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Litter on the seafloor along the African coast and in the Bay of Bengal based on trawl bycatches from 2011 to 2020

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A R T I C L E I N F O

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A B S T R A C T

We present the occurrence of seafloor litter on the coast of Africa and in the Bay of Bengal based on records from the EAF-NANSEN Programme in 2011 to 2020. Litter bycatch records from 534 bottom trawls were standardized to km^2 before analysis. Three percent of the records indicated areas of high littering and the highest densities occurred from 100 to 300 m in depth and 50 to 100 km from the coast. Littering was lower in the Indian Ocean compared to Atlantic Africa. Plastic objects and fishing gear dominated the recorded items (47 % and 22 % respectively) but, regional differences were pronounced. Plastic dominated North Atlantic and East African records (58 % and 80 % respectively) and fishing gear dominated (69 %) in South Atlantic Africa while records from the Bay of Bengal were a mix of categories. The relation between littering and population density, marine industry, major cities, and rivers is discussed.

1. Introduction

The marine environment is subject to pollution threats from several sources, including litter. UNEP defines marine litter as any persistent solid matter, manufactured or transformed, discarded, disposed of, or abandoned in the marine and coastal environment (UNEP, 2009). Litter is made up of a wide range of sizes, shapes and compositions, including plastic, metal, glass and wood. Categories of litter and their densities vary greatly among locations, and litter, in general, has been found in almost all marine habitats ranging from surface waters down to the deep-sea milieus (Barnes et al., 2009). The estimates of the quantity of floating plastics on the ocean surface are approximately 1 % or less of the estimated quantity of plastics that enters the ocean/year (van Sebille et al., 2015). This demands attention to sunken litter, and the underlying factors that contribute to such litter. Marine litter that is composed of some materials that are denser than seawater, such as glass, metals, and certain types of polymers, easily reach the bottom of open seas and oceans, where they can become entangled in corals, interfere with benthos, or even become buried in sediment (Pattiaratchi et al., 2021). Targeted studies of seafloor litter require visual seafloor mapping, however, observations from camera or video are available only from a few study areas (Pham et al., 2014, Bergmann et al., 2017, Buhl-Mortensen and Buhl-Mortensen, 2017). In the absence of adequate dedicated seafloor litter surveys, litter captured as 'bycatch', during bottom trawl surveys, can provide valuable information on seafloor littering (Grøsvik et al., 2018). In the African region and Bay of Bengal, a growing number of studies have focused on the accumulation of litter on beaches and in offshore surface waters, but there is little information on litter in deeper waters (Pattiaratchi et al., 2021; Loulad et al., 2017). Marine litter has the potential to have a negative impact on fishing activities, which

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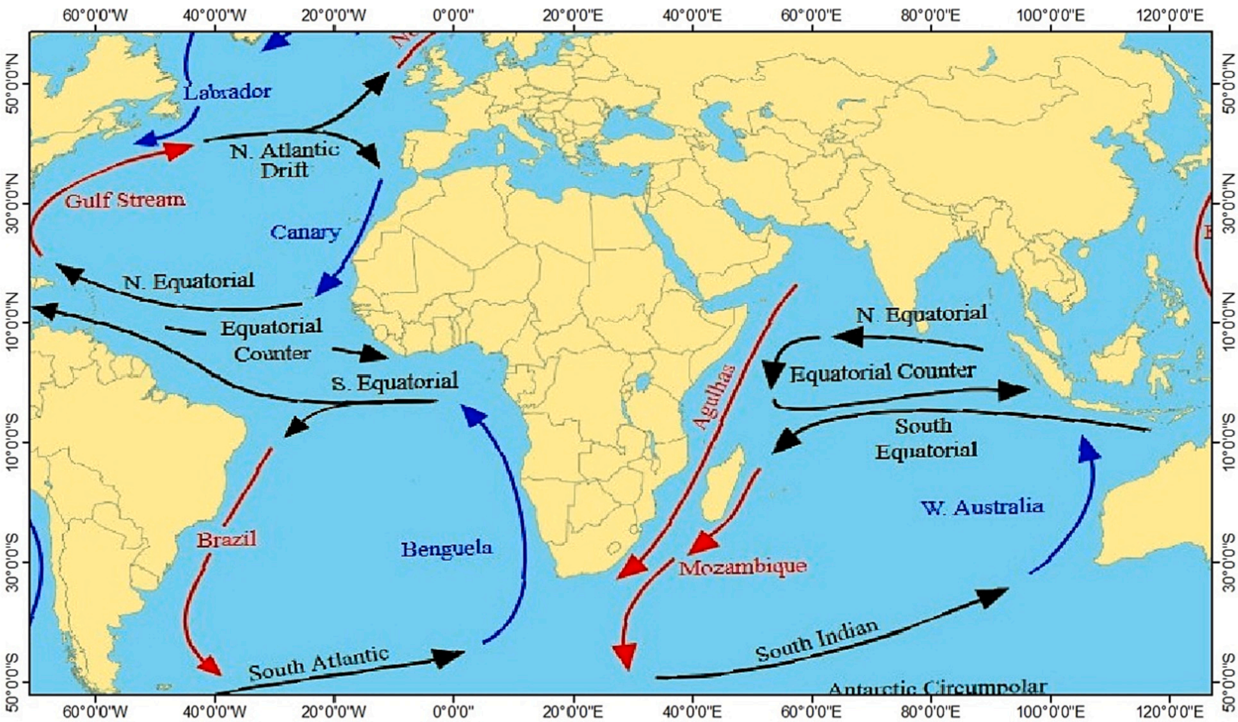

Fig. 1. Ocean currents in the region of Africa and the Bay of Bengal. Warm ocean currents that originate near the equator and move towards the poles or higher latitudes while cold currents originate near the poles or higher latitudes and move towards the tropics or lower latitudes (black arrows). The Warm Currents (red arrows) flow from the low latitudes in Tropical Zones towards the high latitudes in the Temperate and Subpolar Zones. The Cold Currents (blue arrows) flow in the high latitudes from the Polar Regions towards the low latitudes in the warm Equator region.
(Source: http://www.gkplanet.in/2017/05/oceanic-currents-of-world-pdf.html).

employ >12 million Africans. In addition, marine litter poses a potential threat to marine ecosystems, economic development, and the vision of a blue economy (Sambyal, 2018). Among the countries with large amounts of mismanaged waste, many are located along the Indian Ocean rim (Jambeck et al., 2015, 2018), indicating that the deep-sea litter in the Bay of Bengal needs to be assessed in detail. This signifies a fundamental gap in the understanding of the fate of ocean plastics and suggests that there are unknown sinks of marine plastic litter in the Bay of Bengal (Pattiaratchi et al., 2021). The EAF-Nansen Programme of the Food and Agriculture Organization of the United Nations (FAO) is part of a long-lasting effort that started in 1975 with the aim of improving food security in partner countries through improved utilization of fishery resources (Groeneveld and Koranteng, 2017). Surveys with the RV. Dr. Fridtjof Nansen have been an integral part of the Programme since it commenced. The vessel, operated by the Institute of Marine Research (IMR), in Norway, has allowed the collection of marine fishery resources and environmental data, and since 2011, bycatch of macro litter has been reported on a regular basis. Bycatch of litter from 534 bottom trawls was reported from 2011 to 2020 at depths from 20 to 1000 m. This dataset provides new information on seafloor litter along the coast of Africa and the Bay of Bengal, a large area from which very few studies of seafloor litter exist. Here we present the distribution, density and composition of the litter reported and the results are compared with coastal population density, waste management, fishing and shipping activity, distance to land, and the location of major cities, and river outfalls.

2. Study area

2.1. The current systems

Fig. 1 shows the main ocean currents in the region of Africa and the Bay of Bengal. Africa is located between the Atlantic Ocean to the west and the Indian Ocean to the East. The Indian Ocean covers several marine management plans including the Bay of Bengal and the Agulhas/Mozambique Channel. Around the coast of Africa, there is a dominance of warm water, except the Northwest and the Southwest coastlines, characterized respectively by the cold Canary current and the cold Benguela current, South Africa, which have moderate temperature with small ranges. The wind-driven circulation of the North Indian Ocean is forced by the seasonal changes in the monsoonal winds and reverses radically with the season. The semi-enclosed nature of the Bay of Bengal and its proximity to the equator together with an immense quantity of freshwater influx from the Ganges and Brahmaputra rivers (Bangladesh) contribute to the formation of a highly complex system of circulation in this region (Potemra et al., 1991). According to Babu et al. (2003), several studies have reported that during the spring inter-monsoon the circulation in the Bay of Bengal consists of a large anticyclonic gyre that develops in the Bay. The western boundary current along the east coast of India is part of the recirculation portion of the gyre (Legeckis, 1987; Potemra et al., 1991).

2.2. Major river systems

In the recent past, due to rapid population growth, fast urbanization, and industrialization in Africa and in countries around the Bay of Bengal, the quantities of wastewater and solid waste discharged into the rivers are increasing and problems of water pollution are emerging.

In Africa, the lines of the rivers within their watersheds follow capricious contours, sometimes very close to an ocean, sometimes moving away from it to enormous distances. On the Atlantic side, the northern zone of Morocco is the best-watered part, sending a few streams to the ocean with a total flow hardly exceeding 200 m^3. From there to Senegal, over 3000 km of coast, there is no longer a permanent river, but only wadis filled with rain. From Senegal, begins the area of the most numerous and powerful rivers. The Senegal river is among the

Table 1
Available bottom trawls from the EAF-NANSEN Programme from 2011 to 2020. Numbers are listed by year and country listed from north to south and grouped in the regions: North Atlantic Africa, South Atlantic Africa, East Africa, and the Bay of Bengal. Grey colored cells indicate that no records of litter were made. TR: numbers of bottom trawls conducted and TRWL: trawls recorded containing litter.

	Years	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020		Total	Total	%
Region	Countries	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TR	TRWL	TRWL
NA Africa	Morocco	121	20	145	5					45				30				8	1	73	18	422	44	10.4
	Mauritania	52	5	52	2					1	1			6				10	5			121	13	10.7
	Senegal	44	9	44	2	5				5	2			9	2			11	2			118	17	14.4
	Gambia	13		8	1					1								1				23	1	4.3
	Cape Verde Islands	30	3																			30	3	10.0
	Guinea Bissau	28	7	26	2									8	2			26	22			88	33	37.5
	Guinea	30	10	24	1									12	6			46	38			112	55	49.1
	Sierra Leone													7	1			23	23			30	24	80.0
	Liberia													11	2			25	14			36	16	44.4
	Cote d'Ivoire													8	2			53	30			61	32	52.5
	Ghana	4		4								75	15	6	2			58	56			147	73	49.7
SUM		322	54	303	13	5				52	3	75	15	97	17			261	191	73	18	1188	311	26.2
SA Africa	Gabon							46						10	1							56	1	1.8
	Angola	194	1	219	7	284	11	261	10	243	2	195	3	24	1			182	65			1602	100	6.2
	Namibia	56		42	4	11				52		172		27				179	6			539	10	1.9
	South Africa	138		144	5	139	7									20	1	153	5			594	18	3.0
SUM		388	1	405	16	434	18	307	10	295	2	367	3	61	2	20	1	514	76			2791	129	4.6
E Africa	Tanzania															30	5					30	5	16.7
	Mozambique							105	1							139	7					244	8	3.3
SUM								105	1							169	12					274	13	4.7
Bay of Bengal	Seychellene															4	1					4	1	25.0
	Bangladesh															5	1					5	1	20.0
	Myanmar					145	14			173	10					140	22					458	46	10.0
	Thailand															19	14					19	14	73.7
	Sri Lanka															69	19					69	19	27.5
SUM						145	14			173	10					237	57					555	81	14.6
	Total	**710**	**55**	**708**	**29**	**584**	**32**	**412**	**11**	**525**	**15**	**442**	**18**	**160**	**19**	**426**	**70**	**775**	**267**	**73**	**18**	**4815**	**534**	**11.1**

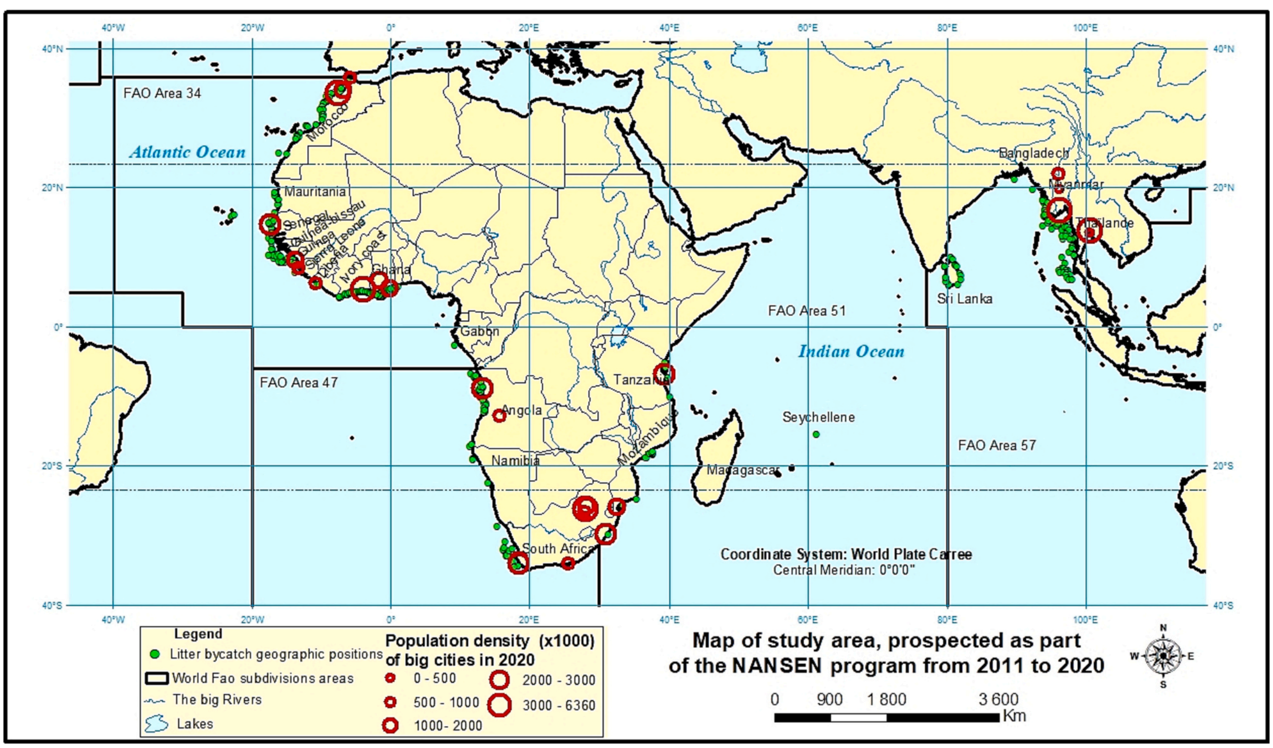

Fig. 2. Map showing all trawl localities (green circles) from which litter was reported from bottom trawls during the period 2011–2020 in the EAF-NANSEN Programme. Major cities are marked with red circles and size indicates city population.

rivers of secondary importance: its length does not exceed 1700 km; its flow rate at low water only reaches 50 m^3/s. In times of flood, its flow increases in a very strong proportion, and it becomes navigable — in its middle and lower course. Further, south, most of the rivers are coastal with relatively low development. Between the mouths of Senegal and Niger, the two most important rivers are the Gambia and the Volta.

By its flow, the Niger ranks among the first rivers in the world. In the Congo, the coast runs parallel to the Crystal Mountains, leaving between them and the sea a narrow coastal zone. The important Congo River opens a passage through these Crystal Mountains and the area where its water enters the Atlantic is shrinking.

The Indian Ocean side has only one large river: the Zambezi. The Zambezi ranks fourth among the major rivers of the African continent; it comes after the Congo, the Niger, and the Nile. In the Bay of Bengal, the Ganga is the largest and the most important river. The Ganga basin is part of the composite Ganga-Brahmputra-Meghna basin, which lies in

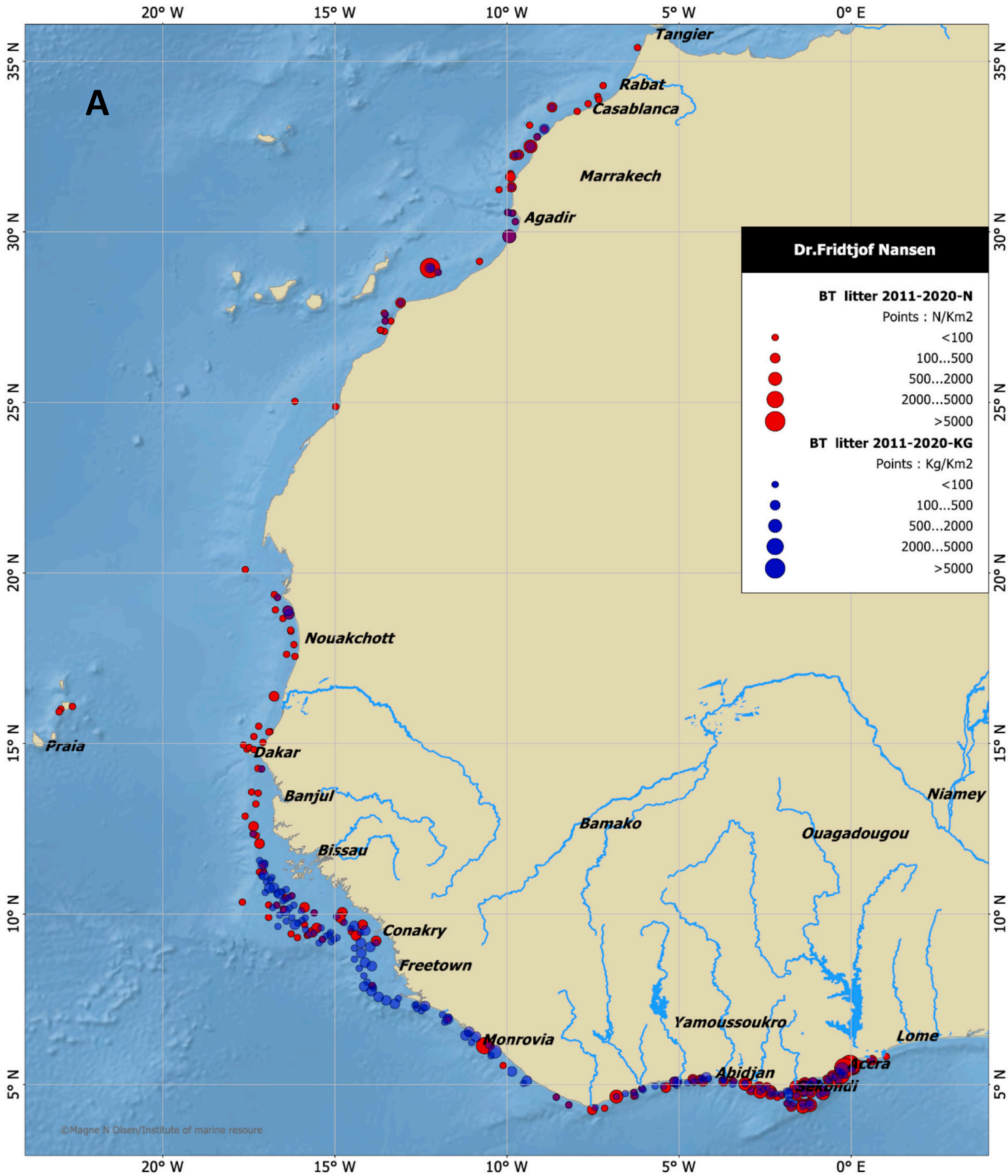

Fig. 3. Maps showing localities where litter was recorded in trawl bycatches from the EAF-NANSEN Programme from 2011 to 2020. A. Records from North Atlantic Africa, B. records from South Atlantic Africa and East Africa, and C. records from the Bay of Bengal. Item numbers/km^2 is marked with blue circles and weight in kg/km^2 with red circles, size indicating the amount recorded.

China, Nepal, India, and Bangladesh and drains an area of 1,086,000 km^2. 80 % of this area is in India where 40 % of the population of India lives. The Ganga River is joined by many tributaries on both the banks in the 2525 km long course to the Bay of Bengal (Trivedi, 2010).

3. Material & methods

Data were gathered from surveys conducted by the cruises RV Dr. Fridtjof Nansen led by the Institute of Marine Research in the period from 2011 to 2020. A total of 534 bottom trawls from 22 countries covering the north and south Atlantic coast of Africa, East Africa, Thailand, Sri Lanka, and Myanmar in the Bay of Bengal. Surveyed sites were located on continental shelves and slopes, ocean ridges, and deep basins, at depths ranging from 20 to 1000 m (Table 1 and Fig. 2).

Bycatches were recorded from bottom trawl hauls conducted using an otter trawl. The width of the trawl was 18.5 m, mesh 2.4 cm, and time and speed were in general 30 min and 3 knots, respectively. Macro litter (>2.5 cm) in the trawl catch was either counted or weighed, and

Fig. 3. (*continued*).

numbers were estimated to density/km^2 based on the area covered by the trawl. The area trawled was calculated for each catch as trawled distance multiplied by trawl width. For the 534 bottom trawls with bycatch reports on litter the categories of litter were reported as items for 360 trawl hauls and weight was reported for 323 trawls. Litter was recorded as six main categories: unidentified waste, plastic, plastic cans-jars, etc., metal, fishing gears, and wood, paper, cardboard as a mixed category, following coarse categories in OSPAR (2010) and Keller et al. (2010). On some cruises, litter was recorded mainly in the two categories, plastic, and unidentified waste, but the large dataset with many records using a broader set of categories allows for analysis of patterns in composition.

During the period 2011 to 2020 litter bycatch information was reported from 22 countries, 11 on the coast of North Atlantic Africa (NAA), four from South Atlantic Africa (SAA), two from East Africa (EA), and five from the Bay of Bengal (BB) (Table 1). From NAA litter information was available from 311 trawl hauls conducted mainly in 2011, 2012, 2017, 2019 and 2020 and mostly from surveys off Ghana, Guinea, and Morocco. For SAA records are available from 129 trawl hauls mainly conducted in 2019 and on the coast of Angola. The recorded litter from EA was from 13 trawl hauls mainly from 2018 and from the countries Tanzania and Mozambique. In the BB litter reports from a total of 81 trawl hauls were available from surveys conducted in 2013, 2015, and 2018, the latter with most records and mainly from Myanmar.

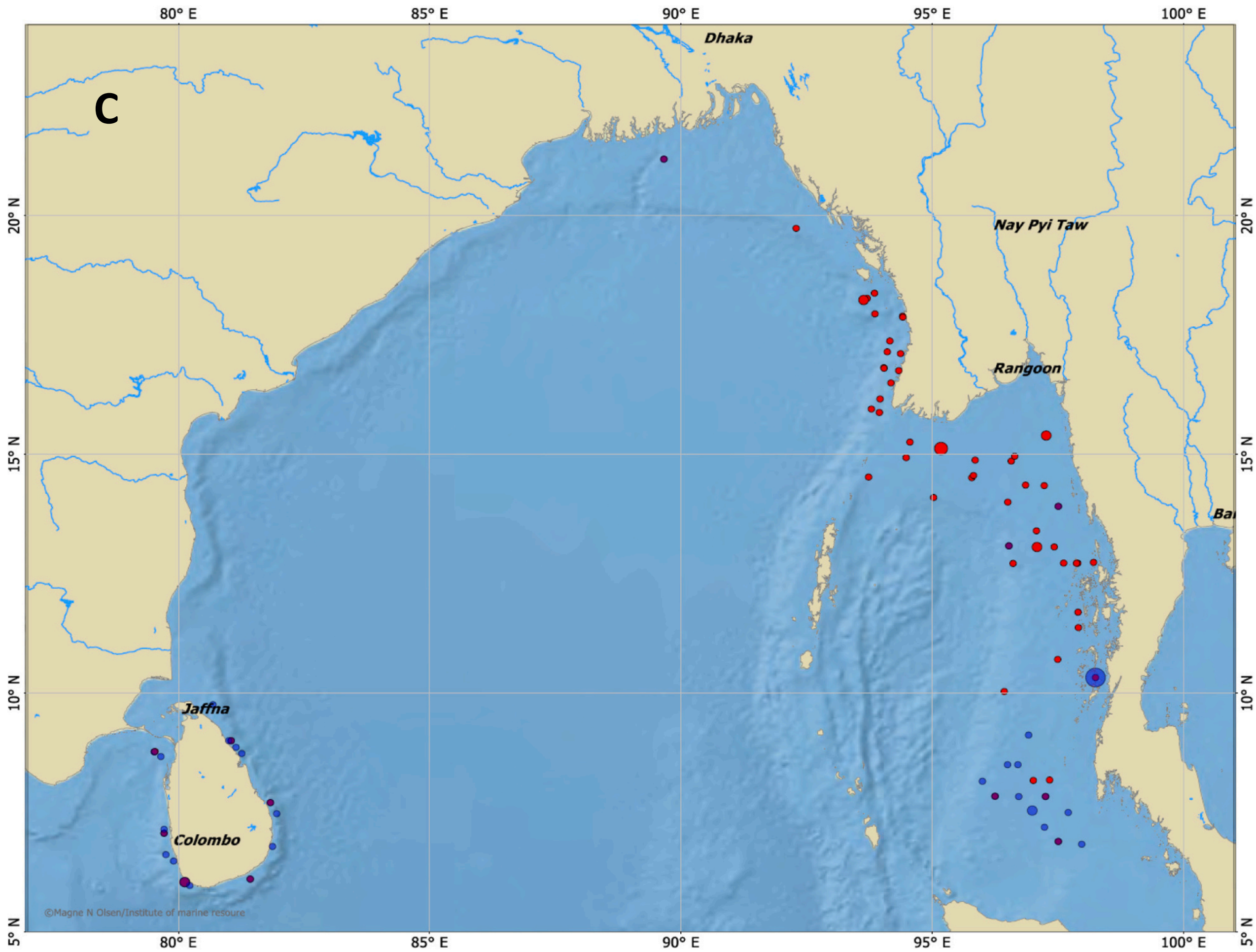

Fig. 3. (*continued*).

The proportion of trawls containing litter is relatively low in SAA and EA compared to NAA and depending on the country it ranges from 1.8 % to 80 %. From around 2010 recording of litter in bottom trawls has become a standard procedure on the Nansen surveys although depending on workload litter may not have been recorded for all trawls and on all surveys. On that basis, we are reporting litter abundance and composition based only on data from trawls that were reported to contain litter. An absence of a record of litter should not be viewed as records of no seafloor litter being present. However, when litter has been recorded the total catch has been recorded as weight or numbers per trawl. Clearly, the number of trawls with litter bycatch recorded differs much between countries, and for some, there are only very few data. Even so, a single trawl with very high densities of litter shows that there are sites along a country's coastline that are strongly affected by littering.

4. Results

In total, >5000 litter items were recorded from 360 trawls and 1600 kg litter from 323 trawls. The average number and weight of litter items recorded in the 22 countries are indicated on the map in Fig. 3 and listed in Table 2. Traditionally, litter has been recorded as numbers but recently records of weight are more common and the EAF-NANSEN Programme data from 2011 to 2020 has almost the same number of records for each type of quantification. Litter has often been reported either as numbers of items or weight and only a few of these records relate to the same bycatch sample.

4.1. Density and distribution

The Density of litter in the study area showed large variations. For records of items, the range was from 11 to 21,275 items/km^2 with an average of 291 items/km^2. Most records (97 %) showed litter densities lower than 1000 items/km^2 regarded as the upper limit for low littering by Pham et al. (2014) based on records in European waters. Based on these observations the average was 99 and a median of 38 items/km^2. For the 3 % of the bycatch records with the density of litter larger than 1000 items/km^2 three records had densities larger than 7000 items/km^2 which are the maximum densities reported from European waters (Pham et al., 2014). A density of 21,276 items/km^2 was reported from off the Moroccan coast halfway between Morocco and the islands of Las Palmas; 16,431 items/km^2, 73 km from the coast of Namibia, and 10,413 items/km^2, 6 km from the coast of Ghana. These areas can be considered 'hot-spot' areas. Weight records of litter ranged from 0.03 to 9414 kg/km^2 and the average was 131 kg/km^2. Most records (96 %) showed <500 kg/km^2, and for these, the average was 46 kg/km^2 and the median of 16 kg/km^2. Four percent of the records had >400 kg/km^2 which was the largest value found by Pham et al. (2014).

4.1.1. Depth and distance to coast

We investigated the relationship between littering and depth (Fig. 4A and B). Most trawls containing litter were from 50 to 100 m in depth and the largest records of litter as items were from 100 to 300 m (Fig. 4A). The density of litter in the zone from 50 to 300 m was in general low <1000 items/km^2, but a few very high records were from this zone.

Table 2
Bycatch of litter reported from 534 bottom trawls collected as part of the EAF-NANSEN Programme from 2011 to 2020 listed by region and countries. N: number of samples with litter and average, median, maximum and minimum observations per country is provided. For 360 trawls litter was recorded as items and for 323 trawls weight has been recorded.

Region	Country	Total	Items/km^2					Weight (kg)/km^2				
			N	Average	Median	Min	Max	N	Average	Median	Min	Max
NA Africa	Morocco	44	43	652.4	56	17.7	21,275.5	22	101.6	3.8	0.04	1691.9
	Mauritania	13	13	104.4	51	11.1	386.2	4	196.4	204.6	0.22	376.2
	Senegal	17	17	37.1	19	12.4	114.3	2	31.2		2.08	60.3
	Gambia	1	1	19.6		19.6	19.6					
	Cape Verde Islands	3	3	32.3	38	18.2	40.8					
	Guinea Bissau	33	13	50.9	25	13.6	252.2	22	55.1	24.9	0.31	220.3
	Guinea	55	18	115.3	67	15.1	393.6	38	64.7	37.6	0.35	440.7
	Sierra Leone	24	2	35.0		17.0	53.0	23	81.9	28.6	0.69	329.9
	Liberia	16	5	862.2	20	18.0	4199.8	14	118.3	80.1	0.04	585.1
	Cote d'Ivoire	32	19	165.3	89	16.4	1215.4	32	27.9	3.2	0.04	197.8
	Ghana	73	51	676.4	276	17.2	10,412.6	59	38.7	4.6	0.04	656.3
Region	NA Africa	311	185	250.1	51	11.1	21,275.5	216	79.5	26.8	0.04	1691.9
SA Africa	Gabon	1	1	42.3		42.3	42.3					
	Angola	100	80	87.3	36	16.4	1399.5	58	278.5	16.3	0.18	9413.5
	Namibia	10	8	2310.3	106	18.5	16,430.5	3	1595.3		4.33	4198.4
	South Africa	18	15	31.3	20	16.9	116.6	5	88.1	38.1	6.66	287.2
Region	SA Africa	129	104	617.8	36	16.9	16,430.5	66	654.0	27.2	0.18	9413.5
E Africa	Tanzania	5	4	72.6	68	20.5	134.0	3	32.6		2.82	74.4
	Mozambique	8	7	29.0	22	17.6	57.2	2	299.2		12.97	585.5
Region	E Africa	13	11	50.8	45	17.6	134.0	5	165.9		2.8	585.5
Bay of Bengal	Seychelles	1	1	19.7		19.7	19.7					
	Bangladesh	1	1	49.4		49.4	49.4	1	25.7		25.70	25.7
	Myanmar	46	46	56.0	23	16.6	764.3	4	1400.0	1.0	0.45	5597.8
	Thailand	14	5	38.8	39	19.6	59.9	12	39.8	22.5	2.06	151.4
	Sri Lanka	19	7	52.7	26	18.1	182.2	19	29.9	6.5	0.03	265.1
Region	Bay of Bengal	81	60	43.3	26	16.6	764.3	36	373.8	6.5	0.03	5597.8
	Total	534	360	290.5	40.5	11.1	21,275.5	323	130.7	26.8	0.03	9413.5

Below 300 littering was low in general. The pattern for items and weight records agreed in general however there were large amounts of litter recorded as weight below 500 m in contrast to records of items (Fig. 4B).

The relation between littering and distance to the coast (Fig. 4C and D) showed a bimodal pattern for records of items, high 0–10 km from the coast, and after a decrease, a new peak occurred at 50 to 100 km from the coast, followed by a decrease further out. The highest densities were related to the second maximum. The pattern for litter reported as weight was unimodal with the largest values at intermediate distances from the coast (15 to 75 km).

4.1.2. *Density by region*

In what follows we report litter records for the four regions, North and South Atlantic Africa (NAA & SAA), East Africa (EA), and the Bay of Bengal (BB) followed by observations per country. More than 50 % of the bycatch records were from 11 countries in the NAA region and of these most records were from Ghana, Guinea, and Morocco (Table 2). The regional average density and weight of litter was 250 items and 80 kg/km^2, respectively. No country had an average above 1000 litter items/km^2, the European based upper limit for low litter densities (Pham et al., 2014), and Liberia had the highest average density with 862 items/km^2. The average weight of litter was below 200 kg/km^2 with the highest average from Mauritania (197 kg/km^2). The maximum density and weight recorded by a trawl were from the coast of Morocco (21,276 items and 1692 kg/km^2) followed by Ghana (10,413 items and 656 kg/km^2). This is double the largest densities (6600 items/km^2) reported from European waters by Pham et al. (2014), where densities higher than 2000 items/km^2 are regarded as high. However, littering of the same magnitude (12,000 items/km^2) was observed on the Norwegian coast (Buhl-Mortensen and Buhl-Mortensen, 2017). Fewer records (~25 %) were from the SAA region and the average density and weight of litter for the region were 618 items and 654 kg/km^2, respectively, this is many times higher than in NAA, and the recorded weight of litter was particularly large. The highest density of litter recorded in the region was 16,431 items/km^2 from off Namibia, while the largest weight record was from Angola, 9414 kg/km^2.

From the EA region, trawl bycatches of litter were only reported from two countries (2.5 % of the records) and the average density for these records was low, 51 items/km^2, but the weight was higher than in NAA (166 kg/km^2) and lower than in SAA. The highest recorded density (134 items/km^2) was from Tanzania while Mozambique had the regional maximum record of 586 kg/km^2. The BB region contributed 15 % to the litter records and as in EA the mean density was very low (43 items/km^2), however, the mean weight of litter was relatively large (374 kg/km^2). Most records in this region came from Myanmar and that had included the highest value recorded with 764 items/km^2 and 5598 kg/km^2.

4.1.3. *Density by country*

The data included 22 countries and for most the average density of seafloor litter was low and only Namibia and Myanmar have densities indicating high littering in general (Table 2, Figs. 3, and 5). However, several countries had records of very high densities e.g., Morocco, Liberia, Ghana, Angola, Namibia, and Myanmar. Records of weight showed high densities and the largest numbers, 9414, 5598, and 4198 kg/km^2, were 10 to 20 times the maximum of 400 kg/km^2 reported by

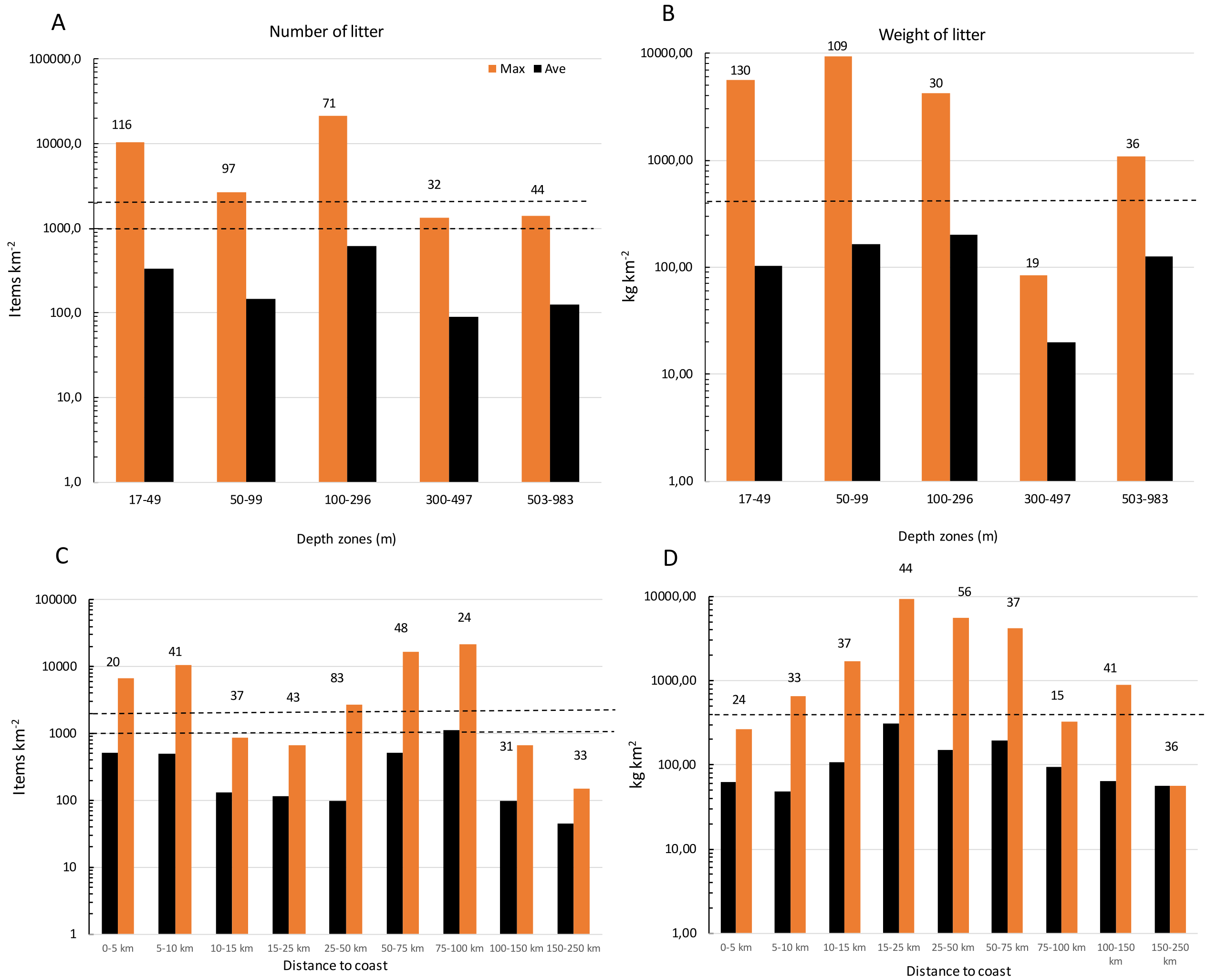

Fig. 4. Density and weight of litter for five depth zones (A and B) and related to distance to land (C and D) based on records from the EAF-NANSEN Programme in the period 2011–2020. The number of trawl bycatch records for each zone is given above each column. A and C are based on records of litter items from 360 trawls, while B and D are from litter records provided as weight from 323 trawl. Black bars are average values and orange are highest record. Horizontal dashed lines in A and C are density levels from Pham et al. (2014) based on European data. For litter items, low density: <1000 items/km^2, medium density: 1000–2000 items/km^2, and high density > 2000 items/km^2. In B and D, the horizontal dashed line is the maximum recorded weight of litter (400 kg/km^2) reporter from Europe.

Pham et al. (2014), based on bottom trawl bycatches from the Mediterranean Sea.

4.2. Litter composition

In the reports on litter bycatches from the EAF-NANSEN Programme litter was recorded in six categories. Here we start by presenting the general results, followed by the composition of litter at the regional level and last the composition of litter recorded from different countries.

Overall macro litter recorded as items in trawl bycatches were dominated by plastic (including cans and jars) and fishing gear that contributed 48 % and 22 %, respectively (Table 3 and Fig. 6A). Records provided as weight were dominated by unidentified waste and fishing gear with 66 % and 21 %, respectively, and plastic contributing only 10 % (Fig. 6B). There was no significant linear relation between the density of the different litter categories on the seafloor and depth or distance to land (Table 4A–D). The relation between density of plastic and distance to land was negative while the three categories, wood, metal, and plastic cans or jars, were positively correlated to depth.

4.2.1. Litter composition by region

Seafloor macro litter differed in composition between regions (Table 3 and Fig. 7). Litter reported as number of items was dominated by plastic in NAA and EA that contributed to the total record with 58 % and 80 %, respectively, while in SAA and BB the dominating category of litter was fishing gear 69 % and 50 %, respectively. Litter recorded provided as weight gave a different picture of litter composition. Fishing gear dominated in NAA and BB contributing with 26 % and 86 % to total weight respectively, while unidentified waste contributing with 86 % in weight to the recorded litter in EA and 87 % in SAA.

4.2.2. Litter composition by country

The composition of seafloor litter recorded from the 22 different countries varied substantially (Table 3 and Fig. 8). For several countries recorded number of items were dominated by unidentified waste e.g., Morocco, Cape Verde Islands, Bangladesh, or recorded as weight were categorized as unidentified waste (Fig. 8A). For 14 of 22 countries plastic was the dominant category for litter reported as number of items, however records of fishing gear were relatively high for Mauritania and Senegal in NAA, Namibia in SAA and Myanmar and Thailand in BB. Metal was relatively high in records from Angola.

Litter categories reported as weight were also dominated by unidentified waste, in addition to records of fishing gear (Fig. 8B). Fishing gears dominated records of weight for Morocco, Mauritania, Ivory

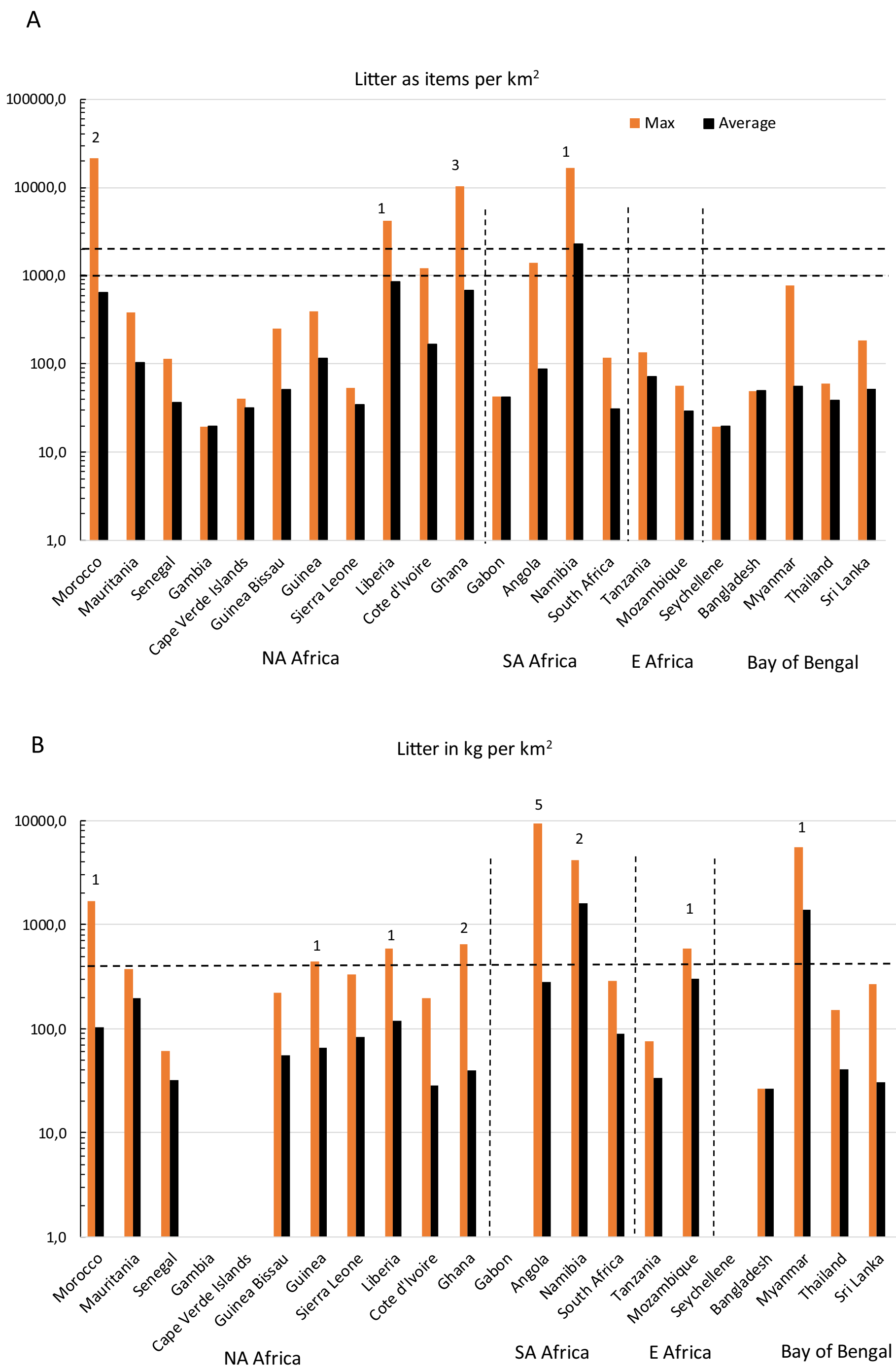

Fig. 5. The density of macro litter by country ordered by region and within regions from north to south based on litter records from 534 trawls from the EAF-NANSEN Programme from 2011 to 2020. A. Litter records provided as items from 360 trawls, and B. records given as weight from 323 trawls. Black bars are country average values and orange highest record. Horizontal dashed lines are density levels from Pham et al. (2014) based on European data. For litter items, low density: <1000 items/km^2, medium density: 1000–2000 items/km^2, and high density > 2000 items/km^2. In B, the horizontal dashed line is the maximum recorded weight of litter (400 kg/km^2) reporter from Europe.

Coast, Myanmar and Sri Lanka. Metal waste is observed in weight for Ghana, Angola, Namibia and Sri Lanka. Plastic totally dominated records from Senegal and Tanzania, and interestingly plastic cans and jars were the main source of plastic recorded by weight from Namibia.

5. Discussion

5.1. Data

Data were available from 22 countries, >50 % are in North Atlantic Africa (NAA), ~25 % from South Atlantic Africa (SAA), 2.5 % from East Africa (EA) and 15 % from Bay of Bengal (BB) (Table 1). Clearly the available records are not covering the regions and countries equally well which affects our results on the density, distribution, and composition of the liter. Even so a single trawl with very high densities of litter shows that there are sites along a country's coastline that is strongly affected by littering. The recorded macro litter (>2.5 cm) was either counted or weighed and only on a few occasions both were recorded for the same bycatch of litter. Because there is no easy way to convert between these two quantifications methods, we have reported on these records separately as was done also by Pham et al. (2014). There was also a lack of litter categories reported from some of the cruises early in the period when mainly the categories, unspecified waste, and plastic were used. Our analysis shows that results are very different depending on whether

Table 3
Categories of macro litter recorded in bycatches from 534 trawls from the EAF-NANSEN Programme in the period 2011–2020 listed by region and country. Densities provided as average number of items/km^2 are based on 360 bottom trawls and as kg/km^2 based on 323 trawls.

Region	Country	Items/km^2						Weight (kg)/km^2					
		Waste unid.	Plastic	Metal	Fishing gears	Wood ++	Plastic cans-jars	Waste unid.	Plastic	Metal	Fishing gears	Wood ++	Plastic cans-jars
NA Africa	Morocco	507.1	59.3	0.9	11.8		16.5	5.84	12.03	0.04	32.24		0.25
	Mauritania		35.3		68.1				0.02		60.42		
	Senegal		14.8	3.0	16.6				3.55		0.12		
	Gambia		17.8										
	Cape Verde Islands	33.0											
	Guinea Bissau	0.5	16.2	0.5	2.1			36.35	0.36				
	Guinea		37.0	0.3	0.3	0.3		43.79	0.33	0.02	0.55		
	Sierra Leone	0.7	2.3					77.12	1.35				
	Liberia	1.1	271.5		2.2			79.66	5.49		18.34		
	Cote d'Ivoire	7.5	90.2		0.5			7.92	3.11		16.86		
	Ghana	22.0	405.0	16.2	34.0			10.07	13.04	2.36	5.82		
	Region	78.2	137.5	4.2	13.9	0.1	2.3	36.94	8.29	0.81	16.18		0.05
SA Africa	Gabon		33.1										
	Angola	16.2	25.9	13.4	3.7	5.0	5.0	134.35	4.27	3.69	0.20	1.77	10.00
	Namibia	23.0	26.9	14.5	1624.1			427.89		58.31			
	South Africa	1.1	18.2	2.0	2.1			19.09	0.37		1.35		
	Region	14.5	25.0	11.8	129.1	3.9	3.9	273.59	6.57	14.43	0.67	2.69	15.15
E Africa	Tanzania	7.6	44.4		4.5				17.97				
	Mozambique	4.8	20.6					67.94					
	Region	5.9	29.8	0.0	1.7			108.71	17.97				
Bay of Bengal	Seychelles		18.0										
	Bangladesh	38.7						20.14					
	Myanmar	3.2	19.8	0.4	30.4	0.9	0.4		0.00	0.01	107.02		
	Thailand		2.6	1.3	5.2	1.3	2.5	31.76					
	Sri Lanka		13.0	1.0	6.7				16.20	3.56	11.32		
	Region	2.3	15.0	0.7	19.7	0.7	0.7	12.91	8.55	1.90	142.72		

the number of items or weight is reported, and to help in the follow-up of the UN target 14.1 to prevent and reduce marine littering it is important that both quantification methods are used when reporting litter bycatches. This will allow for more reliable density estimates and thus increase the possibility to relate to the amount of seafloor litter to specific human activities whether on land or maritime.

5.2. Litter density

Most of the records (97 %) had litter densities of <1000 items/km^2 that corresponds to low littering European waters (Pham et al., 2014) and16 of 22 countries had no records larger than 1000 items/km. The average density of seafloor litter was in general <900 items/km^2 and <300 kg/km^2, only Namibia and Myanmar had densities indicating high littering: 1595 ± 2273 kg/km^2 (2310 ± 5723 items/km^2) and 1400 ± 2799 kg/km^2 respectively, however, densities of the same order of magnitude are found in many other regions of the globe (Table 5). Thus, the overall picture is that offshore seafloor littering in these southern areas is equal to or less pronounced than records from European waters or other areas further north.

5.2.1. "Hot-spot areas"

Several countries had a few records of very high densities representing 2 % of samples recorded as items and 4 % of samples recorded as weight (Fig. 10). The maximum recorded densities in weight were 9414, 5598, and 4198 kg/km^2, densities that are 10 to 20 times the largest record of weight (400 kg/km^2) reported by Pham et al. (2014), based on bottom trawl bycatches in the Mediterranean Sea (Sanchez et al., 2013).

The largest densities of seafloor litter in items/km^2 were 21,276, 16,431, and 10,413, respectively from Morocco, Namibia, and Ghana (Figs. 9 and 10). These values are 2 to 3 times the largest density of 6620 items/km^2 reported by Pham et al. (2014) based on bottom trawl bycatches in the Mediterranean Sea. These values are of the same magnitude as the largest densities reported from the Norwegian coast, near a fishing harbor (12,000 items/km^2) by Buhl-Mortensen and Buhl-Mortensen (2017, 2018) and from the North Sea (11000–14,000 items/km^2) reported by Ioakeimidis et al. (2017) (Table 6).

The areas with high densities of marine litter "hot-spot areas" recorded off Morocco, Namibia, Ghana, Angola and Myanmar are found near or within the subtropical ocean gyres, characterized by littering accumulation through the water column and the seafloor under the combined effects of ocean currents and turbulence (Mountford and Morales Maqueda, 2019). These countries, except Namibia, are characterized by a high coastal population and significant fishing activity (Table 6) In addition Ghana, Angola, Namibia and Myanmar are crossed by large rivers (Volta, Congo, orange and Ganga) that can entrain solid waste from land into the marine environment. Population size has been found as one of the main factors that contribute to the generation of uncaptured waste on land, which is available to become plastic marine litter (Jambeck et al., 2015). Marine litter seems more discernable in the South Asian Seas region, comprising the Northern part of the Indian Ocean, along with parts of the Bay of Bengal and the Arabian Sea. This region is characterized by high population density, low-income development indicators, and high dependence on natural resources for living, which are reasons for the generation of marine litter (Kapinga and Chung, 2020) (Table 6). In the present dataset, we found no statistically significant relation between population size and littering of the seafloor.

We found the largest litter density 50 to 100 km from land and mainly shallower than 100 m, however, high densities were recorded down to 300 m (Fig. 4). Underwater topographic features can increase

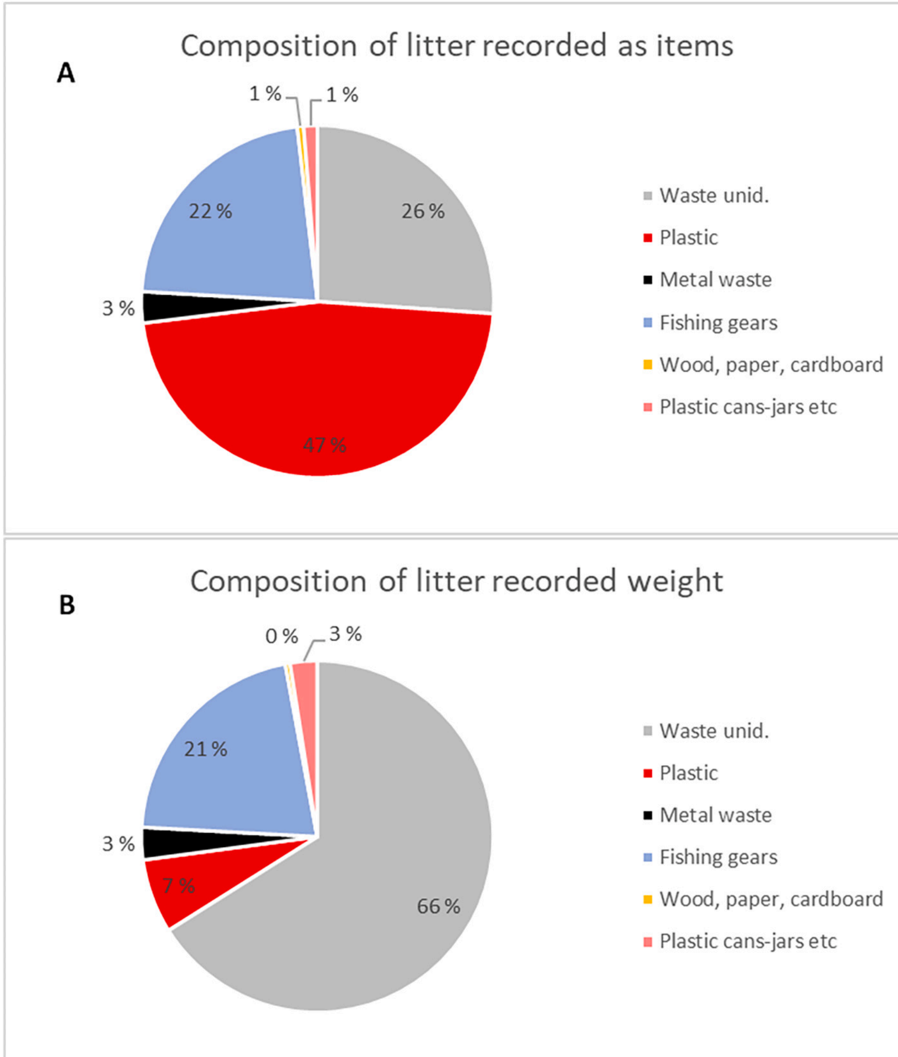

Fig. 6. General composition of macro litter on the seafloor in the study area based on the EAF-NANSEN Programme from 2011 to 2020. A. Recorded categories of litter as number of items/km^2 from 360 bottom trawls. B. Recorded categories of litter as weight (kg/km^2) from 323 bottom trawls. For details see Table 3.

Table 4
Linear correlation coefficients (r) for the relation between densities of different categories of litter provided as items/km^2 (based on 360 bottom trawls) and as kg/km^2 (based on 323 trawls) and distance to coast and depth. Six categories of macro litter were recorded in bycatches 534 from the EAF-NANSEN Programme in the period 2011–2020. For $r = 0.15$ correlation is significant ($p < 0.05$) df > 120, significant correlations are in bold numbers.

Litter categories	Depth	Distance to coast (km)
Waste general (N)	0.01	0.04
Plastic (N)	−0.09	−0.11
Metal waste (N)	0.11	−0.03
Fishing gears (N)	0.02	0.01
Wood, paper, cardboard (N)	**0.19**	0.05
Plastic cans-jars etc. (N)	0.04	−0.05
Waste general (kg)	−0.01	−0.02
Plastic (kg)	−0.06	**−0.15**
Metal waste (kg)	**0.18**	0.00
Fishing gears (kg)	−0.05	−0.06
Wood, paper, cardboard (kg)	**0.23**	0.01
Plastic cans-jars etc. (kg)	**0.17**	−0.02

downdrafts, leading to the retention of marine litter in different locations (Woodall et al., 2014; Chiba et al., 2018). In the deep-sea high densities of litter have been observed to accumulated in specific marine landscapes as canyons and trenches (Pham et al., 2014; Buhl-Mortensen and Buhl-Mortensen, 2017). The relation between litter density and distance to land showed two maxima indicating two separate sources to littering. Abundance of wood, metal and plastic cans-jars were positively correlated to distance to land while the correlation for plastic (unspecified) was negative (Table 4). We speculate that the first maximum is related to litter introduced from land or nearshore fisheries while the litter maximum further from land and in deeper water is related to litter accumulate in specific deep-sea habitats on the shelf and to offshore fishing activity (Fig. 9).

5.3. Litter composition

The large differences in dominating categories between litter recorded as items and weight (Figs. 6 and 7) clearly depends on the difference in density of the categories with fishing gear and metal in general being much heavier than plastic and wood. The large quantity of unidentified

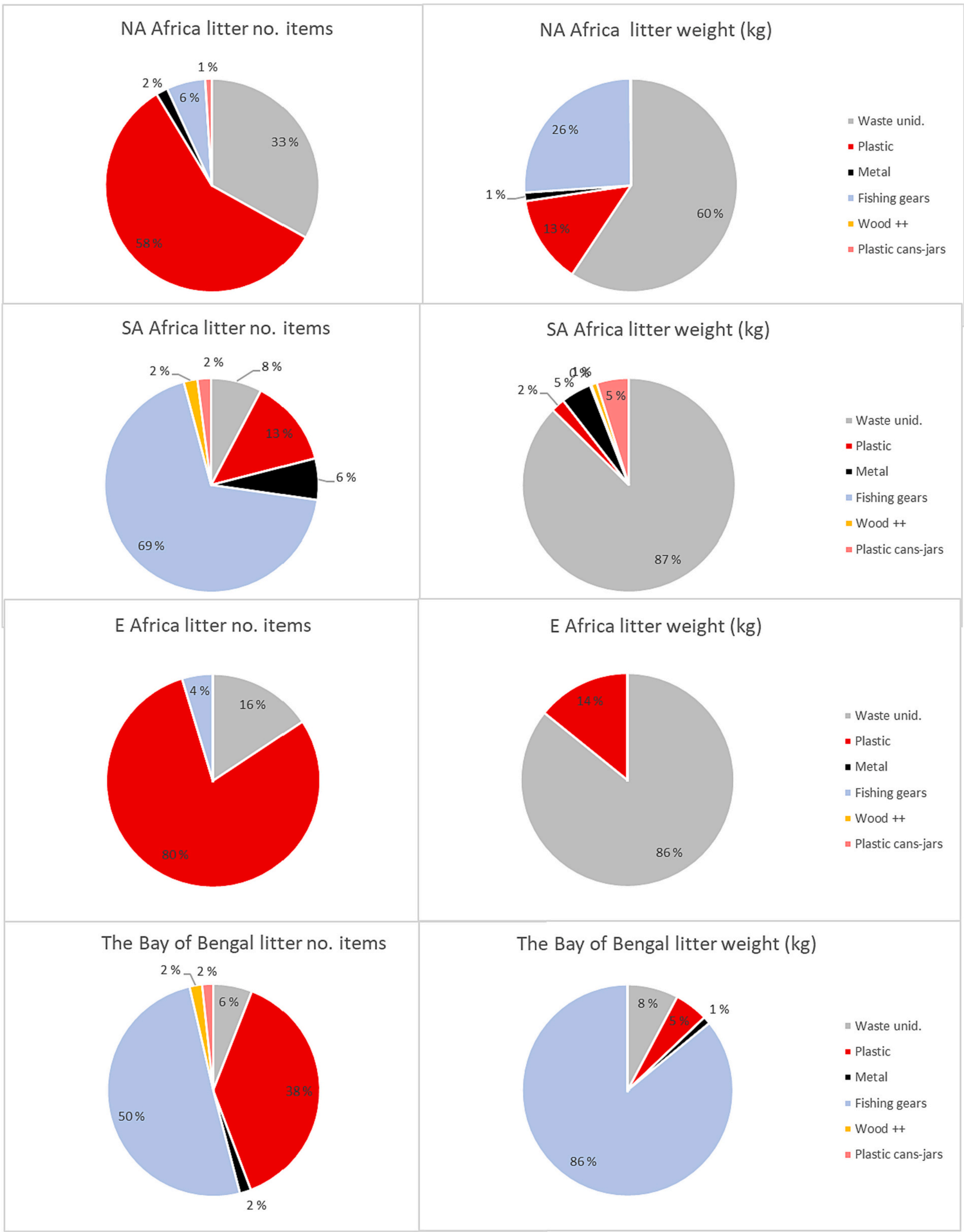

Fig. 7. Composition of macro litter on the seafloor in the four main regions: North Atlantic Africa (NA), South Atlantic Africa (SAA), East Africa (EA), and the Bay of Bengal (BB), based on bycatches from the EAF-NANSEN Programme from 2011to 2020. To the left based on recorded items (N/km^2) in 360 bottom trawls to the right based on litter recorded as weight (kg/km^2) in 323 bottom trawls. For details see Table 3.

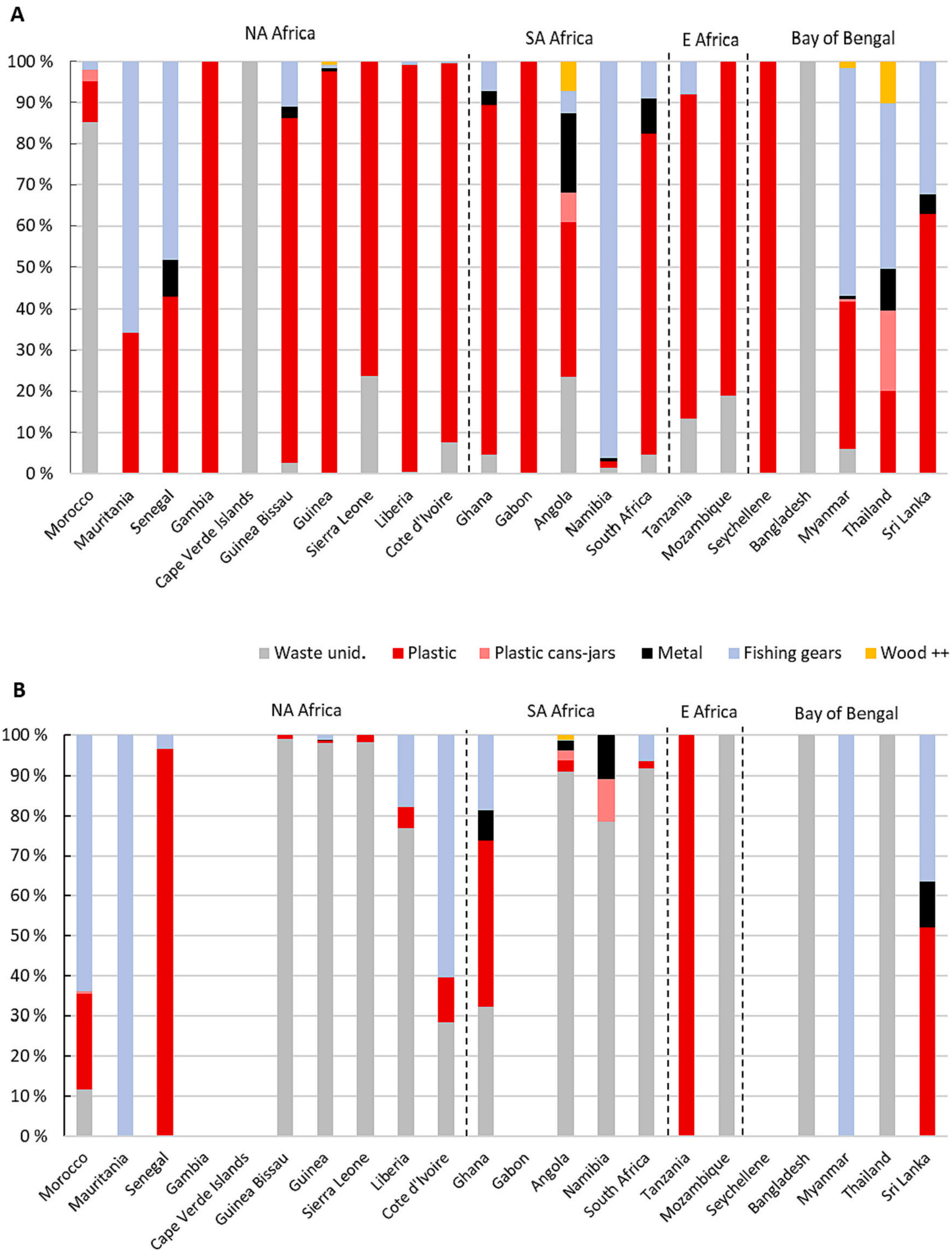

Fig. 8. Percentage composition of macro litter on the seafloor recorded by country from North Atlantic Africa. South Atlantic Africa and east Africa and Bay of Bengal based on trawl bycatches from the EAF-NANSEN Programme from 2011to 2020. A. Categories if litter reported as items (N/km^2) from a total of 360 bottom trawls and B. categories reported as weight (kg/km^2) from a total of 323 bottom trawls. For details see Table 3.

waste among the weighed litter could both be explained by differences in reporting routines on surveys but also that fishing gear normally are a mix of plastic and metal and therefore might be grouped as unidentified depending on routines on board.

In terms of items, 92 % of recorded litter was identified to a category in the SAA region, 84 % in EA, 94 % in BB, and 67 % in NAA (Fig. 7). Of the identified litter plastic and fishing gear dominated both overall and, in all regions, however, patterns differed. Plastic dominated in North Atlantic Africa (NAA) and East Africa (EA), while fishing gear dominated records from the South Atlantic Africa (SAA), and in the Bay of Bengal (BB) records were a mix of the two categories (Fig. 7).

For bycatch quantified by weight 92 % were categorized in the BB region, 40 % in NAA, 14 % in EA and 13 % in SAA. Fishing gear predominates in BB and NAA. While plastic dominates in the bycatch from EA. In SAA, metal dominates with 78 % and was mainly recorded off Namibia, however, this category contributes in general with <5 % in the

Table 5

Litter in trawl bycatches from different parts of the world including the new results from the present study including geographic area, country, survey years, number of trawl stations (items/weight), mesh size, depth covered, mean abundance ± standard deviation, and area surveyed per trawl station. Other studies included are: Ioakeimidis et al., 2017. Pham et al., 2014 and Grøsvik et al., 2018.

Geographical area		Country	Surveys dates	Stations (items/weight)	Mesh-size (cm)	Depth (m)	Abundance (items/km^2)	Abundance (kg/km^2)	Surveyed area (km^2)
Present study — EAF-NANSEN Programme of FAO									
Central Eastern Atlantic	North Atlantic Africa	Morocco	2011.2012.2017.2019.2020	44/22	2.4	28–508	652.42 ± 3242.20	102 ± 359	0.6
		Mauritania	2011.2012.2015.2019	13/4		17–174	104.42 ± 123.04	196 ± 199	
		Senegal	2011.2012.2015.2017.2019	17/2		24–601	37.13 ± 33.40	31 ± 41	
		Gambia	2012	1/–		797	19.57		
		Cape Verde Islands	2011	3/–		31–71	32.29 ± 12.27		
		Guinea Bissau	2011.2012.2017.2019	13/22		23–983	50.87 ± 63.67	55 ± 65	
		Guinea	2011.2012.2017.2019	18/38		21–521	115.27 ± 113.18	65 ± 85	
		Sierra Leone	2017.2019	2/23		22–83	35.03 ± 25.43	82 ± 92	
		Liberia	2017.2019	5/14		22–79	862.15 ± 1865.84	118 ± 146	
		Cote d'Ivoire	2017.2019	19/32		21–99	165.33 ± 272.29	28 ± 51	
		Ghana	2016.2017.2019	51/59		23–113	676.36 ± 1702.53	39 ± 110	
	South Atlantic Africa	Gabon	2019	1/–		118	42.25		
		Angola	2011.2012.2013.2014.2015.2016.2017.2019	80/58		22–760	87.27 ± 182.85	279 ± 1262	
		Namibia	2012. 2019	8/3		119–564	2310.29 ± 5723.38	1595 ± 2273	
		South Africa	2012.2013.2018.2019	15/5		106–669	31.26 ± 25.57	88 ± 115	
Indian Ocean	East Africa	Tanzania	2018	4/3		42–442	72.56 ± 53.76	33 ± 37	
		Mozambique	2014.2018	7/2		24–486	29.01 ± 14.54	299 ± 405	
	Bay of Bengal	Seychelles	2018	1/–		288	19.70		
		Bangladesh	2018	1/1		78	49.42	26	
		Myanmar	2013.2015.2018	46/4		24–767	56.01 ± 112.38	1400 ± 2799	
		Thailand	2018	5/12		328–781	38.84 ± 19.00	40 ± 42	
		Sri Lanka	2018	7/19		21–270	52.66 ± 59.53	30 ± 60	
Data from Ioakeimidis et al., 2017									
North Eastern Atlantic	Biscay bay	France	1992.1993	165	5.5	0–200	142		0.155
	Seine bay	France	1993	8	2.0		7200		–
	Celtic sea	France-Ireland-United Kingdom	1998	50	2.0		528		7.5
	Portuguese coast	Portugal	2013	135	5.5–8.0	90–349	17.3–78.7		56.2
Western Mediterranean	Gulf of Lions	France	1996	15	1	500–1600	3900		0.71
	Gulf of Lion	France	1996–1997	24	1	0–200	143		
	Murcian coast	Spain	2009	6	1	40–80	4424 ± 3743		0.09
	Catalan Coast	Spain	2009	6	1		7003 ± 6010		0.09
	Catalan margin (Blanes Canyon)	Spain	2007–2010	11	41.2	900–2700	–	0.02–3264.6	
Eastern Mediterranean	Saronikos gulf	Greece	2013	41	5	50–350	1211 ± 594		3.1
	Gulf of Patras	Greece	2013	18	5	20–150	641 ± 579		2.9
	Echinaded gulf	Greece	2013	10	5	50–200	416 ± 379		1.9
	Argolokos gulf	Greece	2014	8	2	150–750	360 ± 193		0.8
	Anatalya Bay	Turkey	2012	32	2.4	200–800	115–2762		270–820
Central Mediterranean	Central tyrrhenian	Italy	2009	6	1	40–80	5950 ± 3023		0.09
	Maltese islands	Malta	2005	44	2	49–697	97 ± 78		3.5
	Adriatic sea	Italy	2011–2012	67	4	0–30	170.6 ± 35.8		4.3
		Hungary				30–50	65.4 ± 21.6		
		Slovenia				50–100	47.9 ± 23.4		
North Sea	S. North sea	Belgium	2010	15	1	10–30	3125 ± 2830 (1250–11,227)		0.041
	W. North Sea	UK	1992–2012	44 surveys (74–441 station/year)	2	0–200	115 (0–14,550)		0.15
W. Atlantic	US west coast	USA	2007–2008	974	3.8	55–549	89		

(*continued on next page*)

Table 5 (*continued*)

Geographical area		Country	Surveys dates	Stations (items/weight)	Mesh-size (cm)	Depth (m)	Abundance (items/km^2)	Abundance (kg/km^2)	Surveyed area (km^2)
	N. Gulf of Mexico	Mexico	2000–2002	40	3.8	250–3650	140 (0–6500)		
W. Pacific	S. China Sea	China	2009–2010	4	–	3–9	1135		0.092
	Tokyo Bay	Japan	1995–2000	–	–	0–200	185–338		96.4
	E. China Sea	Korea	2002–2005	20	6–6.5	15–200		30.6	
	S. Korea Sea	Korea	1996–1997	19	6–6.5	15–200		109.8	
Data from Grøsvik et al., 2018									
N. Atlantic	Barents Sea	Norway-Russia	2010–2016	–/624	2.2	50–500		26	37.65
Data from Pham et al., 2014									
Mediterranean sea	Calabrian slope (central Med.)		2009	4		1400		60 ± 40	18.9
	W. Med. slope		2009	8		1500		400 ± 180	56
	E Med.		2009	8		1500		110 ± 30	37.9
	NW Med.		2009	94		1387		120 ± 40	407
	Algero-Balearic basin		2009	3		2883		180 ± 150	16
	Crete-Rhodes Ridge		2009	2	–	3000	–	120 ± 30	2.78
	Calabrian basin		2009	3	–	2967	–	170 ± 60	12.5

different countries in terms of weight and items. These results agree with the studies published from other parts of the world. According to Galgani et al. (2000) and Derraik (2002), plastic is the predominant type of marine litter in the world and covers a percentage higher than 70 % on the continental shelfs and slopes of Europe. Pham et al. (2014) found that plastic and derelict fishing gear were the most abundant litter in European waters, and a large proportion of marine litter coming from fishing activities has also been reported from other regions of the world (Mordecai et al., 2011; Vieira et al., 2014; Neves et al., 2015). One of few studies in the study area showed that seafloor litter off the heavily populated Moroccan Atlantic coast was influenced by human activities, and plastics were common (Loulad et al., 2017; Rhinane et al., 2019).

The world produced >368 million tons of plastic in 2019 (Plastic Europe, 2020) and it is estimated that 19 to 23 million metric tons, or 11 %, of plastic waste generated globally entered the aquatic ecosystems in 2016 (Borrelle et al., 2020). Africa, which has the highest population growth rate in the world has a waste management system constrained by several limitations (Ritchie and Roser, 2018; Mohee and Simelani, 2012). Mismanaged annual plastic waste for the African continent was estimated to be around 4.8 million tons in 2010 and could reach 11.5 million tons by 2025 (Jambeck et al., 2018). The Bay of Bengal is characterized by a high coastal population density coupled with large urban run-off (Lebreton et al., 2012), there are 500–20,000 items/km^2 of microplastics in the surface waters with a higher abundance observed near the Nicobar Island, exceeding 100,000 items/km^2 (Eriksen et al., 2018). Ryan (2013) reported 18,211 items of floating marine litter, with 95.5 % of plastic litter. The 4.5 % of non-plastic items are composed of wood, paper, glass and tin.

Plastics take a very important place in the composition of solid waste and are by far the most prominent material recorded as marine litter across the world (Derraik, 2002; Barnes et al., 2009; Sheavly and Register, 2007). Plastics with low density can go down with the adhesion of phytoplankton and the aggregation of other organic particles. Oceanic processes, such as coastal storms and offshore convections, play a role in the transfer of large volumes of particles and litter. Plastic waste can contaminate the marine environment directly from ocean-based sources such as the fishing industry, commercial and recreational shipping, and offshore platforms.

That fishing gear was the second most abundant litter category was not surprising because about 13 % of the global marine capture of fishes have been originated from the Indian ocean (Pauly and Zeller, 2016) and about 7 % from African countries (FAO, 2021).

Several studies of marine littering have found that fishing gear is an important part of seafloor litter in areas with high fishing intensity or large fishing harbors (Hess et al., 1999; Pham et al., 2014; Buhl-Mortensen and Buhl-Mortensen, 2018).

Abandoned, lost, or discarded fishing gear that are generated by the fishing industry have been identified as a significant contributor to marine plastic pollution representing large amounts of plastic litter, i.e., monofilament lines and nets, that are primarily made of synthetic polymer materials (Sheavly and Register, 2007; Bond et al., 2018). Other impacts of fishing gear include ghost fishing (Brown and Macfadyen, 2007; Carr and Harris, 1997) and entanglement by sessile invertebrates such as corals (Pham et al., 2013), as well as causing damage to fishing equipment (Nash, 1992).

5.4. Future needs

Many studies on litter in surface waters or on beaches have been conducted in recent years while the litter on the seafloor has been far less investigated mainly due to the high cost and the technical difficulties involved in sampling the seafloor at bathyal and abyssal depths (Barnes et al., 2009; Ramirez-Llodra et al., 2011; Pham et al., 2014).

Information on seafloor littering is particularly poor for the densely populated southern oceans where the estimated introduction of litter to the ocean is high (Jambeck et al., 2018). Reviews by Jambeck et al.

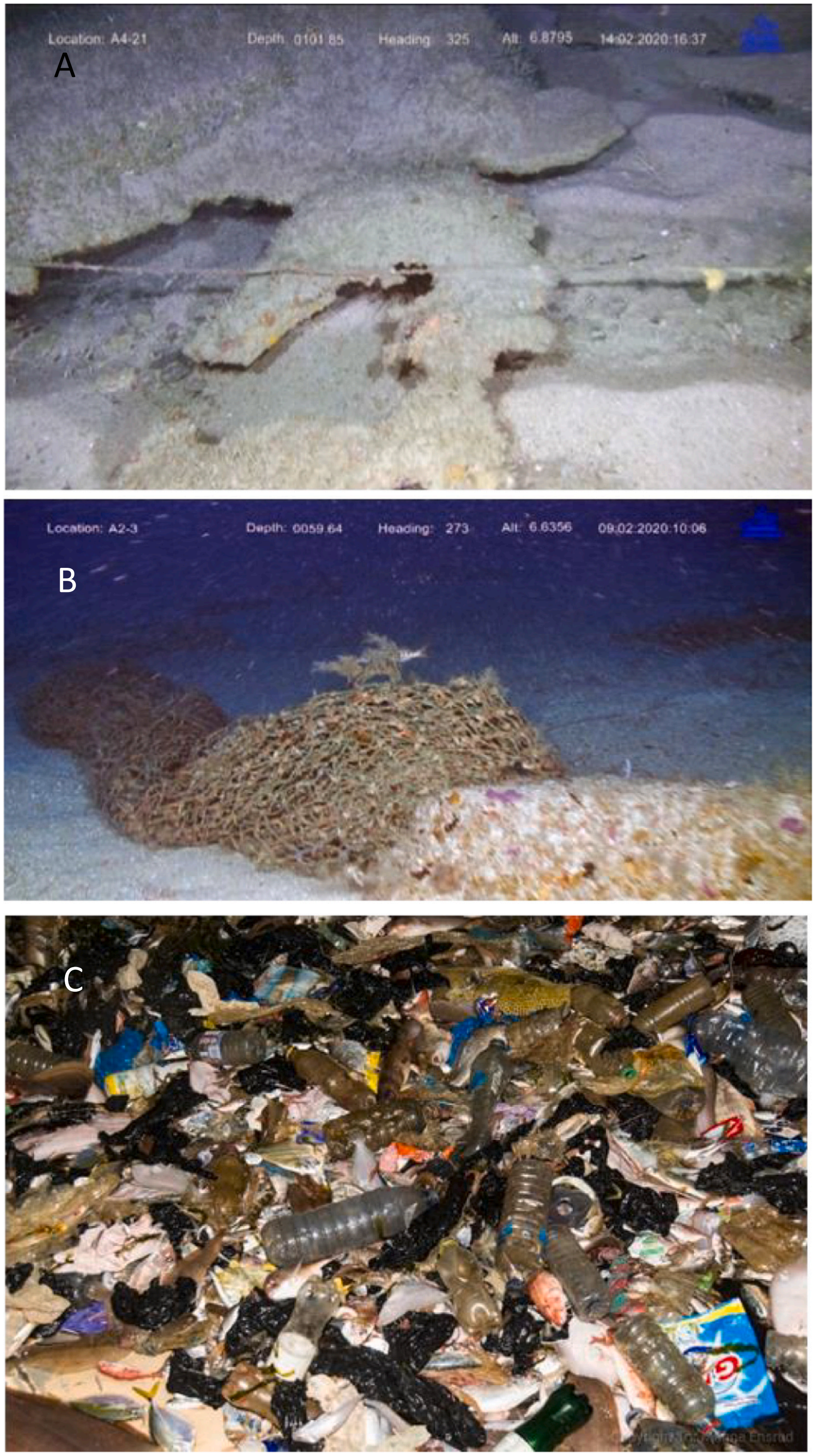

Fig. 9. Photo from the RV Dr. Frithjof Nansen cruise conducted in the area in 2019 and 2020. A. and B. are examples of fishing gear documented by ROV from off Morocco in a demanding terrain with rocky outcrops in which fishing gear easily gets entangled. C. is a photograph of litter from a trawl haul conducted in 2019 off Accra in Ghana representing a particularly large bycatch including many plastic bottles. Photo courtesy Tor Magne Ensrud at IMR.

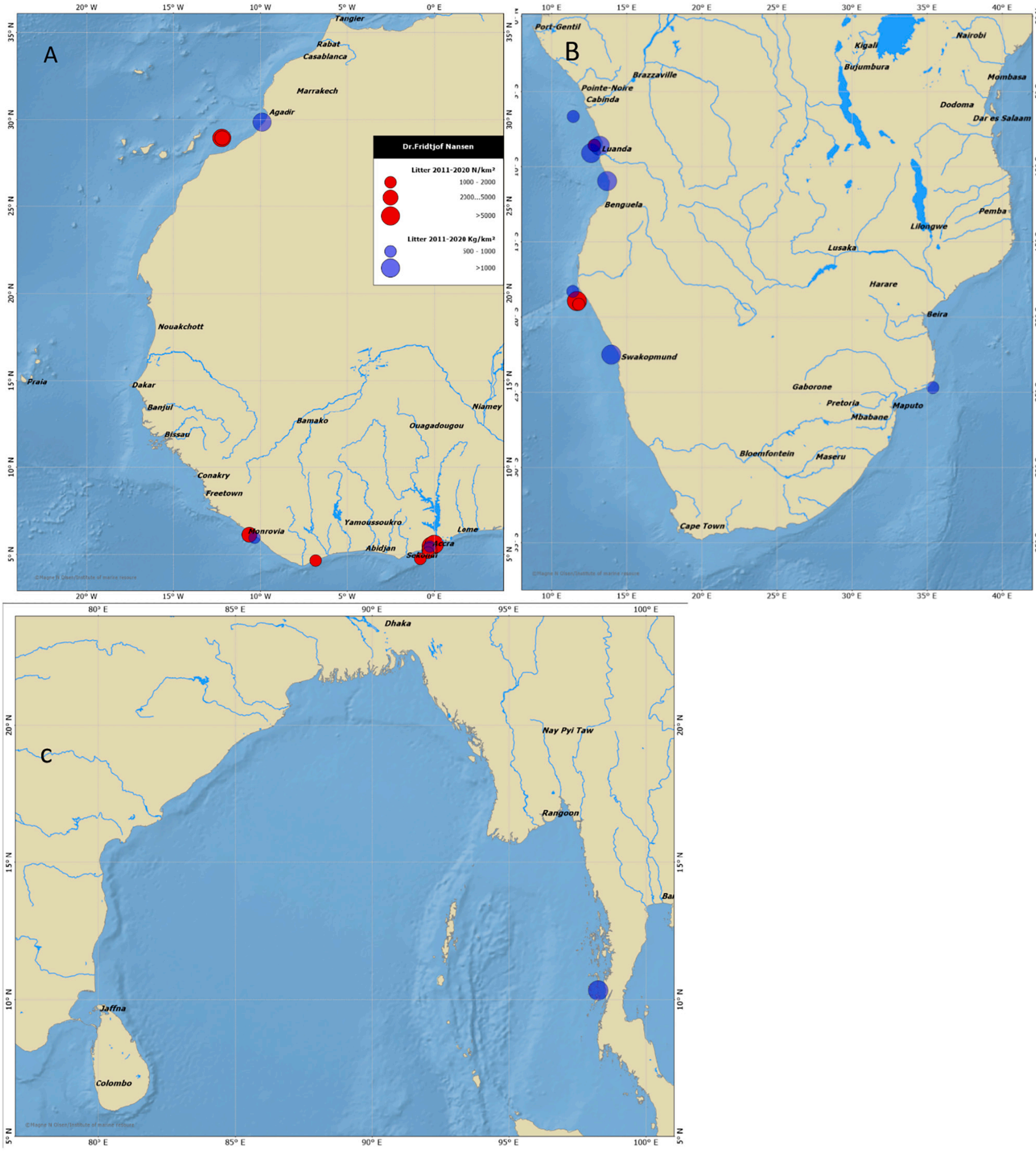

Fig. 10. Map of the largest records of litter from the EAF-NANSEN Programme from 2011 to 2020. Red circles are records of litter items larger than 1000/km^2 and blue are the weight of litter larger than 500 kg/km^2. The size of circles indicates density. For details see Table 2.

Table 6

The coastal and total population of the 22 countries from which litter bycatch data was available from the EAF-NANSEN Programme listed together with information on litter abundance and composition. Countries are ordered by size of costal population in decreasing order for each region. Average and maximum values are provided for litter as items and recorded as weight/km^2. The mean values for litter categories recorded per trawl station is listed with the two plastic categories (plastic and plastic cans pooled). Sources: Fishing vessels (FAO, 2021) and economy and population (Jambeck et al., 2015).

Region	Country	Economy	Coastal population	Fishing vessels (2010–2019)	Waste items/km^2							Waste in kg/km^2						
					Ave	Max	Unid.	Plastic	Metal	Fishing	Wood	Ave	Max	Unid.	Plastic	Metal	Fishing	Wood
NA Africa	Morocco	LMI	17,303,431	19,744	652	21,276	507	76	1	12		102	1692	5.84	12.28	0.04	32.24	
	Senegal	LMI	8,125,063	9805	37	114		15	3	17		31	60		3.55		0.12	
	Ghana	LMI	7,727,702	11,769	676	10,413	22	405	16	34		39	656	10.07	13.04	2.36	5.82	
	Cote d'Ivoire	LMI	6,230,583		165	1215	7	90		1		28	198	7.92	3.11		16.86	
	Sierra Leone	LI	2,887,017	7533	35	53	1	2				82	330	77.12	1.35			
	Liberia	LI	2,148,271		862	4200	1	272		2		118	585	79.66	5.49		18.34	
	Guinea	LI	1,996,496	1339	115	394		37	0.3	0.3	0.3	65	441	43.79	0.33	0.02	0.55	
	Gambia	LI	1,324,214		20	20		18										
	Guinea-Bissau	LI	1,208,106		51	252	1	16	1	2		55	220	36.35	0.36			
	Mauritania	LI	1,005,481	3816	104	386		35		68		196	376		0.02		60.42	
	Cape Verde	LMI	522,245		32	41	33											
SA Africa	South Africa	UMI	12,899,201	1780	31	117	1	18	2	2		88	287	19.09	0.37		1.35	
	Angola	LMI	3,790,041	3475	87	1399	16	31	13	4	5	279	9414	134.35	7.96	3.69	0.20	1.77
	Gabon	UMI	862,328		42	42		33										
	Namibia	UMI	155,084	141	2310	16,431	23	27	15	1624		1595	4198	427.89	58.31	58.31		
E Africa	Mozambique	LI	9,566,559	1064	29	57	5	21				299	586	67.94				
	Tanzania	LI	6,688,695		73	134	8	44		5		33	74		17.97			
Bay of Bengal	Bangladesh	LI	70,874,124	33,425	49	49	39					26	26	20.14				
	Thailand	UMI	26,043,442	11,237	39	60		5	1	5	1	40	151	31.76				
	Myanmar	LI	18,988,522	16,949	56	764	3	20	0.4	30	1	1400	5598			0.01	107.02	
	Sri Lanka	LMI	14,568,174	32,980	53	182		13	1	7		30	265		16.20	3.56	11.32	
	Seychelles	UMI	91,361		20	20		18										

(2015, 2018) have shown that there are many knowledge gaps relating to sources, pathways, composition, transport patterns, distribution, hotspots, and impacts of plastic litter.

Here we have compiled records of litter from bycatches reported from the bottom trawl surveys conducted as part of the EAF-NASEN Programme that covers the southern Oceans with large populations and reports of mismanaged waste. Our findings show no clear relation between offshore littering of the seafloor and on land litter management or population size.

These results, however, are based on information from trawl surveys that are not designed for mapping of seafloor litter and are mainly from offshore localities. Nevertheless, we hope that our findings will help to fill some of the knowledge gaps addressed by Jambeck et al. (2015, 2018), and doing so help to fulfill the goals of the UN sustainability code 14, *Conserve and sustainably use the oceans, seas and marine resources for sustainable development* and in particular target 14.1 stating that: "*by 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution*".

To understand better the sources of seafloor littering and to throw light on its relation to local industrial activities at sea and mismanagement of litter on land it will be essential to conduct mapping programs that are designated and designed to document seafloor litter.

CRediT authorship contribution statement

1. Conception or design of the work. All authors
2. Data collection. EAF-Nansen programme
3. Data analysis and interpretation. First and second authors
4. Drafting the article. All authors
5. Critical revision of the article. First, second and last authors
6. Final approval of the version to be published. All authors

In total first and second author 60 % of the work 40 % shared by the rest.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data are from the EAF-Nansen Program administered by FAO. For original data FAO must be contacted.

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