Bottom trawling threatens European marine ecosystems

Fishing with bottom trawls has extensive effects on marine life and threatens seafloor integrity. It also impacts areas not directly trawled, since suspended sediment can travel far. Recent research on bottom trawling effects points to the need for establishing larger trawl-free areas in all types of habitats to protect sensitive ecosystems and live up to principles of ecosystem-based management.

Protection of marine habitats and biodiversity is a major challenge globally. In Europe, a high proportion of marine species and habitats show an unfavourable conservation status and the loss of marine biodiversity has not been halted (EEA 2020), despite ambitious goals and legislation.

Fishing is one of the key pressures on the marine environment, both through resource extraction and through the damage done to the seabed (EEA 2020). European waters are some of the most intensively bottom-trawled areas in the world (Amoroso et al. 2018); there are a number of regions where more than half of the seabed is trawled each year, in extreme cases up to 99 percent of the seabed, with some hotspots trawled more than ten times per year (Eigaard et al. 2017).

In addition to the documented effects on extracted species, there are serious concerns that this intensive trawling has negative effects on benthic ecosystems, both through direct effects on the seabed and by suspension of sediment and associated substances. This affects biological diversity, production of fish and biogeochemical processes in the sediment that regulate nutrients and carbon cycles. Therefore, reducing bottom trawling and its impacts are important measures for an ecosystem-based fisheries management, in accordance with the Common Fisheries Policy. It is also instrumental for protection and restoration of marine biodiversity in Europe and for achieving the targets for biodiversity and seabed integrity in the EU Marine Strategy Framework Directive. This needs to be acknowledged in the development and implementation of the EU Biodiversity Strategy for 2030.

Direct effects on the seabed

Different types of trawling gear are used on different types of seabed and to catch different species, but have a number of features in common. As well as the net for collecting the catch, they all have components that keep the gear close to or on the seabed, protect the gear from being damaged by rough surfaces, keep the net open and often parts that force or herd organisms into the net.

These gear components interact with the seabed in different ways. For example, during otter trawling the gear is kept on the seabed, and the net opened horizontally, by two trawl doors, also called otter boards, which can weigh more than a ton each. These doors displace up to several decimetres of sediment, depending on their size and on seabed type (Eigaard et al.

2016). Weighted ground gear at the front of the net of otter trawls only penetrates a few centimetres into the sediment, but has a much larger spatial ‘footprint’ than the trawl doors (Eigaard et al. 2016).

This physical disturbance has large consequences for the habitats and species living on the seabed (see box).

Sediment is suspended, affecting water quality

Bottom trawling also suspends seabed sediment, both by the direct contact of the gear with the seabed and by the hydrodynamic turbulence around it (O’Neill and Ivanović 2016). The effect is largest on silty or clayey seabeds (Oberle et al. 2016). Bottom water turbidity (cloudiness) can be increased by several orders of magnitude immediately after a trawl has passed (Dellapenna et al. 2008, Durrieu de Madron et al. 2005, Mengual et al. 2016).

Both the turbidity itself and the increased sedimentation that occurs when the particles settle are often detrimental to marine organisms, particularly those that are not able to move away from the area. Suspended particles may clog fish gills and decrease visibility so that feeding and predation are impaired (Wenger et al. 2017). Filter-feeding animals’ feeding apparatus may become clogged and the quality of the particles available as food in the water may decrease. The survival of eggs and larvae is decreased, for example by particles sticking to their surfaces, making them less buoyant. Plants and algae are affected by reduced light penetration and particles settling on their surfaces.

After a trawl has passed, the sediment plume can extend tens of metres above the bottom and remain in the water for days (Oberle et al 2016, Bradshaw et al 2012, Linders et al 2017). During this time, water currents can transport the suspended sediment several kilometres away (Schoellhamer 1996, Bradshaw et al in review), where it may settle out, increasing the amount of sediment reaching the seabed (Martín et al 2014, Oberle et al 2016). In areas of high trawling intensity, semi-permanent turbid bottom water may form (Durrieu de Madron et al 2005, Mengual et al 2016, Daly et al 2018).

Since turbidity caused by trawling is not restricted to the specific area trawled, this needs to be considered in conservation planning, particularly when aiming to protect seabed habitats or species likely to be sensitive to turbidity. This can either be achieved by increasing the size of protected areas, introducing buffer zones around the perimeter, or reducing trawling in the vicinity.

Effects on biogeochemical processes

There is also a growing concern about whether seabed disturbance and suspension of sediment might affect important biogeochemical processes in the sediments. However, this is one of the most poorly studied and understood aspects of bottom trawling impacts, since effects depend on the frequency of trawling, type of sediment and faunal community, and short- and long-term effects may be different.

Physical disturbance of the seabed disrupts its natural 3-D structure, disrupting carbon and nitrogen cycling between the sediment and water (Duplisea et al. 2001, van de Velde et al. 2018, Tiano et al. 2019). Sediment mixing and suspension may also stimulate the breakdown of organic matter, a process that can result in decreased oxygen levels in the water (Riemann and Hoffman 1991, van de Velde et al. 2018). When trawling removes surface sediments, surface-dwelling organisms, including the majority of the microbes involved in biogeochemical processes, are also removed. Alterations to the abundance and type of burrowing fauna is also important since these animals play a crucial role in biogeochemical cycling.

Scaling up these results to larger spatial and temporal scales is very difficult. However, some calculations have suggested that bottom trawling could affect the carbon storage capacity of sediments, release carbon dioxide and thus potentially contribute to overall carbon cycling, the effects of climate change and ocean acidification (van de Velde et al. 2018, Legge et al. 2020, Sala et al. 2021). Others have suggested trawling may contribute locally or regionally to nitrogen dynamics (Pilskaln et al. 1998, Percival 2005, Dounas et al. 2007, Ferguson et al. 2020).

Lastly, sediment is also an archive for hazardous substances, but these can be suspended and released by bottom trawling, making them bioavailable to organisms (Bradshaw et al 2012). Suspended contaminated sediment seems to be more detrimental than suspended clean sediment, and a range of physiological stress responses in marine animals/species have been observed in lab and field studies (Wenger et al. 2017, Roberts 2012).

Extend protection to all types of habitats

Given the large impact of bottom trawling beyond fish stocks, there is a need to reduce bottom trawling impacts in Europe in order for fisheries to be compatible with achieving the objectives of the environmental legislation in the EU, i.e. the Water Framework Directive, the Marine Strategy Framework Directive and the Habitats Directive.

Some measures have already been taken in European countries to decrease negative effects of trawling on marine ecosystems, including trawling restrictions in sensitive habitats in some marine protected areas (MPAs) and initiatives to protect representative and undisturbed seabeds. Efforts have been made to alter mobile fishing gears to make them less destructive, and to replace mobile gears with passive gears, such as creels (traps) for crustaceans (Hornborg et al. 2016). Still, bottom trawling is impacting species and habitats of conservation concern. Commercial trawling, including bottom trawling, still occurs inside more than 50 percent of European MPAs (Dureil et al. 2018). Very few have a complete ban on bottom trawling and many MPAs lack appropriate monitoring to assess effects of trawling or trawling-induced sediment dispersal on benthic species (Greathead et al. 2020). Trawl-free areas are in many cases small, which means that there is a risk for suspended sediment from surrounding trawled areas to affect the species and habitats inside. Thus, to fully protect sensitive benthic ecosystems, it is important to close larger areas than today from bottom trawling. For instance, a general ban on trawling in coastal areas, as already adopted in some member states, would protect coastal fish stocks, recruitment, spawning grounds and sensitive habitats and reduce conflicts with other fishing gears.

Along with the work to protect sensitive environments, there are strong arguments for establishing areas free of any human disturbance in all types of habitats that occur in a region, not only the most sensitive ones. Firstly, such areas represent the natural species composition and biogeochemical processes and can serve as ecological references to study the effects of bottom trawling and other disturbances on the marine environment and to be able to assess if, as some have suggested, there is reason to ban bottom trawling more generally. Lack of comparable, non-trawled areas has been identified as a major challenge for studies of long-term effects of trawling on benthic communities and seabed biogeochemistry. Secondly, protecting areas representative of different types of marine ecosystems is in line with the precautionary principle of ecosystem-based marine management, providing a refuge for benthic species that can help rebuild populations in impacted areas.

POLICY RECOMMENDATIONS

Establish more and larger trawl-free areas encompassing all types of seabed habitats:

- to protect sensitive benthic species and habitats from direct trawling effects and from suspended sediments from adjacent areas
- as part of a precautionary fisheries management
  as reference areas for evaluating long-term effects of trawling

Reduce the effects of bottom trawling by promoting the use of alternative gears, such as passive gears or trawls with less impact on the seabed.

Facts: Bottom trawling also affects benthic communities

Hundreds of studies have shown that bottom trawling affects species living on the seabed, through their removal as bycatch, damage or mortality on the seabed, disturbance of their habitat or altered interactions with other species (Jennings and Kaiser 1998, Kaiser et al. 2006, Hiddink et al. 2017, Rijnsdorp et al, 2018). The overall effect depends on the type of seabed and fishing gear and the intensity of trawling, but as much as 40 percent of the faunal biomass may be removed during one trawling pass (Hiddink et al 2017). Effects are most severe on previously untrawled seabeds. Benthic communities are an essential part of marine food webs, including supporting fish production, and are an integral part of biogeochemical cycling as they feed on and mix sediments.

Since organisms have a varying sensitivity to trawl disturbance, bottom trawling affects the species composition of seafloor communities. The capacity for recovery is crucial, most affected are long-lived, slow-growing, stationary and fragile species such as sponges and corals. Tolerant species, such as burrowing brittlestars, or short-lived opportunistic species, e.g. some polychaete and nematode worms, may on the other hand benefit from the disturbance and the reduced competition. Scavengers, such as starfish, are also commonly more frequent in trawled areas. Where bottom trawling affects habitats created by key organisms such as coral reefs, seagrass or blue mussel beds, there are knock-on effects on other species who use these habitats.

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