Seabed impacts after mechanical disturbance by beam and pulse trawls in two North Sea experiments

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Flatfish live in, at or near the seabed. Commercial bottom trawl fisheries that target these fish species require close contact with the sediment to increase their encounter and to avoid their escape from the trawl. Close seabed contact is insufficient in itself to result in high flatfish catches. The flatfish-directed trawlers further stimulate flatfish by tickling the flatfish using tickler chains (beam trawls) or by using electricity (pulse trawls). The catch stimuli are distinctly different and so we hypothesized that the expected mechanical impacts and abrasion of beam trawls is distinctly different from pulse trawls. Two Before-After Control-Impact (BACI) experiments were conducted in sandy sediments to compare the mechanical disturbance to the seabed for both gears. The results showed, indeed, that beam trawls penetrated deeper into the sediment than pulse trawls (4.1 cm vs 1.8 cm). The penetration was estimated as a combination of the resuspended sediment and the depth of the disturbed sediment layer assessed from Sediment Profile Imagery (SPI). Sediment resuspension was similar for both gears, as it was primarily caused by hydrodynamic drag of towing the trawl net through the water rather than the different catch stimuli. We assigned the difference in penetration entirely to the gear elements that are in close contact with the seabed, i.e. the tickler chains and the electrodes. The increased penetration depth of beam trawls further caused other differences in seabed impacts. The sediment grain sizes were reworked into deeper layers (up to 4 cm depth) by beam trawls than by pulse trawls (~1 cm). The bathymetrical profile was consequently flattened to a greater extent, trawl tracks were deepened more (beam trawls: 1.5 cm vs pulse trawls: 0.7 cm) and the oxygenated layer, reflecting benthic life, was disturbed deeper and did not recover with the duration of the experiments (~48 h). We conclude that these experiments have quantified the more profound mechanical effects of commercially deployed beam and pulse trawls in a coastal and in an offshore fishing ground. The implication of these findings suggest a decreased seabed effect of pulse trawling as opposed to beam trawling, but its interpretation requires caution when extrapolated to fleet level. Extrapolation requires that the variation in sediment and gear characteristics are compared to the sediment and gear types used in our experiment, and that this variation is accounted for when assessing seabed impacts at ecosystem (or fleet) level.

Keywords: Beam trawl; Biogeochemistry; Habitat impacts; Particle size distribution; Penetration depth; Pulse trawl; Seafloor integrity; Sediment resuspension