

# Fisheries Conservation Solutions to Address Key Environmental Issues

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Rialtas na hÉireann  
Government of Ireland



Arna chomhchistiú ag  
an Aontas Eorpach

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## Introduction

BIM Fisheries Conservation Solutions to Address Key Marine Environmental Issues February 2024

BIMs Fisheries Conservation Section works closely with the Irish Fishing Industry on developing gear-based technical solutions which address key environmental issues. Since 2014 we have developed a suite of solutions which reduce unwanted catches or bycatch through improved gear selectivity and demonstration of high survival rates for some captured species after release back to sea. This work helps the fishing industry meet legal requirements, improves fisheries sustainability and marine biodiversity. More recently, we developed solutions which help the industry deal with climate change and the EU energy transition of the seafood sector. Relatively simple changes to fishing operations and use of accessible new technologies such as artificial lights can greatly assist vessel owners in improving their energy and carbon efficiency.

This, the third iteration of the guide leads with the latest solutions on energy efficiency followed by bycatch categorised as follows:

- A. Small, over quota and non-target fish species in Nephrops trawls
- B. Small Nephrops in Nephrops trawls
- C. Small, over quota and non-target fish species in demersal trawls

### Further Information

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### Acknowledgements

Thanks are extended to all the owners, skippers and crews of Irish vessels who collaborated with BIM. The work was funded by the Irish Government and part financed by the European Union through the EMFF Operational Programme 2014– 2020 and through the EMFAF Operational Programme 2021 – 2027.

# 1 Solutions on energy efficiency in Irish fisheries

## I. Solutions on energy efficiency in Irish fisheries using:

1. Four panel trawls in a *Nephrops* fishery
2. Modified rigging in a *Nephrops* fishery
3. MLD off-bottom trawl doors in a *Nephrops* fishery
4. An image acquisition system in a *Nephrops* fishery
5. Pluto off-bottom trawl doors in *Nephrops* and whitefish fisheries
6. Pair trawling in a whitefish fishery
7. Pair seining in a whitefish fishery
8. Lights on the headline in a whitefish fishery

# Energy efficiency of a four-panel Nephrops trawl

## AREA, VESSEL

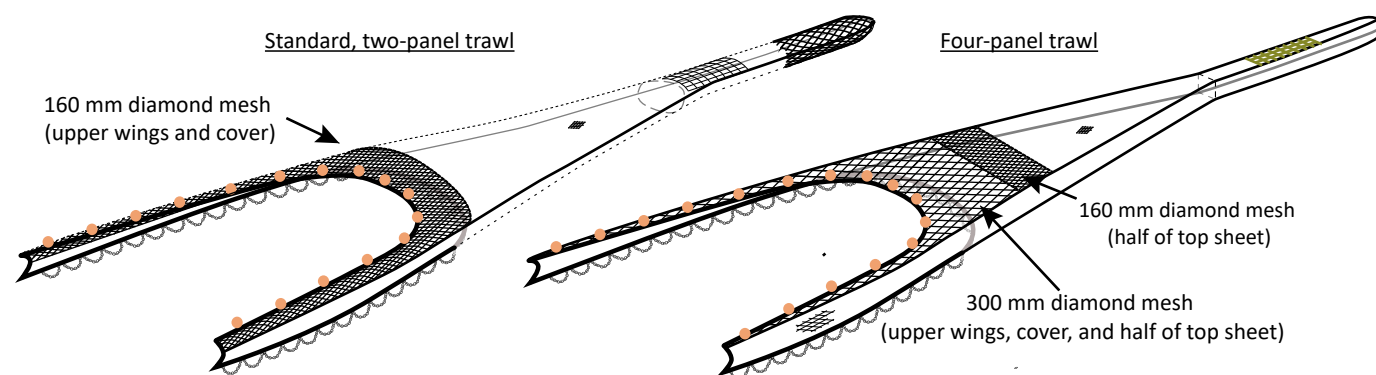
The study took place in the Irish Sea ICES area 7a on board the MFV Emerald Shore (DA 137) (16.89 m, 269 Kw) during November 2021, while targeting *Nephrops*.

## GEAR MODIFICATION

The four-panel trawl has extensive sections of enlarged 300 mm mesh in the top sheet and upper wings, and a SELTRA codend with 300 mm square-mesh panel (SMP) located 4.5 to 7.5 m from the codline. The control gear was a commonly used two-panel trawl with a 300 mm SMP located 9 to 12 m from the codline. Two load



cells were mounted behind the otter boards which isolated load measurements to the trawl.



	Two Panel	Four panel	% Difference
	Mean	Mean	
Loadcell force (Kgf)	1860	1945	5
Wing end spread (m)	13	14	9
Otter board spread (m)	46	46	<1
Fuel usage (l/hr)	37	37	<1
Total catch (kg)*	191	235	23
Total fish (kg)	161	92	-43
Total <i>Nephrops</i> (kg)	95	143	51
Unwanted catch (kg)	156	90	-43

## RESULTS

- 9% increase in wing end spread and swept area
- No increase in fuel consumption and minimal increase in drag
- Steeper trawl side taper and extensive sections of large mesh likely helped reduce drag
- Improved *Nephrops* catches suggests reduced fuel intensity

# Testing of modified rigging towards reduction of unwanted catches in the Nephrops fishery

## AREA, VESSEL

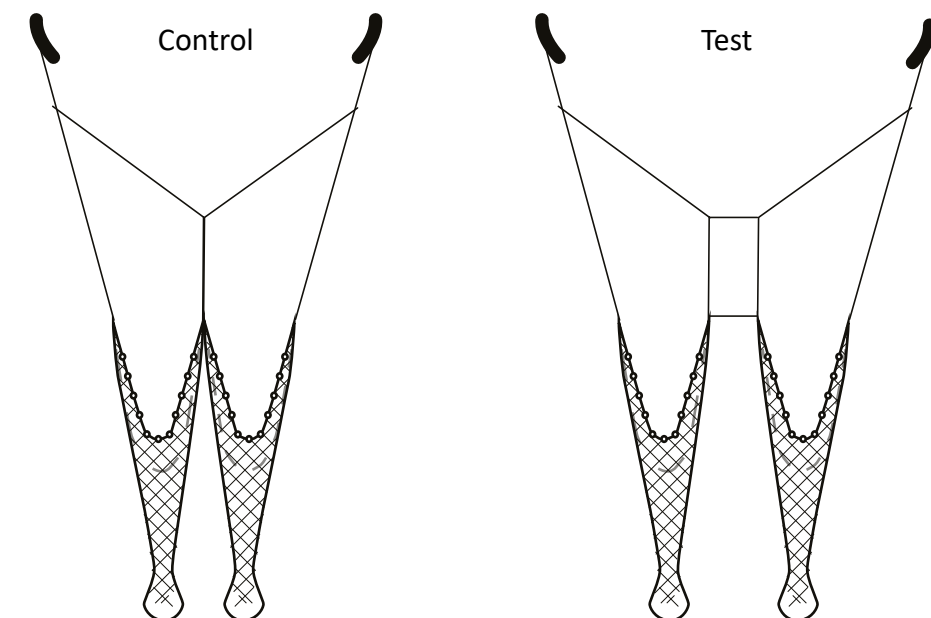
The 16-haul study took place in the Irish Sea (ICES Division 7a) on board the MFV Ocean Breeze (D 96) (17 m, 224 Kw) rigged with a half quad-rig configuration during May 2022, while targeting *Nephrops*.

## GEAR MODIFICATION

Fishing gear comprised two identical 40 m (footrope length) trawls with 4-panel SELTRA sorting box and codend with 300 mm square mesh in the top sheet. The control gear comprised sweeps rigged in standard half quad-rig configuration. Two middle sweeps were joined



fore and aft by 3.6 m horizontal ropes in the test gear.



Species	Control	Test	Difference (%)
<i>Nephrops</i>	633	818	29
Whiting	63	74	17
Haddock	69	95	38
Plaice	136	126	-7
Flatfish	44	42	-5
Lesser spotted dogfish	343	246	-28
Rays	25	16	-36

## RESULTS

- No reduction in catches of small whiting or haddock
- Observed reductions in rays and dogfish
- Observed increases in *Nephrops* catches



# Preliminary assessment of MLD off-bottom trawl doors in the Irish Nephrops fishery

## AREA, VESSEL

The study took place in the Irish Sea ICES area 7a on board the MFV Emerald Shore (DA 137) (16.89 m, 269 Kw) during December 2022, while targeting *Nephrops*.

## GEAR MODIFICATION

The vessel fished a two-warp half-quad configuration, connected to a pair of trawl doors. For each 1.74 m<sup>2</sup> MLD trawl door, the bridles (with two attachment points) comprised two 3 m lengths of long-link (100 mm) chain attached to its top and bottom, while the sweeps were lengthened with 6 m (100 mm long-link) chain. The MLD doors can be pre-set to a target height above the seabed.

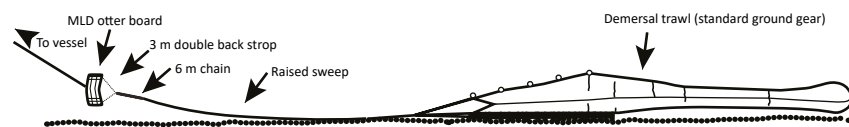


The MLD doors were compared against a set of 2.25 m<sup>2</sup> Standard trawl doors that were conventionally rigged.

Standard configuration: Demersal otter boards and net



Modified configuration: Off bottom MLD otter boards and demersal net



Estimated ground contact (shaded areas)\*



Operational parameters	Standard	MLD	Difference (%)
Fuel (l/Hr, per vessel)	40	37	-8
Engine speed (RPM)	1423	1392	-2
Vessel Speed (kts)	2.63	3.05	16
Wing-end spread (m)	14	12	-14
Trawl door spread (m)	47	43	-9
Load (kgf)	2691	2528	-6
Warp shot (m)	113	109	-4
Swept area (m <sup>2</sup> per min)	1137	1130	-1
Time on seabed (%)	0	89	—

## RESULTS

- Doors remained off the seabed for 89% of haul times
- Wingend spread was reduced but no reduction in swept area
- Further work needed on optimisation of off-bottom doors with different trawl configurations

# Assessment of image acquisition and sediment suppression systems in the Irish Nephrops fishery

## AREA, VESSEL

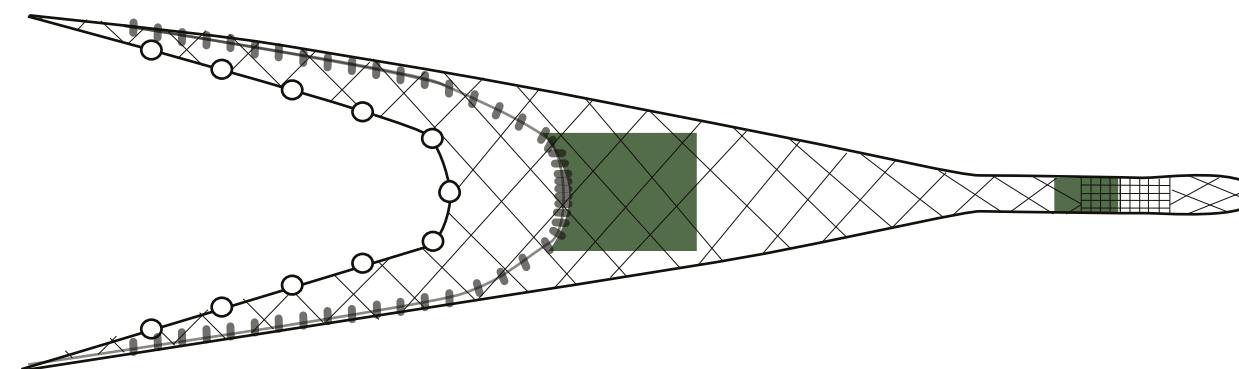
The trial took place on the Galway and Aran fishing grounds (ICES 7b) on board the MFV Karen Mary, (DA 127, 11.6 m, 150 Kw), during 2023 while targeting *Nephrops*.

## GEAR MODIFICATION

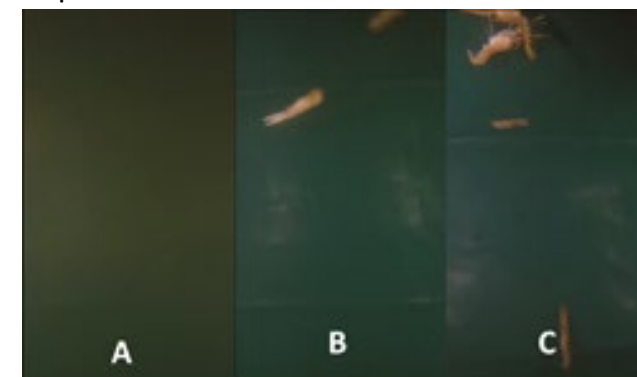
The image acquisition system was in the codend section and comprised a box shaped tarpaulin, stereo GoPro Hero10 cameras and underwater lights. The sediment suppression system (a 3 m wide by 5 m long tarpaulin, attached to the footrope) was used to increase image clarity (See



Figure). A single 23ftm *Nephrops* trawl was used throughout.



A—excessive suspended sediment; B—intermediate levels of suspended sediment; C—and low levels of suspended sediment.



## RESULTS

- Image Acquisition System worked well and high-quality images obtained
- Sediment suppressed from ground gear appears to have entered the trawl aft of the sediment suppression system
- Further work on sediment suppression required to improve consistency of imagery
- Knowledge gained will be used towards the development of more selective and efficient fishing operations

# Preliminary assessment of reduced-drag Pluto trawl doors

## AREA, VESSEL

The preliminary assessment of the Pluto trawl doors took place on the Galway and Aran fishing grounds (ICES 7b) on board the MFV Karen Mary, (DA 127) (11.6 m, 150 Kw), during 2023.

## GEAR MODIFICATION

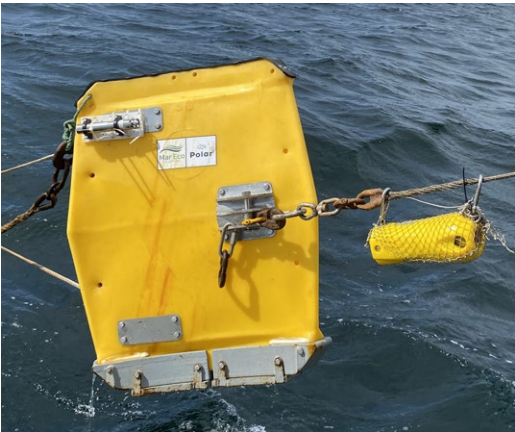
The Pluto doors are high aspect (taller than long) and are likely to be very stable when on the seabed due to a low centre of gravity and most of their weight being in the shoe at the base. We conducted two trials with the Pluto doors, Trial 1 against Standard A doors in a *Nephrops* fishery, Trial



2 against Standard B doors in a whitefish fishery. Both trials used a single rigged 23 ftn trawl.

TRIAL 1	Operational parameters	Standard A	Pluto	Difference (%)
	Size (m <sup>2</sup> )	1.6	1.1	-31
	Weight (kg)	148	124	-16
	Load (Kgf)	1,305	1,168	-11
	Mean Engine revs (RPM)	1,191	1,116	-6
	Speed over ground (SOG) (m s <sup>-1</sup> )	1.31	1.34	2
	Swept area (m <sup>2</sup> per min)	1,449	1,357	-7

TRIAL 2	Operational parameters	Standard B	Pluto	Difference (%)
	Size (m <sup>2</sup> )	2.1	1.1	-48
	Weight (kg)	300	124	-69
	Load (Kgf)	1,480	1,134	-23
	Engine revs (RPM)	1,252	1,184	-5
	Speed over Ground (SOG– m s <sup>-1</sup> )	1.29	1.31	2
	Swept area (m <sup>2</sup> per min)	4,445	3,383	-24



## RESULTS

- Reduced load which is linked to fuel and carbon use
- Reduced swept area which is linked to gear performance
- Optimising door size in relation to vessel and gear size might improve gear performance
- Good potential to reduce seabed impacts

# Assessment of pair fishing towards more efficient targeting of demersal fish species

## AREA, VESSEL

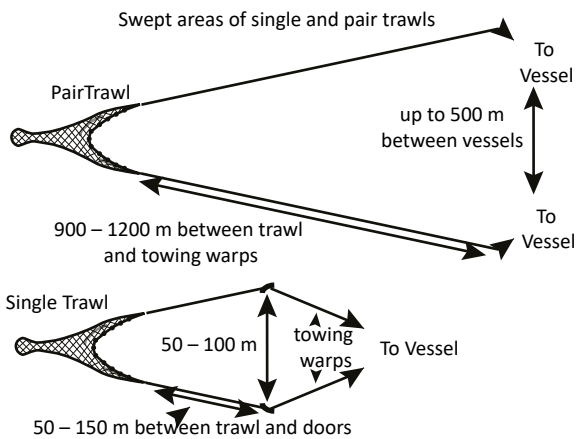
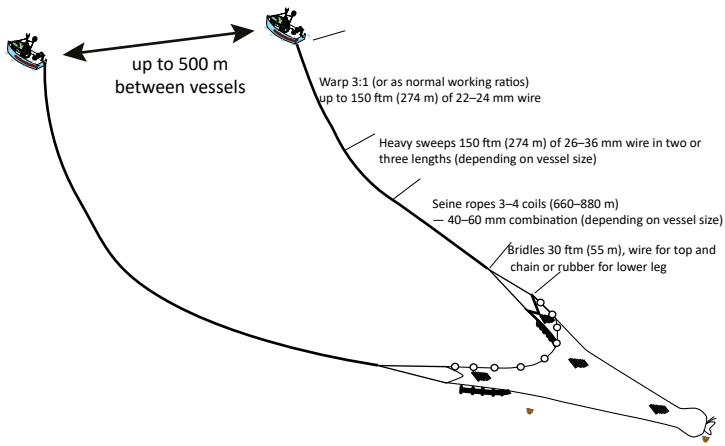
The study took place on board two 25 m trawlers in the Irish sector of ICES Divisions 7g and 7j in the Celtic Sea in October 2022, while targeting mixed-demersal fish species.

## GEAR MODIFICATION

Comprising a mixture of combination (wire rope) and wire diameters, the sweeps used during pair trawling were ~ 4.5 times greater in length than the normal 'solo' sweep arrangement. The same single-rig trawls and 120 mm mesh codends were used in both pair and solo operations on board the trial vessels. An economic analysis was conducted using



sales notes and operational data.



Operational data	Solo vessel	Pair vessels	Difference (%)
Fuel (l/Hr, per vessel)	93	56	-40
Engine Load (%)	56	35	-38
Wing-end spread average (m)	29	29	0
Sweep angle (°)	12	10	-17
Trawl door/ sweep divergence (m)	93	287	>100 (3.1×)
Estimated Swept area (km <sup>2</sup> )	2.5	7.9	>100 (3.2×)

## RESULTS

- 40% reduction in fuel use
- 29% increase in catches
- 32% increase in profitability
- Major scope for scale-up in the Irish whitefish sector



# Assessment of pair-fishing operations in the Irish demersal seine fishery

## AREA, VESSEL

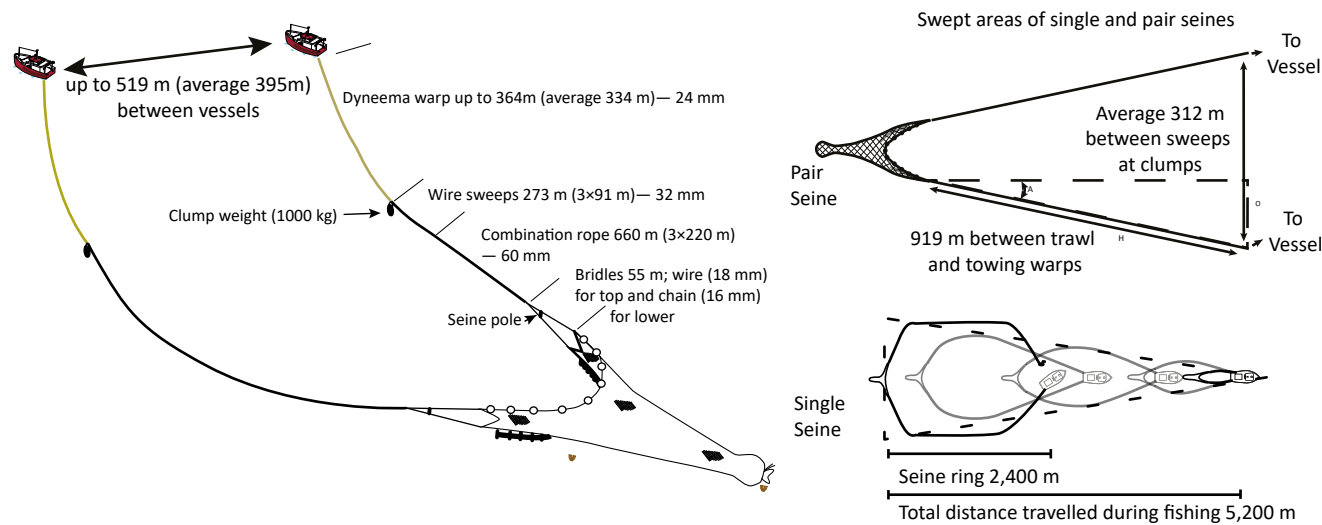
The pair-seine trial was conducted on board two Irish seiners of 26 m and 27 m targeting mixed-demersal fish species in the Irish sector of ICES Divisions 7g and 7j in the Celtic Sea in September 2023

## GEAR MODIFICATION

The seine rope configuration comprised 660 meters of 60 mm seine (combination) rope and 259 meters of 32 mm wire between the net to the Dyneema warp. Chain clump weights (1,000 Kg) were used to counteract the buoyancy in the Dyneema warp.



Comparisons were made with subsequent solo-seine trips on the same ground.



Vessel	Solo seine	Pair seine	Difference (%)
Average Fuel (l/hr)			
Dillon Owen	92	69	-25
Ocean Crest	100	75	-25
Average Engine load (%)			
Dillon Owen	53	36	-32
Ocean Crest	40	27	-33
Carbon (kg CO <sub>2</sub> eq./hr)			
Dillon Owen	259	195	-25
Ocean Crest	281	210	-25
Estimated swept area (km <sup>2</sup> )	4.5	7.6	68

## RESULTS

- 25% reduction in fuel use
- 25% reduction in greenhouse gas emissions
- 32% mean reduction in engine load
- Catch rates were similar during daytime
- In contrast to solo operations, pair-seining successfully caught fish during hours of darkness

# Artificial light on the headline towards improving energy efficiency while targeting mixed demersal fish species

## AREA, VESSEL

The catch comparison study took place in ICES area 7j onboard the MFV Virtuous (S80) (23.4 m, 400 Kw) during March 2023 while targeting mixed demersal fish species.

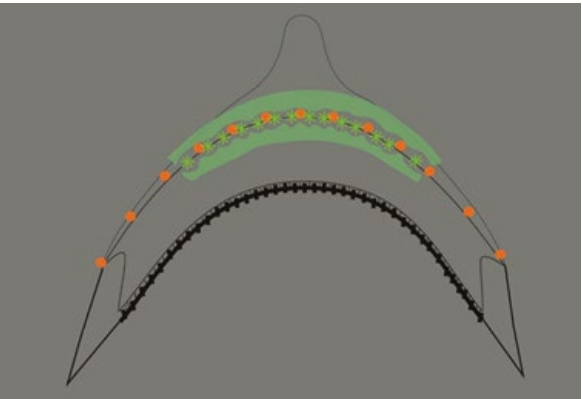
## GEAR MODIFICATION

The vessel fished a single-rig otter trawl with 14 Lindgren-Pitman® green light emitting diodes (LEDs) spaced ~1.5 m apart on the headline. Trawl deployments alternated between 'lights on' (test) and 'Lights off' (control). The vessel deployed a 100 mm diamond (T0) mesh codend and 160 mm



square mesh panel (SMP) in line with current regulations.

Species	Control (kg)		Test (kg)		Difference (%)	
	Day	Night	Day	Night	Day	Night
Haddock	1,304	1,451	1,189	2,193	-9	51
Non-commercial species	818	214	533	226	-35	5
Monkfish	88	68	54	40	-40	-41
Flatfish	80	34	59	19	-26	-44
Hake	74	13	45	17	-39	28
Other fish	70	16	23	8	-67	-50



## RESULTS

- 51% increase in haddock catch weight with lights on the headline during nighttime
- 64% increase in the value of haddock caught with lights during nighttime
- Simple, inexpensive option to boost catch and energy efficiency

# 2.A

## Reduce under size, over quota and non-target fish species in the *Nephrops* trawl fishery

### 2.A Reduce under size, over quota and non-target fish species in the *Nephrops* trawl fishery using a:

9. 300 mm square mesh panel
10. SELTRA sorting box
11. SELTRA sorting box compared with a 300 mm square mesh panel
12. SELTRA sorting box (with 90 mm mesh)
13. Swedish grid
14. *Nephrops* catch sensor (Notus Echo) on a Swedish grid
15. Dual-codend separator
16. Dual-codend separator compared with a 100 mm codend
17. Dual-codend separator compared with a 300 mm square mesh panel
18. Dual-codend net plan
19. Bycatch escape corridor



## Reducing fish catches with a 300 mm square-mesh panel in *Nephrops* trawls

### AREA, VESSEL

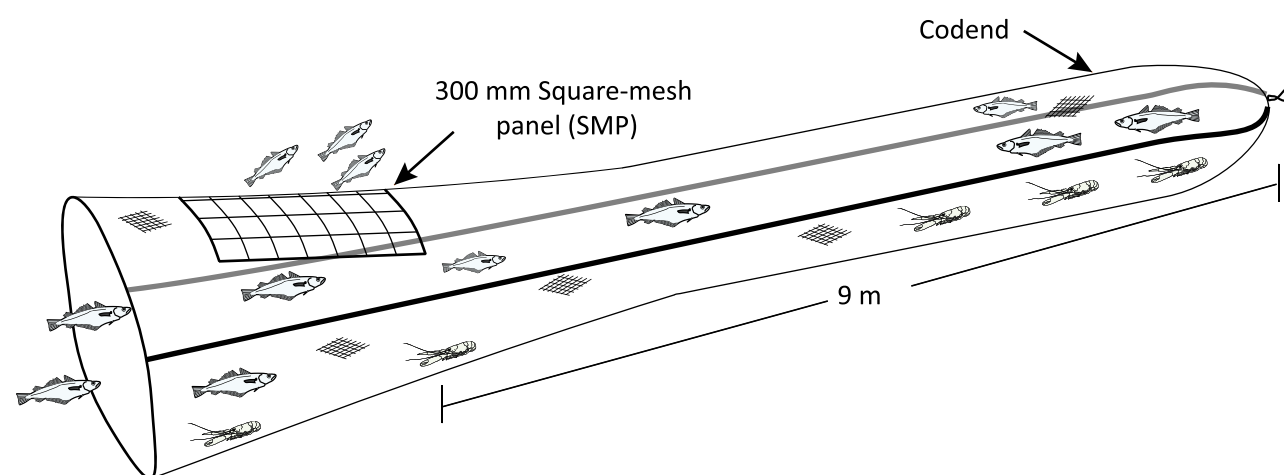
The 23 haul quad-rig catch comparison trial took place in the western Irish Sea (ICES VIIa) on board the MFV Stella Nova (DA57) (23.5 m, 441 kW) during August 2014, while targeting *Nephrops*.

### GEAR MODIFICATION

A 3 m long 300 mm square-mesh panel (SMP) was inserted 9 m from the cod-line in the two-panel test gear. The standard gear was identical but without a square-mesh panel.



Nominal codend mesh size and fishing circle were 70 mm and 386 × 70 mm.



Species	Standard gear (kg)	300 mm SMP (kg)	Difference (%)
Haddock	214	65	-70
Whiting	136	66	-52
<i>Nephrops</i>	1106	1262	14

### RESULTS

- Haddock and whiting catches were reduced across most size grades
- *Nephrops* catches were not reduced
- The 300 mm SMP is a gear measure in the Celtic and Irish Seas

## Reducing fish catches with a SELTRA sorting box in *Nephrops* trawls

### AREA, VESSEL

The twin-rig catch comparison trial took place in the western Irish Sea (ICES VIIa) on board MFV Ocean Breeze (D96) (17 m, 224 kW) during September 2016, while targeting *Nephrops*.

### GEAR MODIFICATION

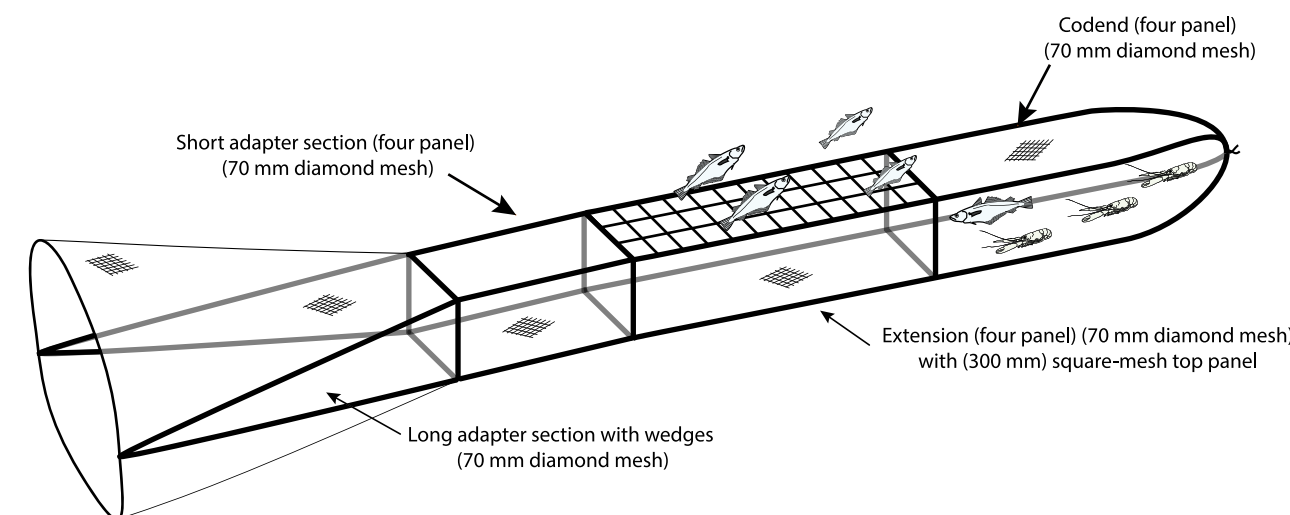
The SELTRA sorting box:

- a 3 m long four-panel section of 70 mm diamond mesh
- with a 3 m long 300 mm square-mesh escape window in the top panel attached 3 m from the cod-line

The standard and SELTRA gears were fished on identical twin-rigged trawls



(380 × 80 mm fishing circle) and both were fitted with a 70 mm codend. A square-mesh panel was not present in the standard gear.



Species	Standard gear (kg)	SELTRA (kg)	Difference (%)
Whiting	152	66	-57
Haddock	126	12	-91
Flatfish	20	6	-69
Monkfish	5	9	72
Dogfish	351	25	-93
<i>Nephrops</i>	362	396	9

### RESULTS

- Substantial reductions in catches of most fish species
- Catches of very small whiting < 20 cm not reduced
- *Nephrops* catches not reduced
- The SELTRA is a gear measure in the Celtic and Irish Seas

# Comparing catches between a SELTRA sorting box and a 300 mm square-mesh panel in *Nephrops* trawls

## AREA, VESSEL

The twin-rig catch comparison trial took place in the western Irish Sea (ICES VIIa) on board MFV Ocean Breeze (D96) (17 m, 224 kW) during December 2016, while targeting *Nephrops*.

## GEAR MODIFICATION

The SELTRA sorting box:

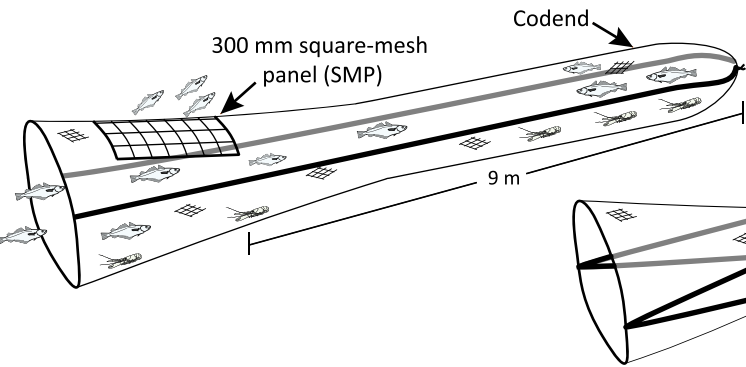
- a 3 m long four-panel section of 70 mm diamond mesh
- with a 3 m long 300 mm square-mesh escape window in the top panel attached 3 m from the cod-line

The standard gear was fitted with a 3 m long 300 mm square-mesh panel (SMP)

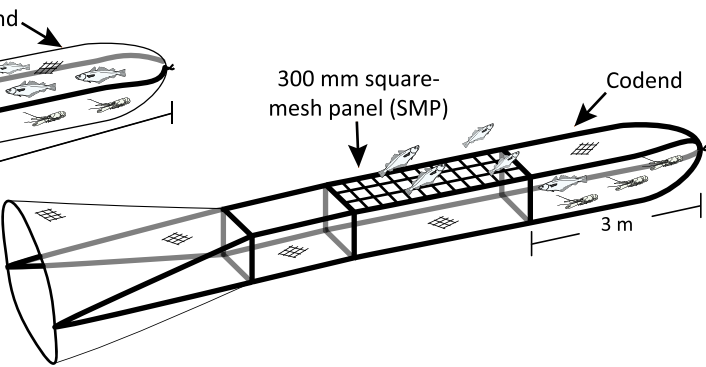


9 m from the cod-line, in a two-panel trawl. Both gears were fished on identical twin-rigged trawls (380 × 80 mm fishing circle) and fitted with 70 mm codends.

## 300 mm SMP gear



## SELTRA



Species	300 mm SMP (kg)	SELTRA (kg)	Difference (%)
Whiting	362	277	-24
Haddock	639	314	-51
Cod	43	8	-81
Flatfish	118	53	-55
Monkfish	123	107	-12
Dogfish	1617	419	-74
<i>Nephrops</i>	610	725	19

## RESULTS

- Substantial reductions in catches of most species
- Catches of very-small whiting < 20 cm not reduced
- Greater *Nephrops* catches in the SELTRA
- SELTRA is a superior gear measure

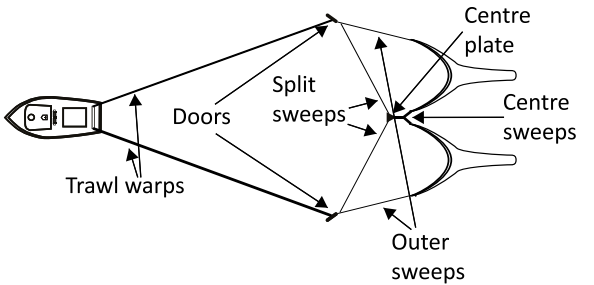
# Reducing catches of small fish with a SELTRA sorting box with 90 mm codend mesh size

## AREA, VESSEL

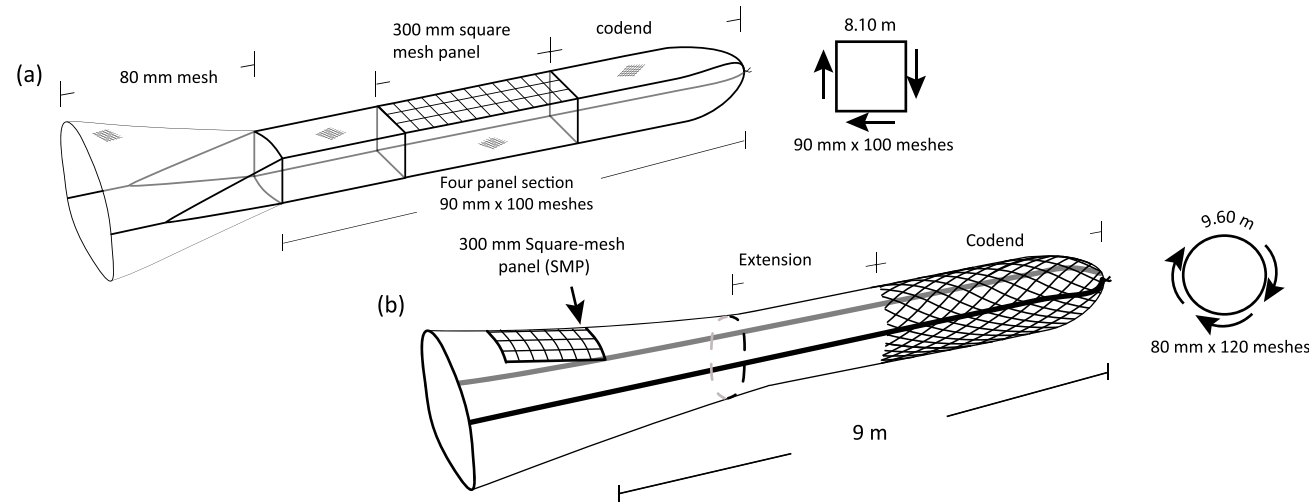
A catch comparison trial was conducted in the western Irish Sea in June 2018 on board an 18 m vessel.

## GEAR MODIFICATION

Trawl gear comprised 2 x 37 m footrope *Nephrops* trawls towed using two warps in a half quad-rig configuration. (a) The test gear consisted of a four-panel 90 mm SELTRA sorting box with a 300 mm SMP mounted 3.7 m metres from the codline.



(b) The standard gear consisted of a two-panel aft section with a 300 mm SMP and 80 mm codend.



## Percentage of total catch weight in each codend

Species	Standard 80 mm (kg)	SELTRA 90 mm (kg)	Difference (%)
Whiting			
≥ 27 cm#	4	2	-56
< 27 cm#	54	13	-75
< 20 cm	42	9	-78
Haddock			
≥ 30 cm#	29	11	-62
< 30 cm#	289	85	-70
< 20 cm	166	51	-69
<i>Nephrops</i>			
≥ 25 mm#*	1009	814	-19
< 25 mm#*	48	31	-34

#MCRS: minimum conservation reference size  
\*carapace length

## RESULTS

- Catches of very small whiting < 20 cm were reduced by 78%.
- Concerns over mortality of very small whiting escaping through codend meshes
- Reductions in *Nephrops* catches mainly occurred for tail grades



# Reducing fish catches with a Swedish grid in *Nephrops* trawls

## AREA, VESSEL

The 12 haul quad-rig catch comparison trial took place in the western Irish Sea (ICES VIIa) on board MFV Our Lass II (DA261) (21.7 m, 484 kW) during September 2015, while targeting *Nephrops*.

## GEAR MODIFICATION

The test gear was fitted with:

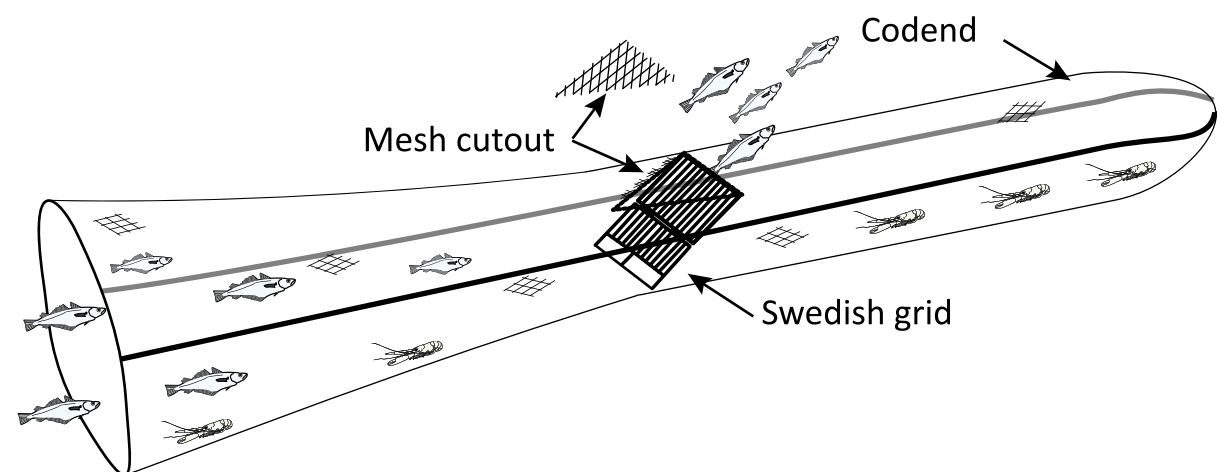
A Swedish grid with vertical bars:

- spaced 35 mm apart and
- a 15 cm high gap at the bottom

An escape hole in the top sheet of the trawl forward of the grid. The standard



gear was identical but without a grid. Nominal codend mesh size was 70 mm for both gears and fishing circle was 380 × 80 mm.



Species	Standard gear (kg)	Swedish grid (kg)	Difference (%)
Whiting	183	42	-77
Cod	75	0	-100
Haddock	42	4	-90
<i>Nephrops</i>	1908	1834	-4

## RESULTS

- Substantial reductions in key fish species across all size classes
- Little difference in *Nephrops* catches
- The Swedish grid is a gear measure in the Celtic and Irish Seas

# Assessment of the Notus Echo catch sensor in the Irish *Nephrops* fishery

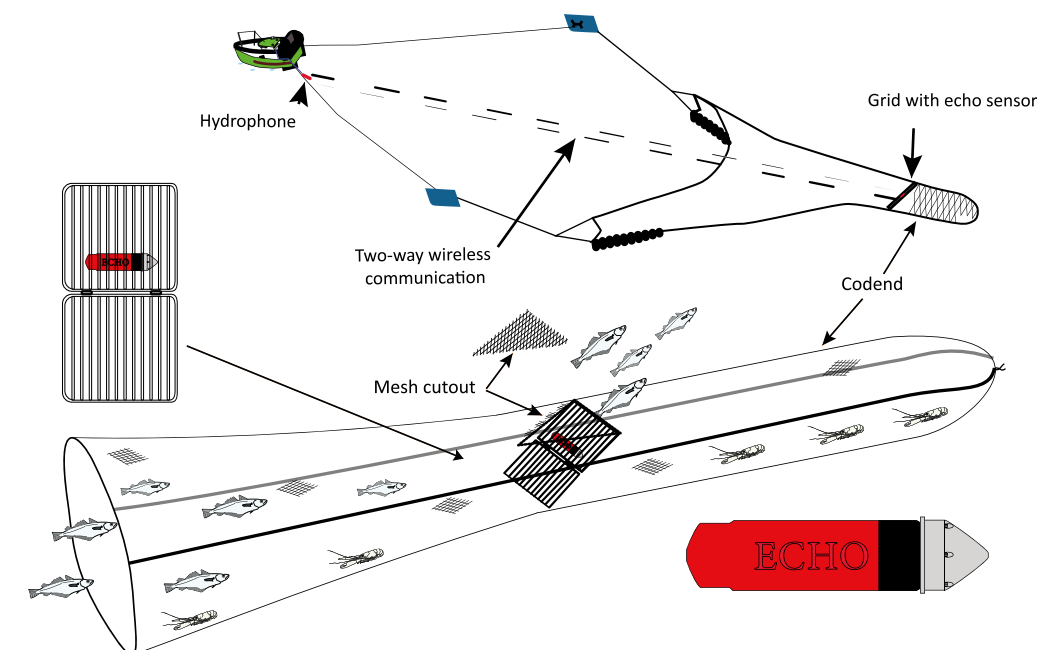
## AREA, VESSEL

The trial took place on the Galway and Aran fishing grounds (ICES VIIb) on board a 11.6 m trawler during Summer 2019.

## GEAR MODIFICATION

A Notus Echo sensor (used to detect crustaceans hitting a grid) was placed on a standard *Nephrops* grid to assess its functionality in detecting *Nephrops*.

The sensor was tested at three sensitivity settings expressed in voltage: 0.60, 1.25, and 1.00 v to determine which was optimal for *Nephrops* detection.



Voltage	Position on grid	<i>Nephrops</i> detection
0.60	Lower half	Inflated
1.25	Lower half	Reduced
1.00	Upper half	Optimum

## RESULTS

- Optimal *Nephrops* detection (at 1.00 v) with sensor on top half of grid
- Potential uses on other grid types
- Potential to improve operational efficiency

# Reducing catches of small fish with a dual-codend separator in *Nephrops* trawls

## AREA, VESSEL

The catch comparison trial took place at the Smalls (ICES VIIg) on board MFV Stella Nova (DA57) (23.5 m, 441 kW) during October 2016, while targeting *Nephrops*.

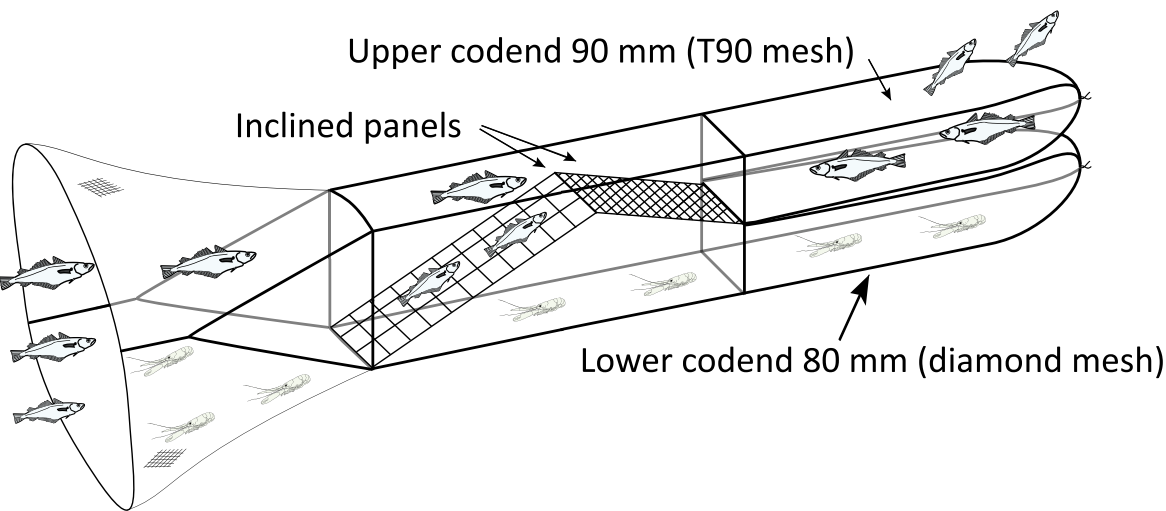
## GEAR MODIFICATION

The test gear consisted of:

- a four-panel 80 mm diamond mesh extension piece
- a 300 mm inclined square-mesh panel
- an 80 mm inclined diamond-mesh panel
- an upper codend with 90 mm T90 mesh
- a lower 80 mm diamond-mesh codend



The standard codend and extension piece were constructed with 80 mm diamond mesh. A square-mesh panel was not present in either gear.



Species	Standard gear (kg)	Test gear (kg)	Difference (%)
Haddock < 30 cm <sup>#</sup>	100	52	-49
Haddock ≥ 30 cm <sup>#</sup>	254	277	9
Whiting < 32 cm <sup>§</sup>	1435	401	-72
Whiting ≥ 32 cm <sup>§</sup>	874	553	-37
<i>Nephrops</i>			
< 25 mm <sup>**</sup>	325	289	-11
≥ 25 mm <sup>**</sup>	2103	2094	0

<sup>#</sup>minimum conservation reference size (MCRS)  
<sup>\*</sup>carapace length  
<sup>§</sup>market size

## RESULTS

- Substantial reduction in catches of small fish
- Reduction in larger whiting
- No loss in larger *Nephrops*
- Gear measure in the Celtic Sea

# Comparing catches between the dual codend and a 100 mm codend with 120 mm square mesh panel

## AREA, VESSEL

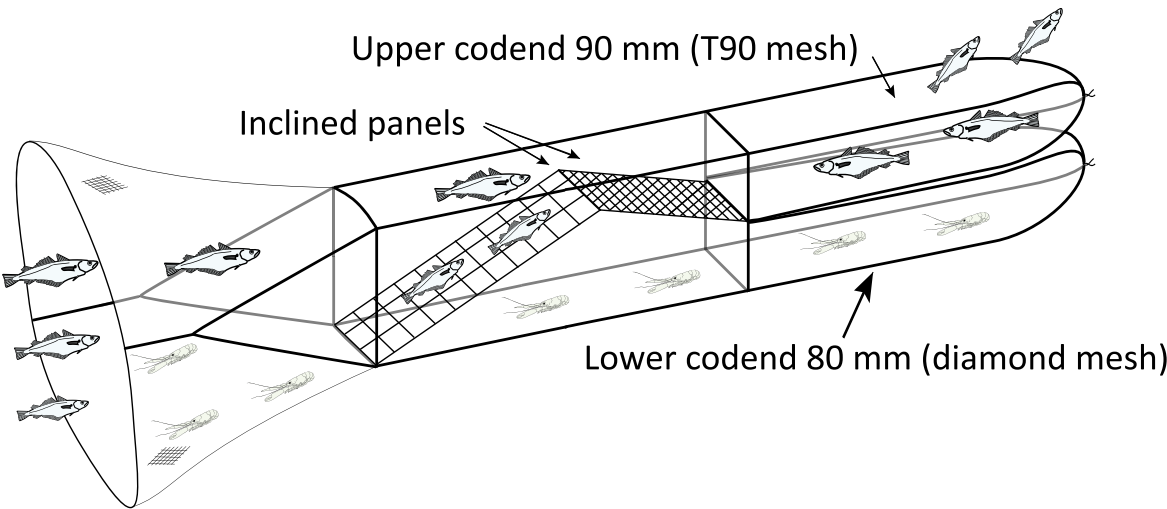
The 6 haul twin-rig catch comparison trial took place in the Celtic Sea (ICES VIIg) on board MFV Ocean Pioneer (S45) (22.4 m, 440 kW) during December 2019, while targeting *Nephrops*.

## GEAR MODIFICATION

The test gear comprised, a four-panel 80 mm diamond mesh extension piece (made with 4 mm Ø twine), a 300 mm inclined square-mesh panel with a 80 mm inclined diamond-mesh panel, an upper codend with 90 mm T90 mesh, and a lower 80 mm



diamond-mesh codend. The standard codend and extension piece were made with 100 mm diamond mesh. A 120 mm square-mesh panel was only present in the standard gear.



Species	Standard gear (kg)	Dual (kg)	Difference (%)
<i>Nephrops</i> < 25 mm <sup>**</sup>	5	22	>100
<i>Nephrops</i> ≥ 25 mm <sup>**</sup>	123	228	85
<i>Nephrops</i> estimated value	€1149	€1445	20
Haddock < 30 cm <sup>#</sup>	641	504	-21
Haddock ≥ 30 cm <sup>#</sup>	32	29	-9
Whiting < 27 cm <sup>#</sup>	27	22	-19
Whiting ≥ 27 cm <sup>#</sup>	24	12	-50
Cod < 35 cm <sup>#</sup>	5	5	0
Cod ≥ 35 cm <sup>#</sup>	11	10	-9

<sup>#</sup>minimum conservation reference size (MCRS)  
<sup>\*</sup>carapace length

## RESULTS

- 20% increase in *Nephrops* catch value
- Little difference in haddock catches
- Substantial reductions in whiting catches
- Gear measure in the Celtic Sea



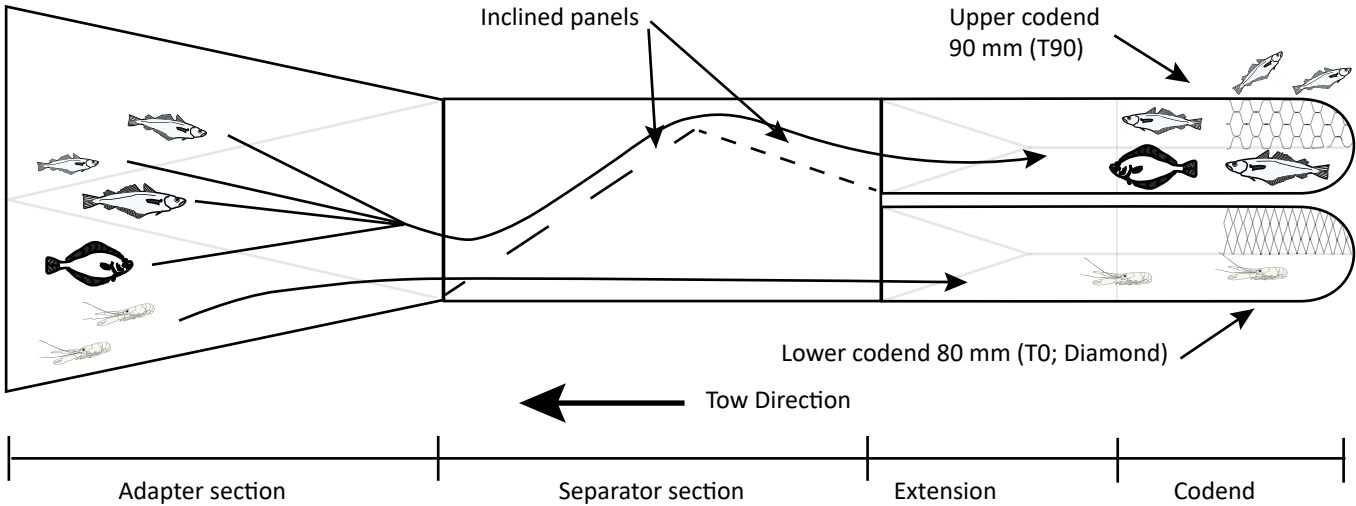
# Comparing catches between the dual codend and a 80 mm codend with 300 mm square mesh panel

## AREA, VESSEL

This trial took place in the Aran grounds (ICES VIIb) on board the 22 m trawler MFV Kittiwake (G25), during May 2021.

## GEAR MODIFICATION

A dual codend, with a 80 mm diamond mesh lower codend and 90 mm T90 (mesh turned 90°) upper codend was compared against a single 80-mm dimond-mesh codend with a 300 mm SMP in a half-quad configuration.

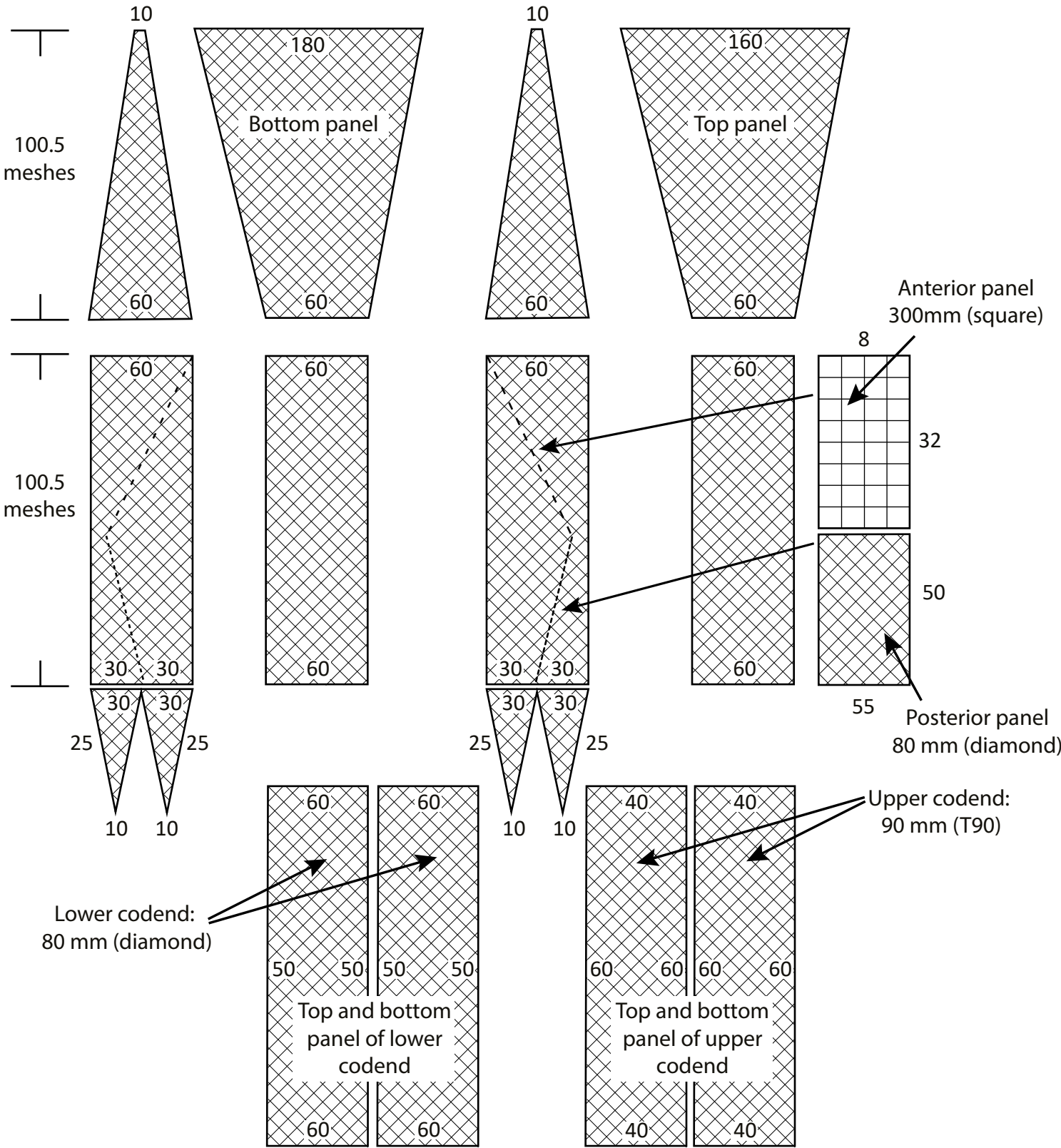


Species	Standard codend (kg)	Dual codend (kg)	Difference (%)
<i>Nephrops</i>	82	71	-13
Wanted fish	13	28	>100
Gurnard	26	22	-15
Lesser spotted dogfish	18	16	-12
Unwanted fish	3	3	0

## RESULTS

- 83% of gurnards captured in upper codend
- Substantial reduction in catch sorting times
- Substantial increase in wanted fish catches with the dual codend
- Gear measure with *Nephrops* high survivability exemption in ICES sub area 7

## Dual codend net plan



## Using side-scan sonar to visualise the bycatch escape corridor

### AREA, VESSEL

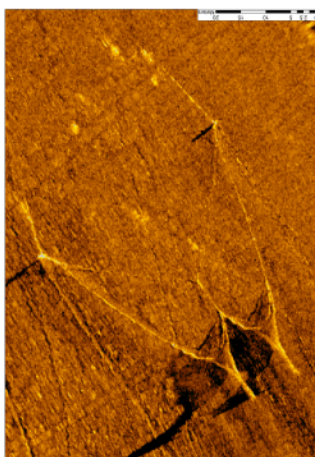
This trial took place in the Irish Sea (ICES VIIa) on board the 17 m trawler MFV Ocean Breeze (D96) and the 12 m RV T Burke II, during June 2021.

### GEAR MODIFICATION

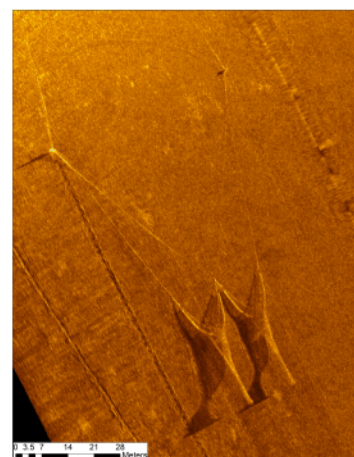
We assessed the utility of side-scan sonar in visualising gear modifications in the Irish Nephrops fishery. A bycatch escape corridor between half quad-rig trawls was used for this purpose.



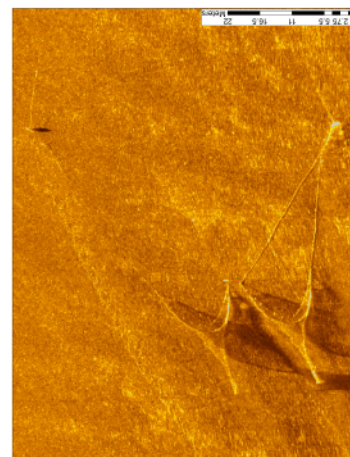
Typical set up



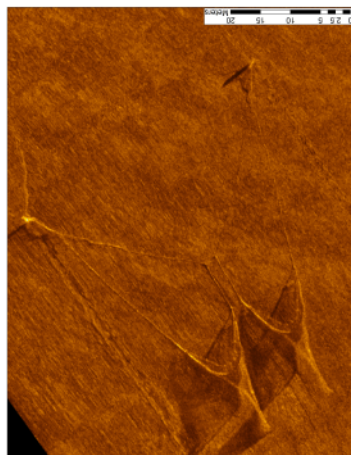
Alternative set up



Alternative set up with gap



Alternative set up with corridor



### RESULTS

- Side-scan imaging successfully used to visualise fishing gear modifications
- Potential to fast track fishing gear development
- Escape corridor/gap warrents further evaluation

# 2.B

## Reduce under size Nephrops in the Nephrops trawl



2.B Reduce under size *Nephrops* in the *Nephrops* trawl by:

- 20. Demonstrating *Nephrops* high survivability using a SELTRA
- 21. Increasing codend mesh size from 70 to 80 mm
- 22. Modifying the codend circumference
- 23. Using a *Nephrops* sorting grid

Reducing landings of small *Nephrops* by demonstrating high survivability of discarded *Nephrops*

AREA, VESSEL

The study took place on the Galway and Aran fishing grounds (ICES VIIb) on board a 11.6 m (150 kW) trawler and a 9.8 m (63 Kw) creel vessel, during July 2017.

GEAR MODIFICATION

A standard SELTRA sorting box with:

- a 3 m long four-panel section
- 80 mm diamond mesh

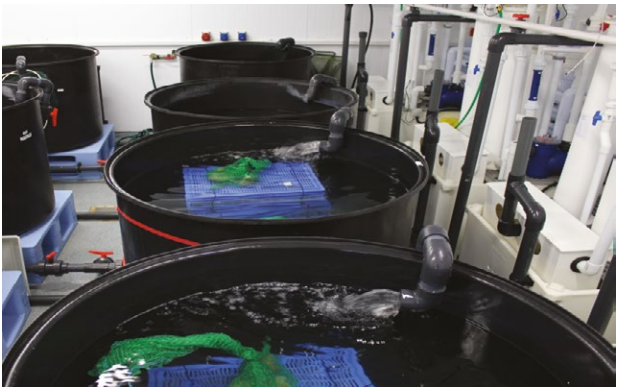
The SELTRA gear was employed on a single-rigged trawl (380 × 80 mm fishing circle) with an 80 mm codend.



Control *Nephrops* caught with creels were stored along with the test *Nephrops* for two weeks at an onshore facility.



*Nephrops* in storage crate



Onshore holding facility

<i>Nephrops</i>	Number caught	Survivors (Number)	Survival (%)
Trawl	1664	1070	64
Creel	204	200	98

RESULTS

- The overall *Nephrops* survivability was:
  - 64%, trawl
  - 98%, creel
- High survivability exemption with selective gears granted in ICES sub area 7

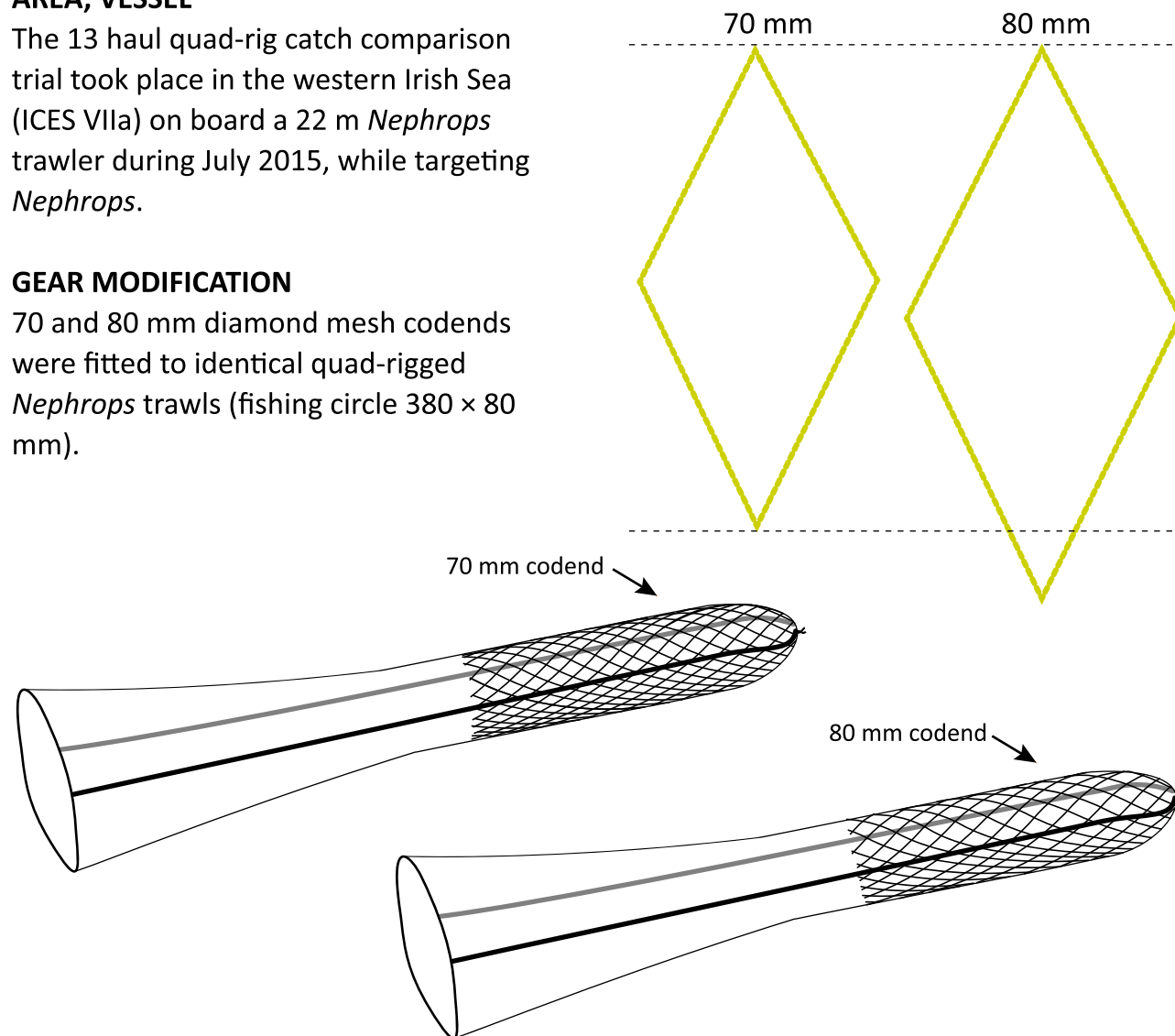
# Reducing catches of small *Nephrops* with an increase in codend mesh size from 70 to 80 mm

## AREA, VESSEL

The 13 haul quad-rig catch comparison trial took place in the western Irish Sea (ICES VIIa) on board a 22 m *Nephrops* trawler during July 2015, while targeting *Nephrops*.

## GEAR MODIFICATION

70 and 80 mm diamond mesh codends were fitted to identical quad-rigged *Nephrops* trawls (fishing circle 380 × 80 mm).



Species	70 mm codend (kg)	80 mm codend (kg)	Difference (%)
<i>Nephrops</i>			
< 25 mm*	53	29	-45
≥ 25 mm*	2040	1808	-11

\*carapace length

## RESULTS

- Significant reduction in catches of small *Nephrops* below 25 mm
- Small reduction in *Nephrops* >25 mm
- No loss in profitability over the course of a fishing season
- New regulated mesh size increase from 2017

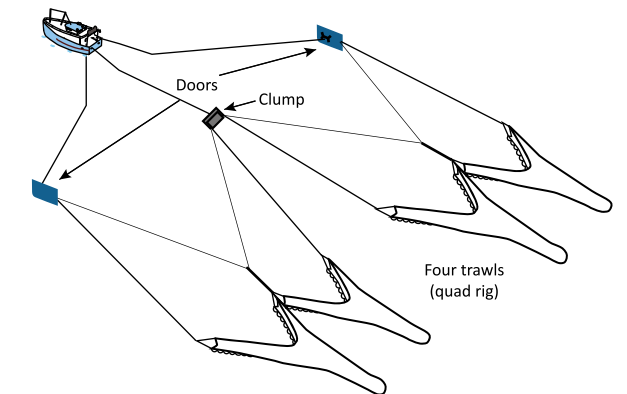
# Modifying the codend circumference to reduce catches of small *Nephrops* and whiting in *Nephrops* trawls

## AREA, VESSEL

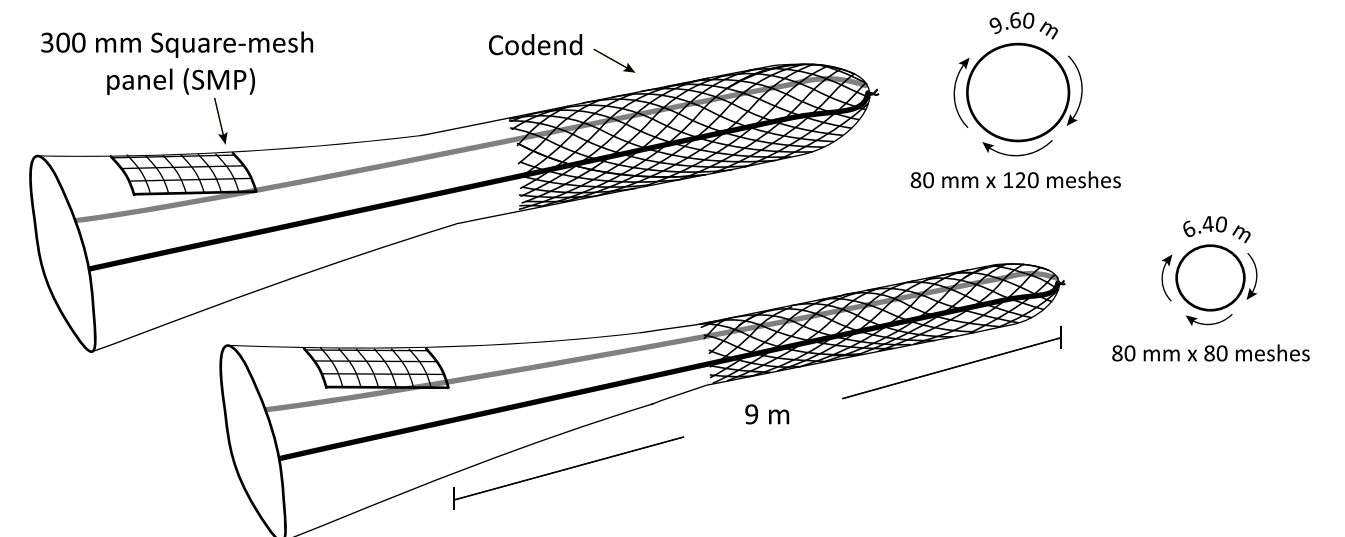
The 12 haul catch comparison trial took place in the Western Irish Sea (ICES VIIa) on a 23 m quad-rig trawler, during February 2018, while targeting *Nephrops*.

## GEAR MODIFICATION

An 80 × 80 codend (mesh size (mm) × number of meshes in diameter) was compared against a standard 80 × 120 codend. The circumference and mesh size in the extension piece matched the codend to which it was attached. A 300 mm square



-mesh panel (SMP) was mounted 9–12 m from the codline in each trawl.



Species	80 × 120 (kg)	80 × 80 (kg)	Difference (%)
<i>Nephrops</i>			
< 25 mm**	48	33	-30
≥ 25 mm**	396	350	-12
Whiting			
< 20 cm	144	122	-15

\*\*Minimum Conservation Reference Size (MCRS)

\*Carapace length

## RESULTS

- Substantial reductions in small *Nephrops*
- Minimal reductions in larger *Nephrops* and very small whiting



# Reducing catches of small *Nephrops* using a modified sorting grid

## AREA, VESSEL

The 12 haul quad-rig catch comparison trial took place in the western Irish Sea (ICES VIIa) on board MFV Our Lass II (DA261) (21.7 m, 484 kW) during September 2015, while targeting *Nephrops*.

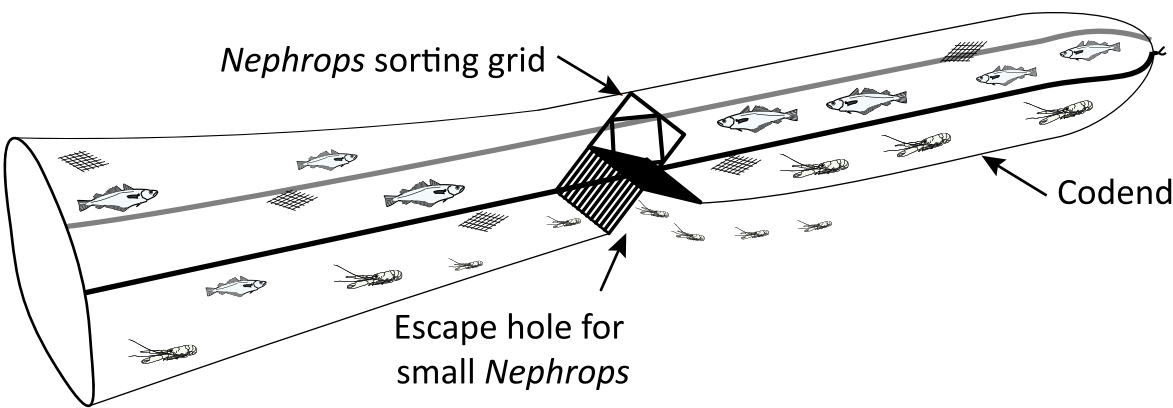
## GEAR MODIFICATION

The test gear was fitted with a *Nephrops* sorting grid (NSG):

- Vertical bars spaced 15 mm apart in the lower half
- Reinforced opening in the top half
- Guiding panel and escape hole in trawl's bottom sheet to the rear of the grid



The standard gear was identical but without a rigid grid. Nominal codend mesh size and fishing circle were 70 mm and 380 × 80 mm.



Species	Standard gear (kg)	NSG (kg)	Difference (%)
<i>Nephrops</i>			
< 25 mm <sup>#*</sup>	454	293	-35
≥ 25 mm <sup>#*</sup>	1454	1232	-15
> 31 mm <sup>£*</sup>	346	332	-4

<sup>#</sup>minimum conservation reference size (MCRS)  
<sup>\*</sup>carapace length  
<sup>£</sup> whole grade

## RESULTS

- Substantial reductions in small *Nephrops*
- Small reductions in larger *Nephrops*
- Fish catches maintained

2.C

Reduce under size, over quota and non-target fish species in the mixed demersal trawl fishery targeting fish species

2.C Reduce under size, over quota and non-target fish species in the mixed demersal trawl fishery targeting fish species by:

- 24. Using 80 mm T90 mesh codend to reduce undersize whiting
- 25. Using 90 mm T90 mesh codend to reduce catches of small fish
- 26. Using 100 mm T90 mesh codend to reduce haddock catches
- 27. Using four-panel T90 codend to reduce unwanted catches
- 28. Raising the fishing line to reduce cod catches
- 29. Staggering the fishing line to reduce unwanted fish catches
- 30. Lights on the raised the fishing line to reduce unwanted catches
- 31. Assessing plaice survivability in a seine fishery

Reducing catches of small whiting with 80 mm T90 mesh in whitefish trawls

AREA, VESSEL

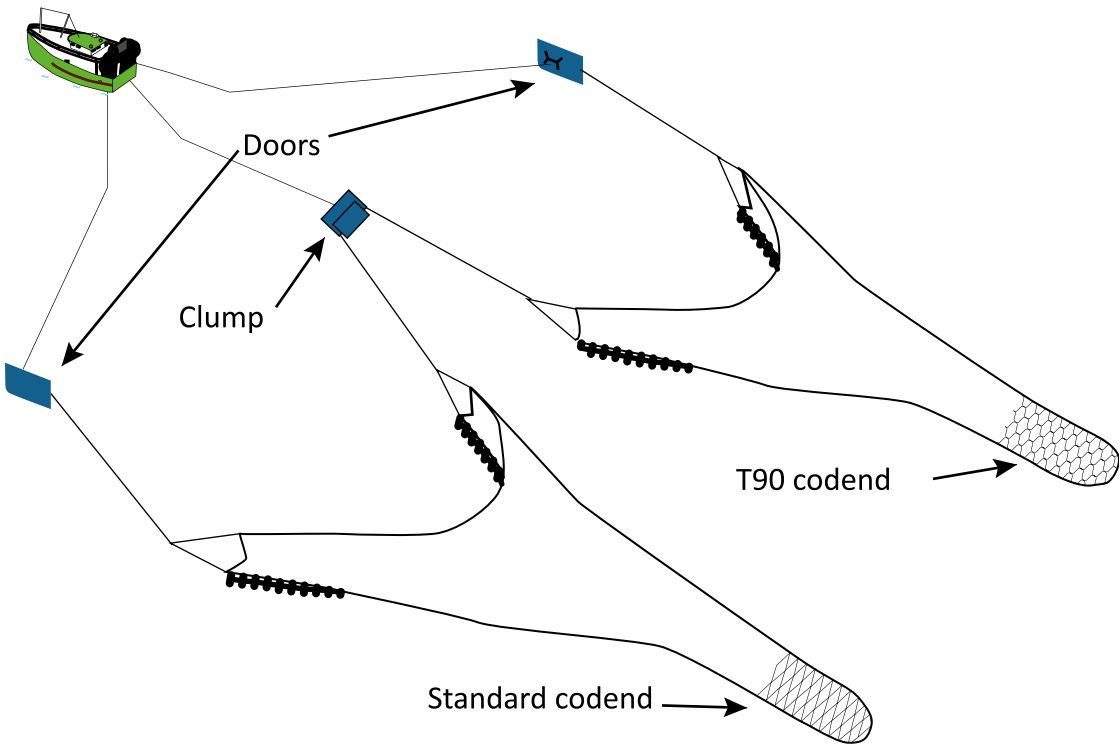
The 13 haul twin-rig catch comparison trial took place in the Celtic Sea (ICES VIIg) on board MFV Foyle Fisher (G497) (24.7 m, 441 kW) during April 2016, while targeting whiting.

GEAR MODIFICATION

The test codend and extension piece were constructed from T90 (turned 90°) 80 mm mesh. The standard codend and extension piece were constructed from diamond 80 mm mesh.



The fishing circle of the twin-rigged hopper trawls was 550 × 80 mm.



Species	Standard gear (count)	T90 (count)	Difference (%)
Whiting			
< 32 cm <sup>§</sup>	2628	857	-67
≥ 32 cm <sup>§</sup>	6691	7774	16

<sup>§</sup>market size

RESULTS

- Substantial reductions in small whiting
- Increases in catches of larger haddock, whiting and plaice
- Substantial increase in catch quality



# Reducing catches of small fish with a 90 mm T90 mesh in a whitefish trawl

## AREA, VESSEL

The 10 haul twin-rig catch comparison trial took place in the Celtic Sea (ICES VIIg) on board MFV Foyle Fisher (G497) (24.7 m, 441 kW) during May 2019, while targeting whitefish.

## GEAR MODIFICATION

The test codend and extension piece were constructed from 90 mm T90 (turned 90°) mesh. The standard codend and extension piece were constructed from diamond (T0) 80 mm mesh.



The fishing circle of the twin-rigged hopper trawls was 550 × 80 mm.



T0  
Diamond

T90  
Diamond  
turned 90°

Species	Standard gear (kg)	T90 (kg)	Difference (%)
Haddock < 30 cm <sup>#</sup>	312	35	-89
Haddock ≥ 30 cm <sup>#</sup>	876	1,236	41
Whiting < 27 cm <sup>#</sup>	25	1	-97
Whiting ≥ 27 cm <sup>#</sup>	307	60	-80
Whiting ≥ 32 cm <sup>§</sup>	143	56	-61
Cod < 35 cm <sup>#</sup>	64	26	-59
Cod ≥ 35 cm <sup>#</sup>	192	192	0
Monkfish	244	380	56

<sup>#</sup>minimum conservation reference size (MCRS)  
<sup>§</sup>market size

## RESULTS

- Substantial reductions in catches of whiting, small haddock and small cod
- Substantial increases in catches of monkfish and larger haddock
- Gear measure in the Celtic Sea

# Reducing catches of small haddock with a 100 mm T90 codend in the Irish Sea

## AREA, VESSEL

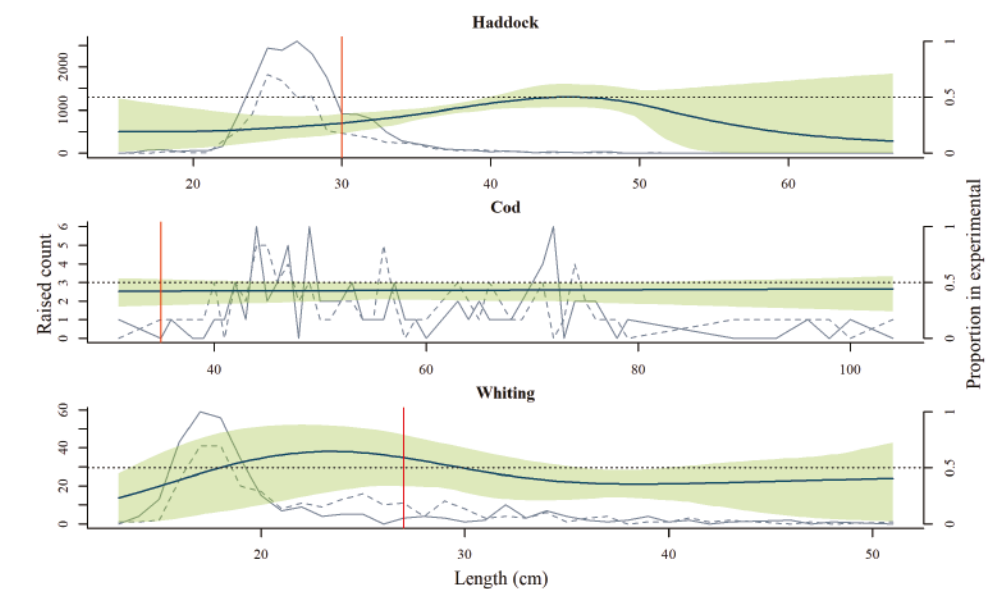
This trial took place in the Irish Sea (ICES VIIb) on board a 22 m trawler during March 2020.

## GEAR MODIFICATION

A 100 mm T90 (mesh turned 90°) codend and extension was compared against a 120 mm diamond (T0) mesh codend and extension to assess its equivalent selectivity. The codends were attached to a single-rigged high opening



whitefish trawl. The trial was completed using alternate hauls.



Species	T0 120 (kg)	T90 100 (kg)	Difference (%)
Haddock < 30 cm	2565	1520	-41
Haddock ≥ 30 cm	1897	1100	-42
Cod ≥ 35 cm	169	179	6
Whiting < 27 cm	12	13	8
Whiting ≥ 27 cm	19	21	11
Plaice < 27 cm	43	246	>100
Plaice ≥ 27 cm	266	442	66

## RESULTS

- Selectivity improved for haddock with the 100 mm T90 codend
- The catch value increased with the 100 mm T90 codend
- The 100 mm T90 codend added as a gear measure in the Irish Sea

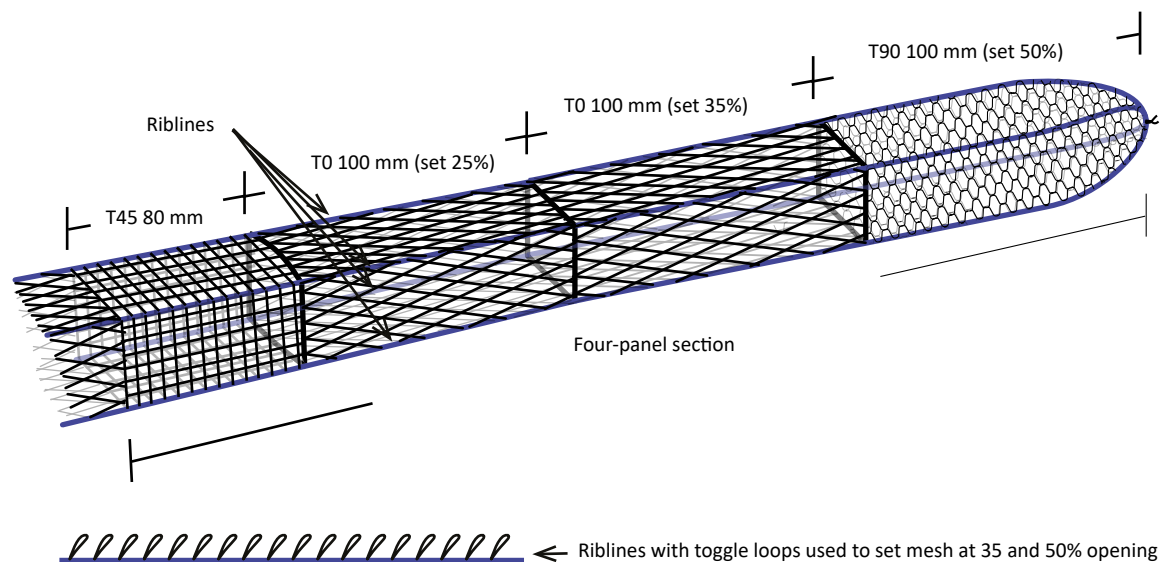
# Reducing catches of small haddock with a four-panel T90 codend in a demersal seine net fishery

## AREA, VESSEL

This trial took place in the Celtic Sea (ICES VIIj&g) on board an Irish demersal seiner, during November 2021. Haddock is a key target species for Irish seiners, with additional quota for this fleet.

## GEAR MODIFICATION

A new four-panel 100 mm T90 codend with shortened riblines or lastridge ropes along each selvedge was compared with a standard two-panel 100 mm T90 codend.



Percentage of total catch weight in each codend			
Species	Control (kg)	Test (kg)	Difference (%)
Haddock small	32	9	-70
Haddock large	24	56	133
Haddock medium	32	83	157
Hake medium	11	11	0
Hake large	54	53	-2

## RESULTS

- Size selectivity improved
- The test codend caught 70% fewer small-grade, and over 100% more medium and large grade, haddock
- 34% increase in total catch value with new codend

# Reducing cod catches with a raised fishing line in whitefish trawls

## AREA, VESSEL

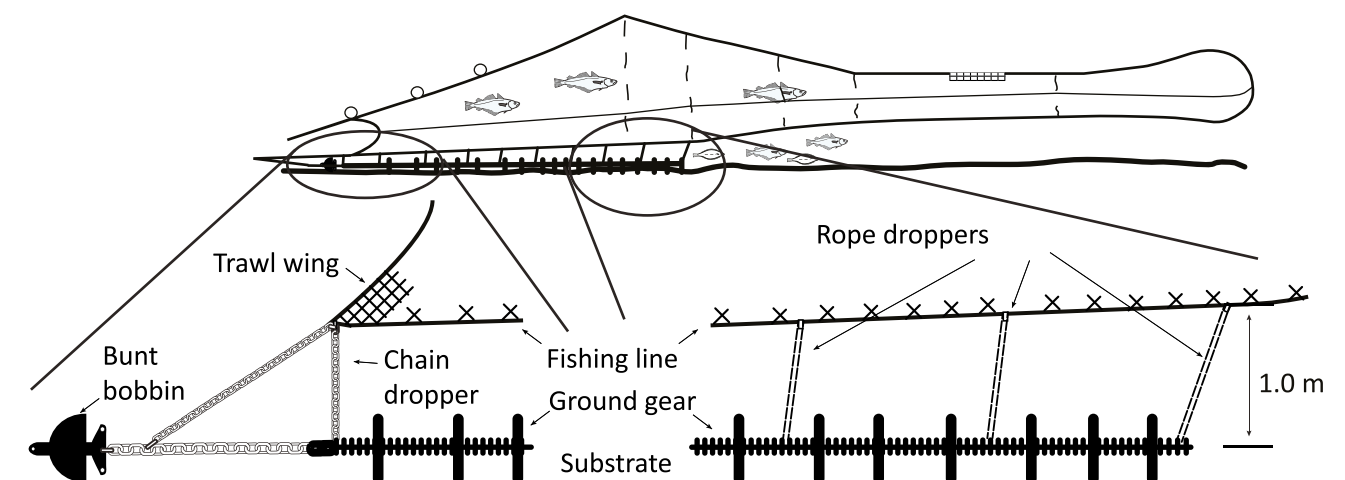
The twin-rig catch comparison trial took place in the Celtic Sea (ICES VIIg) on board a 25 m whitefish trawler during March 2017, while targeting whiting.

## GEAR MODIFICATION

Two identical whitefish trawls (620 × 80 mm fishing circle) were used during the trial. On the standard gear the ground gear/fishing line arrangement was unaltered. On the test gear the droppers between



the fishing line and the ground gear were lengthened to 1 m.



Species	Standard gear (kg)	Raised fishing line (kg)	Difference (%)
Cod	798	488	-39
Whiting	2706	5069	87
Haddock	1975	2713	37
Flatfish	584	250	-57
Monkfish	202	57	-72
Skate and ray	124	25	-80

## RESULTS

- Reduced catches of cod, flatfish, monkfish, and skate and ray
- Substantial increases in whiting and haddock catches
- Total catch value increased by 14%
- Gear measure in the Celtic Sea



# Reducing unwanted fish catches with a staggered fishing line in whitefish trawls

## AREA, VESSEL

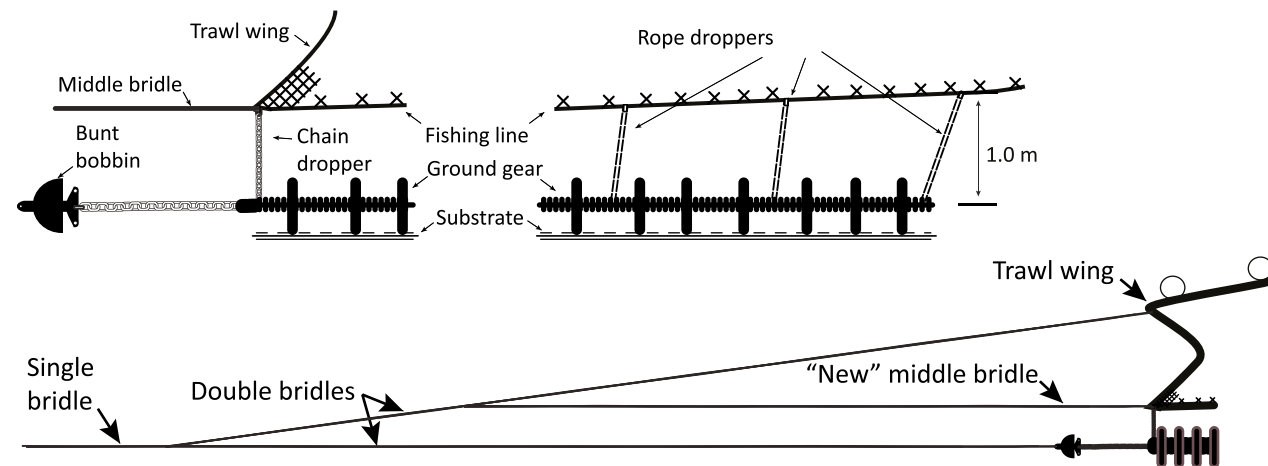
The 24 alternate-haul catch comparison trial took place in the Celtic and Irish Seas (ICES VIIa,g) on board the MFV Northern Celt (SO472) (25 m, 600 Kw) during March and April 2019, while targeting whitefish.

## GEAR MODIFICATION

Following on from the previous field and flume tank testing of a trawl with 1 m droppers between the fishing line and ground gear; modifications were made to



the bridle configuration to improve operation. An additional bridle was attached between the fishing line and upper bridle.



Species	Standard gear (kg)	Staggered fishing line (kg)	Difference (%)
Cod	83	59	-29
Haddock	3,057	2,783	-21
Whiting ≥ 31 <sup>§</sup>	545	562	3
Whiting < 31 <sup>§</sup>	455	246	-46
Flatfish	609	188	-69
Skate and ray	160	35	-78
Dogfish	1,480	180	-88

<sup>§</sup>market size (cm)

## RESULTS

- Moderate reductions in cod and haddock
- Substantial reductions in small whiting, flatfish, skate and ray, and dogfish
- Gear measure in the Celtic Sea

# Lights on the raised fishing line

## AREA, VESSEL

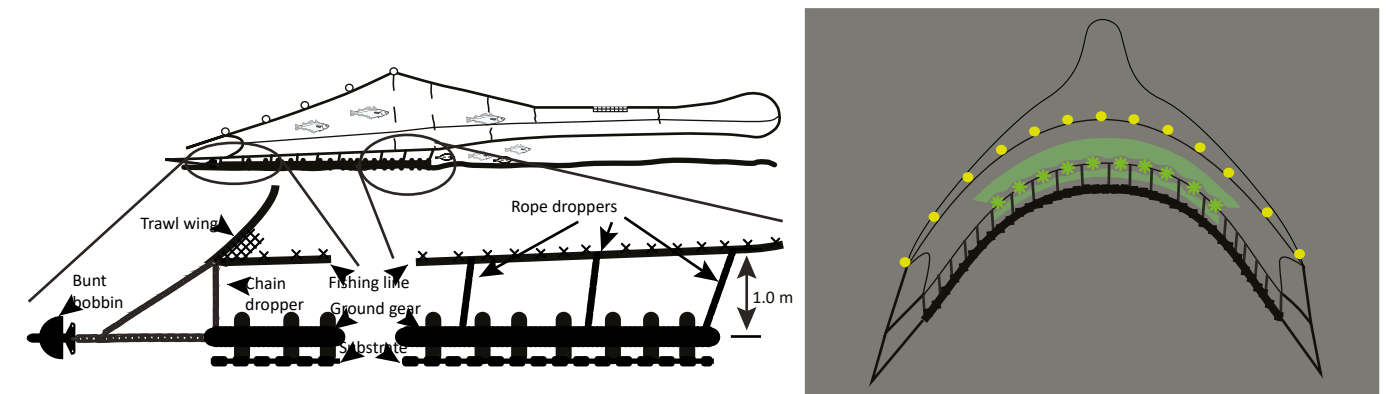
The study took place in ICES 7g & 7j on board the MFV Northern Celt (SO 472) (25 m, 600 Kw) during March 2022, while targeting whitefish.

## GEAR MODIFICATION

20 Lindgren Pitman lights were attached to the fishing line of a raised-fishing-line trawl. The lights were spaced ~1 m apart around the centre of the trawl bosom. The fishing line was raised from the ground gear using 1-meter-long chain and polysteel rope droppers. Alternate hauls were



conducted using RFL gear with artificial lights (test) and without artificial lights (control).



Species	Control (kg)	Test (kg)	Difference (%)
Cod	437	165	-62
Whiting	449	248	-45
Haddock	2473	2146	-13
Hake	198	92	-53

## RESULTS

- Significant 65% reduction in cod
- Substantial reductions in market sized whiting and hake
- Reductions in larger haddock
- Lights on the raised-fishing line currently unviable due to loss of marketable catches
- The raised fishing line remains an important gear option for reducing unwanted catches

# Plaice vitality in a seine fishery

## AREA, VESSEL

This industry-led trial took place in the Celtic Sea (ICES VIIj&g) on board MFV Róise Catriona (T100) (24 m, 413 kW), a fly-seiner, during October 2019.

## GEAR MODIFICATION

A single 68 m (footrope) seine was used to capture plaice that landed directly into a hopper and sorted from a conveyor belt. All plaice were condition assessed (vitality and injuries) and measured.



Comparisons were made with a Danish-seine study completed in ICES division IIIa.



Vitality	Plaice (No)	Plaice (%)
Excellent	282	59
Good	136	29
Poor	55	12
Dead	4	1

## RESULTS

- 59% were in excellent condition
- Vitalities compare well with Danish seine work completed in ICES IIIa
- An application will be made for a high survivability exemption from the landing obligation

Bord Iascaigh Mhara  
An Cheannoifig,  
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