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Review of the science on the impacts of bottom trawling on the climate
(with a focus on seabed carbon stores)

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Background

So far, most climate research has focused on how fisheries will be affected by climate change, rather than on how they contribute to it. But it is 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, and secondly, through gear contact with carbon-rich seabed habitats.

The Transform Bottom Trawling Coalition, of which Oceana is a member, has produced a very informative briefing on **Bottom trawling & the climate crisis**, which summarizes this emerging field of research, outlining the known major impacts from bottom trawling on greenhouse gas emissions and identifying key mitigation opportunities.

This briefing summarises findings from recent scientific literature on the subject, to evidence the broad scale impacts bottom trawling has on the climate. It also addresses the recent criticism by **Hilborn & Kaiser (2022)** of a major article by **Sala *et al.* (2021)** which attempted to identify and prioritise areas to place MPAs that would maximize benefits for fisheries landings, biodiversity conservation, and CO_2 emissions.

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1. The carbon footprint of bottom trawl fisheries

Seafood is widely considered to be a low-emissions dietary choice, requiring **3-6 kg of greenhouse gases** (CO_2-equivalents) to produce **1 kg of edible product**. However, this can vary considerably depending on species targeted and how it is caught (Clune *et al.*, 2017).

Bottom trawling uses more fuel than other major fishing practices. The overall carbon footprint of bottom trawl fisheries is estimated to be **2.8 times higher** than non-trawl fisheries, and is among the highest of all foodstuffs (Clark *et al.*, 2017).

For instance, **demersal species caught by bottom trawls** may create **more than 4 times** the emissions of those caught by gillnets and entangling nets (Gephart *et al.*, 2021).

A recent study of **Mediterranean trawl fisheries** estimated the **amount of fuel burned** from capture to landing to be approximately **7.6 kg CO_2/kg fish on average** (with wide variations of fuel consumption rate according to gear type and vessel size) (Sala *et al.*, 2022).

2. Disturbance of organic carbon by bottom trawl fisheries

Marine sediments are one of the planet's primary carbon stores and strongly influence the **oceanic sink for atmospheric CO_2** (Epstein *et al.*, 2022). They act as a critical reservoir for **long-term carbon storage** (Atwood *et al.*, 2020).

The most widespread human pressure on the seabed is bottom fishing (Epstein *et al.*, 2022), and alongside climate change, fishing might be a critical influence on **the ability of the ocean to sequester atmospheric CO_2** (Cavan *et al.*, 2022).

Bottom trawling activity is the most significant cause of anthropogenic disturbance to the seabed, leading to massive sediment resuspension events and **wide scale impact** to benthic communities (Black *et al.*, 2022).

A recent study found **30% less organic carbon in deep-sea** (500 m) **sediment continuously trawled for shrimp** compared to **sediment where trawling had been banned for 2 months** (Paradis *et al.*, 2021).

Inshore and coastal sediments store significant quantities of highly reactive organic matter that is at greater risk of remineralization when disturbed (organic carbon hotspots) (Smeaton *et al.*, 2022). The North Atlantic region should be prioritized in terms of research and conservation measures to **preserve its high levels of sinking carbon** (Cavan *et al.*, 2022).

Shelf and coastal seas hold vast quantities of sedimentary carbon, which if left undisturbed, will contribute towards long-term carbon storage and **underpin natural ocean climate services** (Black *et al.*, 2022).

The role of Blue Carbon to mitigate climate change in particular is well researched (Hilmi *et al.*, 2021). Possible management interventions to reduce the disturbance from organic carbon hotspots by bottom fishing **must ensure emissions are minimized and natural carbon capital resource is protected.** There is an existing body of peer-reviewed research to quantify **CO_2 abatement potential** for which further research is required (Claes *et al.*, 2022 for McKinsey report).

In Spain, 82% of carbon storage and sequestration by seagrass meadows is located inside Natura 2000 protected sites. However, results from the modeled future scenarios indicate a **constant decrease in the amount of carbon stored** in these ecosystems by 2050 (**24% lost in the business-as-usual scenario**), for an economic impact of these losses equivalent to **17 974 million €** (around **1.6% of the Spanish GDP**) (González-García *et al.*, 2021).

A prospective **global study on rhodoliths**, calcareous red algae that acts as marine biodiversity hotspot, **identified future climate refugia and their trawling threat levels.** It shows that the bottom trawling intensity in Europe is currently **the highest over rhodolith suitable habitats**, and also where most of the long-term suitable rhodolith habitats are predicted (Fragkopoulou *et al.*, 2021).

If disturbed, **the organic carbon within seafloor sediments can potentially be converted to CO_2 and a portion lost to the atmosphere,** where it potentially **contributes to climate change** (Smeaton *et al.*, 2022). The research in this area is still in its infancy, particularly to better quantify the impacts, including how much of the resuspended carbon enters the atmosphere, however the impact is likely important on marine ecosystems.

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Conclusion

As acknowledged in EU policies and laws, Marine Protected Areas are an essential component of ocean conservation efforts, alongside other tools (including fisheries management). **When well-managed, and well protected, they can play an important role in mitigating climate change.**

Some scientific uncertainties remain on the potential for seabed carbon mobilised by bottom fishing to be converted into CO_2, and on which proportion of that CO_2 may re-enter the atmosphere. **Nevertheless, a significant body of research exists which demonstrates that the seabed is a major planetary carbon store; that bottom fishing is the most important cause of disturbance of this store and prevents it from capturing and retaining organic carbon to the same extent as undisturbed areas; and that this disturbance is likely to have wide scale impacts on marine ecosystems.**


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Recent critiques of high-profile scientific studies are welcome, as they provide useful suggestions for future research, particularly a more focused regional analysis including better incorporation of data-poor fisheries. Nevertheless, these gaps, and the necessary assumptions made in an article of the scope of Sala *et al.* (2021) do not undermine the findings of the original paper. **The risks associated with bottom fishing activities on marine biodiversity and the climate are not potential, but well established.**

Rather than waiting for a full and detailed calculation of exactly how much carbon may be mobilized by bottom fishing in EU MPAs and other habitats, and quantifying exactly all its impacts, including how much of that carbon may re-enter the atmosphere as CO_2, it is high time for the European Commission to acknowledge these well-established risks and use the best available science to take a precautionary approach, through preventive measures, towards the likely impacts of bottom fishing on seabed carbon stores in the EU.

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