

# Comparative physical impacts of beam trawling and natural processes on the reworking of seabed sediments in the North Sea

## Introduction

To assess the impacts of human activity on the marine environment, human disturbance needs to be considered in relation to the natural background processes. The seabed in shelf seas is subject to physical disturbance from both natural and anthropogenic activities (Figure 1). Anthropogenic physical disturbance of marine sediments can have a variety of potential impacts on sediment chemistry, biology, and the broader marine ecosystem. Many human activities (e.g. dredge spoil disposal, aggregate extraction, and offshore engineering) have the potential to cause significant local physical disturbance to the seabed, but influence only a limited area. In contrast, fishing activity is widespread and is the focus of this study. An attempt is made here to compare the relative magnitude of the physical reworking of the seabed caused by beam trawling with the natural processes of tide and wave action for the North Sea.

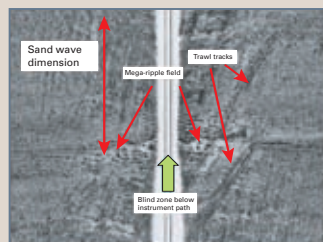


Figure 1: Side-scan sonar image of English East coast at Harwich on the English east coast. Water depth 15 m, horizontal dimensions approximately 500 m. Image illustrates the simultaneous occurrence of natural bed disturbance at various size scales (ripples, megaripples, sand waves) and beam trawling.

## Beam trawling disturbance

The intensity of beam trawling effort in the North Sea was assessed using satellite monitoring data. In accordance with revisions to the European Common Fisheries Policy, fishing vessels over 24 m in length have, since 2001, been required to carry equipment that transmits vessel location and speed that is relayed to shore via satellite. Information is recorded with a minimum temporal resolution of two hours and stored within a Vessel Monitoring Satellite (VMS) database. Access to VMS data is only permitted at the discretion of each European member state. For this study, only English and Dutch beam trawling data were available. Without access to VMS data from all countries, we have not been able to estimate the exact percentage of beam trawling effort represented by the data used in this study. However, Jennings *et al.* (1999) estimated the Dutch beam trawling effort during the early 1990s to account for around 60% of the total beam trawling effort in the North Sea.

The VMS database does not differentiate between those vessels that are stationary, fishing, or steaming. To make this distinction, information on vessel speeds was used. In 2003, approximately 75% of all records had a transmitted speed. For the remaining 25%, speed was derived from two consecutive records. Trawling speeds were determined by inspecting the speed frequency histograms of all beam trawlers recorded in the VMS databases. The frequency distribution indicated that fishing was likely to occur at speeds of 2-8 knots inclusive.

Records of trawling activity were assigned to a grid of resolution  $1/10^\circ$  longitude by  $3/20^\circ$  latitude (approximately  $11 \text{ km}^2$ ). An identical grid was used for estimating natural disturbance, as described later. The area of seabed disturbed by beam trawling was calculated assuming all beam trawlers towed twin 12 m beams (Dimmore *et al.*, 2003) and that vessels moved in straight lines between consecutive speed-filtered VMS locations. For each grid square, the total area for all vessel tracks was calculated. Finally, the total trawled area was divided by the grid box area to yield  $R_T$ , the average number of times the bed was reworked per year within the grid box (Figure 2). This procedure includes multiple tracks disturbing the same location so that  $R_T$  can be greater than one. The depth associated with the reworking is the gear penetration depth, which depends on gear type, mode of operation and seabed substrate. Although Bergmann and Hup (1992) suggest a maximum gear penetration depth of 6 cm for sandy sediment, to allow for uncertainty in comparison with natural reworking, gear penetration was assumed to range from 4-10 cm.

