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Estimating historical trawling effort in the German Bight from 1924 to 1938

H.O. Fock*

Thünen Institute of Sea Fisheries, Palmaille 9, D-22767 Hamburg, Germany

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ABSTRACT

Based on historical landings and landings-per-unit-effort data, fishing effort was estimated in the period of 1924–1938 in a study area representing the German exclusive economic zone (EEZ) in the North Sea. Three main trawling fisheries were identified, i.e. the international flatfish fisheries comprising the effort of steam trawlers and motor cutters, the German shrimp fisheries and the industrial inshore fisheries. Except for shrimp trawling, which was performed by beam trawling with one beam per vessel, all historical trawling effort was identified as otter board trawling. The trawling effort increased from 1,131,000 to 1,232,000 h in 1924 to 3,170,000 to 3,836,000 h in 1937 and declined in 1938. The main fishery effort was contributed by the German shrimp fisheries, accounting for a maximum of 2,140,000 h in 1937. In comparison, in 2006, approximately 540,000 h were spent fishing in the trawl fisheries of the study area, comprising effort from small (≤221 kW) to large beam trawlers (>221 kW), shrimp fisheries and otter board trawling. The bulk of the historical effort was concentrated at water depths of 5–20 m. With the implementation of combustion engines and new gear technology, the period of 1924–1938 marked a new era for marine fishing when virtually all space became accessible and, in particular, the trawling of inshore areas increased.

1. Introduction

The value of historical ecology in environmental management is increasingly acknowledged, both with regard to adopting historical baselines and to revealing the history of the drivers of change (Lotze and Worm, 2009; McKenzie et al., 2011). Environmental policies, e.g. the European Marine Strategy Framework Directive and the Water Framework Directive, warrant baselines against which the ecological state of ecosystems can be assessed (Borja et al., 2010, 2012). In many cases, these baselines will be built upon historical reference points (Cardoso et al., 2010). Ecological change is embedded in a background of large-scale environmental forcing which needs to be differentiated from trends in local human influences (McQuatters-Gollop, 2012). In marine systems, fisheries are often the main driver of change, affecting not only the size and the distribution of marine populations but also the structure of coastal habitats (Jackson et al., 2001; Reise, 2005), and increasing evidence is available on associated population declines and species extirpations in the sea over hundreds of years (Carlton et al., 1999; Lotze, 2007). One often initial effect of a deteriorating ecosystem state in fisheries is the severely declining yield per unit effort (see Poulsen and Holm, 2008). In the North Sea, such signs of severe decline were already recognized in the 1880s and 1890s (Anon, 1913; Sims and Southwood, 2006) and confirmed thereafter by long-term analyses (Lundbeck, 1962; Thurstan et al., 2010).

The demersal fishing effort, measured both by its trend and spatial distribution, is one of the key parameters used to assess and evaluate the effect of fishing on the environment and on fish stocks (Jennings et al., 1999; Rogers et al., 1999). The ecosystem response depends on the overlap between the pressure and the ecosystem features; thus, the fine-scale heterogeneity in the distribution of fishing is important information for the conservation of certain fish species (Shephard et al., 2012) or seafloor habitats (Fock et al., 2011; Hiddink et al., 2007; Piet et al., 2009; Rijnsdorp et al., 1998). Fine-scale analysis requires the use of data with high spatial coverage and resolution, such as VMS data (vessel monitoring system, e.g. Fock, 2008), whereas the analyses of historical effort were often confined to a broader scale by the resolution of either logbooks containing effort information in terms of days spent fishing, trip at sea etc. (e.g. Jennings et al., 1999) or charted fishing data (e.g. English fleet, Engelhard, 2005; Engelhard et al., 2011).

The present paper assesses trawling effort in terms of trend and distribution in a study area in the southeastern North Sea during the historical period 1924–1938 (see Fig. 1), combining the merits of

* Tel.: +49 4038905169.
E-mail address: Heino.fock@ti.bund.de

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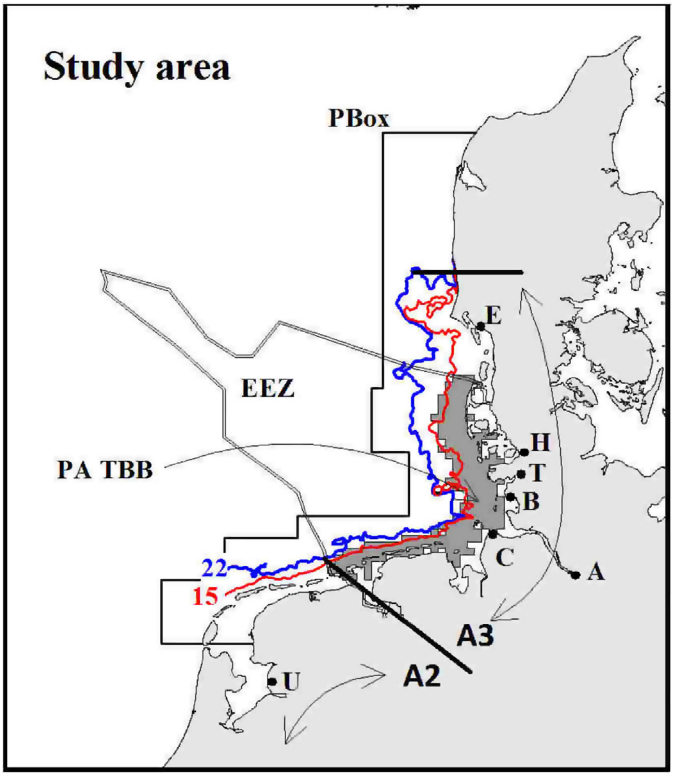

Fig. 1. Study area. The study area refers to the German EEZ. The northwestern extension of the EEZ is called 'duckbill'. The areas A2 and A3 refer to specifications used by the Plaice Committee in 1921 (Anon, 1921) and mark the area inside the 22-m depth contour ('22', blue bold line). A2 extends further along the Dutch coast as indicated by the double headed arrow, A3 extends along the German and Danish Wadden Sea coast. The seaward border of PA TBB (the principal fishing areas for small beam trawlers in 2005/2006 (after Fock, 2008)) is associated with the 15-m depth contour ('15', red bold line). PBox – delineations of the Plaice Box management zone (see Beare et al., 2013). Harbors mentioned in the text: A – Hamburg/Altona, B – Büsum, C – Cuxhaven, E- Esbjerg, H – Husum, T – Tönning, U – Urk.

fine-scale analysis with those of historical survey and commercial landings data when logbook and charted data are not available.

Trend analysis is conducted on a regional scale based on catch statistics and catch- or landings-per-unit-effort data (cpue or lpue), using extensive historical information sampled in the southeastern North Sea for the plaice fisheries from the beginning of the 20th century (see Anon, 1913). Considering that not all the catch is landed, the basic equation for effort

$$\frac{C}{E} = \text{cpue} \quad (1)$$

becomes

$$\frac{L}{E} = \text{lpue} \quad (2)$$

with C = catch, L = landings, and E comprising the fishing effort. A concise description of the fisheries with cpue/lpue values representative for the target species or main catch and of the area for which the assessment is undertaken, is a prerequisite for this approach (Poulsen and Holm, 2008; Walters, 2003). Effort may be expressed in different units (e.g. hours fishing, trip days, catch days).

Conditions underlying the temporal and spatial effort model are inferred from the literature, comprising trends of historic fisheries in the area, corresponding lpue data and known distribution patterns in order to assess the distribution of catches and thus of effort (see Pedersen et al., 2009). Given the speculative extrapolations needed for this analysis, the temporal model is designed as a minimum–maximum model to identify the most reasonable range of effort values, whereas the spatial model is only derived for one particular year (1933) in relation to the effort distribution in 2006 and the historical distribution of fish species.

2. Materials and methods

2.1. Description of the fisheries in the study area

Three main demersal fisheries operated in the 1920s and 1930s in the German Bight and the central North Sea according to landings statistics and reported range of operation, i.e. a mixed fishery for flatfish, i.e. plaice and sole with haddock as bycatch, a coastal shrimp fishery and a fishery for industrial purposes (junk fishery), here referred to as 'Gammelfischerei' (German) or 'pufvisscherij' (Dutch). Plaice and sole also were bycatch in the 'Gammel' an 'puf' fishery, and juvenile plaice is currently a bycatch in the shrimp fisheries (Beare et al., 2013). Danish vessels applied Danish seines in the directed plaice fisheries (Jensen, 1932), whereas otter board trawling was carried out for haddock where plaice was bycatch. With the decline of the haddock fishery from 1924 to 1929, Danish trawlers were gradually replaced by seiners (Jensen, 1932), and no Danish steam trawler fleet was reported participating in the plaice fisheries in the German Bight. Steam trawling was the dominant métier in the English fisheries. Germany and the Netherlands developed a large motor trawler/cutter fleet (Table 1) (Schmidt, 1942; Thursby-Pelham, 1939).

2.2. Historic catches and lpue

2.2.1. International flatfish fisheries plaice lpue and seasonal pattern

In 1924, 10% of the German catches of plaice were fished by sailing trawlers (Anon, 1925), followed by a decreasing trend (Lundbeck, 1955). Given the proportionately few sailing vessels in the fisheries after 1924, these vessels were neglected, and all landings were treated as catches from the motor/steam trawler fleet. Landings composition for the German mixed flatfish fisheries in the German Bight increased from 67 to 77% plaice in the period 1923–1925 (Anon, 1925, 1926) to about 80% afterwards, hence the plaice lpue is deemed representative for the estimation of effort in the mixed fisheries.

Except for the English fleet, the plaice landings from motor trawlers increased and outnumbered landings from steam trawlers after 1930 (Fig. 2). The Danish motor trawl fisheries made a significant increase after 1920–1924, whereas the English fleet participating in the North Sea flatfish fisheries was dominated by steam trawlers, with a decreasing number of motor trawlers (Fig. 2 and Table 1).

Annual lpue data expressed as landings per fishing hour for first-class English steam trawlers from 1923 to 1932 (Thursby-Pelham, 1933) and as landings per catch day for German trawlers for 1925 and 1930–1938 (Lundbeck, 1935; Schmidt, 1936, 1937, 1942) were used for this study likely representative of the study area (more North Sea wide lpue in Rijnsdorp and Millner, 1996).

The monthly data in Schmidt (1938) reveal that the annual values were calculated as simple annual lpue averages, thus covering both the spring plaice fisheries and the summer and winter fisheries, which targeted sole and considered plaice a bycatch. These figures overestimate the effort by ca. 25%, compared with the lpue data weighted by monthly catches, because most of the fisheries activity likely occurred during periods of high lpue values, i.e. spring and early summer. The English lpue series shows an increase in lpue between 1924–1925 and 1928–1931; likely attributed to strong year-classes of plaice in 1922, 1925 and 1928 (Jensen, 1932; Lundbeck, 1935, p. 45; Schmidt, 1938). When rescaled to kg per fishing hour, the German motor trawler lpue values are lower than