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Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Marine litter in the Nordic Seas: Distribution composition and abundance

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ARTICLE INFO

Keywords:

Marine litter
Barents Sea
Norwegian Sea
Deep-sea
Fishing gear
Benthic pollution

ABSTRACT

Litter has been found in all marine environments and is accumulating in seabirds and mammals in the Nordic Seas. These ecosystems are under pressure from climatic change and fisheries while the human population is small. The marine landscapes in the area range from shallow fishing banks to deep-sea canyons. We present density, distribution and composition of litter from the first large-scale mapping of sea bed litter in arctic and subarctic waters. Litter was registered from 1778 video transects, of which 27% contained litter. The background density of litter in the Barents Sea and Norwegian Sea is 202 and 279 items/km² respectively, and highest densities were found close to coast and in canyons. Most of the litter originated from the fishing industry and plastic was the second most common litter. Background levels were comparable to European records and areas with most littering had higher densities than in Europe.

1. Introduction

Marine litter is defined as “any persistent, manufactured or processed solid material discarded, disposed or abandoned in the marine and coastal environment” and it has been estimated that 5–13 million tonnes of litter enter the oceans each year (Jambeck et al., 2015). The litter found in the world's oceans is highly diverse but plastics are by far the most abundant material recorded (Derraik, 2002; Barnes et al., 2009; Sheavly and Register, 2007). Litter type and density vary greatly among locations and litter has been found in all marine habitats, from surface water convergence (fronts) down to the deep sea (Barnes et al., 2009). Recently there has been an increased focus on how litter is distributed in the seas and how it may affect the marine ecosystems (Pham et al., 2014). Distribution and accumulation is influenced by hydrography, geomorphology (Barnes et al., 2009; Galgani et al., 2000), prevailing winds and anthropogenic activities (Ramirez-Llodra et al., 2013). Hotspots of accumulation include shores close to populated areas, particularly beaches (Corcoran et al., 2009), but also submarine canyons, where litter originating from land accumulates in large quantities (Galgani et al., 2000; Mordecai et al., 2011; Pham et al., 2014; Woodall et al., 2015). The sources of litter are variable, depending on distance from shore (Galgani et al., 1995; Mordecai et al., 2011), oceanographic and hydrographic processes (Galgani et al., 1996) and human activities such as commercial shipping (Ramirez-Llodra et al., 2013) and leisure craft (Bergmann and Klages, 2012).

The Nordic Seas represent a large area ~ 3.000.000 km², including the Barents Sea and the Norwegian Sea, with a shelf and slope

(50–4000 m) incised with canyons and troughs, bringing deep-sea close to the coast. The coastline is one of the longest in the world indented with very deep and long fjords. The population is and relatively small and the number of people and only a few industrial sectors contributes with litter to the system. Main activities are fisheries (including aquaculture), oil industry and shipping.

In this paper, we present the distribution and densities of marine litter based on video transects conducted by the Mareano mapping programme in the Nordic Seas, an area that has previously been underreported (Pham et al., 2014). Since 2006 Mareano has conducted more than 1778 video transects to document megafauna communities and their habitat. Litter has been recorded as part of this mapping. Based on this uniquely large dataset we provide a comprehensive overview of the density and composition of litter in different parts of the marine benthic ecosystems in the Nordic Seas. The results are compared with a review on the distribution and density of litter in European Seas (Pham et al., 2014), and the southern Atlantic and the Indian Ocean (Woodall et al., 2015).

2. Study area

The Norwegian Sea, a part of the North Atlantic Ocean, covers an area of about 1.5 million km². Its average depth is 1600 m, ranging from shallow banks to deep-sea basins where the depth reaches 3000–4000 m. It borders the Barents Sea off the northern coast of Norway (Fig. 1), and with the waters of the North Sea to the southeast of the Faroe Islands. The Norwegian Current, a branch of the Gulf

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Received 10 July 2017; Received in revised form 14 August 2017; Accepted 17 August 2017

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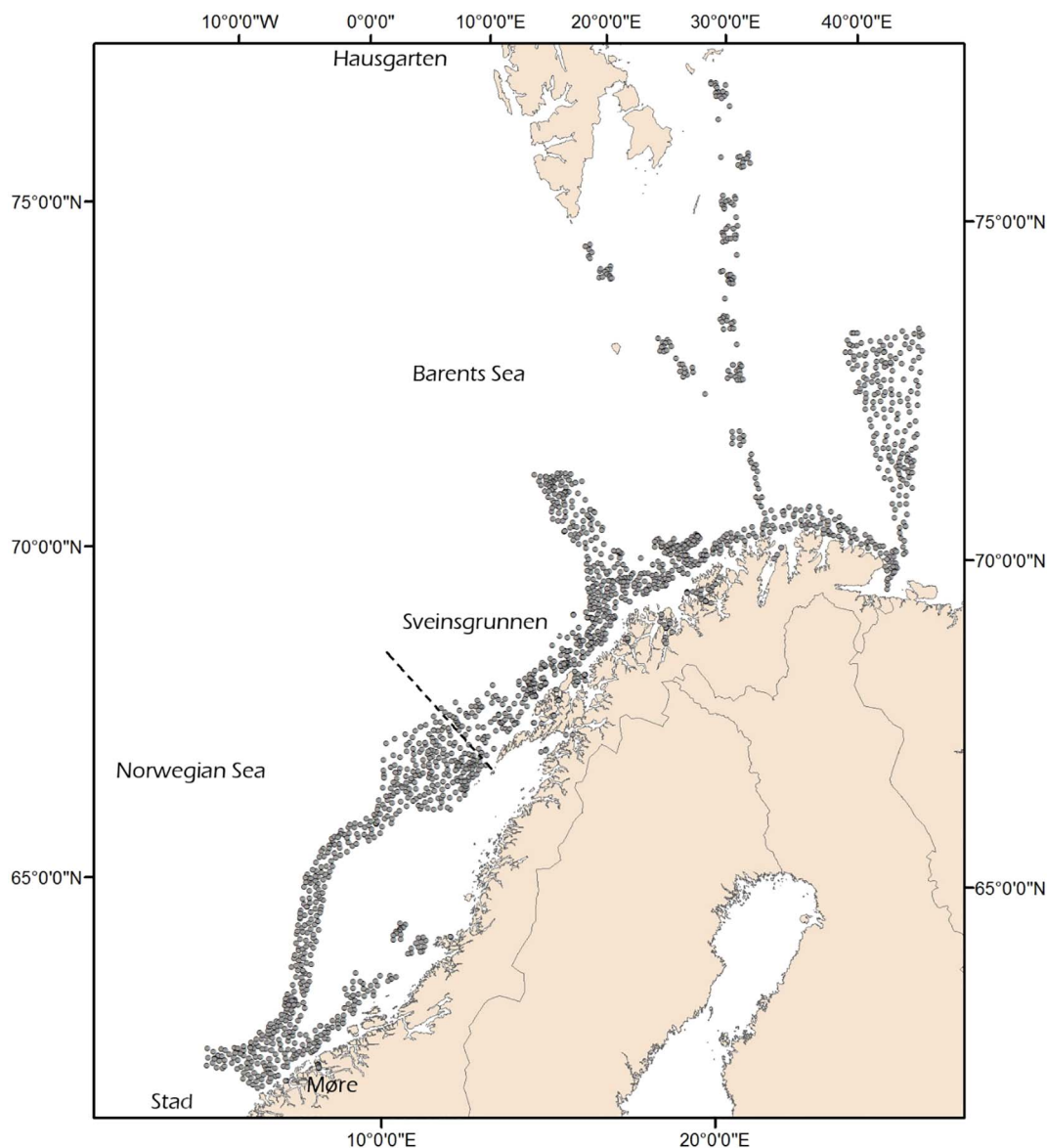


Fig. 1. Location of the 1778 stations sampled with video in the Nordic Seas (data from the Mareano programme 2006–2017). Dashed line marks the border between the Barents Sea and Norwegian Sea. Stations from inside the “Norwegian baseline” are defined as coastal observations.

Table 1

Video material used in the study with information on sampling year, number of cruise and video transects obtained from the two seas. All data is from the Mareano programme.

Year	No of cruises	Barents Sea	Norwegian Sea	Sum No of stations
2006	1	72		73
2007	2	141		143
2008	2	164		166
2009	1	133	1	135
2010	2	158	30	190
2011	3	32	169	204
2012	2		203	205
2013	3	98	123	224
2014	3	130	41	174
2015	2	58	79	139
2016	1	95		96
2017	1	51		52
Sum	23	1132	646	1778

Stream, transports warm water to the north past the United Kingdom (UK), through the Norwegian Sea and on into the Barents Sea. The inflow of warm, saline Atlantic water to the Norwegian Sea is about eight million tonnes per second – eight times the discharge volume of all the world's rivers.

The Barents Sea is a high latitude shelf ecosystem located between about 70° and 80° N on the north-western corner of the European continental margin. It is a shelf area (about 1.6 million km², mean depth 230 m) bounded in west and north by deep basins of the Norwegian Sea and the Nansen Basin of the Arctic Ocean.

The bottom topography with banks and basins steers the currents and governs the distribution of water masses in the Barents Sea (Loeng, 1991). The Norwegian Current splits into two main branches, one flowing into and through the Barents Sea from southwest to northeast, the other flowing around the western and northern flanks of the Barents Sea as the West Spitsbergen Current (Skagseth, 2008; Ingvaldsen and Loeng, 2009; Ozhigin et al., 2011). Cold fresh Arctic waters arrive from the Arctic Ocean, entering the Barents Sea between Nordaustlandet and

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