OSPAR COMMISSION

Marine Litter Thematic Assessment

OSPAR

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OSPAR's Quality Status Report 2023

Marine Litter Thematic Assessment

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l´Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d´Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. Les Parties contractantes sont l´Allemagne, la Belgique, le Danemark, l´Espagne, la Finlande, la France, l´Irlande, l´Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume- Uni de Grande Bretagne et d´Irlande du Nord, la Suède, la Suisse et l´Union européenne

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Executive Summary

Under its North-East Atlantic Environment Strategy (NEAES) 2010-2020, OSPAR set an objective *"to substantially reduce marine litter in the OSPAR maritime area to levels where properties and quantities of marine litter do not cause harm to the coastal and marine environment"*. This thematic assessment describes the marine litter issue and the work of OSPAR to address it. It also looks at the progress made towards achieving the strategic objective that provides the foundation for the next steps.

Overall, marine litter levels are still high and further efforts are needed. There is a predominance of plastics among marine litter that is reported across all OSPAR Regions. Also, microplastics have been reported in sediments, surface waters, water column and in biota for the OSPAR Maritime Area at different concentrations. Single-use plastics and maritime-related litter are frequently found beach litter items at OSPAR level, with some important regional differences. Nonetheless, there are some positive signs: a decrease in the quantities of litter found on OSPAR beaches between 2015-2020 and in the floating litter in the North Sea between 2009-2018. When considered against the upward trend in plastic production and use in Europe over a similar period, this suggests that progress has been made on preventing plastics from entering the marine environment.

Seal with tangled plastic netting around neck. © Shutterstock

Policy responses to managing marine litter need to continue to reduce inputs, reduce the risks associated with materials and products (e.g., develop alternatives to plastics and design solutions) and facilitate societal change. Because of the links between climate change and marine litter, integrated approaches could benefit both problems.

OSPAR's new Strategy (NEAES 2030) includes a new marine litter strategic objective, supported by eight operational objectives involving new measures for specific sources and pathways and the development of ambitious coordinated strategies, control measures, threshold values and targets. The adoption of a second Regional Action Plan in 2022 is key to its implementation. Regular monitoring and assessment, including developing new common indicators, will continue to play a key role in supporting the measures and evaluating their effectiveness.

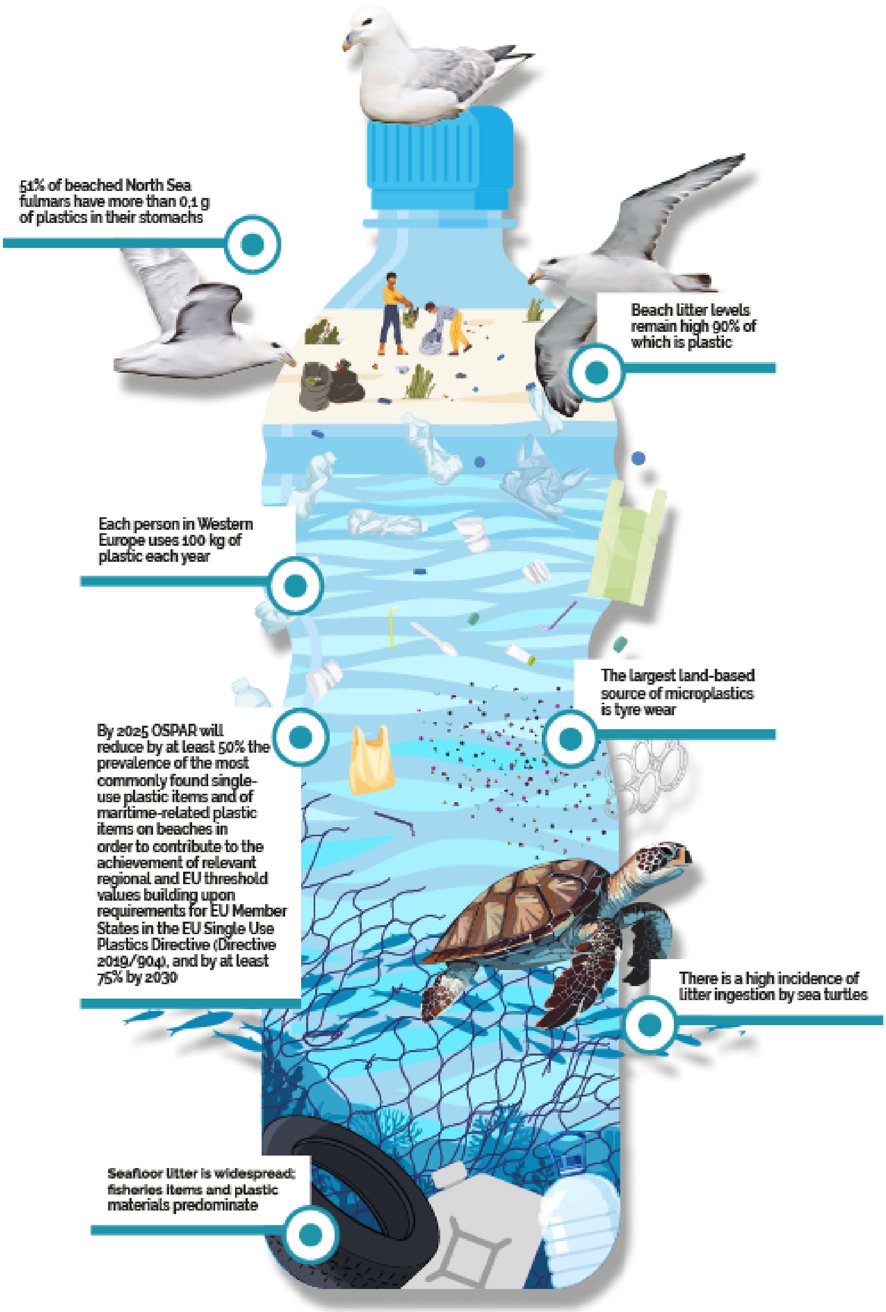
Q1. Identify the problems? Are they the same in all OSPAR Regions?

The huge amount of man-made solid waste that ends up in the oceans and becomes marine litter has been identified as one of the pressing challenges of our time. A great number of land-based and sea-based human activities introduce litter into the marine environment. The main direct sea-based sources identified are fishing, aquaculture, shipping, and recreational boating. In addition, marine litter originates from offshore infrastructure (for example in the oil and gas industry). The major direct and indirect land-based sources of marine litter include poor waste management practices, general littering, untreated sewage, run-off and storm water discharges, sewage sludge applied to soils, land-based industry and construction, tourism and recreation, inland shipping, and agriculture. Rivers act as significant pathways of marine litter and therefore measures should be put into place to ensure that litter does not enter them.

Abundance and composition

Beach litter is abundant across the whole OSPAR Maritime Area. The median total count for the OSPAR Maritime Area is 252 items/100 m, varying between 50 (Wider Atlantic (Region V)) and 360 (Bay of Biscay and Iberian Coast (Region IV)). All Regions, except Arctic Waters (Region I), showed a statistically significant decrease between 2015 and 2020 but, in general, marine litter levels remain high. Plastic is predominant (approximately 95% of items found on beaches). Single-use plastics and maritime-related litter are frequently found beach litter items at OSPAR level though some regional specificities in abundance are seen.

Litter is also widespread on the seafloor in a number of OSPAR Regions: Greater North Sea (Region II), Celtic Seas (Region III) and Bay of Biscay and Iberian Coast (Region IV), with fisheries-related and plastic materials predominating. There are no clear trends in Regions III and IV, but it appears to be slightly increasing in Region II.



Marine litter issues

A high density of floating litter has been identified in Region IV, especially in the south-east corner of the Bay of Biscay. An approximation of the amount of floating litter in Region II is given by monitoring the amounts of plastic particles ingested by the common fulmar seabird. Currently, 51% of beached North Sea fulmars have more than 0,1 g of plastics in their stomachs, exceeding the fulmar threshold value of 10%. However, these amounts decreased significantly in the period 2009-2018. A first assessment also indicates a high incidence of plastic litter ingestion by sea turtles in Region IV, in Region V and Macaronesia.

There is a common consensus that microplastics are widely present in the marine environment. They have been reported in sediments (beach, estuarine, subtidal and seafloor), surface waters, water columns and biota for the OSPAR Maritime Area at different concentrations. The main reported types of microplastics were fibres and fragments/particles. Tyre wear and (macro) litter (breaking down into smaller pieces) were identified as the largest land-based sources. Sea-based activities also contribute to the global burden of microplastics, including fishing, aquaculture, shipping, and other marine activities.

One of the major pathways for litter to enter the marine environment is via rivers and other tributaries. A rudimentary estimate of the total macro litter exported by six rivers (the Seine, Rhine, Meuse, Ems, Weser and Thames) to the Greater North Sea area (Region II) is 10,5 – 220,6 tonnes per year, mostly plastics.

Overall, some indicators show downward trends in some Regions; however, general levels of marine litter remain high.

Impact

Marine litter (including microplastics) is known to have severe ecological impacts. The known adverse effects on marine animals comprise ingestion of plastic particles via filter feeding, suspension feeding, and consumption of prey exposed to microplastics, or direct ingestion in mistake for food, causing blockages and damage to the digestive tract; entanglement, especially with filamentous litter items (such as loops, packaging bands or net-like structures, e.g., from derelict fishing gear); as well as smothering of benthic habitats and generation of artificial hard substrate. Furthermore, floating litter may act as a vector for the transport of contaminants and biota, including microbes which change or modify species assemblages. As a next step, dose-response relationships have to be established in order to develop additional threshold values and targeted measures.

Marine litter is also a pressure on ecosystem services, as its associated ecological consequences may compromise the provision of ecosystem services underpinned by the affected ecological components. Impacts on ecosystem services can have important implications for both the economic and social aspects of human welfare. There can be negative impacts on economic sectors such as tourism, fisheries, aquaculture, navigation, and energy and on the social aspects in terms of the attractiveness, enjoyment and interest from having clean beaches / marine areas and marine fauna in good condition, which in turn also affects people's psychological wellbeing.

Q2. What has been done?

The OSPAR North-East Atlantic Environment Strategy 2010-2020 (NEAES 2010-2020) aimed to "develop appropriate programmes and measures to reduce amounts of litter in the marine environment and to stop litter entering the marine environment, both from sea-based and land-based sources". The primary instrument for achieving this was the OSPAR Regional Action Plan for Marine Litter (RAP ML). When adopted in 2014, it was at the forefront of international collaborative efforts to tackle the issues associated with marine litter. The RAP ML set the policy context for OSPAR's work on marine litter, but also contained prevention and mitigation actions that OSPAR committed to work on between 2014 and 2020. These consisted of 32 collective actions and 23 national actions which aimed to address both land-based and sea-based sources and pathways of marine litter, as well as education, outreach and removal activities. Together, the actions formed a comprehensive strategy / approach to tackle marine litter, with the national actions designed to support implementation of the collective actions.

OSPAR has also adopted specific Recommendations partly resulting from RAP ML collective actions. Recommendation 2016/01 promotes the establishment of fishing for litter (FFL) initiatives in fishing harbours of Contracting Parties, supported by an associated target to "increase the total number of vessels participating in FFL schemes in the OSPAR Maritime Area by 100% by 2021, compared to the baseline situation in 2017"[1]. Recommendation 2019/01 aims at reducing marine litter by promoting the implementation of training programmes for fishers which address the social, economic and ecological impacts of marine litter. OSPAR Recommendation 2021/06 aims at reducing plastic pellet loss by promoting the timely development and implementation of effective and consistent pellet loss prevention standards and certification schemes for the entire supply chain.

Besides the RAP ML, other measures have been taken to combat marine litter, such as national actions resulting from implementing the EU Marine Strategy Framework Directive (MSFD), other EU initiatives such as the Single-Use Plastics Directive, Plastic Bag Directive, Port Reception Facilities Directive, work on microplastics, and several EU-funded projects.

In order to support these measures and determine their effectiveness, further monitoring and assessment work has been carried out including the development of common indicators on seafloor litter and on "ingestion of plastic in turtles".

Q3. Did it work?

A review of the RAP ML reported that, as of June 2021, of the 32 collective actions, 78% (25) were considered complete or fully implemented, 9% (3) were still in progress, and 13% (4) were limited in progress and no further action was foreseen under this RAP ML. Regarding the national actions under the RAP ML, for almost all Contracting Parties over 75% of actions were fully implemented or in progress. The FFL target in Recommendation 2016/01 had already been reached by 2020!

The review of the RAP ML concluded that the work completed under the RAP ML had been extensive but was not always easy to quantify or to illustrate through concrete outputs. The RAP ML was ambitious and had inspired action and progress in OSPAR Contracting Parties and other international organisations (e.g., Arctic Council, G7, UN). Furthermore, OSPAR had contributed to the evidence base for and benefited from the

[1] OSPAR Contracting Party reporting on this target will be available in 2022.

adoption of recent EU initiatives, such as the Single-Use Plastics Directive, the Port Reception Facilities Directive, work on microplastics and several EU-funded projects.

In terms of evidence of change in the quantities of marine litter in the North-East Atlantic, criteria like threshold values only exist so far for beach litter (EU only) and plastic litter in fulmar stomachs when it comes to determining the effectiveness of measures, but additional ones for other marine compartments and impacts are currently being developed.

At present, an important reduction in the abundance of beach litter (currently 252 items/100 m) would be required at the OSPAR level to reach the threshold value of 20 litter items/100 m adopted at the EU level, which is an indicative value of beach litter status in the OSPAR Area. Furthermore, currently 51% of beached North Sea fulmars have more than 0,1 g of plastics in their stomachs, exceeding the fulmar threshold value of 10%.

Nonetheless, there are positive signs of a decrease in quantities of litter found on OSPAR beaches and of floating litter in Region II - the Greater North Sea - over the last 10 years (as identified through the OSPAR Indicator Assessments). When this is considered against the upward trend in plastics production and consumption in Europe over a similar period, as well as the predictions for plastic consumption and waste issues to intensify in the future, it suggests that progress has been made on preventing plastics from entering the marine environment. Under the new RAP ML currently being developed, more specific measures will be taken in order to achieve and quantify further overall reductions of marine litter levels and specific litter items.

Q4. How does this field affect the overall quality status?

The marine litter objective in the NEAES 2010-2020 was defined as “to substantially reduce marine litter in the OSPAR Maritime Area to levels where properties and quantities of marine litter do not cause harm to the coastal and marine environment”. Based on the current assessment it could be concluded that although there are indications that the pressures from marine litter are reducing, marine litter levels are still high. Some seafloor litter even seems to be increasing, not unexpectedly, as the seafloor is a sink for marine litter. Further efforts are needed.

At present, an important reduction in total count would be required at the OSPAR level to reach, for example, the threshold value of 20 beach litter items/100 m adopted at the EU level. Overall, and in view of the observed trends, results show that current measures should be continued and strengthened with additional measures in order to increase the reduction in beach litter in the OSPAR Maritime Area and achieve OSPAR’s objectives. This concerns especially NEAES 2030 Operational Objective S4.O3, which aims at a reduction of 50% of single-use plastic and maritime-related items in 2025 and 75% in 2030. Threshold values need to be developed for other indicators in order to better understand the extent of harm caused by litter to the marine environment.

Since 2010, fisheries and shipping intensity levels have remained relatively stable; future developments are uncertain, but shipping might increase in Region I - Arctic Waters. Aquaculture, tourism, and marine infrastructure developments (renewable energy) have been expanding sectors and will probably further expand until 2030, thus potentially increasing marine litter pressure from these sectors.

There are a number of ways in which climate change could affect the quantities of marine litter entering the marine environment, especially from rivers, and its subsequent distribution and deposition. While there may be a need to adapt to some of these changes, it is not currently a major factor influencing OSPAR's marine litter objectives or the selection of actions for the RAP ML. More work is needed on risk assessment related to extreme weather events. In this connection, the driving factor will be the need to protect vulnerable communities from the devastating effects of flooding; these measures should in turn help to reduce inputs of marine litter.

Q5. What do we do next?

The presence (and associated impacts) of marine litter is driving society to call for action to change producer and consumer habits, reduce inputs and facilitate its removal. Actions are needed that address every stage of the plastic life cycle, with a special emphasis on reducing plastics production. Policy responses to managing marine litter need to consider all these driving forces in order to reduce inputs, reduce the risks associated with materials (e.g., alternatives to plastic) and facilitate societal change. Because of the links between climate change and marine plastic pollution, integrated approaches could benefit both problems.

The NEAES 2030 includes a new marine litter strategic objective (S4): "*Prevent inputs of and significantly reduce marine litter, including microplastics, in the marine environment to reach levels that do not cause adverse impacts to the marine and coastal environment with the ultimate aim of eliminating inputs of litter.*" S4 is supported by eight operational objectives on new measures for specific sources and pathways and on the development of ambitious coordinated strategies, control measures, threshold values and targets. The adoption of a new Regional Action Plan in 2022 is key to its implementation. Regular monitoring and assessment, including developing new common indicators, will continue to play a major role in supporting the measures and evaluating their effectiveness.

- OSPAR will use the QSR findings and continued monitoring and assessment to guide the definition of specific actions under the new RAP and evaluate existing and new measures;
- OSPAR will introduce a microplastics indicator;
- OSPAR will use the new RAP to develop new measures that add value to national and other international actions;
- OSPAR will continue to consider new indicators such as those relating to ingestion / harm to gather evidence to better understand the impact of marine litter;
- OSPAR will further develop its knowledge base on a better understanding of sources, transport, pathways, and fate of marine litter including on seafloor and floating litter and hotspot accumulations;
- OSPAR will continue to monitor, assess, and provide evidence of harm to inform and direct efforts and maximise the impact that they have on protecting the marine environment;
- OSPAR will develop approaches to prevent and reduce riverine input.

Very few knowledge gaps have been highlighted in the thematic assessment on Marine Litter. However, a number of knowledge gaps were identified in the marine litter common indicator assessments, the supporting technical supplements and other assessments. These will all be considered for inclusion in OSPAR's Science Agenda.

D - Drivers

All social and economic drivers influence levels of marine litter in the marine environment

All social and economic drivers have the potential to influence levels of marine litter in the marine environment. Societal needs for food, health and welfare, and stable economies drive demands for, inter alia, materials, industrial processes and trade and movement of goods. Activities associated with the manufacturing, production, packaging, processing, and transportation of fish and the agricultural, industrial, domestic or other commodities required to meet society's needs all have the potential to produce litter. There is a link between plastics production and climate change; Society's need to adapt to the effects of climate change; Society's need to become more resilient to the effects of climate change. The presence (and associated impacts) of marine litter is driving society to call for action to change producer and consumer habits, reduce inputs and facilitate its removal. Policy responses to the management of marine litter need to consider all these driving forces so as to reduce inputs, reduce the risks associated with materials (e.g., alternatives to plastic) and facilitate societal change.

A – Activities

Many human activities contribute to marine litter

Human activities affecting marine litter are distributed widely across the North-East Atlantic, but the intensity of activities and of the pressures they impose on the marine environment vary greatly between OSPAR Regions and sub-divisions. The regional summary below gives a high-level description of the intensity and trends of selected activities across the OSPAR Regions as prepared for the thematic assessment on Human Activities.

Arctic Waters (Region I)

Fishing occurs across the Arctic Waters Region, although pressure from bottom trawling is lower than in most other OSPAR Regions. Major oil and gas extraction occurs in the Norwegian Sea. Finfish aquaculture is important, notably in Norway, with expansion planned for future years, including into offshore environments. Increased shipping and oil and gas activity, for example in the Barents Sea, may bring further pressures in the coming decade. A growth in tourism activity may increase marine litter pressure

Greater North Sea (Region II)

The Greater North Sea is an area of intense activity, influenced by major population centres, intensive agricultural land use, coastal development, and tourism and recreation activity, particularly in southern areas. The presence of major ports in the area results in high pressure from shipping, and fishing takes place across the Region, with mobile bottom trawls deployed over 73% of the ICES ecoregion in 2018. Salmon aquaculture is a significant industry on the Norwegian coast.

Oil and gas production is widespread in the Northern North Sea, and gas production in the Southern North Sea. In the past decade, offshore wind developments have increased substantially in the Southern North Sea and at a lower rate in the Skagerrak and Kattegat, and major expansion of offshore wind energy will be a key issue for the Region in the coming decade.

Celtic Seas (Region III)

Pressures associated with fishing, shipping, coastal development, tourism and recreation, and agriculture are widespread in the Celtic Seas. Mobile bottom trawls were deployed over almost 45% of the ICES ecoregion in 2018. Finfish and/or shellfish aquaculture is important in the United Kingdom, Ireland and France. Energy production (fossil fuel and renewable energy) takes place in the Region, and significant future expansion of offshore wind energy is projected, notably in the Irish Sea.

Bay of Biscay and Iberian Coast (Region IV)

Fishing, shipping, tourism and recreation, land-based industry, and agriculture are the source of the most important pressures. Mobile bottom trawls were deployed over 19% of the ICES ecoregion in 2018. Important shipping routes exist across the Bay of Biscay and off the western Iberian Coast. Shellfish aquaculture takes place in Spain and France.

Wider Atlantic (Region V)

The only human settlements within the Wider Atlantic Region are in the Azores, so pressures from human activities are generally low. Nevertheless, some OSPAR threatened or declining species remain vulnerable to fisheries pressure, even though fishery catches in this Region are relatively small. There is increasing interest in exploring options for harvesting mesopelagic fish and plankton. Littering from shipping, or introduced from outside the Region, also occurs.

A great number of land-based and sea-based human activities introduce litter into the marine environment. The main direct sea-based sources identified are fishing, aquaculture, shipping, and recreation. In addition, marine litter also originates from offshore infrastructure (for example, oil and gas installations and offshore wind-turbines). The major direct and indirect land-based sources of marine litter include, for example, poor waste management practices, general littering, untreated sewage, run-off and storm water discharges, sewage sludge applied to soils, land-based industry / construction, tourism / recreation, inland shipping and agriculture. Rivers act as pathways of marine litter, carrying litter from inland to the marine environment. A high proportion (approximately 95% of items found on beaches) of marine litter found in the OSPAR Maritime Area is made from plastic, and so this assessment also considers plastic production and consumption trends as a key factor in understanding marine litter in the North-East Atlantic. Overall, the environmental awareness and behaviour of citizens, but also of industry, is a key consideration. The following sections provide a short summary of the trends in each of these activities over the last 10 years in the OSPAR Maritime Area (since the QSR 2010) and look ahead to 2030. The information below is mostly taken from the OSPAR QSR feeder reports.

Plastics production and consumption

Plastics production and consumption patterns and trends have a direct influence on quantities of plastics found in the marine environment. Production, both in Europe and globally, has increased substantially since 2010, as has the demand for plastics from converters (manufacturers of plastic products).

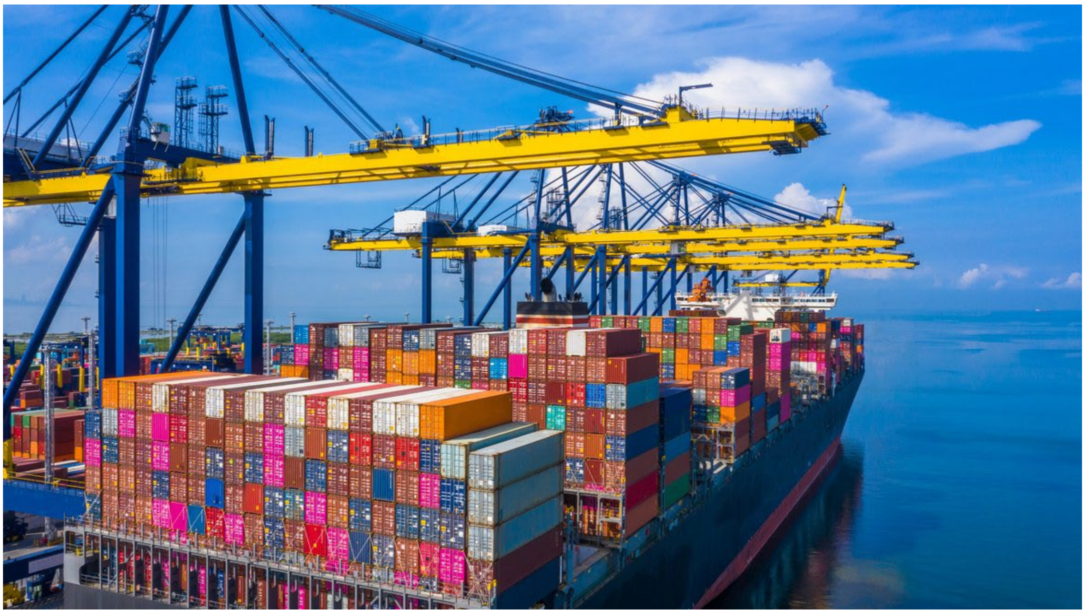
Annual per capita plastic consumption has reached 100 kg in Western Europe and collected post-consumer plastic waste rose substantially between 2006 and 2018. The European Commission in 2018 referred to an estimate of 0,15 – 0,5 million tonnes of plastic waste entering EU seas in 2015, within a global estimate of 4,8 – 12,7 million tonnes. Over time, plastic litter degrades to microplastics, typically defined as 'synthetic water-insoluble polymers of 5 mm or less in any dimension', but the time scale may be very long. Reviews by the European Environment Agency and European Commission have concluded that it is very likely that plastic consumption and waste issues will intensify in the future, and that global annual plastics production is expected to reach up to 1,2 billion tonnes by 2050.

Transport-shipping and transport-land

Transport can contribute to litter in the environment, through items such as lost goods or plastic wrappings torn from products (also in harbours) as well as shipping containers lost at sea.

Between 2018 and 2020, nearly 95% of items found in beach litter monitoring were plastics, and items from sea-based sources (maritime activities covering both fishing and shipping) represented 21% of all litter items observed, or 36 items/100 m (OSPAR Beach Litter Assessment 2021). Litter from maritime activities accounted for varying levels of the litter observed across the different OSPAR Regions, with 51 items/100 m in Region IV, between 29 and 40 items/100 m in Regions I, II and III, and just 1 item/100 m in Region V.

OSPAR Regions II, III and IV (and parts of Regions I and V) continue to have a high density of shipping. The OSPAR Maritime Area includes three of the twenty leading container ports globally, and ten of the twenty largest ports in Europe, with a particular concentration in the Southern North Sea. While global shipping is projected to expand in future years, the extent to which volumes of shipping in OSPAR waters will change remains uncertain (OSPAR Feeder Report 2021 - Shipping and Ports).



Ship being unloaded in port. © Shutterstock

Industrial uses, waste treatment/disposal and urban uses

Waste treatment / disposal and urban uses are both driven by society's need for industrial processes and materials. All these activities contribute to the introduction of litter into the marine environment.

Land-based waste management & industry

Plastics continue to leak from land-based sources into the North-East Atlantic. Despite the long-established history of waste management in the region, there are still inefficiencies or limitations in waste management practices and planning (for commercial, industrial, and residential settings). The scale of this issue varies both within and between the countries of interest, as do the management approaches and chains of responsibility (ref action briefing note).

Although there are no specific estimates of the amounts of marine litter that result from land-based industry and activity, it can be assumed that by addressing every step of the life cycle – reduced production, improved design, increased re-use and improved waste collection and management — waste streams and microplastics will be prevented from finding their way to the sea either via water courses or on the wind.

Waste water treatment (sewage and storm water discharges)

Waste water can contain microplastics which have resulted from toiletries or cosmetics, or from the abrasion of synthetic textiles during washing (producing microfibres). Quantities of sanitary products were observed in the OSPAR Beach Litter Indicator Assessment (2021). Cotton buds were observed as being one of the top 15 litter types recorded across all OSPAR beaches, and were in the top ten most collected items on 44% of OSPAR beaches. This may indicate that the waste water treatment plants are undersized or in disrepair.

Waste water treatment is ubiquitous in the OSPAR signatory countries, with over 95% of households connected to treatment facilities in western Europe and more than 23 600 urban waste water treatment plants covered by the EU's Urban Waste Water Treatment (Council Directive 91/271/EEC - UWWT) Directive (Waste Water Feeder Report). The distribution of treatment plants across Europe broadly follows that of the human population. The UWWT Directive has greatly improved the quality of urban waste water. However, increasing storm surges mean that treatment plants are more regularly bypassed, allowing raw effluent, as well as items which end up as marine litter, to enter water bodies, with the result that the size of plants has to be increased. Uncontrolled and unmanaged stormwater run-off remains an issue.

Extraction of oil & gas and Extraction of minerals

A limited number of offshore chemicals contain plastic or microplastic substances which are used and discharged during other offshore operations. Given the growing concerns related to marine litter, including plastics and microplastics, it is considered relevant to monitor the amount of plastic or microplastic substances contained in offshore chemicals discharged by the offshore oil and gas industry in the OSPAR Maritime Area, and the extent to which the discharges may be contributing to the wider marine litter issue.

Similarly, man-made infrastructures such as pipelines, cables and structures placed on the seabed are normally protected for a number of reasons, including protection from trawl boards, scour protection and pipeline / cable crossings, as foundation support, and to prevent buoyancy and provide stabilisation. Types of protection include the placement of sand, rock or gravel, concrete mattresses and sand or grout bags. Sand or grout bags are typically contained in polypropylene sacks. Concrete mattresses are often held together by polypropylene ropes. Due to the life span of the protection material, the plastic materials contained in these materials deteriorate and eventually disintegrate into the marine environment.

Operational Objectives S4.O6 and S4.O5 have been agreed in order to develop measures on these issues.

The production of hydrocarbons decreased by 28% from 2009 to 2019 (see assessment of impacts of oil and gas industry). This decline was largely due to increasing cessation of production and consequent decommissioning after the drop in the oil price in 2014. Pressure from offshore oil and gas activities is greatest in the Greater North Sea, followed by Arctic Waters and the Celtic Seas. In the other OSPAR Regions, the number of installations is low. The declining trend in production is expected to continue, and as older installations reach their end-of-life, it is anticipated that a number of installations will be decommissioned in the coming decade.

Tourism and leisure activities

Tourism and leisure activities, such as days on the beach when rubbish is left behind, contribute to marine litter.

The OSPAR Beach Litter Indicator Assessment (2021) considers the quantities of single-use plastics (SUP) on OSPAR beaches which could be attributed to high numbers of visitors to an area and therefore linked to tourism and recreation. Across all OSPAR beaches monitored, the median number of SUP items was 45 items/100 m, accounting for 26% of items encountered. Looking at the regional distribution of this usage group, OSPAR Region IV appears to be the most affected by the presence of SUP. Regions II and III are less affected and Regions I and V present the lowest values.

The recreation and tourism sectors are important economic activities for all OSPAR Contracting Parties (see: OSPAR Feeder Report 2021 – Recreation and Tourism in the North-East Atlantic). Recreation and tourism have grown steadily over the past 10 years in the OSPAR Maritime Area, both inland and on the coast. This growth was anticipated to continue until 2030, but this is now less certain due to the COVID-19 pandemic. OSPAR Regions II (47%) and IV (27%) are those with the highest share of tourist arrivals, followed by Regions III (20%), I (6%) and V (>1%). All Regions show a higher concentration of tourist and recreation activities along their coasts than inland. In terms of type of tourism and recreation, great differences can be observed. For instance, recreational boating is highly popular in the Nordic countries, whereas the cruise industry has boomed in Portugal, Norway, and Iceland.

Litter overspill on the beach. © Shutterstock

Marine aquaculture and agriculture

The relative intensity of aquaculture (mostly finfish and shellfish) in Regions I and II is considered high, whereas in Regions III and IV it is considered medium, and in Region V low (see: OSPAR Feeder Report 2021 - Aquaculture). In all five OSPAR Regions aquaculture activities have either remained the same (Regions III and V) or increased (Regions I, II, IV) since 2010, and are expected to continue increasing in all OSPAR Regions except Region V, where it is expected to stay the same. There are prospects for aquaculture in new offshore environments and involving new species (e.g., seaweed).

Plastics used in agriculture should be collected after usage; they have the potential to leach either as microplastics or macroplastics and impact the marine environment. There are no specific data to show the quantities of litter coming from agricultural activities in the OSPAR Maritime Area. However, 'fertiliser and animal feed bags' are included as a litter item in the OSPAR list.

Agriculture is the largest land-use in OSPAR countries, occupying approximately 110 million hectares of land in total (2016). Farming intensity is low in Regions I and V, medium in Regions III and IV, and high in Region II (see: OSPAR Feeder Report 2021 - Agriculture). Overall, there has been little change in farming as a pressure across all OSPAR Regions since 2010, and the forecast trend to 2030 shows no significant changes.

Fish and shellfish harvesting (professional, recreational)

OSPAR's Intermediate Assessment (IA) 2017 identified litter from fishing as one of the main sources of litter in the North-East Atlantic and this is confirmed by OSPAR's latest assessments on beach and seafloor litter. Litter from fishing can include trawl nets, gill nets, traps, cages and pots, ropes and other fishing gear such as dolly ropes. In the OSPAR Beach Litter Assessment (2021), "maritime-related items", which includes fishing and aquaculture-related litter as well as strings and cords (which can come from different sources but are often mainly related to fishing), has a median value of 36 litter items/100 m across all OSPAR beaches in the OSPAR Maritime Area. Of the 15 top beach litter types, four belong to the maritime-related group. The regional distribution is fairly homogeneous (between 29 and 51 litter items/100 m) excluding Region V, which records very low quantities of maritime- related items (1 item/100 m). Also, the Distribution and Composition of Litter on the Seafloor shows that fishing-related items are most commonly found in Regions II, III and IV.

There are substantial fisheries operating in all OSPAR Regions (see: OSPAR Feeder Report 2021 - Fisheries). In Region I total capture production has fallen since 2010, whereas in Regions II and III it has increased. There are no observed changes in capture production for Regions IV and V since 2010. The future of fishing activity in the North-East Atlantic is uncertain and largely dependent on a number of differing factors such as: climate change and resulting stock availability; the continuation of effective fisheries management measures; and the overall economic performance of the sector in relation to ageing vessels, uptake of new entrants to the sector, competition with recreational fisheries and restrictions due to energy production or conservation objectives.

Renewable energy generation (wind, wave and tidal power), including infrastructure

There are limited data to help understand the extent to which renewable offshore infrastructure contributes to marine litter in the North-East Atlantic, but, in line with development goals, offshore wind turbines also play an increasing role. Currently, around 75% of global offshore wind energy capacity is installed in European seas, notably in OSPAR Regions II and III. The scale of offshore wind installation in the OSPAR Maritime Area is expected to increase greatly in the next decade and beyond, primarily in Regions II and III. The current scale of tidal and wave energy installations is small. Nevertheless, some increase in the next decade can be expected.

P – Pressures

Marine litter levels are still high, some positive signs are seen

Table P.1

Indicators	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region IV)	Wider Atlantic (Region V)	OSPAR Maritime Area	Threshold Values
Beach litter S: 2018-2020 T: 2015-2020 Items/100 m	252	205 ↓	278 ↓	360 ↓	50 ↓	252 ↓	20/100 m
Seafloor S&T: 2012-2019 % probability	n/av	69 ↑	55	85	n/av	n/av	n/av
Fulmar S&T: 2009-2018 % of birds	N/A	51 ↓	N/A	N/A	N/A	N/A	10% (OSPAR)
Turtles S: 2013-2019 Pieces/turtle	N/A	N/A	N/A	9.6	16.3	N/A	N/A

Key:
↑: upward significant trend ↓: downward significant trend
If no arrow there are no significant trends
Beach litter TV (20 items/100 m) is only relevant for EU Member States
[1] In addition: 16,3 pieces per turtle were found in Macaronesia (Canary Islands— outside OSPAR Maritime Area)

Overall confidence level for the thematic assessment on Marine Litter, building on the pressure section:

Mostly medium to robust ratings for type, amount, quality and consistency of evidence; however, there are regional differences with respect to data availability. Region II has the highest coverage of indicators and robust evidence but with medium degree of agreement (assessment results mostly in consensus but with some deviation). Regions III and IV have lower coverage, with medium ratings for type, amount, quality and consistency of evidence and for degree of agreement. Limited evidence and degree of agreement in Regions I and V.

Table P.2: Confidence

OSPAR Region	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region III)	Wider Atlantic (Region V)
Confidence	Low	High	Medium	Medium	Low

Input of litter (solid waste matter, including micro-sized litter) [Substances, litter and energy]:

Land and sea-based macro and microlitter exert pressures on the marine environment through distribution along the coastline, in the water column and on the seabed. It can impact animals through ingestion, entanglement and smothering or adversely affect human activities such as tourism and leisure, fishing and aquaculture. The pressure of marine litter on the OSPAR Maritime Area is periodically monitored through four common indicators: beach litter, plastic particles in the stomachs of fulmars (Region II only), seabed litter, and ingestion of plastic particles in turtles (Regions IV and V only). A number of selected other OSPAR and non-OSPAR, often qualitative, assessments, give additional information on pressure, where this is not covered by the common indicators, for example on microplastics and riverine litter. These also cover OSPAR Regions like the Arctic Waters or the Wider Atlantic.

Marine litter indicators have been dealt with as pressure indicators. However, in some cases, they could also be seen as state indicators, as with the common indicators "Plastics in the stomachs of fulmars" and "Ingestion of plastic particles in turtles".

Beach litter

Key message: Beach litter levels remain high, with plastic items predominating. Over the last six years, significant decreases in litter and plastic abundance have been observed at the OSPAR Maritime Area scale and in four OSPAR Regions. To substantially reduce marine litter, it is necessary to continue current efforts and take additional measures.

Scope

The beach litter common indicator reflects spatial differences and temporal changes in the abundance, composition, and sources of marine litter in the coastal environment and is used as a proxy for litter pollution in the OSPAR marine environment.

OSPAR's Beach Litter Assessment describes the beach litter quality status and trends for both the OSPAR Regions and the OSPAR Maritime Area over the period from 2015 to 2020.

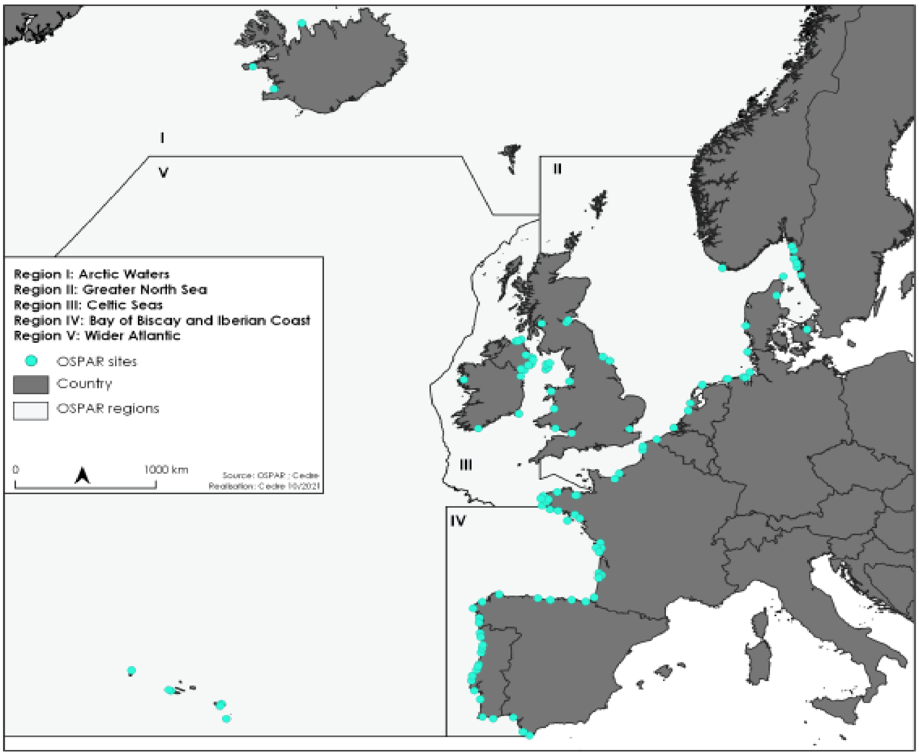


Figure P.1: Location of the 114 OSPAR survey sites considered in the assessment

Examples of litter collected during an OSPAR beach litter survey (bottom) (Litter collected on beach FR002, "Le Stang", France, Bay of Biscay region, on 09/01/2020, photo by Cedre).

Assessment methodology

The assessment of beach litter pollution is based on a time-series of abundance of litter categories, individual litter types, groups of litter types and a total count of litter items recorded on 114 OSPAR beach litter survey sites in all OSPAR Regions.

To provide a snapshot of the current situation, litter abundance and composition were assessed from 2018 to 2020 and current trends were assessed over a six-year period from 2015 to 2020. The surveys were carried out according to OSPAR's Coordinated Environmental Monitoring Programme guidelines for marine monitoring and assessment of beach litter and reported in the OSPAR Beach Litter Database. Non-identifiable mesoplastic fragments (less than 2,5 cm), waxes and other pollutants are excluded.

Assessment results

The median[2] total count for the OSPAR Maritime Area between 2018 and 2020 was 252 items/100 m. Although no operational total abundance objective has yet been adopted at the OSPAR level, this value is much higher than the European beach litter threshold value (EU TV) of 20 items/100 m. The magnitude of beach litter pollution varies between the five OSPAR Regions from 50 to 360 items/100 m, the minimum being in the Wider Atlantic and the maximum in the Bay of Biscay and Iberian Coast Region **(Figure P.2 and Table P.3**). The composition of the litter includes very high proportions of plastic items, a predominance which is also observed at OSPAR Regions scale, where this material group always represents more than 92% of beach litter pollution.

2 Median values are in general lower than mean (average) values. In addition, adjusted calculation methods are needed to combine median values (e.g., adding up to totalcount values)

Single-use plastics (SUP) and litter items related to maritime activities (SEA) are of great interest, since these usage categories are partly targeted by the EU intention to reduce the impact of certain plastic products on the environment. The SUP category includes specific litter items that are also directly targeted by the OSPAR Regional Action Plan on Marine Litter (RAP-ML 2014-2020). In the OSPAR Maritime Area, the median numbers for SUP and SEA usage groups are 45 items/100 m and 36 items/100 m, respectively **(Table P.4)**. Overall, these groups represent respectively 26% and 21% of litter observed. The highest percentage of SUP is observed in Bay of Biscay and Iberian Coast (37%), whereas the highest percentage of SEA items is observed in the Greater North Sea (25%). SUP and SEA items are directly targeted by government measures and are expected to decrease in coming years.

Over the last six years, decreasing trends in total and plastic counts have been observed at the OSPAR area scale and in all Regions except in Arctic Waters, where robust results could not be obtained due to low data availability. However, these decreasing trends appear to be rather slight, with decreases in total count ranging from 9 to 12 items/100 m **(Table P.3)**. Decreasing trends have also been observed for SUP and SEA in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast Regions, but with slopes ranging from –2 to –5 items/100 m per year **(Table P.4)**.

In the present assessment, high confidence is expressed in both the methodology and the data availability, except for the Arctic Waters Region, where data are too limited, especially for trends assessment.

Figure P.2: Median total counts in the five OSPAR Regions over the three-year period from 2018 to 2020

Table P.3: Median total and plastic counts (from 2018 to 2020) and associated slopes (from 2015 to 2020) in the OSPAR Maritime Area and the five OSPAR Regions

Geographical scale	Median total count (items/100 m)	Slope (items/100 m per year) ↓ significant decrease ↑ significant increase	Median plastic count (items/100 m)	Slope (items/100 m per year) ↓ significant decrease ↑ significant increase
OSPAR Maritime Area	**252**	↓ *-11*	**194**	↓ *-9*
Arctic Waters	**252**	*-6*[a]	**172**	*-16*[a]
Greater North Sea	**205**	↓ *-9*	**161**	↓ *-8*
Celtic Seas	**278**	↓ *-12*	**145**	↓ *-11*
Bay of Biscay and Iberian Coast	**360**	↓ *-11*	**284**	↓ *-11*
Wider Atlantic	**50**	↓ *-11*	**35**	↓ *-11*

[a] Trend provided for information due to a limited number of sites

Table P.4: Median counts in SUP and SEA items (from 2018 to 2020) and associated trends (from 2015 to 2020) in the OSPAR Maritime Area and the five OSPAR Regions

Geographical scale	Median SUP count (items/100 m)	Trend of total count (items/100 m per year) ↓ significant decrease ↑ significant increase	Median SEA count (items/100 m)	Trend of plastic count (items/100 m per year) ↓ significant decrease ↑ significant increase
OSPAR Maritime Area	**45**	↓ *-4*	**36**	↓ *-2*
Arctic Waters	***30***	*-4*[a]	***30***	*-5*[a]
Greater North Sea	***37***	↓ *-4*	***40***	↓ *-2*
Celtic Seas	***37***	↓ *-5*	***29***	↓ *-2*
Bay of Biscay and Iberian Coast	***93***	↓ *-4*	***51***	↓ *-4*
Wider Atlantic	***6***	*0*	***1***	*0*

[a] Trend provided for information due to a limited number of sites

Conclusions

Beach litter is abundant in the OSPAR Maritime Area and in the OSPAR Regions. Plastic appears to be predominant in all OSPAR Regions. Single-use plastics and maritime-related litter are important components of beach litter pollution at the OSPAR level, though some regional specificity in proportions of these two groups of litter is observed. At present, an important reduction in abundance is required at the OSPAR level to reach, for example, the threshold value of 20 litter/100 m adopted at the EU level. Significant decreasing trends are observed in all regions (except in Arctic Waters where they could not be assessed robustly), especially for total counts and plastics. However, levels of marine litter remain high. Overall, and in view of the observed trends, results show that current measures should be continued and strengthened and that additional measures need to be taken to obtain a stronger reduction of beach litter in the OSPAR Maritime Area in order to substantially reduce beach litter pollution and achieve OSPAR objectives, especially objective S 4.O3 recently adopted in the NEAES 2030. This objective aims to reduce *"by at least 50% the prevalence of the most commonly found single-use plastic items and of maritime-related plastic items on beaches in order to contribute to the achievement of relevant regional and EU threshold values building upon requirements for EU Member States in the EU Single-Use Plastics Directive (Directive 2019/904), and by at least 75% by 2030.*"

Seafloor litter

Key message: Seafloor litter is widespread across the area assessed; fisheries-related items and plastic materials predominate. The Bay of Biscay and the Iberian Coast had a higher probability of litter collected than both the Greater North Sea and Celtic Seas. In the Greater North Sea, the probability of litter collected has increased.

Scope

The seafloor is a sink for marine litter, as evidenced by research into both coastal and deep-sea waters using techniques such as snorkelling, scuba diving, trawl surveys and sonar, as well as manned and unmanned submersibles. The presence of large amounts of plastic litter has been reported on the European continental shelf. Benthic trawl surveys are a practical way to monitor seafloor litter on the continental shelf, because they are already in use for fish stock assessments, cover a wide area of seafloor and collect sufficient litter for analysis. There are some limitations to these data as the surveys' priority is to assess fish stocks, rather than litter accumulation and trends. The trawls cover only soft sediment (there are sampling restrictions in rocky areas), small litter items are not collected and, although there has been significant work to improve the sampling, there are still concerns over the quality of the data submitted due to limited technical guidelines, differing mesh sizes in fishing nets and lack of quality control. How well the different types of gear sample litter is not well understood.

Marine litter collected during a survey on board the RV Endeavour ©J. Thain

Display tank showing collected seafloor litter © Cefas

Assessment method

This assessment is based on data collected in line with the guidelines established as part of the OSPAR Coordinated Environmental Monitoring Programme (CEMP). The assessment draws on 12 survey programmes in three OSPAR Regions (Greater North Sea, Celtic Sea and Bay of Biscay and Iberian Coast). To take into account specific variables including gear type, area swept and unequal sampling effort in a given space, a statistical modelling approach was adopted.

The main part of the assessment shows the modelled probabilities that hauls will contain litter for the selected years (2012 to 2019). These models focus on the presence or absence of litter collected for each haul. Counts are not used for the main part of the assessment as there is a lack of confidence in the data between Contracting Parties, because their interpretations of how to count items differ.

Results

Litter is widespread on the seafloor in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast, with plastic the predominant material encountered (2012 to 2019). In spatial maps of the proportions of hauls containing litter items, separate assessments were made for each Region. In the Greater North Sea, there was a north-west (low) to south-east (high) gradient in probability that hauls would contain litter; in the Celtic Seas there was a north (low) to south (high) gradient. The combined probabilities for 2019 for some of these spatial gradients are shown in **Figure P.3.** Overall, the Bay of Biscay has the highest probability that a haul will contain a litter item (87%), with the Greater North Sea next (69%) and Celtic Seas the lowest (45%).

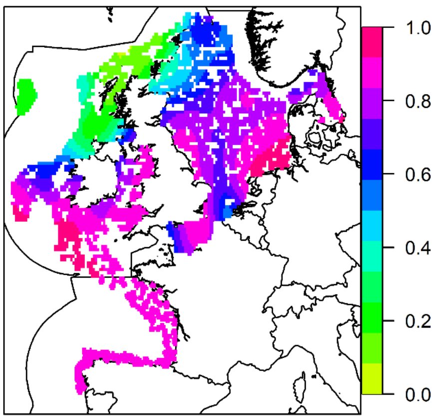


Figure P.3: Smoothed maps for the three Regions (GNS, CS and BB) combined, for 2019, of the probability that a haul will contain a litter item

The Greater North Sea was the only area to show a slight but statistically significant increasing trend in probability that hauls would contain litter, for the period between 2012 (approximately 0,6) and 2019 (approximately 0,7). Although there appeared to be a potentially increasing trend for fishing litter, it was not statistically significant.

The items most commonly found in each Region over time were mainly either made of plastic (bags, caps, bottles, band, sheets) or related to fishing activities (synthetic rope, other rope, monofilament fishing line, tangled fishline, fishing net). Other items included clothing, processed wood, and drinks cans. The top ten lists were similar for each of the three OSPAR Regions assessed.

A United Kingdom case study which looked at the NS-IBTS survey of the Greater North Sea Region showed no clear temporal trend (2015 to 2020), although a trend is difficult to show for such a small number of years. The lowest counts were in 2015, rising in 2016 and then reducing over the next four years. The statistically significant spatial components in 2017 and 2018 reflected a similar change to that seen with the probabilities, with more items collected per unit effort in the south of the Greater North Sea.

On examination of the catchability assessments, it is clear that the type of gear affects the type of litter caught during a survey. Initial catchability ratios were calculated for the litter types in each region and show that more items are collected by beam hauls than by *Grand Ouverture Verticale* (GOV) hauls. For these gear types, the ratio for total litter collected per haul varied from 1:5 in the Greater North Sea and 1:12 in the Celtic Seas.

Conclusions

Some broad conclusions can be drawn concerning the spatial and temporal changes affecting the probability that a haul will contain litter in the Greater North Sea, Celtic Seas and Bay of Biscay and Iberian Coast, and a demonstration study of count data was carried out in the Greater North Sea. Catchability estimates can be given for the ratios between different types of gear. To make further progress it is important to ensure that all surveys provide reliable counts of litter items.

Modelling of the presence / absence data took into account potential biases caused by unequal sampling in space, area swept and gear type. However, it has been recognised that to be able to fully combine all the available data, there is need for greater understanding of how the types of gear are set up and how different countries have been interpreting the litter-counting guidelines. OSPAR will be drawing on the experience of fishing survey analyses to improve the modelling.

There is moderate confidence in both the methodology and the data availability.

Plastic particles in the stomachs of fulmars

Fulmar in flight, Scotland. Source: Lucy Ritchie

Key message

Currently 51% of beached North Sea fulmars have more than 0,1 g of plastics in their stomachs, exceeding the Fulmar Threshold Value (Fulmar-TV) of 10%. This reflects the abundance of floating litter and provides an indication of harm. The amounts of ingested plastics have decreased significantly in the period 2009 to 2018.

Scope

Fulmars are abundant and widespread seabirds known to regularly ingest litter, with nearly all individuals having at least some plastic in their stomachs. Although fulmars forage at or near the water surface, their stomachs may also contain items from deeper water or items indirectly ingested through their prey.

The purpose of the Common Indicator on Plastic Particles in Fulmar Stomachs is to monitor the amounts of plastic particles ingested by the fulmar and to give an approximation of the amount of floating litter. These results are necessary for OSPAR reporting and for Marine Strategy Framework Directive (MSFD) reporting of litter ingested by marine animals (criterion D10C3).

Mostly the mesoplastics (0,5-2,5 cm) and large microplastics (1-5 mm) present in the stomach of the fulmar are assessed. Some macroplastics (e.g., filaments) may also be present. The total mass of the plastic particles in fulmar stomachs is assessed and the percentage of fulmars with more than 0,1 g of plastics in their stomachs is calculated. The threshold value for fulmar plastics was set at 10% by OSPAR in 2020, based on the study by Van Franeker et al., (2021). This determines that not more than 10% of the fulmars should have more than 0,1 g of plastics in their stomachs.

The fulmar indicator is applied in the OSPAR Greater North Sea Region. This Region consists of the five sub-regions English Channel, Skagerrak, East England, Scottish Islands, and South-eastern North Sea. Both the Greater North Sea Region and its sub-regions are assessed separately and provide information on different spatial scales and with different statistical power and significance. A recent OSPAR pilot study has shown that the fulmar indicator is applied in the Arctic Waters Region for monitoring by Iceland, and has been applied for research purposes by Denmark and Norway, respectively.

Plastics from a fulmar stomach with industrial granules (left) and a mix of thread-like (centre left), sheet-like (centre), and fragmentary (right) consumer plastics. Size indicated by the spherical industrial granules, which are of 4 to 5 mm diameter. (Fulmar sample NEE-2018-017 photo by J.A. van Franeker).

Assessment method

The plastic pollution status and trends relating to fulmar stomachs were assessed using the total mass of plastic particles (mostly pellets and non-identifiable mesoplastic fragments) per stomach.

For state assessment, the percentage of fulmars with more than 0,1 g of plastics in their stomachs was calculated by aggregation of the five most recent years of data (2014 to 2018). The state assessment values were compared to the Fulmar Threshold Value (Fulmar-TV).

For trend assessment, linear regression of ln-transformed total mass data per fulmar stomach was performed for the period 2009 to 2018.

These state and trend assessments were performed at the OSPAR Region II level as well as for its five sub-regions. See the [CEMP Guidelines for monitoring and assessment of plastic in fulmar stomachs]() for full methodological details.

Results

State Assessment 2014-2018

Over the period 2014-2018, the OSPAR long-term goal in terms of plastic litter ingestion by seabirds was not reached anywhere in the Greater North Sea Region. Among the 393 fulmar stomachs analysed, 51% contained more than 0,1 g of plastic, whereas the aim of the Fulmar-TV is to reduce this to less than 10%. Of all birds analysed, 92% had ingested some plastic, and the average values per individual bird were 21 particles and 0,26 g. Regionally, the Fulmar-TV percentage ranged from 49% in the Skagerrak and on the Scottish Islands to 68% in the English Channel. Within the Greater North Sea Region, the earlier tendency for decreasing plastic loads further north became less clear. In previous assessments the English Channel had been significantly more polluted than the more northern sub-regions. This appeared to continue but not at a statistically significant level. **Figure P.4** shows the sub-regional differences in ingested plastics in the Greater North Sea.

On the larger scale of the North-east Atlantic, a latitudinal pattern remains evident (Van Franeker et al., 2011; Van Franeker & Law 2015; Van Franeker et al., 2021). Only in the far north-western Atlantic (the Canadian Arctic) are the plastic ingestion levels, as expected, close to the Fulmar-TV. In the first assessment period 2010 to 2014 the numbers were 58% and 0,31 g. The 56% and 0,28 g calculated for the second assessment period 2012 to 2016 and the new values for the third period suggest a continued decrease, that however has to be evaluated in the agreed statistical approach.

Trend assessment 2009 to 2018

Time-related trends in the fulmar monitoring programme are tested over periods of 10 years. The first assessment for 2005 to2014 did not reveal any change. However, the second assessment for 2007 to 2016 showed a significant decline in the ingested plastic mass. In the 2009 to 2018 period the significant decline continued, but was less pronounced.

In contrast to earlier years, the reduction was driven by decreases in user plastics and, to less extent, by industrial plastics.

Statistically significant progress in the direction of the Fulmar-TV for the Greater North Sea Region as a whole was thus achieved. Four of the five trends for the separate sub-regions (Figure 1) showed no statistically significant changes. This illustrates the statistical advantage, for the regional North Sea assessment, of combining all samples from the different sub-regions.

There is high confidence in both the methodology and the data availability.

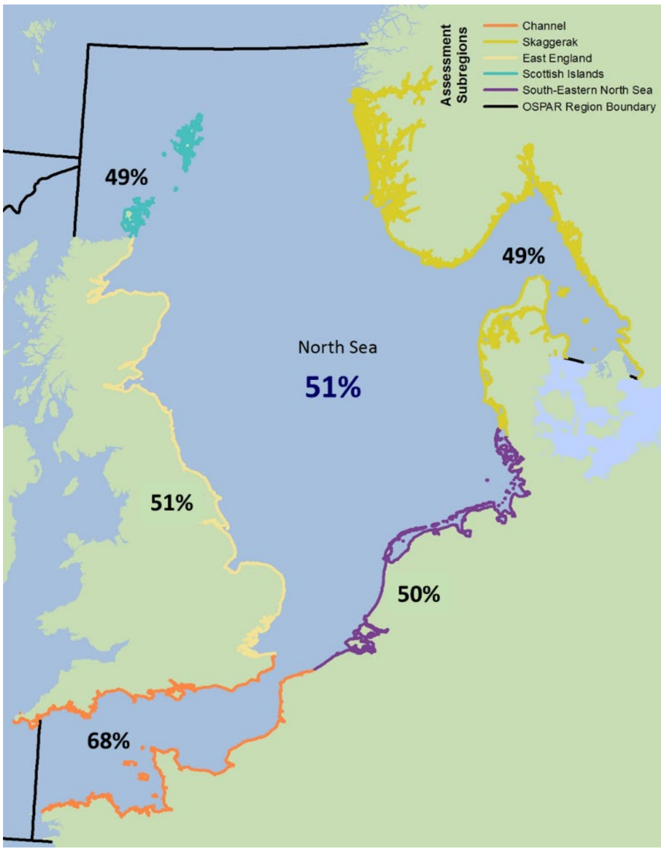


Figure P.4: Proportions of fulmars having more than 0,1 g of plastic in the stomach (EcoQO performance) in different sub-regions of the North Sea over the period 2014 to 2018. Details of sample sizes and average number and mass of ingested plastics are shown in the full 2021 fulmar indicator assessment.

Conclusion

The indicator appears to move in the direction of fewer plastics in the North Sea marine environment, but still far exceeds the Fulmar-TV. The North Sea fulmar population has suffered substantial decline over the past decades. Although direct evidence for the causes of decline is not available, the ingestion of plastic litter is considered a potential contributing factor, because the sub-lethal effects of reduced body condition and health may affect almost all individuals in the population. Measures in the OSPAR Regional Action Plan aim to reduce litter and are expected to lead to a reduction of litter ingested by fulmars.

Ingestion of plastic particles in turtles

Sample of marine litter excreted by an individual loggerhead turtle (Caretta caretta) in a rescue centre (credit D. Gambaiani, Cestmed)

Plastic collected in the oesophagus of a necropsied loggerhead turtle (Caretta caretta) (Bay of Biscay). Source: La Rochelle aquarium

Key message: There is a high incidence of litter ingestion by sea turtles in the Bay of Biscay, the Azores and Macaronesia, but with regional differences. Mean abundance of ingested plastics was 9,6, 16,3 and 16,3 pieces, respectively. This new common indicator provides the baseline for further monitoring and evaluation of trends.

Scope

The amount of litter and microlitter ingested by sea turtles may indicate adverse effects on the health of these animals, which could eventually prevent obtaining a good environmental status. The assessment provides information about environmental status in southern OSPAR areas (Regions IV and V).

The wide distribution of sea turtles, their use of various marine compartments and their propensity to ingest debris make them a relevant indicator. Since the indicator was initially proposed in 2015, progress has been realised in terms of networking and the collection of standardised data to provide an assessment of the indicator in the southern OSPAR seas where sea turtles live. While Macronesia is outside the OSPAR Maritime Area, it nonetheless provides a useful case study.

Assessment method

The indicator focuses on the loggerhead turtle, *Caretta caretta.* The prevalence of litter ingestion in sea turtles is calculated as the percentage of dead turtles found with ingested litter, based on occurrence (or incidence) reported as presence or absence (see images 5 and 6). While a precise definition of a threshold value is under review, the data collected provide the first assessment and supply important knowledge for measuring the impact of actions on single-use plastics and, more generally, for reinforcing measures related to the conservation of sea turtles.

According to the distribution of sea turtles, the monitoring is applicable to OSPAR Regions IV and V as well as Macaronesia. See the protocol elaborated within the MSFD and updated in the framework of the European Union INDICIT project for full methodological details.

Results

For this first assessment, 182 dead loggerhead turtles obtained from 1988 to the end of 2019 in the southern OSPAR area were necropsied to measure the prevalence of ingestion (% of individuals affected) and amount of litter ingested (dry mass and abundance of litter in the digestive tract).

A total of 52,5% of the turtles were found with ingested litter (plastics) in their digestive tract and, on average, 0,6 ± 0,1 g, equivalent to 13,1 ± 2,0 pieces, were found in each individual's digestive tract. By only considering the data collected from 2013 to 2019 inclusive, which presented a more standardised collection of data in line with the MSFD protocol, the occurrence of litter ingestion increased to 68,1%, while the mean dry mass and the mean abundance of ingested plastics reached, respectively, 0,7 ± 0,22 g and 14,3 ± 6,7 pieces.

Considering the data from 2013 to 2019, among the three areas there was a significant difference in the occurrence of ingested dry mass, but no difference in numbers of items. The occurrence of plastic ingestion was lowest in the Bay of Biscay, at 47,6% (N=21), while it was 71,1% in the Azores (N=38) and reached 100% in the Canary Islands (N=10). The mean dry mass of ingested plastic was, respectively, 0,2 ± 0,1 g in the Bay of Biscay, 1,0 ± 0,3 g in the Azores, and 0,2 ± 0,1 g in the Canary Islands). The mean abundance of ingested plastics for these three regions was 9,6 ± 4,1 pieces; 16,3 ± 4,3 pieces; and 16,3 ± 3,1 pieces, respectively.

Table P.5: Mean prevalence (% of affected individuals), dry mass (g per individuals), and amount of litter ingested by sea turtles (abundance) in the southern OSPAR area; N = sampling size (INDICIT, 2021)

Area	2013-2019			
	N	Prevalence	Dry mass	Abundance
Biscay (OSPAR Region IV)	21	47,6	0,2 ± 0,1	9,6 ± 4,1
Azores (OSPAR Region V)	38	71,1	1,0 ± 0,3	16,3 ± 4,3
Canary islands (Macaronesia)	10	100	0,2 ± 0,1	16,3 ± 3,1
TOTAL	69	68,1	0,7 ± 0,2	14,3 ± 6,7

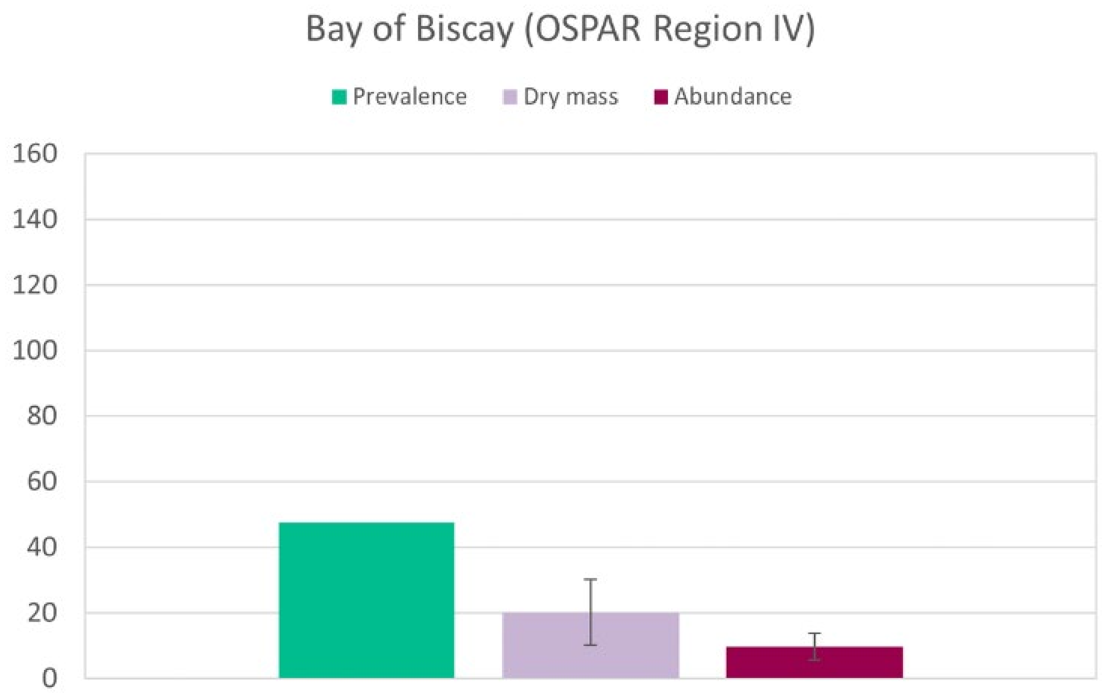


Figure P.5: Mean prevalence (% of affected individuals), dry mass (g per individual X 100), and number of items ingested by sea turtles (abundance) in the Bay of Biscay, N = sampling size (after INDICIT, 2021)

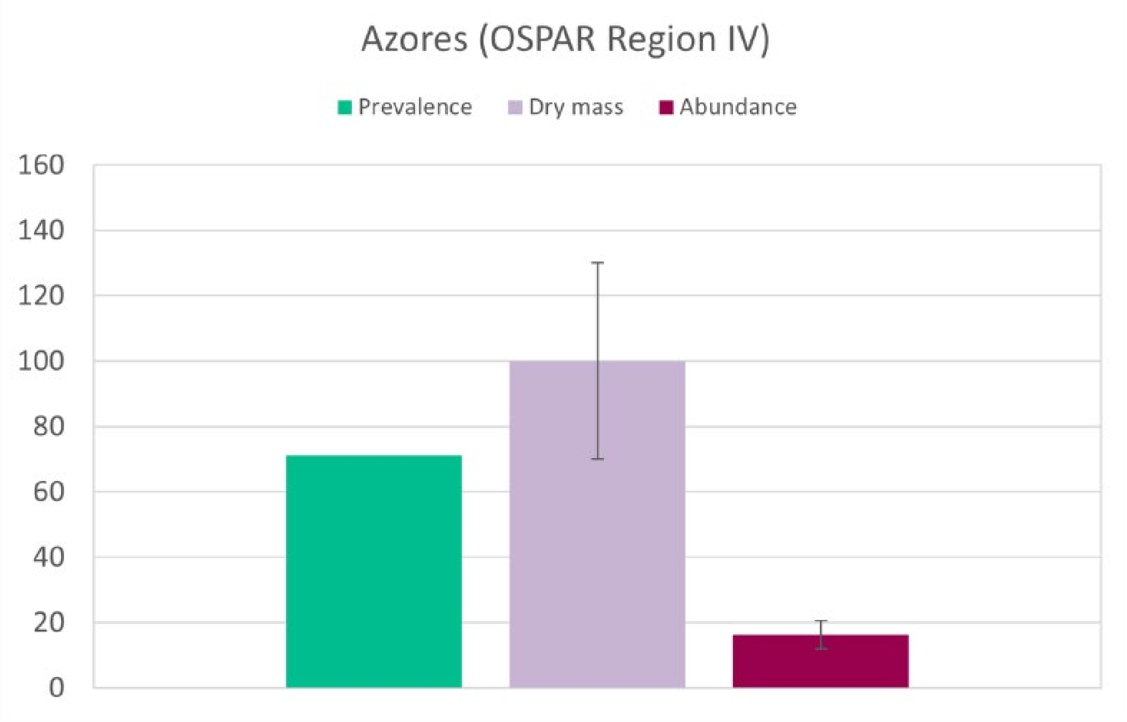


Figure P.6: Mean prevalence (% of affected individuals), dry mass (g per individual X 100) and number of items ingested by sea turtles (abundance) in the Azores; N = sampling size (INDICIT, 2021)

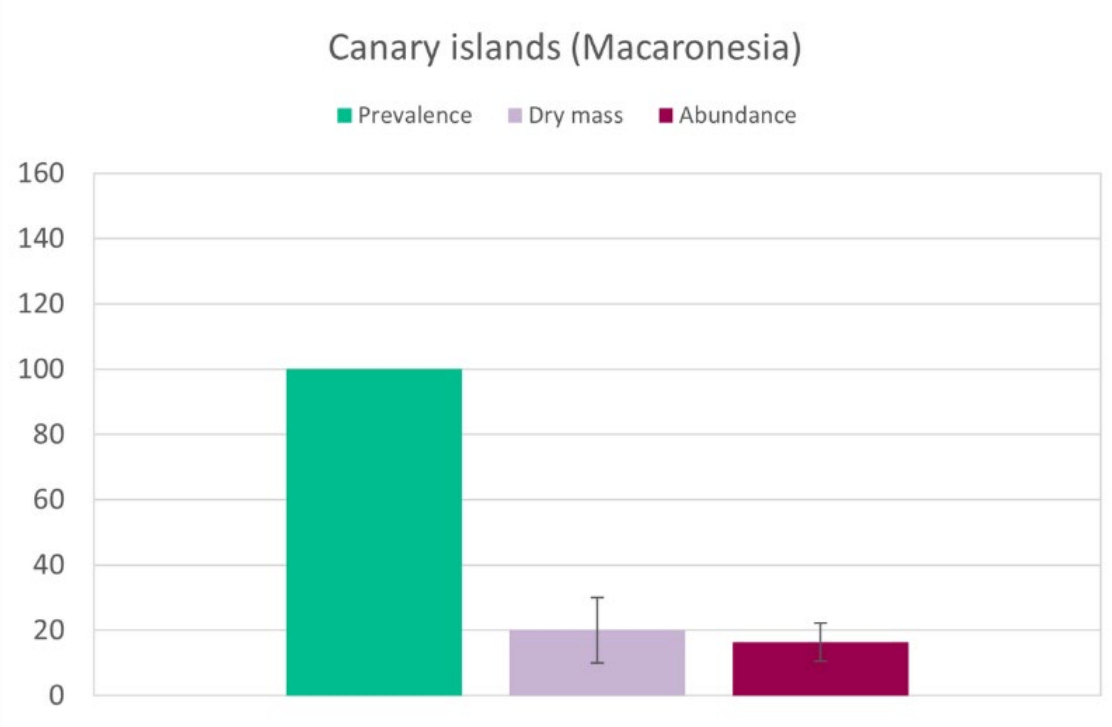


Figure P.7: Mean prevalence (% of affected individuals), dry mass (g per individual X 100), and number of items ingested by sea turtles (abundance) in the Canary Islands, N = sampling size (after INDICIT, 2021)

Conclusions

The first assessment of the Common Indicator "Litter ingested by sea turtles" indicates a high incidence of litter ingestion by sea turtles in OSPAR Regions IV and V and Macaronesia but with regional differences. It provides a first baseline for further monitoring and evaluation of trends. The approach will enable the evaluation of the efficiency of reduction measures, including some specific actions such as developing national strategies to tackle single-use plastics from the first OSPAR Regional Action Plan.

This initial assessment provides consistent data and the technical and scientific basis for future implementation of monitoring. Further sampling will also enable greater coverage which will record all stranded animals in all parts of Regions IV and V and Macaronesia. Long-term management of sampling and data collection will also enable the evaluation of trends. Alignment of the data with the threshold value preliminarily defined by the EU INDICIT project, which has yet to be agreed by OSPAR, indicates that the population of sea turtles in the OSPAR area is strongly affected by marine litter, and that reinforced and new actions are required.

Other (OSPAR) assessments

Microplastics

Microplastics pollution of marine environmental compartments is an issue of concern worldwide, but information on the key sources, pathways, distribution and impacts is still scarce in many cases, fragmentary at best and, typically, difficult to compare owing to a lack of harmonisation in methodologies.

Sources of microplastics in the OSPAR Maritime Area

Microplastics have been reported for sediments, water and biota globally including across the OSPAR Maritime Area. Sources of microplastics are varied and often difficult to identify due to their dynamic transport in the terrestrial, freshwater and marine environment and are mainly classified as land- and sea-based sources (**Figure P.8**). Land-based sources have been generally assumed to be the main contributors of plastic (macro) waste to the marine environment (Gilardi *et al.*, 2020; Meijer *et al.*, 2021), although sea-based sources are also recognised as an important contributor in the OSPAR area (GESAMP, 2021). For the OSPAR catchments, tyre wear and (macro) litter (breaking down into smaller pieces) were identified as the largest land-based sources of microplastics, with estimated amounts of around 100 000 tonnes per year (OSPAR, 2017). Sea-based activities also contribute to the global burden of microplastics, including fishing, aquaculture, shipping, ocean dumping and other marine activities. To date, estimates of the total contribution of sea-based sources to the OSPAR Maritime Area are not possible due to the limited available quantification of marine litter inputs from the scientific, peer-reviewed and grey literature (Gilardi *et al.*, 2020).

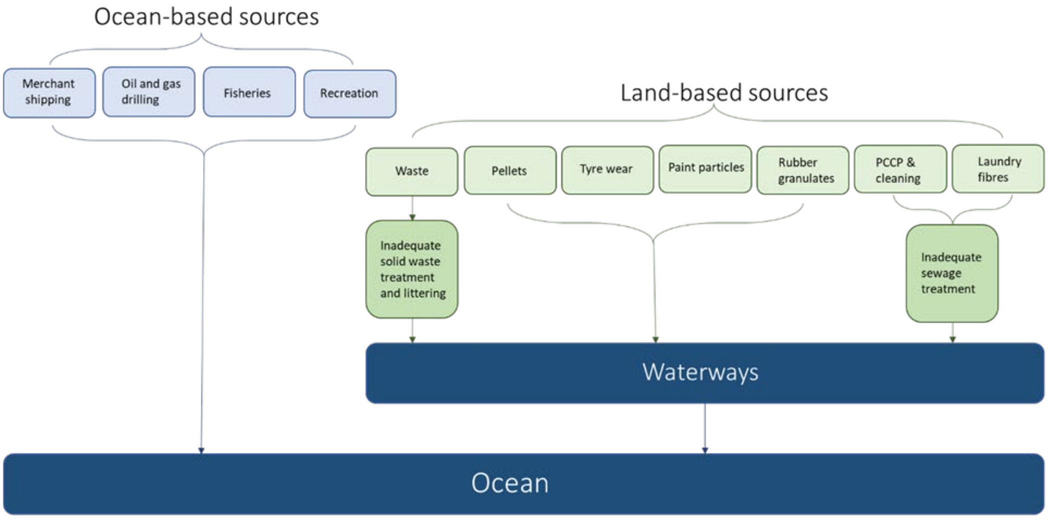


Figure P.8: Overview of sources and pathways of microplastics to the marine environment identified in the scientific literature. (Modified from source: OSPAR, 2017.)

Occurrence and abundance of microplastics in the OSPAR Maritime Area

While monitoring data for microplastics are limited for the OSPAR Maritime Area, some data are available on their abundance in sediments (seafloor, subtidal, beach and estuaries), surface and near-surface waters, the water column and biota for various locations. A lack of standardised analytical and reporting protocols makes comparisons between datasets difficult. International efforts are currently being focused on the production of guidelines at national and international levels to produce monitoring data which can be used for national, regional, and sub-regional assessments. Microplastics have been reported for all the environmental compartments assessed (sediments, water, and biota) in all OSPAR Regions. A knowledge gap in monitoring data was identified for Region V, owing to a lower number of available studies reporting on the abundance of microplastics in the area. Reported concentrations of microplastics varied greatly according to the environmental compartment targeted and across locations. Reported polymer types appeared to be consistent across Regions, with a prevalence of polyethylene (PE), polypropylene (PP) and polyester (and, in addition, polystyrene (PS) and polyvinyl chloride (PVC) in sediments). The main reported types of microplastics were fibres and (or followed by) fragments.

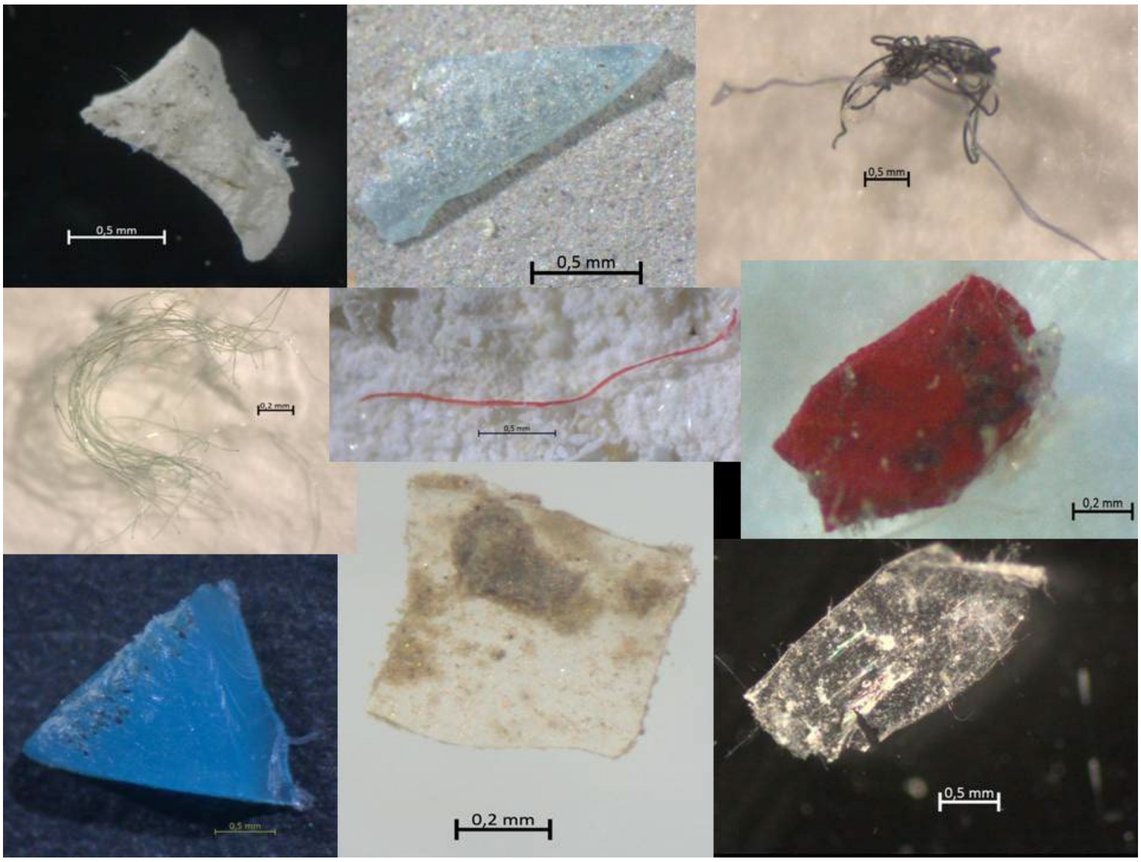


Figure P.9: Photographs of different types of microplastics collected in seawater and sediments in Ría de Vigo (NW Spain) ©Instituto Español de Oceanografía (IEO)

Summary and conclusions

Despite the absence of widely accepted, harmonised, protocols for the analysis of microplastics in environmental samples, there is a common consensus that microplastics are widely present in the marine environment. Microplastics have been reported in sediments (beach, estuarine, subtidal and seafloor), surface waters, the water column and biota for the OSPAR Maritime Area at different concentrations. However, the lack of applied standardised sampling and analytical protocols for the monitoring of microplastics makes comparison between datasets difficult, and a fully integrated qualitative assessment is not feasible.

There is, therefore, an urgent need to develop and adopt common indicators and supporting guidelines for the monitoring of microplastics in the OSPAR Maritime Area. Seafloor sediments have been identified as likely sinks for microplastics in the marine environment and work is ongoing to develop guidelines for their monitoring for the OSPAR Maritime Area which take into account future spatial and temporal assessments, better integration with the monitoring of other contaminants as well as an understanding of subsequent risks to marine life and impacts on key environmental processes (e.g., global nutrient cycle and oxygen levels in the ocean (Kvale et al., 2021)).

Riverine litter

One of the major pathways for litter to enter the marine environment is via terrestrial waterways, namely rivers and other tributaries. An overview has been prepared (link to overview) of the current state of knowledge on macroplastics export by six rivers in OSPAR Region II (Greater North Sea): Seine, Rhine, Meuse, Ems, Weser and Thames. A rudimentary estimate of total macroplastics export by these rivers to Region II is 10,5 – 220,6 tons per year (**Figure P.10**). Two main insights can be derived from comparing the observed amounts of macroplastics in rivers within the OSPAR area. First, the export of macroplastics by rivers in the OSPAR area varies greatly and, second, the estimated range of macroplastics exported is large, often showing a difference of one order of magnitude or more between the lower and the higher estimates. These large ranges are an indicator of the level of uncertainty that comes with these data.

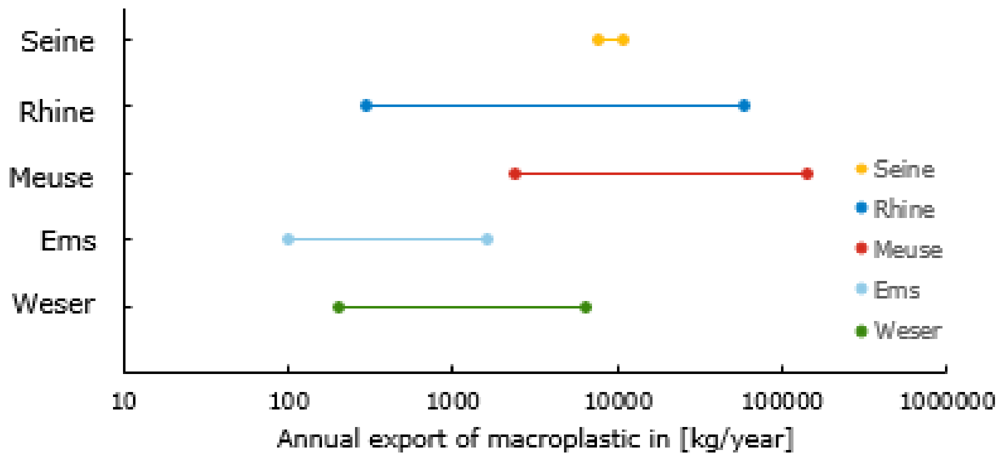


Figure P.10: Overview of floating macroplastic exports from rivers located in the OSPAR area (no mass transport data for the Thames available)

Plastic is the predominant material type of macrolitter pollution found in all rivers (approximately 80%). Most of the items found in rivers can be linked to consumer use (such as bottles, plastic bags, food wrapping and sanitary items). However, the most frequently found items are unidentifiable small pieces of plastic of < 5 cm. The large presence of smaller pieces of plastic indicates that plastic items already experience breakdown processes within a river system (to a large degree through UV-light and wear and tear by wind, waves, and traffic). Long term, integrated monitoring strategies need to be developed in order to better quantify plastic pollution and to identify possible ways to reduce it. A number of riverine litter activities are foreseen in the revised OSPAR RAP ML. They are supported by the following operational objective in NEAES 2030:

"By 2025 OSPAR will develop approaches to prevent and reduce riverine marine litter inputs in cooperation with the relevant international river or river basin commissions, and other appropriate authorities and organisations."

Any future work to address the issue of riverine litter as a source of marine litter in the North-East Atlantic will require close cooperation and collaboration with the various river commissions or the appropriate national responsible bodies. Furthermore, collaboration with the work underway at the EU level is essential to the success of any initiative or proposed way forward, including consideration and discussion of the benefits of a harmonised approach to monitoring.

Marine litter in the Arctic

Very little data are available on the Arctic marine region (PAME 2019). The area is not well covered by OSPAR's monitoring programme. The state of knowledge on marine litter, including microplastics, primarily stems from (anecdotal) information and case studies, and is not comparable to the information on other areas. This information is more prevalent for areas where human activities are concentrated, including the Barents, Norwegian and Bering Seas, or for specific research topics (e.g., seabirds). Few data are available for the central Arctic Ocean and the coastal areas around it in Siberia, Arctic Alaska, mainland Canada and the Canadian Arctic archipelago.

The limited analysis carried out of macrolitter washed ashore on Arctic beaches or accumulating on the seafloor indicates that most can be attributed to fishing activity, for example, nets, floats, and other debris. The “plastic in a bottle” project coordinated by the PAME Secretariat also highlights the long-distance and often transboundary transport of marine plastic waste throughout the Arctic.

Beach litter is abundant in Region I (based on a few datapoints) with a median total abundance of 252 items /100 m on the three Icelandic beaches considered in the assessment. Plastics accounted for up to 97% of the litter observed.

A study of the distribution and abundance of marine litter in the Nordic Seas examined 1 778 video transects, of which 27% contained litter. The density of litter in the Barents Sea and Norwegian Sea was 202 and 279 items/km^2, respectively, with the highest densities close to the coast and in canyons. Plastic and fishing-related items were the most common, a similar finding to the OSPAR seafloor litter assessment. Litter levels were comparable to others recorded in Europe (Buhl-Mortensen, 2017)

There is some evidence that marine litter, including microplastics, is transported into the Arctic by ocean surface currents from distant sources. The presence of microplastics in sea ice has also been documented, and the role of sea ice as a pathway for redistributing marine litter, including microplastics, in the Arctic Ocean has been investigated. The flow of sea ice from the inner Arctic towards the Fram Strait and the Greenland Sea, associated with the Transpolar Drift Current, has been proposed as a possible mechanism by which microplastics are transferred towards the marginal ice zone (i.e., the transition between the open ocean and sea ice), where they are released into the water when the sea ice melts.

CleanAtlantic – floating litter assessment

Floating marine macrolitter is the proportion of marine litter, comprising items larger than 2,5 cm, that floats in the superficial layer of the water column. As the mobile component of marine litter, it can provide indications of the main sources, sinks, and pathways and enable the effectiveness of waste prevention measures to be assessed.

As part of the global assessment of the status of marine litter in the Atlantic area carried out under the CleanAtlantic project (Interreg Atlantic Area Programme), IEO and IFREMER analysed their floating macro litter-data on the OSPAR Maritime Area. These data, obtained by visual observation following common methodologies, were recorded by experienced top-predator observers during fish-stock assessment campaigns carried out from 2007 to 2020 in the north-west Iberian shelf, the Bay of Biscay, the Celtic Seas, the English Channel and the southern part of the North Sea.

The spatial (at ICES cell level) and time-averaged floating macrolitter densities recorded ranged from zero to 4,60 items km^{-2}, plastic being the type of litter more commonly found. The area with the highest density was the Bay of Biscay, especially in the south-east corner where the maximum values were found (maximum average density was 23,6 items km^{-2} in 2016 off the coast between San Sebastian and Bilbao in Spain). No temporal tendency could be derived from the data. The complete report and online viewer (see screenshot in **Figure P.11**) are available on the project website (http://www.cleanatlantic.eu/).

These preliminary results will be further assessed to check the effect of any potential confounding factors that might be hindering the detection of spatio-temporal trends (e.g., the different number of surveys available per ICES cell, which ranged between 1 and 491).

Figure P.11: Screenshot of the CleanAtlantic Marine Litter Viewer showing the time- and spatial- averaged density of floating macro litter (items > 2,5 cm). The colour scale indicates the density in each ICES cell where data are available (the darker the colour the higher the density, ranging from zero to 4,60 items km^{-2}). For more detailed information (average densities, time series, histograms, and pie charts with main types of litter recorded) go to: http://www.cleanatlantic.eu/MarineLitterViewer/index.html

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Technical supplement 1 - Synthesis of data on riverine macrolitter in OSPAR region II

Technical supplement 2 - Qualitative assessment microlitter in the OSPAR area with a focus on microplastics

S – State

Ecological effects of litter in the marine environment

Marine Litter indicators have been dealt with as pressure indicators. However, in some cases, they could also be seen as state indicators, like the common indicators "Plastics in the stomachs of fulmars" and "Ingestion of plastic particles in turtles".

The bow-tie analysis for marine litter shows the relationships between the DAPSIR components which need to be considered in a cumulative effects assessment. Human activities have been identified which contribute to the marine litter pressures and have the potential to contribute both individually and cumulatively to biodiversity state changes in the thematic assessments for a number of species and habitats. (See bow-tie section on marine litter).

Although there are some indications of reductions in pressure from marine litter that may, over time, result in a relative improvement in environmental status, quantitative data is lacking. Levels of marine litter are still high and objectives and threshold values have not (yet) been reached, and ecological impacts and impacts on ecosystem services are occurring.
A regional breakdown of the state changes is currently not appropriate, other than a breakdown of the relevant (pressure) common indicators.

Harm to biota

Marine litter (including microplastics) has become a major stressor of marine wildlife and ecosystems, adding another severe impact to the existing human pressures on the marine environment. Marine litter further weakens the ecological resilience and adaptive capacity of marine species and ecosystems and, as a result, their ability to withstand adverse impacts from climate change. Known adverse effects on marine animals worldwide, including in the OSPAR Maritime Area, comprise: ingestion of plastic particles via filter feeding, suspension feeding and consumption of prey exposed to microplastics, or direct ingestion in mistake for food, causing blockages and damage to the digestive tract; reduced nutritional value of food and increased exposure to plastic-associated chemical pollutants through the release of additives incorporated during manufacture as well as absorption of persistent organic pollutants by plastics from seawater; entanglement, especially with filamentous litter items (such as loops, packaging bands or net-like structures, e.g., from derelict fishing gear) leading to immobility or direct injury and death; and the smothering of benthic habitats and generation of artificial hard substrate altering the structure of benthic communities and even impacting whole populations of marine species. Furthermore, floating litter acts as a vector for the transport of biota, including microbes which change or modify assemblages of species.

Seabird (Morus Bassanus) entangled in fishing net (NW Spanish coast). ©Xulio Valeiras, Instituto Español de Oceanografía (IEO)

During the last couple of years, the number of species shown to be affected by marine litter has significantly increased. According to a review in 2020, a total of 914 marine species were documented to be affected by marine litter through entanglement and / or ingestion. Ingestion was documented for 701 species, and entanglement was recorded for 354 species. According to the online database “Litterbase”, some 2 788 marine species have encountered plastics to date. This increase correlates with increasing numbers of studies on harm from marine litter.

As elsewhere in the OSPAR Maritime Area, the number of standardised monitoring procedures for impacts of marine litter on biota is still rather small. Until now, the monitoring protocols for ingestion of plastic particles by northern fulmars and by loggerhead turtles are the only agreed methods for quantifying effects. In contrast to the small number of agreed indicators, there are numerous case studies on biota encounters with marine litter and many direct and indirect consequences have been recorded with potentially lethal and sub-lethal effects. In the recent past, the percentage of biota encounters with marine litter has increased for all taxonomic groups. For further information see the full review giving an overview of the available knowledge on harm to various species in the area of interest (the North-East Atlantic) for different taxonomic classes, including endangered species.

The leatherback turtle (all OSPAR Regions) and the loggerhead turtle (Regions IV and V) are listed among OSPAR’s Threatened and Declining Species. Status assessments (see: leatherback turtle and loggerhead turtle) show, although data are still limited, that both species are still in decline and are significantly impacted by by-catch and marine litter.

Evidence for ecosystem scale is available but limited, which is probably due to the fact that such effects are difficult to quantify, especially in combination with other anthropogenic pressures.

An underlying ethical aspect of the above-mentioned biological impacts of marine litter is the issue of animal welfare. According to the European Union´s Treaty (as amended in the Treaty of Lisbon), animals are recognised as sentient beings, meaning that they are capable of feeling pleasure and pain. Marine animals which become entangled by, trapped in, or ingest marine litter often experience trauma, damage, infection and compromised ability to feed, move and carry out their normal behaviour. The resulting suffering and pain create a compelling argument that marine litter represents not only a serious environmental and conservation issue, but also a significant global animal welfare issue. To summarise, it can be stated that the numbers of animals affected by negative interactions with marine litter and the associated suffering affecting their welfare, in combination with the extent of such encounters, which in some animals represents a substantial proportion of a population, clearly show that further reductions in the existing inputs and amounts of marine litter are urgently needed.

From the evidence available on the ecological impacts of marine litter it can be inferred that plastic marine pollution is an increasing threat to marine species and habitats in the OSPAR Maritime Area. Many studies recommend potential indicator species for ingestion and entanglement. Direct harm is in general more frequent for entanglement than for ingestion, since negative effects on individuals are more obvious to detect. Regarding ingestion, mussels and lugworms are interesting, because as sessile organisms they are easy to monitor, and as filter feeders, nearly all species of this order contain microplastic particles. The majority of ingested plastics consist of fragments. Mammals reveal a broad size spectrum for ingested plastics, while birds mostly ingest mesoplastics and fish and invertebrates mainly microplastics. The most visible effect of interaction with marine litter is entanglement of wildlife, often in abandoned, discarded or lost fishing gear or rope (so called ghost-fishing). A new protocol for entanglement of northern gannets and other seabirds is already being applied in some breeding colonies in the North Sea. It classifies the amount of plastic per nest based on the number of items and the associated entanglement rates. Seals typically become entangled round the neck for some time, their entanglement is therefore easy to monitor.

For a comprehensive future assessment, further targets and thresholds need to be developed. This calls for additional standardised sampling protocols, necropsies, plastics categorisation and analyses in order to make observations comparable and to generate time series. The latter serves to prepare the data for statistical analyses, which in turn make it possible to define baselines and detect trends. Both baseline and trend analyses serve to implement targets and threshold values for marine litter ingestion and entanglement. As the next step, additional litter type-specific measures need to be implemented, and their results, again, can be controlled by time-series analyses.

Targeted measures to avoid ingestion of plastics are difficult to develop, because fragments are non-identifiable litter types. By contrast, the entanglements of all groups of species most often occur in filamentous litter, which in turn mainly consists of fishing-related litter types, such as the remains of nets, fishing lines, dolly ropes and ropes. Packaging (e.g., strapping bands) has been identified as a further cause of entanglement. The available evidence needs to be assessed carefully on a species basis. As an example, there have been reports of stray finds of northern gannets, often with their beaks entangled in plastic bags. A target to reduce plastic bags, in line with the EU Plastic Bag Directive (Directive (EU) 2015/720), therefore represents a measure which is easy to implement and effective in reducing mortality among northern gannets. Another example is a prohibition on the use of dolly ropes. If applied widely, preferably over the whole of the North-East Atlantic, this would lead to substantial decreases in the use of strings as nesting material and in the associated mortality among seabirds.

To conclude, quantifying the effects of marine litter on biota is a complex task, especially when evaluating multiple species with different ecological requirements. As a next step the available data for the different species could be evaluated with a view to assessing the risk of plastic marine-litter ingestion and entanglement by integrating inter-species factors such as plastic exposure rates and life history traits (e.g., mortality, habitat, and body size). This would require a modelling exercise to identify and estimate their exposure to plastic litter across the OSPAR Maritime Area, using the data in the literature, species distribution maps and plastic dispersion models in order to identify hotspots for the risk of plastic ingestion and entanglement for the chosen species.

In a next step, dose-response relationships would have to be established in order to develop additional threshold values and targeted measures.

I – Impact (on Ecosystem Services)

Benefits and services affected

A regional breakdown of the Impact on ecosystem services changes is currently not appropriate.

In addition to its ecological consequences (see previous section) marine litter also exerts a pressure on ecosystem services (ES), with important implications for human welfare, by impacting negatively on economic sectors such as tourism, fisheries, aquaculture, navigation, and energy and inflicting economic losses on individuals, enterprises, and communities. Figure 1 presents an overview of the linkages between

'State changes/Environmental impacts' and 'Impacts on ES' for the Marine Litter thematic assessment (Federico Cornacchia, 2022; report includes in-depth assessment of linkages).

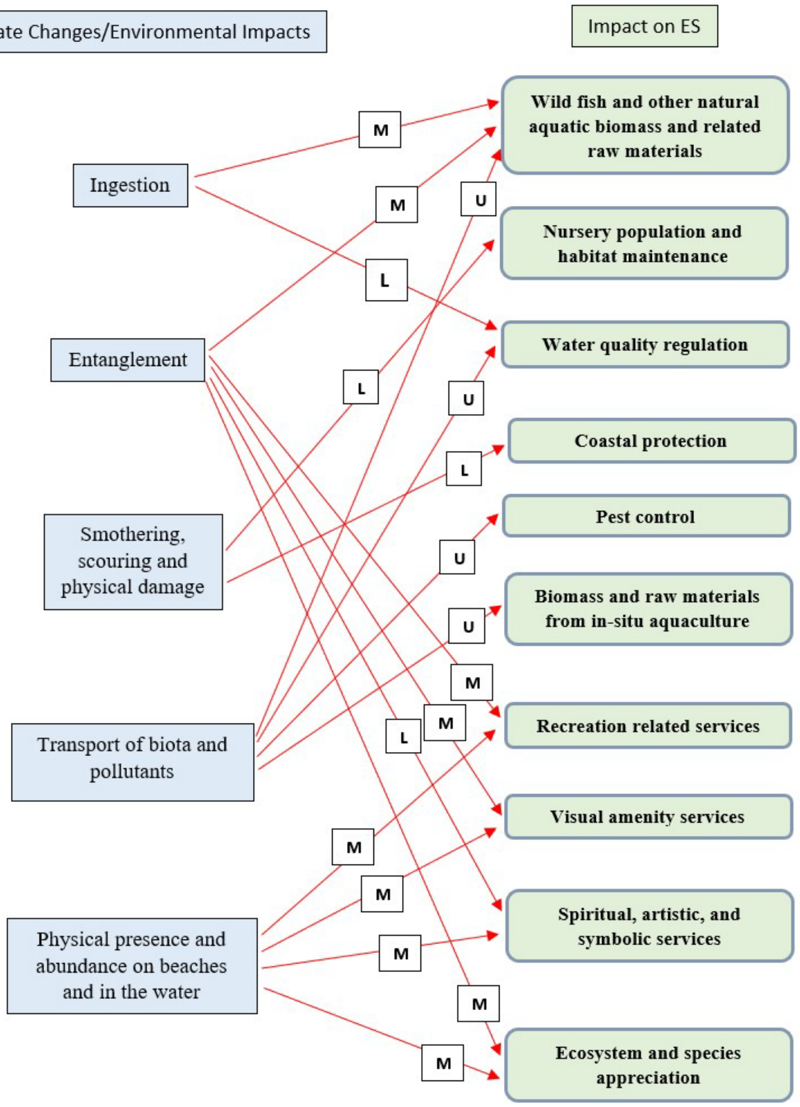

Figure I.1: Overview of the 'State changes/Environmental impacts' - 'Impacts on ES' linkages for the Marine Litter thematic assessment. The ecosystem services shown are those considered most relevant in relation to the Marine Litter thematic assessment. Each arrow also denotes an expert-based estimate of the magnitude of the impact of an environmental state change on a particular ecosystem service (Red arrow = negative impact, Green arrow = positive impact, H = high impact, M = medium impact, L = low impact, U = unknown impact)

As shown schematically, each state change / environmental impact associated with marine litter affects a different marine ecosystem service. The following describes how marine litter can impact ecosystem services.

Wild fish and other natural aquatic biomass and related raw materials: Marine litter, by impacting on marine ecological components through physical entanglement and other types of damage related to ingestion, smothering and damage of habitats, diffusion of invasive species and transmission of viruses, pathogens and various pollutants, damages wild stocks of fish and other marine organisms and consequently reduces biomass provision.

Nursery population and habitat maintenance: Marine litter presents mainly negative impacts on the provision of this service. The generation of artificial hardgrounds can degrade pre-existing habitats favourable to native species by altering the structure of habitat components (corals, biogenic reefs, microphytobenthos, etc.), leading to changes in the assemblages of such species (e.g., more short-lived species). Moreover, it increases the range of habitats available for colonisation, including by invasive species.

Water quality regulation: The illustrated lethal and/or sub-lethal effects related to marine litter can impair to varying degrees the ability of marine ecosystem components to provide water quality regulation, for example through the death of components such as reefs, and the death of or adverse effects on invertebrate organisms such as mussels, given their contribution to water filtration.

Coastal protection: Considering the contribution of biotic elements such as coral reefs, microphytobenthos, kelp forests and infauna to processes such as erosion control and thus to coastal protection, their degradation (and possible death) as a result of smothering or ingestion can more or less compromise the provision of this ecosystem service.

Pest control: The environmental impacts associated with marine litter, such as its role as a vector for invasive species, non-invasive proliferating species, nuisance algae and other agents, affect the normal pest control service provided by the marine ecosystem by increasing the presence and range of non-indigenous species. Other negative effects of marine litter, such as increased mortality of species as a result of ingestion, disease, and other factors, also have a negative impact on this ecosystem service if the affected species naturally contribute to pest control.

Biomass and raw materials from in-situ aquaculture: Marine litter, by impacting on marine ecological components through ingestion, diffusion of invasive species, transmission of viruses, pathogens and various pollutants damages marine organisms reared in aquaculture processes and consequently reduces biomass provision.

Recreation-related services and visual amenity services: Visible pollution by marine litter (on beaches, on the seabed, entangled with species) can have a significant negative impact on experiential recreation. It is known that people deplore this, given its negative effect on the sense of place associated with the marine location, on sensory enjoyment and consequently on recreational activities. The presence of litter on organisms can reduce or disrupt the ability of such biotic components to underpin activities such as diving, wildlife-watching, and others. The detrimental effect on people's mood and mental wellbeing following time spent on coastlines affected by litter pollution has been documented.

Ecosystem and species appreciation: Charismatic marine organisms such as birds, turtles and cetaceans are of cultural and/or emotional importance to individuals. Direct sightings and / or images and articles shared through the media of stranded cetaceans and of seabirds with their stomachs full of plastic have a negative effect on human wellbeing in relation to their awareness of the damage and / or loss of these charismatic species. Furthermore, in respect of this ecosystem service, it should be mentioned that marine litter can have negative effects on marine animal welfare, causing them avoidable suffering (Werner et al., 2016). From an ecosystem service perspective, it could be argued that marine animal welfare can benefit humans, in the sense that they derive satisfaction from seeing animal welfare maintained. However, the direct beneficiaries are the marine organisms, and the issue of animal welfare may go beyond the concept of ecosystem services.

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R – Response

Are the measures working?

A regional breakdown is not really appropriate. Generally, OSPAR's collective measures and the different EU measures cover all the OSPAR Regions combined.

The North-East Atlantic Environment Strategy (2010 to 2020) committed to "*develop appropriate programmes and measures to reduce amounts of litter in the marine environment and to stop litter entering the marine environment, both from sea-based and land-based sources*".

Action and measures to prevent pressures and/or to mitigate impacts

The primary instrument for achieving this was the OSPAR Regional Action Plan for Marine Litter (RAP ML). When adopted in 2014, it was at the forefront of international collaborative efforts to tackle the issues associated with marine litter.

The RAP ML set the policy context for OSPAR's work on marine litter, but also contained actions that OSPAR committed to work on throughout the implementation period (2014-2020). These consisted of 32 collective actions and 23 national actions (adopted for national reporting on a two-yearly basis) which aimed to address both land-based and sea-based sources and pathways of marine litter, as well as education, outreach, and removal activities. Together, the collective actions and national actions formed a comprehensive strategy / approach to tackle marine litter, with the national actions designed to support implementation of the collective actions.

Information on the concrete outputs of actions / measures taken in the RAP ML can be found on the OSPAR webpage.

The overall assessment of the adequacy and effectiveness of marine litter measures draws on the RAP review assessment of effectiveness and its conclusions and recommendations, and includes other significant regional measures.

Progress on RAP ML actions

A review of the RAP ML was undertaken in October 2020, incorporating an assessment of the status of actions at the time, an analysis of the impact of those actions, as well as collecting feedback via a questionnaire from interested stakeholders, OSPAR Contracting Parties and observers. Those results were published in 2021 (https://www.ospar.org/documents?v=46422) and have been used to inform the initial stages of developing a new RAP for the post-2021 period.

Since the review was undertaken, the RAP ML (2014 to 2021) has been completed. Out of its 32 collective actions, 78% (25) were considered complete or fully implemented, 9% (3) as still in progress, and 13% (4) as limited in progress, with no further action foreseen.

Regarding the national actions, for all 12 Contracting Parties, over 50% of actions were either fully implemented or in progress, and for 11 Contracting Parties over 75% of actions were either fully implemented or in progress.[3] No Contracting Party reported limited progress on more than six of the 23 actions. Three Contracting Parties had fully implemented 70% (or over) of the national actions and three Contracting Parties had fully implemented less than 5% of them.

OSPAR has also adopted specific recommendations partly resulting from RAP ML collective actions. For example, Recommendation 2016/01 promotes the establishment of Fishing for Litter (FFL) initiatives in the fishing harbours of Contracting Parties, supported by an associated target to 'increase the total number of vessels participating in FFL schemes in the OSPAR Maritime Area by 100% by 2021, compared to the baseline situation in 2017'[4].

Box with picture: "Fishing for Litter has several aims: to raise awareness among fishers about the impacts of marine litter, to change fishers' waste-related behaviour while at sea and to directly remove litter from the sea. Participating fishers are provided with large, hard-wearing bags to keep on board their vessels. Any litter brought up in their nets is placed in the bag and delivered back in port at no cost to the fishers. This simple yet successful idea is recognised by other international marine protection bodies including the European Commission (which highlights it as best practice) and the UNEP Mediterranean Action Plan (for the Barcelona Regional Sea Convention)."

[3] Nine CPs had over 85%, 6 CPs over 90%

[4] OSPAR Contracting Party reporting on this target will be available in 2022.

Fishing for litter, Lerwick, Shetlands (KIMO International, 2019)

Recommendation 2019/01 aims at reducing marine litter by promoting the implementation of training programmes for fishers which address the social, economic, and ecological impacts of marine litter. OSPAR Recommendation 2021/06 aims at reducing plastic pellet loss by promoting the timely development and implementation of effective and consistent pellet-loss prevention standards and certification schemes for the entire supply chain.

Other Measures

Besides the RAP ML, other measures have been taken to combat marine litter. These include additional national actions resulting from implementing the EU Marine Strategy Framework Directive (MSFD - 2008/56/EC) and other EU initiatives such as the Single-use Plastics Directive (EU 2019/904), the Plastic Bag Directive (EU 2015/720), the Port Reception Facilities Directive (EU 2019/883), work on microplastics and several EU-funded projects.

Adequacy and Effectiveness of Measures

The initial review of the RAP ML concludes that the work completed under the RAP ML has been extensive but is not always easy to quantify or to illustrate through concrete outputs. Furthermore, the actions included in the RAP are in many cases so broad in nature that their true impact cannot be easily assessed when it comes to reducing quantities of marine litter in the North-East Atlantic. Behaviour and awareness remain at the heart of litter reduction and need to be supported by policy responses in order to manage marine litter.

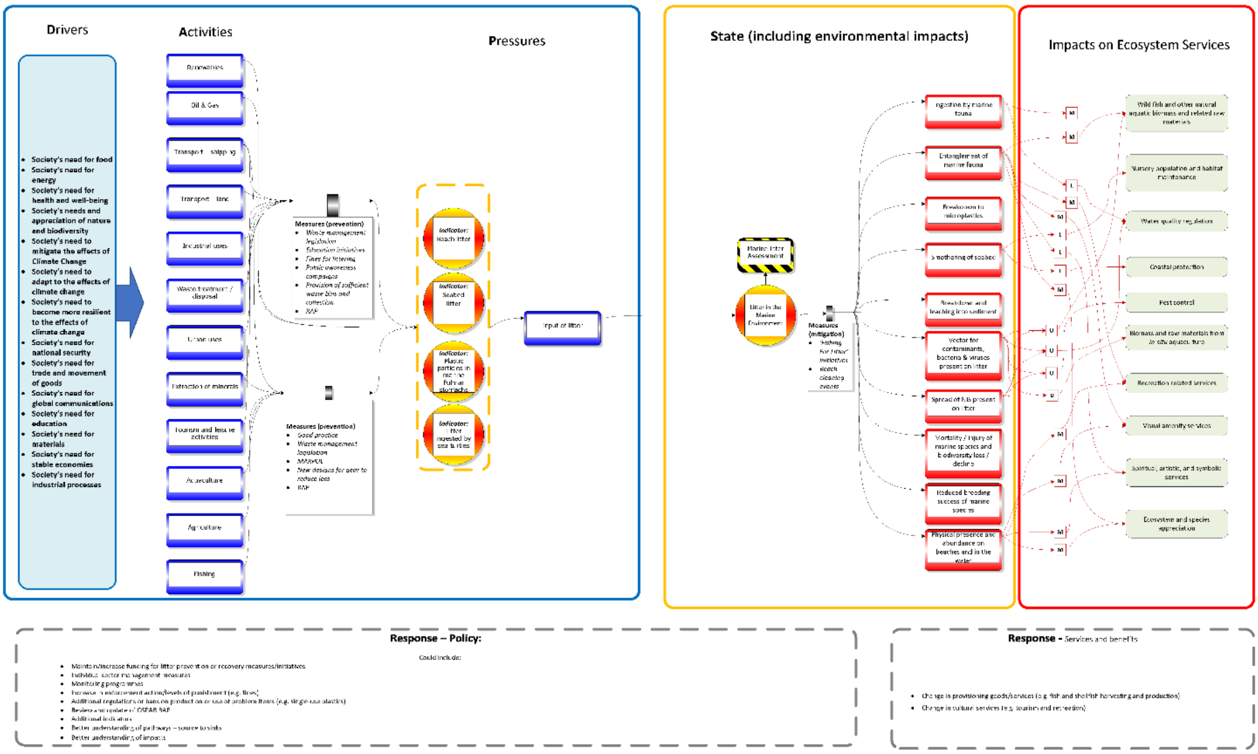
The RAP ML was ambitious, and intentionally so, and has inspired action and progress in OSPAR Contracting Parties. The evidence to show that it has also inspired other similar international organisations is limited, but the experience of ICG-Marine Litter members who work in other international forums is that the OSPAR RAP ML has had a strong influence and inspired other international organisations (e.g., Arctic Council, G7, UN). Furthermore, OSPAR has contributed to the evidence base for and benefited from the adoption of recent EU initiatives, such as the Single-use Plastics Directive (EU 2019/904), the Plastic Bag Directive (EU

2015/720), the Port Reception Facilities Directive (EU 2019/883), work on microplastics and several EU-funded projects.

One of the main recognised outputs of the RAP ML has been to guide and steer advancements across OSPAR Contracting Parties on issues related to marine litter; the advancements in thinking and scientific understanding have been clear, although not always easy to measure. The role that OSPAR and the RAP ML play in coordinating efforts and sharing knowledge and information between Contracting Parties is paramount, according to stakeholders. Indeed, the value that Contracting Parties and OSPAR Observers apply to the RAP ML is an indication in itself of its impact and relevance.

In terms of evidence of change in the quantities of marine litter in the North-East Atlantic, criteria such as threshold values for determining the effectiveness of measures do not yet exist, but these are currently being developed and adopted. However, there are initial signs of a decrease in the quantities of litter found on OSPAR beaches and of floating litter in the North Sea over the last 10 years (as identified through the [OSPAR Indicator Assessments]). When this is considered against the upward trend in plastics production and consumption in Europe over a similar period, as well as the predictions for plastic consumption and waste issues to intensify in the future, this suggests that there have been some significant positive changes to prevent plastic from entering the marine environment.

Bow-tie analysis



Please Note: The Thematic Assessment and accompanying Bow Tie Analysis are ongoing pieces of work and should be regarded as draft. There may be areas and linkages that have not yet been identified. These will be added as the expert groups review and update the thematic assessments. Work on identifying the responses, management measures and impacts on ecosystem services has recently started. The thematic assessments and bow tie analysis will be updated with the outputs as they become available.

The Bow-tie diagram aligns with the DAPSIR narrative in the TA - **provisional** confidence assessment: Medium (Medium Agreement on DAPSIR content + Medium Evidence to support connections) based on approach described in [Agreement 2019-02.]

The bow-tie analysis for marine litter shows the relationships between the DAPSIR components which need to be considered in a cumulative effects assessment. Human activities have been identified which contribute to marine litter pressures with the potential to both individually and cumulatively contribute to biodiversity state changes in the thematic assessments for:

- **Benthic Habitats - Input of litter :** Marine litter (including plastics) can lead to smothering of benthic habitats and generation of artificial hard substrate altering the structure of benthic communities and leading to loss of biodiversity.
- **Fish - Input of litter (solid waste matter, including micro-sized litter):** The land-based introduction of litter (e.g. rivers, industrial sources, tourism) and marine-based introduction of litter (shipping, fishing, aquaculture) can cause ingestion and entanglement leading to injury or death. Input of litter into the environment can also cause diseases affecting fish species.
- **Marine Birds - Input of litter (solid waste matter, including micro-sized litter):** The land-based introduction of litter (e.g. rivers, industrial sources, tourism) and marine-based introduction of litter (e.g., shipping, fishing, aquaculture) can cause ingestion, presence of plastic in seabirds' stomachs and entanglement leading to injury or death (including reduced reproductive rate due to entanglement in plastics used as nest material). Input of litter into the environment can also cause habitat loss of breeding and nesting sites, alterations to suitable foraging habitat and diseases, affecting seabird abundance.
- **Marine Mammals - Input of litter (solid waste matter, including micro-sized litter):** The land-based introduction of litter (e.g., rivers, industrial sources, tourism) and marine-based introduction of litter (e.g., shipping, fishing, aquaculture) can cause ingestion and entanglement leading to injury or death. For example, if a marine mammal gets caught in lost fishing nets, it can cause injuries, reduced movement or even drowning. Input of litter into the environment can also cause diseases affecting marine mammal abundance.
- **NIS - Input of litter (solid waste matter, including micro-sized litter):** Marine litter also contributes to the input/spread of non-indigenous species by providing mobile artificial substrate that can transport non-indigenous species from location to location.

The State section describes the potential ecological impacts associated with marine litter in the marine environment. The input levels, frequency of occurrence, spatial extent, and exposure to different human activities all collectively contribute to the extent to which marine litter pressures are exerted on benthic habitats, fish, marine birds and marine mammals, and marine litter can facilitate the spread of NIS. To undertake a full quantitative analysis of cumulative effects requires consideration of the exposure pathways and ecological impacts. Further analyses and evidence of ecological impacts are required in order to progress the assessment of cumulative effects.

Marine litter can also combine with other pressures to collectively affect marine species and habitats. The assessment of cumulative effects is considered within the biodiversity thematic assessments Benthic Habitats, Fish, Marine Bird, NIS and Marine Mammal Thematic Assessments.

Climate change

Climate change affecting marine litter (and vice versa?)

There are links between climate change and marine plastic pollution (Ford et al., 2022), and measures could be beneficial in tackling both problems. Some marine species and ecosystems are vulnerable to both. Plastic contributes to greenhouse gas emissions throughout its life cycle. Engagement in solving plastic pollution (reducing plastic over-consumption) can increase action against climate change (reducing greenhouse emissions). Integrated approaches are needed, including conserving the blue economy and circular economy.

In the 2017 OSPAR Intermediate Assessment, two marine litter indicators were identified as potentially being affected by climate change: beach litter and the seafloor.

Litter may arrive on a given OSPAR beach via ocean currents, rivers, and wind drift from distant sources. Water currents, weather conditions and prevailing wind conditions have a significant influence on the deposition and retention of litter on beaches and therefore litter abundance.

The abundance of seafloor litter is also influenced by anthropogenic inputs, including litter transported by rivers, prevailing winds, and ocean currents, which can redistribute this material over long distances. Other studies have shown that, for example, the Bay of Biscay receives large amounts of litter from local rivers and transport that may result from large-scale circulation in the sub-region as a whole. Further knowledge would be useful on seasonal influences, weather patterns and changes in currents and their effect on litter distribution.

The exact effects that climate change will have on the marine litter issue in the North-East Atlantic are as yet unstudied and still difficult to predict. Therefore, the potential effects described below are hypothetical and highly uncertain, but form a starting point for further exploration of the issue. In general, climate change will not directly affect marine litter or its impact on biota per se, but its influence on atmospheric and ocean circulation may affect some of the pathways for and retention of litter.

Changing ocean currents (affecting the distribution of marine litter)

It was noted in the 2017 Indicator Assessment that changing weather patterns and currents caused by climate change may have an effect on marine litter distribution. [A study by Welden and Lusher]() (2017) also discusses the potential impacts of global climate change on the abundance and distribution of marine plastic pollution. They state that a better understanding of changes in weather patterns and currents would allow a more targeted approach to marine litter:

''The ability to predict areas of plastic input and deposition would enable the identification of at-risk species, and it would allow for efforts to reduce and remove plastic debris at targeted locations. The current uncertainty as to the effects of global warming on our oceans is the greatest challenge in predicting the future patterns of plastic aggregation in relation to global circulation.''

Changing weather patterns (higher and more frequent peak run-off events)

Changes in precipitation patterns due to climate change will probably increase the frequency and severity of peak rainfall events, which may result in increased flooding from rivers and rainfall. This may lead to increased discharge of debris and litter. The summer 2021 flooding events in North-western Europe unfortunately demonstrated the impact of such events, not only causing losses of life but also leading to large quantities of debris and litter moving downstream in the rivers.

Increase in beach tourism

It is possible that as average temperatures rise, the coastal areas around the North-East Atlantic will see an increase in leisure and tourism activities on their beaches, and a longer beach season, especially in northern Europe. This could lead to an increase in marine litter items associated with these activities, such as bottles, cans, food packages and other items.

Impact on fisheries

The future of fishing activity in the North-East Atlantic is uncertain and largely dependent on a number of differing factors including climate change. This could lead to changes in marine litter items associated with this activity.

Species migration and fragility

Changes in the temperature of the sea will cause the gradual migration of marine species from south to north. It is conceivable that marine litter could pose an extra threat to species that are already vulnerable, having been forced to adapt to new circumstances. For example, changing water temperatures could impact the availability of food, making the ingestion of marine litter more common.

Conclusion

There are a number of ways in which climate change could affect the quantities of marine litter entering the marine environment, especially from rivers, and then the subsequent distribution and deposition of litter. While there may be a need to adapt to some of the changes, it is not currently a major factor influencing OSPAR's marine litter objectives or selection of actions for the RAP on Marine Litter. More work is needed on risk assessment related to extreme weather events. Related to these events, the driving factor will be the need to protect vulnerable (upstream) communities from the devastating effects of flooding; these measures should in turn help to reduce inputs of marine litter. Because of the links between climate change and marine plastic pollution, integrated approaches could benefit both problems.

Ocean acidification is a perturbation of the physicochemical environment of the world's oceans that changes the acidity of the water (pH). The way ocean acidification is influencing or could be influenced by marine litter was considered when drafting this assessment, however no clear links were described at this time.

References

Ford, H.V., Jones, N.H., Davies, A.J., Godley, B.J., Jambeck, J.R., Napper, I.E., Suckling, C.C., Williams, G.J., Woodall, L.C. and Koldewey, H.J. (2022) – The fundamental links between climate change and marine plastic pollution. Science of the Total Environment. https://doi.org/10.1016/j.scitotenv.2021.150392

Welden and Lusher (2017) – impacts of changing ocean circulation on the distribution of marine microplastic litter. Integrated Environmental Assessment and Management (Wiley online library)

Thematic Metadata

Field	Explanation
Linkage	https://doi.org/10.1016/j.envpol.2011.06.008 http://dx.doi.org/10.1016/j.envpol.2015.02.034 https://doi.org/10.1016/j.marpolbul.2021.112246 https://indicit-europa.eu/cms/wp-content/uploads/2019/09/INDICIT-Final-report_Final.pdf http://dx.doi.org/10.1016/j.marpolbul.2017.08.048 https://doi.org/10.1016/j.scitotenv.2021.150392
Relevant OSPAR Documentation	Agreement 2020-02 CEMP Guidelines for marine monitoring and assessment of beach litter Agreement 2015-03 CEMP Guidelines for monitoring and assessment of plastic particles in stomachs of fulmars in the North Sea area Agreement 2017-06 CEMP Guidelines on Litter on the Seafloor Agreement 2020-03 CEMP Guidelines for monitoring and assessment of marine litter ingested by sea turtles

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Our vision is a clean, healthy and biologically diverse North-East Atlantic Ocean, which is productive, used sustainably and resilient to climate change and ocean acidification.

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