



Marine litter on the seafloor of the southern Baltic

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ABSTRACT

Marine litter occurrence and composition were investigated during routine bottom trawl fish surveys type BITS performed in the Polish Maritime Areas (the southern Baltic Sea). Sampling covered a distance of 325 km and an area of 16 km² at a depth range of 19–110 m. Litter densities varying between 0 items/ha (34% of tows) and 2.23 items/ha with a mean of 0.20 items/ha (SD = 0.30) are at the bottom range of densities reported from other shelf habitats worldwide at similar water depths. The majority of the items (40%) were found at a depth range of 51–60 m. Overall, plastic was the most common litter type (67% of all items) found in all tows with litter. The results of this study indicate that despite the Baltic being a semi-enclosed basin, with a densely populated coastline and extensive shipping, marine litter pollution of the southern Baltic seafloor is low compared to other coastal areas.

1. Introduction

Pollution of the marine environment by anthropogenic debris and its effects on ecosystem health and services are nowadays in the heart of scientific interest. The aesthetic aspect of this phenomenon is important, but truly alarming is the threat posed by this kind of pollution to marine fauna: the number of species representing various groups of marine fauna known to have been affected by either entanglement or ingestion of marine litter has doubled since 1997 (Kühn et al., 2015). Even though it is not a global problem yet, there have been many records of entanglement and various effects of active or passive consumption of litter by fauna such as: decline in food uptake, limited mobility hindering migration and escape from predators, the overall decline in the body condition, the reduction of the reproduction rate and mortality (Laist, 1987; Murray, 2009; Kühn et al., 2015). Plastics – by far the most common component of marine litter - associated with chemicals that accumulate onto their surface, may act as a source of toxic substances that can be lethal to marine fauna (Zarfl and Matthies, 2010; Cole et al., 2011; Engler, 2012; Rochman, 2015; Hermabessiere et al., 2017). In addition, the process of mechanical degradation of plastic litter leads to the formation of microplastics that are considered the most abundant solid-waste pollution on our planet. Understanding the scale of litter pollution in the sea, sources and pathways of the litter transport and (re)distribution is therefore fundamental to understand the threat to ecosystems, their goods and services, and to undertake suitable remedial measures.

Although litter is found in various marine environments worldwide the majority of reports are related to the relatively accessible water surface, coastal areas and beaches (Aliani et al., 2003; Thomson et al., 2004; Barnes and Milner, 2005; Zhou et al., 2011; Van Cauwenberghe et al., 2013; Rosevelt et al., 2013; Topçu et al., 2013; Laglbauer et al., 2014; Schernewski et al., 2017). Unfortunately, debris on the seafloor where it constitutes a hazard to the benthic and demersal fauna (Lusher et al., 2013; Kühn et al., 2015; Rummel et al., 2016; Courteney-Jones et al., 2017) is less extensively studied. Published reports on litter occurrence on the seafloor (including continental shelf and slopes, submarine canyons, and deep basins) are mostly from the Atlantic and Mediterranean (Pham et al., 2014; Galgani et al., 2015 and references therein). Even though, the semi-enclosed Baltic Sea with densely populated shores, intensive marine traffic and limited water exchange through the Danish Straits, is highly vulnerable to various types of pollution, the studies on marine litter in the Baltic are scarce. They are limited to five samples taken in the western Baltic seafloor (Galgani et al., 2000) and recent extensive study performed on German and Lithuanian beaches (Schernewski et al., 2017).

The intention of our study is to assess the status of seafloor litter pollution in the southern Baltic Sea. This aim has been achieved by investigating density and composition of marine litter collected during the standard bottom trawl fish surveys type BITS-Q1 and BITS-Q4 (Baltic International Trawl Surveys) performed in the Polish Maritime Areas, within the period of 2015–2016.

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2. Materials and methods

The Baltic Sea is a shallow, inland basin with only a limited water exchange with the world ocean through the Danish Straits. The catchment area of the Baltic Sea is approx. 4 times larger than the sea itself. Fourteen countries, in majority highly urbanized and industrialized, are located within this catchment area and the overall population amounts to ca. 85 million people (Pastuszak, 2012). The Baltic is a brackish sea strongly influenced by freshwater inflow from a number of streams and rivers including the major rivers of the North Europe such as the Neva, Neman, Vistula, Oder. Sixteen big cities such as Saint Petersburg, Stockholm, Riga, Gdańsk, Helsinki, Tallin, Rostock, Kiel, Lubeck and Klaipeda, and 14 popular resort towns are located along the Baltic coast. In addition, 32 big ports, 14 shipyards and 2 Baltic oil platforms operate in the Baltic Sea. The maritime transportation intensity accounts for > 2000 sizable ships at sea at any one time whilst the number of leisure boats is around 900,000. Fishery activities are mainly concentrated in the southern parts of the Baltic. However, due to data access issues it is currently difficult to get accurate information on fishing vessel movement (HELCOM, 2010).

Marine litter was collected in the framework of the Baltic International Trawl Surveys programme (BITS) realized by the National Marine Fisheries Research Institute (NMFRI, Poland) on R/V *Baltica*. Both sampling and reporting of marine litter were additional tasks of BITS surveys, recommended and partly coordinated by the Baltic International Fish Survey Working Group (WGBIFS - ICES; ICES 2015, 2016). Towing was performed at the water depth range of 19–110 m inside the Polish exclusive economic zone of the total area of 22,595 km² (Fig. 1), in February 2015, November 2015 and February 2016 (Table 1). Bottom sediments in the study area are strongly dominated by sand, silt and clay (Kramarska, 1995). In accordance with the standard procedure described in detail in the *Manual for the Baltic International Trawl Surveys* (2017), fish control-catch sites were randomly selected by the WGBIFS from the fixed list of sites sampled within the BITS programme. The standard rigging cod ground trawl type TV-3#930 (without bobbins and additional chains connected with the footrope) was applied. Mesh bar length of 10 mm in the codded

allowed sampling macro-litter and larger fractions of meso-litter.

Fish control-hauls were conducted at 3.0 knots vessel speed. The standard trawling-time was 30 min, however, the time was shortened to 15 min in a few hauls due to unexpected logistical reasons. Horizontal and vertical net opening was on average 32.0 and 5.5 m respectively. All litter items collected by trawling were manually sorted out and transported to the NMFRI laboratory for detailed analysis. The latter included litter categorization to the following litter categories: plastic, metal, rubber, glass/ceramics, derelict fishing gear, textiles, wood (wood items bearing visible traces of being anthropogenically modified was classified as wood of anthropogenic origin and was distinguished from natural wood), and miscellaneous. Items in each category were then enumerated and their size, weight and colour were determined and reported in the database. Weight was determined after removal of excess water, sediment and shells of sessile fauna often present on the litter surface. Fauna or their remains present on the litter surface were identified to the lowest possible taxonomic level.

3. Results

Overall, 131 trawls of a total area of 16.3 km² (4.9–16.9 ha/trawl with an average of 12.6 ha/trawl, SD = 2.6) were performed in this study. The biggest sampling effort expressed by both the number of trawls and the bottom area covered by trawling was made in depth ranges of 21–40 m and 51–60 m (Table 1, Fig. 2).

Debris was recorded in 86 tows (66% of the total number of tows), precisely in 63%, 49% and 80% of the tows realized in February 2015, November 2015 and February 2016, respectively. Litter densities varied between 0 and 0.8 items/ha, except two locations at the seawater depths of 57 and 58 m, where litter concentrations reached 1.36 and 2.23 items/ha, respectively (Fig. 2). Mean litter density reached a value of 0.20 items/ha (SD = 0.30).

In total, 334 litter items were encountered. The majority of items (40% of the total number of litter) were found at the depth range of 51–60 m. The lowest litter aggregations were recorded in shallow waters (7 items in total were found at depths < 20 m) and in the deepest stations (3–16 items per tow at depths > 80 m).

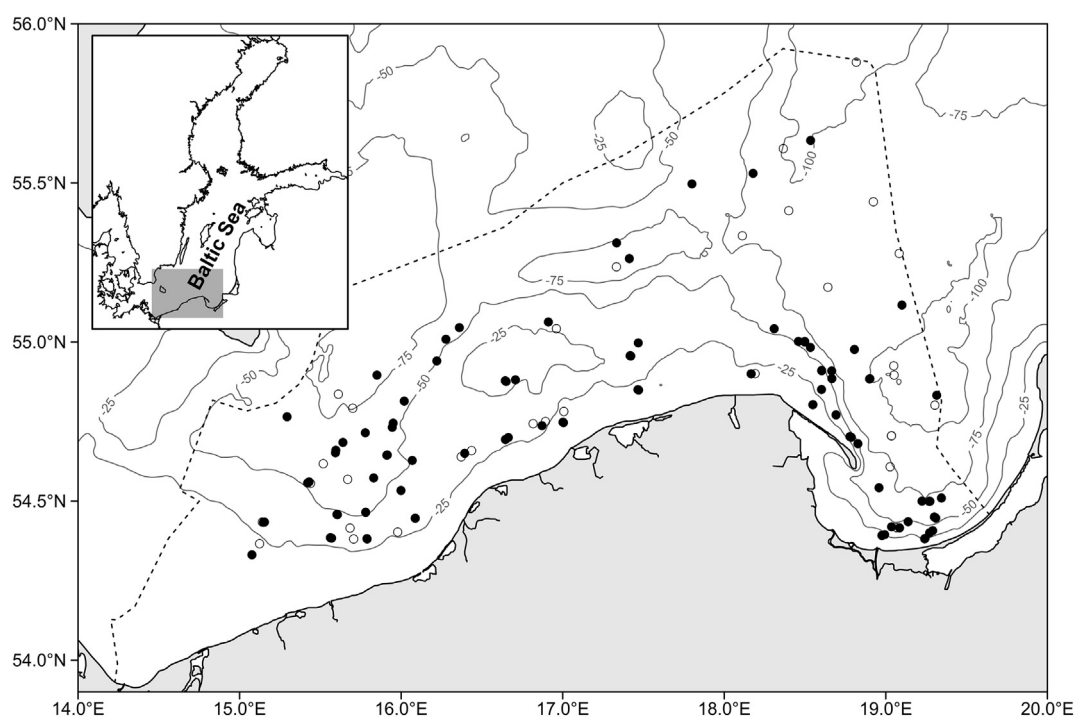


Fig. 1. Map of the study region and distribution of bottom trawls. Full and empty marks indicate trawls where litter was present and absent, respectively. Dotted line indicates the Polish exclusive economic zone.

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