

# Precision-fishing Re-imagining bottom-trawling through innovation

NSAC/EAPO Seminar  
Innovative Fishing



Funded by  
the European Union

Hybrid meeting  
Brussels, 7 March 2024





**ICES**  
**CIEM**

International Council for  
the Exploration of the Sea  
Conseil International pour  
l'Exploration de la Mer

**NSAC/EAPO Seminar on Innovative Fishing**  
Hybrid meeting (Brussels) 7th March 2024



**NSAC**  
North Sea Advisory Council



# EU request on innovative gears for potential use in EU waters and their impacts

*ICES Workshop on Innovative Fishing Gear*  
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# EU Request

- Building on the previous work (WKING 2020), update the **catalogue of innovative gears** presenting the innovations per sea basin, including their objectives, technical specificities, and benefits in terms of selectivity on target and non-target species, and environmental impacts on marine ecosystems and sensitive habitats.
- For those innovations which are ready for deployment, assess the **level of uptake** of innovative gears by the EU industry. Aspects considered: finance needs, user friendliness, risks to health and safety of the crew.
- For those innovations not implemented, identify the **main drivers that prevented their use**, including the analysis of behavioural drivers and social and economic trade-offs and propose ways to facilitate their implementation.

# Technical Measures Regulation (TMR)

The request from DGMARE relates to Article 31 of the technical measures regulation, where ICES is specifically mentioned

## Regulation (EU) 2019/1241 of the European Parliament and of the Council of 20 June 2019

<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1241&from=EN>

### *Article 31*

#### *Review and reporting*

**By 31 December 2020 and every third year thereafter**, and on the basis of information supplied by Member States and the relevant Advisory Councils and following evaluation by STECF, the **Commission** shall submit a report to the European Parliament and to the Council on the implementation of this Regulation.

That report shall assess the extent to which **technical measures** both at regional level and at Union level have contributed to achieving the objectives set out in Article 3 and reaching the targets set out in Article 4. The report shall also refer to **advice from ICES on the progress that has been made, or impact arising from innovative gear**.

The report shall draw conclusions about the **benefits for, or negative effects** on, marine ecosystems, sensitive habitats and selectivity.

# Joint Recommendations

**Regulation (EU) 2019/1241 of the European Parliament and of the Council of 20 June 2019**

<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1241&from=EN>

Member States should have the possibility **to develop joint recommendations** for appropriate **technical measures that differ from these baselines** in accordance with the regionalisation process set out in Regulation (EU) No 1380/2013, based on scientific evidence.

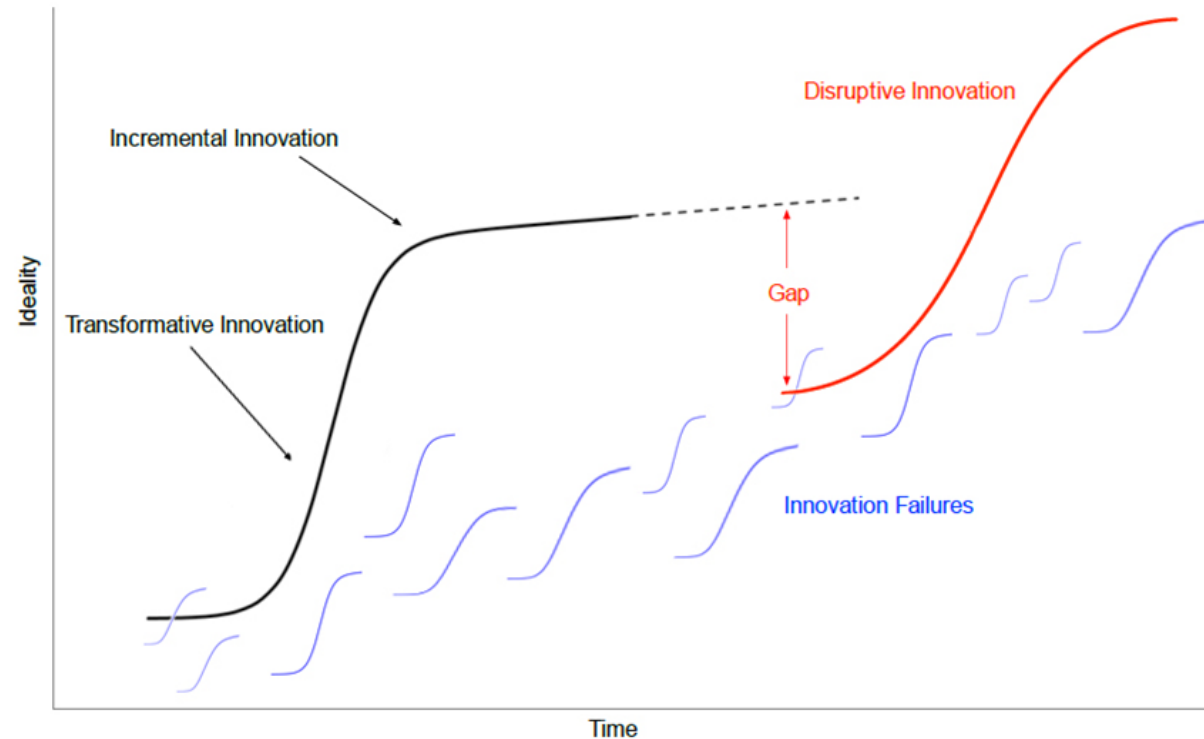
When developing joint recommendations in relation to size and species selective characteristics of gear alternative to the baseline mesh sizes, regional groups of Member States should ensure that **such measures result in similar, as a minimum, or improved selectivity** characteristics as the baseline gear.

On the basis of an assessment of the impacts of innovative gear, the use, or extending the use, of such **innovative gear could be included as an option in joint recommendations** from regional groups of Member States.

# General definition of Innovation

Any new ideas, creative thoughts, new imaginations in the form of technology or method

**A successful innovation gives to customers a more ideal solution than what had previously been available**



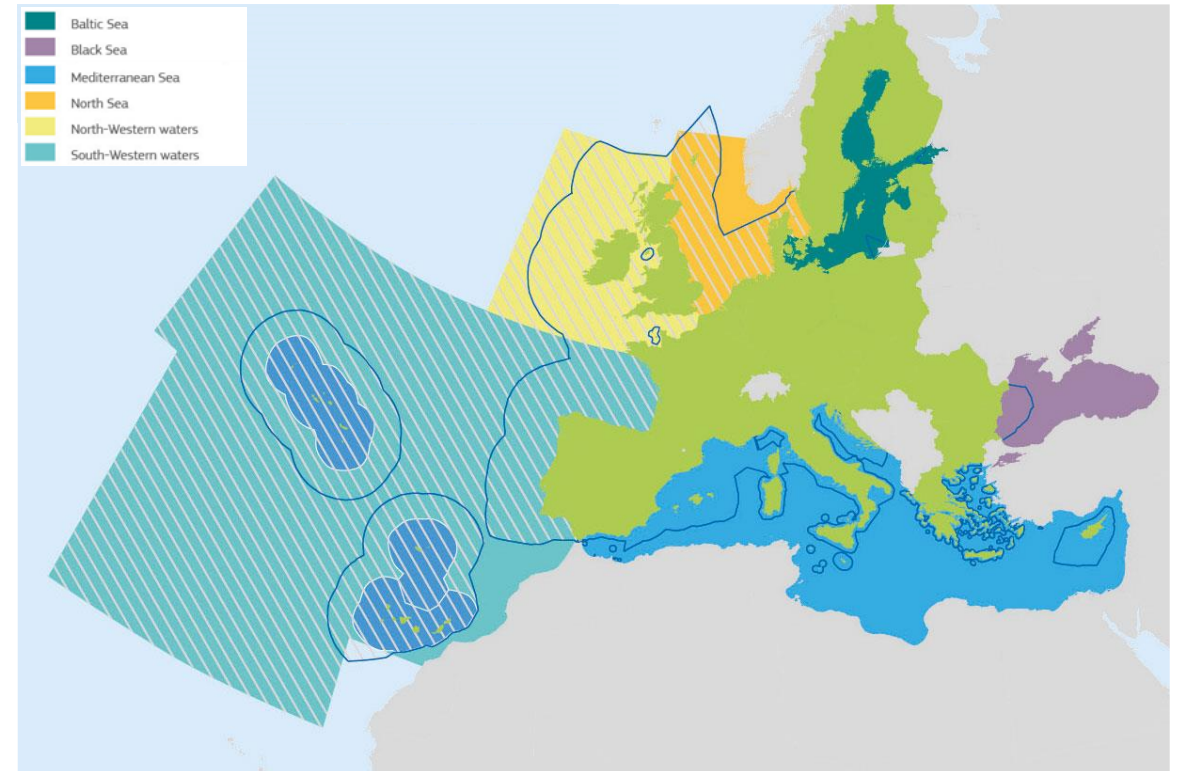
Innovation evolution dynamics. Systems jump from one S-curve to another in the direction of Ideal Final Result outcomes.

# Innovative gear

An “**innovative fishing gear**” is a gear or a significant component of a gear that is different from the baseline in the current EU Regulations – or, in the absence of such legislation - different from the gear commonly used in the specific sea basin (area)

# Sea basins identified in the EU Regulation 2019/1241

- North Sea: 27.4
- Northwestern Waters: 27.5, 6, 7
- Southwestern Waters : 27.8-10, 34.1.1-1.2, 2
- Baltic Sea : 27.3
- Mediterranean Sea: 37.1, 37.2, 37.3
- Black Sea: 37.4



# Ecological performance: criteria of assessment

## 1. Catch efficiency

## 2. Selectivity

- ❖ target
- ❖ bycatch

## 3. Impact on marine ecosystems

- ❖ Seabed or benthic impact
- ❖ Gear loss, ghost fishing and marine plastic pollution
- ❖ Impact on endangered, threatened, and protected (ETP) species

# Performance improvement

- **Incremental performance**  
Minimal or modest performance improvement compared to the existing baseline fishing gear
- **Transformative performance**  
Substantive performance improvement
- **Disruptive performance**  
Radically and significantly superior performance improvement
- **Not applicable - no effect**  
No effect on the performance improvement
- **Negative performance**  
Negative performance improvement. Innovations to be rejected

# Levels of technological complexity

## ➤ Minimal complexity

Low degree of complexity. Innovative fishing gears do not require radically new knowledge or technology, they can be readily adopted with minimal difficulty compared to the existing baselines

## ➤ Medium complexity

Fishing gears sufficiently different from the baselines, limited training required. The use of these gears may involve modest change in vessel design, processes, operations, and handling

## ➤ Significant complexity

Fishing gears radically different from the baselines. Their operation requires considerable training. They may involve considerable change in vessel design, processes, operations, and handling

# Technology Readiness Level (TRL)

TRLs category	European Union TRLs scale
Low	TRL 1 – Basic principles observed TRL 2 – Technology concept formulated TRL 3 – Experimental proof of concept
Moderate	TRL 4 – Technology validated in lab TRL 5 – Technology validated in relevant environment TRL 6 – Technology demonstrated in relevant environment
High	TRL 7 – System prototype demonstration in operational environment TRL 8 – System complete and qualified TRL 9 – Actual system proven in operational environment

# Technological readiness and ecological performance matrices

## Performance

- Catch efficiency
- Selectivity
- Impact on marine ecosystems

<b>Performance</b>	<b>Disruptive</b>	Probably worth considering	Highly promising	Unicorn "no brainer"
	<b>Transformative</b>	May be worth considering	Some potential	Very promising
	<b>Incremental</b>	Not worth considering	Probably not worth considering	Possibly worth considering
	<b>No effect</b>	Not worth considering	Not worth considering	Not worth considering
	<b>Negative</b>	Negative outcomes	Negative outcomes	Negative outcomes
		<b>Low</b>	<b>Moderate</b>	<b>High</b>
<b>Technology readiness level</b>				

# Economic costs (purchase and use)

<b>Return on Investment (ROI)</b>	Significant	Promising	Highly promising	Unicorn "no brainer"
	Substantial	May be worth considering	Promising	Highly promising
	Minor	Probably not worth considering/Refine	May be worth considering	Promising
	Negative	Discard / Seek alternatives	Discard / Seek alternatives	Discard / Seek alternatives
		High	Moderate	Low
		<b>Capital cost</b>		

# PESTEL Framework

Six groups of “umbrella factors”

- Political
- Economic
- Social
- Technological
- Environmental
- Legal

Individuals who provided the information (factsheets) were asked to what extent they thought each of the six factors influenced the **adoption of the innovative fishing gear**



# PESTEL Framework

*Six groups of “umbrella factors:” Political, Economic, Social, Technological, Environmental and Legal.*

<u>Political factors</u>	<b>Level of fishers’ support for policies</b> , top-down regulations, absence of a level playing field when gears are adopted voluntarily.
<u>Economic factors</u>	Cost of purchasing the gear, changes in marketable catch composition, <b>change in running costs</b> , priority to short-term benefits over longer term benefits of using the new gear, presence of grants or subsidies.
<u>Social factors</u>	<b>Resistance or reluctance to change</b> , social norms, peer pressure, effectiveness of outreach about the new gear, demotivation because of policy developments, different understanding of the problem between fishers and other stakeholders (e.g., discards, bottom-trawl impacts).
<u>Technological factors</u>	Technical knowledge, gear is difficult to deploy or <b>requires specialist knowledge or training</b> , extent of the adaptability of the gear to different vessel designs.
<u>Environmental factors</u>	<b>Fuel reduction, reduced unwanted bycatch</b> of fish, reduced unwanted catch of other marine species (benthos, marine mammals, birds), lower <b>seabed impact</b> .
<u>Legal factors</u>	<b>Gear is currently not allowed</b> (e.g. tested under a derogation, regional restrictions), having to meet minimal legal gear standards.

In 2020, ICES published advice (WKING, 2020) on innovative fishing gears based on a catalogue of 33 factsheets that described innovative fishing gears potentially relevant to EU fisheries

<https://www.ices.dk/community/groups/Pages/WKING.aspx>

The last ICES advice (WKING2, 2023) is based on the innovative gear catalogue, which contains an additional 75 factsheets and includes two updates to innovations of gears (shrimp pulse trawl and Flemish panel) from the previous advice <https://www.ices.dk/community/groups/Pages/WKING2.aspx>

# Information collection (factsheets)

- Description of gear
- Area of development
- Technology Readiness Level (TRL)
- Level of Complexity
- Ecological performance (C: Catch efficiency, S: Selectivity, I: Environmental Impact)
- Economic performance (Capital Cost and Return on Investment, ROI)
- PESTEL Framework

Factsheet	Description	Area	Gear type	TRL		Compl.	Performance					PESTEL Framework					
				Category	Scale		C	S	I	Cost	ROI	P	E	S	T	E	L
20	Netting-based alternative to rigid sorting grids	NS	Trawl	3	TRL9	1	0	3	3	2	2	+	NK	NK	+	+	+
21	Alternatives for processing and storing UUCs	NS	Trawl	1	TRL2	3	1	0	0	3	3	NK	NK	NK	NK	NK	NK
22	Alternative codend in unrestricted trawl	NS	Trawl	3	TRL7	1	1	1	1	1	1	NK	NK	NK	NK	NK	NK
23	Predictive methods to estimate gear selectivity	NS	Trawl	2	TRL6	1	1	1	1	1	1	NK	NK	NK	NK	NK	NK
24	Sorting grid to improve size selection of shrimp	NS	Beam trawl	3	TRL9	2	1	1	0	2	1	NK	NK	NK	NK	NK	NK
25	Multibeam sonars application	NS	Purse-seine	3	TRL7	3	3	2	2	3	3	NK	NK	NK	NK	NK	NK
26	Pulse trawling	NS	Beam trawl	3	TRL9	3	3	2	2	3	3	-	+	-	+	+	-
27	Modular Harvesting System (MHS)	NS	Trawl	3	TRL8	3	3	3	3	3	1	NK	NK	NK	NK	NK	-
28	Shrimp pulse trawl	NS	Trawl	3	TRL9	3	1	1	2	2	3	-	+	NA	NA	NA	-
29	Self-adjusting semi-pelagic doors	NS	Trawl	2	TRL5	3	-1	0	2	3	2	+	-	+	-	+	+
30	Sea stars HydroTrawl	NS	Beam trawl	3	TRL8	1	2	2	2	1	2	NK	NK	NK	NK	NK	NK
31	TrawlMonitor	NS	Trawl	3	TRL7	3	2	2	0	3	2	+	-	+	-	+	+
32	Intelligent fishing (Smartrawl)	NS	Trawl	1	TRL2	3	2	3	3	2	3	+	NK	+	NK	+	NK
33	CatchCam	NS	Trawl	3	TRL9	3	2	2	2	3	3	NA	-	NK	NK	NK	NA
34	Square-mesh cylinder in the extension (CMC)	NWW	Trawl	3	TRL7	1	-1	1	0	1	1	NK	-	NK	NK	NK	-
35	Hydrodredge	NWW	Dredge	3	TRL7	1	-1	1	2	1	0	NK	-	NK	+	+	NK
36	Quad-rig trawling to improve Nephrops fishery	NWW	Trawl	3	TRL9	2	1	1	1	3	2	+	+	+	+	+	NA
37	Black sea bream fish pot	NWW	Pots	3	TRL7	1	1	1	1	2	1	NA	-	+	+	+	NA
38	Selective Beam Trawl	NWW	Beam trawl	3	TRL9	1	1	2	2	1	2	NK	+	+	+	+	NK
39	Artificial LED lights on leadline in trawl	NWW	Trawl	3	TRL9	1	2	2	0	1	2	NA	NA	NK	NK	NA	NA
40	Artificial LED lights on raised fishing line	NWW	Trawl	3	TRL9	1	2	2	0	1	0	NA	NA	NK	NK	NA	NA
41	Modified rigging to reduce of unwanted catches	NWW	Trawl	3	TRL9	1	2	2	0	1	2	NA	NA	NK	NK	NA	NA
42	Alternative codend to reduce unwanted catches	NWW	Trawl	3	TRL7	2	2	2	1	1	1	NK	+	+	+	+	+
43	Flemish panel	NWW	Beam trawl	3	TRL8	1	1	2	2	1	1	+	NK	NK	NK	NK	+
44	Raised Trammelnet (Aranha)	NWW	Set-nets	2	TRL6	2	2	2	2	2	1	+	-	+	+	+	NA
45	Four-Panel Nephrops trawl	NWW	Trawl	3	TRL7	2	2	2	-	2	1	NK	-	-	NA	NK	NA
46	Raised fishing line trawl	NWW	Trawl	3	TRL9	1	2	2	2	1	1	NK	-	-	NK	NK	NA
47	Dual codend with net separator panel	NWW	Trawl	3	TRL9	2	2	2	2	2	3	NK	-	-	-	+	NA

# Criteria of assessment and technological readiness

<b>Catch efficiency improvement</b>	<b>Disruptive</b>			26	27	3						
	<b>Transformative</b>	32	44	17	40	1	33	46	50			
	<b>Incremental</b>	64	21	63	19	8	36	68	10	53	22	62
	<b>No effect</b>			75	9	11	54	51				
	<b>Negative</b>			29	49	74	14					
		<b>Low</b>	<b>Moderate</b>	<b>High</b>	<b>Technology readiness level</b>							

<b>Selectivity improvement</b>	<b>Disruptive</b>	32			50					
	<b>Transformative</b>		44	69	40	1	38	53		
	<b>Incremental</b>	64	63	19	75	8	6	36	10	22
	<b>No effect</b>	21	9	29	11	54	51			
	<b>Negative</b>				61	57	59			
		<b>Low</b>	<b>Moderate</b>	<b>High</b>	<b>Technology readiness level</b>					

<b>Ecosystem impact improvement</b>	<b>Disruptive</b>	32		8	27						
	<b>Transformative</b>	64	19	44	18	7	1	33	46	50	
	<b>Incremental</b>		75	23	6	36	10	22			
	<b>No effect</b>	21	63	49	61	40	73	57	24		
	<b>Negative</b>				4	55	56	34	16	41	71
		<b>Low</b>	<b>Moderate</b>	<b>High</b>	<b>Technology readiness level</b>						

# Criteria of assessment and technological readiness

Most innovative fishing gears (80%) were considered to result in a positive effect (incremental, transformative, or disruptive) in **catch efficiency and selectivity**. 80% of these were also considered to have a high level of technological readiness.

Most innovative fishing gears (64%) were considered to result in a reduction (incremental, transformative, or disruptive) of the **impact on the marine ecosystem**. 77% of these were also considered to have a high level of technological readiness.

Almost 80% of the 75 innovative gears were categorized as having a high level of **technological readiness**, while less than 4% were categorized as having a low level of technological readiness. Almost half (47%) of the innovations were perceived to have a **minimal level of complexity**.

# Cost matrix analysis

The capital cost of 36 innovative fishing gears (48%) was classified as low.

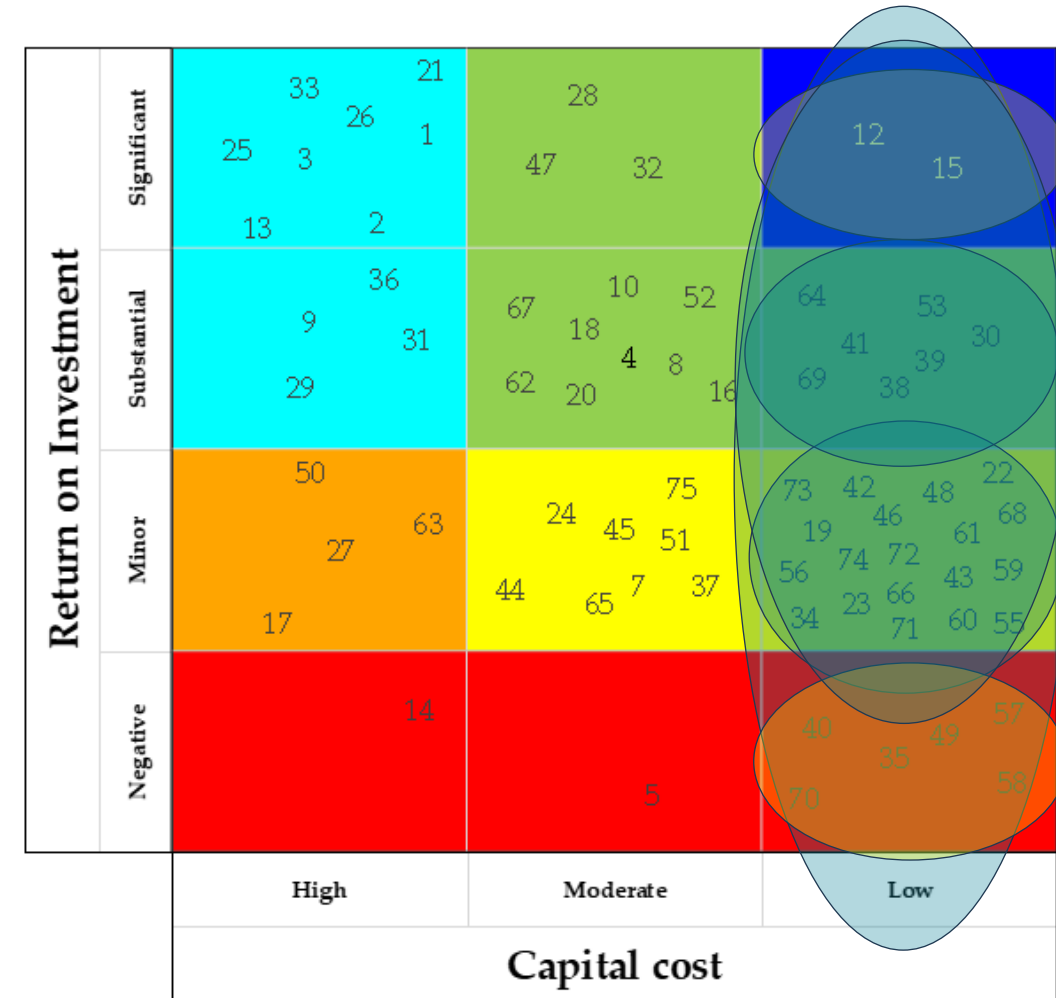
Nineteen (53%) of those 36 gears were considered to provide minor ROI, i.e. minor profit after accounting for costs

Seven (19%) to provide substantial ROI

Two (6%) to provide significant ROI

Six (17%) to provide negative ROI.

More than 78% of low-cost innovative gears were considered to provide a positive ROI and, thus, could be considered reasonable replacements for the currently used gears.



# Case studies on technological innovation uptake

There are four intrinsic motivations for a fisher to change practices and apply new technologies:

- (i) to increase revenue by catching more
- (ii) to increase revenue by raising the value of the catch
- (iii) to reduce the costs of fishing, and
- (iv) to enhance comfort and safety onboard

While fishers may cognitively be aware that change is necessary and important, emotionally they may think otherwise and be unprepared to change

# Case studies on technological innovation uptake

Fishers' behaviour towards gear innovation and uptake is driven by a complex interplay of *Political, Economic, Social, Environmental and Legal* (PESTEL) factors. Innovations that reduce environmental impact and cost of fishing (fuel savings) or improve the catch efficiency may be more readily adopted by fishers.

## Examples

- Experimental pulse-trawl
- Giant scallop *HydroDredge*
- Sea stars *HydroTrawl*
- Semi-pelagic otterboards



BENTHIS EU project: otterboards testing in wind tunnel (Rostock, Germany)

# Dual codend

The dual codend is a modified section with two codends

Irish Nephrops fisheries to reduce unwanted fish catches while maintaining Nephrops

Mediterranean demersal trawl fisheries to separate fish and shrimps from debris

## Economic factors

- Substantial reduction in catch sorting times
- Substantial improvement in catch quality

## Technological factors

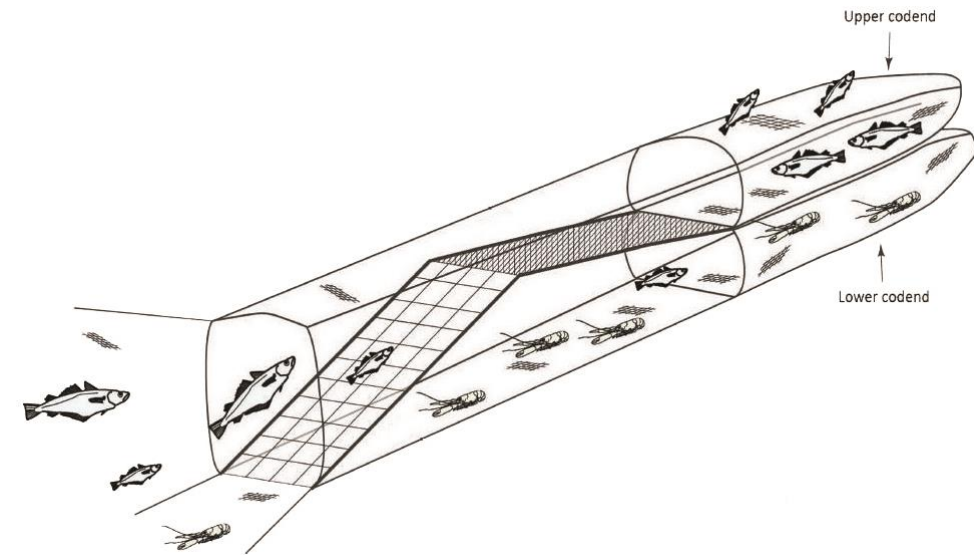
- Repairs are likely to be a little more difficult

## Environmental factors

- Selectivity improvement: upper codend mesh size  $>$  MMS

## Legal factors

- Irish: legal but on single- or twin-rig and not in quad-rig
- Mediterranean: only single codend is legal



Cosgrove *et al.* (2016). Illustration by Matthew McHugh (BIM)

# Conclusions and suggestions

A large proportion of gear innovations were found to be ready for uptake by industry

The level of uptake and the main drivers influencing the uptake remain to be identified

ICES has developed a new strategic PESTEL framework containing political, economic, social, technological, environmental, and legal factors for evaluation of the barriers and opportunities for innovative fishing gears to be systematically applied

# Conclusions and suggestions

At present it remains unclear how best to collect information on levels of actual uptake and factors influencing uptake

Alternative methods need to be applied, such as interviews with fishers, focus groups with fishers or fleet wide surveys

Greater effort and understanding of the factors that influence the uptake of innovative fishing gears is necessary

# Thank you for your attention

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