

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

### Advice summary

ICES defines “innovative gear” as 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 a specific sea basin (area) in EU waters.

For the current advice, ICES created an initial catalogue of innovative fishing gears for EU fisheries. This catalogue, in its current form, provides an overview of relevant state-of-the-art technologies, innovations, and their expected impacts. It contains 33 example factsheets that are indicative of gear innovations in different areas in EU waters.

A proposed framework for assessing the performance of innovative fishing gear includes catch efficiency, gear selectivity, and impact on marine ecosystems as the main criteria, evaluated on a relative scale (i.e. scored relative to the existing gear). Complexity and technology readiness levels (TRLs) are proposed as criteria for evaluating the suitability, readiness, and potential adoption of an “innovative gear”. In the ensuing innovation matrix, three assessment criteria highlight the main areas where innovation is currently happening.

ICES advises that technical innovations are always sociotechnical. The level of uptake and sociotechnical aspects associated with the innovation should therefore be part of the development of a more comprehensive state-of-the-art review.

### Request

ICES is requested to:

- *In order to prepare the report described in article 31.1 of Regulation 2019/1241, the EU Commission seeks ICES advice on the progress that has been made, or impact arising from innovative gear within EU waters. This advice should assess the benefits for, or negative effects on, marine ecosystems, sensitive habitats and selectivity.*
- *Specifically, and to the extent possible, the advice sought should provide information on what kind of innovative gears are being used, their objective, their technical specificities and the impact on both target species, non-target species and the environment in which they had been deployed.*

### Elaboration on the advice

The proposed definition of “innovative gear” is based on a general definition of innovation as “any new ideas, creative thoughts, and new imaginations in the form of technology or method” (Techau *et al.*, 2020). An innovation is something that is original and more effective than previous technology and, as a consequence, is new when it emerges on the market or in society. “Innovative gear” is therefore 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) in EU waters. In EU fisheries, baseline standards are derived either from existing technical measures, as specified in EU Regulation 2019/1241 (EU, 2019) and associated legislative instruments, or from unregulated, commonly used commercial practices (e.g. groundgears). These standards consist of objectives and measurable criteria (ICES, 2020a).

For the current advice and the subsequent triennial cycle, ICES drafted an innovative fishing gear catalogue for EU fisheries. The catalogue, in its current form, provides an overview of those state-of-the-art technologies and innovations that are relevant to EU fisheries. It currently contains 33 example factsheets that are indicative of gear innovations in different areas within EU waters: North Sea (nine innovative gears), Northwestern waters (six), Southwestern waters (two), Baltic Sea (seven), and the Mediterranean Sea (nine). In addition, ICES has identified nine gear innovations outside of the EU area that are potentially relevant for EU fisheries (ICES, 2020a). Pulse trawl for flatfish is not included in the current preliminary innovative gear list, but ICES has advised on the ecosystem/environmental effects of the pulse trawl sole fishery on North Sea ecosystems previously (ICES, 2020b).

The innovations are reviewed on the basis of three assessment criteria: (a) catch efficiency, (b) selectivity on target species and reduction of catch of unwanted and incidental species, and (c) impacts on the ecosystem. For each innovation, the main technical features and the technological complexity of the innovation were reviewed, based on an empirical three-

level scoring system. Because of resource constraints and the set time-frame, the review did not encompass all gear innovations in EU waters, nor did it comprehensively evaluate the innovation against the three criteria or assess the level of uptake by fishers in the fleets concerned or include the sociotechnical aspects of gear innovation. This would require substantial resources and time, which were not available.

ICES adapted the approach developed by Techau *et al.* (2020) in its assessment of gear innovations. The resulting innovation matrix analysis indicates that high technological readiness exists for most innovative gears for all three criteria assessed (Tables 1–3).

**Table 1** Innovation matrix for the catch efficiency criterion relating the potential performance improvement and technology readiness level of innovative gears. The performance assessment indicates demonstrated or potentially significant, minimal, or no improvement relative to existing conventional gears. Definition and details on Performance and TRL are provided in the Methods section under “Basis of the Advice”.

Performance	Disruptive	-	Flying drone*, echo-sensor detector	Flemish panel, Nemos + Roofless, Guardian-nets
	Transformative	-	Controllable doors, electro-razor, crustacean BRDs, ADD	Floating sweeps, scaring ropes, Hookpod, FlexSelect, brown shrimp sorting grid, Netgrid, SepNet, combination grid, grid and double codend, shrimp pulse, dual codend, semi-pelagic doors, high-strength materials, Flex-TED, detached groundgear, JTED
	Incremental	-	Pontoon trap	Mini Danish seine, pearl-nets, alternative pots, boat seine
	No effect or negative	-	-	-
		Low	Moderate	High
Technology readiness level (TRL)				

\*For an explanation of innovative gears, see Table A1 in the Annex.

**Table 2** Innovation matrix for the selectivity criterion relating the potential performance improvement and technology readiness level of innovative gears.

Performance	Disruptive	-	Flying drone, controllable door	Hookpod, Flex-TED
	Transformative	-	Electro-razor, echo-sensor detector, crustacean BRDs	FlexSelect, brown shrimp sorting grid, Netgrid, SepNet, combination grid, grid and double codend, shrimp pulse, floating sweeps, scaring ropes, Flemish panel, Nemos + Roofless, alternative pots, dual codend, semi-pelagic doors, high-strength materials, Guardian-nets, detached groundgear, JTED, lionfish trap
	Incremental	-	Pontoon trap	
	No effect or negative	-	-	-
		Low	Moderate	High
Technology readiness level (TRL)				

**Table 3** Innovation matrix for the criterion of impact on marine ecosystems relating the potential performance improvement and technology readiness level of innovative gears.

Performance	Disruptive	Recycled plastic doors	Flying drone, PingMe, controllable door, electro-razor	Shrimp pulse, pearl-nets, Nemos+Roofless, dual codend, semi-pelagic doors, Flex-TED, JTED
	Transformative	-	Echo-sensor detector, crustacean BRDs, pontoon trap, ADD	FlexSelect, SepNet, grid and double codend, floating sweeps, Flemish panel, Hookpod, mini Danish seine, alternative pots, boat seine, high-strength materials, Guardian-nets, detached groundgear, lionfish trap
	Incremental	-		Brown shrimp sorting grid, Netgrid, combination grid
	No effect or negative	-	-	-
		Low	Moderate	High
Technology readiness level (TRL)				

### Suggestions

ICES considers the present advice a first step into a longer time-frame process, where a more comprehensive review of gear innovations and their impacts could be provided to the EU on a triennial basis. It must be stressed that further work and agreement is still needed on the approach to be used for carrying out such work. This should be part of the future terms of reference of relevant expert groups in ICES and would require the involvement of experts with a broad array of competence.

ICES notes that innovations are always sociotechnical. To assess state-of-the-art gear innovations and manage gear-related fishing transitions, it is important to understand the wider social, political, and economic context in which innovations are

embedded (Haasnoot *et al.*, 2016). Assessing the impacts of gear innovation is thus broader than assessing impacts on catch efficiency, selectivity, and the marine ecosystem. Successful innovation requires uptake by fishers (Eayrs and Pol, 2018) and by the wider society. Uptake, apart from regulatory possibilities, involves socioeconomic considerations, such as financial aspects (investments, cost reduction), user-friendliness, and health and safety. The level of uptake and sociotechnical aspects associated with the innovation should therefore be part of a comprehensive state-of-the-art review, as requested by the European Commission, in the next triennial cycle.

## Basis of the advice

### Methods

To evaluate state-of-the-art innovative gears in EU waters, ICES has created an initial catalogue based on a standard template (ICES, 2020a). While this catalogue does not provide a comprehensive overview of innovative gears of the EU fishing industry, it does, however, provide examples of current technologies and innovations that are relevant to EU fisheries. The catalogue also includes some information of innovative gears from outside EU waters.

Three main criteria of assessment (CA) were used in the evaluation of performance of an innovative fishing gear: (i) catch efficiency, (ii) selective properties of the gear for target and non-target species, and (iii) impacts on marine ecosystems, which includes impacts on the seabed and benthic ecosystem, risk of gear loss, ghost fishing, and marine plastic pollution, as well as impacts on protected, endangered, and threatened species. Where available, indirect or peripheral effects, such as energy consumption, greenhouse gas emission, and marine contamination were also evaluated. These performance evaluations were carried out against baseline gear in current EU regulations. Two additional criteria—complexity and technology readiness level (TRL)—were used to: (i) assess suitability and readiness for adoption of an innovative fishing gear, or (ii) encourage introduction of innovative gears with positive characteristics, or (iii) assess subsequent effort in the reduction in complexity, improvement in usability, and maturing technology or method.

A basic evaluation of each innovative gear was performed based on a simple scoring matrix, to estimate the potential performance gain and the technology complexity for each CA (catch efficiency, selectivity, and the impact on marine ecosystems).

### Defining performance

Depending on the expected performance improvement, compared with the conventional fishing gear, the performance indicator was defined as a four-level scoring system (ICES, 2020a):

1. *Disruptive performance.* The innovation is a novel solution compared to conventional systems and offers potential for significant step-change performance improvement compared to current baselines in Europe. This is usually a newly developed fishing gear or technology that has rarely or never been used in commercial fisheries anywhere in the world.
2. *Transformative performance.* The innovation may provide significant performance improvement compared to conventional systems (baseline). It can be any fishing gear or technology utilized in the given area or in other areas but modified from the regulated operation or commercial practice.
3. *Incremental performance.* The gear may be considered an innovation with only minimal or small performance improvement. Typically, these are existing fishing gears or technologies that are or have been used in other fisheries in the area or in similar fisheries in other areas, which are now introduced into a specific fishery that has never used these gears/technologies before.
4. *No effect or negative performance.* The new fishing gear or technology has few benefits or has negative effects on one or more CAs compared to baselines. These innovations are relatively rare or short-lived as the market/consumer rejects them.

**Table 4** Defining the technology readiness level (TRL).

TRL category	The European Union's TRL 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 ( <i>industrially relevant environment in the case of key enabling technologies*</i> ) TRL 6 – Technology demonstrated in relevant environment ( <i>industrially relevant environment in the case of key enabling technologies*</i> )
High	TRL 7 – System prototype demonstration in operational environment TRL 8 – System complete and qualified TRL 9 – Actual system proven in operational environment ( <i>competitive manufacturing in the case of key enabling technologies*</i> )

\* EU (2011).

The assessment of the TRL was performed by three categories: low, medium, and high (EU, 2015; ICES, 2020a).

### Innovation matrix

Each innovative gear was scored for the performance improvement for all CAs and TRL, compared to the baseline (conventional fishing gear).

### Additional information

The work carried out by ICES should be considered as an initial assessment and requires further development.

### Sources and references

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**Annex**

**Table A1** Short description of the terms of innovative gears. The Ref. column refers to the factsheet number as reported by WKING (ICES, 2020a).

Ref.	Term	Description
6.1.1	FlexSelect	A counter-herding device for demersal trawls to reduce catch of unwanted fish by scaring or directing unwanted fish away from the path of the trawl
6.1.2	Brown shrimp sorting grid	Size-sorting grid to reduce undersized shrimps
6.1.3	Netgrid	Inclined net grid comprised of a four-panel box section inserted into a standard two-panel trawl, into which an inclined net panel of 80 mm netting is laced
6.1.4	SepNep	Combination of an inclined U-shaped tapered net panel, a grid, and double codends to improve selectivity of <i>Nephrops</i> , plaice, dab, and whiting
6.1.5	Combination grid	Combination grid system made of a species-selective upper half grid and a size-selective lower half grid to improve selectivity of <i>Pandalus</i> and <i>Nephrops</i>
6.1.6	Grid and double codend	Grid system with two codends to separate flatfish from roundfish and improve species and size selectivity
6.1.7	Shrimp pulse	Shrimp pulse trawl; the mechanical stimulation to catch shrimp replaced by an electrical stimulus
6.1.8	Flying drone	Flying drone with scientific echosounder to improve individual and school-size selectivity before the net is deployed
6.1.9	PingMe	Acoustic device to locate ghost-fishing nets and equipment, as well as active fishing gear underwater
6.2.1	Controllable doors	Remote controllable trawl doors made from highly efficient aerodynamic designed wings
6.2.2	Floating sweeps	Floating sweeps between the trawl doors and trawl wing ends
6.2.3	Scaring ropes	Fish scaring ropes ahead of a <i>Nephrops</i> trawl's mouth
6.2.4	Electro-razor	Razor clam dredge with a collecting basket, located behind electrodes to improve razor clam selectivity and to reduce impact
6.2.5	Echo-sensor detector	Acoustic sensor installed on a grid to quantify <i>Nephrops</i> catches
6.2.6	Flemish panel	A flatfish beam trawl with a large mesh panel in the rear part of the lower belly
6.3.1	Crustacean BRDs	Three different grid systems experimented in the Portuguese fisheries to improve size and species selectivity of <i>Nephrops</i> and shrimps
6.3.5	Hookpod	Hook pod that keeps a hook's barb covered during deployment to avoid seabird bycatch
6.4.1	Mini Danish seine	Mini Danish seine as an alternative to gillnet to reduce seal bycatch
6.4.2	Pontoon trap	Large trapnet fishery in coastal waters as an alternative to gillnet fisheries for the reduction of seal bycatch
6.4.3	Pearl-nets	Small acrylic glass spheres for standard gillnets to improve the acoustic visibility for small-toothed whales
6.4.4	Nemos + Roofless	Selectivity device to reduce cod bycatch, while maintaining the catch efficiency for flatfish; the device consists of a square net section (four-panel extension) mounted between the belly of the trawl and the codend and an escape window in the top panel
6.4.5	Alternative pots	New pot fishery for cod in areas where traditionally trawl and net fishery is carried out; the aim is to reduce marine mammal bycatch
6.4.6	ADD	Devices added on the gillnet, producing acoustic sound that keep animals away from the gear
6.4.7	Boat seine	Alternative gear to replace gillnet impact on the seal population
6.5.1	Dual codend	Dual codend with the uppermost codend, manufactured with larger meshes; fish and shrimps can pass through cuttings on the uppermost netting panel of the lower codend
6.5.2	Semi-pelagic doors	High efficient hydrodynamic shaped trawl doors with proven higher spreading force in low angle of attack to work off the seabed
6.5.3	Recycled plastic doors	Highly efficient aerodynamic shaped fishing doors made from recycled plastic
6.5.5	High-strength materials	New material for trawl manufacture (Dyneema)
6.5.6	Flex-TED	Turtle-excluding device (TED) to reduce sea turtle bycatch
6.5.7	Guardian-net	Trammelnet provided with "guarding net" to reduce unwanted bycatch
6.5.8	Detached groundgear	Modified groundgear by cutting the rigging between fishing line and footrope in the central part and reduce physical impact
6.5.9	JTED	Juvenile and trash excluder device; sorting grids with different bar spacing to improve target species selectivity
6.5.11	Lionfish trap	Bottom fish trap for long-term immersion and target invasive species (lionfish)

**Table A2** Information collected for the innovative gears: Factsheet template (ICES, 2020a).

Title/Name of the “Innovative gear”			
General information			
Date	[Select a date]	Source supplier name	
Region	Select a Region	FAO Area (Division, L2)	
Gear sub-category	Select a gear sub-category	Gear code	
Baseline gear	<i>Baseline standards are derived from either existing EU Regulations or commonly used unregulated</i>	Baseline Regulation	e.g. EC Reg. 1967/2006
Target species	<a href="#">Use FAO 3-alpha code</a>	Bycatch species	Incremental / Transformative / Disruptive
Definition of the Innovative gear	<i>Define the innovative gear / Innovation</i>	Technological complexity level	Minimal / Medium / Significant
		Technology readiness level	Low / Moderate / High
Main criteria	<i>List the main criteria affected (e.g. selectivity, catch, impact)</i>	Additional criteria	<i>List the additional criteria affected (e.g. pollution, GHG emission, energy saving)</i>
Technical specificities	<i>Compare the technical specificities between the baseline gear and the Innovative gear</i>		
Outcomes expected	<i>Outlines the main outcomes expected and/or tested</i>		
Drawing / picture of the Innovative gear / Solution			
Relevant information / Reference			