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Exploring alternatives to Europe's bottom trawl fishing gears

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Photo mosaic of bottom trawlers and their impact.

Contents

Executive Summary

The effects of bottom trawling are wide-spread in the European Union (EU), seriously affecting the seabed, its associated ecosystems, and its carbon-storing capacity, as well as fuelling the overexploitation of fish stocks. Phasing out bottom trawling might at first seem unimaginable given it lands 7.3 million tonnes of marine life, which represent 32% of the EU's total landings and a great variety of species. There exist, however, alternative gears to partly replace bottom trawling. These alternative gears each have their own associated impacts that need to be considered, especially with regard to bycatch of sensitive species. In order to match bottom trawling's current landings, these alternative gears would need to be scaled up.

To avoid scaling up their associated environmental impacts, a reduction of fishing effort should be considered. The species most landed by bottom trawlers are sandeel and cod, both overfished stocks that could benefit from reduced fishing effort. Sandeel and other species landed in high quantities by bottom trawlers are used for fish feed in aquaculture; reducing fishing efforts as a result of the transition to alternative gears would therefore not necessarily have consequences for current human food supply. It would, however, be of great benefit to the environment and associated dependent coastal communities. In the transition away from bottom trawling, the socio-economic wellbeing of the people employed by the trawl fleet needs to be ensured by designing and implementing effective just transition programmes.

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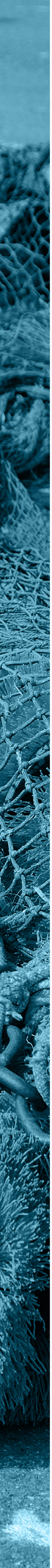

Introduction

Bottom trawlers destroy habitats by incidentally killing bottom-living organism and by causing physical disturbance to bottom sediments, thereby ruining seafloor integrity. They also hinders the capacity of the ocean to mitigate climate change by altering or triggering geochemical processes such as the release of nutrients and chemical substances, including blue carbon stored in coastal areas, thereby affecting the functioning of the entire ecosystem (Olsgard et al. 2008; van de Velde et al. 2018; Luisetti et al. 2019). If these ecosystems are degraded or lost, they may release part of their carbon back into the atmosphere (Hilmi et al. 2021, Epstein et al. 2022, Sala et al. 2021). The recovery time for seabed communities affected after a single pass of a beam trawl has been estimated at between 7.5 and 15 years (Pedersen et al. 2009). Bottom-trawling vessels also emit three times more CO_2 than non-trawlers, resulting in one of the highest carbon footprints for seafood – and indeed for any protein source – thereby contributing directly to climate change (Clark and Tilman 2017). Switching to alternative gears and practices to avoid bottom trawling presents an opportunity to conserve fisheries resources and protect marine ecosystems and the climate; these are central to the European Union's Biodiversity Strategy for 2030 (European Commission 2020) but also to the European Green Deal's objectives to make Europe climate-neutral and protect our natural habitat in order to deliver the wellbeing of people. In this report, we quantitatively describe the impacts of bottom trawling and potential alternatives that exist in the EU.

We used the EU's Scientific, Technical and Economic Committee for Fisheries (STECF) 2015–2019 catch-composition dataset (STECF 2020) to describe bottom trawling in the EU and identify potential alternatives to bottom trawling, if it were phased out. It is important to note that given the methods (see end of document) used to identify potential alternatives to bottom trawling, the alternative gears identified imitate the catch composition of bottom-trawling gears. Such alternatives are not necessarily the lowest environmental impact gears (which usually are hand line, pots and traps, creels), but instead non-trawl gears that can catch species similar to trawls; they therefore might have some negative environmental impacts, such as bycatch (purse seines, gillnets, longlines) (Zhou et al. 2010).

Herein we use "bottom trawling" to refer to all mobile bottom-contact towed gears, including beam trawl, bottom otter trawl, bottom pair trawl, otter twin trawl, boat dredges, and mechanised dredges, all of which involve beam trawling, demersal trawling and/or seining, and dredging techniques.

Why should bottom-trawling be phased out in the EU?

The effects of bottom trawling are wide-spread

There is a wide range of scientific literature and evidence showing the major and degrading effects bottom trawling has on the seabed. These have demonstrated that bottom trawling endangers valuable and sensitive habitats across the EU and beyond. In the EU, however, where bottom habitats are in especially poor condition (Eigaard et al. 2017), bottom trawling serves as one of the main fishing techniques, accounting for 32% (7.3 million tonnes) of total landings (Figure 1). This makes European waters the most trawled in the world, with more than 50% of its surface regularly impacted, compared to a global average of 14% (see Fig. 2 from Amoroso et al. 2018). The analysis also shows, however, that about 25 other fishing gears are used in Europe, with some categories – such as pelagic trawls (38.9%), purse seines (15.8%), or all other passive gears combined (11.4%) – making important contributions to total landing volume.

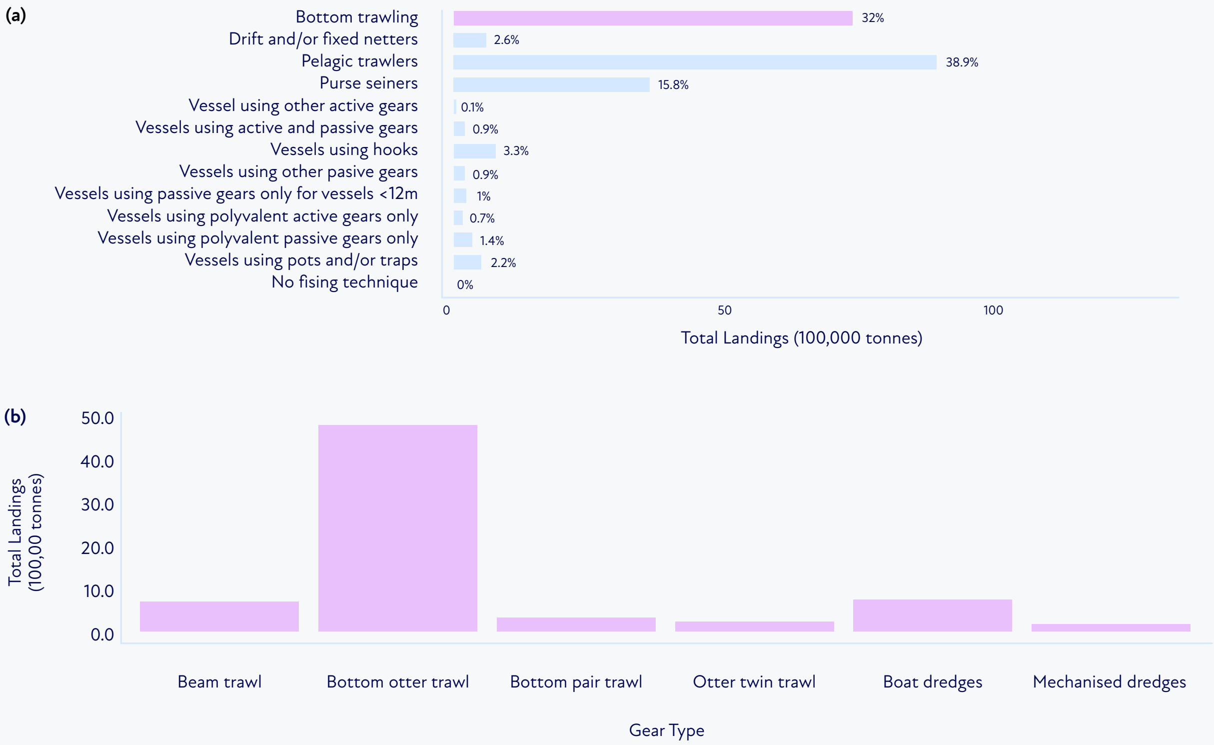

Figure 1. Total landings of bottom-trawling gears (combined; pink bar) compared to all other fishing techniques in the EU (a) and by gear type (b). Percentages in panel (a) represent the respective fishing technique's proportion of total landings in the EU.

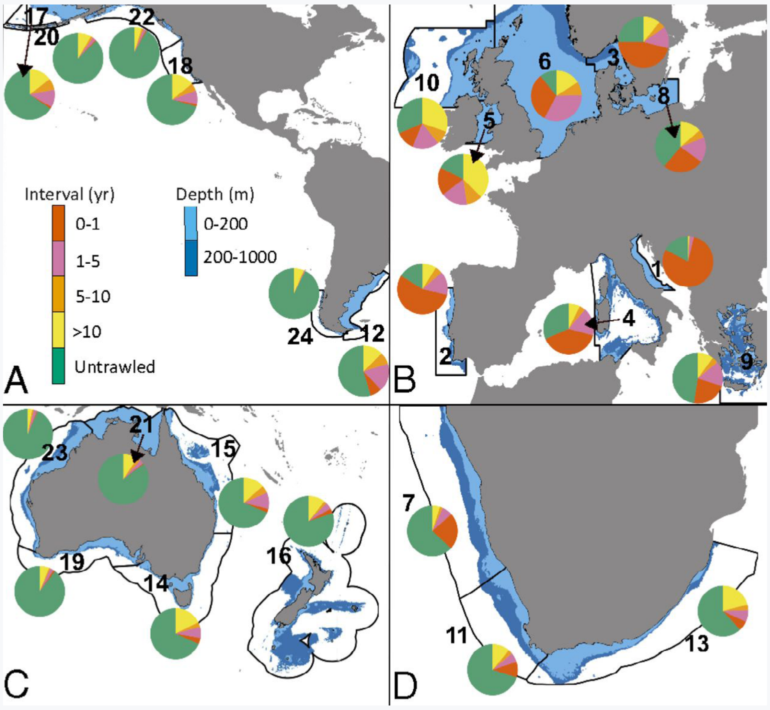

Figure 2. Europe has the highest trawling intensity overall when compared to other world regions. The Adriatic Sea has the highest trawling intensity in the world. (Amoroso et al. 2018).

Bottom trawling is not essential

Sandeels represent the species most landed by bottom trawling, contributing 10.7% of total bottom-trawling landings, followed by Atlantic cod (6.66%). Sandeel is an exceptionally oily fish harvested for the fish-oil and fish-meal industries for aquaculture or pet food. Many marine animals such as seabirds, cetaceans, or seals feed on sandeels, as do commercially important fish stocks such as cod or haddock. Overexploitation of sandeel is associated with significant negative environmental impacts. These include benthic disturbance, bycatch, and potential food-web restructuring, particularly impacting species of commercial interest such as cod and haddock. These important environmental impacts have been recognised, for example, by the Scottish government, which prohibited this fishery after realising sandeel overfishing was causing a decline in other fish stocks, marine life, and birdlife that depended on them (McBride 2021).

Like sandeel, sprat and blue whiting are fish species used mainly for non-human consumption (EUMOFA 2019), and they represent 3.1% and 2.2% of bottom-trawling landings respectively, being the 7th and 14th most fished species (in tonnes) among the more than 1,411 species landed by bottom trawling (Table 1). Denmark is by far the largest producer of fish oil, accounting for almost 50% of the EU total, followed by Spain, which accounts for 20%. While Spanish production is based on waste/trimmings from the processing industry, Danish production is mainly based on landings of small pelagic fish such as sprat, blue whiting, and sandeel (EUMOFA 2019).

Sandeel and Atlantic cod are also both overfished stocks in EU waters, and the likely reduction of fishing pressure that would result from phasing out bottom trawling might allow these stocks to recover.

Bottom-trawling landings of blue mussels and tangle (also called *Laminaria hyperborea*, a species of kelp that forms dense underwater forests) are also significantly represented: 3.8% and 2.2%, respectively. Mussel beds and kelp forests are key marine "ecosystem engineers" providing complex habitats suitable for other organisms. Moreover, kelp forests, which are blue-carbon habitats, are also crucial in the current climate crisis, as they represent an important carbon sink (Pessarrodona et al. 2018, Filbee-Dexter 2020). Restricting bottom trawling for wild mussels and kelp would have great environmental benefits without affecting seafood supply or human diets. Mussel aquaculture should in fact be prioritised over wild harvesting, and alternative technology such as rope/net seed collectors could be used for mussel-seed collection for aquaculture (Kamermans & Capelle 2018).

	Common Name	Tonnes	% Total Landings
1	Sandeels (Sandlances) nei	7.652.659.597	10.72
2	Atlantic cod	4.756.055.568	6.66
3	European plaice	3.293.325.887	4.61
4	Argentine hake	305.813.061	4.28
5	Great Atlantic scallop	2.744.104.073	3.84
6	Blue mussel	2.712.985.368	3.80
7	European sprat	2.195.798.921	3.08
8	Saithe (Pollock)	2.136.735.438	2.99
9	Whiting	2.078.232.693	2.91
10	Norway lobster	2.049.658.855	2.87
11	Haddock	1.886.255.811	2.64
12	European hake	1.845.553.233	2.58
13	Common shrimp	1.686.533.628	2.36
14	Blue whiting (Poutassou)	1.553.088.957	2.18
15	Tangle *(Laminaria digitata)*	154.222.223	2.16
16	Atlantic mackerel	1.264.249.351	1.77
17	Anglerfishes nei	1.150.376.877	1.61
18	Atlantic horse mackerel	105.173.614	1.47
19	Monkfishes nei	91899.03	1.29
20	Atlantic redfishes nei	865.273.096	1.21
21	Common sole	8.549.890.096	1.20
22	Striped venus	8.336.961.924	1.17
23	Musky octopus	7.588.210.377	01.06
24	Deep-water rose shrimp	7.518.140.932	01.05
25	Greenland halibut	714.125.907	1.00
26	Common cuttlefish	6.947.624.732	0.97
27	Megrims nei	6.847.366.192	0.96
28	Common cockle	677.483.917	0.95
29	European flounder	6.386.375.533	0.89
30	Red mullet	605.193.557	0.85

Table 1: Top 30 of the 1,411 species landed by bottom trawlers ranked by live weight (tonnes).

Bottom-trawling contributes to the overexploitation of fish populations

Bottom trawls not only damage benthic habitats, they also contribute to the overexploitation of target and non-target species (bycatch) (Hiddink et al. 2019). Due to their unselective nature, bottom-trawling gears are responsible for almost all reported discards in the EU (1 million tonnes, or 93.2% of total EU discards) (Figure 3a). This high discard level is not only an environmental problem; it also presents challenges in implementing the landing obligation. Bottom trawlers are more likely to face the problem of "choke" species, where the quota for a particular species is exhausted before the quotas of the other species that are caught with it.

Among the various bottom-trawling gears, bottom otter trawlers and beam trawlers have the highest discard levels (500,000 tonnes and 450,000 tonnes respectively, Figure 3). It is important to note that this bycatch may be underestimated due to limitations in the data used (many unknown or confidential records for discards, depending on vessel segment or Member State reporting).

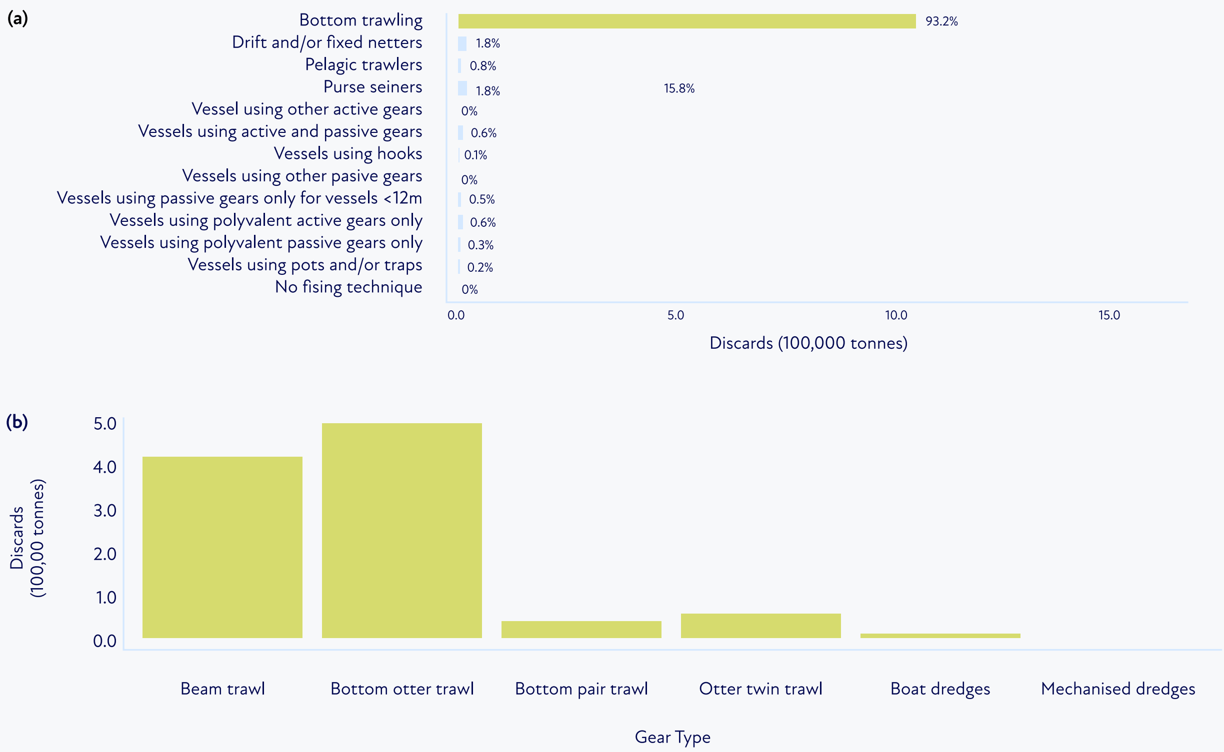

Figure 3. Discards by bottom-trawling gears (combined; green bar) compared to all other fishing techniques in the EU (a) and by gear type (b). Percentages in panel (a) represent the respective fishing technique's proportion of total discards in the EU.

Transition to low-impact fisheries in the EU: Are there alternative gears to bottom trawling?

Fishing is the biggest threat to marine biodiversity (IPBES 2019), causing bycatch of sensitive species, damaging the seafloor and its carbon-storage capacity, and overexploiting fish populations. Given the current climate and biodiversity crises as well as current political commitments, a transition to low-impact fisheries is imperative. As identified above, bottom trawling has serious, wide-spread negative impacts on the environment in the EU. Switching to alternative gears and practices that target the same species as bottom trawling therefore presents a key opportunity to fish better, thus conserving fisheries resources, protecting marine ecosystems, and halting biodiversity loss while combatting climate breakdown. This report has identified potential alternatives to each of the bottom-trawling gears and compared them to their respective bottom-trawling gear using metrics such as landings, species composition, or discards. The usefulness of a given alternative gear depends on the metric being compared (e.g., total landings versus discards). Some identified alternative gears may not have landings close to bottom-trawling gears in terms of biomass; they will, however, have reduced bycatch impacts.

To identify the most viable alternative gears in terms of catch composition, the five most abundant species landed by each bottom-trawling gear were compared with the five most abundant species landed in each of the other gear types currently used in the EU (see Methods, below). The alternatives presented here have the most matching species and could therefore potentially replace bottom trawling. This does not mean that the alternatives presented are low-impact gears; some have associated environmental problems, especially in terms of bycatch of sensitive species. Phasing out bottom trawling would therefore require a more sophisticated approach that accounts for site-specific (potential) environmental impacts of alternative gears and weighs these against the utility of each alternative gear (how, when, and where the gear does not have bycatch of sensitive species).



Several alternative fishing gears exist to replace bottom trawling

Alternative gears have been identified that could replace bottom trawling. Given the high landings associated with bottom-trawling gears, most of the alternative gears do not equal their respective bottom-trawling gear in total landings with the currently deployed effort. Exceptions are the alternatives to otter twin trawlers (set gillnets) and mechanised dredgers (pots and traps and trammel nets), which surpass the landings of their respective bottom-trawling gear. Other alternative gears perform reasonably well; purse seines for otter trawl, and pots and traps for boat dredge, for example, have a 78% and 77% match in landings, respectively (Figure 4).

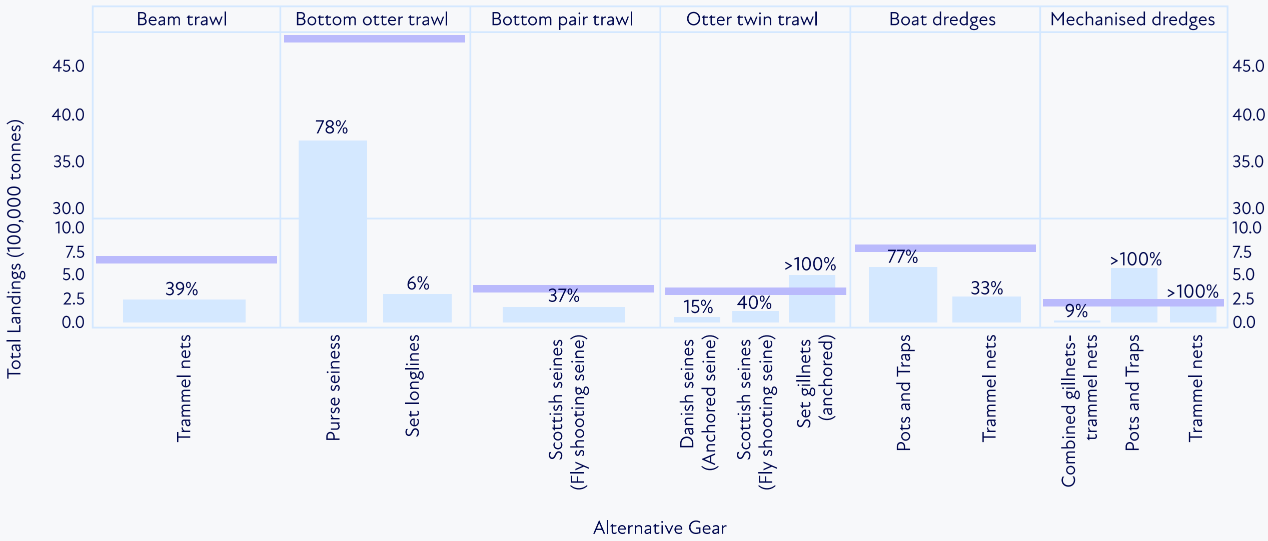

Figure 4. Total landings of alternative gear(s) (light blue) compared to landings of the respective bottom-trawling gear (purple line). Percentages represent the proportion of landings that each alternative gear can land compared to the respective bottom-trawl gear type. If the light blue bar is below the purple line, this means the alternative gear does not match its respective bottom-trawling gear in total landings. For example, purse seine vessels can land 78% of the total landings of bottom otter trawls.

Likewise, alternative gears could land many of the species landed by bottom trawlers. Most alternative gears land >50% of the species landed by their respective bottom-trawling gear, with some relatively robust alternatives, such as trammel nets for beam trawls (88%); set gillnets for otter twin trawls (88%); or pots and traps and trammel nets for dredges (between 86% and 95%). Considering bottom trawling targets so many species due to its unselective nature, no alternative lands all the different species landed by their respective bottom-trawling gear (Figure 5). This means some of the species that are landed in each bottom-trawling gear would not be landed by its alternative(s). In some cases, this might affect the value of landings, depending on the species.

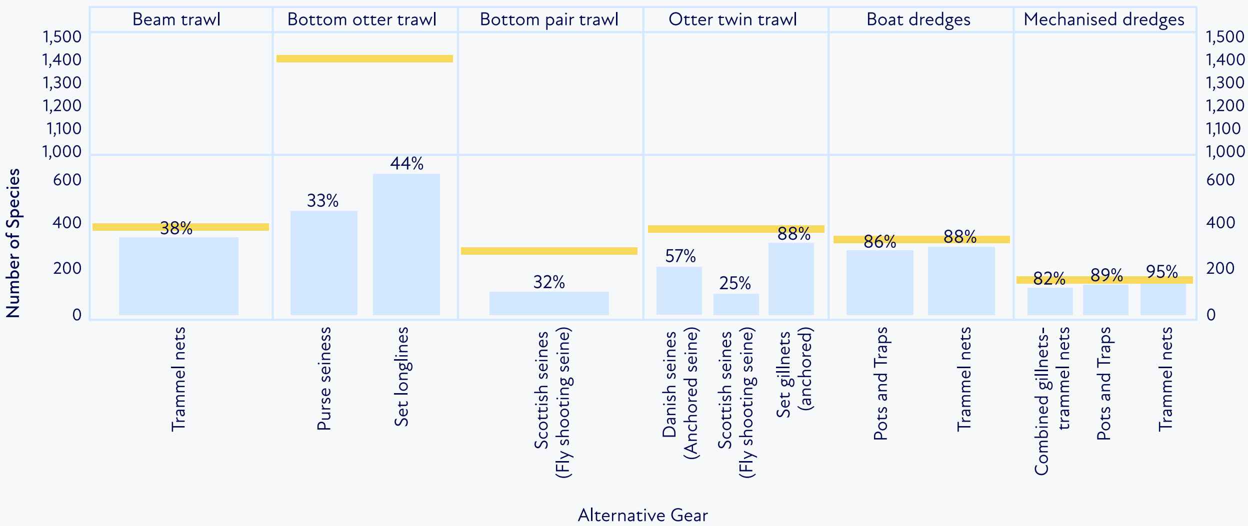

Figure 5. Number of unique species landed by alternative gear(s) (light blue bar) compared to the number of different species landed by the respective trawling gear (yellow line). If the light blue bar is below the yellow line, this means the alternative gear does not match its respective bottom-trawling gear in species landed. Percentages represent the proportion of species each alternative gear landed that match those caught by the respective bottom-trawling gear type. For example, set longline vessels landed 44% of the species landed by bottom otter trawls.

Selectivity of alternative gears

In terms of non-target species overexploitation, most alternative gears have considerably fewer discards than their respective bottom-trawling gear, except for the alternatives to dredgers (Figure 6).

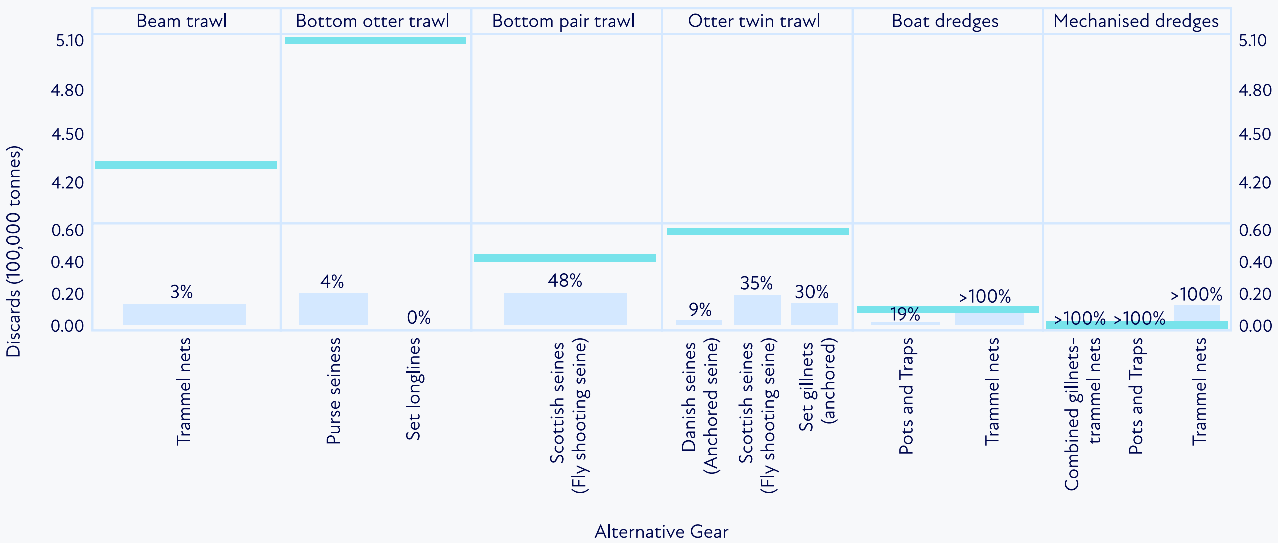

Figure 6. Total discards of alternative gear(s) (light blue bar) compared to landings of the respective bottom-trawling gear (turquoise line). Percentages represent the proportion of discards each alternative gear landed compared to the respective bottom-trawl gear type. If the light blue bar is below the turquoise line, this means the alternative gear does not match its respective bottom-trawling gear in discards (tonnes). For example, purse seine vessels discarded 4% of the total discards of bottom otter trawls.

Conclusion

Currently, bottom trawling is a very popular fishing technique in Europe (and globally) because of its large catches. This comes at a high environmental cost in terms of ecosystem damage, however: it contributes to the overexploitation of EU fish stocks through high bycatch and discards rates; puts pressure on EU seabed integrity and its associated benthic ecosystems; and significantly jeopardises attempts to mitigate the climate crisis, both directly, as the most fuel-intensive fishing method, and by contributing to the release of vast amounts of carbon stored in marine sediments. Bottom trawlers, whose profits are to some extent built on being allowed to cause such environmental damage, don't take these external costs into account, instead passing them along to society.

Because bottom trawling is so prevalent in Europe, accounting for 32% of the total landings of fish and other marine life, reducing it with a view to gradually phasing it out entirely is a real challenge. The destructive nature of this fishery can no longer be ignored: a large number of scientists and the European Environment Agency have given us clear warnings about the accelerating crisis in European seas. This report has therefore identified existing alternative fishing gears that could replace bottom trawling in the EU, both in terms of volume and catch composition. At present, however, these alternative gears would not be able to equal current bottom-trawl landings without scaling them up and designing a mix of alternatives most suitable for the region where the fishing takes place.

Potential alternative gears can also have their own associated environmental problems, especially in terms of bycatch of sensitive species. When planning a reduction of bottom-trawling activity and making the transition to low-impact, low-carbon fisheries, careful spatial and temporal planning of the use of alternative gears must be undertaken to avoid environmental consequences caused by the transfer of gear types.

To avoid scaling up alternative gears to the point where they would cause significant additional environmental problems, an overall reduction in the amount of fishing should be considered. Such a reduction will have only a limited impact on human diets, as many of the main species landed by bottom trawlers – namely sandeels, sprat, and blue whiting – are primarily used to produce fish oil and meal for aquaculture and are not for direct human consumption. Feeding wild fish to raise farmed fish is in general an unsustainable practice, as the environmental impact from aquaculture has to be added to the environmental impact stemming from fishing for fish oil and meal. Furthermore, finfish aquaculture requires bigger amounts of feed (input) than it produces farmed fish for human consumption (output). Ecologically responsible alternatives to fishmeal and fish oil-based diets, i.e. plant-based feed exist, hence, stopping bottom trawling for aquaculture feed production is a plausible option with little consequences for human diets. In addition, several other species, such as Atlantic cod, are severely overfished in Europe and could benefit from a reduction in fishing pressure. Reduction of bottom-trawling catches of these species – attainable without major consequences in terms of seafood supply – would be of huge benefit to the marine environment, fish populations, and the climate.

Transitioning to sustainable fishing meets important policy objectives, but, much more importantly, it is urgently needed if we are to halt ocean degradation and enhance its resilience to climate change. This means developing the political will to tackle bottom trawling and phase out all destructive fishing in Europe sooner rather than later.

The EU Green Deal is perhaps the biggest political opportunity to align policies with societal demands, and initiate this much-needed transition for European fisheries. Existing policies and tools already allow for action, such as the allocation of quota to small-scale, low-impact fishers by better implementation of Article 17 of the Common Fisheries Policy; using the European Maritime Fisheries and Aquaculture Fund (EMFAF) to test solutions and support the switch to less impactful fishing gears; and by ending harmful fuel subsidies (e.g., in the review of the Energy Taxation Directive) that contribute to skewed competition/market forces by providing substantial support to fuel-intensive bottom-trawling fisheries and leaving passive fisheries at a relative disadvantage. Proper implementation of environmental legislations such as the Habitats Directive or the Marine Strategy Framework Directive should, for instance, inevitably restrict bottom trawling inside marine protected areas or sensitive habitats. EU Policy makers are at a turning point: they need to embrace an ambitious vision for 2030. The European Commission in particular has a responsibility to set this vision, and, in conjunction with the report on the functioning of the CFP, the upcoming EU Action Plan to conserve fisheries resources and protect marine ecosystems is especially important to achieving this ambition. Transitioning away from bottom trawling also means embarking on a dialogue with fishers to minimise socio-economic costs and design appropriate and just transition programmes that ensure the support and wellbeing of coastal communities in the short-term.

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Methods

To identify alternative gears for each bottom-trawling gear type we identified the top five most abundant species landed and compared these species to the top five most abundant species landed by each other gear type in the EU. Those gear types with the highest number of matches in terms of most abundant species landed were used to identify alternative gears to each of the respective trawling-gear types. A given trawling gear could have multiple alternatives if multiple gears shared the same number of matches (the maximum is five).

Since the most abundant species landed by dredging gears are rarely caught in other gear types, we found no species-landed matches between specific dredging gears and any other gear types not in contact with the seafloor. We therefore relied on the target assemblages instead of species to identify alternatives for each dredger type. Like the methods used in the species context, gear types with the highest number of matches in the most abundant target assemblages landed were identified as an alternative gear to the respective dredging-gear type. A given dredging gear could have multiple alternatives if multiple gears shared the same maximum number of matches (maximum is three for boat dredges and one for mechanised dredges).

Several metrics can be used to describe the impacts of bottom-trawling gears and compare their impacts with their respective alternative(s): total landings (tonnes), catch diversity (number of different species), and bycatch (discards in tonnes). We used fishing techniques to compare bottom trawling (combined) with all other fishing techniques in the EU and we used gear types to compare metrics between each bottom-trawling gear and their respective alternatives. To avoid interannual variability, values for each metric represent cumulative values from 2015–2019 for a given fishing technique and gear type.

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