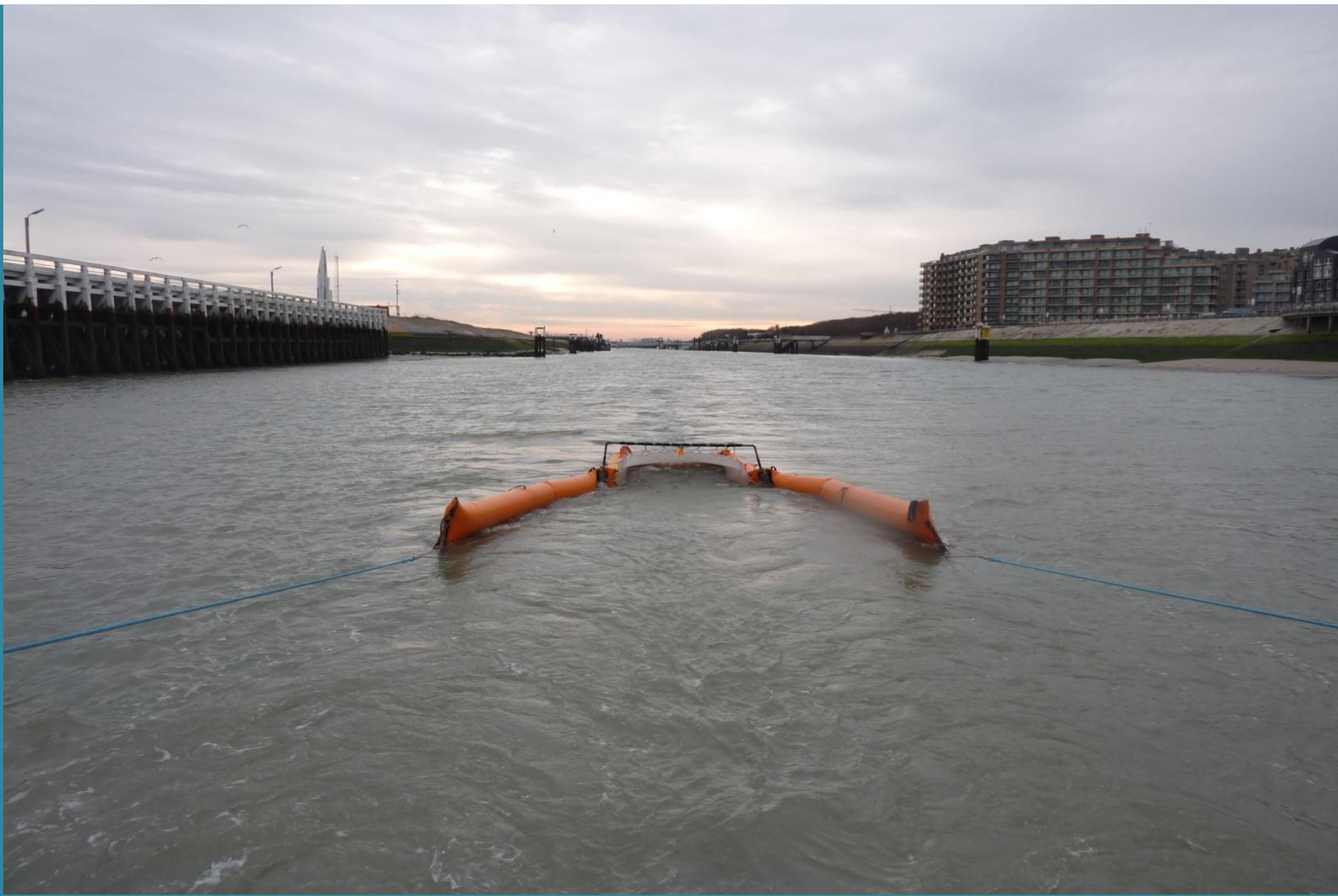
Waste Free Oceans Belgium

A pilot study



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1. Introduction

1.1 Waste Free Oceans

European Waste Free Oceans is an industry-led initiative with the aim of reducing floating marine debris on Europe's coastlines by 2020. It is the successor program to the "Save the North Sea" project and the "Fishing for litter" project. Using existing fishing trawls and new technology, WFO will engage Europe's fishing community in cleaning up floating marine debris and bringing it back to land for sorting and recycling.

There are many factors that have contributed to a rise in marine litter: poor waste management practices in ports and marinas, dumping from ships and vessels, not to mention general public attitudes towards littering are all reasons for this growing problem. It is time for Europe to show leadership in solving this issue.

Although the issue of marine litter is not strictly a 'plastics problem', plastic makes out 60% to 80% off all marine debris (Derraik, 2002). The plastics industry is therefore committed to present a united front in tackling the issue of floating marine debris. With the support of corporate sponsors, NGOs, and local and European politicians alike, WFO want to raise awareness of this concern and restore the beauty and purity of Europe's coastlines and waters.

The European Plastics Converters have set up the Waste Free Oceans project as a foundation that is willing to provide a solution to the problem of floating marine debris. Fishing boats outfitted with a special trawl will be able to collect between 2-8 tons of waste for cleaning and recycling. Using fishermen and homegrown technology, the project will help reduce the floating marine debris on Europe's coastlines by 2020.

1.2 The origin of marine litter

The origin of marine litter can be attributed to a number of different sources: land based material, waste and debris from maritime activities, coastal tourism, etc (Table 1). Eventually all litter will enter the marine environment either directly (sea based sources) or indirectly (land based sources) and have its influence on marine ecosystems (Figure 1).

Monitoring studies have shown that the fishing industry has a fairly large share in the total amount of litter at sea. Up to 18% of all plastic litter is derived from fishing activities (Andrady 2011). Up until the ratification of the OSPAR convention (1998) it was very common for fishing boats to discard their broken nets and waste in the sea; those practices are now largely in the past and it is estimated we will see a further improvement in the near future. Besides debris from fishing boats, also losses during shipping of user plastics or plastic pellets have their share in polluting the marine environment. Next to these sea based sources of marine litter also land based sources cannot be underestimated. The waste water from urban regions and the litter that is left behind at beaches because of tourism constitutes a fair amount of input into the marine environment as well.

Table 1: Sources of marine litter and their specific items (Ljubomir 2009)

Source	Indicators
Fisheries, including aquaculture	Jerry cans, fish boxes, fishing line, fishing weights, rubber gloves, floats/buoys, ropes/cords/nets <50 cm, and >50 cm respectively, tangled nets/cords, crab/lobster pots, octopus pots, oyster nets and mussel bags, oyster trays, plastic sheeting from mussel culture ("Tahitians")
Galley waste from shipping, fisheries and offshore activities (*non*-operational waste)	Cartons/tetrapaks, cleaner bottles, spray cans, metal food cans, plastic gloves, plastic crates
Sanitary and sewage-related waste	Condoms, cotton bud sticks, sanitary towels/panty liners/backing strips, tampons/tampon applicators
Shipping, including offshore activities (*operational waste*)	Strapping bands, industrial packaging, hard hats, wooden pallets, oil drums (new and old), light bulbs/tubes, injection gun containers
Tourism and Recreational activities	4-6-pack yokes, plastic shopping bags, plastic bottles/containers for drinks, metal bottles/containers for drinks, plastic food containers, glass bottles, crisp/sweets packets and lolly sticks

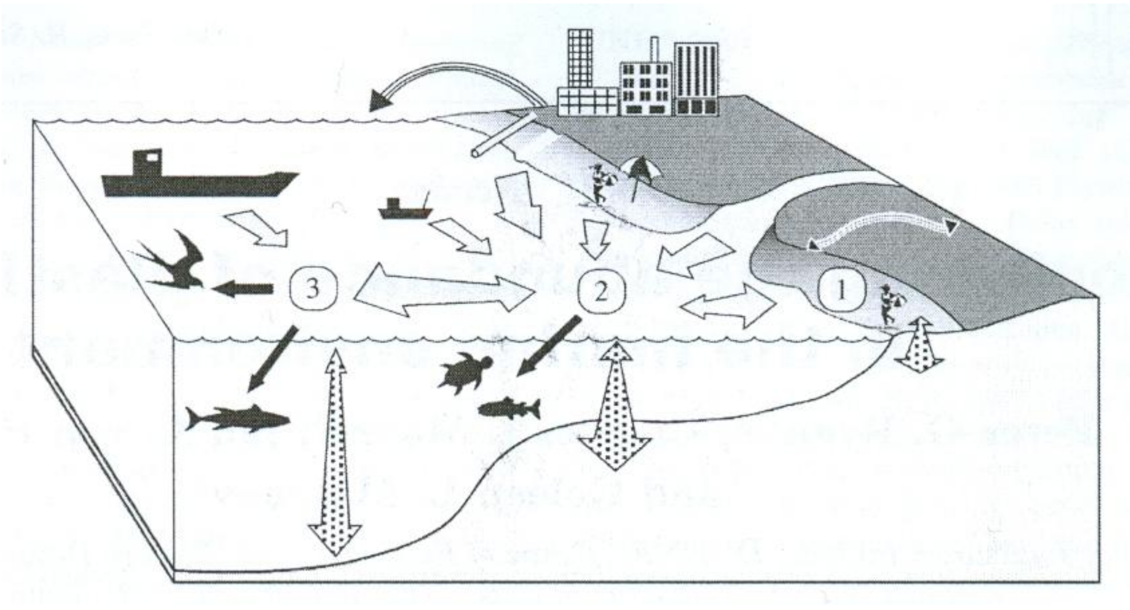

Figure 1: Source-sink drawing of litter in the marine ecosystem. Black arrows: ingestion or entanglement of plastics by marine species. White arrows: sea based sources of marine litter by shipping and fishing boats. Curved arrows: land based sources such as tourism on beaches, waste water of urban locations and river effluents. Dotted arrows: vertical movement of litter throughout the water column and on beaches. (Ryan et al. 2009)

1.3 The problem of marine litter (macro- & microscale)

The main issue with marine litter, and more specifically with plastic debris, is the influence it has on marine species and thus the marine ecosystem (Thompson et al. 2004; Moore 2008; Costa et al. 2010). Almost all animal species across the food chain can be impacted: from filter feeders like the common mussel (*Mythilus edulis*), to small and larger fish, seals and several bird species that live near the coastline (van Franeker et al. 2011).

The effects of marine debris on species can be separated into three main categories: entanglement, ingestion and adsorption of pollutants. Also a few recent discoveries have led to a more clear view on the problem.

Entanglement

Entanglement of sea animals is a widely known and widely investigated problem. Over 250 different species have been recorded to be entangled in macroplastic debris such as fishing nets, six-pack carriers, etc. (Gregory 2009). In case of entanglement of smaller animals in large discarded fishing nets the problem expands even further. These small entangled animals disintegrate after a short amount of time and the net becomes available again to capture new animals. This process is called "Ghost-Fishing". The main consequences of entanglement are: skin wounds, obstructing or preventing the intake of food, and even suffocation has been reported in some cases.

Ingestion

A second and maybe even more disturbing influence of marine litter is the ingestion of marine debris. Many animals consider these smaller pieces of debris as a source of food. Once these pieces are taken into the digestive system of the animal, several different things may occur. The consequences include: wounds, internal injuries, skin lesions and ulcerating sores; blockage of digestive tract followed by saturation, starvation and general weakening often leading to death (Figure 2); reduction in quality of life and reproductive capacity; drowning and limited predator avoidance. (Gregory 2009). Plastic resin pellets[1] (Turner and Holmes 2011) form a very specific kind of plastic debris and are similarly shaped and colored as many food sources for several birds and fish.

A study by van Franeker et al. (2011) investigated the stomach contents of northern fulmars (*Fulmaris glacialis*) for plastic debris. The threshold value was assigned as: no more than 10% of fulmars are allowed to exceed a critical level of 0.1 g of plastic in the stomach. 95% of 1295 fulmars sampled in the North Sea had plastic in the stomach (on average 35 pieces weighing 0.31 g) and the critical level of 0.1 g of plastic was exceeded by 58% of birds, with regional variations ranging from 48 to 78%.

Abu-Hilal and Al-Najjar (2009) did a study on pellets on beaches of the northern Gulf of Aqaba and found that there is a high accumulation rate for these pellets, which makes them even more available for birds to feed on them.

[1] Plastic resin pellets are small granules generally with the shape of a cylinder or a disk with a diameter of a few mm. These plastic particles are industrial raw material transported to manufacturing sites where "user plastics" are made by re-melting and molding into the final products.

Figure 2: Deceased Albatross, with stomach content consisting of several tens of items of plastic.

Adsorption of pollutants

As described above resin pellets are some of the most ingested forms of debris. In addition to this problem, there is a possibility that these pellets adsorb POPs (persistent organic pollutants). These synthetic organic compounds, such as PCBs (polychlorinated biphenyls), DDTs (insecticides) and PAHs (polycyclic aromatic hydrocarbons) are commonly present in the environment and in seawater. It remains unknown if plastics can act as agents for the transfer of POPs from the environment to organisms in this way but evidence suggests this to be a potential portal for entering food webs.

The program "International Pellet Watch" has resulted in maps for the global distribution of POPs in coastal waters. In Greece, for example, a study of pellets derived from four different beaches has shown that pellets found on beaches close to highly industrialized regions contain more PCBs than pellets found on "clean" beaches (Karapanagioti et al. 2011). Another study from plastics debris derived from de North Pacific Gyre has shown that over 50% contained PCBs, 40% contained pesticides, and nearly 80% contained PAHs (Rios et al. 2010). The real danger is that these POPs can disrupt different hormones in animals as well as in humans.

Not only do POPs raise concern, also additives added to plastics during manufacturing may leach out upon ingestion, potentially causing serious harm to marine life. The global demand for plastic additives is estimated at 11.1 million tons in 2009, about half of this volume is plasticizers. Comparing this 2009 figure to plastics production, additives account for around 4% of the total weight of plastics produced (Leslie et al. 2011). Endocrine disruption by plastic additives may affect the reproductive health of humans and wildlife alike. The implementation of the European REACH regulations should effectively reduce these risks in the near future in European waters as it requires substitution of CMR substances (CMR = carcinogenic, mutagenic or reprotoxic).

Adsorbed pollutants are known to accumulate throughout the food web, making this chronic effect that is mainly visible in predators such as marine mammals, large fish species, birds, and humans.

2. PILOT STUDY FOR THE BELGIAN COAST

The Belgian fisheries organization, represented by the Foundation for Sustainable Fishery Development (SDVO) and the Belgian plastics industry, represented by the Belgian Association of Manufacturers of Plastic and Rubber Products (Federplast VZW), are committed to help reducing the plastics problem in the Belgian part of the North Sea. In 2011, together they joined Waste Free Oceans, and proposed a pilot study for WFO Belgium.

The goals of this pilot study were:

- To assess the size of the problem of floating debris in the Belgian coastal waters;
- To find an appropriate method to land floating plastics for further recycling;
- To actively involve the fishery community in helping to make our seas cleaner.

2.1 Materials & Methods

In order to maximize catch success, we opted to perform the trial trawls in the coastal waters close to the three Belgian harbours. Ostend, Zeebrugge and Nieuwpoort were each sampled during 2 days (one day the West side and one day the East side). The sampling was performed with the Thomsea net (trawl gap 7m), towed by the catamaran N.32 Jolly Jumper. Visual observation using binoculars were also logged.

In total 9 corridors with a total area of 4,5 km² and a transect parallel to the coastline between Nieuwpoort and Ostend (circa 15km) were sampled.

The Thomsea net, which is the standard apparatus within WFO, performed well, unless there was a strong sideway current, when the net was pushed out of angle, through which the gap of the net was smaller than 7m (Figure 3).

Figure 3: Towed Thomsea net. Left: normal conditions; right: net pushed out of angle by a strong sideway current (Zeebrugge West).

Visual sightings

During entering and leaving the different harbours a visual inspection of the harbour walls was performed with binoculars.

Between the outer rocks of the harbour wall no waste items were observed, except for one part of the east wall of Zeebrugge where several big items were observed (bottles and plastic sheets).On the inner side, on the other hand, several plastic items were observed, and this for all three harbours (Figure 4).

Figure 4: Plastic items between rocks of the harbour wall (inside) (Ostend)

2.2 Results

In only three trawls, several plastic items were caught (Table 2; Figure 5). The items in the trawls of Zeebrugge West and parallel to the coast showed marks of being in the water for some time. The can and tetra brik of the Nieuwpoort East, in contrast, showed no marks and the expiration date was not yet exceeded, which suggests they had recently been thrown in the water.

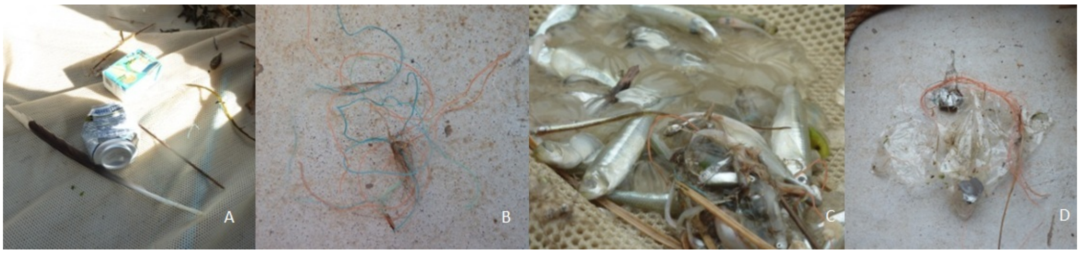

Figure 5: Catch results. a: can and tetra brik (Nieuwpoort East); b: fishing gear fibers (Nieuwpoort East); c: fishing gear fibers tangled with fish; d: plastic sheets and fishing gear fibers (parallel coast).

Table 2: Results of the WFO pilot study in three Belgian harbours (/ : nothing was caught during this trawl)

Location	Side	# Corridors	Date	Catch
Ostend	West	1	21/10/2011	/
	East	1	28/10/2011	/
Zeebrugge	West	2	24/10/2011	small plastic sheet
	East	2	25/10/2011	/
Nieuwpoort	East	2	26/10/2011	/
	West	1	27/10/2011	soda can, tetra brik, fishing gear fibers
Parallel coast	*	1	27/10/2011	Plastic bottle, 3 plastic sheets, fishing gear fibers

The simplified routes of the trawls are visualized in the appendix.

3. DISCUSSION

Comparison to worldwide results

Solid marine debris deposited in the sea consists of two types: particles that immediately sink to the seafloor and debris with a high capacity to float for extended periods (weeks to several months). Floating marine debris (FMD) is commonly transported by currents and wind before it finally is cast ashore or loses floatability and sinks (Thiel et al. 2003). Every year 20 000 tons of marine litter is dumped in the North Sea, of which 70% sinks to the bottom, 15% floats on the surface and 15% is washed on the coast (Save the North Sea project results). Distribution and composition of marine debris floating at sea may depend largely on local current regimes and may not necessarily coincide with the debris found on shores (Thiel et al. 2003). Floating objects, like plastics and seaweed rafts, are highly buoyant and can travel huge distances in only a few weeks time, under the influence of winds and surface or tidal currents (Vandendriessche 2007).

In this pilot study, which only gives a snapshot picture of floating debris along the Belgian coast, an average of 2.8 items per km² was found. This is higher than the average that was found in a recent, comparable study led by Ghent University, AS-MADE, in which 0.56 items per km² were caught using a neuston net (Colin Janssen, pers. comm..). Earlier studies reported 1 to >3 items per km² for the North Sea (Dixon and Dixon 1983). Table 3 shows that the coastal waters of California, the Pacific coast of Mexico, the North Sea and the SE-pacific all have similar densities of floating marine debris (0.8 – 3 items/km²).

Table 3: Densities of Floating Marine Debris (FMD) in different regions of the world's oceans (Thiel et al. 2003).

Densities of FMD in different regions of the world's oceans

Region	Density (items km^{-2})	Type	Method	Reference
N-Pacific (subarctic)	0.15	P	VSS	Dahlberg and Day (1985)
NE-Pacific (>40°N, coastal)	1.0	P	VSS	Matsumura and Nasu (1997)
NW-Pacific (>40°N, coastal)	0.2	P	VSS	Matsumura and Nasu (1997)
N-Pacific (subtropical)	3.15	P	VSS	Dahlberg and Day (1985)
NE-Pacific (20°N–40°N, coastal)	1.0	P	VSS	Matsumura and Nasu (1997)
NW-Pacific (20°N–40°N, coastal)	0.8	P	VSS	Matsumura and Nasu (1997)
NE-Pacific (<20°N, coastal)	1.8	P	VSS	Matsumura and Nasu (1997)
NW-Pacific (<20°N, coastal)	0.25	P	VSS	Matsumura and Nasu (1997)
N-Pacific (central)	2.20	P	VSS	Venrick et al. (1973)
N-Pacific (central)	0.01	P	VSS	Matsumura and Nasu (1997)
Indonesia	>4000	P	VSS	Uneputty and Evans (1997)
S-Pacific (subantarctic)	1–2	P	VSS	Gregory (1990) (cited in Gregory and Ryan, 1997)
S-Pacific (<40°S)	<20	P	VSS	Gregory (1990) (cited in Gregory and Ryan, 1997)
S-Pacific (20°S–40°S, costal)	1–36	P	VSS	This study
S-Pacific (>40°S, coastal)	<1	P	VSS	This study
S-Atlantic (~30°S, <10 km)	19.6	P	VAS	Ryan (1988, 1990) (cited in Gregory and Ryan, 1997)
S-Atlantic (~30°S, 50 km)	1.6	P	VAS	Ryan (1988, 1990) (cited in Gregory and Ryan, 1997)
North Sea	1 to >3	P	VSS	Dixon and Dixon (1983)
Mediterranean	~1200	P	VSS	Morris (1980)
Gulf of Mexico	0.2–0.8	P_l	VAS	Lecke-Mitchell and Mullin (1992)
Gulf of Mexico	0.8–2.4	P	VAS	Lecke-Mitchell and Mullin (1997)

P, plastic items; P_l, large (>23 cm) plastic items; VSS, visual ship-based surveys; VAS, visual aerial surveys.

These densities remain far below those reported from the Mediterranean in the late 70ies, approximately 1200 items/km² (Table 3). Thanks to a growing environmental awareness, and more stringent legislation in Europe, these number had dropped significantly to 3 – 25 items per/km² by the year 2000 (Aliani et al. 2003). Few studies exist of the number of floating marine debris in developing countries, but Thiele et al. (2003) and anecdotal evidence clearly illustrate the huge size of the problem: for instance in Indonesia, the number exceeds 4000 items/km² (Thiele et al. 2003).

The combination of multiple diffuse and point-source inputs and the non-random transportation of debris by winds and currents results in great temporal and spatial variability (Ryan et al. 2009).

The influence of weather conditions on the catch rate of marine debris was studied by Moore et al. (2002, 2004). Sampling of the surface water in Santa Monica Bay (L.A.) was carried out in two different sets of weather conditions: once just after stormy weather and once after benign weather conditions. Surface samples were collected using a 0.9 x 0.15 m² rectangular opening manta trawl with a 3.5 m long, 333 micron net and a 30 x 10 cm² collecting bag.

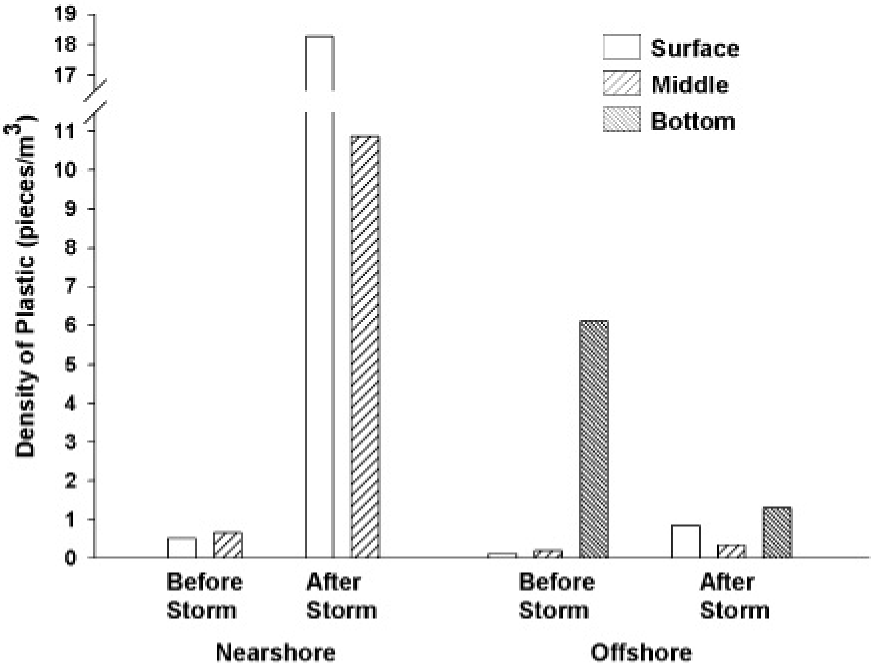

Figure 6: Results of the manta trawl sweep for amounts of plastic (pieces/m³) before and after a storm at different depths and proximities to shore. (Moore et al. 2004)

Figure 6 clearly shows a big difference in plastic debris concentrations at the water surface. After a storm much more items were found in the top layer of the water whereas for the seabed the exact opposite was observed. It is hypothesized that during storms, plastic debris that has sunk to the seabed is brought back into suspension due to turbulence. Before and during the pilot study, no stormy conditions occurred in the sampling area.

4. SUMMARY & ADVICE

Up to now most surveys on marine floating debris were visual ship based surveys. With this method, only bigger, fully floating items are spotted with binoculars. Smaller items (only several cm^2 big, like fishing gear fibers, small bottles, cans, etc.) or items that float just below the surface will be missed in the sightings, so there will be an underestimation of amount of floating marine debris. Sampling with a net, such as the Thomsea net from this pilot study, is a quantitative method and makes sure all floating debris, on the surface or just below, is caught. The downside, however, is the total sampled surface, which is much lower than with visual sightings. The size of the sampled marine debris is determined by the net mesh size. For this pilot study, the emphasis was on macroplastics, for which the Thomsea net has been designed.

The sampled quantities of floating marine debris were within the expected range of < 5 items/km^2 for a period with no exceptional weather conditions. A higher catch rate might be possible after stormy conditions, or when favourable currents accumulate floating material around obstacles such as ports. However, no predictive model currently exists to assist with planning a possible cleaning campaign.

The question whether the success rate of working with the Thomsea net along the Belgian coast warrants the efforts of a regular campaign using fishing boats has to be answered negatively: the environmental impact of navigating a small vessel for several hours is much higher than the positive effect of removing a limited amount of floating debris from the sea. The pilot study, however, cannot exclude that targeted fishing, for instance after storms, or after periods with high riverine offload, could be useful. We therefore recommend to have at least one dedicated plastics fishing net (e.g. the Thomsea net, or an improved version which can also withstand side currents) stand-by. This net could also be used after calamities, for instance loss of cargo at sea.

To assess the impact of stormy conditions and of riverine offload on floating marine debris, we recommend to do an additional test period after a heavy storm, and to directly target river outflow, for instance by positioning a net across one of the rivers that flow into the Belgian North Sea.

Finally, we think that the fisheries community and the plastics industry can really make a difference by using their dedication, knowledge and resources to help where the problem is most acute: in developing countries. By setting up projects that combine education, cleaning up marine debris and recycling plastic waste in countries in South-East Asia, Africa or Latin America, Waste Free Oceans can be a huge step towards cleaner and healthier seas.

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6. Appendix

Maps of the followed routes for capturing marine litter with the Thomsea net. The indicated routes represent a simplified of the sampled quadrants. Caught plastics are shown with red arrows.

Zeebrugge

Figure I.1: Zeebrugge East Corridor 1

Figure I.2: Zeebrugge East Corridor 2

Nieuwpoort

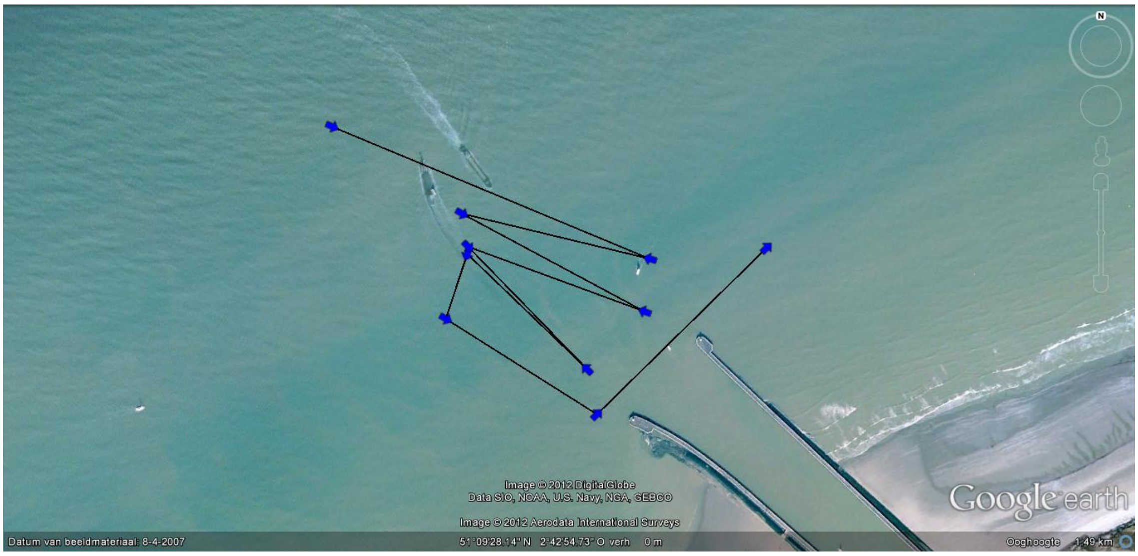

Figure I.3: Nieuwpoort East Corridor 1

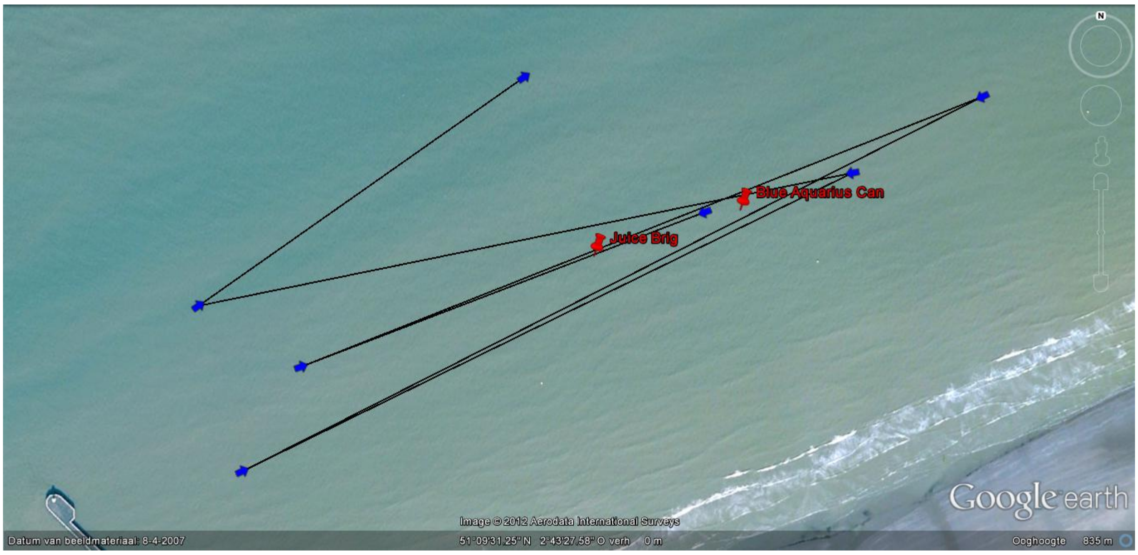

Figure I.4: Nieuwpoort East Corridor 2

Figure I.5: Nieuwpoort West

Parallel to the coastline

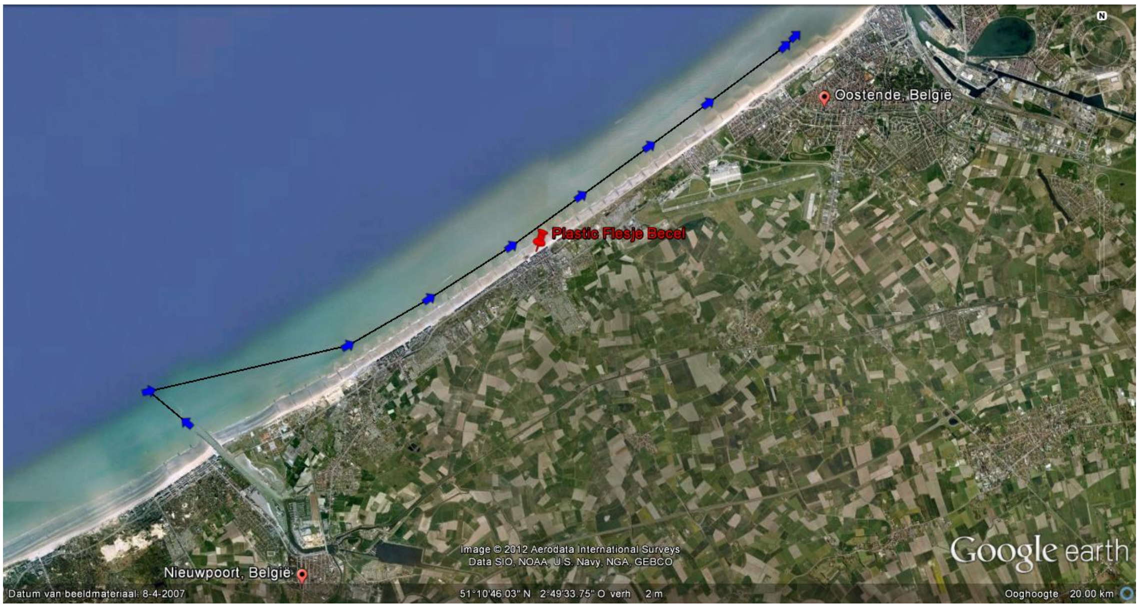

Figure I.6: Parallel to the coastline (Nieuwpoort to Oostende)