OSPAR COMMISSION

OSPAR Background Document on loopholes and best practices in waste management that contribute to marine litter

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Environmental Impacts of Human Activites

OSPAR Background Document on loopholes and best practices in waste management that contribute to marine litter

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Table of contents

Table of contents ..... **I**

List of figures ..... **II**

List of tables ..... **III**

Abbreviations ..... **IV**

Glossary ..... **V**

Summary and key messages ..... **VIII**

Récapitulatif ..... **XIII**

1 Setting the scene **1**

2 Plastics and the oceans **3**

Plastics and plastic waste 3

Evidence for plastics in the oceans 6

Sources of plastic litter and pathways to the North-East Atlantic 8

Action against marine litter 11

3 Waste management and marine litter in the OSPAR region **13**

Avoiding land-based inputs by improving waste management 13

Waste management in the OSPAR region 15

EU policies on waste and marine litter 16

Marine Strategy Framework Directive 16

Waste Framework Directive and supporting directives 17

Marine litter in the EU Circular Economy Action Plan 18

4 Factors contributing to leakage of plastics from land to sea **22**

Production and use of (single-use) plastics 23

F1: Production and use of (single-use) plastics 23

F2: Unsatisfactory separate collection and recycling rates 25

F3: Littering 27

F4: Waste crime and illegal dumping 29

F5: Marine litter is not addressed in waste management plans 30

F6: Insufficient waste management activities or infrastructure 31

F7: Specific waste management practices posing a risk 31

F8: Insufficient or ineffective financing of waste management 33

F9: Inadequate operation of active landfills 35

F10: Historic landfills 36
F11: Emissions from sorting and recycling processes or products 36
F12: Unsatisfactory management of plastic waste from agriculture and other environmentally open applications 37
F13: Unsatisfactory management of waste from tourism and other coastal activities and industries 38
F14: Unsatisfactory management of construction & demolition waste 39
F15: Plastic waste inputs from heavy weather events 40
F16: Insufficient cleaning of open areas 40
F17: Export of plastic waste to countries, where a safe recovery or disposal is not guaranteed 41

5 Potential priority fields of action to prevent leakage of plastics and marine litter 43

FoA1: Awareness raising 44
FoA2: Horizontal integration 44
FoA3: Performance assessment 46
FoA4: Inclusion of marine litter in waste management and waste prevention plans 46
FoA5: Prevention of plastic waste 48
FoA6: Collection and sorting of all plastic waste 50
FoA7: Separate collection and sorting of plastics 51
FoA8: Increase of plastic recycling rates 53
FoA9: Optimization of waste collection and transport 54
FoA10: Reduction of risk of leakage from landfills 56
FoA11: Reduction of emissions from sorting and recycling 58
FoA12: Cleaning of litter on land 59
FoA13: Application of economic instruments 60
FoA14: Green Public Procurement 62
FoA15: Waste management concepts or practices for certain sectors 63
FoA16: Enforcement of regulations 65
FoA17: Communication platforms and material 67

6 The institutional response 68

7 References 71

List of figures

Figure 1: Linear usage of plastics 4
Figure 2: Global plastic production and its fate (1950-2015). [m = megatons, Mt]) 4

Figure 3: Plastic waste generation per EU citizen in 2015.) ..... **Error! Bookmark not defined.**
Figure 4: Material types of litter documented under the OSPAR beach litter monitoring (year 2017, survey type 100m, number of surveys 399) 7
Figure 5: Documented litter biota interactions in the OSPAR region **Error! Bookmark not defined.**
Figure 6: The OSPAR regions and catchment area. ..... **Error! Bookmark not defined.**
Figure 7: Regional action plans on marine litter 12
Figure 8: Most common littering areas ..... **Error! Bookmark not defined.**
Figure 9: Plastics leaking from overfilled bins 32

List of tables

Table 1: OSPAR RAP ML Action 39&40, the actions of interest in this document 1
Table 2: Covered items and proposed measures of the directive proposal 20
Table 3: Overview of the 17 factors contributing to the leakage of plastics 21
Table 4: Exemplary suggested waste management practices in tourism, events, construction & demolition and agriculture 64

Abbreviations

BAT	Best available technique/technology
BEP	Best Environmental Practice
BREF	Best available techniques reference document
C&D	Construction and demolition
CIPA	Comité International des Plastiques en Agriculture
CH	Switzerland
CP	Contracting Party
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
DEFRA	Department for Environment Food & Rural Affairs
EC	European Commission
EEA	European Environment Agency
EPI	Environmental Policy Integration
EPR	Extended Produced Responsibility
ETC/WMGE	European Topic Centre on waste and materials in a green economy
EU	European Union
FoA	Field of Action to prevent leakage of plastics and marine litter
F	Factors contributing to leakage of plastics from land to sea
GES	Good Environmental Status
GDP	Gross Domestic Product
GPA	Global Programme of Action
GPP	Green Public Procurement
GPML	Global Partnership on Marine Litter
ICG-ML	Intersessional Correspondence Group on Marine Litter
IPPC	Integrated pollution prevention and control
ISWA	International Solid Waste Association
JRC	Joint Research Council
LDPE	Low-density polyethylene
LCA	Life Cycle Assessment
ML	Marine litter
MSFD	Marine Strategy Framework Directive
Mt	Million metric tons
NFTPG	National Fly-Tipping Prevention Group
NFC	near field communication
NGO	Non-governmental organization

NILGA	Northern Ireland Local Government Association
NO	Norway
NOK	Norwegian krone
PAYT	Pay-as-you-throw
PoM	Programme of Measures
PP	Polypropylene
PPP	Polluter pays principle
PRO	producer responsibility organisation
RAP ML	Regional Action Plan for Marine Litter
RFID	Radio-frequency identification
SOLACE	Society of Local Authority Chief Executives
SUP	single-use plastics/ Single-use plastic products
UBA	Umweltbundesamt, German Federal Environment Agency
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environmental Programme
VAT	Value added tax
WFD	Waste Framework Directive
WM	Waste management
WMP	Waste management plan
WPP	Waste prevention plan

Glossary

Extended producer responsibility	The WFD (see 3.3.2) defines extended producer responsibility schemes as "a set of measures taken by Member States to ensure that producers of products bear financial responsibility or financial and organisational responsibility for the management of the waste stage of a product's life cycle."
G7 and G20	The Group of Seven (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States) and the Group of Twenty (G7 plus Argentina, Australia, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey and the European Union) are both fora for cooperation between the biggest economies.
HELCOM	HELCOM (**Hel**sinki **Com**mission) is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention, 1974)
Leakage	An insufficiency in a waste management system. The relationship between 'leakage from the system' and 'leakage to the North-East Atlantic' is elaborated in 2.1.
Litter	Any waste item that is in an unacceptable location.
Littering	Intentional or unintentional discarding of items in unacceptable places.

Macro- and microplastic litter	Although it is controversial and seen as a pragmatic definition, rather than an evidence based one, the common 5mm size limit of particles is applied in this document. Plastic litter particles bigger than 5mm are considered macroplastic litter, particles smaller than 5mm are considered microplastics (GESAMP, 2015). A separation between macro and mesoplastic litter is not applied.
Marine litter	The United Nations Environment Programme defines marine litter as "any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment" (UNEP, 2009).
North-East Atlantic	The North-Eastern part of the Atlantic Ocean, which consists of five sub regions (see Figure 6).
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic from 1992, combining the **Os**lo Convention (1972) and the **Par**is Convention (1974)
Plastic	The term plastic comprises all thermoplastic and thermoset synthetic polymers (large organic molecules composed of repeating carbon-based units or chains) (UNEP, 2016).
Polluter pays principle	The principle describes the practices that those who produce any pollution are responsible to bear arising costs and is e.g. applied in the WFD (see 3.3.2), which states, that "the costs of waste management, including for the necessary infrastructure and its operation, shall be borne by the original waste producer or by the current or previous waste holders."
Recycling	The WFD (see 3.3.2) defines as "any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes" and explicitly includes reprocessing of organic material and excludes energy recovery.
Reuse	The WFD (see 3.3.2) defines reuse as "any operation by which products or components that are not waste are used again for the same purpose for which they were conceived"
Separate collection	The WFD (see 3.3.2) defines separate collection as "the collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment"
Single-use plastic product	The adopted Directive on the reduction of the impact of certain plastic products on the environment (see 3.3.3) defines a single-use plastic product as "means a product that is made wholly or partly from plastic and that is not conceived, designed or placed on the market to accomplish, within its life span, multiple trips or rotations by being returned to the producer for refill or re-used for the same purpose for which it was conceived."
Waste	The WFD (see 3.3.2) defines waste as "any substance or object that the holder discards or intends or is required to discard". Municipal waste is mixed or separately collected waste from households or other sources with nature and composition typical for household waste.
Waste hierarchy	The waste hierarchy, as adopted in the WFD (see 3.3.2) shall "apply as a priority order in waste prevention and management legislation and policy". It ranks the following actions in the presented order: 1. prevention 2. preparing for re-use 3. recycling 4. other recovery, e.g. energy recovery 5. disposal
Waste management	The WFD (see 3.3.2) defines waste management as "the collection, transport, recovery (including sorting), and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker".

	Following the argumentation presented by (Dri, et al., 2018), “not only waste management companies but also waste authorities […] are considered to be within the boundaries of the sector”
Waste management plan	The WFD (see 3.3.2) decides, that waste management plans “shall set out an analysis of the current waste management situation in the geographical entity concerned, as well as the measures to be taken to improve environmentally sound preparing for re-use, recycling, recovery and disposal of waste and an evaluation of how the plan will support the implementation of the objectives and provisions of this Directive”
Waste prevention	The WFD (see 3.3.2) defines waste prevention as “measures taken before a substance, material or product has become waste, that reduce the quantity of waste […], the adverse impacts of the generated waste on the environment and human health, or the content of harmful substances in materials and products”

Summary and key messages

Significant amounts of plastics leak from land-based sources to the North-East Atlantic. The larger portion of these leaked plastics are caused by inefficient or insufficient waste management and could be prevented by improvements in waste management practices or planning. Actions 39 & 40 of the OSPAR Regional Action Plan for Marine Litter (RAP ML) address this link between land-based waste management and marine litter in the North-East Atlantic. This background document summarizes results of a questionnaire distributed among OSPAR Contracting Parties, multiple expert interviews and an extensive literature review. The document will be applied in further persuing the goal to minimise land-based inputs of marine plastic litter through measures in waste management.

This Background Document identifies 17 '**factors** contributing to leakage of plastics from land to sea' (addressing Action 39 of the OSPAR RAP ML) and 17 'potential priority **fields of action** to prevent leakage of plastics and marine litter' (addressing Action 40 of the OSPAR RAP ML). The identified **factors** and **fields of action** are summarized below. Please note, that the fact that the two lists have the same number of elements is incidental and not one field of action per problem is presented.

Factors contributing to leakage of plastics from land to sea

The leakage of plastic is most likely to be caused by the following factors (**F**):

- *F1 Production and use of (single-use) plastics*
  Plastic products that are not produced cannot turn into marine litter. The production and use of plastics is a necessary requirement for marine plastic litter.
- *F2 Unsatisfactory separate collection and recycling rates*
  If waste plastics are not collected separately and fed into high-quality recycling process, other waste treatment forms need to be applied. For several reasons, these alternative treatments for unpreventable plastic waste (especially landfilling), are less desirable from the perspective of marine litter prevention.
- *F3 Littering*
  A portion of litter in the (marine) environment is caused by individuals who intentionally or unintentionally drop plastic items or plastic waste. These actions are affected by many aspects of waste management, e.g. infrastructure provision.
- *F4 Waste crime and illegal dumping*
  A portion of litter in the (marine) environment is caused by illegal waste dumping activities or other criminal actions in the waste management sectors.
- *F5 Marine litter is not addressed in waste management plans*
  If the issue of marine litter is not addressed in waste management plans, opportunities for hollistic approaches in national, regional or local approaches are missed. Since many aspects of waste management planning are defined in these plans, resource allocation or other important questions may be affected to the detriment of marine litter prevention.
- *F6 Insufficient waste management activities or infrastructure*
  Although the entire population in the region of interest has access to waste management

systems, insufficiencies still exist. As examples, long distance to collection points or low collection frequencies can be linked to (marine) litter generation.

- *F7 Specific waste management practices posing a risk*
  Plastics can leak during all stages of waste collection, transport, handling, storage and treatment if precautionary measures are not taken.

- *F8 Insufficient or ineffective financing of waste management*
  Sophisticated waste management is required for the maximum marine litter prevention. Since associated measures are often costly, current waste management funding is often insufficient to minimize plastics leakage. Besides insufficient funding, ineffective funding schemes can be identified, e.g. if waste prevention is not awarded in a way.

- *F9 Inadequate operation of active landfills*
  Landfilling of plastic waste is forbidden or highly regulated in many countries. Where plastic waste is disposed of this way, or where regulation is not enforced and/or implemented, plastics can leak to the environment through various pathways including into the marine environment.

- *F10 Historic landfills*
  Knowledge of historic landfills is often rather limited, but evidence suggests that historic landfills may be a significant source of marine plastic litter, especially if they are poorly managed and located near the coast and waterways on ground not suitable for agriculture or housing.

- *F11 Emissions from sorting and recycling processes or products*
  Plastics can leak from recycling processes during storage or sorting. Plastics can also leak if they are not the material of interest, e.g. in bio-waste composting.

- *F12 Unsatisfactory management of plastic waste from agriculture and other environmentally open applications*
  Plastics that are used in environmentally open applications like agricultural plastics are particularly prone to become litter and marine litter. This is especially true if plastics cannot be retrieved or collection systems are unavailable or unattractive.

- *F13 Unsatisfactory management of waste from tourism and other coastal activities and industries*
  Coastal tourism and other coastal activities or industries are responsible for a proportion of marine litter, because they bring the usage of plastics close to the marine environment. Any leakage to the environment here is associated with a higher risk of marine litter generation.

- *F14 Unsatisfactory management of construction & demolition waste*
  Large amounts of plastic waste are produced in the construction and demolition sector. If waste management systems are not appropriately designed, plastic litter can be generated.

- *F15 Plastic waste inputs from heavy weather events*
  Heavy weather events can cause the mobilization of significant amounts of plastic waste or plastic litter. They can further generate huge amounts of litter themselves. If heavy rains, floodings or strong winds occur, plastic litter is often transported from land to the oceans or introduced by untreated stormwater.

- *F16 Insufficient cleaning of open areas*
  Plastic litter represents a problem regardless of where it occurs. Because of this and because litter on land can often be mobilized again, frequent cleaning is required and litter in any open areas (not only on the coasts), which is not cleaned up as soon as possible causes environmental damage.

- *F17 Export of plastic waste to countries, where a safe recovery or disposal is not guaranteed*
  Plastic waste exported for recycling can overstrain local collection and treatment systems in importing countries and accordingly domestic plastic waste may also leak to the world's oceans. Leakage from transport, storage and recycling processes are expected to be higher and of higher importance for marine litter generation than if plastics are not exported for recycling.

Potential priority fields of action to prevent leakage of plastics and marine litter

Actions have been suggested and could be pursued in the following 17 fields of action (**FoA**):

- *FoA1 Awareness raising*
  Awareness among waste management actors of the existing insufficiencies in waste managament systems and their contribution to marine litter is fundamental for marine litter prevention measures in land-based waste management. Similarly important is ensuring awareness among all stakeholders, including the general public to make the successful adoption of measures possible.

- *FoA2 Horizontal integration*
  Actors from different backgrounds need to join forces to prevent marine litter through measures in waste management. Marine protection experts need to cooperate with waste managers. Such integration, resulting in effective collaboration, is of prime importance and should be fostered, e.g. by sharing experiences.

- *FoA3 Performance assessment*
  The effectiveness of currently implemented systems needs to be assessed to identify those factors contributing to leakage that require the most urgent action. Multiple indicators can be applied to identfy specific needs for action and set baselines against which the effects of measures can be evaluated.

- *FoA4 Inclusion of marine litter in waste management and waste prevention plans*
  Waste management and waste prevention plans represent powerful tools in waste management planning. By defining basic strategies in waste management and allocating resources accordingly, these plans represent a great chance for coordinated effort against marine litter inputs. Additionally, the proposed inclusion of such plans is required by EU legislation and the process of transposition in national laws is ongoing in most countries.

- *FoA5 Prevention of plastic waste*
  Waste prevention, the option ranked highest in the waste hierarchy should also be the preferred choice in marine litter prevention. Several approaches to achieve waste prevention are available and action in this field is needed to decouple plastic waste generation from economic growth worldwide.

- *FoA6 Collection and sorting of all plastic waste*
  Plastic waste that cannot be prevented needs to be collected and sorted. While a household

waste collection system is widley available some types of plastic waste still remains uncollected. To achieve a state off 100% collection of all plastic waste, improvements in infrastructure provision or increased collection frequencies are measures that are available.

- *FoA7 Separate collection and sorting of plastics*
  Separate collection of plastics is of key importantance for further treatment according to the waste hierarchy (see FoA8). Significant amounts of waste are collected for landfilling and/or incineration an therefore the quality of collecting systems and sorting is rather low and basic. Separate collection of plastics generates other benefits as well and examples of well-funtioning systems are widely available but may be challenging to implement, e.g. due to budget restrictions. Deposit systems assist in high quality collection by ensuring high return rates of identifiable material streams.

- *FoA8 Increase of plastic recycling rates*
  Besides being desirable from multiple perspectives (resource efficiency or energy consumption), recycling plastic waste can contribute to marine litter prevention in several ways. If plastics are recycled, they may be percieved as high-value materials with cascading, positive effects on littering rates. A circular economy such as envisaged by the EU Circular Economy Action Plan with the economic interest to keep all produced plastics in a technical loop can contribute to leakage prevention in different ways.

- *FoA9 Optimization of waste collection and transport*
  It is widely acknowledged that plastic waste can leak before, during and after collection, transport, storage and any treatment. Several technichal solutions are available to minimize this leakage and measures to put more of them into practice can contribute to prevent plastics leakage to the (marine) environment.

- *FoA10 Reduction of risk of leakage from landfills*
  In places where plastics are landfilled, leakage prevention measures should be taken. A variety of measures are available, depending on the reason why the plastics leak (e.g. biota interference or winds) and where they leak from (e.g. intermediate storage or the landfill itself). Marine litter prevention is supported if these precautionary measures are taken. Nevertheless, following the waste hierarchy, landfilling of plastics should be prevented in the first place.

- *FoA11 Reduction of emissions from sorting and recycling*
  Similarly to leakage from landfill sites, precautionary measures should be taken at recycling plants, especially if some or all of the treated plastics are not the desired material in the process. Regulations regarding emissions to the air or to waterbodies are required. The regulatory approach followed for bio-waste recycling products should be evaluated and adjusted at the EU level if necessary.

- *FoA12 Cleaning of litter on land*
  Since several factors contributing to leakage of plastics to the environment are very difficult to eliminate or even address, cleaning of plastic litter from land will always remain important. Cleaning should be extended to areas that are currently not cleaned frequently. Guidelines for safe and effective cleaning could help to prevent marine litter.

- *FoA13 Application of economic instruments*
  With multiple examples, economic instruments provide a set of measures to support marine

litter prevention. Suggested by many experts, economic instruments may present softer alternatives to a regulatory approach, guarantee more stakeholder support and even yield higher impact and/or lower costs. A wider uptake of economic instruments is thus recommended.

- *FoA14 Green Public Procurement*
  Trends in worldwide plastics markets can be influenced with the enormous market influence of the public sector's buying decisions. Desired developments (e.g. towards waste prevention or plastics recyclability) can be pushed if public actors have the freedom and awareness to decide accordingly.

- *FoA15 Waste management concepts or practices for certain sectors*
  Those sectors, which have been identified to be of special importance for plastic leakage from land to sea need to adopt marine litter prevention measures. Waste management for tourism and other recrational activities and events especially near the coast must combat individual littering and guarantee safe disposal of unavoidable plastic waste. Collection systems for plastic waste from construction & demolition as well as for agricultural plastics need to be established up or extended where they exist already.

- *FoA16 Enforcement of regulations*
  Regulations already exist in most of the fields mentioned above but weak enforcement interferes with their effectiveness. Best practice knowledge of waste legislation enforcement needs to be gathered, followed and shared, e.g. in the field of littering, waste crime and (illegal) waste exports.

- *FoA17 Communication platforms and material*
  Any available knowledge should be shared much more widely. To achieve this, new platforms and means of communication are required. Improvements in horizontal and vertical communication locally, nationally and internationally should be envisioned for achieving a link between waste management and marine litter prevention.

Policy recommendations

This Background Document concludes with a number of policy recommendations, which are:

- Actors in waste management need to be made aware of the situation and their responsibilities with regards to marine litter.
- The legal basis to take action needs to be created and / or existing legislation should be used to greater effect.
- The integration process (horizontal integration of waste management experts and marine litter experts) should be started with assessments of waste management performance to identify those factors contributing to leakage relevant to the site and context.
- Available measures need to be evaluated and discussed with wide stakeholder participation.
- Implementation of measures needs to be accompanied with on-going monitoring of their effectiveness (e.g.by applying adequate indicators).
- Experience and knowledge regarding the link between waste management and marine litter as well as litter prevention measures in waste management should be shared more actively.

Récapitulatif

Des quantités importantes de plastiques s'échappent de sources terrestres vers l'Atlantique du Nord-Est. La plus grande partie de ces fuites de plastiques est due à une gestion inefficace ou insuffisante des déchets et pourrait être évitée en améliorant les pratiques de gestion des déchets ou la planification. Les Actions 39 & 40 du Plan d'action régional OSPAR pour les déchets marins (RAP ML) abordent ce lien entre la gestion des déchets terrestres et les déchets marins dans l'Atlantique du Nord-Est. Ce document de référence résume les résultats d'un questionnaire distribué parmi les Parties contractantes à OSPAR, de multiples entretiens avec des experts et d'une analyse documentaire approfondie. Le document sera utilisé pour poursuivre l'objectif de minimiser les apports terrestres de déchets plastiques marins par des mesures de gestion des déchets.

Le présent document de fond identifie 17 "facteurs contribuant à la fuite de matières plastiques de la terre vers la mer" (répondant à l'Action 39 du RAP ML d'OSPAR) et 17 "domaines d'action prioritaires potentiels pour prévenir la fuite de matières plastiques et les déchets marins" (répondant à l'Action 40 du RAP ML d'OSPAR).

1 Setting the scene

OSPAR has been actively contributing to the fight against marine litter, most prominently in the form of its Regional Action Plan for Marine Litter (RAP ML)[1]. The RAP ML responds to the North-East Atlantic Environment Strategy[2] and the 2010 OSPAR Minister Declaration (the Bergen Statement), which stated that the quantities of marine litter in many areas of the North-East Atlantic were unacceptable. Adopted by OSPAR in 2014, the RAP ML sets out objectives and related actions to reduce marine litter from various land- and sea-based sources. The prevention and reduction of further inputs of marine litter and the removal of litter from the marine environment are set out alongside actions concerning education and outreach. In total, 56 actions were adopted. Actions 39 and 40 (see Table 1 for original wording) address land-based sources, namely those with a link to land-based waste management. These two actions will be in the focus of this study. This background document was created to set the ground for further work at the interfaces of waste management and marine litter input reduction in the regional sea area of the "North-East Atlantic" and possibly beyond.

Table 1: OSPAR RAP ML Action 39&40, the actions of interest in this document

RAP § no. 39	Highlight those waste prevention and management practices that impact significantly on marine litter. Engage with the industry and other authorities, at the appropriate level, in order for them to be able to develop best environmental practice, including identification of circumstances where litter "escapes" into the marine environment. Encourage the recyclability of plastic products (e.g. through reduction of additives).
RAP § no. 40	Share best practice on waste management, e.g. on landfill bans of high caloric wastes (especially for plastics).

To start these two actions, an Action Task Group[3] decided to circulate a "Waste Management Questionnaire"[4], which was distributed to all OSPAR Contracting Parties in the summer of 2018. This document was produced on the basis of the results of the analysis of the Questionnaire followed by additional expert interviews and an extensive review of relevant literature in 2019 and 2020. This subject is of particular political interest due to recent revisions in EU waste legislation (see section 3.3.3) in addition to the general uncertainties around how and why plastic leaks, despite established waste management systems, and what could potentially be done about it.

Without claiming to be exhaustive, the document represents an overview of factors in waste management that contribute to leakage of litter and its pathway from land to sea and identifies fields of actions in waste management to prevent more litter from entering the North-East Atlantic from

[1] OSPAR Commission (2014)

[2] The North-East Atlantic Environment Strategy (OSPAR Agreement 2010-3) sets out a roadmap for the Protection of the Marine Environment of the North-East Atlantic in the period of 2010–2020. It will be further extended beyond 2020 and is currently under review. Besides general strategic elements, the strategy consists of five thematic strategies and marine litter is addressed in the thematic strategy regarding 'Biological Diversity and Ecosystems' (OSPAR Commission, 2010).

[3] Consisting of experts from Germany, the Netherlands, PlasticsEurope and the International Waste Working Group

[4] The questionnaire was made available online at https://jennifer-ospar.typeform.com/to/sKhK9M

land-based sources. The two questions arising from the two separate actions are dealt with separately resulting in two lists of 17 factors contributing to leakage and 17 potential priority fields of action are presented. Please note, that the fact that the two lists have the same number of elements is incidental and not one field of action per problem is presented. Because leakages and suggested solutions always depend on specific local, national and regional contexts and should be dealt with accordingly, this collection of information generates more added value in respect of the OSPAR RAP ML than exemplar lists of site-specific loopholes or instruments. While it is not recommended to do just that, the chapters about factors contributing to leakage and fields of action do stand alone and factors and fields can be drawn up individually. Links to other chapters are inserted where relevant.

The background document addresses land-based inputs of macro plastic litter in all five OSPAR marine regions. Significant differences regarding several factors for waste management questions (e.g. urban-rural, morphology or weather) are visible between and within OSPAR Contracting Parties. Still, because in most parts of this region, waste management systems have a long history and are considered rather sophisticated, the significance of the 'remaining leakage' is of higher interest than the general problem of a lack of waste management. Point sources as well as diffuse sources on the coasts and inland (input via rivers or winds, see 2.3) are also part of the considerations. Often, the marine litter discussion quickly turns to single-use plastic products. This will not be the focus in this document, but addressed from the waste management perspective, meaning that the focus lies on the circumstances of inputs entering the environment, and not distinct products. Micro plastics as well as waste from shipping including waste management in ports, will not be addressed since these issues are within the scope of other actions of the RAP ML. In addition, no special focus will be laid on certification schemes.

Waste management is discussed, both as the problem (leakage due to insufficient or missing waste management practices) and as the solution to the marine litter crisis. Dri et al. (2018) argue that "from the perspective of the environmental performance of the waste management sector, not only waste management companies but also waste authorities […] are considered to be within the boundaries of the sector, because the consequences of the decisions made at public administration level are key to determining the sector's performance". In this document, the boundaries of the sector will be further extended to include questions of product design, social and behavioral questions and research regarding relevant topics.

The three main chapters of the background document describe evidence for the link between waste management practices and marine litter and basic information about waste management in OSPAR Contracting Parties (see 3.2), the identified factors contributing to leakage of plastic waste from land to sea (see chapter 4) and the identified priority fields of action (see chapter 5). Chapter 6 gives an overview of guidance for decision makers towards an institutional response. An introduction to plastic litter in the oceans, acting as an evidence base, is provided as a background and to put the issue of insufficient waste management in a wider context (chapter 2).

2 Plastics and the oceans

Since the worldwide acknowledgement of plastic litter and its negative impact on ecosystems, garbage accumulations in the oceans and traces of plastic particles in food chains have been documented. In light of these findings, the issue of plastic litter is widely perceived one of the main threats to the marine environment. It is a ubiquitous, transboundary, complex, social, economic and environmental problem and should thus be considered a "common concern of humankind" (UNEP, 2016). Marine litter has been referred to as a "tragedy of the reverse common"[5] (Landon-Lane, 2018), a "public bad" (Oosterhuis, et al., 2014) with unacceptably high and still increasing costs of inaction (UN Environment, 2017 & Van Acoleyen, et al., 2014). Efforts to combat the problem, such as by lowering the inputs, are complicated in light of increasing plastic consumption and plastic waste generation, urbanization, and growing population, especially in coastal areas.

Marine plastic litter is an alarming issue, especially due to the persistence of the material. This is a major reason why plastic litter accumulates throughout the ocean, including the entire water column, the sea floor, sediments, biota, and along coastlines. Marine litter, consisting mainly of plastics, causes direct and indirect negative impacts on marine animals and habitats, which results in the degradation of marine and coastal ecosystems.

Seabirds, fish and marine mammals are specifically prone to negative effects, and significant environmental impacts include injuries, entanglements, and ingestions of litter by wildlife. Another significant consequence is the colonization of floating debris, which can cause dispersal of invasive species. Adverse effects are widely documented (see 2.2) for marine and coastal habitats and were reviewed and assessed, for example, by the EU Technical Group on Marine Litter (Werner, et al., 2016). Weathering of plastic litter further leads to the generation of microplastic particles, prone to ingestion by species at the lower end of the size fraction and therefore at the base of the marine food web. In addition to the ecological impacts, the reduced provision of ecosystem services has detrimental social, economic and environmental consequences (UN Environment, 2017), including negative effects on human safety and health. Floating debris, for example represents a navigation hazard and additional socio-economic impacts (Werner, et al., 2016 & UNEP, 2016).

This chapter will introduce plastics as the material of the modern age, its usage and fate. It will also look at the pathways of how plastics enter the worlds' oceans and global and regional actions to address the issue of marine plastic litter.

Plastics and plastic waste

Plastics are usually cheap, lightweight, easy to produce and form into almost any shape (UNEP, 2018). Due to these characteristics, plastics are used around the globe, and traces of them can be found in all ecosystems. There has been an increase in the use of different plastics over the past century, and this usage has mostly been a rather linear one (see Figure 1).

[5] The tragedy of the commons (introduced by William Foster Lloyd in 1833) is a term used to describe the thought, that a publicly available and shared resource is necessarily overexploited because individual actions do not reflect common interest in a sustainable usage. In the case of ocean plastic pollution, the ocean is the common resource and disposing plastic in it is a 'reverse' exploitation.

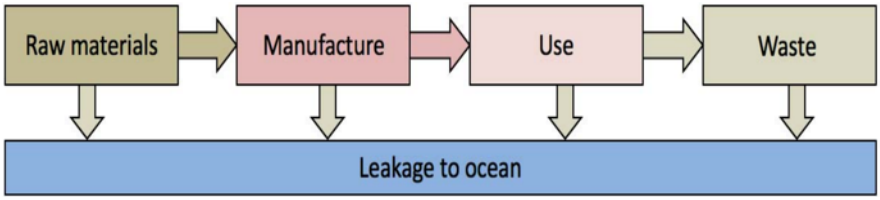

Figure 1: Linear usage of plastics
Source UNEP (2016)

After the production and use stage of plastics, plastic waste is still often sent to landfill, littered or ends up in the (marine) environment by other means. An estimated 8,300 million metric tons (Mt) of virgin plastics have been produced worldwide and plastic waste from primary plastics has reached 5,800 Mt by 2015 (Geyer, et al., 2017) the vast majority of which ended up in landfill or discarded in the environment (see Figure 2). Taking into account primary and secondary (recycled) plastics, the generated amount of plastic waste between 1950 and 2015 is estimated to be as high as 6300 Mt. According to the estimated provided by Geyer et al. (2017), 302 Mt of plastics waste was generated in 2015 alone.

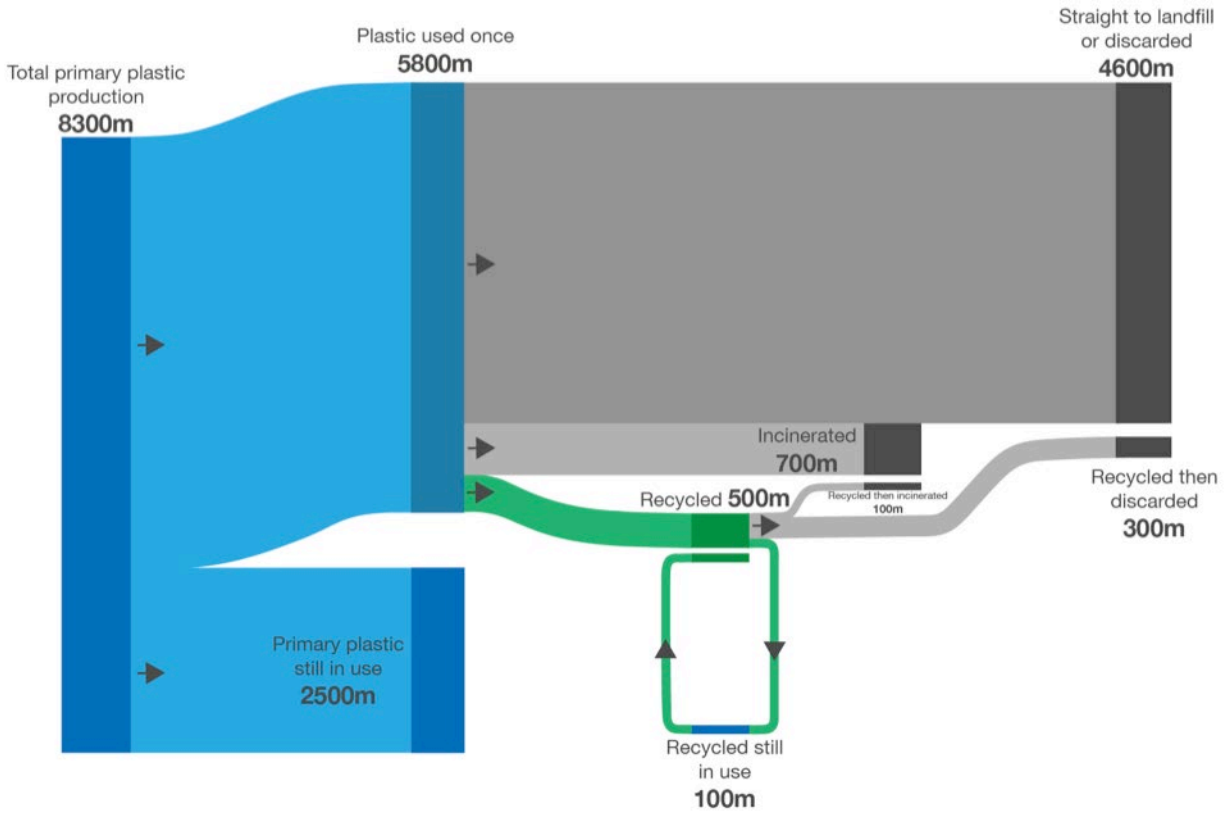

Figure 2: Global plastic production and its fate (1950-2015). [m = megatons, Mt]
Source Ritchie et al. (2018) based on Geyer et al. (2017)

The European plastics industry, seen in the context of global plastic trade, is of significant economic importance and ranks 7th in Europe in industrial value-added contribution. In 2016 the global pro-

duction of plastics reached 335 Mt[6], 60 Mt (19%) of this originating from Europe (PlasticsEurope, 2018). This is expected to increase to 1.2 billion tons in 2050 if business continues as usual. Therefore, preventing, reducing and managing plastic litter represents one of the major environmental challenges of the 21st century not only globally, but also in Europe. The plastic demand of the EU is currently estimated to be 48 Mt per year (Deloitte, 2017). The most relevant plastic materials are Polypropylene (PP, 19.3%), mostly used in packaging and low-density polyethylene (LDPE, 17.5%), commonly used in films applied for packaging or in agriculture.

A total of 27.1 Mt of plastic post-consumer waste were collected in the 28 EU countries, Norway and Switzerland[7], which represents an increase of 11% in the past ten years (PlasticsEurope, 2018). In the rationale for the European Strategy for Plastics in a circular economy (see 3.3.3) the EU Parliament uses a similar number of 25.8 Mt of generated plastic waste per year (European Parliament, 2018). On average, every EU citizen is responsible for 31kg of plastic packaging waste each year (see Figure 3)

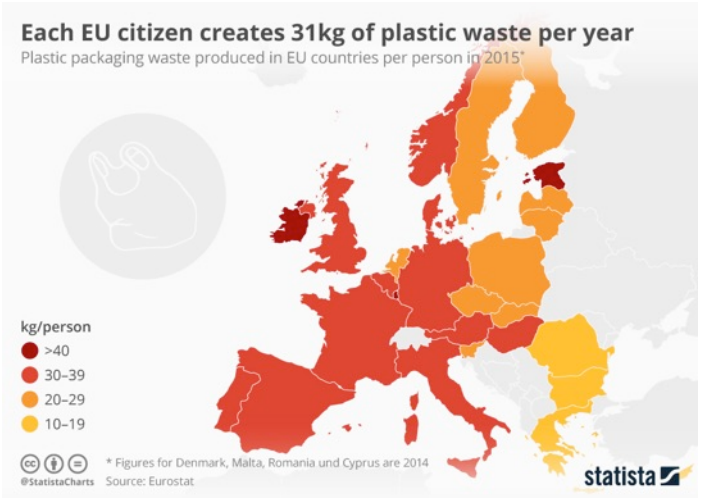

Figure 3: Plastic waste generation per EU citizen in 2015. Source: Armstrong (2018)

In 2017, a total of 21,8Mt of plastics were produced and 11.82Mt were used by (private and commercial) consumers in Germany alone (Conversio, 2018). Of this amount, 27% were used as packaging[8] and 22% in the construction sector, followed by application in cars, electronic goods and other applications. In the same year, 6.15 Mt of plastic waste was generated, which represents an increase of 3.35 Mt (or 3.5% per year) since 1994. This drastic increase is almost entirely attributed to post-consumer waste (4.4% increase per year over the past 13 years) (Conversio, 2018).

In a life-cycle approach the positive environmental impacts of plastics are often highlighted including its light weight, in relation to transport. Plastic production, plastic usage and plastic waste are

[6] This estimation for 2016 by PlasticsEurope (2018) is significantly lower than the 2015 estimate of 407Mt that entered the use-phase by Geyer et al. (2017), which shows the uncertainties of concrete figures in the field of plastic production and plastic waste generation on a global scale.

[7] In the same year, 242 million tons of plastic waste were generated worldwide. This mass represents 12% of the 2.01 billion tons of municipal solid waste, an amount that could grow to 3.40 billion tons by 2050 (Kaza, et al., 2018).

[8] According to Deloitte (2017), plastics in packaging represent up to 40% of the plastic demand in the EU.

responsible for a series of environmental problems, which emerge when plastic waste becomes litter. Interestingly, life-cycle assessment only considers impacts in the production and usage stage of a product not what happens after. Although marine litter is currently the most prominent problem with unsustainable usage of plastics (see 2.2), there are other issues arising with the application of this material. Despite the fact that it represents a rather small share of fossil fuel usage, plastic production contributes to emissions and resource depletion. Multiple added substances, which can comprise plasticisers, fillers and other additives (Deloitte, 2017), may be a factor contributing to the leakage of hazardous substances to the environment and, depending on the application, also to human health issues beside the mechanical consequences to marine life such as strangulation, injury/blockage of digestive system, with numerous lethal and sub-lethal consequences (Werner, et al., 2016).

Evidence for plastics in the oceans

The unsustainable usage and disposal of plastics has caused a severe crisis in the world's oceans. Jambeck et al. (2015) estimate that 8 Mt (range of 4.8-12.7) of plastic waste ends up in the ocean each year. This is the equivalent of one garbage truck per minute and results in an estimated 150 Mt of marine plastic litter in the world's oceans (Ocean Conservancy, 2015). The World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company (2016) conclude that in a business-as-usual scenario, the ocean could contain more plastics than fish (by weight) by 2050. If marine fish stocks continue to decrease and plastic usage growth rates exceed the conservative estimates applied, this state could also be reached much earlier. Combining several models, Sherrington et al. (2016) conclude, that yearly 54,300-145,000 of macro plastic waste reach the oceans from the EU coastal areas (50km from the sea) and an additional 500-20,000 tons per year from inland sources via rivers. The impact assessment[9] for the EU directive addressing specific single-use plastic items found, that 15,604 tons of plastic litter enter European Seas only from the addressed single-use items (see 3.3.3). Bertling et al. (2018) present the results of different models to estimate the marine litter inputs from Germany and calculate an amount of 34,000 tons of macro plastic inputs (which represents an average of 412 grams per person per year) into the seas from Germany alone.

While these values are the results of modelling activities, objective evidence for the occurrence, dimensions and characteristics of marine litter is obtained from regular and standardized beach litter monitoring and other well-established monitoring protocols. These include monitoring of seafloor litter and plastic particles ingested by seabirds and sea turtles. Almost all EU member states have already established a beach litter monitoring programme as an indicator for marine litter and its reduction (Van Acoleyen, et al., 2014). The OSPAR Intermediate Assessment of the state of the North-East Atlantic summarizes the results of on-going monitoring and concludes, that the goal to "*substantially reduce marine litter in the OSPAR Maritime Area to levels where the properties and quantities of marine litter do not cause harm to the coastal and marine environment*", was missed so far. Litter is abundant in North Sea Fulmar stomachs, on the seafloor and on the beaches (OSPAR, 2017). Plastics comprise the majority of litter found on beaches on the coast of the North-East Atlantic (see Figure 4) and even more than 90% of the documented beach litter in some regions. No overall trend regarding composition or amounts is observable in the period of 2009-2014 (OSPAR, 2017).

[9] SWD/2018/254 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2018:0254:FIN

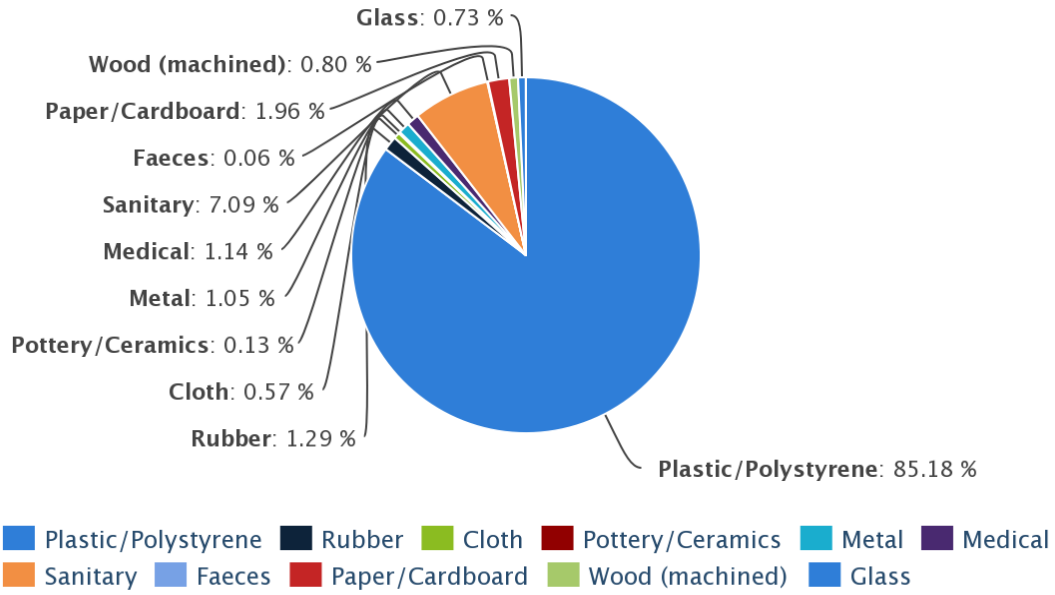

Figure 4: Material types of litter documented under the OSPAR beach litter monitoring (year 2017, survey type 100m, number of surveys 399)
Source: OSPAR Beach Litter Database, available at https://www.mcsuk.org/ospar/

The AWI LITTERBSE summarises 1,606 studies, which concludes, that at least 3,461 species of microbes, plants and animals are affected by marine litter. Figure 5 shows that harmful interaction between marine and biota must be expected for the entire OSPAR region. The CBD (2016) found that, despite significant gaps in knowledge of many aspects of marine debris, evidence "strongly suggest that marine debris is an important source of anthropogenic stress affecting marine and coastal biodiversity and habitats".

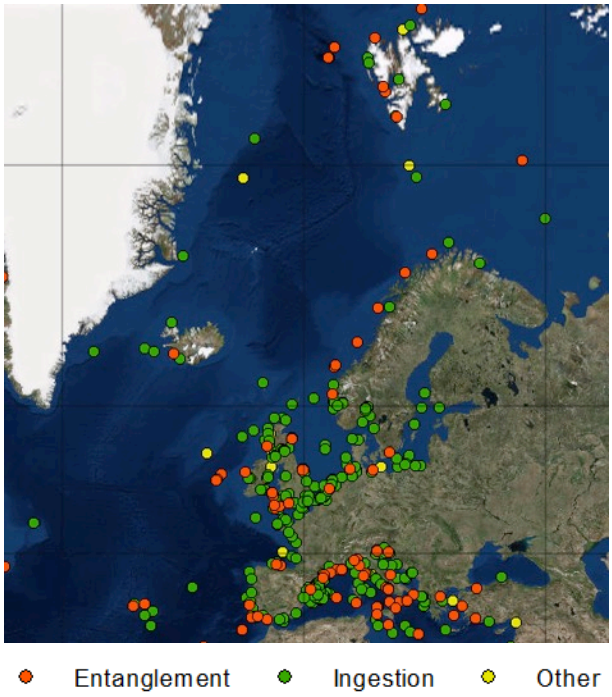

Figure 5: Documented litter biota interactions in the OSPAR region
Source: Tekman et al. (2019)

The marine environment is certainly not the only environmental compartment in which plastic litter accumulates. Evidence for plastic litter in the terrestrial environment is available for agricultural land, for example, where German researchers found 206 pieces of macroplastic per hectare on German farmland (Piehl, et al., 2018). Plastics also accumulate in rivers, lakes, urban areas or forests. From these environments, plastics can often be re-mobilized and transferred to the oceans by wind transport, water or biota (see 2.3).

Sources of plastic litter and pathways to the North-East Atlantic

To describe how plastic litter ends up in the marine environment, Veiga et al. (2016) use a concept including the following five elements, which will be discussed for marine litter subsequently:

- *Source*: The economic sector or human activity from which litter originates;
- *Means of release*: The way in which a given item leaves the intended cycle and enters the environment;
- *Geographic origin*: The location of the source and where the release took place;
- *Pathway*: The physical or technical means by which litter enters the marine environment;
- *Transport mechanism*: The mechanisms through which litter moves into and within the marine environment.

Sources of marine litter can be identified by attributing discovered litter items according to clear functions, barcodes or container information, or based on likelihoods (e.g. from models or stakeholder participation). Although, many litter items cannot be directly connected to a particular

source[10] it is widely acknowledged, that land-based sources outperform sea-based sources on a global scale (Veiga, et al., 2016). Examples for land-based sources are coastal and beach tourism, recreational activities, events, households, agriculture, industries, waste management activities, dumps and landfills.

For the North-East Atlantic including the North Sea, the share of marine litter from sea-based sources is estimated to be above the global average. Sherrington et al. (2016) calculate from the 2012 Ocean Trash Index[11], that 80% of the litter found on the beaches of countries with a coast to the North-East Atlantic stem from land-based sources. Comparing studies on litter found on the sea floor, they estimate that 60% of litter found in this component of the North-East Atlantic has its origin on land. ARCADIS (2012) estimate that only around 50% of marine litter in the North Sea stems from land-based sources. Important land-based sources include coastal tourism (26.19%), construction and demolition (5.88%), households (5.35%), waste collection/transport (3.54%), industrial activities (2.43%), agriculture (1.16%), and dumpsites/ landfills (0.98%) (ARCADIS, 2012).

Releases of marine litter can be caused by accidental losses, improper disposals or deliberate littering and dumping. Accidental losses include unintentionally dropped litter, waste removed from collection, transport or storage infrastructure by wind, biota or other means. Deliberate littering or dumping actions are generally attributed to lacking awareness, laziness, potential individual benefits and others (see Factors F3, F4 in Chapter 4).

While less than 5% of plastic land litter is believed to end up as plastic marine litter in the impact assessment for the SUP Directive Proposal (see 3.3.3)[12], the share of litter ending up in the seas increases with decreasing distance to the sea or rivers. Hardesty et al. (2016) who modelled marine litter generation and pathways in Australia found, that local inputs (e.g. littering on the beaches) are more important than inland litter transported to the sea and called this the 'key driver' for marine litter. Accordingly, site characteristics are more important than transport processes. At the same time, the study highlights, that many critical variables are under-sampled. Veiga et al. (2016) contrarily find that the origin of marine litter is often "distant from the sea or the site where the ML [marine litter] item is recorded" and highlight the importance of distinguishing between locally, regionally and globally generated marine litter, when planning measures to prevent marine litter in a certain area.

Pathways through which plastics turn into marine litter include direct inputs into the sea, distant 'inputs' (e.g. through inland littering and transport by wind or rivers) or sewage systems. Lebreton et al. (2017) estimate that worldwide, rivers transport between 1.15 and 2.41 Mt of litter per year into the oceans. Rivers transport 2.8–18.6% of the coastal (50km from the coast) plastic marine litter contribution to the oceans, which amounts to 356,000–893,000 tons per year worldwide. Sherrington et al. (2016) compare 4.8 – 12.7 Mt per year land-based (coastal) inputs estimated by Jambeck et al. (2015) to 75,000-1.1 Mt per year land-based (inland) riverine input calculated by scaling up an estimate made by Lechner et al. (2014). Using mid-point estimates of these ranges, inland sources contribute only around 5.5% of land-based marine plastic litter. The same calculation

[10] E.g. due to their state of weathering, fragmentation or application in different fields

[11] Introduced in the Ocean Conservancy's 'International Coastal Cleanup' reports, available e.g. at: http://coastalcleanup.nus.edu.sg/download/Final%20Reports/2013_ICC_Report.pdf

[12] SWD/2018/254 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2018:0254:FIN

for the EU plastic litter inputs results in around 10% contribution of inland sources and 90% from coastal areas.

Estimates for riverine litter in Europe range from 500 to 20,000 tons annually up to 9,300 tons and 10,500 tons, according to the impact assessment for the SUP Directive Proposal[15]. Lebreton et al. (2017) estimate that 3,900 tons of litter per year come from European rivers (0.28% of the world-wide riverine input) and that the biggest share of plastics reaching the oceans via rivers (0.79–1.52 Mt per year) originates from inland areas with distances to the shore of more than 50km. Van der Wal et al. (2015) identify urban waste management as an important factor in the context of river plastics and Van der Wal et al. (2013) estimate that rivers cause the inflow of about 50% of all floating plastic litter in the North Sea, while the rivers Rhine, Meuse and Scheldt contribute about 15 % of all floating plastic litter. A model produced by Conversio (2018) estimates, that 381 tons of macro plastic litter enters the North Sea from Germany via rivers (47% of the land-based sources), 322 tons from the coasts (31% of the land-based sources) of a total amount of 938 tons of macro plastic litter input. ARCADIS (2012) report that household waste transported by rivers to the marine environment was seen as a potential pathway to the North Sea in stakeholder interviews, yet it is much more significant in other (European) regions. Gasperi et al. (2014) find that floating plastic debris contributes 0.8% and 5.1% of total floating debris in the French river Seine. Additionally, Morritt et al. (2014) find that significant amounts of submerged plastic litter are transported to the sea via rivers. Besides litter transport and ultimately inputs in the seas through rivers, winds are an important aspect in marine litter pathways, yet less important than riverine inputs (Hardesty, et al., 2016).

As a consequence of the potentially far-dispersing pathways of plastic litter, this document is addressing the whole OSPAR catchment area (see Figure 6). The document has identified factors contributing to leakage as well as fields for action are considered relevant in context of the entire area. Despite the fact that plastic litter is also responsible for negative (environmental, social and economic) impacts even if it does not reach the marine environment (which is not further elaborated in this work), we argue, that a share of all plastic litter in the entire catchment area has the potential to contribute to marine litter in the North-East Atlantic. This has implications for the scale of necessary action against to prevent marine litter and while for a long time, marine litter prevention was focused on sea-based sources and coastal areas, more attention needs to be paid to 'upstream' sources. Such a process to address this challenge has been initiated in Scotland, where the Marine Litter Strategy and the National Litter Strategy are designed "to jointly manage litter in Scotland's terrestrial (including inland waters), coastal and marine environments" (Chen, 2015).

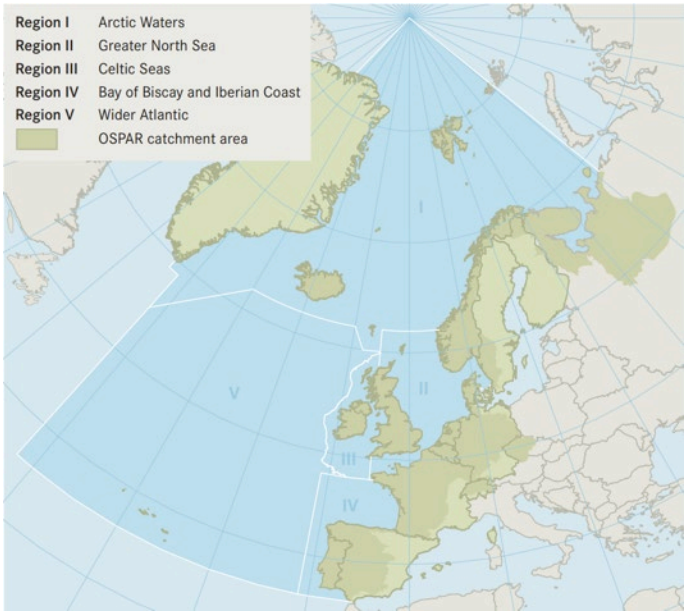

Figure 6: The OSPAR regions and catchment area. Source: OSPAR (2010)

Action against marine litter

As a response to the observed negative impacts and the increasing public attention, conventions, agreements, regulations, strategies, action plans, programs and guidelines have been adopted at international, regional and national level. The instruments contain preventive, mitigating, removal and behaviour-changing measures (Chen, 2015). The following collection only represents a selection of global, regional and national initiatives.

Global agreements were first put forward for pollution from sea-based sources (MARPOL 1970, London Convention 1972, and UNCLOS 1994). Since 1992, the Basel Convention regulates the transportation of hazardous (plastic) wastes. With the Honolulu Strategy, the United Nations created a global framework for prevention and management of marine debris in 2011. The Global Partnership on Marine Litter (GPML) under the Global Programme of Action (GPA) is a UN initiated global partnership gathering a multitude of international actors to implement the Honolulu Strategy. Marine litter is now also addressed by the Sustainable Development Goal 14 under the 2030 Agenda for Sustainable Development. Target 14.1 aims to "prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" by 2025 (United Nations, 2015). The G7 Summit adopted an Action Plan to combat marine litter in June 2015 and the G20 adopted a plan in June 2017. Beside for OSPAR, Regional Action Plans for Marine Litter were adopted by several other regional seas' conventions including HELCOM for the Baltic and UNEP/MAP (MEDPOL) for the Mediterranean Sea (see Figure 7). Action plans are currently developed for the Black Sea, the North East Pacific, the ROPME Sea Area and for East African region. In one way or another, the plans address land-based and sea-based sources, awareness raising and education as well as removal from sea. Chen (2015) mentions, that international initiatives have in many cases not yet been transposed into national management schemes or legislation and where they have been transposed, there is often a lack of clarity and enforcement. In a recent report it is stated that "there is substantial debate on whether the problems of the world's oceans need more regulatory framework or need more effective implementation of existing regulations" and suggest that "the answer may be a combination of the two"(Landon-Lane, 2018).

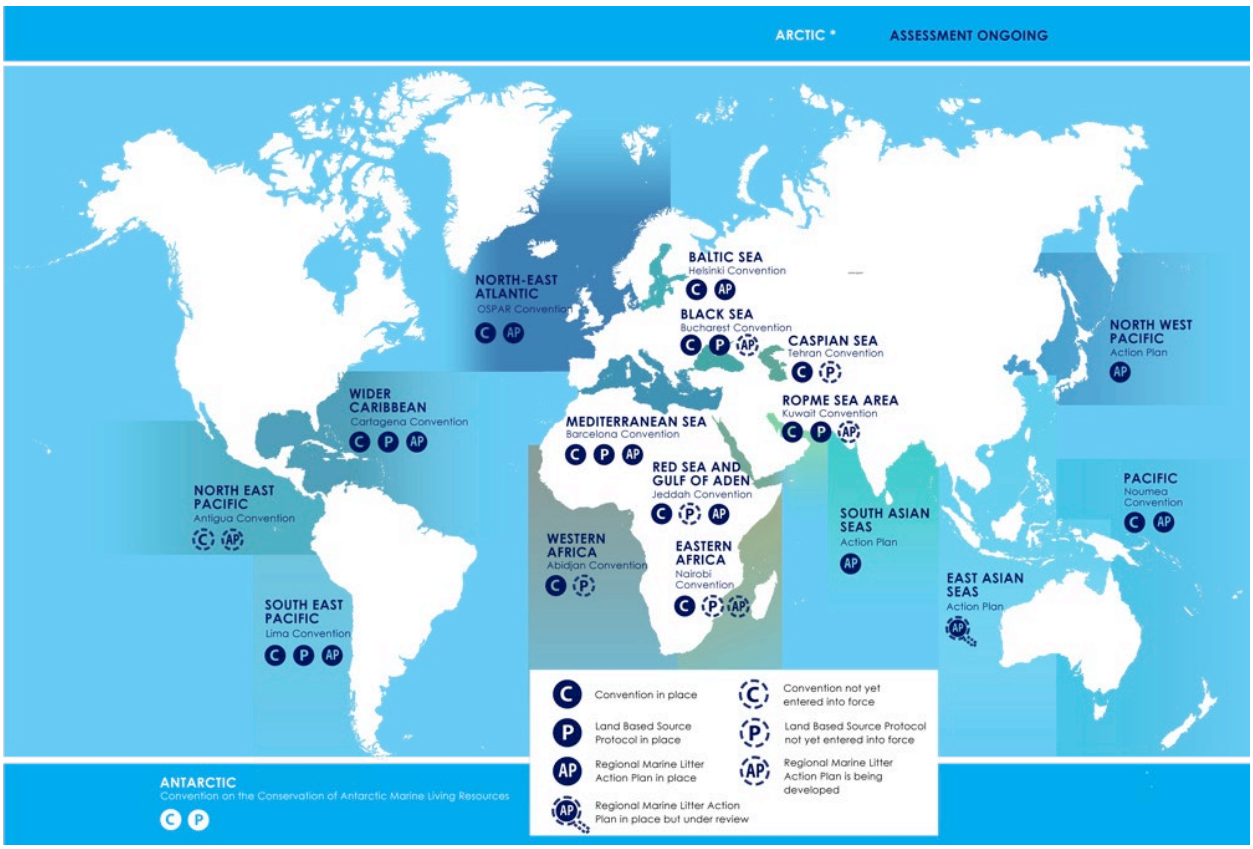

Figure 7: Regional action plans on marine litter
Source: Global Partnership on Marine Litter Platform

A great variety of initiatives to address the issue has also been implemented or planned in the European Union (see 3.3.3), and on national level in several OSPAR Contracting Parties. Strategies or plans specifically addressing marine litter have been adopted in Belgium[13], England (DEFRA, 2017), Northern Ireland (DOENI, 2013) and Scotland[14]. Monitoring programs, bans, taxes or fees on specific plastic products, deposit-refund systems and policies related to landfills have been adopted in several countries (Arroyo Schnell, et al., 2017).

[13] Available at: https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/action_plan_marine_litter.pdf

[14] Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/report/2014/08/marine-litter-strategy-scotland/documents/00457889-pdf/00457889-pdf/govscot%3Adocument

3 Waste management and marine litter in the OSPAR region

The findings presented in chapter 2 (see 2.2 and 2.3) clearly show that significant amounts of plastic litter leak from land-based sources in the OSPAR region. Velis et al. (2017) find that on a global scale, "the majority of marine litter originates from unsustainable waste management practices, particularly in low and middle-income countries". While changes in waste management systems are undoubtedly and most urgently needed in those countries with the highest leakage of plastic waste to the oceans[15], inputs are also considerable in the OSPAR region. Besides several other direct negative environmental impacts[16], the JRC Report on 'Best Environmental Management Practice for the Waste Management Sector' finds, that "the accumulation of litter on land and in the oceans is a direct consequence of poor waste management" (Dri, et al., 2018). Besides waste prevention, minimising the amount of waste becoming marine litter by collecting and properly treating waste is of major importance to tackle land-based sources of marine litter (UN Environment, 2017). This chapter describes the special role of waste management in marine litter prevention as well as approaches to harness the potential benefits in the fight against marine plastic litter inputs from land-based sources on both a global level and with a specific focus on the OSPAR region. It further introduces an overview of current waste management practices in the OSPAR region and relevant legal frameworks at the EU level.

Avoiding land-based inputs by improving waste management

On top of the overarching goal to guarantee safe disposal for generated waste, waste management systems are currently faced with increasing requirements regarding several environmental perspectives. These include reduction of climate-relevant emissions, emissions of hazardous substances to air, soil and water, and increase of overall resource efficiency of worldwide economies. For the global challenge of marine plastic litter, establishment, or improvements in waste management systems, without further specifications is the most commonly mentioned field of action. UNEP (2016) compare the increase in gross national products of the focus countries for the study by Jambeck et al. (2015), with their human development index. It showed the latter increased much slower and conclude that waste management capacities have not kept pace with the consumers' buying power, which again is linked to plastic consumption, plastic waste generation and more generally with today's throw-away society. Currently around 2 billion people globally are estimated to have no access to adequate waste collection services and 3 billion people have no access to appropriate disposal facilities (Velis, et al., 2017). Ocean Conservancy (2015) estimates, that 25% of the marine litter inputs from the priority countries was once collected and only leak due to inappropriate management and technologies. World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company (2016) estimate, that globally 32% of plastic packaging waste is either not collected or leaks during or after collection and/or disposal.

[15] See Jambeck et al. (2015)

[16] Waste disposal leads to direct environmental impacts, such as land occupation, resource depletion, amplification of global warming due to methane and other greenhouse gas emissions, eutrophication and ecotoxicity in waters from leachate in the case of landfilling, or resource depletion, and acidification and ecotoxicity effects from emissions to air in the case of incineration (Dri, et al., 2018),

Additional to the resulting volumes of inadequately managed waste, Jambeck et al. (2015) estimate 2% littering[17], which results in significant amounts of plastics prone to leakage. While the estimations listed above refer to the global situation, some experts believe that the 2% 'littering rate' is also valid in regions with advanced collection infrastructure, such as the United States and Europe. Bertling et al. (2018) provide a model to estimate plastic waste leakage from Germany, which is representative of the systems applied in large parts of the OSPAR region better than the rather simplified global model by Jambeck et al. (2015). While the 2% rate is criticized as too high and even more importantly as applied to the wrong values[18], significant amounts of plastic waste still leak into the environment and eventually the worlds' ocean. While mismanaged household waste is believed to be near zero, the model's results indicate significant losses to the environment despite the rather sophisticated systems widely applied in in the OSPAR region. An estimated amount of 115,913 tons of macro plastic waste leak to the environment each year from Germany alone and only around 30% (34,000 tons) are retrieved by cleaning activities.

The publication integrating the results of three marine litter studies[19] financed by the European Commission in 2012 and 2013, finds that "appropriate waste management is another crucial issue to close the largest loopholes for household waste including plastic packaging waste". Suggested characteristics of an appropriate management are for example increased collection frequency or increased capacity during peak season (ARCADIS (2012), BiPRO (2013). Mihai et al. (2017) find severe issues with illegal dumping and fly-tipping in EU countries where waste management services are statistically available for the whole population and conclude, that serious gaps in the waste management systems may exist. Besides the wide availability of plastic products and a consumption trend for convenience, a "lack of incentives to ensure a proper collection and treatment of waste leading to poor management and insufficient infrastructure" is identified as a contributing factor to marine litter inputs from single-use plastic products (European Commission, 2018e).

A survey analyzing public perceptions regarding marine litter conducted by Hartley et al. (2018) finds that organizations collecting, and processing wastes are amongst the stakeholder groups perceived least responsible for the problem of marine litter in Europe. At the same time, participants of the survey regard the sectors' competence to reduce marine litter as rather high but the motivation as rather low.

On top of the plastic leaking to the North-East Atlantic from, or rather despite of implemented waste management systems, UNEP (2016) point out, that past improvements in waste management (e.g. increased recycling rates) have to a certain extent been achieved by exporting waste to other countries (see factor F17 in chapter 4) and plastic waste from the OSPAR Contracting Parties may also reach the world's ocean via this pathway.

In this document we argue, that where factors contributing to leakage (see chapter 4) can be identified, the benefits of specific action in the context of (marine) litter generation have been underval-

[17] Waste management and awareness raising about the former are part of the influencing drivers for littering, illegal disposal, besides the individual behavior through awareness raising (see F3, FoA1 and FoA6)

[18] Bertling et al. (2018) suggest, that the 2% rate should be applied to the difference between consumed plastic and plastic waste collected, but highlight, that the quantification of this uncollected waste is rather complicated and again usually done indirectly through studies on littering behavior.

[19] ARCADIS (2012), BiPRO (2013) and Vernon et al. (2013)

ued in waste legislation and waste management system design or are currently not yet considered or even completely unknown.

Waste management in the OSPAR region

Waste generation, composition and management is very heterogeneous between and within countries of the OSPAR maritime region. Factors that are relevant and should be considered when addressing the linkages between waste management and marine litter include among others current performance, roles and responsibilities, legislative frameworks, waste management and waste prevention plans, capacities, costs and financing, applied strategies and instruments as well as declared targets.

Recycling and landfill quotas are figures that are often used to describe the efficiency or sustainability of waste management systems and are consulted to quantify improvements towards a circular economy. Data for all OSPAR Contracting Parties, including these two quotas and extensive country profiles are published[20] by the European Topic Centre on waste and materials in a green economy (ETC/WMGE), a consortium contracted by the European Environment Agency (EEA) to provide information about waste management data (EIONET, 2018). 2016 was the first year that more of the collected post-consumer plastic waste was recycled (31.1%) than landfilled (27.3%) in the EU28+NO/CH, according to PlasticsEurope (2018). The proposed reason for the increase of the former and decrease of the latter in several countries are landfill restrictions for plastic waste. However, the largest fraction of collected plastics in Europe is at the same time still incinerated (41.6%)[21]. The European Commission (2018a) reports slightly different values for the EU and state that only 30% (7.8 Mt/year) of all post-consumer plastic waste (26 Mt/year) is collected for recycling and 31% (8.6 Mt/year) still go to landfill. Recycling rates for plastic packaging wastes are significantly higher and the 2016 target quota of 22.5% was achieved by all EU countries. Still, it is estimated that the European economy loses 95% of the value of plastic packaging products, which amounts to yearly losses between €70 billion and €105 billion (European Parliament, 2018). Even in the case that plastic packaging products are recycled, a share of their value may be lost if the product of recycling is of lower value than the recycled material. Since a significant share of the 30% recycled post-consumer plastic waste is rather 'downcycled' than recycled, only 5% of the original value can currently be kept.

Waste legislation is a shared responsibility between local, national and regional actors in most OSPAR Contracting Parties. On the ground waste planning and management (including collection, transportation and storage) is usually under the responsibility of municipalities but commissioned to public or private organisations. Nordic Competition Authorities (2016) report, that e.g. in the Nordic countries, only few municipalities manage waste collection through in-house services and constitutional autonomies of municipalities allow "municipalities, to a large extent, to independently choose how to manage their local waste markets". Accordingly, significant differences between municipalities exist. Municipalities play multiple roles in waste management, including administration, organisation, and surveillance and in some cases also waste collection, transport, storage and treatment or disposal through public undertakings (Nordic Competition Authorities, 2016).

[20] Available at: https://www.eionet.europa.eu/etc-wmge/municipal

[21] It is not distinguished between treatment in an incinerator or a co-incinerator plant https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN#page=9 Definitions 3 (40), (41)

According to Dri et al. (2018), 99.7% of all companies in the waste management sector are small and medium-sized enterprises with less than 250 employees and 77% have less than 10 employees. The market share of the largest 3 operators ranges between 23% (in the UK) and 57% (in Spain). The sector has approximately 900,000 employees, most of them in waste collection, which is the most labour-intensive sector.

Several 'best practice' or 'good practice' guidance documents for the sector with relevance for the area of interest, describing what systems could or should look like, are available. These include e.g. the 'Best Practice Municipal Waste Management Information pool' by Bilitewski et al. (2018) and the JRC policy report on 'Best Environmental Management Practice for the Waste Management Sector' by Dri et al. (2018).

EU policies on waste and marine litter

It is pointed out by BiPRO (2013), that "the feasibility of measures is closely related to the question whether a measure can be based on a legal requirement or obligation". While the main priority in waste policy in the European Union is waste prevention, the implementation of a Circular Economy and disposal safety, aspects relevant for the issue of marine litter are found in several EU Directives. The strongest linkage is now the 2018 amendment to EU waste legislation[22], which was introduced with the goal to protect the European Seas against the generation of further marine plastic litter and to strengthen the previously rather weak link between waste management and marine litter prevention, which again is required by the Marine Strategy Framework Directive. With the aim to evaluate the chances arising from EU frameworks, legislation and strategies[23], this chapter will briefly describe the EU policies regarding marine litter and waste management respectively and ultimately discuss the opportunities arising from the recently created links between the former two.

Marine Strategy Framework Directive

The Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive, MSFD)[24] is the environmental pillar of the EU Integrated Maritime Policy and of paramount importance in the context of marine litter. The main aim of the Directive is to protect the marine environment in the European seas and to achieve or maintain a Good Environmental Status (GES) by 2020. GES is qualitatively described by 11 descriptors in Annex 1 of the Directive with descriptor 10 addressing marine litter by describing the desired state that "properties and quantities of marine litter do not cause harm to the coastal and marine environment". The descriptor is further specified in an according Commissions Decision revised in 2017 setting criteria and methodological standards. For descriptor 10 there are two primary criteria (one for macro and one for micro litter occurrence in the different marine compartments

[22]2018 Update: Directive (EU) 2018/851, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.150.01.0109.01.ENG

[23]Marine litter is e.g. addressed in the 7th Environmental Action Programme (available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN) which aims to protect, conserve and enhance the Union's natural capital, and requires the establishment of a Union-wide quantitative reduction headline target for marine litter supported by source-based measures.

[24]Consolidated version from 07.06.2017: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02008L0056-20170607

and characteristics) and two secondary criteria (macro and micro litter ingested by marine animals and number of individuals of each species adversely affected by other impacts such as entanglement). In this context the setting of baselines and threshold values is required for the different criteria and, under development by the EU Technical Group on Marine litter. In 2015, based on their monitoring results EU member states were required to define their Programmes of Measures (PoMs) to achieve GES.

Waste Framework Directive and supporting directives

One of the basic ideas of European waste legislation is that waste is a commodity and its collection and treatment is an economic activity. By providing the overarching framework legislation, the EU is ensuring the functioning of the internal market in this area (Kummer, et al., 2003). This framework consists of the Waste Framework Directive, supported by technology-oriented directives (e.g. Landfill Directive), waste stream related directives (e.g. Packaging Directive) and directives regarding the supervision and monitoring of waste management (Bilitewski, et al., 2018), the most relevant of which will be introduced briefly. Please note that the latest revision(s) of the listed Directives, which are of special importance for marine litter prevention, are addressed in 3.3.3.

- **Directive 2008/98/EC on waste (Waste Framework Directive)[25]**
  The Waste Framework Directive provides the general framework for waste management in the European Union. It introduces a 'waste hierarchy', which "shall apply as a priority order in waste prevention and management legislation and policy". The hierarchy prioritizes waste 'prevention' over 'preparing for re-use', 'recycling', 'other recovery', e.g. 'energy recovery' and ultimately 'disposal'. The Directive further defines the concepts of the 'polluter pays principle', and the 'end-of-waste status', requires Member States to set up separate collection where appropriate and sets binding targets regarding reuse and recycling of specific waste streams (Bourguignon, 2016). The Directive also requires member states to draw up and regularly evaluate and revise (every six years) waste management plans as central waste planning instruments to describe current and future waste generation and plan measures to be taken to improve environmentally sound preparing for re-use, recycling, recovery and disposal.
- **Regulation (EC) No 1013/2006 on shipments of waste[26]**
  The regulation on the shipment of waste prescribes supervision and control regimes for waste shipments between member states, imports, exports and transit shipments, depending on the origin, destination, route, waste type, and intended treatment for the waste at its destination.
- **Directive 1999/31/EC on the landfill of waste (Landfill Directive)[27]**
  The landfilling of waste is the least desired option to handle waste according to the waste hierarchy and is regulated by the Landfill Directive. The Directive aims to prevent negative effects from landfilling of wastes and from landfills on surface waters, groundwater, soil, air

[25]Consolidated version from 05.07.2018: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02008L0098-20180705

[26]Consolidated version from 01.01.2018: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1454069470717&uri=CELEX:02006R1013-20180101

[27]Consolidated version from 04.07.2018: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:01999L0031-20180704

and human health. To achieve this, stringent technical requirements (Bilitewski, et al., 2018), bans on landfilling of untreated waste and targets varying for the countries (Bourguignon, 2016) are introduced. The technical requirements include among others measures to minimize nuisance from wind-blown materials. The Directive prescribes control regimes and regulates member states' approaches to non-compliant landfills.

- **Directive 94/62/EC on packaging and packaging waste (Packaging Directive)**[28]
  The Packaging Directive defines 'packaging' and the different available treatment methods and aims to lower the environmental impact of packaging and packaging waste and to avoid obstacles in intra-Union trade that aroused after member states started addressing packaging on a national basis. It requires member states to achieve certain recycling quotas for packaging waste and to prevent packaging waste e.g. by developing packaging reuse systems (Bourguignon, 2016). It prescribes that "the amount of packaging per product must be limited to the minimum necessary to be safe, hygienic and acceptable to the consumer" (Van Acoleyen, 2018). The fact that waste exported outside the EU can be claimed as "recycled" led to a strong increase in waste exports to Asia and a lack of investments in infrastructure within the EU.

The 'Municipal Waste Compliance-Promotion Exercise 2014-2015' performed by the European Commission (2016b) identified problems with compliance with EU waste regulation on member state level. The main findings of the problem analysis include lacking policy implementation (e.g. long implementation timescales; lack of enforcement and unclear responsibilities), lacking application of the waste hierarchy (e.g. lacking waste prevention policies and funding for waste infrastructure not following the hierarchy), over-emphasis on residual waste treatment in some member states, and lacking integration of producer responsibility schemes. Accordingly, the main recommendations to improve national waste management are to update waste management plans (e.g. with more emphasis on future waste generation, strategies and targets), to ensure clear devolution of responsibilities down to the local level, to introduce programmes to support municipalities and educate householders, to reform funding mechanisms (e.g. by applying EPR or PAYT schemes), to increase waste prevention and re-use, and to improve data quality and transparency.

Marine litter in the EU Circular Economy Action Plan

Several EU Directives require the EU to review and update targets and other specifications in certain intervals. As an example, the Waste Framework required Commission actions by the end of 2014, the Landfill Directive the Packaging Directive required a review of targets by July 2014 and the end of 2012 respectively (Bourguignon, 2016). Urged by the EU Parliament, the EU Commission presented the 'EU Action Plan for a circular economy' in 2015 titled, "Closing the Loop" and with a target to reduce marine litter by 30%[29]. The plan, which proposed modernization of EU waste legislation represents another 'horizontal framework' in EU waste regulation besides the Waste Framework Directive (Bilitewski, et al., 2018). It includes general provisions on waste prevention and marine litter and several measures of significant importance to this work. The 54 actions contained in the plan have been delivered or are currently being implemented by at the time of creation of this document. The following topics are addressed by the action plan:

[28]Consolidated version from 04.07.2018: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:01994L0062-20180704

[29] Available at https://ec.europa.eu/transparency/regdoc/rep/1/2015/EN/1-2015-614-EN-F1-1.PDF

- **Revision of waste related directives in 2018**
  Several changes in EU waste legislation have entered into force in July 2018 as part of the revision of several EU Directives (European Commission, 2019). The revision of the Waste Framework Directive[30] introduces updated targets e.g. for recycling (65% of municipal waste by 2035), strengthened and extended separate collection obligations and minimum requirements for extended producer responsibility schemes. Generally acknowledging that "the fight against litter should be a shared effort between competent authorities, producers and consumers", the revised Directive suggests education and awareness raising measures among consumers to accompany the wider uptake of Extended Producer Responsibility (EPR). The objective to prevent waste is emphasized through the requirement for member states to draw up waste prevention plans. Member states are now required to include specific measures into their waste management and waste prevention plans to reduce marine litter to a level, which fulfils the goal of the MSFD (see 3.3.1) as a contribution to achieve EU commitments to the United Nations Sustainable Development Goals. The choice of measures is left to the member states (European Commission, 2018e).
  The revision of the Landfill Directive[31] includes among others a binding target to reduce landfilling to a maximum of 10% of municipal waste by 2035, which is seen as a step towards compliance with the waste hierarchy and plans for a resource efficient circular economy. One of its main aims is to avoid overcapacities in landfilling, which could thwart other initiatives aiming at resource efficiency in the long term. The revision of the Packaging Directive[32] introduces among others a common EU target for recycling 70% of packaging waste (55 % of plastic packaging) by 2030.
  The impact assessment for the proposal of the revision[33] finds a positive environmental impact of the proposed changes in waste legislation, including reduced marine litter inflows of as much as 7% by 2020 and 23% by 2030.
- **A European Strategy for Plastics in a Circular Economy 2018**
  In January 2018, the Commission adopted the "European Strategy for Plastics in a Circular Economy",[34] which recognizes that marine litter remains an issue and that plastic is a significant source of pollution (European Commission, 2018a). Because of low numbers in separate collection, recycling and contents of recycled materials, the strategy thus aims to transform the way plastics and plastic products are designed, produced, used and recycled. One of the key elements of the strategy is that all plastics packaging in the EU should be recyclable "in a cost-effective manner" by 2030 (Van Acoleyen, 2018). Investment and innovation in economics and quality of plastic recycling are envisioned.
  The strategy points the way to "step up waste collection, particularly near the coasts, and improve coordination between the authorities responsible for waste management, water and the marine environment" (European Commission, 2018a).

[30] Directive 2018/851, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.150.01.0109.01.ENG

[31] Directive 2018/850, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32018L0850

[32] Directive 2018/852, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32018L0852

[33] SWD(2014) 208, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014SC0208 and additional information in SWD(2015) 259, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1551875985650&uri=CELEX:52015SC0259

[34] Communication COM/2018/028 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN

- **Directive on the reduction of the impact of certain plastic products on the environment (SUP-Directive, 2019/904/EU)[35]**

  The SUP-Directive complements the measures envisaged in the EU Strategy for Plastics in a Circular Economy for the ten most frequently found items on European beaches and fishing related litter floating at sea. Its main objective is is the prevention and reduction of plastic marine litter from single-use plastic items and fishing gear containing plastic (European Commission, 2018e). The single-use plastic items covered by this directive and the envisaged measures are presented in Table 2. The SUP-Directive also complements the revised Waste Framework Directive, as it requires measures, which will result in a decrease in the generation of marine litter. Besides the prevention of marine litter, it further requires extended producer responsibility schemes for certain products, which should also cover clean-up of litter from the environment (European Commission, 2018e).

  The impact assessment[36] conducted for the directive found, that "the amount of marine litter is proportional to the amount of plastics produced, placed on the market and purchased, all things equal" and accordingly, the purchase of plastic items must be addressed in addition to the pathway through which plastic waste becomes marine litter. The proposed measures are estimated to reduce the amount of the addressed items that ends up as marine litter from 15,604 tons (312,070 tons end up as litter, but only around 5% are estimated to end up in the marine environment) by 35% to 4,850 tons. The expected reduction in number is calculated as 56% by count.

  Member states need to incorporate the measures specified in the Directive into national law by 2021.

Table 2: Covered items and proposed measures of the directive, according to European Commission (2018e)

	Consumption reduction	Market restriction	Product design requirement	Marking requirements	Extended producer responsibility	Separate collection objective	Awareness raising measures
Food containers	X				X		X
Cups for beverages	X				X		X
Cotton bud sticks		X					
Cutlery, plates, stirrers, straws		X					
Sticks for balloons		X					
Balloons				X	X		X
Packets & wrappers					X		X
Beverage containers, their caps & lids			X		X		X
Beverage bottles			X		X	X	X
Tobacco product filters					X		X
Wet wipes				X	X		X
Sanitary towels				X			X

[35] COM(2018) 340 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018PC0340

[36] SWD/2018/254 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2018:0254:FIN

Lightweight plastic carrier bags					X		X
Fishing gear					X		X

4 Factors contributing to leakage of plastics from land to sea

Reasons for the existence of leakage are manifold and where it occurs, awareness or knowledge is lacking, or the responsible actors undervalue the potential benefits from marine litter reduction. While chapter 5 will try to answer the question of how we can 'turn off the tap', this chapter will first look into how and why plastic waste from the sources described in chapter 2.3 end up in the North-East Atlantic. The collected 'factors contributing to leakage of plastic from land to sea' presented here include situations where marine litter is generated by the absence of, or inadequate waste management practices, as well as what one would call 'missed potential'. Accidental losses and deliberately dumped litter are addressed, because it should not be accepted that either is happening within an established waste management system. Because this raises the question of responsibilities, we want to emphasize once more, that for the purposes of this document the term "waste management" is used in a much broader sense. In this perspective, anyone who could potentially contribute to marine litter prevention but does not is 'missing potentials' and waste managers or producers are not to blame for unsustainable behaviour by others.

Dri et al. (2018) argue that the application of better treatment technologies is usually not done with the goal to reduce the amount of waste. They instead observe, that the countries with well performing waste treatment systems are those with the highest municipal waste generation in Europe. While the applied treatment of waste is not the main reason for this phenomenon, it may certainly play a role in case the population is under the impression, that the produced waste is treated in the best available way. Specifically addressing the whole life cycles of plastics in the first place, including the production and usage of plastics, prone to become marine litter is thus of special importance when suggesting changes in waste management to reduce marine litter inputs and the overall environmental burden arising from consumption in the EU. Why waste leaks from established waste management systems is the key question in this document, however, the question why the waste is generated needs to be asked first. This is achieved by considering the first two factors described below (F1,F2), which also represent the fulfilment of the requirements of the waste hierarchy. Proposing solutions, or even naming problems, without keeping this hierarchy in mind can be dangerous and cannot necessarily be called 'source reduction'. The argument that the waste generation is not a problem *per se* and could be dealt with is unrealistic and only valid in an ideal world, where all other identified factors contributing to leakage of plastic waste from established collection and treatment systems do not exist. To illustrate, the lack of measures to reduce the production quantities of plastic packaging products (PPP) is the first item in the list of loopholes in the flow of PPP, which are considered most relevant for the problem of marine litter in the European Seas by BiPRO (2013).

This document will address waste that leaks during or after it is collected (e.g. F7, F9, F10, F11, F17) and waste that is currently uncollected (e.g. F3, F4, F6, F16). In this context, the leakage of collected waste is of prime importance, especially worldwide where 25% of all generated marine litter results from leakage of previously collected waste. The impact of collecting the 75% of marine litter, which is currently uncollected will be higher if the leakage of collected waste is lowered first (Ocean Conservancy, 2015). Nonetheless, the order in which the factors are presented does not indicate a valuation of their importance. It should rather be seen as following the product (or waste) life cycle from generation to collection and ultimately to treatments. An overview list of these factors is presented in table 3 and detail provided in the following paragraphs.

Table 3: Overview of the 17 factors contributing to the leakage of plastics

Factor	
F1	Production and use of (single-use) plastics
F2	Unsatisfactory separate collection and recycling rates
F3	Littering
F4	Waste crime and illegal dumping
F5	Marine litter is not addressed in waste management plans
F6	Insufficient waste management activities or infrastructure
F7	Specific waste management practices posing a risk
F8	Insufficient or ineffective financing of waste management
F9	Inadequate operation of active landfills
F10	Historic landfills
F11	Emissions from sorting and recycling processes or products
F12	Unsatisfactory management of plastic waste from agriculture and other environmentally open applications
F13	Unsatisfactory management of waste from tourism and other coastal activities and industries
F14	Unsatisfactory management of construction & demolition waste
F15	Plastic waste inputs from heavy weather events
F16	Insufficient cleaning of open areas
F17	Export of plastic waste to countries, where a safe recovery or disposal is not guaranteed

F1: Production and use of (single-use) plastics

All leakage of single-use plastics and plastic items in general is avoided if their production and usage is avoided. The production and application of unsustainable amounts of single-use plastic products is one of the key issues that needs to be addressed to avoid leakage of plastics from land to sea. Single-Use plastics are low-valued products that are thrown away after being used only once and include e.g. packaging, bags, disposable cups, lids, straws and cutlery. They have in common, that they are rarely recycled and prone to be littered (European Commission, 2018b). Besides littering (see F3), they are also prone to being dumped illegally (see F4) and losses before, during and after collection due to the field of their application (often to-go products) and their composition (their low weight is the reason that they are prone to be blown out of systems by winds). Waste from single-use plastic products also represents an enormous problem due its sheer volume, which over-strains waste management systems. Financing collection and treatment infrastructure and practices for the enormous amounts of generated plastic waste in a fair manner and respecting the polluter-pays-principle is a challenge (see F8).

Problems arising from the production and usage of Single-Use plastics are addressed in several other actions of the OSPAR RAP ML[37]. However, there is a need to consider them also here and emphasize that the basic problem lies in our prevailing production and consumption patterns. Despite the alarming findings of the negative environmental and socioeconomic impacts of plastic, the excessive marketing of plastic products has not been reduced but is instead still increasing dramatically worldwide. The production and usage of a certain share of applications of single-use plastics is driven by market restrictions or legal requirements (e.g. medical equipment), another significant share is put on the market to decrease food and other waste by keeping food or other products fresh or clean for longer periods of time. Yet another share is only applied for the sake of advertisement/branding/convenience. The latter is made possible by the fact that the level of the packaging fees does not represent a significant cost compared to the price of the product that is packaged. At the same time sophisticated packaging can represent an important sales argument (European Commission, 2018a). A large amount of single-use plastic packaging waste is also generated from secondary packaging, e.g. for transport.

UNEP (2018) found that 36% of plastic production is used in packaging. Geyer et al. (2017) estimate that 42% of all non-fibre plastics worldwide in 2015 have been used for packaging and that 54% of all plastic waste was packaging material. Worldwide, especially single-use plastic products make up a large share of the plastics produced and an even bigger share of marine plastic debris. A survey of the top 11 UK supermarkets conducted by EIA&Greenpeace (2018) discovered that 10 supermarkets are placing over 810,000 tons of single-use plastics on the market every year (not including plastic bags), 7 supermarkets account for 59 billion single-use plastic items per year and retailers are generally more focused on plastic recycling than plastic waste reduction. 350,000 tons of waste (105,000 tons of this plastic waste) were generated from single-use to-go products in 2017 in Germany alone, which represents a 44% increase since 1994 (NABU, 2018). These two studies can be seen as representative for OSPAR Contracting Parties for single-use plastic packaging and single-use to-go products respectively.

While households and the "throw-away culture"[38] are responsible for a fair share of the plastic packaging waste currently generated (47% of all packaging waste in Germany), commercial and industrial packaging represents an equally big share of all packaging waste (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2018). While plastic packaging products, which in households (or comparable places, end consumers) most likely turn into waste are e.g. in Germany covered by a new packaging law, commercial and industrial packaging mainly utilized during transportation of products is not. Multiple legal requirements regarding (plastic) packaging, including the Extended Producer Responsibility scheme (see F8 and FoA13) thus do not apply to this significant fraction of packaging which is therefore not included in the overall recycling percentages for plastics claimed.

Hartley et al. (2018) find that the "extensive use of plastic in products & packaging" is perceived as the most important factor contributing to marine litter amongst the 1127 participants of the conducted study and the single-use nature of products & packaging ranks third. Similarly, 98.5% of the more than 1800 respondents to the public consultation regarding the Single-Use Directive proposal,

[37] Action 43: "relevant instruments and incentives to reduce the use of single-use and other items"
Action 44: "Reduce the consumption of single use plastic bags and their presence in the marine environment"

[38] Reasons for the increasing amounts of packaging waste in the "throw-away-culture" include online shopping, to-go food and drinks and smaller household sizes.

considered that action to tackle SUP marine litter is “necessary”, and 95% even considered it “necessary and urgent”, while only 2% responded that there should be no new measures taken at EU level (European Commission, 2018e).

The connection between the production and usage of the products and marine litter (through the factors contributing to leakage described in this document) is not equally intuitive for all applications. While to-go-plastics are much more likely to be littered, packaging for food bought at food retailing is usually collected through municipal waste collection. The SUP Directive is thus primarily addressing the items most frequently found on European beaches. The Plastic Strategy as a whole aims to decouple plastic waste production from economic growth. Van Acoleyen (2018) highlights, that this can only be achieved if plastic production is decoupled from economic growth at the same time.

F2: Unsatisfactory separate collection and recycling rates

Too low rates, or in some parts of the world even a total lack of separate collection and recycling of plastics is a frequently mentioned factor contributing to leakage of plastic from land to sea. The topics of resource efficiency in a circular economy and marine litter are highly interconnected in national, EU and worldwide policies and strategies. While the argumentation for similar approaches to reduce marine litter is often fragmented or even completely lacking, this section will elaborate how and why the insufficiencies of lack of separate collection and resulting low recycling rates can contribute to marine litter generation.

While generally acknowledging, that recycling can contribute to a solution for the most urgent problems in plastic waste management causing the leakage of plastics from land to sea, it must be emphasized once again that this is only true for waste that cannot be avoided and reduced (see F1). Geyer et al. (2017) argue, that recycling does not avoid but only delay final disposal and plastic waste generation is only reduced if primary plastic production is displaced. Despite this fact plastic waste can also leak from recycling processes (see F11). However, for unavoidable plastic waste, recycling is the preferential treatment, not only according to the waste hierarchy, but also from the perspective of marine litter. This is the case where recycling of plastics replaces treatment and disposal practices, which cause a higher risk for marine litter generation (such as landfilling) but also due to the fact that recycling of plastics could partly finance waste management (see F8) and can increase the perceived value of plastic products with positive implications for littering behaviour. Currently, significant amounts of waste are still collected for landfilling and/or incineration an therefore the quality of collecting systems and sorting is often rather low and basic.

Deloitte (2017) found that end-of-life treatment of plastics is underperforming, partly due to increasing complexity of products design, for which recycling is too often not a priority. The diversity of polymers and added substances (additives) are constraints to their recyclability (Velis, et al., 2017). Improvements in plastic recycling are among others further hindered by insufficient quality and volumes of separate collection, and currently less than 30% of plastic waste is collected for recycling in the EU and only 6% of plastics demand in Europe is covered by recycled plastics (European Commission, 2018b) (see 2.1). The separate collection of different plastics is a crucial factor affecting the technical economic recyclability of plastic products. However, incentives to re-

turn recyclable material streams separately are in many cases too low[39] or hurdles to do so are too high[40]. Van Acoleyen (2018) identifies the clause "in a cost-effective manner" as the most innovative aspect of the EU plastic strategy (see 3.3.3) and interprets this as a shift from required 'technical recyclability' to 'economic recyclability'. While recycling is theoretically possible for most materials[41], Van Acoleyen (2018) states that “after all, plastic is very difficult to recycle”, which results in the problem that the quality for food grade applications is usually not achieved. Because of the rather low quality of recycled materials, recycled (or rather down cycled) materials are currently mostly used in agricultural application where they reached nearly 35% content, and construction with 21.5%, both in Germany (Conversio, 2018). The often low quality of recycled material can be linked to a linear way of collecting (commingling waste-streams) and sorting, the use of cheap multi-material solutions and a lack of enforcement. Good examples exist (e.g. with rPET and rPP) in high quality applications with food grade recyclates of up to 100 percent, which can be recycled several times without major losses of mechanical properties.

Due to contamination of collected plastics with food scraps or other non-desired materials, complex sorting and cleaning is necessary with adverse effects for the economics of recycling. Besides the material, the quality (e.g. cleanliness, purity) and the quantity (also steadiness) of the input and output materials of recycling operations, the financial attractiveness of recycling further depends on the crude oil price. It is one of the drivers of the demand for recycled materials competing with virgin plastic material. Hogg et al. (2018) identify the lack of full internalisation of costs, relatively high search or transaction costs, imperfect information and inappropriate standards as market failures with impacts on demand for recycled material in the UK. Groot et al. (2014) thus indicate, that improving separate collection for recycling can increase costs for waste management and fair financing mechanisms are required (see F8 and FoA13). In general there is a lack of market uptake for recyclates which can be addressed by making a certain recycling content in plastics mandatory, e.g. as part of extended producer responsibility systems for brand owners or retailer.

Velis (2014) points out, that recycling is often conducted close to production, and a shift towards Asia in plastics production has been observed, which can potentially pose a risk for marine litter generation (see F17). Currently the capacity to recycle plastic waste in Europe is too low to meet recycling targets, but Messenger (2018) citing FEAD, the federation representing the European private waste and resource management, states that the industry is prepared for the necessary €10 billion investments in waste collection, sorting and recycling to meet EU targets if only legislative measures ensure the uptake of recycled material. Deloitte (2017) calculate, that ”achieving a 55% recycling target in 2025 means that more than 10 Mt of recycled material need to be absorbed by the end-markets”. Until the share of plastic waste, which is recycled has grown significantly, increasing plastic waste amounts are (over-)straining household waste collection, treatment and disposal systems and potentially contribute to leakage of plastic litter from land to sea.

[39] An example for financial incentives to return recyclables are deposit-refund schemes. Currently there are multiple countries with no systems implemented and even where systems are running, slippage occurs and only few product groups are targeted.

[40] This is e.g. the case where separate household collection is not offered, citizens are not sufficiently trained for potentially complicated separate collection requirements or where products are designed in a way that makes separation of plastics complicated or even impossible.

[41] An example for a plastic application, which can usually not be recycled in a cost-effective manner, are foamed plastics, like foamed polystyrenes and foamed polyurethanes. 95% of their volume is usually air making it costly to collect and transport relevant amounts (UNEP, 2018).

Separate collection and recycling are especially lacking for 'on the go' waste. According to a survey conducted in 100 local authorities in the UK by RECOUP (2017), 'on the go' collection and recycling infrastructure are currently inadequate. One reason for this is that collection units have been removed because of high maintenance costs and high levels of contamination. One factor contributing to the latter is "inadequate budget for consumer communications and education". Currently, separate collection of 'on the go' wastes is not considered cost-effective and municipalities in the UK rather spend their limited budgets "on increasing quantities and reducing contamination in kerbside collections".

Currently both efficiency of separate collection systems and capacities of plastic recycling facilities are too low to meet the targets laid out in the EU Strategy for Plastics in a Circular Economy (see 3.3.3). To use plastics in a resource efficient and environmentally sound manner, significant improvements in both fields are urgently needed. The presented findings regarding the current insufficiencies justify the argument for better separate collection and higher recycling rates also from a marine litter prevention viewpoint.

F3: Littering

'Littering' describes the behavior of individuals who are intentionally or unintentionally discarding items in unacceptable places where these items then represent 'litter'. Additional to the alarming consequences of marine litter, litter on land causes additional environmental, but also social (economic and human health) as well as aesthetic problems. Littering behavior accordingly has a long history of prevention campaigns and research, yet uncertainties in highly relevant questions still exist (Schultz, et al., 2011). The most important questions when designing measures to prevent littering are 'who litters', 'where do people litter' and 'why do people litter'. While littering is certainly one of the main sources for litter in the environment and ultimately marine litter, it is not the only one and the existing various other sources for are addressed in the following sections.

In a large-scale study in the United States, Schultz et al. (2011) discovered that 17% of all observed disposals in a public place were improper and 81% of these littering instances occurred with intent. Of the observed littering cases, 85% are explained by 'personal qualities' and only 15% result from 'contextual variables'. The role of personal qualities is addressed in several studies, which have shown, that littering behavior is usually affected by gender (males usually litter more than females) and age (negative relationship between littering and age). The relevant contextual variables include presence, characteristics, and placement of receptacles (Schultz, et al., 2011). Several studies state that presence and number of trash receptacles have a significant impact on littering, and that littering is most commonly observed at considerable distances from a receptacle (e.g. Vernon et al. (2013), NACS and KAB (2017)). Another explanation of littering behaviour is litter already present in a location. This mechanism is explained by the popular but controversial "Broken Window Theory" introduced by Wilson et al. (1982), which describes that disorder leads to more disorder and litter is one type of this disorder. Vernon et al. (2013) find that "unnecessary" packaging, shopping bags, advertising flyers, etc. motivate people to litter and that the design of packaging influences the chances of it being littered. Another problem is, that some items or materials (e.g. cigarette butts are often perceived as paper but are actually plastics) are not perceived as litter.

While littering is, independently of the location, problematic and a potential source of marine litter even if it occurs inland, some areas are prone for littering and some are of special relevance for marine litter. Results of a survey on convenience store owners experience with littering conducted by NACS and KAB (2017) are presented in (see Figure 8) and indicate, that the sheer presence of

receptacles is not sufficient and individual behaviour, receptacle design and maintenance are relevant aspects. 'Involuntary littering' may occur due to inadequate waste infrastructure maintenance (e.g. broken or not frequently emptied receptacles). Litter hotspots are usually also roads where the most littered items (besides illegally dumped wastes, see F4) are usually tobacco, food and beverage to go products (Schultz, et al., 2011).

The special relevance for marine litter applies on coasts and in all places, from where winds, rivers or biota can transport plastics to the sea (see 2.3). Generally, the closer to the sea, the more important is litter prevention for marine litter generation and in this context, it is especially coastal populations and tourists who generate highly problematic litter (see 2.3). A sampling campaign of Mediterranean tourist beaches under the Interreg Blue Islands Project discovered that the litter on the sampled beaches the average accumulation rate more than doubled (+117.2%) from 0.1145 items/m^2/day during low season to 0.2486 items/m^2/day during the high season and that share of plastic litter also increased with increasing tourist numbers (Grelaud, 2018). This clearly indicates, that a large share of beach litter originates from littering by tourists.

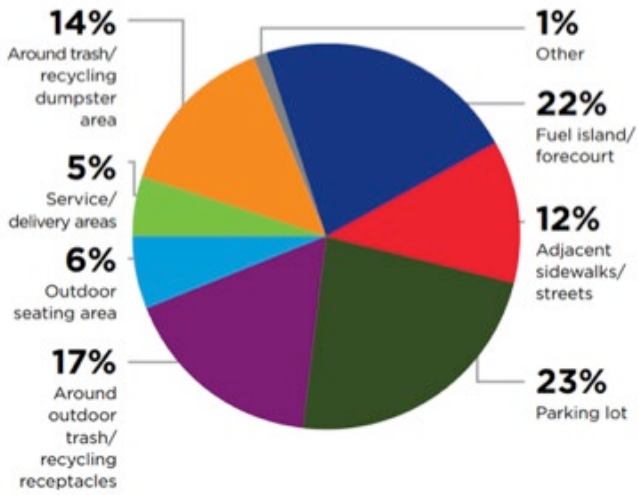

Figure8: Most common littering areas
Source (NACS and KAB, 2017)

It is not widely known how much litter is generated in total and even less is known about how much plastics ends up in the environment (and eventually the oceans) due to littering. The Corporate Europe Observatory (2018) argue, that "it is a calculated decision by the plastics lobby to put the problem of litter at the heart of the waste debate" in order to shift the responsibility for marine litter entirely to consumers (or rather litterers), and herewith play down the responsibility of producers and distributors for litter in the world's oceans. It was observed that "littering is a shared responsibility for producers, distributors and consumers along the life cycle phases of a product"(Van Acoleyen, et al., 2014). In any case, waste management needs to provide adequate infrastructure and services and raise awareness for the former. Where no infrastructure is provided, and enforcement of littering regulation is lacking, preventable plastic litter can enter the seas.

F4: Waste crime and illegal dumping

According to Baird et al. (2014), waste crime is a type of pollution crime and represents a large share of all environmental crime in parts of Germany or in Scotland. It is described as not complying with national and international regulations regarding shipments, treatment or disposal of wastes and has received special attention mostly in the context of hazardous waste and e-waste shipments and disposal. Crimes can take place during the entire waste chain and include tax fraud, money laundering, falsification of documents, false classifications of waste and bypassing other environmental regulation for profit (Rucevska, et al., 2015).

The form of waste crime most relevant in the context of land-based inputs of marine plastic litter is illegal dumping, also called fly-tipping. This criminal act refers to the illegal deposit of waste outside of an existing system or designated areas and differs from littering (see F3) in that it "invariably involves the removal of waste from premises where it was produced with the deliberate aim of disposing of it unlawfully, or as a result of legitimate outlets not being available" (NFTPG, 2014). Because it is usually a "victimless" or "unknown crime", most cases remain unreported and the true extent of the problem of waste crime and illegal dumping specifically is largely unknown (Baird, et al., 2014). The issue has received increasing attention in England, where statistics are published regularly by the Department for Environment, Food & Rural Affairs (DEFRA). According to the most recent publication by DEFRA (2018), local authorities had to deal with just under 1 million cases of fly-tipping in the one-year assessment period of 2017/18, resulting in costs for clearance to local authorities of £12.2 million. Both values do not include those cases, where private landowners cleared illegally dumped waste[42]. Much higher values with costs for the public sector of over £36 million and to private landowners of £50-150 million or more a year are reported by NFTPG (2014). These costs include clean up and disposal costs but exclude costs of administering fly-tipping reporting and response services and the costs of impacts on local amenity and the environment. The most common place for fly-tipping to occur is on highways (47% of all cases in 2017/18), but large numbers are also reported from council land, forests, footpaths, back alleyways and others. In most incidents, household waste was dumped, and the dumped amounts were equivalent to a "small van load" on a scale from 'Single Black Bag' to 'Significant/ Multi Loads' (DEFRA, 2018).

It must be expected, that cases of illegal dumping of wastes occur in all countries in the region of interest and significant amounts of plastic leak into the environment this way. Velis et al. (2017), found that illegal dumping is not a phenomenon of less developed countries but is also widely reported from developed economies. They argue, that "whilst litter is a more critical issue in terms of sources of marine litter in high and middle-income countries, uncontrolled dumping still takes place." The only available estimate of 1.6% of all inputs of marine litter from illegal dumping incidents is published by UN Environment (2017) citing the Scottish Government.

A lot of effort has been put in to unveil the motivation behind illegal dumping and other illegal waste handling. NFTPG (2014) identify financial gain or financial saving as a principal reason but add potential lack of waste disposal facilities or access to them and laziness of people committing the crimes. Webb et al. (2006) argue that fly-tipping occurs where "perceived benefits exceed perceived costs". This may for example be the case where landfill taxes (or Pay-As-You-Throw fees) are collected or prices for waste, which is usually sold are too low. Other reasons are ignorance and

[42] Illegally dumped waste on private land has to be cleared by land owners in the UK, which costs money and may lead to litter not getting cleaned up (NFTPG, 2014)

limited (kerbside) collection or disposal services. Rucevska et al. (2015) identify profits made from payments collected as fees for safe disposal of waste as the key driver for illegal exports (see F17).

Fly-tipping is widespread but it is not one single problem, but rather a crime committed by different perpetrators in different circumstances and places and with all sorts of wastes (also including waste from agricultural and construction& demolition activities). Accordingly the reasons why cases are currently not prevented and illegal dumping is still on-going are diverse (Webb, et al., 2006). Summarizing multiple studies, Baird et al. (2014) list among other factors that make waste crime possible, weak enforcement (see FoA16), increased costs of legal operations (e.g. through regulations) and the complexity of illegal businesses. Rucevska et al. (2015) add inadequate resources for monitoring and enforcement as well as low penalties. Bertling et al. (2018) note that catalogues of fines exist but are barely used and that there is too little criminal prosecution.

F5: Marine litter is not addressed in waste management plans

Waste management planning is seen as the "cornerstone of any national, regional or local policy on waste management" (European Commission, 2018f) and the role of waste management plans is of special importance because it "allows taking stock of the existing situation, defining the objectives that need to be met, formulating appropriate strategies, and identifying the necessary implementation means" (European Commission, 2018f). Waste management plans represent a chance for marine litter prevention, because they require fulfillment of the waste hierarchy, the application of the polluter-pays-principle, the assessment of waste streams and performance of installations and now also specific measures to prevent marine litter. They play a central role in the allocation of resources and creation of capacities as well as in the prioritization of waste streams and waste management practices and raise currently lacking awareness for the need for horizontal integration to combat land-based inputs of marine litter.

Waste management plans, which are required by the European Waste Framework Directive, usually do not have a normative character but still represent an important tool in waste management planning in European Union member states. Ten Brink et al. (2018) find that marine litter commitments lacked integration with other objectives of environmental policy, including resource efficiency and waste management, until the the last revision of the Directive. Since the revision, new requirements for waste management plans apply and they can be seen as a great opportunity to halt the leakage of plastic litter from land to sea. The revised Article 28 requires the plans to conform amongst other aspects from other directives (Packaging Directive, Landfill Directive and Water Framework Directive) with Article 13 of the Marine Strategy Framework Directive (see 3.3.1). After transposition of the 2018 revision and during the process of creating a waste management plan, which conforms to the new requirements, the responsible bodies will need to identify cost-effective measures in waste management to stop land-based plastic litter inputs into European Seas.

Efforts to create the required links in legislation have been made in several countries, e.g. in the National Waste Management Plan in Iceland that focuses on reducing the amount of plastic waste, which is linked to the impacts on marine ecosystems; the French National Program for Waste Prevention; and Sweden's Waste Plan, which addresses litter in general and marine litter specifically and requires Swedish municipalities to include goals and measures to prevent littering in their waste management plans, while emphasizing that plastic that may cause marine littering shall be prioritized. Those waste management plans that do not yet specifically address marine litter represent missed potential for actions in waste management to eliminate leakage of plastic waste from land to sea.

F6: Insufficient waste management activities or infrastructure

Providing access for the entire population to some sort of waste collection is of significant importance when trying to avoid marine litter generation. Gaps in collection services can result in illegal activities like backyard burning or illegal dumping with resulting risks for environmental pollution (air, soil and water). While only one country in the OSPAR regions showed considerable gaps in the share of total population served by municipal waste collection in the past[43], a collection coverage of (or near to) 100% is now reported from all OSPAR Contracting Parties. Uncollected waste, which represents a large part of marine litter generation worldwide, is thus not the key problem in the area of interest. Still, especially less densely populated regions are rather expensive to serve with collection services. In competitive markets without a legal obligation (regulatory provision) for the coverage of the entire population, this can prevent operators from expanding routes in remote or rural areas (RPS Group, 2018). Even if collection services exist, pick up frequencies and/or separate collection systems may be substandard due to increased costs.

Marine litter can also be generated if waste management systems' capacities are not prepared for seasonally fluctuating waste occurrence. The biggest differences between normal and peak waste generation is observed in tourist regions with low population density. The problem that tourists and the tourism industry generate high amounts of waste in sensitive areas is aggravated by lack of awareness of local specifications of waste management systems of some tourist groups (Muñoz, et al., 2015). Tourism and accordingly also seasonally fluctuating occurrence of waste is often concentrated in areas of high nature value and especially coastal zones, which are sensitive to littering in general and marine litter generation specifically (Styles, et al., 2013).

Limited capacities for treatment of the seasonally or generally increased amounts of waste can be problematic, especially if treatment systems do not rely on nationwide or Europe-wide shipments. In countries where this is not the case, storage and transport capacities may get overstrained. Peak seasons and accordingly fluctuating waste occurrence are not only potential problems for collection systems, but also for waste collection infrastructure (bins) in public places. Insufficient numbers for high visitor numbers, unsuitable devices (e.g. too small or without cover, biota and wind) inappropriate positioning (e.g. in the wrong places or not marked on maps) or lacking maintenance (e.g. emptying and cleaning) can increase littering in public places (Bildberg, et al., 2017).

F7: Specific waste management practices posing a risk

Renaud et al. (2018) find that untidy collection and transfer points or uncovered vehicles contribute to potential plastic leakage into waterways and the ocean. Velis et al. (2017) argue, that plastic waste can leak from established and well-organised systems before and during collection, transport

[43] According to https://unstats.un.org/unsd/environment/municipalwaste.htm only 76% of the Irish population served by a collection system in 2005. A public consultation recently carried out for the Irish Competition and Consumer Protection Commission CCPC concluded from available data that around 20% of the managed household waste remained uncollected in 2011 (RPS Group, 2018). A part of these 276,665 tons ended up in collection systems e.g. through bring facilities though. Major improvements have been achieved recently and The Irish EPA http://www.epa.ie/nationalwastestatistics/municipal/ reports that 44,868 tons of municipal waste remained unmanaged and uncollected in 2016, which represents less than 2% of the collected and managed municipal waste.

and storage[44] including in high income countries. While multiple cases of spillages from garbage collection trucks raised public attention e.g. in the United States, barely any information about losses during waste collection is available. The Florida Center for Solid and Hazardous Waste Management (2003) conducted a visual survey of spillage of waste during pick-up from commercial dumpsters and on the road between pick-ups and found that spillage occurred in both cases. Proposed reasons are overfilled or uncovered dumpsters, not bagged garbage (most spills were small pieces of plastic or paper) and truck drivers not getting out of the vehicle to clean up litter. The reasons why people working in waste collection/treatment let waste slip are according to Vernon et al. (2013) comparable to the motivation for littering e.g. by tourists (see F3). A further problem may be time pressure where people are only employed to collect garbage and not to pick up litter.

Figure 8: Plastics leaking from overfilled bins

A risk of leakage even before pick-up may occur e.g. when waste is put out on the streets for kerbside collection. While animals tearing up the bagged waste can cause dispersal, wheelie bins can get blown over by (heavy) winds. Especially dispersal by animals is frequently reported around Europe. If public waste bins are not covered or no tear-resistant waste bags are used, animals and especially (scavenging) birds can spread waste over a great distance and especially near the coasts also to places where it is prone to become marine litter. In coastal towns or regions, seagulls are commonly found scavenging and problems are reported e.g. by Van Acoleyen et al. (2014) and Vernon et al. (2013). Still the issue of seagull disturbance was only described as a minor loophole during the Pilot Project 4 Seas regional stakeholder workshop in Belgium (ARCADIS, 2012). While wheelie bins are usually considered safer than sacks, they may fall over, or waste can leak if they are overfilled and the lids do not close anymore (See Figure 9). This can cause dispersal of plastic

[44] Leakage from treatment operations (e.g. recycling) and disposal (e.g. in landfills) are addressed in F9, F10 and F11

waste, especially when the waste is not bagged. Waste collection systems using wheelie bins are usually rather complex and more expensive compared to sacks but considered much more effective and safer with respect to (marine) litter. However, to prevent spill-overs of wheelie bins public services need to adapt the frequency of collection to the needs of waste accumulation.

Plastic waste may further leak from collection systems during transfer actions, if it is not constantly kept in closed or covered containers. Once waste has been collected and transported to transfer or storage stations, plastic can leak of waste is not kept sheltered from wind, rain and animals (Bilitewski, et al., 2018). If premises are not fenced properly, litter can get dispersed by winds.

F8: Insufficient or ineffective financing of waste management

The management of municipal wastes usually lies under the responsibility of the municipalities (see 3.2) and the required services are provided either 'in-house' by the municipality itself or are contracted to private service suppliers. In any case, significant costs arise, which must be covered. Waste management is "indispensable" (Bilitewski, et al., 2018), but generally expensive and accounts for about 4% of municipal budgets in high-income countries[45] (Kaza, et al., 2018). It is thus highly important to secure sufficient funding to offer adequate infrastructure and services (see F6) and to utilize the impact that sourcing and spending of the money can have. Insufficient funding for waste management activities and infrastructure can result in plastic leaking from land to sea. Financial pressure in the costly recycling sector (see F2) is one of the main reasons for the export of enormous amounts of plastic waste to those parts of the world, where treatment (landfilling or incineration) is offered at lower costs (see F17).

Costs are generated by the necessary staff, the collection fleet and bins and treatment and disposal (Dri, et al., 2018). Usually, collection and transport operations account for 60-80% of the total costs and cost savings can be achieved by improvements in organization and implementation. Still, financing is needed for the services and also for any further development. Any improvements in the form of advanced technologies are always associated with additional costs (Bilitewski, et al., 2018). High costs are particularly linked to end-of-life treatment of plastics due to the specificities of the material and applications like low weight and high volumes. The relatively low value of recycled plastics in relation to the described costs generated by their collection represents one of the significant obstacles to overcome when trying to increase plastic recycling rates (Deloitte, 2017). Groot et al. (2014) analyze the costs of separate collection of post-consumer plastic packaging waste (see F2) in a 'municipal waste collection cost model' and for this purpose consider vehicle cost, fixed vehicle costs, labor cost, container and bag cost and emission costs (using a CO_2-tax). Findings indicate, that in source separation systems, costs are on average twice as high than in post-separation systems and especially curbside collection is very expansive compared to drop-off separate collection. Hogg (2002) similarly finds that bring schemes are usually cheaper than kerbside collection of recyclables.

At the same time, these more expensive practices are desirable from the perspective of marine litter prevention and investing in more recycling creates green jobs. Saikkonen (2018) estimate, that to improve waste management in one public area on the coast and one non-coastal area in Finland to prevent marine litter would require a budget increase of €300,000 and €585,000 per year respec-

[45] The share of the municipal budget, which is spent on waste management is usually higher in middle-income (10%) and low-income countries (up to 20%) where it may represent the single highest budget item (Kaza, et al., 2018).

tively. Willis et al. (2018) study marine litter reduction campaigns in Australian coastal municipalities and find that investments in waste management and the provision of a budget dedicated for waste management on the coasts contribute to less litter on the coastline and that "the proportion of total budget spent on waste management in a council will have a greater effect on reducing coastal pollution than having a council budget specifically for coastal waste". Applying at least 8% of the municipal budget towards waste management and investments in waste facilities and outreach programs contributes to marine litter prevention, according to the authors.

Dri et al. (2018) highlight the "influence of the economic performance on the environmental performance" and find that smaller companies may be limited in their investments in new technologies or capacities. In a report about competition in waste management systems in Nordic countries[46] prepared by Nordic Competition Authorities (2016), the authors find that waste management systems are currently often designed inefficiently, partly due to lacking competition in the sector, which could create innovation and efficiency. According to the study, this is especially true for the case of environmental targets, which could be reached more efficiently if legislation and regulation allowed more competition "to maximise value, limit costs and encourage innovation".

In the context of (marine) litter prevention looking only at how and on what money is spent is not sufficient because how and from whom the money is collected is also of significant importance. "Municipal waste charges are a key tool in order to minimise the undesired effects of waste disposal and to guarantee sufficient and stable economic resources for the provision of adequate waste collection and treatment services at the local level" according to Puig-Ventosa et al. (2017). Positive incentives for waste reduction, negative incentives for waste generation, effective separate collection and recycling can be provided through different financing mechanisms both on the producer (e.g. incentives for recyclability) and consumer side (e.g. incentives for waste reduction through PAYT schemes). Potentials in this field are currently not exploited. Puig-Ventosa et al. (2017) who analyse municipal waste charges in 125 Spanish municipalities in the year 2015 find, that "flat fees are frequent" and funding is generally "far from applying the polluter pays principle" and "ineffective for promoting the proper application of the so-called 'waste hierarchy'".

Bilitewski et al. (2018) interpret the PPP in a way that cost-covering fees for the entire waste service should be charged to each individual user. The Waste Framework Directive also states, that "the costs of waste management, including for the necessary infrastructure and its operation, shall be borne by the original waste producer or by the current or previous waste holders" but gives the member states the chance to decide "that the costs of waste management are to be borne partly or wholly by the producer of the product from which the waste came and that the distributors of such product may share these costs". Minimum requirements for these extended producer responsibility (EPR) schemes are described in Article 8 of the Directive. Established EPR schemes in some countries are receiving criticism, e.g. in the UK where fulfilment of obligations for producers is "relatively cheap"[47] and local authorities, barely benefit from the existence of the scheme. EPR schemes, which are only implemented to cover collection and treatment costs are e.g. criticized by (Van Acoleyen, et al., 2014) who describe EPR schemes in which that producers should also be responsi-

[46] Denmark, Faroe Islands, Finland, Greenland, Iceland, Norway and Sweden

[47] Plastic Packaging Shedding Light on the UK Data – EUNOMIA report
The existing producer responsibility scheme for packaging has a number of supporters. The principal reason for this is that, for the companies who are obligated under the scheme, it offers a relatively cheap form of compliance compared with the approach adopted in other EU Member States

ble to contribute to waste prevention policies and highlight, that anti-littering campaigns are funded by producers in several countries. Recently, the option to cover costs for cleaning of litter from the environment by EPR has been raised in the discussion in the EU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2018), also closely linked with the new provisions arising from the SUP Directive (see 3.3.3).

F9: Inadequate operation of active landfills

While mismanagement of waste deposited on land is globally seen as one of the many contributors to ocean plastics[48], none of the 50 most polluting dumpsites[49] are located in the area of interest. Landfilling any combustible waste is banned in the Netherlands, Sweden and Denmark, landfilling of any untreated and high caloric waste is banned in Belgium and Germany (Dri, et al., 2018). Bildberg et al. (2017) find that poorly managed landfills are a thing of the past in the Nordic countries, but significant risk of litter spreading remains a challenge even for well managed landfills, especially if they are located near rivers or the sea. Although the share of plastic waste in landfills has decreased significantly in many countries including the EU and national legislation is in place, landfills containing plastic waste are considered a potential source of leakage to the ocean in several OSPAR Contracting Parties according to the conducted questionnaire. Plastics can be blown by wind, swept away during heavy rains or carried away by biota, especially birds. Lack of wind-protection, regular coverage and precautionary measures for safe transportation and intermediate storage represent a risk for marine litter generation.

The Landfill Directive (see 3.3.2) sets out operational and technical requirements to landfills in Europe. It requires the assessment of location specific risks of flooding and distance to water bodies in the permit process and that nuisance from wind-blown materials is minimized. These two points are believed to reduce potential dispersal of plastic packaging waste to the marine environment. Regularly, cases of non-compliance with the directive (usually the existence of illegal landfills in member states) are brought as cases to the EU Court of Justice. In the UK, the Environment Agency (2009) criticized the European Commission for the absence of a best available techniques reference document (BREF) for landfills. This is still the case today. Technical standards are therefore only specified by the Landfill Directive itself or by the IPPC Directive[50]. While guideline documents addressing risks of fugitive emissions from landfills (which include wind-blown litter potentially contributing to marine litter) are published in some countries, this is not the case in all OSPAR Contracting Parties.

Summarizing the thoughts above, a factor contributing to leakage of plastics is the fact that still too much plastic waste is placed in landfills, and where management is not sufficient to eliminate wind-blown or animal caused leakage. Reasons for this can lie in national legislation not requiring high enough security standards but are more likely to be found in lacking enforcement and monitoring and control of landfill operators. Another point is that existing knowledge and proven best practices are neither existing nor shared widely enough within and between countries.

[48] Ocean Conservancy (2015) finds that waste deposited at such sites in the five countries focused in the study (China, Indonesia, the Philippines, Thailand, and Vietnam) each year adds between 1.1 million and 1.3 million metric tons of plastic to the oceans.

[49] A map is available at: http://www.atlas.d-waste.com/Documents/Waste-Atlas-report-2014-webEdition.pdf

[50] Directive 2008/1/EC concerning integrated pollution prevention and control, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0001

F10: Historic landfills

Landfills, which are no longer operating still fall under the scope of the Landfill Directive and require aftercare of the operators to limit plastic emissions. Accordingly, similar problems as in the case of active landfills may occur, e.g. if sites are not monitored and aftercare is not properly conducted. This can include for example, unsafe cover materials and/or construction.

Besides disused landfill sites, the term 'historic landfills' also comprises potentially unknown historic waste disposal sites, which are omnipresent around Europe and potentially relevant in the context of marine plastic litter if they contain plastic waste. If these sites of highly variable size are located close to waterways or the coast, they can represent a significant problem, mostly due to insufficient knowledge of their extent or even existence until cover material is removed by wind, water or coastal erosion. Cooper et al. (2012) identify material release due to wave or tidal erosion and landslips as potential pathways for plastics from landfills at undefended shoreline, and material release due to mobilisation by flooding, overtopping waves, surges, or breaches in embankment from defended shorelines.

While the mapping of such historic (coastal) landfills is currently taking place in some countries (e.g. Denmark), more information is already available in others. Widespread pollution has occurred in the UK, due to more than 21,000 sites of which almost 3,000 are located in floodplains and 1,264 located in coastal areas and estuaries at the risk of erosion. In these cases the focus of the attention is on chemicals leaching to the (aquatic) environment, which is why they are called "toxic timebombs" (Bawden, 2016). Uncertainties in legislation and (financial) responsibilities add to the severity of the issue, especially in those cases where potentially toxic waste has been landfilled and in areas, which are now used otherwise. In Sweden, the extent of the potential problems arising from closed landfills is unknown and no national overview of the number of sites (estimated to be several thousands) and the risk they represent is available. Accordingly, the Swedish Environmental Protection Agency (2012) finds that "there is a need to identify, inventory, risk-classify and, when necessary, perform protection measures at closed landfills", which also accounts for other OSPAR Contracting Parties.

F11: Emissions from sorting and recycling processes or products

Velis et al. (2017) found that leakage of plastics can occur during treatment of waste and the processing of secondary materials. Plastic emissions from plastic recycling plants are unquantified and expected to be relatively low, but still exist, especially in poorly managed facilities and the informal sector (UNEP, 2016). Leakage, similar to the risks identified for all waste handling activities, can occur at sorting and recycling plants. This includes wind-blown litter from wastes transported in an unsafe manner (e.g. uncovered) or stored in unsafe places (e.g. exposed to winds or uncovered). Lack of wind protection fences or nets are a factor contributing to leakage from premises with possible emissions to the air and water. Velis et al. (2017) argue that wastewater of recycling facilities with sink/float sorting systems can contain plastic items and argue that although plastic emissions in different forms are a bigger problem in low-income countries, they can also occur in high-income countries.

The share of incoming material that cannot be recycled requires further treatment and risks may arise if these residuals of sorting and recycling are not treated properly. According to Schüler (2018), residuals represent around 15-30% of material sent to recycling processes in Germany. These high rates are affected by wrong sorting in households and businesses, the excessive applica-

tion of composite materials (e.g. carton beverage packaging), and contaminations e.g. with food or other waste. Rather low plastic recycling rates and accordingly rather high rates for other treatments (e.g. incineration or landfilling) must also be expected in recycling plants and processes, which do not focus on plastics, but other materials. This is the case for plastic parts in used cars, plastic content in demolition waste streams or plastic films in carton beverage packaging. If preventive measures are not installed, emissions of macro plastics into the air may occur during recycling of lightweight material, especially in those cases. Cases of plastic films being blown from cardboard beverage container recycling plants have recently gained attention in Germany.

Focussing on yet another waste stream besides separately collected plastic waste and those listed above, household collection of bio-waste contributes significantly to improved utilization of the resources represented by some wastes. At the same time, plastic contamination of collected bio-waste represents a significant problem with respect to emissions to the environment. While micro plastics come up more often in this context[51], it is also macro plastic litter, which is lost to agricultural land or water bodies after composting or in residues of anaerobic digestion. The relevant EU fertilizer regulation states that the share of foreign objects over 4 mm in size (e.g. glass, metal, and plastic) in fertilizer products made from organic waste should not exceed 0.5% by weight (Velis, et al., 2017). According to Plastic Soup Foundation (2018), the main cause for the fact that these values are often exceeded is that “green waste handed in by consumers is often polluted with plastic” and that “composting companies cannot remove all of this plastic”. Contamination can also come from bio-waste collection bags, which are marked as biodegradable but cannot be processed in treatment plants. Besides contaminated organic waste from households, it was recently discovered, that wastewater from the anaerobic digestion treatment of food waste from expired products from supermarkets, which was still packed, has caused inputs of enormous amounts of plastics into a German river. While the practice will soon be addressed in this case via German waste legislation, shredding of food waste together with its plastic packaging is currently widely unregulated.

F12: Unsatisfactory management of plastic waste from agriculture and other environmentally open applications

Plastics are considered an unavoidable necessity and are thus widely used to improve agricultural production (Le Moine, 2015). Plastic waste from agricultural activities has been found in the oceans and marine organisms and comprises among others irrigation pipes, planting containers and protective meshes and sheets (UNEP, 2016). UNEP and GRID-Arendal (2016) add films used in greenhouses, walk-in tunnel and low tunnel covers, mulching and silage; nets for protection from birds, insects and hail; strapping for bales; bags for fertilizer and packing for agrochemicals to the list and emphasize the high plastic demand and waste generation of the sector. As an example, the Environmental Investigation Agency (2018) describes that Spain is the largest user of mulching (120,039 ha), followed by France (100,000 ha) and that ‘agriplastics’ can leak to the marine environment through wind or riverine transport.

Le Moine (2015) estimates that 1,050,000 tons of plastic waste is generated each year in Europe and 60% of this amount comes from films. The EU market for plastic mulch film is rather specific and estimated to have a size of around 100,000 tons a year. Of this amount, it is estimated that only

[51] Bertling et al. (2018) estimate 169g/(cap a) of micro plastic leakage to the environment through compost. This would sum up to nearly 14,000 tons per year for Germany alone.

around 32% are currently collected after use and the rest is burnt, landfilled or left on soils (European Commission, 2016). Besides the large quantities that cause challenges for any attempt to collect the waste and the outdoor application of the plastics, difficulties with the recycling of the often highly contaminated material is a serious issue, which increases the cost of managing the waste. According to Le Moine (2015), 300 kg of plastic put on the field results in 1000 kg or even more dirty film. Films and especially also fertilizer and pesticide containers can also be contaminated with dangerous substances, which lower the technical and economic recyclability and accordingly as well as the motivation for collection.

Where national collection schemes are implemented (currently only 8[52] out of 29 European countries), collection rates can be as high as 85-95% and up to 98% of collected agriplastics are recycled[53]. At the same time, Elliot et al. (2018) estimate a recycling rate of only 11-14% for agricultural plastic waste in the UK. Briassoulis et al. (2013) discover generally rather low and widely varying collection and recycling rates of agriplastics from country to country and at regional level. The authors further found, that "many of these degraded plastic fragments end-up in the sea, polluting the sea water and threatening sea organisms", due to absence of or inefficiencies in adequate agricultural waste management schemes in Europe. Surfrider Foundation Europe (2017) discovered that nearly 90% of all plastic litter items on the banks of one French river came from agricultural activities and that agricultural plastic waste can be found in large quantities in European freshwater and marine ecosystems. In their guide for prevention of pollution from agricultural activity, the Scottish Government (2005) also finds, that biodegradable crop covers are applied but "do not degrade sufficiently well to avoid a litter problem".

Piehl et al. (2018) studied an agricultural site "which only receives conventional agricultural treatment" without application of agricultural plastics or organic fertilizers, which can contain macroplastics (see F11). They found significant contamination of the agricultural land with around 209 pieces of macroplastic[54] per hectar and discuss animal feed packaging, the application of manure-based fertilizers and breakdowns of the multitude of plastic materials present at farms. The authors further suspect that if plastic is applied on fields (e.g. in the form of mulch films), then an even higher plastic contamination should be expected. Significant amounts of plastic litter can thus be lost the environment due to unsatisfactory management of (plastic) waste in agriculture. While losses from agriculture directly to the marine environment are rather unlikely, agricultural plastic litter can easily be transported to the North-East Atlantic by winds, rivers or biota.

F13: Unsatisfactory management of waste from tourism and other coastal activities and industries

Adverse effects of litter on the generated revenue are obvious in the coastal tourism sector, which is highly dependent on clean beaches and seas. Together with the shipping industry, coastal tourism generates more than one third of the value of the maritime sector in the OSPAR region and represents the biggest employer in France, Spain and Portugal. The industry has been growing steadily and reached 146 million visitors in 2007. Tourism infrastructure is still continuously increasing, and

[52] All 8 countries are OSPAR Contracting Parties: Ireland, Iceland, Sweden, France, Spain, Norway, UK, Germany

[53] http://www.plastiques-agricoles.com/ape-europe-missions/agricultural-plastics-european-regulation/

[54] The most common polymer was polyethylene with 67.9% of all pieces and 62.4% of the mass. The most frequently found litter items were films and plastic fragments (Piehl, et al., 2018).

the industry is seen as one of the main sources of marine litter in the area of interest (OSPAR, 2010).

The Horizon 2020 funded project "Urban Strategies for Waste Management in Tourist Cities" found that tourism contributes around 10% of the waste streams in the whole of the EU and by far most to the stream of municipal waste. Yet specific EU regulation and national legislation for waste generated in tourism is lacking (Bjørn Olsen, et al., 2017). Especially hotels often generate unnecessarily high amounts of often unsorted waste and while the generation of the (plastic) waste itself is a serious problem for overstrained waste collection and treatment systems locally, the likely even bigger problem is the large number of people in the very sensitive (in the context of marine litter) areas of beaches and coasts in general. Littering of drink and food containers, cigarette butts and other items is a significant problem, even more if beaches or promenades are not cleaned regularly.

In the OSPAR Quality Status Report of 2010, local businesses are also seen as a main source of marine litter (OSPAR, 2010). For example, the topic of coastal food stalls is brought up regularly. Chances that single-use and usually deposit-free to-go food and drink packaging end up in the environment are very high if the vendors do not offer a place to securely dispose of the waste.

F14: Unsatisfactory management of construction & demolition waste

Packaging waste from construction materials, materials used during construction (e.g. buckets, films or expanded polystyrene (EPS)), as well as the construction material itself (in the demolition phase) and bulky material usually disposed of during renovation works (e.g. furniture) are a potential source of marine litter. Plastic construction waste has been found on all European maritime coasts (Surfrider Foundation Europe, 2017). Plastic products used in construction are often those with the highest expected lifetime (e.g. plastic pipework) and offer various advantages but require special attention as soon as they have become waste. This is partly due to the facts the waste is generated selectively, not continuously and when it occurs, quantities are often very high.

Building and construction currently represents 19.7% of the plastics demand in the EU28+NO/CH (Plastics Europe, 2018). Given that the usage of plastics in construction started to increase approximately 40 years ago and materials have a life expectancy in a range between 25 and 80 years, the current amounts of plastics used, and plastic waste produced are still diverging (Conversio, 2018). Plastic waste from demolition works is accordingly expected to increase steadily. In this sector in Germany in 2017 alone 2,763,000 tons of plastics were produced for the construction sector, 2,650,000 tons of plastics were used and 500,000 tons (~19%) going to waste (Conversio, 2018).

Plastic waste from construction and demolition require special collection, transport and treatment systems. Functioning systems are not in place everywhere, proper separation is often not enforced and construction and demolition wastes are one of the streams most prone to waste crime, illegal dumping or disposal in landfills. Additionally, plastics can be blown away from sites by wind and wastes nonspecific for the sector may be littered outdoors by workers on the sites. Separate collection and tidiness at sites are often not an element of the education is the often low-wage sector. If, for example, PVC or PE pipes or window profiles are collected separately, experience has shown that recycling back into the original products proofs to be possible with similar long life times.

Requirements regarding waste management on construction and demolition sites have not been thoroughly assessed during the creation of this document, but too low requirements for the sector (e.g. regarding planning of waste management beforehand including safe and separate collection

for recycling, see F2) and lacking enforcement of existing regulation are expected for large parts of the area of interest.

F15: Plastic waste inputs from heavy weather events

Worldwide, very high amounts of plastic waste leak to the oceans during and after disaster events. Lebreton et al. (2013) modelled the marine litter generated by the tsunami, which hit the Japanese coastline in March 2011. The authors discovered that a staggering amount of 1.5 Mt of material floating in the Pacific Ocean can be traced back to this catastrophe. This represents 3200 years' worth of a very high estimate of elsewise occurring debris input from Japan. While the example of an earthquake with following tsunami is extreme, it still illustrates, how much marine litter can potentially originate from natural disasters. A potential factor contributing to leakage of plastics, relevant in other parts of the world (e.g. the United States or South-East Asia) are hurricanes/typhoons. Heavy weather represents a risk for plastic leakage worldwide and link marine litter generation to climate change resulting in cumulating heavy weather events

Disasters we consider most relevant in the OSPAR region and the context of marine litter, are storms and flooding. While the famous and regularly occurring (heavy) wind systems in Europe are mostly located around the Mediterranean Sea (e.g. Mistral and Bora), many parts of the European North-East Atlantic coast are regularly affected by strong winds and heavy storms. Hawcroft et al. (2018) argued that despite high levels of uncertainty in large-scale circulation models, "large increases in the frequency of extreme extratropical cyclones" and significant increases in precipitation from "extreme extratropical cyclones" are expected in Europe and North America by the end of the century. Comparing different global warming scenarios and their effect on flood risks in Central and Western Europe, Alfieri et al. (2018) find that substantial increases over most countries and at all warming levels are expected.

Exceptional weather conditions like storms, high tides, or watercourse flooding with effects on beach litter accumulations are frequently reported (Surfrider Foundation Europe, 2017). Floods and storms can mobilize inland litter and transport it towards the sea from where it is very hard to retrieve or simply disperse it from originally concentrated litter hotspots, from household or business waste receptacles or waste management facilities. Litter leaks as a result of an absence of preparation and consideration in planning, because litter is not cleaned frequently (see F16) and because there is usually no or insufficient dedicated capacity to clean litter after extreme events.

F16: Insufficient cleaning of open areas

Plastic litter in open private or public places has the potential of contributing to marine plastic litter through transportation by biota, wind, water or tides if on the coast. As elaborated in the previous chapters, this litter leaks to the environment from manifold sources and through various pathways. Although a significant share of most leakage, such as littering[55], can be prevented by different measures, cleaning will remain necessary.

One of the main motivations to conduct cleaning activities of beaches, promenades and other public places is often a financial one. Tourism revenue losses due to aesthetic disturbances from plastic (or other) litter are considered an expensive problem (see chapter 2). Because cleaning of public

[55] The conclusion of the analysis of littering behaviour (see F3) highlights, that 'litter creates litter' if not cleared quickly enough.

spaces and especially of beaches and promenades is costly, this can result in lower cleaning frequencies during the winter months when less revenue losses are expected. Areas with less relevance for tourism may even be neglected. Maladapted street cleaning activities, especially near the quays were identified as a loophole in the Regional Stakeholder Workshop in Belgium organised by ARCADIS (2012). Orthodoxou et al. (2014) suggest, that cleaning activities may not always be very efficient. This is the case if cleaning is not conducted before high tides or expected heavy weather (see F15). Other insufficiencies identified by Orthodoxou et al. (2014) include, that authorities organise too few clean-up activities and too little regular cleaning, especially in hotspot areas. Besides too much reliance on voluntary clean-up activities by NGOs, one reason for that is a lack of funding (see F8). During the public consultation for the SUP Directive (see 3.3.3), respondents overwhelmingly favored the use of extended producer responsibility schemes to cover the costs of cleaning up litter (see FoA13), which is now part of the requirements of the SUP Directive. Orthodoxou et al. (2014) further identify a lack of enforcement for regulations requiring private land owners to clean their properties of litter. If land owners or users do not adhere to their responsibilities, there is a risk for the generation of marine litter.

Unclear responsibilities to clean up (plastic) litter from the environment cause delays in or an absence of cleaning on both private and public lands. In German cities, responsibilities to pick roadside litter are somewhat unclear, because street cleaning only cleans the streets, but not the surrounding green areas. If no special orders are placed and no budget allocated, litter may remain uncollected. For those areas that are cleaned, Bertling et al. (2018) estimate that 80% of roadside litter is collected in cities and only 50% outside of towns. Although significant amounts can be retained[56], services need to be expanded, cleaning activities and efficiencies increased (especially in sensitive areas like coastal roads, beaches, river banks etc.), responsibilities revised, regulations enforced, and sufficient budgets allocated.

F17: Export of plastic waste to countries, where a safe recovery or disposal is not guaranteed

An emerging issue in the context of marine litter is the outsourcing of waste treatment by exporting plastic waste for further treatment, although more and more of these former receiving countries close their borders for further waste imports. These exports are driven by relatively high domestic management costs in exporting countries and considerably lower costs in importing nations (Brooks, et al., 2018). According to UNEP (2016), the improvement in waste management in richer countries (see 3.2) has to a certain extent been achieved by exporting waste to third countries. For example, in the UK, the fulfilment of EU recycling targets relies on “exporting materials […] without adequate checks to ensure this material is actually recycled” (National Audit Office, 2018). Schemes to set standards, enforce requirements or even check waste treatments in third countries are currently generally lacking.

Velis (2014) found that the EU-27 countries as of 2014 exported almost half of the plastics collected for recycling (3.4 Mt, worth of €1.7B). 87% of this was shipped to China. With 3 Mt/year and 85% of wastes exported outside EU going to China (in 2014), a Commission Staff Working Document uses similar figures as reasoning for the European Strategy for Plastics in a Circular Economy (European Commission, 2018a). Brooks et al. (2018) find that the EU-28 countries account for 31% of all global

[56] Bertling et al. (2018) estimate the amount of macro plastic litter cleaned up in authority organised cleaning to be 64,000 tons per year in cities and 18,000 tons outside of towns.

plastic waste exports and would thus rank first on the list of cumulative exports while only ranking third on the list of cumulative imports with 8.0%. 5 EU countries are among the top 10 exporting nations[57] and only 4 are part of the top 10 importing nations[58].

This list of importing nations was until recently led by China with 45.1% of all imports (72.4% if considering imports that first go through Hong Kong). At the same time, China was found to be the biggest contributor to marine plastic litter with 27.7% of total mismanaged plastic waste and 1.32-3.52 MMT/year plastic marine debris generation (Jambeck, et al., 2015). Between 2010 and 2016, the imported plastic waste contributed 10 to 13% additional mass to the plastic waste generated within the country. Velis (2014) states that there was no evidence on the fate of imported material when it reached China and a large share of the waste was treated by small manufacturers using low-tech equipment and pollution practices with no environmental protection controls. After China announced a ban on the import of nonindustrial plastic waste in 2017 (in force since the beginning of 2018), the European plastic waste continued to be exported to other countries, mostly in South East Asia (e.g. Malaysia, Thailand and Vietnam) and other parts of Europe (e.g. Czech Republic and Poland) and it is highly questionable, that the treatment will be more transparent and safer with the new main importers.

Emissions from the waste treatment processes (see F11) in third countries is expected to be higher than in the EU (because it is even less well sorted and thus costlier to treat waste that is exported) and especially the treatment of residues (or material with too low value for economically attractive recycling) represents significant risks of marine litter generation. Investigations by Greenpeace Unearthed, a group of investigative journalists, found plastic waste exported for recycling from UK and other European countries in illegal and unsafe dumpsites in Malaysia (Ross, 2018), which represent a major risk for litter generation (see F9).

Additionally, the transport of plastic scrap causes a risk of marine litter generation. To better control shipments and to avoid mismanagement, the government of Norway proposed to change the status of plastic waste under the Basel Convention from green listed to “wastes requiring special consideration”. This could lead to less marine plastic litter, increased traceability, more control, and less illegal dumping of plastic waste (IMPEL, 2018). Ocean Conservancy (2015) on the contrary suggest, that separate solutions for imported plastic waste are not required and general solutions aimed at reducing plastic waste leakage from the local waste stream in the importing countries should be focused.

[57] Germany with 8.22% of all exports, UK 4.31%, Netherlands 3.59%, France 3.52%, Belgium 2.99%

[58] Netherlands with 2.72% of all imports, Germany 2.27%, Belgium 1.76%, Italy 1.41%

5 Potential priority fields of action to prevent leakage of plastics and marine litter

While a large share of the relevant literature suggests specific measures or instruments to be implemented, this chapter presents a collection of all fields where actions should be taken to address the factors in chapter 4 identified as contributing to the leakage of plastic litter from land to the sea. While a total of 17 potential fields for action (FoA) are introduced, the list should not be perceived as exhaustive. Basic actions (FoA1-FoA4) are followed by improvements in waste prevention (FoA5), collection systems for remaining waste (FoA6-FoA7), safer and more resource efficient treatment and processing of collected waste (FoA8-FoA11), clean ups of leaked plastics (FoA12) and general approaches to implement and support the previously listed targets (FoA13-FoA17). The proposed fields of action should be seen as indications where to start and whom to involve in the case of marine litter prevention through measures addressing waste management in the OSPAR maritime region. Generally, recommendations are given from the perspective of plastic leakage prevention. Although it was not possible to address all other environmental factors of concern in-depth it is still important to have in mind other relevant environmental and social impacts (like costs or greenhouse gas emissions) as necessary when planning any measures.

Following a methodology to describe concrete instruments, which has been suggested within the EU project MARLISCO, measures can among other factors be grouped according to the scale of implementation[59], the initiating body or the source of funding[60] (Loizidou, et al., 2014). BiPRO (2013) suggests assessing the overarching and specific objective, the targeted material, the stage in the life cycle, which is addressed, relevant actors addressed by the measure and relevant actors responsible for its implementation, the type of instrument and the country relevance. Possible types of instruments include e.g. research and development, regulation, direct investments, market-based instruments, awareness-raising tools, clean up measures (UN Environment, 2017), encouraging best/good practice, introducing best available techniques/technologies (BATs), introducing guidelines or voluntary agreements and codes of practice (UNEP, 2016), enforcement of legislation, provision of (improved) infrastructure and green public procurement. Interventions are possible in all stages of the product life cycle (Veiga, et al., 2015). Like for all themes included in the OSPAR RAP ML[61] the following guiding principles should guide action:

- The precautionary principle
- The polluter pays principle
- Integration
- Ecosystem-based approach
- Public participation and stakeholder involvement
- Sustainable consumption and production
- Best available knowledge and socioeconomic effectiveness

[59] The most relevant scale of instruments described in this document is the European or the regional level. National and sub-national instruments are discussed where relevant.

[60] Initiating bodies and sources of funding can be the EU, national governments, local authorities, other public bodies, NGOs, Charities, Foundations, private companies or other institutions

[61] OSPAR Commission (2014)

FoA1: Awareness raising

Recognizing the amounts and understanding the ecological, social and economic impacts of plastic litter in the seas, which can be, *inter alia,* addressed by improved waste management, is key when initiating countermeasures. Significant amounts of marine litter are currently leaking from OSPAR Contracting Parties to the North-East Atlantic. This fact needs to be acknowledged by all relevant actors and to achieve this, awareness of the issue must be raised including in policy makers, authorities, businesses and industries involved in all stages of the plastic life cycle, as well as the general public. Awareness of the problem is the starting point for all measures addressing marine litter from land-based sources, including horizontal integration processes (see FoA2).

While marine litter is globally regarded as one of the main challenges in marine conservation, the awareness about suitable contributions to curb further inputs especially on the regional, municipal and individual level is fairly low. Van Acoleyen et al. (2014) highlight the importance of convincing the target groups of interest of the size of the problem, the effectiveness of proposed actions and the resulting societal benefits. Awareness raising aimed at the public needs to encourage individual actions, including waste prevention (see FoA5), participation in separate collection (see FoA7) and combating littering. While all three points are of high importance, the most widely studied field are awareness raising efforts to prevent littering. NFTPG (2014) further highlights the need to raise awareness for on-going illegal dumping activities and the need to report them when discovered.

Actions of individuals as employees need to be encouraged in all fields as well, including people working in waste management (e.g. cleaning of waste facilities, see FoA9-FoA11), agriculture, construction and demolition, recreational and other industries (see FoA15) to stop careless littering, avoidable mismanagement and illegal activities. Addressing businesses is also key, because stakeholder engagement is needed in the form of expertise, acceptance, and potentially voluntary actions. Exemplarily, BiPRO (2013) suggest involving the retail and tourist sector in actions to improve consumer behaviour.

According to Dri et al. (2018), when aiming to combat lack of knowledge, detrimental attitudes and perceptions, it is best practice to:

- Ensure continuity, consistency, complementarity and clarity of all communications with well-defined aims and objectives;
- Create clear messages appropriate to, and directed at, well-defined target audiences;
- Ensure efficient delivery through the integration of activities and clear lines of responsibility

FoA2: Horizontal integration

Marine litter is a major part of the reasoning for the EU Strategy for Plastics in a Circular Economy (see 3.3.3) and likewise the issue should generally be seen as a potential impulse to improve waste management practices. A very important first step when aiming to reduce and ultimately eliminate inputs of marine plastic litter by applying measures addressing land-based waste management is horizontal integration. Actors with different backgrounds need to join forces and expertise for sustainable waste management to prevent marine litter, which is also one of the main novelties of the revised Waste Framework Directive (see 3.3.3). The European Commission (2018b) identifies improvements in coordination between authorities responsible for waste management and marine environmental protection as a key measure to curb plastic waste and littering. According to the European Environment Agency (2015), most waste prevention programmes stress that cooperation with all stakeholders and actors in the value chain is a precondition of success.

Capacity and awareness in the waste management sector to consider the protection of the marine environment is needed when deciding, planning and implementing measures. The participation of several sectors on multiple scales must be targeted. Hartley et al. (2018) state that "actions must involve the general public, commercial users of the ocean and coasts, waste management agencies, industry (e.g., product designers and manufacturers), regulators, educators, environmental NGOs and CSOs, national, regional and local government".

Still, the problem of marine litter has traditionally been approached as an isolated issue and actions were often focused on end-of-pipe solutions, separate from other fields of policy, according to Hastings et al. (2013). They further identified the issue of marine litter as well suited for Environmental Policy Integration (EPI), a process with the aim to ensure "changes in political, organisational and administrative structures to embrace environmental factors through all stages of decision making" and that "policy developments take environmental considerations into account in a holistic fashion". The main difficulty when implementing EPI to prevent marine litter will most likely be political and administrative challenges for integration processes with and without of the governments involved. Currently actors in waste management mostly address the issue as a 'downstream' consequence, while actors in marine protection look 'upstream' to identify the sources of marine litter.

Sweden's National Waste Plan 2012-2017[62] is an example for horizontal integration processes and states that litter generation reduction will be carried out "in a dialogue with the Swedish Agency for Marine and Water Management". This encompasses among others the development of litter measurement methods (see FoA3). The Plan further encourages the connection between actors within municipalities to jointly implement measures to reduce litter generation and the development of partnerships between departments within the municipalities. In another example from Denmark, the Danish EPA has a close on-going dialogue with the municipalities and Danish Waste Association about waste management and other relevant actors who play a key role in Denmark managing waste.

Actions in this field have been proposed e.g. by BiPRO (2013) suggesting to "improve national institutional arrangements regarding the addressing, preventing and combating the marine litter problem" especially in the inclusion of chapters on (marine or river) litter in waste management plans (see FoA4) and by Vernon et al. (2013) who urge policy makers at EU level to "strengthen the relationship between water and waste management policies". The latter has been taken up in the form of the revision of the Waste Framework Directive in 2018 (see 3.3.3). Because different skills and resources from a variety of partners can support all work on marine litter, Ten Brink et al. (2009) suggests to "enhance and encourage collaboration among NGOs, industry, governments, citizens, academia, fisheries management organizations, local communities and municipalities". Hastings et al. (2013) highlight the importance of a clear "understanding of how coordination would be achieved and who would undertake a leading role to ensure integration". The integration of marine litter prevention in the conceptual 'Source-to-Sea' framework provided by the Stockholm International Water Institute (SIWI)[63] is currently undertaken. The framework outlines a system to involve different stakeholders, sectors and geographical entities in multi-stakeholder partnerships to address downstream problems in the marine environment.

[62] Swedish Environmental Protection Agency (2012)

[63] Introduction available at https://www.siwi.org/what-we-do/source-to-sea/

FoA3: Performance assessment

The assessment of current systems against the background of marine litter is an important step and necessary to identify, which contributing factors are relevant in a specific area or context. Dri et al. (2018) highlight the importance of assessing performances of waste management systems for identification and understanding of the status quo and for checking the compliance with local, national and international legislation and strategies. Assessments and on-going monitoring will also allow the evaluation of the effectiveness of changes in the municipal solid waste management system and support further decision-making processes. The latter aspect is of special importance, because some measures to prevent marine litter will most likely have "restrictive effects on intra-Union trade"[64] or, more generally, are contrary to the interest of some stakeholders. In these cases, implementing authorities need to prove that the measure is "adequate to attain the objective of preventing and reducing littering in the natural and marine environment" [65].

Dri, et al. (2018) suggest the application of 'meaningful environmental performance indicators' to evaluate the systems' performance as a whole, to identify weaknesses and by this to identify the most relevant fields for action. The European Environment Agency (2015) stated that it is good practice to develop "effective and meaningful indicators of the environmental pressures associated with waste generation aimed at contributing to its prevention at all levels". Potential indicators can be quantity-based or performance ratios. Indicators we consider relevant for the context of plastic litter leakage from land to sea are all those that are related to the identified factors in (see F1-17) and could include e.g.:

- Quantity-based: Amount of plastic used in certain applications (esp. single-use and packaging); Amount of littered and illegally dumped waste found or cleaned; Number of businesses with voluntary commitments; etc.
- Performance ratios: (Separate) collection rate of recyclable plastics from different applications (households, businesses, agriculture, construction & demolition, tourism); Recycling and landfill rate of plastics (esp. packaging); etc.

The assessments should include mapping of relevant measures that are already being implemented. Vernon et al. (2013) further suggest national support for local authorities and NGOs to monitor the effectiveness of implemented measures. This can happen in the form of national or regional governments paying for monitoring work conducted on lower levels, e.g. in cases when local NGOs support measure implementation through on-going monitoring of plastic leakage.

FoA4: Inclusion of marine litter in waste management and waste prevention plans

A specific link between marine litter and waste management is now required through revised EU legislation (see 3.3.3), although it has been questioned, whether the inclusion of marine litter issues in waste management or waste prevention plans is adequate or whether other instruments are better suited to achieve marine litter reduction. Already in 2013, BiPRO (2013) brought up this inclusion in coastal and river catchment areas and Vernon et al. (2013) recommended policy makers

[64] Intro to 2018 WFD revision https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.150.01.0109.01.ENG

[65] Intro to 2018 WFD revision https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.150.01.0109.01.ENG

at local/regional level to “check and improve local waste management services”, which should include considering littering in local waste management plans and river management. Starting with monitoring of the current situation (see FoA3), Dri et al. (2018) suggest, that integrated waste management strategies need to consider:

- Current and future expected trends of waste streams;
- The waste hierarchy, prioritising measures according to the hierarchy;
- Availability and capacity of nearby waste sorting/treatment facilities;
- Current environmental attitudes and perceptions of residents;
- Any other specific condition affecting waste management.

In an ‘area adapted waste management planning’ approach, Bilitewski et al. (2018) consider an area’s dwelling, commercial, transportation and industrial structure, the structure of heating and regional particularities in waste planning activities. Because similar areas “in principle offer similar opportunities for waste management planning and implementation”, examples of waste management plans with references to marine litter are of high value. An example of where marine litter is already addressed is the waste management plan for Stockholm 2017–2020[66]. The plan introduces the issue, maps relevant actors and introduces actions to be taken by authorities of the city of Stockholm. These include the creation of an inventory of the danger areas, source identification, development of partnerships and activities and communication directed to the public. The plan further specifies a concrete approach to continuous cleaning of waters and shorelines.

The Waste Framework Directive also requires EU member states to establish programmes especially addressing waste prevention (see FoA5) and either integrate these in their waste management plans (or into other environmental policy programmes) or create separate waste prevention plans[67]. As an example, Dri et al. (2018) mentioned the ‘National Waste Prevention Programme of Spain’ (‘Programa Estatal de Prevención de Residuos’), which sets the Spanish goal of reducing 10% of the generated waste in the period of 2010-2020 in order to contribute to reducing marine litter. The authors note, that the existing waste prevention plans are usually rather general and only a few concrete measures are mentioned so far.

The mandatory requirement of including marine litter in waste management and waste prevention planning represents an opportunity for horizontal integration and an integrative approach to environmental issues arising from waste generation and management. It also represents an important opportunity for collaboration of OSPAR Contracting Parties in order to establish a similar level of ambition, minimize work and agree on a coherent approach as bordering countries of the same marine region. Nonetheless, because of legal questions causing country specific challenges, this background document cannot provide guidelines,[68] but is instead rather intended to give indications as to which fields for action could be included in waste management plans to reduce leakage. Indications for what topics could be addressed in waste prevention programmes in order to achieve marine litter generation reduction are highlighted in this chapter (see FoA5).

[66] http://www.stockholmvattenochavfall.se/globalassets/pdf1/riktlinjer/avfall/avfallsplan/sva072-avfallsplan_en.pdf

[67] According to an analysis conducted by (European Environment Agency, 2015), 17 programmes are dedicated programmes and 10 are part of waste management plans.

[68] A guidance note assisting responsible authorities in the general creating on waste management plans is available from 2012 (http://ec.europa.eu/environment/waste/plans/pdf/2012_guidance_note.pdf)

FoA5: Prevention of plastic waste

Measures addressing environmental issues related to waste and waste management need to follow the waste hierarchy[69] and waste prevention ranks highest in this hierarchy. Following the definition of waste prevention provided in the Waste Framework Directive (see Glossary), this chapter will address quantitative measures that reduce the quantity of plastic waste per product or prevent plastic products turning into waste (reuse, repair, lifespan increase) and qualitative measures to reduce the harmful contents of used plastics (European Environment Agency, 2015). The prevention of plastic waste generation and the decreased incorporation of harmful substances (additives) can prevent a large share of (marine) litter inputs and the harm it causes once it entered the (marine) environment respectively. The persistence of plastics as a desired product feature causes harmful impacts to species and habitats for long time scales once it has entered the marine environment. These can differ along the degradation process, e.g. whereas a ghost net is causing entanglement at first, it will later degrade to microplastic particles prone to be ingested by marine organisms. Biodegradable polymers do not yet represent a viable option for the replacement of conventional plastics, as they only potentially degrade faster under determined industrial conditions (e.g. constant high temperature), but not in the marine environment, and standards underlying certification of the latter are still lacking. The very important role of the Packaging Directive (see 3.3.2), that has the aim to prevent or reduce the impact of packaging and packaging waste in the environment is highlighted by Arroyo Schnell et al. (2017). Plastic packaging is one of the product groups with the highest share of generated plastic waste (see 2.1) and should also be focused under a harm prevention perspective, as besides items such as discarded fishing items and other litter items, they cause most harm in marine environments (Werner, et al., 2016).

Plastic waste prevention can be achieved by eliminating[70], changing[71], reusing[72], or replacing the products, materials, or services of interest. In the case of replacing plastic with other materials in some applications (e.g. biodegradable, glass or paper packaging) or replacing plastic products with other plastic products (e.g. those that have a longer lifespan), special attention needs to be paid to the potential environmental consequences of these alternatives. To achieve this, Life Cycle Assessments (LCA) to evaluate environmental performance of replaced and replacing product or material, are frequently applied, but the results are often intensively discussed because costs associated with leakage to the environment is not part of a LCA (taking into account the production and usage stage only) and is therefore too often ignored. Assessment tools to predict for and include ecological and economic harm caused in the environment into account are currently not available.

[69] In contrast to that, Dri et al. (2018) highlight that life cycle analyses can "lead to choices which may depart from the waste hierarchy, since local conditions can improve or worsen the environmental performance of the different stages of the waste hierarchy".

[70] Services or products that can be considered not essential, e.g. bottled water where safe tap water is provided or application of single-use dishes and cutlery when dining in

[71] One example for this is 'dematerialisation' which is "the act of reducing or even eliminating the need for packaging, while maintaining utility", applying the three promising levers light-weighting, rethinking packaging design, and virtualisation (World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 2016). At the same time, Velis et al. (2017) point out, that lighter plastics are more readily dispersed by winds and currents.

[72] Reuse is not always a recommendable strategy, at least when considering all environmental impacts and not only marine litter. Dri et al. (2018) provide examples for these cases.

Process-wise the desired prevention can furthermore be achieved through product, material or application bans, legal requirements, disincentives for undesired and incentives for preferred materials or products, support and promotion of voluntary commitments (e.g. by producers or retailers) and awareness raising. The analysis of more than 440 waste prevention measures in EU member states' waste prevention plans conducted by the European Environment Agency (2015) revealed, that 63% of the measures concern information and awareness raising; economic and regulatory instruments account for 16% and 14%, respectively; and 7% are voluntary agreements.

- **Awareness raising**: Seen as a promising approach pursued by multiple governments and NGOs is to raise customers' environmental consciousness and thereby influence purchasing decisions, awareness raising is briefly addressed in (see FoA1).
- **Bans**: NABU (2018) suggest that single-use products causing environmental problems should be banned if environmentally beneficial "multi-use solutions" are available. Similarly, but not identically, the recently adopted EU Directive addressing single-use plastic products, which are most commonly found on beaches (see 3.3.3) prescribes bans for those of the top ten littered items, for which "alternatives", not necessarily multi-use alternatives are readily available.
  Knowledge is available from decades of experiences with some prominent environmentally problematic items, most famously plastic bags. These can give indications for how to deal with legal uncertainties that may arise from product bans. As relevant measures to start reducing marine litter in terms of low-hanging fruits, BiPRO (2013) suggest the "step-wise introduction of the geographical coverage of ban on plastic bags, starting with coastal cities, and coastal regions during the summer months" and to "ban plastic bottles during beach parties, events, concerts" (see F13 and FoA15).
- **Regulations/obligations**: According to Van Acoleyen (2018), the Packaging Directive (see 3.3.2) sets the most important obligation by requiring, that "amount of packaging per product must be limited to the minimum necessary to be safe, hygienic and acceptable to the consumer". However, this is often misinterpreted as "what the consumer wants" instead of "what he/she can still accept" (Van Acoleyen, 2018), therefore following this basic rule is of high importance. Bertling et al. (2018) state that prescribed reuse quotas and increased durability of products can reduce plastic consumption and accordingly also plastic waste. Prescribed recyclability of products will be addressed in the context of the plastic circular economy (see FoA8).
- **Incentives/Disincentives**: Subsidies and other support for desired (especially multi-use) and taxes or charges on undesired (e.g. single-use and/or especially harmful) products or applications are a common economic instrument applied in various fields of environmental policy. Their potential role in the prevention of waste and ultimately the prevention of marine litter will be elaborated in (see FoA13). Existing incentives for plastics prone to become (marine) litter and disincentives for more environmentally responsible behaviour and production need to be eliminated.
- **Support voluntary commitments**: BiPRO (2013) suggest, that commitments of retailers and the touristic sector (see FoA15) to reduce plastic packaging and plastic bottles and bags respectively could support waste prevention. Where they are expected to deliver sufficient improvements, such commitments should generally be supported and promoted for all sectors.

Generally, waste prevention measures should consider the production, the distribution and the consumption stage. The European Environment Agency (2015) found, that currently 39% of measures focus on the design, production and distribution phase, 40% are related to the consumption and use phase; and 21% focus on the general framework of waste generation.

Although avoided waste is usually connected with avoided primary resource use (Ten Brink, et al., 2018), waste prevention measures may conflict with prevailing business models, e.g. by decreasing the demand for new products (European Environment Agency, 2015). To avoid discrimination, the waste prevention debate should thus not be focused on plastics as a single material, but rather waste generation as a whole. The extensive promotion of a circular economy, which has been observed in Europe focuses on the establishment and further development of the plastic recycling industry and because supply of recyclable and demand for recycled material significantly affect the sector (see F2), waste prevention potentials to reduce marine litter have far less been exploited. Another conflict with some of the goals of a plastic circular economy is identified by Velis et al. (2017), who point out, that while the usage of lighter (or thinner) plastics can result in environmental benefits, the collection and recycling of these materials is less attractive.

FoA6: Collection and sorting of all plastic waste

The existence of a collection infrastructure covering the amount of occurring waste during the entire year, including peak waste occurrence, e.g. in peak seasons, is crucial. 'The collection of all plastic waste' in this chapter comprises everything that is needed to potentially collect all waste, including the collection from households and businesses, as well as collection infrastructure (with maintenance, emptying service etc.) in all public places where it is necessary and appropriate. Generally, separate collection (see FoA7) is best practice in most cases, but the most important aspect from the perspective of marine litter prevention is, that plastic waste is collected at all. Additionally, separate collection of recyclable materials should be the preferred practice. Dri et al. (2018) find that commingled collection with post-collection separation is a popular strategy, which yields higher recycling rates in areas with less history of recycling but that at the same time "post-collection separation scenarios were found to have the highest costs and environmental impacts owing to the limited number of separation centres". This shows, that investments in high quality collecting and sorting infrastructure need to be prioritized flanked by consumer awareness raising measures (see FoA1) for adequate separate collection.

The basic requirement to achieve a 100% collection coverage not only for household plastic waste, but all plastic waste, is the provision of adequate numbers of waste containers (private or at collection points), their emptying and the transportation of the collected waste to the treatment or disposal facilities. Vernon et al. (2013) highlight the possible need to increase waste management services during peak days or seasons, and the importance to evaluate local waste management services (see FoA3) before planning additional capacities. BiPRO (2013) suggested that requirements regarding density and proximity of collection infrastructure should be included in regulation. In any case, responsibilities must be clear, especially in the case of collection from public spaces. Responsibilities must also be clear for regular checks, whether the provided infrastructure is sufficient and operational.

For the sake of completeness, it should be mentioned that not providing any waste receptacles is also seen as a possible alternative. If this approach is chosen (which is e.g. attractive in nature protection areas where receptacles would disturb aesthetics), it may require accompanying awareness raising measures (see FoA1) and enforcement (see FoA16) of littering prohibition, e.g. through a surveillance system in form of patrols.

Providing collection infrastructure is especially important at littering hotspots (see F3) and in areas where litter is easily transported to rivers, oceans or other environmental compartments, especially where it is difficult to retrieve litter. Beaches have been the focus of collection infrastructure provi-

sion initiatives and the issue has been taken up for example by beach certification organisations. The requirements of the 'Green Coast' include the provision of "properly secured and covered litter bins in adequate numbers"[73]. The 'Blue Flag'[74] further requires provision of infrastructure for separate collection (see FoA7) if local recycling facilities are available in the community.

While a lack of disposal infrastructure does not excuse inappropriate practices like littering (see F3) and illegal dumping (see F4), the availability of such can contribute to reduction of unsustainable behaviour. If efforts are made so that all wastes from individuals, households, business and industries are collected by organisations acting within the law, less plastic will leak to the oceans.

To achieve this state, those waste management systems or installations with too low capacity need to be expanded, new systems or infrastructure implemented where necessary and financial and technical barriers overcome. Dri et al. (2018) suggest that inter-municipal cooperation among municipalities could make implementation of improvements, which are otherwise too costly, possible thanks to the economy of scale. This is especially true for the application of best practices and best available techniques that small municipalities could not afford alone. Hogg (2002) illustrates the significant influence of scale on the costs of different treatments and accordingly also the need to scope with the observation that wide differences occur between the sizes of responsible entities in different countries. The difference is obvious between France with 35,000 communes and the UK with 400 local authorities, which have roughly the same population. The economies of scale apply to both two different aspects of waste management financing distinguished by Bilitewski et al. (2018), which are 'financing of the service' and 'financing of investments in improved solutions'. Various ways to raise the necessary money are available and addressed in FoA13. In any case, the collected money needs to provide cost recovery (Bilitewski, et al., 2018).

Especially for plastic items prone for littering, the provision of collection infrastructure only has not proven to be effective and deposit-refund schemes (see FoA13) have been set up. Popular examples are available for bottled beverages, which are effective against littering (Van Acoleyen et al. (2014), Bertling et al. (2018)) by achieving high collection rates in terms of both quantity and quality (Deloitte, 2017), both aspects being very important in the context of recycling (see FoA7 and FoA8). The improvement and/or expansion of existing systems, e.g. to new product groups, is desirable and required by the SUP Directive. Items used in outdoor applications (see F12), or typical to-go items (see F3) are predestined to be addressed with deposit-refund scheme. Changes in product designs (e.g. to make currently detachable parts of items irremovable) are another approach to increase the collection rates of items difficult to collect.

FoA7: Separate collection and sorting of plastics

To collect plastic waste separately is the prerequisite for plastic product reuse and for profitable recycling contributing to decreased littering (seeFoA8) and reduction of landfill rates of recyclable plastics (see FoA10). Separate collection of non-preventable plastic waste should be implemented for collection from households, businesses and public places (on-the-go recycling). So far collection

[73] 2017 criteria are available at https://www.keepwalestidy.cymru/Handlers/Download.ashx?IDMF=55c2a13d-293f-459d-9deb-4b6a7292a2c6

[74] 2018 criteria and explanations are available at https://static1.squarespace.com/static/55371ebde4b0e49a1e2ee9f6/t/5a1e9c0d085229dccc4a64c1/1511955471563/Beach+Criteria+and+Explanatory+Notes+2018.pdf

for reuse is usually implemented in rather sophisticated systems, only collecting a small number of different items (e.g. reuse cups at events or certain places, transport box solution, etc.) and are often coupled with a deposit-refund scheme (see FoA13). Special infrastructure and handling and transport systems are needed and the public needs to accept and participate in the recycling, which requires awareness raising (see FoA1) and education campaigns.

Separate collection from households is already widely applied in the OSPAR region (see 3.2). Bilitewski et al. (2018) give an overview of possible collection systems and conclude, that "the type, size and combination of the receptacles used for collection, and the collection frequency furthermore influence the composition of household waste as well as the quality and quantity of the separately collected recyclables".

Because the collection of all waste in public places is perceived highly important, collection infrastructure is often 'open' to all kind of waste[75] with detrimental effects on usability of collected material. The establishment of recycling on-the go thus represents an extension of waste collection in public places and thus similar requirements apply. Orthodoxou et al. (2014) list the provision of an adequate "number, size and type of waste bins and recycling receptacles in all public spaces" and that the receptacles need to be emptied frequently adapted to accumulation times. A conclusion from the literature review conducted by WRAP (2018) is, that "the best approach to achieve success is to use a tailored and very local, site specific approach" when aiming to increase separate collection rates. It is important to provide an adequate type and number of bins in convenient, well-lit and perceived safe and clean location. BiPRO (2013) add, that there is a need for "proper, uniform and internationally recognisable marking of bins/containers". RECOUP (2017) suggest that 'businesses cases' for on-the-go collection schemes must be proven and for that "good data to assess costs and potential benefits" is required. The associated costs include funding for "procurement and installation of bins, scheme maintenance and collection of material, and also for consumer communication and education to promote effective use of 'On the Go' schemes".

Both for recycling on-the-go and for recycling at home, people need to be motivated to participate, which is favoured if people understand the importance of their contribution. Besides positive impacts of their separate collection efforts, people always also need to be informed about how the systems work. In addition to the provision of guidelines for correct separate collection, BiPRO (2013) suggest requiring the local waste management companies to control whether waste from households is correctly separated. A study of recycling schemes in different countries conducted by WRAP (2018) finds, that the following aspects likely have a great contribution to high levels of performance of recycling system:

- Having strong legislative drivers providing a legal requirement for residents to recycle;
- Differential charging for the provision of residual waste collection services compared with recycling services, which encourages the use of recycling schemes;
- Frequent collection of a wide range of dry recyclable materials through the delivery of a high-quality service;
- Pro-active multi-channel communication with residents, which informs residents about the service and encourages its use.

[75] In Hamburg, public litter bins have been opened for dog waste bags, which would otherwise cause litter problems

The separate collection system, which will most likely yield the highest quality input material for reuse and recycling, is a deposit refund scheme (Deloitte, 2017). This is usually implemented as a bring scheme. As part of its Plastic Strategy, the EU thus encourages national and regional authorities in its member states to consider the introduction and further extension of deposit refund schemes especially for beverage containers (European Commission, 2018b). Such a scheme has been implemented in many European countries, but even where a scheme already exists, extensions, e.g. to new products or additional bottle fractions, can be aspired. For example, most schemes currently in use, explicitly exclude fruit and vegetable juices as well as milk and milk products (CM Consulting & Reloop, 2016). The establishment of any new or extended deposit refund scheme requires a comprehensive assessment of site- or region-specific expected environmental and economic impacts, including marine litter prevention potential with according ecologic, economic and social benefits. Based on marine litter findings existing deposit systems should be expanded to include all kind of beverage packaging and to address also other problematic items such as cigarette butts.

FoA8: Increase of plastic recycling rates

Increasing plastic recycling rates will have positive impacts on marine litter prevention in the OSPAR Contracting Parties. Please note, that the term 'recycling' is just in line with the definition introduced by the Waste Framework Directive (see glossary) and that 'recycling at home' is addressed in the chapter on separate collection (see FoA7). A transition to a circular economy for plastics can cause a reduction of leakage of plastic from land to sea[76]. Van Acoleyen et al. (2014) who analysed the potential impact of increased recycling rates of packaging waste, find that from a 2012 perspective, the fulfilment of all recycling targets would result in a decrease of beach litter in 2020 and 2025, but this would not be enough to eliminate the increase in litter production, estimated from modelled consumption increase. These effects were quantified in the impact assessment conducted for the proposal for reviewing the targets in the Waste Framework Directive, Packaging and Packaging Waste Directive and the Landfill Directive[77] (which resulted among others in the revision of the Waste Framework Directive in 2015, see 3.3.2). It was found that increasing reuse and recycling targets for municipal and packaging waste (together with a ban of landfilling of recoverable materials and an extension of the landfill ban to all waste similar to municipal waste) could "lead to an additional reduction of marine litter of 7% by 2020 and 23% by 2030"[78].

These positive effects could be achieved partly through potential reduction in littering in case the public perception is that plastics are efficiently recycled when properly disposed (Bertling, et al., 2018). The survey conducted by ARCADIS (2014) concluded, that EU citizens value the development of "techniques for more efficient recycling of a wider range of waste streams" as the most "strongly recommended" action for the waste management sector to combat marine litter. The indirect effect on marine litter through increased perceived and actual value of plastics due to a growing recy-

[76] This thought was e.g. presented by ten Brink during the Workshop on 'EU Action to Combat Marine Litter' held in Brussels in May 2017, documentation available at: http://www.europarl.europa.eu/RegData/etudes/STUD/2017/602059/IPOL_STU(2017)602059_EN.pdf

[77] Document available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0208&from=EN

[78] Document available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0208&from=EN

cling industry is accompanied by the prospect that the industries will eventually have a strong economic interest in well-organized separate collection (see FoA7) of all generated wastes, which may influence financing of waste management (see F8).

For the establishment of properly functioning and stable markets for secondary plastics, Velis et al. (2017) highlight the importance of "better data and information sharing on waste and recycled materials at all stages". Hogg et al. (2018), who evaluated measures to increase uptake of recycled material found, that many of the measures implemented worldwide aim at overcoming information failures or reducing transaction costs. Deloitte (2017) similarly identify a lack of communication and reasons that the whole plastic value chain needs to get involved. This includes product design (where complexity should be reduced and the choice of materials should reviewed), the conversion of pre-production pellets into products (where additives need to be reduced and transparently declared), waste collection (to guarantee high quality input material for recycling), sorting and recycling (where technologies and capacities need to be developed) and the end-use of recycling products (uptake that needs to increase drastically).

The Nordic Council of Ministers (2017) called for enhanced competencies and improve technical infrastructure in waste management to enable efficient collection and grading systems in order to increase recycling rates. Further the Council also highlighted the importance of recyclability, which can be achieved by designing products that "allow for the disassembly of plastic components". Redesign of products and used materials (e.g. additive reduction or increased material homogeneity) need to be legally required or made financially attractive, which is the chosen approach taken, for example, in the new German Packaging Law. The law coupled the fees due under the extended producer responsibility schemes (see FoA13) with the recyclability of plastic packaging (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2018).

In the strategies to increase recycling rates of plastics, governments and authorities on different levels play key roles in supporting effective separate collection (see FoA7), facilitating the establishment of funding mechanisms, and providing an appropriate regulatory and policy landscape, by banning or incentivizing certain materials or actions (see e.g. FoA14). Further, public authorities need to make sure, that a better functioning recycling system does not distract from the need to prevent plastic waste in the first place (see FoA5). In any case there will be a strong interest of the recycling industry in constant (non-decreasing) inflow of material, because recycling and sorting plants need a minimum throughput to be economically stable (Dri, et al., 2018).

Recycling of plastics retrieved from the oceans is seen as a promising approach to finance removal of litter from the marine or coastal environment. Recycled 'ocean plastic' is sold in a variety of products, including sports equipment and fashion. Because collection and recycling are associated with high costs (e.g. due to the state of the collected material, which requires expensive cleaning and sorting), 'ocean plastics content' in products is currently intensively used in marketing by producers. However, although this aspect is interesting for awareness raising, this is still an end-of-pipe solution taking the focus away from preventing of marine litter in the first place. Any kind of greenwashing should be avoided and retrieval costs should rather be covered by extended producer responsibility schemes.

FoA9: Optimization of waste collection and transport

Plastic waste can leak during all processes of waste collection, transport, handling and treatment. Once it leaked it can easily become litter in the environment and ultimately marine litter. Still, when

aiming to identify 'best practices' in on the ground waste practices, one needs to discuss more than only marine litter. Relevant aspects include e.g. disposal safety, greenhouse gas production, energy and resource consumption and cost generation. "Waste collection and transport accounts for 60 - 80% of the total cost of waste disposal", according to Bilitewski et al. (2018) and considerable savings can be achieved in this field. This chapter will focus on marine litter prevention though.

Renaud et al. (2018) highlight, that it is the municipalities' duty to "prevent waste leakage during collection and transport" and functioning and maintained equipment and services must thus be provided either by the municipality or contracted organisations. According to (Dri, et al., 2018), it is best practice to set up waste collection strategies (see FoA4), which specifies the systems' properties. The systems should include the following aspects:

- Frequent door-to-door separate collection of food waste (e.g. weekly or more often depending on the season and climate);
- Less frequent collection of mixed waste (e.g. every two weeks)[79];
- Door-to-door collection of recyclables (including plastic waste), individually source separated where public acceptability allows, otherwise co-mingled and sorted at a material recovery facility;
- A convenient network of civic amenity sites that accept all waste fractions not collected door-to-door, alternatively at least the presence of one civic amenity site or regular periodical presence of a mobile site.

If it is necessary to achieve provision of all these points, collaboration opportunities with neighbouring municipalities or waste management organisations should be explored (see FoA6).

Dri et al. (2018) promote the installation of "alternative collection systems to road transport, such as a pneumatic system" to minimize waste transport on roads. In more traditional systems with kerbside collection, both wheelie bins and waste bags are discussed as 'best practice' to minimize leakage of waste before and during collection. While wheelie bins may be blown over or spill waste if overfilled or not closed, bags can get torn open by animals. While wheelie bins are considered safer with regard to litter generation, they cause specific requirements to collection infrastructure and frequency, most of all collection vehicles. Waste bags are thus widely used, both for mixed municipal waste and recyclables and other ways to deal with birds disturbing waste collection are implemented. Litter dispersal from waste brought outside for kerbside collection is also not only a question of the used receptacle, but also of the correct application. This includes, that both bags and bins are not placed outside too early before collection and brought back to a place protected from winds and biota as soon as possible after emptying. This is especially important during windy conditions and some municipalities such as in the UK, have issued corresponding guidelines for citizens[80]. Although it represents additional waste from the bags, it has been suggested to collect bagged waste from wheelie bins. This does not only reduce risk of spillage before collection, but also during waste transport and reloading. Litter dispersed from collection vehicles discovered by the Florida Center for Solid and Hazardous Waste Management (2003) was usually not bagged. To avoid leakage of plastics (or other waste) during waste reloading and transport, Bilitewski et al.

[79] lower frequency can increase citizens' consciousness of the need to reduce residual waste, see FoA5 and FoA13

[80] Examples are e.g. available from Conwy (http://www.conwy.gov.uk/en/Resident/Recycling-and-Waste/Top-Tips-For-Windy-Days.aspx), Swansea (https://www.swansea.gov.uk/recyclinginwindyconditions) or Cheltenham (https://www.cheltenham.gov.uk/news/article/2194/keep_household_recycling_secure_in_windy_conditions)

(2018) further suggest the application of "exchangeable or swap body container systems" and BiPRO (2013) recommend "training of waste operators to introduce simple measures to prevent that collected plastic packaging waste becomes litter". Vernon et al. (2013) propose to exchange ideas and best practices between waste professionals, municipalities, etc. (see FoA17). Creation and enforcement of legal requirements for waste management operators to limit littering during collection and transfer, especially in areas most relevant for marine litter generation, should be considered.

Adequately sized and positioned infrastructure to collect on-the-go wastes in public places, which efficiently prevents intervention of wind or biota is a crucial service to prevent marine litter inputs (see FoA6). The design of waste bins must thus prevent the escape of plastic packaging (BiPRO, 2013). Accordingly, councils in Northern Ireland have invested in provision of compactor waste bins, which do not only protect collected waste from seagull disturbance, but also doubles the storage capacity (DOENI, 2013). Reduction in need of waste collection from public bins as well as in the need to pick up street litter have been observed in the city of Nottingham after solar powered compactor bins have been installed[81]. Another one of many existing examples for innovative approaches to public bin waste collections is reported from the city of Santander where more than 6,000 Internet of Things devices with various sensors, Radio-frequency identification (RFID) and near field communication (NFC) have been installed "to improve the urban waste management by knowing in real time the locations and the status of rubbish bins and containers and also the fill level" (Bjørn Olsen, et al., 2017).

FoA10: Reduction of risk of leakage from landfills

The reduction of the risk of leakage of plastics from active landfills can be achieved by reducing/eliminating the plastic content in landfilled waste, by improving the management of landfills and by closing those sites that do not comply with legal requirements. In the following these three aspects are introduced and an overview of approaches to all potential problems with landfilled plastic is provided. This chapter also introduces ways to deal with historic landfills that represent a threat to the marine environment.

It is generally accepted, that unsafe dumping practices represent one of the major sources of marine plastic litter on a global scale. A ban (or reduction) of plastic going to landfills on a global scale has accordingly been linked with expected marine litter input decreases[82]. At the same time Van Acoleyen et al. (2014) find, that a decrease in plastics going to landfill does not have a major direct effect on marine litter while positive indirect effects may be generated through the impact it could have on the recycling industry, which again can contribute to decrease of marine litter inputs (see FoA8). The reduction of plastics in European landfills is thus mostly a priority in the context of the circular economy. Because separate collection and recycling of plastics is still rather expensive and waste treatment options are 'competing' for waste, landfilling needs to be restricted or made more expensive, although taxes on and other increased costs of landfilling have been linked with higher numbers of illegal dumping incidents (Watkins, 2015). Too ambitious targets for reducing plastics

[81] Further information available at https://iotuk.org.uk/smart-bins-as-a-service-in-nottingham/#1463069850260-40432ad9-2af3

[82] A global landfill ban for plastic/paper/glass/metal by 2030 (max 5%) could lead to a reduction of marine litter of 7% by 2020 and 23% by 2030 according to an impact assessment conducted in the EU (available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0208&from=EN)

going to landfill without parallel increase in recycling capacities may also result in too large capacity for alternative treatment methods, which are not desired in a circular economy, e.g. incineration. The EU Landfill Directive (see 3.3.2) thus suggests a successive reduction of plastics in landfills.

According to Van Acoleyen et al. (2014), landfills are not seen as one of the main sources of marine litter in the North Sea Region. The questionnaire conducted during the preparation phase of this document yielded a different picture, where half of the respondents reported that landfills are indeed seen as a source of marine litter in their country. In any case, management practices to prevent any leakage to the environment should be applied at all sites, especially where deposited material is prone to be blown off by strong winds. Martel et al. (2004) divide the available instruments to reduce litter from landfills in prevention, control and collection measures. Prevention techniques include load management (e.g. keeping the open face as small as possible or careful positioning of light items (UN Environment, 2017), regular coverage and compaction. Control techniques include the application of fences (6 meters high catching fences can be considered best practice), nets or screens and ultimately methods to collect litter that has not been prevented or controlled include manual picking and mechanical collection devices.

To combat site-specific problems of scavenging birds and other animals disturbing landfilling operations and distributing litter, Johnson (2009) suggests four different types of control action. The first choice is to follow accepted practices of daily or if necessary immediate coverage to secure the waste from scavengers. In severe cases where this did not solve the problem, species specific harassment (e.g. with noise or chemicals), relocation or even depredation have been applied, e.g. in the United States. Because it would require thorough evaluation of all environmental impacts of these drastic measures, they will most likely not be seen as potential solutions in for plastic leakage from landfills in Europe.

To minimize the risk of marine litter inputs from landfills, BiPRO (2013) suggest enforcing the technical requirements of the Landfill Directive and to identify and close non-compliant landfills. The creation of the necessary capacity to supervise landfills more often, the revision of national regulation and the wide sharing of best practice guidelines may be additional suggestions. Martel et al. (2004) suggest that landfill site operators should develop litter control plans to ensure that all litter reduction potential is exhausted. Examples of where litter originating from landfills have been taken up in OSPAR Contracting Parties' legislation or environmental guidelines are manifold. The Norwegian Environment Agency[83] requires that measures should be taken at landfills to minimize hazards arising from (among others) wind-blown materials. In the UK, the Environment Agency (2009) published guidance for how landfill operators need to act to comply with their environmental permit. This includes:

- Ensuring that incoming waste remains sheeted for as long as possible;
- Ensuring that vehicles get fully discharged at the site;
- Daily meteorological monitoring;
- Closing the site to specific or all waste during adverse weather conditions;
- Installation of permanent and mobile litter fences;
- Regular inspections and collection of litter around the site boundary and beyond

[83] Further information available at http://www.miljodirektoratet.no/en/Legislation1/Regulations/Waste-Regulations/Chapter-9/

In Ireland, a publicly available licence[84] issued by the Environment Protection Agency for a company operating landfills for non-hazardous waste specifies requirements for litter control. Requirements put on the licensee include:

- Prior to the disposal of any waste in any cell, litter fencing shall be installed and maintained around the perimeter of the active tipping area and portable litter nets/screens shall also be used at the active tipping face;
- All litter control infrastructure shall be inspected on a daily basis. The licensee shall remedy any defect in the litter netting as follows:
  a) A temporary repair shall be made by the end of the working day;
  b) A repair to the standard of the original netting shall be undertaken within three working days;
- All loose litter or other waste, placed on or in the vicinity of the facility, other than in accordance with the requirements of this licences, shall be removed, subject to the agreement of the landowners, immediately and in any event by 10.00am of the next working day after such waste is discovered;
- The licensee shall ensure that all vehicles delivering waste to and removing waste and materials from the facility are appropriately covered.

Also in Ireland, the Environmental Protection Agency (2014) further published guidelines specifically for the proper coverage of landfills and highlight, that "type, quantity and method for daily cover should, among other highly important tasks, prevent wind-blown litter".

To minimise risks from historic landfill sites Cooper et al. (2012) propose a four-step approach including site identification and characterisation (with risk assessment), option appraisal[85], solution delivery and performance evaluation. The Swedish Environmental Protection Agency (2012) advises all municipalities and county administrative boards to "identify, inventory, risk-classify and, when necessary, perform protection measures" to reduce to risks from closed or disused landfills. This includes to "investigate who is responsible" and to "impose a requirement for measures to be undertaken by the party […] or alternatively investigate the possibility of state funding for remediation if the area has been given a high priority and no party has been designated as responsible". The Agency further suggests investigating the potentials of 'landfill mining' and the inclusion if the matter in municipal waste plans (see FoA4).

FoA11: Reduction of emissions from sorting and recycling

Recycling operations represent a potential source of plastic litter just like any other waste handling activity and thus special care needs to be taken at several stages of the processes. (Heavy) winds, rains and scavenging animals represent pathways for plastic litter from land to sea from all waste handling and treatment facilities. Similarly to landfills (see FoA10), incoming wastes thus need to be covered, a full discharge from trucks must be ensured and (if not processed immediately) a safe place for storage provided. Recycling, especially of lightweight items (e.g. plastic foils) should always be performed in enclosed halls. The entire site should be secured e.g. by nets or fences to ensure that no litter leaks to the surrounding areas (especially waterways or the sea directly) and

[84] Document available at http://www.epa.ie/licences/lic_eDMS/090151b2805d615d.pdf

[85] The five options suggested by Cooper et al. (2012) are to do nothing, inspection and surveillance, remove the source of the risk, break the pathway between the source and the receptor, remove the receptor to the risk

premises where litter does escape needs to be cleaned regularly. Existing regulation in these fields need to be enforced and more attention could be paid during planning, approving and licencing of recycling operations. One of the main obstacles for policy action in the field of macro plastic leakage from recycling plants e.g. in Germany, is the lack of statutory threshold values for plastics in the environment. While other (gaseous or liquid) emissions are regulated, a legal basis for preventive action against plastic emissions to the air is not yet in place.

An area that is already regulated, although not sufficient, is emissions through bio-waste treatment processes and products. One of the most important measures to reduce this leakage is to ensure that the plastic content of separately collected bio-waste is reduced. Awareness for the issue needs to be raised (see FoA1) and information must be available in a form accessible and understandable for the target group. A clear understanding and associated communication of issues arising from the increasing usage of so-called compostable or biodegradable plastics is required as they seem to be undesired in conventional plastic recycling processes and some also cause problems in bio-waste treatment. Other sources of plastics in bio-waste that need to be addressed include packed food waste (e.g. through a ban for supermarkets to dispose of expired fruits of vegetables packed in plastic foils) and plastic litter collected with grass cutting waste (e.g. by picking litter from roadsides before cutting the greens, see FoA12). Besides these actions to reduce input, technical improvements (e.g. additional screening) to further reduce the plants' outputs may be required. Stricter limits (in EU and national legislation) and enforcement of the former can help generate improvements.

To reduce the risk arising from sorting and recycling residues, safe treatment or disposal options need to be chosen. Besides plastics sorted during bio-waste treatment, this is of special importance for those products where plastic is not the main focus of recycling, like plastic lids for containers made from other materials or various other examples (see F11). Safe collection on site, safe transfer to the site for treatment, where possible a form of recycling and if applicable safe final disposal must be guaranteed.

FoA12: Cleaning of litter on land

Cleaning the environment from plastic litter is an end-of-pipe solution and chances of avoiding marine litter by exploiting cleaning potential should not influence the efforts put into litter prevention. Nevertheless, once litter reaches the environment, cleaning of the polluted land or waterbody is necessary wherever possible, regardless of the source and pathway. Because cleaning practices are addressed by Action 54 of the OSPAR RAP ML, this chapter will only provide a brief overview of suggestions for improvements.

Responsibility for cleaning activities varies, depending on country and affected area. In England for example, local councils are responsible for litter clearance of the majority of roads (DEFRA, 2017). In Ireland, owners of or persons responsible for a "place to which the public has access" are required to keep the place litter-free and private property owners or occupiers must keep any outdoor area of a property that is visible from a public place free of litter (Citizens Information Board, 2019). Understanding of all affected actors (see FoA1) and capacities for enforcement (see FoA16) are prerequisites for similar regulations to guarantee more plastic being removed from the environment.

Technical improvements in cleaning activities are considered not implementable for wide parts of the OSPAR region. While large amounts of litter from large areas of roads or footpaths can be cleaned using sweepers, litter in more difficult to reach sites or tangled up in vegetation still re-

quires hand-picking. The values of 80% retrieval of litter within cities and only 50% outside of towns estimated by Bertling et al. (2018) (see F16) can still be increased, e.g. by increasing the frequency of cleaning. This could intercept additional amounts of litter where occurring, which is quite often on roads and footpaths, before it is transported (e.g. by winds or biota) to places where it is costlier to clean up.

Guidance provided by DEFRA (2005) for the UK, suggested areas of action for Council Leaders, Chief Executives, Cabinet Members and Service Directors and concludes that "increased quality of service often requires not extra resources but more effective use of existing budgets". To achieve this, actions regarding (performance) monitoring systems, coordination and development of staff and management skills through training across the sector are suggested. The development of comprehensive cleansing service delivery strategies is another way to address challenges arising from changing service requirements, e.g. from population growth or narrower night-time windows for significant street cleansing activities and others.

NABU (2018) propose that cleaning activities on streets or beaches should be (similarly to the provision of suitable waste bins, see FoA6) improved and adapted to be adequate for peak waste generation. The most important litter to clean from the perspective of marine litter prevention is litter on beaches and in other coastal areas from where it can directly reach the marine environment and in or around rivers from where it is transported to sea even over great distances. For these potentially costly operations, (innovative) funding must be secured, e.g. through extending EPR schemes to cover the arising costs (see FoA13). Beach and river clean-ups organized by NGOs are further seen as effective measures to raise awareness (see FoA1) for the problem of marine litter among (voluntary) participants.

It must be highlighted, that independently of who cleans, cleaning of litter on land must be conducted in an environmentally sound manner. If big machinery is utilized, which is the case on many tourist beaches, harm for biota may be caused. Similar harm may be caused if untrained staff or volunteers move through sensitive areas for the sake of litter picking. Still, environmentally sound cleaning should be extended beyond tourist beaches, also further inland. Activities must also not cause risks for cleaning staff, which could be the case in difficult terrain. The creation of environmental or safety standards could improve the situation. To fill financial gaps arising with greater cleaning efforts in responsible authorities, the operationalisation of the new EPR (see FoA13) requirements in the EU Single-Use Directive (see 3.3.3) should be fostered. If plastics producers need to contribute to cleaning of litter in the environment, great opportunities arise for marine litter prevention.

FoA13: Application of economic instruments

This chapter provides a brief overview of potential instruments and risks, with a special focus on *Pay-As-You-Throw* (PAYT) and *Extended-Producer-Responsibility* (EPR) schemes. Economic instruments for marine litter reduction are defined as instruments "increasing the relative monetary costs of economic activities that result in marine litter" (Oosterhuis, et al., 2014) and comprise incentives and disincentives. Under the European Strategy for Plastics in a Circular Economy (see 3.3.3), national, regional and local authorities are encouraged to "make better use of economic instruments, especially to raise the cost of landfilling and incineration and promote plastic waste recycling and prevention" (European Commission, 2018b). Annex IVa of the revised Waste Framework Directive (see 3.3.3) now lists examples for economic instruments to provide incentives for the application of the waste hierarchy. According to Dri et al. (2018), it is best environmental management practice to

apply economic instruments in waste management to prevent waste, encourage preparation for reuse and recycling of waste and to improve product design. Boteler et al. (2015) see a potential for marine litter reduction from broadening and adapting the application of economic instruments to this field and from expanding the geographic scope of existing instruments. Ten Brink et al. (2009) see great potential in additional research in the field. Oosterhuis et al. (2014), who proposed the application of economic instruments for marine litter control, emphasize that achievable marine litter declines depend on the "effectiveness of the chosen economic instrument, as well as the exact causal pathways that link marine litter with their original land-based sources".

A list of instruments compiled from Ten Brink et al. (2009) and Dri et al. (2018) comprised:

- Deposit refund systems (see FoA7);
- Taxes, charges or fees;
- Product levies;
- Fines, penalties, non-compliance fees (and their enforcement, see FoA16);
- Incentives and technical or financial support and subsidies;
- Waste pricing, such as unit-based pricing and pay-as-you-throw (PAYT) schemes;
- Extended producer responsibility (EPR) schemes;
- Green procurement (see FoA14);
- Tradable permits;
- Value added tax (VAT) exemptions[86].

Two of the underlying principles offering a foundation for economic instruments are the *Polluter-Pays-Principle* (PPP) and the idea of full cost recovery for waste management in one way or another without the need for the taxpayer to step in (Ten Brink, et al., 2009). In some countries, neither is fully applied and opportunities for more environmentally sound municipal waste management remain unexploited (Puig-Ventosa, et al., 2017). Newman et al. (2015) find, that polluters currently do not pay for the costs arising from marine plastic litter although the Waste Framework Directive requires member states to apply the polluter-pays-principle (PPP, see glossary).

Pay-as-you-Throw (PAYT) is a popular instrument to encourage waste reduction (Oosterhuis, et al., 2014) and should be considered "the most suitable option to ensure fairness in paying for waste management services" according to Bilitewski et al. (2018). Seyring et al. (2015) discover a correlation between the type of waste charge applied and the separate collection rate (see FoA7) and while cities applying PAYT generally show rather good performance, those that base their funding only on flat rates do not. Fixed costs for waste producers are usually combined[87] with variable costs raised under PAYT schemes based on volume (e.g. size of a provided container), pick-up (e.g. pick-up frequency) or on weight of mixed wastes (Bilitewski, et al., 2018). This incentivizes the separation of recyclable waste streams (see FoA7 and FoA8). Kaza et al. (2018) described the PAYT scheme implemented in San Francisco and highlight the importance of regular inspections and, in case of non-compliance with separate collection guidelines, financial penalties. Another risk besides the exploitation of the system by declaring mixed waste as recyclable waste is an increased motivation for illegal dumping (see F4) to avoid costs.

[86] Belgium introduced a reduced VAT rate applicable to reused products, 6% rather than the usual 21% (European Environment Agency, 2015).

[87] Bilitewski et al. (2018) find that fixed costs usually make up 60-80% of the fees and only 20-40% is sources from variable fees.

These risks do not apply under EPR schemes, which are required by the EU Waste Framework Directive. EPR shifts the financial responsibility for waste collection and treatment from municipalities to producers by extending "the responsibility of producers and importers to the post-consumer stage of a product's life cycle". EPR is usually implemented through one or more so-called producer responsibility organisations (PROs) on a national basis (Nordic Competition Authorities, 2016). EPR can provide multiple benefits, including "increased collection and recycling rates, reduction of public spending on waste management, reduction in overall waste management costs and design for environment innovations" (CBD, 2016). Van Acoleyen et al. (2014) identify a contribution to marine litter reduction in cases where PROs are also requested to financially contribute to waste prevention policies, which is the case in some countries.

Since the revision in 2018 (see 3.3.3), the Waste Framework Directive sets out general minimum requirements for EPR schemes. Such schemes must cover the costs of separate collection, transport and treatment (see FoA6-FoA8), the costs of providing adequate information to waste holders (see FoA1) and finally also the costs of data gathering and reporting (see FoA3). All schemes established before July 2018 must bear at least 50% of the arising costs, all schemes established later must bear at least 80%. At the same time, the contributions must not exceed "the costs that are necessary to provide waste management services in a cost-efficient way" (see FoA9). The recently adopted Directive on Single-Use Plastics (see 3.3.3) is intended to go even further and extend the producer responsibility for some of the plastic items most frequently found in the marine environment to costs for clean-up and further treatment of litter in the environment (see FoA12), which is currently borne by NGOs, tax payers or negatively affected industries who clean up themselves.

An issue not yet addressed by EU regulation, is the fact that significant amounts of the money collected under EPR schemes, which is ultimately paid for by the consumer, is currently used to pay fees and costs for exports of recyclable waste to countries where it may face a risk of becoming marine litter (see F17). The fees should instead be intended to extend the domestic plastic recycling systems and the requirement for EPR under the Waste Framework Directive to cover costs of "cost-efficient" waste management should be updated accordingly.

FoA14: Green Public Procurement

Inputs of marine litter from land-based sources can also be addressed by focussing on the potentials of Green Public Procurement (GPP). Because it is difficult to directly address marine litter risks in public procurement, waste prevention, separate collection and recycling should be focused. Public authorities spend around €2 trillion through public procurement (which represents 14% of the EU GDP) according to the European Commission (2016c) and therefore significantly contribute to waste generation. Accordingly, they are the principal buyers in several sectors and can start or support trends and new business models focussing on waste prevention, reuse, recyclability or recycled contents.

The European Strategy for Plastics in a Circular Economy encourages national and regional authorities to favour reusable and recycled plastics in public procurement (European Commission, 2018b). Since the reform of the EU public procurement system in 2016[88], public authorities are now allowed to require bidders to comply with environmental obligations or even the requirements of certain

[88] Directive 2014/24/EU on public procurement, available at https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32014L0024

labels. As part of a life-cycle costing approach, authorities are further enabled to consider "costs related to environmental externalities". Hansen et al. (2014) expected, that 'green solutions' are in many cases as cheap as or even cheaper than less green alternatives, if the external costs (total costs) are assessed.

Examples for existing GPP initiatives are available from several countries. In the UK, all consumer single-use plastics will be phased out from the central government estate offices[89]. In Norway, a budget of NOK 15 million has been allocated to work with guidance and expertise to promote climate and environmental considerations in public procurement in 2017. Strategies for the preference of products made from recycled material are e.g. applied in France, Germany, Norway, Spain, Sweden and other countries. A guide on how public procurement can support waste prevention and the circular economy and a green procurement task force to assist authorities on different levels will be established under the Danish national waste prevention strategy.

Hansen et al. (2014) identified lacking knowledge and competence to include relevant criteria in GPP among decentralized purchasers as one important barrier and accordingly suggest training of purchasers and provision of guidelines, e.g. in the form of breaking the abstract goal of waste prevention down to more specific requirements.

The role of competition in optimization within the waste management sector has been highlighted in F8. Besides potential positive effects from the competition itself, the aspect of procurement of public duties in waste management is also highly interesting when looking at the procurement processes. Between 2009 and 2013, an average of 10% of the EU member state governments' expenditure for waste management have been procured (Adamsen, et al., 2016). Once certain waste management practices or specifications of the former are identified as 'best practices to prevent marine litter', GPP in the waste sector can represent a powerful tool to require their uptake by contractors. Dri et al. (2018) suggest performance-based waste management contracting as a tool to achieve improvements and the Nordic Competition Authorities (2016) finds, that "embracing market solutions may create opportunities for new and innovative solutions that could bring about cost savings, reduce resource scarcity and generate an overall increased efficiency of waste management services".

The great potentials of GPP (represented both by the waste prevented or recycled by the public buyers themselves and the impact this can have on markets) should be utilized more progressively, also to contribute to marine litter prevention. This can be achieved by sharing best practice examples more widely. The first step though, will most likely be the identification and potentially revision of regulations hampering GPP efforts.

FoA15: Waste management concepts or practices for certain sectors

Best practices in waste management for the sectors identified as significant sources for marine litter (see F12-F14) need to be further identified, shared and taken up by the relevant actors. For some activities, waste management plans are already required or at least recommended in some countries. In any case, engagement of actors from all sectors should be fostered (LINK FoA2) and awareness should be raised for best practice examples and benefits of implementing these best practices,

[89] Further information available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

both in terms of (marine) litter reduction and potentially generated financial benefits for the actors themselves. Voluntary commitments of actors from all fields to exceed current legal obligations should be supported. Landon-Lane (2018) proposed to consider the principle of Corporate Social Responsibility (CSR) to address marine litter issues, especially for those cases, where currently no EPR scheme applies. While mandatory 'product stewardship' in the form of EPR should generally be the preferred option, CSR can also contribute to a shift of responsibilities from the consumers and the general public, to product or service providers, which can generate the benefits described in (see FoA13).

Table 4: Examples of suggested waste management practices in tourism, events, construction & demolition and agriculture

In the **tourism and recreational sector**, which is at the same time a significant source of marine litter (see F13) and heavily affected by its consequences (see 2.2), quantities of produced wastes need to be reduced, littering prevented, and waste logistics improved including paying more attention to separate collection. The main pathway of marine litter from tourism or other recreational activities is most likely littering and actions to prevent this are needed, e.g. prevention of waste generation (see FoA5), wide uptake of reuse solutions, the provision of adequate collection infrastructure (see FoA6) and enforcement of littering bans (see FoA16). Styles et al. (2013) find, that waste generated in accommodation establishments shows a similar composition as household waste and it is best practice to separately collect plastics, which cannot be avoided. Best practices to prevent plastic waste include efficient ordering and storage, local sourcing and packaging return, selection of low packaging products, efficient bathroom toiletries, provision of low impact drinking water and efficient breakfast provision. One of the factors influencing the efficiency of separate collection is simply the availability of the service in different locations. Further best practices for waste prevention and waste management in tourist cities are e.g. available from Bjørn Olsen et al. (2017).
At (coastal) **events**, innovative waste prevention and waste management can reduce marine litter inputs. Municipalities in several countries already require waste plans or specific measures if certain criteria apply. These waste plans or concepts can. include the installation of additional bins and thorough cleaning. Event organisers in Ireland are required to ensure litter control "before, during and after the event" and if authorities perform this task, the event organiser has to bear the cost (Citizens Information Board, 2019). NABU (2018) suggest, that the authorities authorising events should be obliged to require the application of multi-use products in combination with deposit systems where possible and BiPRO (2013) propose a ban on plastic bottles during beach parties, events and concerts.
To limit the leakage of waste from **construction & demolition** sites and activities, the creation of a waste management plan for each site is considered useful (Dri, et al., 2018). Multiple different types of plastic waste occur both during construction and demolition and providing infrastructure and guidance for separate collection of plastics on each site should thus be in the focus. Guidelines provided by the European Commission suggest minimizing packaging material coming onto construction sites in the first place and highlight risks of insecure and potentials of secure stockpiling of wastes on

sites. They further suggest that authorities should “set up integrated waste management strategies that allow for C&D waste management to be promoted in a more systematic way” (European Commission, 2016a). To fulfil recycling targets for demolition (and renovation) activities, the European Commission published guidelines for ‘waste audits’ that represent the waste planning step in demolition projects (European Commission, 2018d).

As for all outdoor activities where waste occurs, it must be ensured, that no litter can be blown of the site by winds and precautionary measures (like the installation of fences) need to be taken in wind-prone regions. Awareness raising (see FoA1) among and training of construction and demolition workers to prevent litter and safely handle plastics can prevent marine litter inputs. New approaches in enforcement of legislation and prevention of illegal activities are also important in this sector (see F14).

Issues arising from application of plastics in **agriculture**, which may ultimately lead to plastic leakage to the environment and the sea can be addressed in different ways. Currently, a common EU regulation on agriplastics is lacking, but several countries are addressing the issue in national legislation or strategies and different schemes and guidance are available. Potential marine litter reduction is assigned to legislation focused on ensuring collection, recycling and eco-design[90] and solutions include adopting plastic-free, reusable or recyclable alternatives, investments in collection and take back systems and facilities to transport, clean and recycle. Last but not least EPR schemes to guarantee the former investments and influence the markets yield great potentials (Environmental Investigation Agency, 2018). Under the EU Strategy for Plastics in a Circular Economy, national and regional authorities are encouraged to "consider introducing EPR, in particular to provide incentives for […] recycling agricultural plastics” (European Commission, 2018b). Industry organized take-back and recycling schemes for agricultural plastics are already in place in some countries[91].

In the available best environmental management practice reference document available for the agriculture sector, (Antonopoulos, et al., 2015) list management practices for agricultural wastes and advise farmers among others to use biodegradable plastics for mulching, to reduce silage film and correctly apply all films, to reduce losses and to separate waste at the source. A guidance document including ‘DOs’ and ‘DON’Ts’ for farmers to manage and minimise waste is available from the Scottish government[92]. The Comité International des Plastiques en Agriculture (CIPA) as the representative body and speaking voice of the plasticulture’s world has recognized the problem of marine litter from agriplastics and entered into the voluntary commitment that “no agricultural used plastics must be founded in the oceans”[93]

FoA16: Enforcement of regulations

It is widely acknowledged, that the best ways to deal with illegal actions causing litter in the (marine) environment is an integrated approach including awareness raising (see FoA1), service and infrastructure provision (see FoA6) and deterrence through fines and their enforcement. The need

[90] E.g. according to the new European standard EN 17033 on biodegradation of plastic mulch films

[91] One example is the German ERDE scheme (further information available at http://www.erde-recycling.de/startseite.html) organises collection and recycling of agriplastics and was implemented by producers of plastics for agricultural applications

[92] Scottish Government (2005)

[93] Further information available at http://cipa-congress.com/the-cipa

for increased enforcement of existing laws and regulation is regularly highlighted in the context of marine litter (Ten Brink et al. (2009), Hastings et al. (2013)), because substantial shortcomings (e.g. lacking capacities) in the field are identified in many countries, also in Europe. “Enforcement consists of all the measures that can be organised by law, leading to discovery, deterrent, rehabilitation and punishment”, according to Dri et al. (2018).

To discover illegal activities, like illegal dumping or littering, citizen notification systems have proven effective, yet concluding from the amounts of litter found in the environment it is obvious that the largest share of littering and illegal dumping is discovered too late to identify the polluter. If possible, following punishments usually take the form of fines, which have also been identified as a highly effective instrument to reduce marine litter inputs from littering in the North Sea area (Boteler, et al., 2015) and are existent in all OSPAR Contracting Parties in one form or another. In Scotland, local authorities or the police can e.g. issue ‘fixed penalty notices’ of £80 for littering and £200 for fly-tipping to give offenders the chance to pay the fixed sum and avoid a court case[94], in Germany the level of fines for littering and illegal dumping is set by the states and ranges from €5 to several thousands of Euros, depending on type of waste littered or dumped. In Ireland, on-the-spot fines of €150 are possible for littering and up to €130,000 for “causing environmental pollution” (Citizens Information Board, 2019). Generally, fine are considered rather low to deter polluters from littering or dumping waste illegally. Fines should be revised accordingly and increased if necessary. A popular and non-financial type of punishment is to use cleaning of public areas by picking litter as a sanction. While this may help to raise awareness (see FoA1) among offenders and at the same time support public cleaning efforts (e.g. in areas where cleaning is very labour-intensive, see FoA12), DEFRA (2017) suggests handling this approach with care to not “deter law-abiding citizens from volunteering to take part in these activities”.

The enforcement of household (or business) waste separation obligation by waste collectors (BiPRO, 2013) as well as supervision of waste management activities by the general public offer additional potential. Watkins (2015) reported that “in cases of non-compliance, advice or guidance is normally provided to the offender in the first instance, and solutions and timescales for improvements agreed where appropriate”. Enforcement e.g. in the form of a fine should only be applied if the softer approach is not effective. DEFRA (2017) also highlighted the importance of carefulness when exercising enforcement powers to punish littering in order to “uphold public confidence in a fair judicial system”. Actions should be accompanied by education measures and should be taken only for “relevant incidences” (e.g. when evidence of intent is available) and whenever they are “proportionate and in the public interest”.

DEFRA (2017) further elaborated, that effective enforcement as a part of an integrative approach against littering “should lead to a reduction in the need for enforcement action in the medium to long term”. Important actions to achieve this effect include the provision of guidance to enforcement authorities, awareness raising for potentials of effective enforcement among responsible authorities and active public outreach with enforcement successes to increase the deterrent effect. Enforcement efforts can also support the identification of prevention opportunities when generated data is examined accordingly (as part of assessment of systems, see FoA3). Frequently occurring offences in certain places or occasions can indicate low hanging fruits for intervention, e.g. by improving available services or infrastructure (see FoA6).

[94] Further information available at https://www.zerowastescotland.org.uk/content/litter-flytipping-enforcement

Enforcement of regulation is especially important to reduce the risk of marine litter generation as a consequence of exports of plastic waste and a first step should be to eradicate illegal exports of plastic waste. Only one out of 4 high-risk exporters was subject to an inspection in 2017 according to National Audit Office (2018). Capacity increases to increase this number of inspections can contribute to the goal. Rucevska et al. (2015) identify that "inadequate resources for monitoring, enforcement and low penalties" provide opportunities for large-scale transnational organized crime in the waste sector.

Best practices in the field of enforcement of legislation in the waste sector should be shared more broadly (see FoA17). To do this, initiatives to promote the sharing of best practice between local government officials have e.g. been created in Northern Ireland (DOENI, 2013). These include the 'Society of Local Authority Chief Executives' (SOLACE) and the provision of common enforcement training by Tidy Northern Ireland.

FoA17: Communication platforms and material

Different formats for sharing/disseminating information regarding marine litter and stakeholder involvement in general have been discussed and implemented all over the OSPAR region. Working groups on marine litter have been set up, for example, in Germany (National Round Table on Marine Litter), the UK (working group of stakeholders to tackle litter including items that reach the marine environment under the litter strategy) and Spain (a permanent technical group on marine litter will facilitate access to information and serve as an alternative platform for exchange of information). Formats, applied as communication platforms in the waste sector include among others a contact forum for waste established in Norway, a waste council in Sweden (to assist the Swedish EPA for ensuring efficient waste management) and a dedicated working group on litter abandoned or dumped on land in France.

Ten Brink et al. (2009) suggested the creation of "opportunities for all stakeholders (public and private sectors) to communicate, exchange information, share technological expertise, the latest marine litter research, guidelines, and successes". Velis et al. (2017) determine effective communication of best practice in waste management to prevent marine litter as the first task of the International Solid Waste Association (ISWA) Marine Litter Task Force. The authors highlighted the need to identify, analyse and communicate best and worst practices in this context and see themselves and the members of the ISWA in a leading role, which they plan to fulfil by disseminating ISWA's extensive knowledge base. The information/expertise to disseminate could e.g. include training materials for professionals in waste operations, ideas or knowledge of best practices.

Besides the communication between waste experts, processes to build capacities to share expertise and experience between authorities (both top-down and bottom-up, on all levels, national and international) is of significant importance. An example from Northern Ireland is the Improvement Collaboration and Efficiency Programme sponsored by the Northern Ireland Local Government Association (NILGA), which is only one of the existing initiatives to promote and share best practice between local government officials (DOENI, 2013). The format for the communication platforms and materials needed will be one of the main outputs of the proposed horizontal integration processes (see FoA2). Vernon et al. (2013) suggest that policy makers at local and regional level foster the exchange best practices between municipalities and that policy makers at member state level also facilitate coordination between authorities within the countries and with neighbouring countries, e.g. by providing platforms to share information and collaborate.

6 The institutional response

With 17 factors contributing to leakage of plastics from land to sea and 17 potential priority fields of action to prevent leakage of plastics and accordingly marine litter, this document provides an overview of the main interfaces between waste management and marine protection from plastic litter. Several fields of action (FoA1,2,4) indicate starting points to apply the knowledge and influence policy making. Because of often site-specific multiple factors influencing plastic leakages with different responsibilities as well as different waste management and legal regimes currently in place, recommending adequate institutional responses is complicated. Recommendations on how the issue of plastic leakage from land-based sources should or could be approached by actors on different levels (international, national, regional, local) thus usually highlighting the need for a holistic or integrated approach, leaving space to include site or case specific characteristics. This document has therefore been compiled to provide colleagues working in marine environmental protection with evidence and tools to engage effectively with their colleagues working in waste prevention and management to discuss and develop suitable approaches and solutions together.

The DPSIR 'conceptual framework for the identification of intervention points' provided by UNEP (2016) suggests that actors should assess drivers (e.g. food security, laziness), pressures (e.g. waste generation), states (e.g. plastics are found in the marine environment), impacts of an environmental problem and possible responses. After the problem is defined and its risk assessed, responses to the problem can aim at the driver (e.g. changing mentalities, see FoA1, FoA5, FoA13 and FoA15), the pressures (e.g. minimize waste, see FoA5, or reduction of non-recyclable waste, see FoA8), the state (e.g. collecting all waste, see FoA6, and cleaning up, see FoA12) or the impact. After measures are evaluated and ultimately chosen, UNEP (2016) highlight the need for "a process to review and monitor the risk and consequences of introducing the measure". A 10-step process is suggested both by UNEP (2018) for governments to address the marine litter problem arising from single-use plastics and by Orthodoxou et al. (2014) as an implementation guide for best practices on a local level. The latter comprises identification of local specificities, review existing best practices, selection of the most suitable practices, preparation of an action plan, definition of a SMART (specific, measurable, achievable, realistic and time-bound) target, engagement with the key target groups and stakeholders, awareness raising for the problem and the proposed solutions, implementation the chosen practices, monitoring of the progress, and ongoing monitoring of marine litter levels.

Key elements of the institutional response to ongoing marine litter inputs from land-based sources into the North-East Atlantic should include the following elements:

1. **Ensure a dialogue between marine litter/marine protection actors and waste management actors:**
   As a crucial first step, raising awareness for the ongoing marine litter inputs from land-based sources into the North-East Atlantic was identified. Awareness raising measures addressing awareness for the problem as well as what actors can and need to contribute are necessary. Entering into a dialogue with actors in waste management is the basis for horizontal integration processes, which require motivation for collaboration from all parties involved. While this motivation is partly guaranteed by the requirement of the revised Waste Framework Directive (see 3.3.3), actors in waste management need to incorporate the protection of the marine environment into the reasoning to expansion of legislation or management activities.
2. **Create and/or exploit the legal basis to get active:**
   National, regional and local waste legislation, regulation and strategies should reflect the

need to get active in the field of land-based waste management in order to prevent marine litter. Waste legislation must aim to contribute to reaching the target of 'no harm' caused by marine litter and in order to achieve this state, obligations, requirements and enforcement are necessary. Additionally, legal basis for supporting voluntary initiatives is desirable, as is the general provision of legal security for actors on the local level who are implementing measures on different scales. This support is frequently mentioned in those cases, where measures represent (or in some other way cause) market restrictions.
The update of national waste legislation according to the requirements set by the revised EU waste framework and legislation should be seen as a chance to initiate horizontal integration and design the process of transposition in a way that ensures ongoing involvement of relevant actors from different fields.

3. **Start the integration process with assessing waste management performance to identify those factors contributing to leakage relevant in the site and context:**
   Different criteria for the assessments of waste management systems' performances are available. These include collection or recycling quotas, littering rates (e.g. drawn from litter monitoring or street cleaning activities) or others. The application of statistical methodologies to identify leakage of plastics is promising. The creation of a 'heatmap' for litter in the area, accounting for the characteristics of the area (e.g. roads, tourism, industries, population or landfills) or monitoring data can represent a major contribution to local marine litter source identification. Identifying the main factors contributing to leakage of plastics in a specific site and context will make targeted action possible.
4. **Evaluate possible measures and discuss with wide stakeholder participation:**
   While this document identifies potential priority fields of action, multiple collections of recommended actions to combat marine litter are available. Due to site and context specific differences, resources being limited, and some actors potentially being required to 'pay a higher price' than others, depending what measures are installed, thorough evaluation of measures is an essential requirement, especially for nationwide measures. BiPRO (2013) suggest considering measures' 'administrability'[95], 'affordability'[96], 'effectiveness'[97] and 'transferability'[98]. In the report prepared by Ocean Conservancy (2015) measures are evaluated regarding their 'ease of implementation' and expected monetary or monetized 'net benefits'. Willis et al. (2018) follow a rather sophisticated and thus not necessarily in all circumstances practical modelling approach to identify the optimal response to marine litter and highlight the importance of 'integrated solutions'. Loizidou et al. (2014) created the evaluation tool 'DeCyDe-4-Marlisco' for the best practice examples identified under the MARLISCO project, which is not only seen as a tool to assess possible measures, but also as

[95] Feasibility of carrying out a measure against the administrative, infrastructural, cultural, socio-economic and geographic context

[96] Negative and positive costs related to the implementation (public, industry, other actors concerned); Socio-economic costs/benefits (particularly job losses and gains); Time needed for implementation

[97] Relevance with respect to marine litter; Expected measurable changes in amount of marine litter and/or in amount of waste produced or possibly entering the marine system; Coherence (possible dependency, complementarily or disturbance between measures); Community added value; Sustainability (sustainable availability of funds; continuous or one-off impact); Political effectiveness (addressing loopholes & gaps per regional sea/Member State); Monitorability (time and efforts required); Evidence of Effectiveness, probably the most important

[98] potential and limitations to implement a measure for other countries, geographic areas, target groups

a tool to enhance stakeholders' participation in marine litter prevention.

A special focus needs to be put on potential risks arising with the implementation of any measure. These risks include among others spatial relocation of practices or industries, substitution of undesirable products or practices with others, which do not represent an improvement for marine litter prevention or cause other negative environmental effects (e.g. greenhouse gas emissions).

ARCADIS (2014) observe wide public support over all sectors and all suggested measures to reduce presence and impact of marine litter[99], including the four recommended actions for the waste management sector. The most strongly recommended action in waste management is 'more efficient recycling', followed by 'source separation', 'exchange ideas' and 'training'. According to Loizidou et al. (2014), stakeholders prefer "preventative measures rather than mitigating actions", "practices with high degree of social responsibility" and "initiatives that involve the public and promote active citizenship".

5. **Implement measures and monitor their effects by applying adequate indicators:**

   Implementation of measures must be planned in steps beforehand. If these steps are followed, a wider stakeholder support can be expected throughout implementation. Results of previous discussions must be considered and potentially reconsidered during implementation. This should happen on the basis of intermediate findings, which are drawn from monitoring of the measures' effects. Loizidou et al. (2014) highlight the importance of monitoring data to record and document the impact of a best practice, which otherwise is hard to assess.

   Transparency is of significant importance, especially if the support of many actors is required for an effective measure. Clear responsibilities and the ability to continuously steers developments, contribute to success.

6. **Actively share experiences:**

   Since marine litter prevention and ultimately reaching the goal of 'no harm caused by marine litter' need to be aimed at jointly, a special focus should be put on ways of sharing experiences with other actors on national, regional and ultimately global level. Communicating positive as well as negative experiences with plastics leakage and measures with other institutions, actors or organisations nationally and internationally require according platforms.

[99] In the public consultation conducted in the end of 2013, public perception regarding recommended actions for authorities, the plastic industry, the retail and the tourism and recreation sector was evaluated. With only one exception (adopt-a-beach schemes), the majority of respondents rated all suggested actions as 'strongly recommended'.

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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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