DualC**
AIC-value	1813.95	1825.99	1743.62	1741.46
p-value	0.1236	< 0.0001	0.1334	0.1439
Deviance	42.54	127.03	38.66	40.50
DOF	33	33	30	32

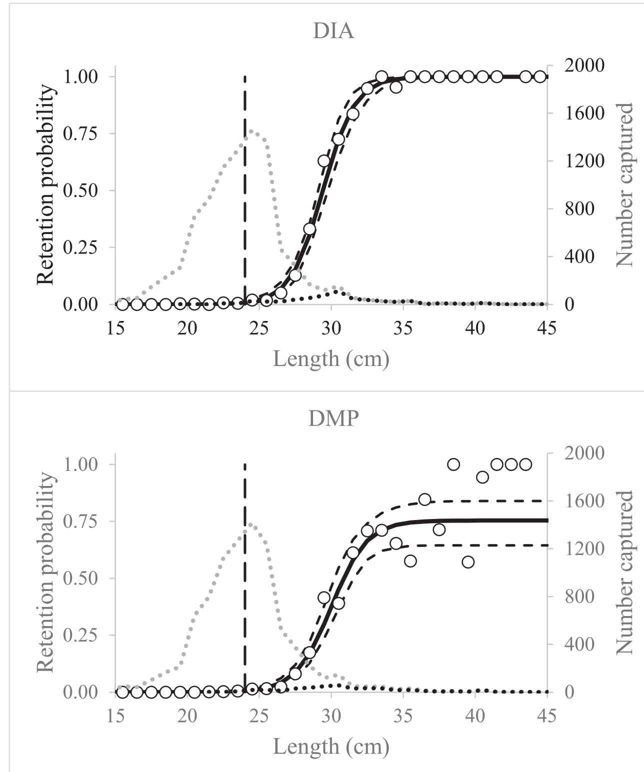

Fig. 2. Selectivity curves for sole in the two codends. Mean selection curves (solid lines) with associated 95 % CIs (broken lines). The fished (gray dotted curves; $nc_l + ncc_l$) and retained populations (black dotted curves; nc_l). The broken black vertical line indicates the current MCRS of 24 cm.

Table 3
Estimated values parameters in the size selection models selected for DIA and DMP. Values in () represent 95 % confidence bands. NA: not applicable.

Codend	DIA	DMP
Model	Logistic	DualC
$L_{50\text{-}combined}$ (cm)	29.41 (29.10–29.77)	30.85 (30.18–31.65)
$SR_{combined}$ (cm)	2.45 (1.98–2.92)	7.29 (3.61–121.27)
C_{DMP} (%)	NA	24.59 (15.89–35.29)
$L50_{codend}$ (cm)	29.41 (29.10–29.77)	30.02 (29.38–30.71)
SR_{codend} (cm)	2.45 (1.98–2.92)	2.71 (2.09–3.30)

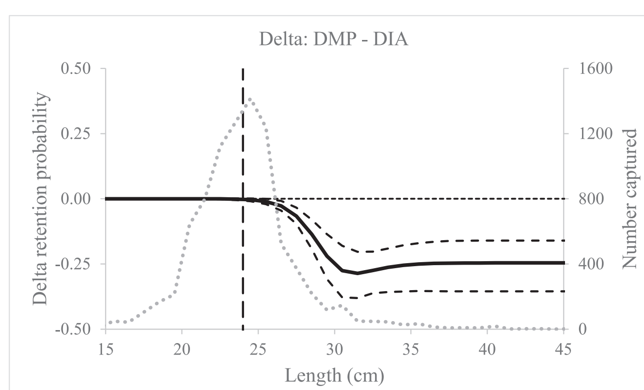

Fig. 3. Difference in retention of sole between the DIA and DMP. No difference between codends (delta = 0) is indicated by the solid horizontal line. Negative delta values indicate panel escapement in the DMP. 95 % CI values are shown (broken lines), as is the current MCRS (broken black line). Population fished (gray dotted curve).

3.3. Catch performance indicators

For both codends, retention efficiency was low for individuals above MCRS, both in numbers (*nP*+) (13.09 % (DIA) and 9.48 % (DMP)) and in weight (*w*P+) (22.34 % (DIA) and 16.97 % (DMP)), resulting in a loss of marketable sole in the DIA of 86.01 % in numbers and 77.66 % in weight. For the DMP, loss of marketable sole through the panel and the codend meshes was 90.52 % in numbers and 83.03 % in weight (Table 4). Not surprisingly, retention of individuals below MCRS was extremely low in both gears (< 0.4 %) (Table 4). Despite differences in mean values, inspection of overlap of 95 % CIs revealed no significant difference for the performance indicator values between the DIA and DMP (Table 4).

Table 4
Overview of total retention in numbers of sole and the performance indicators: retention above (*nP*+, *wP*+) and below (*nP*-, *wP*-) MCRS and the discard ratio (*nDRatio, wDRatio*) in numbers and weight. The 95 % CI is shown in brackets.

Indicator	DIA	DMP
nP- (%)	0.34 (0.05–0.72)	0.20 (0.00–0.51)
nP+ (%)	13.09 (10.89–15.73)	9.48 (7.09–12.16)
nDRatio (%)	2.79 (0.48–5.52)	2.16 (0.00–5.42)
wP- (%)	0.37 (0.03–0.87)	0.24 (0.00–0.62)
wP+ (%)	22.34 (18.22–26.79)	16.97 (13.16–21.20)
wDRatio (%)	0.98 (0.07–2.18)	0.75 (0.00–2.09)

4. Discussion

In agreement with the fisher's observations, our study demonstrated a severe loss of commercially sized sole through the codend meshes and an additional loss through the large mesh escape panel resulting in a total loss of 83 % and thus a very low catch efficiency. This is expected to be a strong incitement for fishers to circumvent the technical regulations. If fishers comply with the regulations, trawling for sole will require a disproportionate effort to catch their quota. This may in turn challenge end user support, as an inefficient fishery will increase the industry's environmental impact due to additional trawling effort, which cause carbon emissions and seabed impacts (Lozano et al., 2009; Thrane, 2006).

The catches of sole in the experimental study were high and allowed for an accurate estimation of selection parameters in commercially used otter trawls. The selection factor ($SF = L50$ / mesh size) for the DIA (3.0) was within the range (2.6–3.3) obtained for beam trawls (Bayse et al., 2016; Fonteyne and M'Rabet, 1992; van Beek et al., 1981), which indicates that codend selection of sole in the two gear types was similar, despite differences in towing speed and gear construction. Madsen et al. (2013) reported similar findings for plaice. The two codends tested in this study were constructed of two (DIA) and four (DMP) panels respectively. The number of open meshes around the codend was consistent, but the difference in design could have affected the selective properties of the codend. However, *SF* of the two codends was similar (DIA: 3.03 vs. DMP: 3.08), which suggests that the difference in codend design did not affect selectivity of sole in this case.

In mixed species trawl fisheries targeting sole, large mesh sections have been used to aid the escape of juvenile round fish (Méhault et al., 2020 (otter trawl); van Marlen, 2003 (beam trawl)). In contrast with the present study, in which a significant fraction of the legal sized individuals escaped through the large mesh panel, the previous studies reported no loss of sole. This difference may be explained by the position of the escape panel relative to the codline. We placed the panel in the non-tapered extension, only 4–7 m from the codline, whereas both Méhault et al. (2020) and van Marlen (2003) placed the large mesh section in the tapered forward part of the trawl body. Proximity of escape panels to the accumulation zone at the codline has previously been shown to have a significant positive effect on escape through panel meshes (Graham et al., 2003; Krag et al., 2008; O'Neill et al., 2006).

Our results demonstrate the need for a more efficient gear and at present, there is no additional selective device that will increase retention of sole without increasing the risk of catching cod. In other areas, minimum mesh size in beam trawl fisheries targeting sole has been adjusted to the MCRS of sole (i.e., 80 mm) (van Marlen, 2003). Despite the fact that sole is targeted when aggregating, bycatch of juvenile and sensitive species can be considerable if mesh sizes are reduced, and selective devices removed. Additional control of catches is therefore needed.

Part of the fleet operating in Kattegat has installed on board CCTV (remote electronic monitoring, REM) on a voluntary basis. If the recorded data stream is used to count the entire catch against the vessels quota, this measure of control could facilitate a relaxation of technical regulations and thus allowing a freer gear choice (CORDIS, 2018; Kindt-Larsen et al., 2011; Ulrich et al., 2015; Feekings et al., 2019). Fishers using REM could in such a setting, when target sole during their annual aggregation in deeper waters, use a more appropriate mesh size for catching sole efficiently while continuously being aware of and consequently avoid unwanted bycatch. Our trials in this seasonal Autumn-Winter sole fishery show that such REM based relaxation regarding gear choice could be realistic since not a single cod was captured during our experiment. Furthermore, new technologies available to the fisher, such as real-time trawl cameras and automatic image analyses using artificial intelligence (AI) ((CORDIS, 2018; Sokolova et al., 2021), may, in near future, provide strong decision-making tools for fishers to minimize bycatch and optimizing catch. Combination of such technologies may address the challenge of harvesting sole efficiently with minimized environmental impact.

CRediT authorship contribution statement

Rikke Petri Frandsen: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Ludvig Ahm Krag:** Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Bent Herrmann:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

We thank the skipper and crew of the fishing vessel as well as Flemming Thaarup (DTU Aqua). This study was conducted with financial support from the European Maritime and Fisheries Fund through the Danish Fisheries Agency (Project on "Improvement of the Biological Advice for Common Sole in Danish Waters," no. 33113-B-16-021) and from the EU-funded Horizon 2020 project SMARTFISH - Innovation for sustainable fisheries, grant agreement number 773521. Finally, we express our gratitude to the two reviewers for their valuable comments, which helped to improve our manuscript.

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