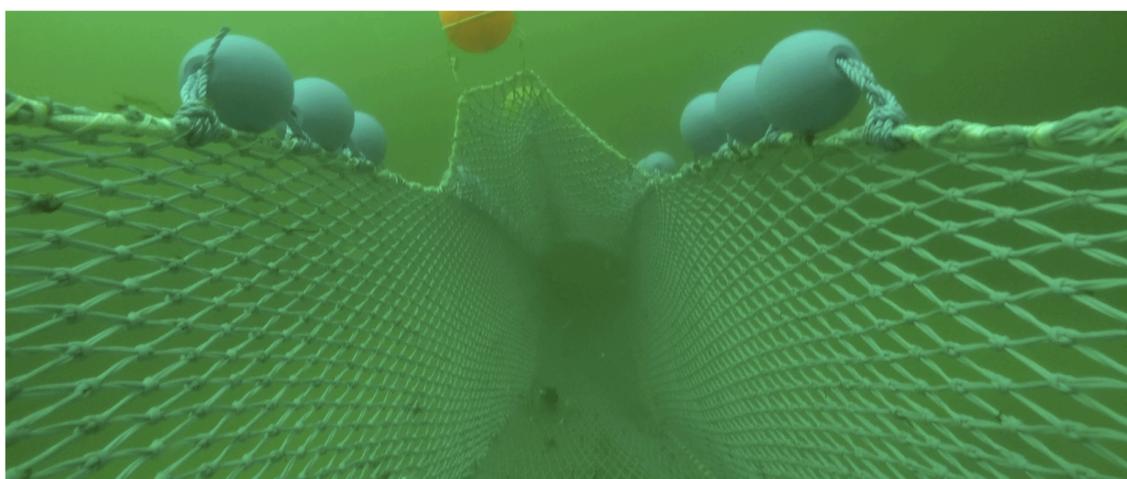


ROOFLESS_175

Gear ID: RL175

General description of the gear / selectivity device

The ROOFLESS_175 (RL175) device is a simple adaptation of the trawl gear, based on the removal of a section of the top panel from the piece of net which connects the codend to the trawl body. The opening creates a zone of visual and hydrodynamic perturbations to trigger upwards escape reactions of fish. The aim of this device is to reduce the bycatch of cod/gadoid species while maintaining a high catch efficiency for flatfish species.



RL175

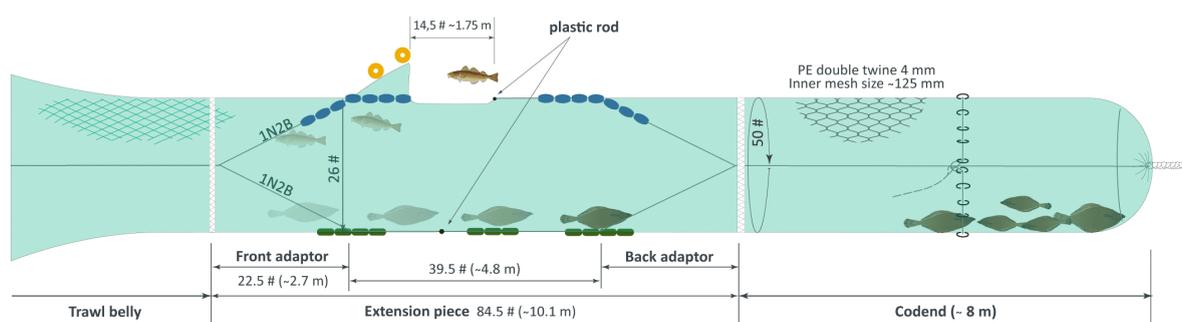


Figure 1: Schematic drawing with general characteristics of the RL175 device, as it was established in the NEMOS gear for experimental tests. Bottom: The RL175 device involves a 14.5 meshes-long escape opening (~175 cm, stretched netting) established on the top panel of NEMOS (NEMOS is a 4 panel extension piece). The top panel directly in front of the escape opening was raised by two floats (2,5 kg buoyancy each) mounted in line one after another. Optionally, the NEMOS + RL175 device can be connected to the trawl body by a 2-to-4 panels adaptor and to the codend by a 4-to-2 panels adaptor. It is also optional to rig NEMOS with lines of weights (green marks) and floats (blue marks) to ensure structural stability of RL175. Further technical specifications of the device can be found in the technical drawing provided at the bottom of the document. During experimental fishing, the NEMOS + RL175 gear was mounted together with a T90_125_2P codend (see related factsheet). Top: View of the roofless device. The picture is taken from the rear side to the fore, showing the escape opening and the front edge of the net raised by the two yellow floats in the drawing.

Basic functional principle

RL175 was specifically designed to reduce the bycatch of cod in flatfish fisheries. The species selection is intended by exploiting observed differences in behaviour of cod and flatfish (plaice and flounder) at the non-tapered section of the trawl (extension). The functional principle of RL175 relies on the assumption that the visual and hydrodynamic perturbations created by the removed top panel (roofless) will trigger escape reactions from cod towards the escape opening, while flatfish will not react to the presence of the device, keeping their path towards the codend. The RL175 device provides escape possibilities for cod of any size, and it is conceived to supplement the size selection of the codend to which it is attached to.

Experimental data

The gear has been recently developed and tested in the Baltic Sea. The results presented here are based on fishing trials conducted during two different cruises in the Baltic Sea.

Experimental setup

The main aim of the experiments was to assess the effect of RL175 when combined with a selective codend. Accordingly, catches of a test trawl, combining the RL175 and a T90_125_2P codend, were compared with catches obtained with a reference trawl using the same codend without the RL175 device.

Experimental setup (Cruise 1// Cruise 2)

Period tested	December 2019 // February 2020
Fishing area	Baltic, SD24
Vessel	FRV "Clupea" [https://www.thuenen.de/en/infrastucture/research-vessels/clupea/] // FRV "Solea" [https://www.thuenen.de/en/infrastucture/research-vessels/solea/]
Trawl	TV300/60 [link to trawl info] // Solea Double Belly Trawl [link to trawl info]

Experiment type, aim	paired-gear, catch comparison (T90_125_2p codend used in both reference and test gear)
Number of hauls	8 //13
Towing time [minutes]: average (min-max)	52.5 (30-60) // 40 (15-60)
Fishing depth [meters]: average (min-max)	15 (13-17) // 37 (12-76)

Fish caught/sampled (Cruise 1// Cruise 2)

Species	Number individuals			Weight [kg]		
	in catch	measured	factor	in catch	measured	factor
cod	925 // 1254	925 // 1254	1,00 // 1.00	889 // 1289	889 // 1289	1.00//1.00
plaice	723 // 329	723 // 329	1,00 // 1.00	251 // 85	251 // 85	1.00//1.00
flounder	291 // 3267	291 // 3267	1,00 // 1.00	122 // 1118	122 // 1118	1.00//1.00

Selectivity estimates

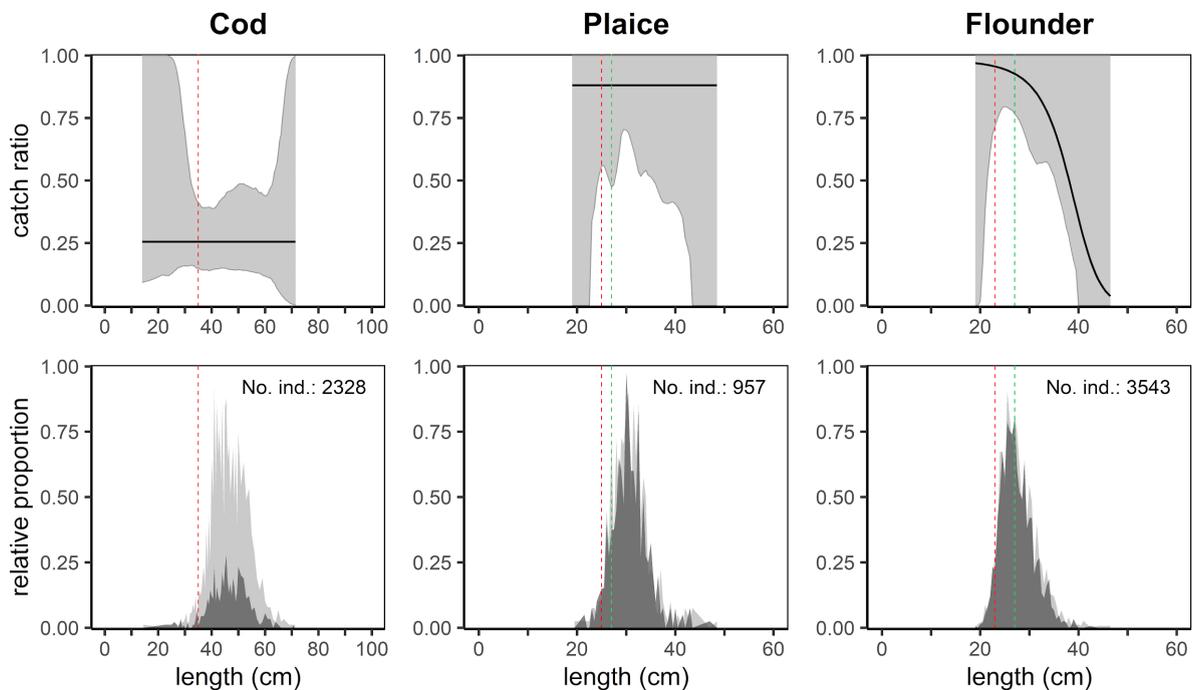


Figure 2: Selectivity results for the RL175 device for cod, plaice and flounder. Top panel: selectivity curves and corresponding confidence intervals for the size ranges found in the experiment. Bottom panel: Length distribution of the population encountered during the experiment. The red vertical lines correspond to the current minimum conservation reference sizes (MCRS; cod = 35 cm; plaice = 25 cm; flounder = 23 cm, the latter depending on area). The green vertical line indicates a potential alternative commercial minimum size (27 cm) used frequently in the fishery. The dark shaded area in the population structure plot, indicates those individuals retained by the ROOFLESS-gear, while the lighter area indicates escapees.

Performance indicators

An important decision criterion for specific gear designs is the effect on the catch. This includes two main aspects:

- the potential low retention of cod catch;
- the ability to keep catches of flatfish (mainly plaice and flounder) high.

The performance indicators provide such information. For each studied species, the indicators express the catch efficiency of the gear as a percentage of individuals retained out of a specific

population that entered the trawl. The indicators are estimated for the catch fractions below and above Minimum Conservation Reference Size (MCRS), as well as for the total catch.

A value of 100% for a given catch fraction refers to full retention, whereas 50% means that half of the individuals escape capture.

For the purpose of avoiding cod catches regardless of length size, it is desirable to obtain low values of all indicators for cod and high values for flatfish above MCRS.

This section gives performance indicators based on two types of calculation

- 1) by numbers (e.g. relevant for mortality estimates)
- 2) by weight (e.g. relevant for quota usage of fishery)

Performance indicator by numbers

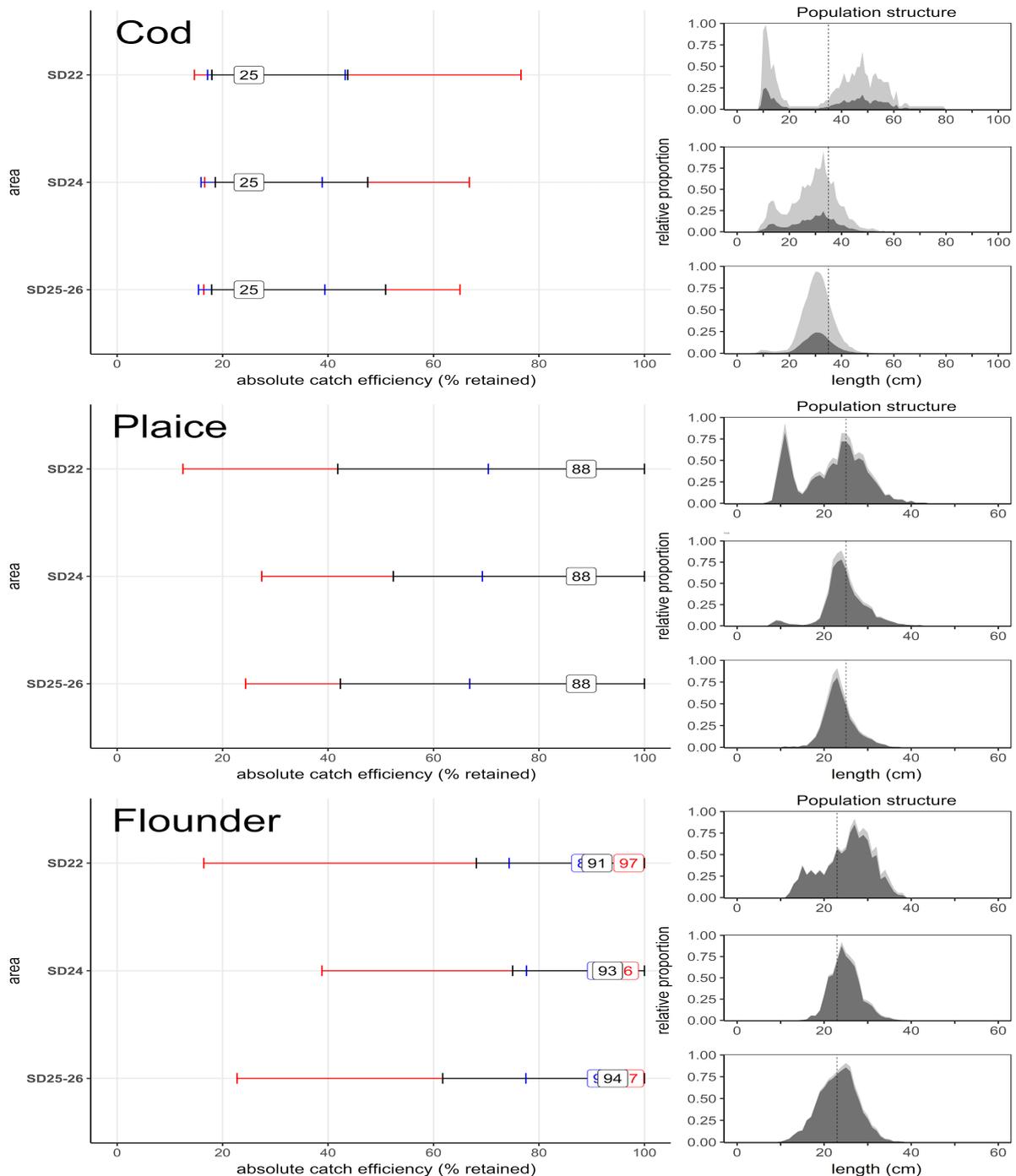


Figure 3: Performance selectivity indicators (**based on number of fish**) for the RL175 device in three different areas of the Baltic Sea (ICES SD22; SD24; SD25-26). The calculation of the indicators is based on a simulated catch, using the specific gear (RL175) fishing on the population structure of cod, plaice and flounder in the specific areas. The population structures are derived from DATRAS-database (combination of Q4 2019 and Q1 2020). The performance indicators give the absolute catch efficiency (as % of individuals retained) of a certain fraction (**red**: fish < MCRS; **blue**: fish ≥ MCRS; **black**: total) of the specific population and their corresponding confidence intervals. The lesser the performance of the device depends on the length of the fish, the closer the values of the three indicators. Consequently, equal performance of the device across lengths (cod and plaice) leads to same values for the three indicators. Example: a catch efficiency of 40% means that 60% of the individuals of the specific species and size category was able to use the RL175 device to escape, while 40% were retained in the codend (the

selectivity of the codend is not considered). The dark shaded area in the population structure plot, indicates those individuals retained by the gear, while the lighter area indicates escapees.

Performance indicator by weight

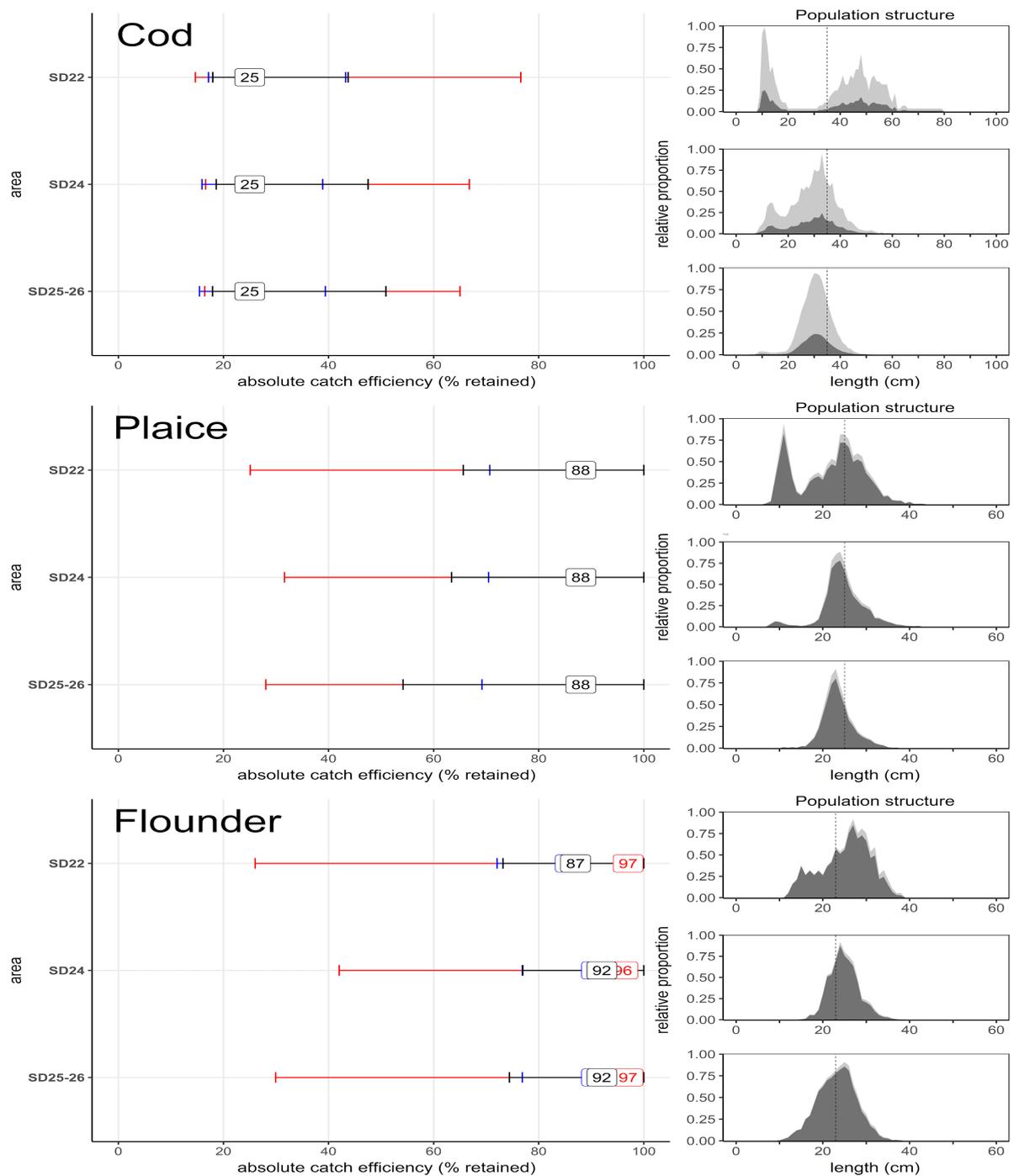


Figure 4: Performance selectivity indicators (**based on weight**) for the RL175 device in three different areas of the Baltic Sea (ICES SD22; SD24; SD25-26). The calculation of the indicators is based on a simulated catch, using the specific gear (RL175) fishing on the population structure of cod, plaice and flounder in the specific areas. The population structures are derived from DATRAS-database (combination of Q4 2019 and Q1 2020). The performance indicators give the absolute catch efficiency (as % of individuals retained) of a certain fraction (**red**: fish < MCRS; **blue**: fish ≥ MCRS; **black**: total) of the specific population and their corresponding confidence intervals. The lesser the performance of the device depends on the length of the fish, the closer the values of the three indicators. Consequently, equal performance of the device across lengths (cod and plaice) leads to the same values for the three indicators. Example: a catch efficiency of 40% means that 60% of the individuals of the specific species and size category was able to use the RL175 device to escape, while 40% were retained in the codend (the selectivity of the codend is not considered). The dark shaded area in the population structure plot, indicates those individuals retained by the gear, while the lighter area indicates escapes.

Description/Discussion of results

Catch ratio test/reference (Figure 2)

Compared to the catch efficiency in the reference trawl, mounting the RL175 device significantly reduced the catch efficiency of cod in the test trawl to values clearly below 50%. Catches of marketable sizes of plaice and flounder were slightly reduced in the test trawl (~10% reduction), however, the experimental results yield no statistically significant association between the reduction in flatfish catches and the use of RL175.

Performance indicator cod (Figure 3 and 4)

The population structure for cod differs between areas (ICES SDs). Nevertheless, as there is no length dependency found for the bycatch reduction for cod when using the RL175-device, the performance indicators for all length groups (<MCRS, ≥MCRS, all lengths) are identical. When using RL175, the catch efficiency of cod is 25% compared to the same gear without RL175.

Performance indicator flatfish (Figure 3 and 4)

The catch efficiency for flatfish of ROOFLESS_175 (RL175) is relatively high, resulting in little loss of plaice and flounder above MCRS (plaice = 25 cm; flounder = 23 cm, depending on area). For plaice and flounder, the loss is around 10-12% in numbers and in weight.

Conclusion/Summary

General summary

The RL175 is a simple, cheap and handy selection device with demonstrated efficiency to reduce the bycatch of cod before entering the codend. It's selective properties are independent of the size of the fish. Therefore, it can be used to supplement the size selection of the codends in order to achieve a reduction in the bycatch of cod, which covers all length classes.

Evaluation matrix

Pro	Caution	Contra
Reduction of cod catches of all sizes	Design potentially sensitive to external factors (e.g. handling, rigging)	.
Easy handling, it does not require rigid constructive elements	The escape behaviour of fish can be influenced by intrinsic (e.g. fish condition) or extrinsic factors (e.g. light, water temperature...). Therefore, these factors can influencing the performance of the RL175 device	
Supplementary device, it can be combined with any codend, widening the range of possible selective patterns.	The adoption in the fishery of the RL175 might require changes in the current legislation relative to fishing gear.	
Potential for further improvement		

Cost indication

type of cost	amount	comment
material / total costs	1000€ / max. 2000€	The net section where the RL175 is established does not suffer the same degree of working stress as other parts of the gear such as codends, no frequent maintenance or renovation investments required.
mounting time	2h	

Legal status

The RL175 is currently not implemented in commercial fisheries.

It needs to be clarified whether the use of TL175 is legal in commercial Baltic fisheries or whether the legal basis need to be changed to allow the use of RL175.

Additional information

Contact data

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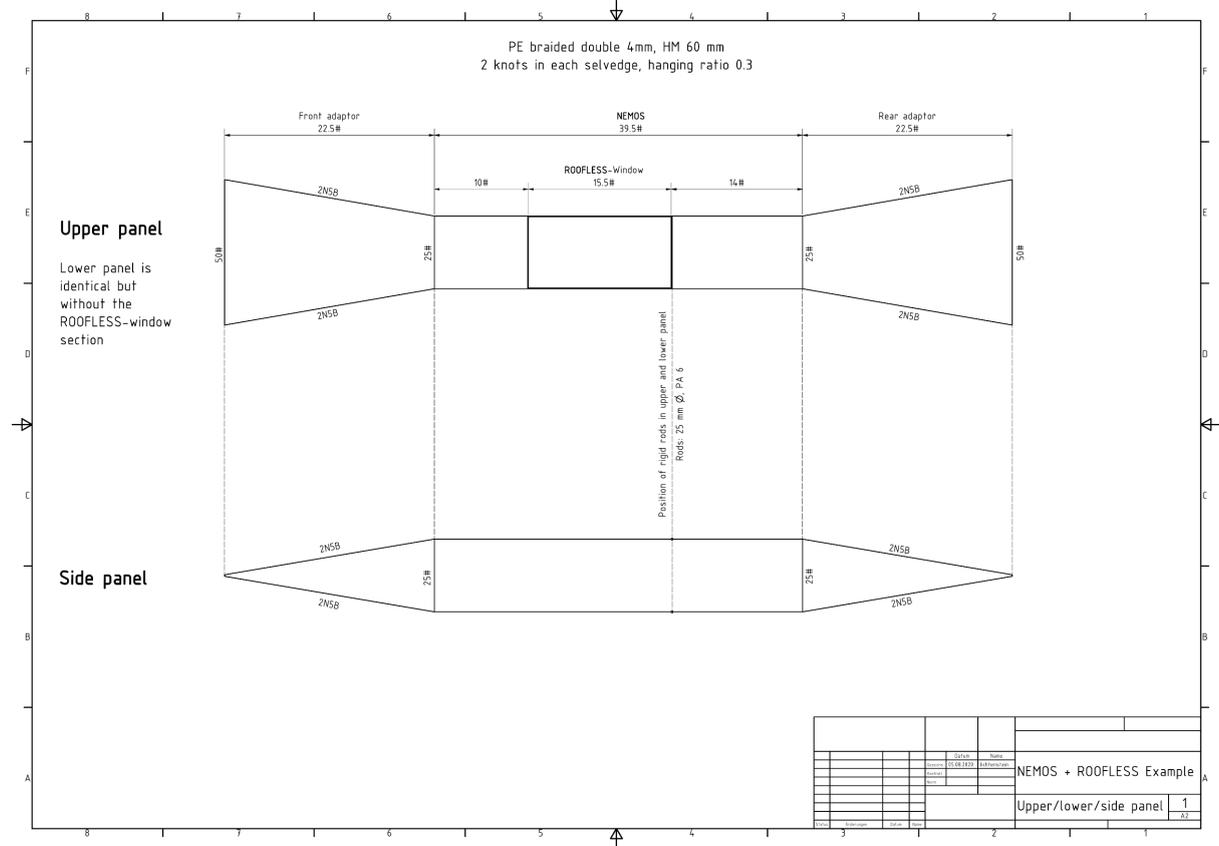
Media available

This gear has been recently developed and tested in the Baltic Sea and North Sea bottom trawl fisheries. Information related to trials from the two marine regions is provided.

Type	Source
reports	<p>Cruise reports "Clupea 340" and Solea 773 [https://tinyurl.com/35fr69s6]</p> <p>Daniel Stepputtis, Juan Santos, Christopher Zimmermann (2020) Technical approaches to avoid cod catches in Baltic Sea trawl fisheries (Report for Baltic fisheries manager), Thünen Institute of Baltic Sea Fisheries, Rostock, 37 pp.</p> <p>Daniel Stepputtis, Juan Santos, Bernd Mieske, Uwe Lichtenstein, Annemarie Schütz, Rainer Stechert (2020) Projekt CODEX (CodExcluder) - Netzmodifikation zur Reduktion des Dorschbeifanges (Abschlußbericht/final report) in German, English summary, Thünen Institute of Baltic Sea Fisheries, Rostock, 99 pp.</p>
scientific papers	submitted to the Ocean and Coastal Management journal
Web sites	
Multimedia	Thuenen Institute of Baltic Sea Fisheries [https://tinyurl.com/y3c824w9]

Technical specification

Technical drawing



Technical description to be used in JR
to be discussed