Bottom trawling & the climate crisis

Research **briefing 01**
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Transform Bottom Trawling Coalition

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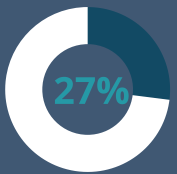
BOTTOM TRAWLING AND THE CLIMATE CRISIS

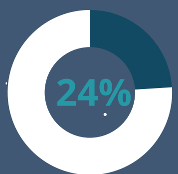
The ocean is **critically important** in the fight against **climate breakdown**



% OF ALL CARBON EMITTED EACH YEAR CAPTURED BY THE OCEAN[i]

Bottom trawlers land...

19M TONNES OF SEAFOOD EACH YEAR[ii]



A QUARTER OF ALL MARINE LANDINGS [ii]

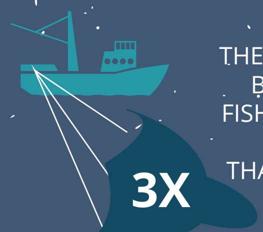
Emissions from **food** and **fisheries** are one of the biggest drivers of the **climate crisis**

FOOD CAUSES UP TO 40% OF GLOBAL EMISSIONS[iii]

FISHING VESSELS RELEASE 159M TONNES OF CO_2 EACH YEAR[iv]

This is **equivalent to CO2** from...

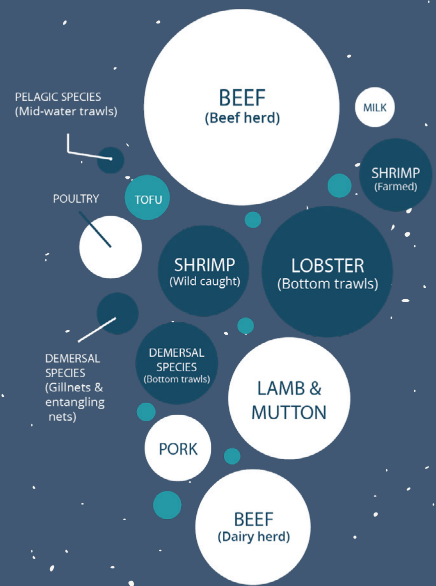
... 40 coal-fired power stations[v]



THE FOOTPRINT OF BOTTOM-TRAWL FISHERIES IS THREE TIMES HIGHER THAN NON-TRAWL FISHERIES[vi]

The **carbon footprint** of bottom trawled seafood is among the **highest of all foods**

FOOTPRINT OF **ANIMAL**, **SEAFOOD** AND **PLANT-BASED** FOODS[vii]



Bottom trawling disturbs **the world's largest carbon stores**

1bn

TONNES OF CO_2 RELEASED FROM THE SEABED EACH YEAR BY TRAWL NETS[viii]

54

TONNES OF CO_2 RELEASED EACH YEAR PER TONNE OF SEAFOOD LANDED

Bottom trawling can **reduce its contribution** to the climate crisis in **six key ways**

1. Rebuilding fish stocks and reforming management
2. Prioritising lower-fuel fishing gears over bottom trawls
3. Strengthening inshore exclusion zones for small-scale fishers
4. Transitioning to low-emission technologies amd reforming subsidies
5. limiting bottom trawling in marine protected areas
6. Freezing expansion into untrawled habitats

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i) IPCC 2018. ii) Amoroso et al 2018. iii) Crippa et al 2021. iv) Greer et al 2019. v) EPA greenhouse gas equivalencies calculator. vi) Clark & Tilman 2017. vii) Gephart 2021, Poore & Nemecek 2018, Clune et al 2017. viii) Sala et al 2021

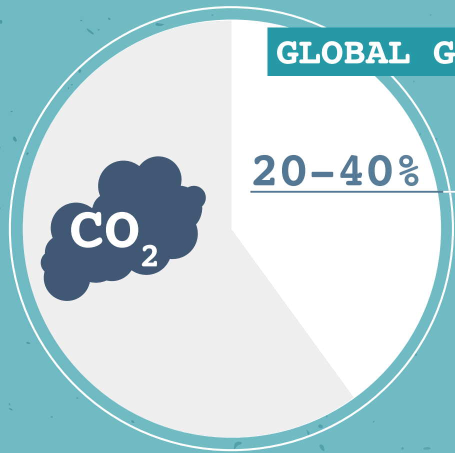
Bottom trawling is a controversial but globally dominant fishing practice that involves dragging weighted nets along the seafloor to catch seafood. It has long attracted attention and debate for its impacts on non-target species and seafloor habitats, and is thought to be the most widespread cause of human disturbance to these habitats. In recent years, concerns have also been raised about bottom trawling's potential contributions to the climate crisis. This briefing summarises this emerging field of research, outlining the known major impacts from bottom trawling on greenhouse gas emissions and identifying key mitigation opportunities.

***Throughout, Co_2 refers to CO2-equivalent greenhouse gases**

The global food system is one of the biggest drivers of the climate crisis

Greenhouse gas emissions from food production, which includes fisheries, are a major contributor to climate change. Recent work has estimated that 20-40% of global emissions come from food, approximately 16 billion tonnes annually[1,2,3].

Reducing the size of this carbon "foodprint" is critical to meeting global emissions targets and to keeping global warming within manageable limits[4,5]. While all foods generate some emissions, seafood provides protein and nutrients for billions of people at a relatively low environmental cost[5,6]. As such, it has a critical role to play in achieving key Sustainable Development Goals to end hunger (goal 2), ensure sustainable consumption and production (goal 12), combat climate change (goal 13) and conserve and sustainably use marine resources (goal 14).



GLOBAL GREENHOUSE GAS EMISSIONS[2]

20–40% IS FROM FOOD PRODUCTION:

16 BILLION TONNES OF CO_2 ANNUALLY

Wild-capture marine fisheries are a substantial contributor to global food production and currently account for 14% of dietary animal protein intake and 4% of food system emissions[7,8,9]. There is consensus that greenhouse gas emissions in the sector are largely attributable to fuel use by vessels[4,6,10,11,12,13,14,15] though emerging research on carbon release from seabed disturbance by bottom trawls is shining light on an additional contribution of trawling to the climate crisis[16].

Much of the world's seafood is landed by bottom trawlers, but the practice is not without controversy

Bottom trawling is one of the most common industrial methods for catching fish but also among the most contentious[17]. Bottom trawlers, vessels that drag weighted nets over the seabed, land around 19 million tons of seafood annually, a quarter of wild-capture production[18]. In some parts of the world, including the UK, over half of all seafood landed is caught in this way[19].

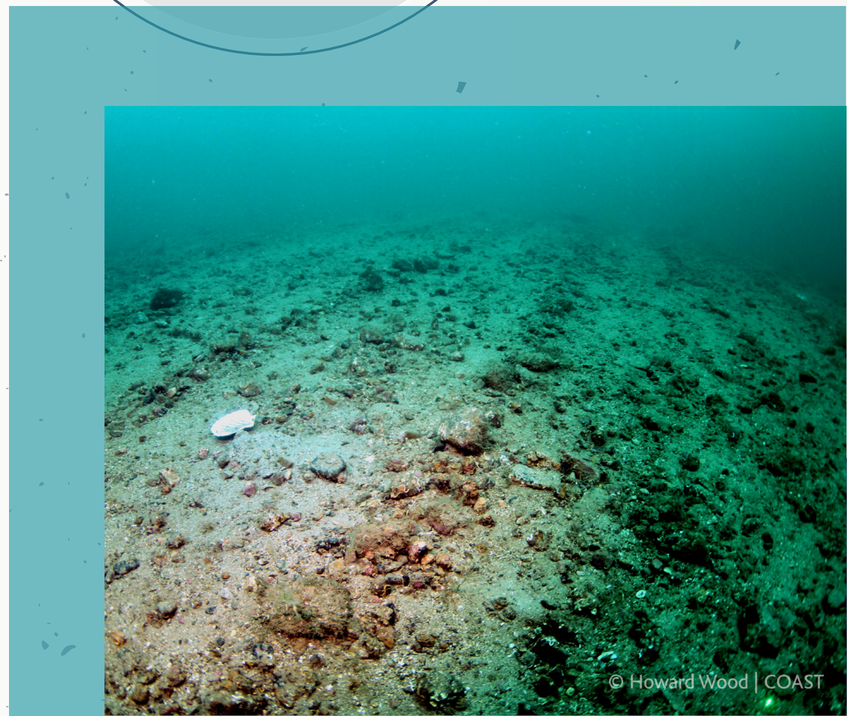
Bottom trawling can have a wide array of potentially negative environmental and socio-economic impacts. Historically, much of the research attention has centred on both the damage that can be done to seabed habitats by heavy trawl nets, and on the large quantities of bycatch: marine life that trawlers don't target, but which is caught accidentally and discarded overboard.

Over the past 65 years alone, bottom trawlers have discarded overboard more than 400 million tonnes of bycatch[20]. Had this catch been landed, it would have been worth around US$560 billion[19]. Gear modifications have reduced bycatch substantially in recent years, but in some shrimp trawl fisheries, levels may be as high as 80-90%[21,22,23].

The most widespread source of human-induced physical disturbance to global seabed habitats, bottom trawling can reduce habitat complexity and the biomass, diversity and abundance of seafloor fauna, with negative consequences for community composition, structure and function[24,25,26,27].

The extent of habitat damage and the speed of recovery varies depending on habitat type, gear used and the intensity and frequency of trawling[23,28]. It takes up to six and a half years for seabed biota to recover following trawling, but sensitive habitats and species may take far longer[23,29].

19 MILLION TONNES OF SEAFOOD ANNUALLY



BOTTOM TRAWLING: The most widespread source of human-induced physical disturbance to global seabed habitats. Photo credit: © Howard Wood/COAST.

Bottom trawling is attracting increasing attention due to its impact on greenhouse gas emissions

Whilst bottom trawling's potentially significant and unwanted effects on seafloor habitats and non-target marine species are well established, its role in the climate crisis is an emerging area of interest[4,10,16,30]. So far, most climate research has focused on how fisheries will be affected by climate change, rather than on how they contribute to it[31], but it's becoming clear that bottom trawling can impact the climate crisis in two major ways: firstly through the burning of fossil fuels to catch, transport and process seafood[6,8,10-14], and secondly through gear contact with carbon-rich seabed habitats[16,30].

Bottom trawling uses more fuel than other major fishing practices

As with other forms of food production, fisheries are reliant on burning fossil fuels. Fuel combustion generates atmospheric CO_2 and drives climate breakdown. Fuel use occurs throughout the supply chain from vessel construction, gear manufacture and bait acquisition through to the capture, storage, transport, processing and preparation of the catch[6,8,12-14]. In general, the fuel needed to move the vessel, deploy gears and refrigerate the catch is the primary driver of energy demand, accounting for between 60 and 90% of emissions[32]. Post-landing activities, particularly transportation of fishery products by air, can also contribute substantially[12,33].

Total annual CO_2 emissions from fuel burnt by industrial vessels may be as high as 159 million tonnes[31] (but see[14]). This is equivalent to the amount of CO_2 emitted by 40 coal-fired power plants in one year and represents a four-fold increase over 1950 estimates[31].

Although industrial fisheries benefit from government fuel subsidies worth an estimated US$7.7 billion dollars a year[34], energy costs remain the sector's largest overhead[35]. Subsidies have enabled fleets to travel large distances from port to reach remote fishing grounds and often shore up otherwise unprofitable fisheries, particularly deep sea bottom trawling[36,37]. Many industrial vessels also have fossil-fuel driven coolant systems.

Leakage from such systems can also produce significant amounts of emissions because the warming potential of some compounds found in refrigerant gases can be 13,000 times higher than equivalent amounts of CO_2[35,38].

Of the major fishing gear types, bottom trawling has the highest emissions from fuel use, largely because the process of dragging a heavy net across the seafloor is hugely energy intensive[4,8,10-12,14]. Bottom trawl fisheries that target shrimps and lobsters are among the least energy efficient in the world, with reported fuel-use intensity values of up to 17,000 L t-1, 24 times higher than the global average for all fisheries[13]. Flatfish bottom trawls are also very fuel intensive, around four times the global average[13].

The carbon footprint of bottom trawled seafood is among the highest of all foodstuffs

Dietary choices can have a profound impact on personal carbon footprints and on emissions from the global food system[4,11,14]. There are large differences between foods, with the footprint of the most climate friendly foods 100-200 times smaller than those of the most climate unfriendly[12,39]. Seafood is widely considered to be a low-emissions dietary choice, requiring 3-6 kilograms of greenhouse gases (CO_2-equivalents) to produce 1kg of edible product[11,12,39]. This is 10-20 times lower than some estimates for beef and lamb, and roughly equivalent to the footprint of poultry[11,12,14,39].

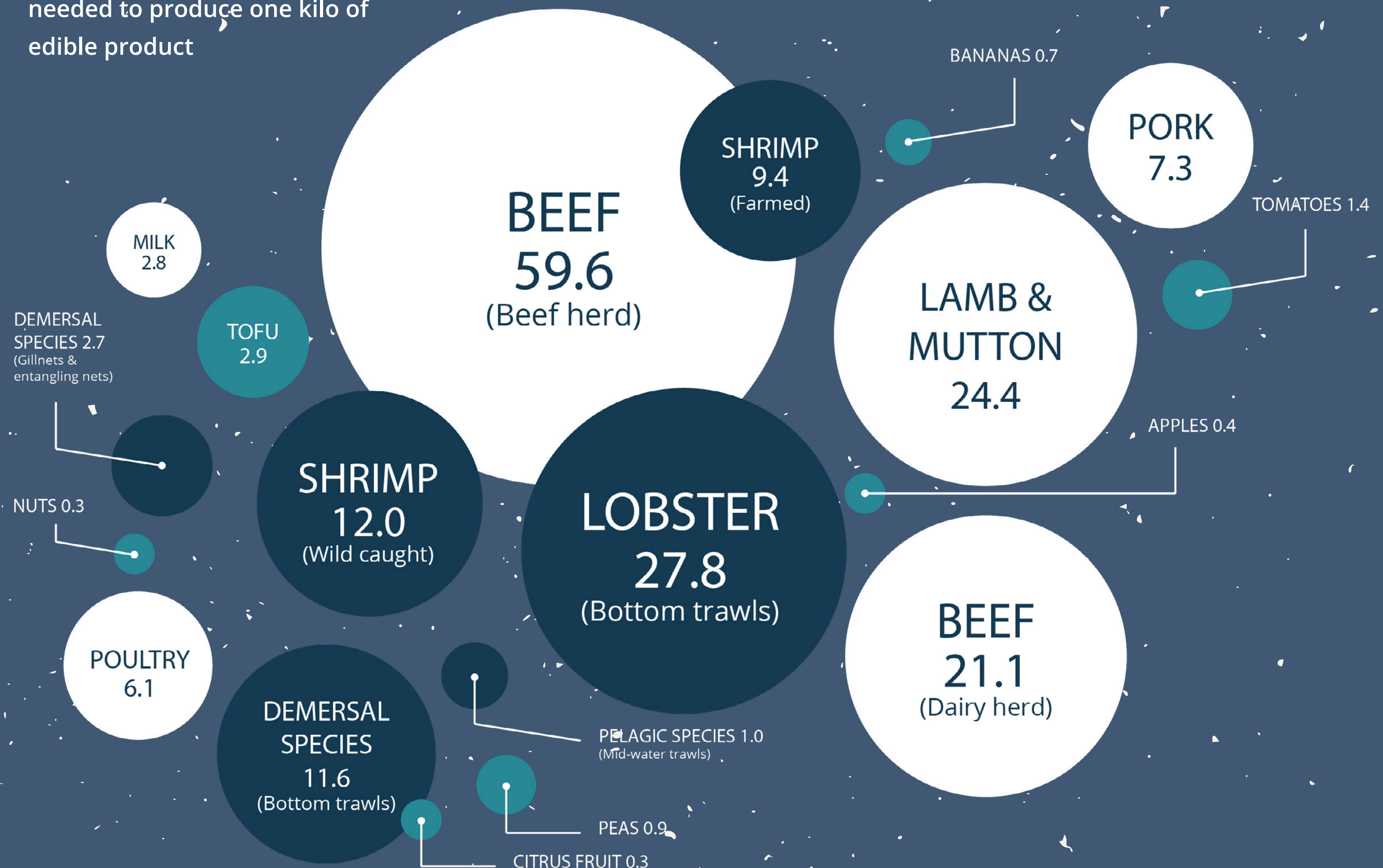
However, the carbon footprint of seafood can vary considerably, depending on the species targeted and how it is caught. Small pelagic species that form dense schools (e.g. sardines, herring) have a carbon footprint that is comparable to or lower than many vegetable sources of protein, and as such could play a role in reducing food-related emissions[4,6,14]. At the other end of the spectrum, certain species that are caught by bottom trawling (including flatfish, shrimp and lobster) may have some of the highest footprints of any protein source, largely due to the fuel requirements of dragging a heavy net across the seafloor (Figure 1).

The overall carbon footprint of bottom-trawl fisheries is estimated to be 2.8 times higher than non-trawl fisheries[10] (but see[6]). Demersal species caught by bottom trawls may create more than four times the emissions of those caught by gillnets and entangling nets[4]. Within these fisheries, the footprints of crustaceans (shrimp and lobster) and non-schooling flatfish are substantially larger than those from schooling species (mackerel, cod and cod-like species)[10], and above those from most other sources of animal protein, except for lamb and beef (Figure 1).

However, it may not seem fair to compare the footprints of seafood and livestock. For most food, a majority – 80% – of greenhouse gas emissions results from land use change and processes at the farm stage[39]. Fishing is essentially hunting – fishers do not rear fish, feed them, or convert habitat for them. Yet despite this, bottom trawled seafood still ranks among the most carbon intensive forms of food production (Figure 1). In addition, emerging research has estimated that for every tonne of bottom trawled seafood landed, around 54 tonnes of CO_2 are released from the seabed by trawl nets[16]. Were this "land" use change to be included in footprint calculations, emissions from the production of bottom trawled seafood would likely exceed those from all other protein sources.

THE CARBON FOOTPRINT OF ANIMAL, SEAFOOD AND PLANT-BASED FOODS

Figure 1. Kilos of CO_2 equivalent needed to produce one kilo of edible product



Sources. Animal and plant-based foods from Poore & Nemecek 2018. Seafood from Gephart et al 2021, except lobster, which is from Clune et al 2017

Bottom trawling may release as much CO_2 as the entire aviation industry by disturbing seabed sediments

The seabed contains the largest pool of organic carbon on the planet and acts as a critical reservoir for long-term carbon storage[30]. Marine sediments store 2,322 gigatonnes of carbon in the top 1 metre, an amount almost twice as large as terrestrial soils[30]. When bottom trawls make contact with the seafloor, they can disturb and resuspend this carbon, with potentially significant consequences for greenhouse gas emissions[16,30,36]. The research in this area is still in its infancy, but a recent estimate suggests that each year, bottom trawling could release between 0.6 and 1.5 billion tonnes of CO_2 a year from the seabed, an amount that some have equated to emissions from the entire aviation sector[16,40].

This figure has attracted controversy since it implies that all of this aqueous CO_2 will be released into the atmosphere and therefore has the potential to greatly exacerbate climate change. In fact, it is not yet known what happens to the carbon released from the seafloor by bottom trawling, how it impacts marine ecosystems, and what proportion of resuspended carbon enters the atmosphere. This is an area ripe for urgent and substantially increased research attention.

Nonetheless, even if it all remains in the water column (which seems doubtful), it is likely to contribute to ocean acidification and undermine marine productivity and biodiversity[16].

Moreover, with the oceans already capturing more than a quarter (27%) of carbon emitted each year[41], any increase in CO_2 in the water column may reduce their capacity to absorb future emissions.

There are several ways of mitigating bottom trawling's contribution to the climate crisis

As one of the most carbon-intensive methods of food production, there is a need for bottom trawling to transform its practices and reduce its contribution to the climate crisis. Several key interlinked steps are needed to achieve this transformation.

1 CONTINUE MANAGEMENT REFORMS TO REBUILD STOCKS AND OPTIMISE CAPACITY

One of the most effective ways to improve the carbon footprint of bottom trawl fisheries is to continue efforts to rebuild stocks and reduce overcapacity[4,13,14]. Increasing stock biomass could reduce the amount of energy required per unit of catch. Fuel use reductions have been observed in several fisheries following management reforms to reduce capacity and improve biomass, in Asian, European and Australian waters[13]. Overall, the potential for such practices to reduce greenhouse gas emissions is estimated at between 20 and 80%, depending on the fishery[42].

2 PRIORITISE LOWER-FUEL FISHING METHODS

Switching to fishing practices that are less fuel-intensive than bottom trawling can have positive impacts on emissions that are linked to both fuel use and seabed modification. Studies have shown that fuel use can be reduced by up to four times per kg of lobster and cod, and by up to 15 times per kg of flatfish, by changing gears to creel, gillnet and Danish seine nets, respectively[43,44,45]. In total, prioritising lower-fuel methods can reduce greenhouse gas emissions by 4-61% and create additional biodiversity benefits, depending on the species targeted[4].

3 INTRODUCE INSHORE EXCLUSION ZONES, AND CONSIDER CARBON OBJECTIVES IN MPAS

At present, only 2% of sediment carbon stocks are located in highly protected or fully protected areas, where disturbance to the seafloor is prevented[16]. The majority of seafloor carbon stocks are thus highly vulnerable to human disturbance. Establishing, expanding and strengthening national inshore exclusion zones for small-scale fishers in which bottom trawling is restricted, could both protect high blue carbon habitats such as kelp forests and seagrass meadows[46], and safeguard the rights of small-scale fishers who depend on them[47]. Limiting bottom trawling in MPAs could similarly support the recovery and protection of carbon rich habitats[48].

4 FREEZE THE SPATIAL FOOTPRINT OF BOTTOM TRAWL FISHERIES

The sheer volume of carbon stored in marine sediments could greatly exacerbate climate change even if only a small fraction is released[30]. Since untrawled habitats are estimated to remineralise around 2.5 times more carbon than repeatedly trawled habitats[16], a key way to mitigate emissions from bottom trawling would be to prevent it from expanding into untrawled areas. In essence, freezing the spatial footprint could help manage the carbon footprint.

5 TRANSITION FLEETS TO LOW-EMISSION ALTERNATIVES

Finally, bottom trawl fleets could transition to low-emission alternatives. Some fisheries have moved towards electric, hybrid, hydrogen and sail-assisted vessels already, but for this approach to realistically scale, governments will need to remove fossil fuel subsidies and redirect them to incentivise and support transition[4].

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