

Acute plastic pollution: causes, problems and solutions



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Acronyms and abbreviations

Acronym/Abbreviation	Explanation
BC	The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal
CBD	Convention on Biological Diversity
CCC	IMO Sub-Committee on Carriage of Cargoes and Containers
EMSA	European Maritime Safety Agency
EU	European Union
GPML	Global Partnership on Marine Litter
HELCOM	Helsinki Convention, regional sea convention on the Baltic Sea
HNS	International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, also known as the HNS Convention
HTW	IMO Sub-Committee on Human Element, Training and Watchkeeping
III	IMO Sub-Committee on Implementation of IMO Instruments
IMDG	The International Maritime Dangerous Goods (IMDG) Code
IMO	International Maritime Organization
IMSBC	International Maritime Solid Bulk Cargoes (IMSBC) Code
KIMO	Kommunenes Internasjonale Miljøorganisasjon (Local Authorities International Environmental Organisation)
MARFO	Norwegian Centre against Marine Pollution
MARPOL	The International Convention for the Prevention of Pollution from Ships (MARPOL Convention)
MEPC	IMO Marine Environment Protection Committee

MSC	IMO Maritime Safety Committee
MSFD	Marine Strategy Framework Directive
NCSR	IMO Sub-Committee on Navigation, Communications and Search and Rescue
OSPAR	Oslo-Paris Convention, regional sea convention on the NE Atlantic Ocean
POP	Persistent Organic Pollutants
PPR	IMO Sub-Committee on Pollution Prevention and Response
PRF	EU Port Reception Facilities Directive
SDC	IMO Sub-Committee on Ship Design and Construction
SOLAS	The International Convention for the Safety of Life at Sea
SSE	IMO Sub-Committee on Ship Systems and Equipment
SUP	EU Single Use Plastics Directive
SwAM	Swedish Agency for Marine and Water Management
UN	United Nations
UNCLOS	UN Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WFD	EU Water Framework Directive
WD	EU Waste Directive

Executive summary

Introduction

In 2020, the Motor Vessel Trans Carrier, a cargo ship sailing from the Netherlands to Norway, lost 13.2 tons of plastic pellets. As a result, part of the coastlines of both Norway and Sweden were polluted by plastic pellets. This posed a number of problems and raised questions with the national governments: what is acute plastic pollution, how to deal with this form of plastic pollution effectively and can it be prevented? Those are the reasons why the Nordic Council of Ministers initiated the research presented in this report. In order to determine an effective approach, interviews were held and literature was reviewed, evaluating laws, policies and four maritime incidents where pellets were lost.

Conclusions

In this report Acute Plastic Pollution (APP) is defined as "pollution caused by the sudden and unexpected release of a large amount of small plastic items that requires immediate response to protect human health and/or the environment". The loss of plastic pellets presents a unique challenge, particularly when the loss is catastrophic. It is estimated that globally 230,000 tonnes of pellets enter the environment annually. The actual figure is not known. When spilled, there is no easy way of cleaning-up pellet pollution from the environment, the challenge is significant as no "one size fits all" solution exists. Mitigation and ultimately prevention is key. Prevention starts with addressing the value chain of plastics, by ensuring to significantly limit losses during production and transportation of pellets and during their application for the production of plastic end products. Neither the current legislation for more secure stowage of containers on container ships transporting large amounts of pellets, nor technical measures are sufficient to prevent loss of small plastic items like pellets. At national or regional sea basin level, there are no general contingency plans present for addressing acute plastic spills and their environmental and economic impact. Plastic pellets are not currently labelled as a "hazardous substance", either internationally, regionally, at EU-level, or nationally in the Nordic countries. As a result, they are not included in nor addressed by most existing legislation apart from a few national examples. Political lobby is needed to change this.

A considerable number of international agreements and policies at UN and international level on pollution are in place. However, many of those do not specifically address acute plastic pollution or are of a voluntary nature and thus not

legally binding. There is an organisational framework for the coordination of activities in the chain underway, through the implementation of Resolution UNEP/EA.5/Res.14, which is entitled *"End plastic pollution: Towards an international legally binding instrument"*, but this will take time and it is not known whether acute plastic pollution will be included in the final text. At regional level, the Bonn Agreement, Copenhagen Agreement and the Arctic Council, in addition to the Helsinki Agreement, have very concrete plans for preparedness, international coordination and joint action in case of acute pollution. Although the focus of these plans is not on acute plastic pollution, they can help to inform the development of specific plans to address acute plastic pollution events and pellet spills.

Recommendations

Derived from the conclusions, the following recommendations are proposed which are divided over the international, regional and the national level:

Recommendations for the international level

1. Assess the magnitude and locations of acute plastic pollution and especially that of pellet loss.
2. Agree on an internationally accepted definition for acute plastic pollution for application in international and national pollution control acts and policies.
3. Classify pellets officially as hazardous goods at UN level, so that they are covered by stricter regulations for transportation and carriage, etc. Including plastic pellets in international agreements would be helpful as it would automatically include them also in national legislation on dangerous goods.
4. A supply chain approach as proposed in detail by OSPAR (OSPAR, 2018), Fidra (Fidra, 2020) and others whereby all companies involved in making, using or transporting pellets need to commit to following specific and standardized guidelines that prevent pellet loss throughout all stages of plastic production, like a strict application of Operation Clean Sweep.
5. The reporting system on cases of incidents needs to be improved – from ship to port, from port to responsible agencies, as well as between agencies in different countries – to give the best possible conditions for containing the spill, predicting how the pellets will spread and preparing for coastal clean-up without losing valuable time.
6. General awareness of the pellet's pollution problem should be raised, transport companies and ship owners encouraged to take action also before legislation is in place, to train their staff properly. All companies in the plastics value chain should be encouraged to join the Operation Clean Sweep programme that must be regulated stringently.
7. The problem of APP should be recognized in European plastics strategies and in the upcoming Global Plastics Treaty.

8. Incorporate acute plastic pollution in a legal framework with concrete actions for preparedness, international coordination and joint actions. This could be done under the Bonn Agreement, Copenhagen Agreement, the Arctic Council or the Helsinki Agreement.
9. Prevention is key, hence, measures that could be considered regarding prevention of APP in the shipping industry are:
 - a. Revise the existing technical and legal regulations for container ships regarding the design limits of cargo securing equipment, approved loading and stability conditions and the consideration of shallow water effects and speed on ship motions and resulting accelerations and forces.
 - b. Evaluate and assess possible technical solutions that can assist the captain/crew in the prevention and, if an accident happens, the detection of the loss of containers and to propose international standards for implementation of such solutions.
 - c. Raise awareness and develop guidelines for the Masters and Navigational Officers on risks and actions to be taken when cargo is lost when sailing with dangerous cargo particularly near sensitive areas. \
10. Encourage the development of improved clean-up technology of plastic pellets in water environments, on beaches and shores.

Recommendations for the regional (sea-basin) level

1. Research what the magnitude of the acute plastic problem is. Include an overview of where plastic pellets are produced and the transport routes, create more knowledge on the impact of spills to understand the severity of the problem better and to assess the risks. Existing frameworks like HELCOM and OSPAR should exchange knowledge and best practice and work together on the issue.
2. Establish standardized disaster response protocols for acute plastic pollution incidents. The Bonn Agreement and the Copenhagen Agreement have protocols for international cooperation on emergency response to acute pollution of the marine environment. These protocols could possibly be applied more widely to include plastic pollution. The organisations could work together, sharing best practice on emergency response and clean-up operations.

Recommendations for the national level

1. Prepare an acute plastic pollution contingency plan nationally, including how to:
 - a. Organise the clean-up operations of acute plastic pollution and possibly a combined oil and chemical spill. The clean-up of APP should be led by the same governmental agency that is responsible for handling other forms of acute marine pollution. The approach and emergency plans used when working with larger oil spills also works with this kind of pollution.
 - b. Communicate with the responsible polluters, insurance companies and other stakeholders using one single contact point. This makes it easier to establish common goals for the operation, secure compensation of cost, etc.
 - c. Inform and acquire information from the public.
 - d. Coordinate communication with and emergency support from neighbouring countries and other countries of relevance.
 - e. Implement surveillance and salvage of the wreck and containers (if present), and the area affected by acute plastic pollution.
 - f. Assess the environmental damage over the short and longer-term.
 - g. Support impacted economic sectors, particularly coastal fishing communities and the tourism industry.
 - h. Investigate legal and financial issues associated with the incident.
 - i. Address filing of compensation claims.
2. When an acute pollution incident occurs, organise a rapid response, clean up the plastic before it relocates. This requires preparedness to mobilize people on short notice. Ensure that responsible authorities have links to those structures and schemes for coastal clean-up that exist in each country, and that can mobilize local communities, associations, schools and volunteers on short notice. Promote and support such structures/schemes. Ensure that they know how to handle plastic pellet spills. In a clean-up operation it is valuable to hold regular meetings where the different stakeholders can share their knowledge of methods and experiences along the way.
3. Ensure that there is an interactive reporting system available to relevant actors and to the public where finds, photographs, material collected, et cetera can be recorded.
4. There should be preparedness to analyse the plastics lost. There are many different types, some more harmful than others. The analysis is also an important part of finding the source of the pollution. By analysing the plastic and through industry networks it is possible to see where it was produced.
5. Every country should ratify relevant conventions on pollution, including those

that (will) address acute plastic pollution.

6. The Nordic countries should be in the frontline to spread best practice globally, and when possible, to introduce stricter regulations before international rules are in place.

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Members of the Steering Committee

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Interviewees

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1. Introduction

Our oceans are of utmost importance to life and our own survival and wellbeing, they regulate our climate, provide food and recreation, and mental and physical wellbeing (Vierros, et al., 2015). Notwithstanding their importance, our oceans are under severe threat. An assessment conducted for UNESCO showed clearly that most, if not all, marine nature sites globally have been affected at least to some extent by plastic waste (Mannaart, et al., 2019). In response to the problem, there are global efforts to remove existing plastic litter from the marine environment, for example through schemes such as the collection of passively fished waste, which forms part of the EU Port Reception Facilities Directive, and the Fishing for Litter scheme (Mannaart & Bentley, 2022 and 2017). A considerable part of clean-up operations is carried out by both volunteers and professionals, and financed by either/or private business, foundations and authorities (local, regional, and national level). However, collecting and removing plastic waste from the marine environment, and especially addressing plastics that are small or have been degraded into micro- and nanoparticles is challenging. While clean-up activities are extremely valuable, the prevention of further inputs of plastics into our seas ('turning off the tap') is vastly preferable if we are to try to mitigate the effects of plastic pollution to a point where it does not harm the marine environment. There are many good intentions that have been turned into policies and even measures to address this huge challenge. Despite these, pollution by plastics of our environment including the seas and oceans still occurs both unintentionally and intentionally. Pollution caused by mass emission of small plastic items and especially plastic pellets is a particular challenge, and the basis upon which this report was commissioned.

1.1 Background

On 23 February 2020, the Motor Vessel Trans Carrier, a cargo ship, sailing from the Netherlands to Norway, lost 13.2 tons of plastic pellets. As a result, part of the coastlines of both Norway and Sweden were polluted by plastic pellets. Shortly after the incident, local governments and volunteers started extensive clean-up operations and tracing of the source began. The clean-up operations proved to be very difficult and time consuming, while pellets kept on spreading over the coastline and at sea (Nyberget, 2021). The environmental risk to the marine and coastal ecosystems from this incident was high, and remains so to this day plastic pellets cause harm to fish, marine mammals and seabirds through ingestion, and eventual breakdown into microplastics, with the associated risks to human health when these enter our own food chain. This case of "Acute Plastic Pollution" triggered a discussion in Norway and within the Nordic countries on the importance of Nordic cooperation on acute plastic pollution. The Nordic countries acknowledge this

problem. The Nordic Council of Ministers have as part of their action plan for 2021-2024 included a high ambition "to act as an international driver of global agreements against marine plastic waste and microplastics". In addition, the Nordic Region is seeking to put in place "an ambitious framework for biodiversity and a new agreement on chemicals and waste" (Nordic Council of Ministers, 2020). As a result, an assignment was formulated and issued to assess the current state of play of acute plastic pollution globally and in the Nordic region and what policies, legislation and measures exist. It is expected that this research will assist the Nordic Council of Ministers to define an effective approach to address acute plastic pollution for the Nordic countries as a whole.

1.2 Purpose and structure of this document

Prevention and mitigation of acute discharges of plastics, both through appropriate and effective response and through preventive measures, will make a significant contribution towards limiting further input of plastics into our seas. This report aims to lead the way by describing the policies and legal frameworks that apply, important spills that occurred and by defining measures that can be applied to address the issue effectively. After this introduction (chapter 1), the problem is described: the nature, composition, amounts and impacts of marine litter and acute plastic discharges are covered in chapter 2. The emphasis of the pollutants described in this chapter is on plastic pellets. The regulations, measures, stakeholders and their roles and responsibilities and gaps in regulations are described in chapter 3. Chapter 4 describes the discussion and conclusions, and chapter 5 presents recommendations on the way forward. Chapter 6 is on the references and concluded is by the annexes.

1.3 Methodology

1.3.1 The approach applied

To assess the nature of the problem, its magnitude and the way it is addressed both internationally and nationally, and to be able to define solutions, the following approach was applied:

1. After contact with the client on the needs of the assignment, a set of research questions was defined that form the core of this assessment.
2. Next, a conversation with the client was organised for specific requests and further agreements on the process and updates on the progress of the study.
3. Relevant stakeholders in Nordic countries and beyond were contacted to announce that the project has started and that they will be contacted for information.
4. A literature review was conducted.
5. In line with the research questions, interview questions were designed and

interviews with stakeholders were held (see the next section and annexes I and II for more details).

6. A first draft report was submitted on 30 December 2022, and discussed with the client.
7. Comments on the 1st draft report were elaborated in the report.
8. An internal stakeholder workshop for reflection and acquiring additional input was elaborated.
9. Comments of the steering committee's members on this 2nd draft were received and elaborated into a 3rd draft.
10. On 30 May 2023, a launch event was organized, to present the outcomes of the research and the report as next step for addressing the issue of plastic pollution in the Nordic region and beyond.
11. Comments on the 3rd draft were provided and elaborated into the final report during the first half of June 2023.

1.3.2 Research questions

The research questions that were defined and are answered in the next sections of this report are:

1. What is the nature and magnitude of plastic pollution, emphasizing the marine environment?
2. What is acute plastic pollution and what is its nature and magnitude, emphasizing the marine environment?
3. What acute plastic pollution incidents of a relevant magnitude occurred at the Nordic countries and globally?
4. What approach was applied during clean-up operations after acute plastic pollution incidents?
5. What relevant (global) agreements and regulations are present that address acute plastic pollution?
6. What organisational structure(s) are present at regional and national level and what cooperation exists between countries to address acute plastic pollution?
7. What guidelines and measures could be considered to be used for addressing acute plastic pollution?
8. What gaps are present regarding prevention, emergency response and clean-up of acute plastic pollution, after analysis of the legislation and policies at UN, EU, Nordic regional and national level?

2. Acute plastic discharges: the problem, types, their composition and sources

2.1 A brief introduction to the problem of plastic pollution and its impacts in general

2.1.1 Amounts, nature, composition and impacts

It is estimated that since 2018, around 359 million tonnes of plastic is produced globally per year (Napper and Thompson, 2020) and it is expected that production will double in the next 20 years (European Commission, 2018; Napper and Thompson, 2020). The OECD states that even in 2019, 460 million tonnes of plastic was produced leading to 353 million tonnes of plastic waste. Of this waste, about 50% ends up in landfill, 22% is not managed at all and only 9% of the plastic waste is recycled (OECD, 2022). The other percentages were not mentioned by the sources. Recent estimates suggest that since 2019, about 22 million tonnes of plastic materials enter the environment each year. Of this amount between 6.1 (OECD, 2022) and 8 million tonnes (Napper and Thompson, 2020) of mismanaged plastic waste enters the oceans every year and there is evidence of increasing quantities over time. A 2021 study estimated that more than 17 million metric tons of plastic enters the oceans, which makes up 85% of marine litter (United Nations, 2022a).

2.1.2 Sources and pathways of plastic pollution

Sources of plastic marine litter are diverse, and can be land-based, riverine, sea-based and even airborne (Mannaart et al, 2019). Most of the sources of plastic waste are land-based, due to the fact that its production, consumption and dumping mainly takes place on land. Landfills, inadequate waste management practices, fly-tipping, domestic and industrial effluents and sewer overflows also play a significant role (Veiga, 2016), both as a source and a pathway. Other sources include untreated municipal sewage, construction and demolition, ship-breaking yards, and agricultural activities (Werner, 2013). The main sources of plastic debris found in the ocean are land-based, coming from urban and storm water runoff, sewer overflows, littering, inadequate waste disposal and management, industrial activities, tyre abrasion, construction and illegal dumping. Ocean-based plastic pollution originates primarily from the fishing industry, nautical activities and

aquaculture (IUCN, 2021). A large part of plastic pollution is non-acute. Rivers are the main pathways for the transport of marine litter from land and especially for its land-sea interaction (Mannaart et al., 2019). Meijer et al. (2021) estimates that more than 1000 rivers account for 80% of global annual plastic emissions, which range between 0.8 million and 2.7 million metric tons per year. Of those, small urban rivers are among the most polluting ones.

2.1.3 The Definition of Acute Plastic Pollution

The nature of plastic pollution is presented in the previous section. The focus of this report, however, is on a part of plastic pollution, acute plastic pollution, but what is that actually? The Norwegian Pollution Control Act, chapter 6, paragraph 38, defines *acute pollution* as follows: "For the purpose of this Act, acute pollution means significant pollution that occurs suddenly and that is not permitted in accordance with provisions set out in or issued pursuant to this Act" (Ministry of Climate and Environment of Norway, 2023). Another definition is: "acute pollution means significant pollution that occurs suddenly and demands immediate response to protect human health and the environment" (Lawinsider, 2023).

An important issue is the size limit of the plastic objects described. One could, for example, apply the 5 mm size limit used for microliter, or leave it out of the description. In the description that is applied in this report this limit is not included, allowing a rather broad range of items to be addressed. Despite the fact that literature often refers to plastic pellets to be causing acute plastic pollution, the definition implies that the objects' size could include both other small but larger plastic items as well. Concerning smaller objects think of plastic powders and flakes and regarding larger ones, biocarriers are an example. For the purpose of this document, acute plastic pollution is defined as:

Acute Plastic Pollution (APP):

Pollution caused by the sudden and unexpected release of a large amount of small plastic items that requires immediate response to protect human health and/or the environment.

2.2 Acute plastic pollution, emphasizing plastic pellets: the nature of the problem

2.2.1 Nature, composition and amounts

As stated above, a special type of plastic pollution and especially acute plastic pollution is caused by the loss of plastic pellets. Plastic pellets are a specific group of plastic items within the overarching group of marine plastic litter. They are small granules of usually a few millimeters across, so sit readily within the group termed as microplastics. Together with plastic flakes and powders, they are considered to be an industrial raw material. Most of the consumer products made of plastics are comprised of plastic pellets that are melted down, molded, and then remolded into shape as required (Polyvisions, 2022). Plastic pellets are made of refined crude oil and other additives (MARFO, 2022), so they can be composed of a range of plastic types like e.g., polyethylene and many others. The composition of plastic marine litter matters, because this determines a part of the impact on the environment. Plastics Europe state that the most abundant plastic type demand in Europe in 2019 is PE (Polyethylene), in either high, medium or low-density varieties, making up 31% of the total plastic demand (Plastics Europe, 2021). The second most abundant type is PP (Polypropylene, used mostly for packaging materials).

The acute plastic pollution on the shores of Norway and Sweden in 2020 consisted of these PP pellets. Research on the coastal areas around Texas in the USA showed that over 80% of the pellets are made of polyethylene, corroborated by the analysis of the pellets on the beaches of Sri Lanka, after the acute plastic pollution disaster from Motor Vessel X-Press Pearl in 2021 (de Vos et al., 2021). In that case, mostly low- (LDPE) and some high- (HDPE) density polyethylene was found. The rest is mostly polypropylene (PP), polyester, polystyrene, polyethylene-vinyl acetate, and polyvinyl chloride (Jiang et al., 2022). With regard to quantities lost, it is estimated that globally 230,000 tonnes of pellets enter the environment annually (Eunomia Research and Consulting Ltd., 2016). The European Union alone produces between 58-70.6 million tonnes of plastic pellets per year (Hann et al., 2018). This equates to up to 1,400 billion pellets entering the environment per year (OSPAR, 2018). Furthermore, there is estimated that the three biggest sources of pellet losses are producers, intermediary facilities and converters/processors. The estimated total pellet losses in Europe amounts per year to between 16,888 tonnes and 167,431 tonnes (Han et al., 2018; OSPAR, 2018).

2.2.2 Impacts

It is obvious that considerable amounts of plastic pellets enter the environment, but what effects do they have?

1. Pellets can be present on land (Operation Clean Sweep, 2022a), enter freshwater and marine environments (Environmental Protection Agency Victoria, 2022) and lagoons (Partow et al., 2021).
2. Pellets can cover and/or mix with sediments, especially when present on sandy beaches (Foekema et al., 2021; Partow et al, 2021; Kystverket, 2020a).
3. Plastic pellets washed up on shores could create secondary pollution and expansion of the pollution to land during removal and cleaning operations (Partow et al., 2021).
4. When large numbers of plastic items enter the sea the levels of those could remain elevated for a considerable period of time, even years. This applies also to plastic pellets, as is suggested by finds of pellets washed-up on beaches (University of Groningen, 2023; Natuurmonumenten, 2020).
5. Pellets can attract and carry chemical pollutants on their surfaces (Environmental Protection Agency Victoria, 2022).
6. Plastic pellets can create additional pollution and risk to the environment and/or health when burnt or/and mixed with other substances (Partow et al, 2021).
7. Pellets can enter the food chain, causing aquatic and marine animals that eat those to become sick or die, and can impact human health. (Environmental Protection Agency Victoria, 2022)
8. Furthermore, plastic could also function as a vector of dispersion for marine species with an invasive potential (García-Gómez et al., 2021). This may also apply to pellets.

2.2.3 Sources and pathways for dispersion

There are many reports on pellets loss during transport, storage and production. Some examples: the *Swedish Environmental Research Institute* (IVL) issued a report in March 2016 on: "*Swedish sources and pathways for microplastics to the marine environment*". The report estimated the total loss of industrially produced plastic pellets in Sweden in connection to manufacture and handling to between 300 and 530 tons per year, but the volumes discharged to the sea were described as unknown. It quotes two earlier reports (Franeker and Law, 2015; Morét-Ferguson et al., 2010) that are claiming that the amount of pellets found in the oceans has decreased by approximately 75% over the last decades, but it also quotes another report (Norén, 2007) about a very high concentration of pellets in an industrial harbour in Sweden. Although acute plastic pollution from ships at sea is not explicitly addressed in the IVL report, the authors point out that "*industrial plastic*

pellets and powders are transported in different types of containers by train, truck or boat from manufacturers to processors. Some material will be spilled while loading or reloading, during transport or at the processing facilities"...There is however no published data on the amounts of released pellets or prevented release of pellets..." (Magnusson et al., 2016).

In 2018, the *University of Gothenburg* presented a report on plastic pellet spills from a polyethylene production site in Stenungsund on the Swedish west coast, claiming that millions of pellets enter the surrounding waterways annually. That plastic spills also occur during transport, storage, loading and cleaning. Furthermore, that the main pollution is local but long-range transport may also be possible. Additionally, that there is a regulatory framework that could to a high degree prevent the pollution and that there was an urgent need to increase the responsibility and accountability of these spills (Karlsson et al., 2018). A paper from Danish NGO Plastic Change and international NGO Fauna & Flora in 2018 includes reports from field studies conducted close to plastic production facilities, where pellets had been detected in the environment in six out of seven locations (Plastic Change, 2018).

2.3 Acute Plastic Discharges

2.3.1 Acute plastic discharges at sea

2.3.1.1 Incidents in the Nordic region

The Trans Carrier incident

On 23 February 2020 the container ship M/V Trans Carrier sailed into severe weather in the North Sea about 120 nautical miles south-west of Esbjerg. The ship was on its way from the INEOS factory in Rotterdam to the Norwegian pipeline manufacturer Pipelife in Surnadal. Suddenly, the ship was hit by several large waves and as a result 14 containers moved sideways. One container was damaged and its contents, 13.2 tonnes (equal to 620 million pellets) made of polypropene were partly released into the sea. The company who managed the ship, Stødig Ship Management, Part of SeaTrans Group, Norway, reported the incident to the Norwegian Coastal Administration to the port of destination, Tananger in Norway. Furthermore, the ship owner's insurance company was informed as well (Oslofjordens friluftsråd, 2021a).

Initially, the amount of lost pellets was underestimated and there was also an internal misunderstanding at the coastal administration about the location of the incident. As a result, no further measures were taken (Gard, 2022).



Figure 1. Plastic pellets on the Norwegian coast after the Trans Carrier incident

Source: Norwegian Coastal Administration

Since plastic pellets are not covered by MARPOL, there are no legal requirements for their storage and packing. Thus, the spill was not considered a potential environmental risk and subsequently the company did not have any specific procedures for transportation of pellets (Oslofjordens friluftsråd, 2021b). As of three weeks after the incident, increasing amounts of plastic pellets were discovered on shores in Scandinavia. This happened mainly in the Oslofjord area in Norway, but also on the Swedish west coast and to a limited extent in Jutland, Denmark.

In the Oslofjord area, cleanup operations were initiated by the municipalities concerned and coordinated by Oslofjordens friluftsråd. This is the Oslofjord Outdoor Recreation Council, a cooperation of the 23 municipalities and three regions situated along the Oslofjord. An interactive map was launched where the public could report finds of pellets. Soon after its launch, hundreds of reports were made. Due to the long distance between the locations where pellets were found and the place of the incident (550 km), the findings were at first not connected to the Trans Carrier incident. A few weeks later, pellet samples from three different sites in the Oslofjord area were analysed by Norner, the Polymer Institute of the Norwegian Material and Plastics Industry. The results were presented on the 15 April, and identified by Operation Clean Sweep, a voluntary programme in the plastics industry, as coming from the Trans Carrier incident. This was acknowledged

by the shipowner, Sea-Cargo, in a press release of 3 May 2020 (Oslofjordens friluftsråd, 2021a). Since the amount of pellets on the beaches increased as did the scale of the cleanup operation, Norwegian ministries declared on 7 May the incident to be "acute pollution" as defined in section 38 of the Pollution Act. This led to the launch of a so-called "national action". Oslofjordens Friluftsråd coordinated the action on behalf of the Norwegian Coastal Administration. The shipowner involved actively in the process and took the financial responsibility for the cleanup action in Norway. Several NGOs were engaged in the work as well as private cleanup companies. A joint technology team was set up between involved parties, including the ship management (Kystverket, 2020a). Throughout the year, 165 locations in the Oslofjord area were cleaned. The cleanup took 10,000 hours of work (Oslofjordens friluftsråd 2021a).

In Sweden, an estimated 2.5 tonnes of pellets were cleaned up, while the amount in Norway was 4.2 tonnes. Despite the relatively large amount, the Swedish approach was different from the Norwegian one. The pollution found was not considered "acute pollution" and therefore the cleanup was integrated into existing cleanup schemes. This meant neither national coordination was applied nor was support from the polluter received. The Swedish Coast Guard has the following comment in its annual report for 2020: *"It can also be concluded that, regarding emissions of hazardous substances, there can be a problem defining if an action shall be regarded as environmental rescue service. One example where the Coast Guard and the Rescue services were posed with a new question arose in May 2020. Then, polyethene pellets washed ashore on the Swedish west coast after the release of 13 tonnes of pellets from a damaged container on a ship at sea off the Danish coast. The responsible Swedish authorities decided that emission control was not to be regarded environmental rescue"* (Kustbevakningen, 2020).

After more than a year the national action in Norway stopped on 31 May 2021. At that time, less than half the amount of pellets was recovered (Oslofjordens friluftsråd, 2021a). The Norwegian Coastal Administration reports that the shipowner had shown responsibility in the cleanup phase. It paid all expenses for the cleanup through its insurance company, bought equipment for the cleanup and contributed to developing new methods to clean the coast in the most efficient way (Kystverket 2022a). According to the National Maritime Authority, the incident falls outside Norwegian jurisdiction since it did not happen in the Norwegian economic zone and the ship was flying a foreign (Bahamas) flag despite being owned and operated by Norwegian companies (Oslofjordens friluftsråd 2021b). Furthermore, the incident coincided with the fact that in March 2020, many dead and dying eider ducks (*Somateria mollissima*) were found in the outer Oslofjord area. Altogether 104 dead common eiders were collected by local staff from the Norwegian Nature Surveillance (SNO) and shipped to the Norwegian Institute for Nature Research (NINA) in Trondheim for further analysis and autopsy. However, plastic pellets were found in only two of the examined birds and then only in small quantities. It was therefore concluded that the intake of plastic pellets by eiders only occurred to a small extent and cannot explain the increased winter mortality of eiders in the

outer Oslofjord in spring 2020 (NINA, 2020). Another study was made on 633 fish of nine different species, where no pellets were found. The Coastal Administration concluded that the pollution had not caused direct harm to the wildlife (Kystverket 2022a).

In June 2020, during a Norwegian Parliament meeting, an MP asked the Minister for Climate and the Environment what the Government planned to do to prevent similar incidents in the future. The Minister stressed the international nature of the problem and said that it would be important to follow up in IMO under the action plan against plastic littering (Stortinget, 2020). A report from the Coastal Administration, summarizing experiences of the cleanup action, concludes that *"clean-up of plastic pellets/nurdles is certainly possible, but is time consuming and extensive. It is important to survey thoroughly, followed by a clean-up shortly afterwards. Mapping software was used to record locations of stranded pellets, progress in clean-up operations and amount of collected pellets. Different vacuum cleaners and sifting methods worked satisfactorily and were widely used. Suction trucks were used to remove large accumulations of pellets. An excavator, in combination with a water bath to separate pellets, was used at one site and worked efficiently. It is important to test new methods and focus on technology development and special machines/tools that can be used. A cost-benefit assessment is important with regard to the level of clean-up operations"* (Kystverket, 2020a).



Figure 2.a & b Plastic pellet containment and collection on Norwegian shores after the Trans Carrier incident.

Source: Norwegian Coastal Administration

Lessons learned from the clean-up operation in Norway as presented in IMO, 2022, PPR/9/15/2 are:

- It is important that an incident with plastic pellets, is covered by the definition of acute pollution in any national pollution control acts. This allows to promptly designate the responsibility to the appropriate governmental agency.
- The clean-up operation was led by the same governmental agency that is responsible for handling other forms of acute marine pollution. The approach and emergency plans used when working with larger oil spills also works with this kind of pollution.
- It is also important to have a single contact point for communication with the responsible polluter, insurance companies and other stakeholders, as it makes it easier to establish common goals for the operation, secure compensation of cost, etc.
- Clean-up after a spill of plastic pellets/nurdles is possible but it is an extensive and time-consuming exercise. It is important to survey the affected areas thoroughly, immediately followed by clean-up. Plastic pellets are remobilized much more easily than oil by tides, currents, high waves and heavy rain. Mapping software was used to record locations of stranded pellets, the progress in clean-up operations and the amount of collected pellets. Different vacuum cleaners and sifting methods worked satisfactorily and were widely used.
- Suction trucks were used to remove large accumulations of pellets. An excavator, in combination with a water bath to separate pellets, was used at one site and worked efficiently. It is important to test new methods and focus on technology development and special machines/tools that can be used. Cost/benefit assessment is important with regard to the level of clean-up operation.
- Information from the public through social media was also very important. The public could use the open mapping tool and register their findings accompanied by photos. As part of the work following the Trans Carrier incident, a report was written (Dolva et al., 2020) summarizing the experiences from the plastic pellets pollution incident, with focus on shoreline clean-up operations.

Locations of pellets

The beaches where pellets were expected to wash ashore were inspected. Outcomes of inspections must mainly be considered of a temporary nature since the weather can change the location of pellets rapidly. During these inspections the following conclusions regarding pellet distribution on beaches in Norway were drawn. The distribution was determined by (Dolva et al., 2020):

- Sea currents.
- Weather conditions in general (during bad weather and in the case of early deposits, plastic pellets washed up far beyond the edge of the beach).
- Wind conditions when washed ashore (due to their low specific gravity, pellets are affected by the wind and are moved around on hard surfaces when there is no vegetation).
- Heavy rain (this could wash pellets down from the beach to the sea).
- The presence of vegetation, which will immobilize pellets for a while.
- The presence of biological material, which can make pellets heavier.
- High water line/floodmark (pellets usually accumulate in a narrow belt above the high-water line).
- Waste accumulation sites will probably also be the sites where pellets will be present.

Pellet collection and removal

Since the weather conditions can influence the presence of pellets greatly, clean-ups need to start soon after inspections. In the case of the Trans Carrier incident the following removal methods were applied:

1. Manual sieving
2. Tractor sieving
3. Vacuum cleaners
4. Leaf vacuums (reverse leaf blowers)
5. Sucking vehicles
6. Flotation (e.g., water baths)
7. Machine tumbling
8. Trap systems in streams/pools
9. Others small scale methods like hand picking

Of these, the primary methods applied were vacuum cleaners, leaf vacuums and sieving (Dolva et al., 2020).

Finnbirch incident

In November 2006, the container vessel Finnbirch sank in the Swedish part of the Baltic Sea between Öland and Gotland. The cargo consisted of hazardous goods, and 70 tonnes of polymer pellets on the main deck. According to a report from 2008, the cargo was not collected as it was not considered a major environmental risk (Räddningsverket, 2008). Focus in this case was on the potential oil spill. About 200 out of the 520 cubic meters of oil present leaked into the environment at the time of the accident. The rest was recovered during operations in 2007 and 2019/2020 (Sjöfartstidningen, 2020). No information was retrieved on the fate of the 70 tonnes of plastic pellets the ship was transporting when it sunk, nor on whether they are still there or have leaked into the environment. This case illustrates the long-time character of potential pollution from sea accidents.

2.3.1.2 Relevant incidents outside the Nordic Region

MSC Zoe incident, the Netherlands

In the evening of 1 and the morning of 2 January 2019, the Ultra Large Container Ship MSC Zoe lost 342 containers with an estimated amount of 3,257 tons north of the Dutch and German Wadden Sea Islands (Van Duin et al, 2019). The ship is one of the world's largest container ships (BSU et al., 2020), and has a total theoretical container capacity of 19,224 TEU, corresponding to a deadweight of approximately 200K tons and is sailing under Panamanian flag (Panama Maritime Authority, Dutch Safety Board, Federal Bureau of Maritime Casualty Investigation Germany, 2019). It was en route from Sines, Portugal to Bremerhaven, Germany. Due to its severity, the accident is classified as a very serious marine casualty as defined by the Casualty Investigation Code of the International Maritime Organization (IMO) and European Union Directive 2009/18/EC (Panama Maritime Authority, Dutch Safety Board, Federal Bureau of Maritime Casualty Investigation Germany, 2019.).

Most of the contents of the lost containers consisted of consumables and associated packaging materials. One container contained 22.5 tons of pellets, with a diameter of 4 millimeters. Those washed up on the beaches after the event and were difficult to remove from the environment due to their small dimensions (Panama Maritime Authority, Dutch Safety Board, Federal Bureau of Maritime Casualty Investigation Germany, 2019). After the incident, large numbers of plastic pellets were found on the Eastern Dutch Wadden Islands and the shores of the three Dutch Provinces Noord-Holland, Fryslân and Groningen (Foekema et al., 2021).

A number of containers contained chemicals and batteries. Floating objects spread with wind and sea currents, while others ended up on the seabed. Mainly plastic objects washed ashore on the coast of the Wadden Islands the days following the

accident. Large-scale coastal clean-ups and salvage operations at sea were successful to the extent that the bulk of the lost cargo was recovered (Panama Maritime Authority, Dutch Safety Board, Federal Bureau of Maritime Casualty Investigation Germany, 2019).

Not only the amount of the cargo that fell overboard determined the severity of the consequences, the location where it happened was also of great importance. MSC Zoe lost its cargo in the vicinity of the Wadden Sea, both being a UNESCO World Heritage Marine Site and a Natura 2000 site which is a high level nature conservation status in the European Union (BSU et al., 2020). Furthermore, the vulnerability of the Wadden Sea was officially recognized in 2002 by IMO by the designation of the Wadden Sea which is shared by Denmark, Germany and the Netherlands as a Particularly Sensitive Sea Area (PSSA). International recognition of this kind of area as a PSSA offers the possibility of adopting additional protective measures within the mandate of the IMO, such as routing measures. In addition, as of 2009, the Wadden Sea is listed by UNESCO as World Heritage site which obliges the States of Denmark, Germany and the Netherlands to collaboratively ensure the protection and conservation of this natural heritage (Panama Maritime Authority, Dutch Safety Board, Federal Bureau of Maritime Casualty Investigation Germany, 2019).

An interesting issue was the interaction between the organisations responsible for emergency response and clean-ups at national, regional and local level. The Dutch Ministry of Infrastructure and Water Management, the "Safety Regions" of Provinces Noord-Holland (Noord), Fryslân and Groningen and the municipalities of the affected region had to work together (Van Duin et al, 2019). A "Safety Region" is an umbrella organization that has a coordinating role in a specific assigned Dutch region during calamities. To coordinate the approach of calamities during the first period of an event like this, each of the Islands has a Coordination Team Wadden Islands (CoWa). This includes representatives of the municipality, police, fire brigade, ambulance unit and when needed the Royal Netherlands Sea Rescue Institution (KNRM), Ministry of Infrastructure and Water Management and the Forestry Department. Soon after the disaster, the mayors of the island municipalities were informed, and the municipal organisations were involved together with the CoWa teams and local volunteers. In some cases "beach cleaners" (large tractors with a special waste collection device attached) were deployed. Hundreds of volunteers from the mainland were transported to the islands by the regular ferries for free to help clean as well. The Dutch military was brought in to help cleaning Schiemonnikoog Island.

Apart from large amounts of debris, this island's coastline was extensively polluted with plastic pellets (NOS, 2019). The dispersion of pellets was mapped using both scientific techniques and citizen science. On 11 January 2019, the Dutch University of Groningen launched an interactive map to register pellets finds at the Dutch coastline. The map can be found at www.waddenplastic.nl (University of Groningen, 2023). According to the nature management organisation "Natuurmonumenten",

the research showed that 24 million plastic pellets washed ashore in the easterly part of the Wadden Sea area, 5.5 million of these landing on Schiermonnikoog Island's North Sea beach. This location became the pellets hotspot in the region, where plastic pellets washed ashore for more than a year after the incident (Natuurmonumenten, 2020). Collecting the pellets manually was very difficult and in order to collect those more effectively a large beach vacuum cleaner that was attached to a tractor was deployed.

After about one week, large amounts of debris (including large numbers of plastic items) were collected by the mixed teams of volunteers and professionals on the different islands:

- Vlieland Island: 60 tonnes collected, costing 30,000 euro and 1000 man hours
- Terschelling Island: 250 tonnes, no hours presented.
- Ameland Island: 350 tonnes, no hours presented.
- Schiermonnikoog Island: 250 tonnes were collected, in comparison, the island's own annual domestic waste production is 400 tonnes (Van Duin et al, 2019).

By mid-November 2019, 87% of the containers and 75% of the cargo had been found and removed. It is expected that the majority of the remaining lost content can no longer be traced and cleaned up (Panama Maritime Authority, Dutch Safety Board, Federal Bureau of Maritime Casualty Investigation Germany, 2019).

The association of coastal municipalities, KIMO the Netherlands and Belgium, has coordinated the Fishing for Litter scheme in Dutch waters. This scheme supports fishermen to take waste they collect in their nets at sea to shore. A considerable proportion of this waste is plastics. KIMO takes care of the on-shore collection, transport and processing, but also of the funding of the operations. One of the authors of this report (M. Mannaart) coordinates the scheme and was directly involved. Directly after the container loss there was expected that a huge spike in the amount of marine litter collected by the fishermen in the area would occur. That was why negotiations with the Dutch Ministry of Infrastructure and Water Management were started for support. Support was received, from ports in the northern part of the country as well. And this proved to be true, as the amount of marine litter collected in the Dutch North Sea increased significantly. The amounts of marine litter collected in the period 2016–2018 (before the MSC Zoe incident) were respectively: 246, 288 and 338 tonnes annually. After the incident, the collected amounts during 2019–2021 were respectively: 567, 648 and 756 tonnes. The increase after 2018 is remarkable and the amounts of marine litter are lower, but still elevated to this day. This is an indication that suggests that when large amounts of cargo (including pellets) are lost, their presence in the marine environment is measurable for at least a number of years. Causality is difficult to prove which is depending e.g., on the number of fishermen participating in the clean-up scheme, locations where is fished et cetera. However, a fact is that after

the disaster significantly more waste was and is collected (M. Mannaart, personal comments) and the experiences on the beaches of Schiermonnikoog Island point also in that direction (Natuur-monumenten, 2020). The entire clean-up operations that included both salvage of containers at sea and beach-clean-ups were complex because of the different environments (sea and land), the large amounts of debris and the vast area and the number of organisations involved. Despite the extensive operation having its challenges, the acute part of the problem was solved in the end. The incident and the governmental responses and cooperation were discussed by the governmental organisations during an event organized by KIMO the Netherlands and Belgium on 17 November 2021 (Mannaart et al., 2022).

The Merchant Marine General Directorate, Panama, the Dutch Safety Board, Netherlands, and the Bundesstelle für Seeunfalluntersuchung, Germany made a number of recommendations to their responsible administrations in their capacity as representative of the flag states in the various committees of the IMO, which are presented integrally here (Panama Maritime Authority, Dutch Safety Board, Federal Bureau of Maritime Casualty Investigation Germany, 2019):

1. Revise the existing technical and legal regulations for container ships regarding the design limits of cargo securing equipment, approved loading and stability conditions and the consideration of shallow water effects and speed on ship motions and resulting accelerations and forces. In doing so, especially the following provisions and aspects are to be taken into account:
 - a. IS-Code (Off-design stability conditions for very large containerships and Second Generation Intact Stability started in May 2020)
 - b. Code of Safe Practice for Cargo Stowage and Securing for very large containerships
 - c. Container safety convention (CSC) and ISO 1496-1 Freight containers - Specification and testing respectively
 - d. IMO Circular MSC.1/Circ. 1228 dated 11 January 2007, Revised guidance to the master for avoiding dangerous situations in adverse weather and sea conditions whether it works at all sea conditions.
 - e. Stability booklet, include that all loading conditions should be checked on high accelerations/forces.
 - f. Cargo securing manual, include design limits of the cargo securing equipment in accordance to the design accelerations. In doing so, the aforementioned authorities should act in such a way that results attained by existing international working groups are incorporated.
2. Generate an obligation on all container ships:
 - a. To install electronic inclinometers or similar (inertia) systems to measure and display this information in real-time to the captain/crew, and
 - b. To install sensors on critical locations on the ship in order to measure

- accelerations and to provide this information in real-time to the captain/crew in order to allow them to monitor these;
- c. And for ships with mandatory equipped VDR to record actual roll angle, roll period and accelerations for the purpose of safety investigations.
3. Evaluate and assess possible technical solutions that can assist the captain/crew in the detection of the loss of containers and propose international standards for implementation of such solutions.
 4. The following recommendation to the ship-owning company were provided:
 - a. In the construction and operation of ships, reduce high acceleration forces, which can cause damage to crew, passengers and cargo, by installing, for example, bilge keels or anti-roll tanks or stabilizers or setting operational stability limits by limiting the operational GM.

X-Press Pearl incident, Sri Lanka

One of the largest plastic pellet spills globally recorded so far was that of the X-Press Pearl, which occurred off the Sri Lanka coast on 20 May – 17 June 2021. The vessel caught fire and sank eventually. Apart from oil, nitric acid, caustic soda, methanol and other substances, an estimated 1,680 tonnes of plastic pellets were lost, which littered 300 km of shoreline. A considerable proportion of the stranded plastics on the shoreline were burnt fragments of various sizes. They were mixed with various types of debris from the ship and its cargo. This caused concerns about contamination and toxicity of the environment in general but also of fish stocks. The nature of the disaster had multiple dimensions that had to be taken into account during management and cleaning-up, including:

- dealing with oil and chemical spills.
- coordinating emergency support from neighbouring and other countries.
- surveillance and salvage of the wreck and containers.
- assessing the environmental damage over the short and longer-term.
- support to impacted economic sectors, particularly coastal fishing communities and tourist industry.
- legal investigation of the incident.
- filing of compensation claims.

To address all challenges as thoroughly as possible, the Cabinet of Ministers of Sri Lanka appointed an Inter-Ministerial Committee of senior government officials headed by the Minister of Justice for an overall coordinated response to the incident. Five sub-committees have been created thereunder dealing respectively with:

- legal action.
- compensation claims.
- environmental impacts.
- fisheries impacts.
- economic damages.

A UN team was deployed to assess and address the disaster. Its key recommendations focused primarily on mitigating the key risks identified including:

1. the oil slick emanating from the wreck including a potential major sudden release of bunker oil ('worst-case-scenario');
2. on-shore oil spill response planning;
3. development of a detailed plan to remove the wreck and containers lost at sea;
4. the shoreline pellet clean-up strategy; and
5. focusing the environmental assessment on key hotspot areas to support decision-making in the emergency phase (Partow et al, 2021).

Massive clean-up operations took place at 48 sites along 180km of impacted coast (Partow et al, 2021). By 14 July 2021 approximately 1,610 metric tonnes of plastics, other debris and contaminated sand were collected. This included larger debris, and various types of pellets and small burnt plastic fragments that were deposited along the beaches. A lagoon was protected from floating plastic pellets by application of booms along two entrance channels, which may have prevented up to 80% of the plastics entering. Mixed pellets and sand were separated by manual sieving and flotation in seawater which was both highly labour intensive. Trailing of mechanical recovery techniques was planned, including the use of vacuum cleaners, mechanical sieving, trommels and beach graders. Burnt plastic fragments caused specific challenges due to their irregular shape and brittleness. Secondary pollution of pellets was created during storage and transport of sediment with pellets during clean-up work. As a result of the pollution caused by the ship, a spike in reported deaths of sea turtles and dolphins and whales was reported. The disaster had a substantial impact on Sri Lankan coastal fishing communities, especially those that were (or were suspected) of being impacted by the pollution. Coastal fishing was initially banned along an 80-km littoral stretch adjacent to the incident. A UN research team assisted the national authorities and in their report many recommendations on further research activities were done, including a long term-plastic beach clean-up programme with a community-based approach (Partow et al, 2021). Based on the experiences, a report from IPEN, a global network of NGOs for a toxics-free future, recommended the international community to classify plastic pellets as hazardous substances and called on coastal countries to ratify the hazardous and noxious spills (HNS) convention (Rubesinghe et al., 2022).

After the experiences of the actions in Sri Lanka, the recommendations of the UN-team regarding the plastic pollution clean-up include:

1. Chemical analyses of the pellet and burnt plastic mix to assess the level of their contamination should be conducted as a matter of priority.
2. The results of the chemical assessment should inform the characterization of the plastic waste as hazardous or non-hazardous.
3. If found to be hazardous, additional waste criteria testing (e.g., leachate analysis) should be carried out to determine the appropriate disposal method.
4. If found to be non-hazardous, then the potential for the reuse and recycling of the plastic waste should be prioritized.
5. On-site separation of the plastic waste should be maximized to reduce sand collection, transport and storage.
6. Beach sediment analysis should be conducted to quantify the presence of small burnt plastic particles (<3 mm) that may not be recovered during clean-up operations.
7. Develop clean-up methods to recover small burnt plastic particles (<3 mm) (e.g., adaptation of the flotation method to capture small burnt particles).
8. Recover floating pellet and burnt plastic pollution in the inlet channels of one of the affected lagoons (Negombo lagoon) to prevent incoming pollution dissemination deeper in the lagoon and mangroves.
9. Improve pellet storage at the backshore of the beach to avoid secondary pollution (e.g., protecting the temporary storage areas by placing a tarpaulin or equivalent under the bags).
10. Improve handling and transportation of pellet bags particularly from the beach to the main road to avoid secondary pollution (e.g., establish defined routes, use wheelbarrows for transportation).
11. Set specifications to guide the microplastic clean-up effort and help assess the environmental impact of clean-up techniques to determine when to stop cleaning and prevent additional environmental damage.
12. Develop a long-term plastic beach clean-up programme along the coastline to collect chronic beach pollution by plastic debris, including that from the Xpress Pearl. A community-based approach for waste collection should be considered. (Source: Partow et al, 2021).

2.3.1.3 Other types of acute plastic pollution

Biocarrier spill in Iceland

In Iceland in 2017 there was a leakage of biocarriers from a fish farm on land, biocarriers that are used in the cleaning system. The fish farm is on the coast and

the plastic reached the sea through the sewage system. The biocarriers ended up on a beach with clay, but the winds moved much of it to a grassy area. It has been a challenge to clean up after the incident. The industry developed a plan on how to do it. The environment agency assessed and approved the plan. Students in the area were engaged to do the work, but although there have been repeated cleanup operations every year, it is still not completely solved (Interview with Katrín Sóley Bjarnadóttir and Halla Einarsdóttir on 13 Dec 2022).

There has been a similar incident in Denmark (Interview with Frank Jensen on 23 Nov 2022).

2.3.2 Sources and amounts of pellet loss

A number of events are presented in the previous sections that show examples of considerable amounts of lost pellets. But what is the loss globally per year? The global loss of pellets is estimated at 230,000 tonnes that enter the environment annually (Eunomia Research and Consulting Ltd., 2016). In Europe alone, the pellet losses are estimated to be between 16,888 tonnes and 167,431 tonnes per year (Han et al., 2018). Since the three main sources of pellet losses are producers, intermediary facilities and converters/processors, there might be assumed that a considerable portion of this will be lost on land. The estimation of pellet pollution in rivers is more challenging, but something can be said about its fate. According to Van Emmerik & Schwartz (2020) the fate of plastics in freshwater systems is strongly dependent on three processes, which are 1. the transport, 2. the accumulation, and 3. the degradation processes. This means that not all plastics discharged in rivers eventually end up into the ocean, at least not of the sizes and shapes present when released at source.

3. Regulations, responsibilities and measures

Regulations, policies and measures that address the problem of acute plastic pollution, or could be utilised as a framework to address this, are divided here into four levels. There is the global dimension, the EU dimension, the overarching regional Nordic/Scandinavian dimension that includes e.g. the regional seas conventions, and finally the national dimension of the different Nordic countries, including the roles and responsibilities of governmental as well as some non-governmental actors.

3.1 The global dimension: organisations, goals and treaties

3.1.1 United Nations Environment Programme (UNEP)

The importance of marine pollution was reaffirmed during the United Nations Environment Programme's Ministerial Assembly in 2017, where it was stated that: *"...it is our commitment to working towards a pollution-free planet for the health and well-being of our people and the environment."* It is acknowledged however, that it will be a long-term endeavour (United Nations, 2017c). During the same gathering special attention was paid to marine pollution, which led to resolution UNEP/EA.3/Res.7 on Marine Litter and Microplastics (United Nations, 2017a). In the resolution, the importance of SDG 14 on "Life Below Water" and its target 14.1 is reaffirmed, especially because the assembly: *"noted with concern the high and rapidly increasing levels of marine plastic litter and the expected increase in negative effects on marine biodiversity, ecosystems, animal well-being, fisheries, maritime transport, recreation and tourism, local societies and economies, and the urgent need for strengthened knowledge of the levels and effects of microplastics and nano plastics on marine ecosystems, seafood and human health"* (United Nations, 2017a).

To encourage member states to develop and implement appropriate actions to reduce waste and manage waste better, a declaration was endorsed (United Nations, 2019a) and during the same meeting a resolution to decrease the environmental impact of single-use plastic products was adopted (United Nations, 2019b). The resolution encourages and invites stakeholders to take appropriate action, but it does not set binding rules to do so. Other umbrella organisations voiced their concern regarding marine litter and especially microlitter such as microbeads (for example, the Secretariat of the Pacific Regional Environment Programme (2017)). The G20 countries also developed policies, such as the "Implementation Framework for Actions on Marine Plastic Litter", which is a voluntary scheme (G20, 2019).

One of the results of the increased awareness is the Global Partnership on Marine Litter (GPML)- a multi-stakeholder partnership which provides a unique mechanism to bring together all actors working on marine litter and plastic pollution prevention to share knowledge and experience and advance solutions with respect to this pressing global issue. The GPML was launched at the 2012 United Nations Conference on Sustainable Development (Rio+20) in response to a number of previous meetings. The GPML is led by a Steering Committee and the United Nations Environment Programme (UNEP) provides Secretariat services (United Nations Environment Programme, 2021). As well as the focus on pollution, and especially pollution of the environment by plastics, specific regulations apply to behaviour at sea and the transportation of goods.

3.1.2 The International Maritime Organization (IMO)

Due to a number of tragic events, the need for the establishment of an international organisation that deals with navigation issues arose. As a result the International Maritime Organization (IMO) was established in 1948. IMO is a United Nations agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships (IMO, 2022a). The organisation is the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that covers all aspects of international shipping, in order to ensure that the sector remains safe and environmentally sound (IMO, 2022a). One of the many examples of regulatory frameworks created by IMO is the MARPOL convention.

The organization consists of an Assembly, a Council and five main Committees: the Maritime Safety Committee; the Marine Environment Protection Committee; the Legal Committee; the Technical Cooperation Committee and the Facilitation Committee, plus a number of Sub-Committees that support the work of the main technical committees (IMO, 2022b). Apart from this there are the Legal Committee, the Technical Cooperation Committee, the Facilitation Committee that works on eliminating unnecessary formalities in international shipping by implementing all aspects of the Convention on Facilitation of International Maritime Traffic 1965 and any relevant issues concerning the facilitation of international maritime traffic. The linking pin is IMO's Secretariat based at IMO's headquarters in London. Apart from this global structure, IMO is also present in 5 regions to facilitate technical cooperation activities (IMO, 2022b).

IMO's Assembly is the highest Governing Body of the Organization. It consists of all Member States and it meets once every two years in regular sessions, but may also meet in an extraordinary session if necessary. The Assembly is responsible for approving the work programme, voting the budget and determining the financial arrangements of the Organization. The Assembly also elects the Council. The Council is the Executive Organ of IMO and is responsible, under the Assembly, for supervising the work of the Organization (IMO, 2022b).

Maritime Safety Committee (MSC)

Within IMO the MSC is the highest (technical) organ, which comprises all Member States (IMO, 2022b). The Maritime Safety Committee (MSC) deals with all matters related to maritime safety and maritime security, part of the scope of IMO aiming at both passenger ships and cargo ships. The Maritime Safety Committee adopts amendments to conventions and includes all Member States as well as other countries when needed (IMO, 2022b). Conventions included are e.g. the SOLAS Convention and related codes which deal with safety and dangerous goods; amendments to the STCW Convention on training and certification of seafarers and updating of the Global Maritime Distress and Safety System (GMDSS) (IMO, 2022c).

The Marine Environment Protection Committee (MEPC)

Like the MSC, the MEPC consists of all contracting Member States. The Committee deals with topics related to prevention and control of pollution from ships. It works specifically on the adoption and amendment of regulations, conventions and measures ensuring their enforcement (IMO, 2022b).

Sub-Committees

For the implementation of their tasks, both the MSC and MEPC are assisted by a number of sub-committees. Those sub-committees are also open to IMO's Member States, the following sub-committees are present:

- Sub-Committee on Human Element, Training and Watchkeeping (HTW);
- Sub-Committee on Implementation of IMO Instruments (III);
- Sub-Committee on Navigation, Communications and Search and Rescue (NCSR);
- Sub-Committee on Pollution Prevention and Response (PPR);
- Sub-Committee on Ship Design and Construction (SDC);
- Sub-Committee on Ship Systems and Equipment (SSE);
- Sub-Committee on Carriage of Cargoes and Containers (CCC) (IMO, 2022b).

Of these sub-committees two are especially important regarding pollution, its prevention and response, and therefore further described below.

Sub-Committee on Pollution Prevention and Response (PPR)

IMO's sub-committee on Pollution Prevention and Response (PPR) deals with all matters in relation to pollution prevention and response that fall within IMO's remit. The scope ranges from the MARPOL Convention to the control and management of harmful aquatic organisms in ships' ballast water and sediments; biofouling; anti-fouling system; pollution preparedness, response and cooperation for oil and hazardous and noxious substances; and the safe and environmentally sound recycling of ships. The Working Group on the Evaluation of Safety and Pollution Hazards of Chemicals works under the auspices of the PPR Sub-Committee (IMO, 2022d). The 9th session of IMO's Sub-Committee on Pollution Prevention and Response (PPR) on 4–8 April 2022 supported a proposal from Norway to develop the HNS response guidelines based in the inter-regional manual and to develop guidelines on best practice related to clean-up of plastic pellets. Norway is now leading an IMO PPR correspondence group, instructed to further consider the options for reducing the risk and advice the Sub-Committee on the way forward (IMO, 2022; Bonn Agreement, 2022b).

Sub-Committee on Carriage of Cargoes and Containers (CCC)

The Sub-Committee on Carriage of Cargoes and Containers (CCC) deals with the carriage of packaged dangerous goods, solid bulk cargoes, bulk gas cargoes, and containers. The Sub-Committee keeps the International Maritime Solid Bulk Cargoes Code (IMSBC Code) and the International Maritime Dangerous Goods (IMDG) Code updated. It also reviews other Codes including the International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code) and the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). The Sub-Committee closely collaborates with other UN bodies dealing with the multimodal transport of goods (IMO, 2022f).

3.1.3 Sustainable Development Goal 14

According to a UN gathering of Heads of State and Governments and other high-level representatives, the oceans are valued as being of great importance to our planet, since those key stakeholders "*...are mobilized by a strong conviction that our ocean is critical to our shared future and common humanity in all its diversity*" (United Nations, 2017b). That is why the General Assembly of the United Nations included earlier in its 2015 resolution on sustainable development a specific goal, goal 14: "*Conserve and sustainably use of the oceans, seas and marine resources for sustainable development*". This goal pays specific attention to marine pollution by introducing target 14.1, that states: "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" (United Nations, 2015a). A plan of action is

attached to this resolution (United Nations, 2015b). To measure the magnitude of pollution by both nutrients and plastics and the effect of actions taken to address this, specific indicators were created: 14.1.1 (a) Index of coastal eutrophication; and (b) plastic debris density (United Nations, 2015c).

3.1.4 Global legally binding agreement on plastic pollution – under preparation

An important new development is that the United Nations are preparing an international instrument to address plastic pollution from 2024 onwards. *"The United Nations Environmental Assembly decided that the intergovernmental negotiating committee is to develop an international legally binding instrument on plastic pollution, including in the marine environment, henceforth referred to as "the instrument", which could include both binding and voluntary approaches, based on a comprehensive approach that addresses the full life cycle of plastic, taking into UNEP/EA.5/Res.14 3 account, among other things, the principles of the Rio Declaration on Environment and Development, as well as national circumstances and capabilities (...)"* (UN, 2022b). As a result, in order to take addressing plastic pollution a step further, a UN Plastic Pollution Treaty is being prepared, that will also address microplastics. This will become an international legally binding instrument on plastic pollution, that includes the marine environment. The first meeting to discuss this action, to implement Resolution UNEP/EA.5/Res.14 that is entitled *"End plastic pollution: Towards an international legally binding instrument"* (UN, 2022b) took place in Uruguay from 28 November to 2 December 2022.

3.1.5 Convention on the Law of the Non-navigational Uses of International Watercourses

The introductory text of the convention on its scope states that the convention applies to uses of international watercourses and of their waters for purposes other than navigation and to measures of protection, preservation and management related to the uses of those watercourses and their waters. Additionally, it says that the uses of international watercourses for navigation is not within the scope of the present Convention except insofar as other uses affect navigation or are affected by navigation (UN, 2014).

Article 20 Protection and preservation of ecosystems

Watercourse States shall, individually and, where appropriate, jointly, protect and preserve the ecosystems of international watercourses.

Article 21 Prevention, reduction and control of pollution

1. For the purpose of this article, "pollution of an international watercourse" means any detrimental alteration in the composition or quality of the waters of an international watercourse that results directly or indirectly from human conduct.
2. Watercourse States shall, individually and, where appropriate, jointly, prevent, reduce and control the pollution of an international watercourse that may cause significant harm to other watercourse States or to their environment, including harm to human health or safety, to the use of the waters for any beneficial purpose or to the living resources of the watercourse. Watercourse States shall take steps to harmonize their policies in this connection.
3. Watercourse States shall, at the request of any of them, consult with a view to arriving at mutually agreeable measures and methods to prevent, reduce and control pollution of an international watercourse, such as:
 - a. Setting joint water quality objectives and criteria;
 - b. Establishing techniques and practices to address pollution from point and non-point sources;
 - c. Establishing lists of substances the introduction of which into the waters of an international watercourse is to be prohibited, limited, investigated or monitored.

Article 23 Protection and preservation of the marine environment

Watercourse States shall, individually and, where appropriate, in cooperation with other States, take all measures with respect to an international watercourse that are necessary to protect and preserve the marine environment, including estuaries, taking into account generally accepted international rules and standards. (UN, 2014)

3.1.6 The United Nations Convention on the Law of the Sea (UNCLOS)

The United Nations Convention on the Law of the Sea, UNCLOS for short, is a multilateral treaty agreed upon during the third United Nations Conference on the Law of the Sea (UNCLOS III) (which was organised between 1973 and 1982). The Convention defines and codifies the standards and principles of international maritime law, inherited from customary international law relating to maritime affairs and are expressed to a great extent in the United Nations Charter and current international maritime law norms, such as the Geneva Conventions of 1958. The Convention also created the International Court of the Law of the Sea,

competent to hear disputes relating to the interpretation and application of the treaty (UNCLOS, 2022).

Amongst many topics, UNCLOS also addresses marine pollution. The most relevant articles are presented below (UNCLOS, 2022):

Article 1.4 states: "pollution of the marine environment" means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities".

Article 195 on "Measures to prevent, reduce and control pollution of the marine environment" states:

1. States shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonize their policies in this connection.
2. States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention.
3. The measures taken pursuant to this Part shall deal with all sources of pollution of the marine environment. These measures shall include, *inter alia*, those designed to minimize to the fullest possible extent:
 - a. the release of toxic, harmful or noxious substances, especially those which are persistent, from land-based sources, from or through the atmosphere or by dumping;
 - b. pollution from vessels, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, preventing intentional and unintentional discharges, and regulating the design, construction, equipment, operation and manning of vessels;
 - c. pollution from installations and devices used in exploration or exploitation of the natural resources of the seabed and subsoil, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment, operation and manning of such installations or devices;

- d. pollution from other installations and devices operating in the marine environment, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment, operation and manning of such installations or devices.
4. In taking measures to prevent, reduce or control pollution of the marine environment, States shall refrain from unjustifiable interference with activities carried out by other States in the exercise of their rights and in pursuance of their duties in conformity with this Convention.
5. The measures taken in accordance with this Part shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life.

Article 195 on "duty not to transfer damage or hazards or transform one type of pollution into another" states: "In taking measures to prevent, reduce and control pollution of the marine environment, States shall act so as not to transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another."

Article 198 on "Notification of imminent or actual damage" states: when a State becomes aware of cases in which the marine environment is in imminent danger of being damaged or has been damaged by pollution, it shall immediately notify other States it deems likely to be affected by such damage, as well as the competent international organizations.

Article 202 on "Scientific and technical assistance to developing States" states: States shall, directly or through competent international organizations:

- a. promote programmes of scientific, educational, technical and other assistance to developing States for the protection and preservation of the marine environment and the prevention, reduction and control of marine pollution. Such assistance shall include, *inter alia*:
 - i. training of their scientific and technical personnel;
 - ii. facilitating their participation in relevant international programmes;
 - iii. supplying them with necessary equipment and facilities;
 - iv. enhancing their capacity to manufacture such equipment;
 - v. advice on and developing facilities for research, monitoring, educational and other programmes;
- b. provide appropriate assistance, especially to developing States, for the minimization of the effects of major incidents which may cause serious pollution of the marine environment;

- c. provide appropriate assistance, especially to developing States, concerning the preparation of environmental assessments.

Article 203 on "Preferential treatment for developing States" states: Developing States shall, for the purposes of prevention, reduction and control of pollution of the marine environment or minimization of its effects, be granted preference by international organizations in:

- a. the allocation of appropriate funds and technical assistance; and
- b. the utilization of their specialized services.

Article 204 "Monitoring of the risks or effects of pollution" states:

1. States shall, consistent with the rights of other States, endeavour, as far as practicable, directly or through the competent international organizations, to observe, measure, evaluate and analyse, by recognized scientific methods, the risks or effects of pollution of the marine environment.
2. In particular, States shall keep under surveillance the effects of any activities that they permit or in which they engage in order to determine whether these activities are likely to pollute the marine environment.

Articles 213–233 on "Enforcement" are also linked to pollution.

Article 235 on: "Responsibility and liability" states:

1. States are responsible for the fulfilment of their international obligations concerning the protection and preservation of the marine environment. They shall be liable in accordance with international law.
2. States shall ensure that recourse is available in accordance with their legal systems for prompt and adequate compensation or other relief in respect of damage caused by pollution of the marine environment by natural or juridical persons under their jurisdiction.
3. With the objective of assuring prompt and adequate compensation in respect of all damage caused by pollution of the marine environment, States shall cooperate in the implementation of existing international law and the further development of international law relating to responsibility and liability for the assessment of and compensation for damage and the settlement of related disputes, as well as, where appropriate, development of criteria and procedures for payment of adequate compensation, such as compulsory insurance or compensation funds (UNCLOS, 2022).

3.1.7 The International Convention for the Prevention of Pollution from Ships (MARPOL)

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The convention was adopted on 2 November 1973 at IMO (IMO, 1973). MARPOL was updated by amendments over time. (IMO, 2022g).

In addition to the main text of the Convention are currently VI annexes addressing specific types of pollution:

- Annex I Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)
- Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)
- Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992)
- Annex IV Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003)
- Annex V Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988)
- Annex VI Prevention of Air Pollution from Ships (entered into force 19 May 2005) (IMO, 2022g).

MARPOL's Annex III contains general requirements for the issuing of detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifications. With regard to this Annex, "harmful substances" are those substances which are identified as marine pollutants in the International Maritime Dangerous Goods Code (IMDG Code) or which meet the criteria in the Appendix of Annex III (IMO, 2023). This Annex could offer an opportunity regarding addressing plastic items like pellets when included.

Annex V prohibits the discharge of all types of garbage into the sea unless explicitly permitted under the Annex (IMO, 1973). Guidelines (MARPOL, 2017) were developed to assist:

1. Governments in developing and enacting domestic laws which implement MARPOL Annex V;
2. Shipowners, ship operators, ships' crews, cargo owners and equipment manufacturers in complying with requirements set forth in MARPOL Annex V and relevant domestic laws; and

3. Port and terminal operators in assessing the need for, and providing, adequate reception facilities for garbage generated on all types of ships. In the interest of uniformity, Governments are requested to refer to these Guidelines and related guidance developed by the Organization when developing and enforcing appropriate national regulations (IMO, 2017).

Annex V is amongst others about waste minimization, handling materials that could become wastes and discharging of waste, including plastic waste, by ships. It has a link to port reception. Regulation 3.2 of MARPOL.

Annex V prohibits the discharge of all plastics into the sea. Fishing gear is included as well (IMO, 2017).

Dumping of waste including plastics is addressed but acute plastic pollution as such is not addressed.

3.1.8 The International Maritime Dangerous Goods (IMDG) Code

The code urges Governments which have not hitherto implemented the IMDG Code to adopt it as the basis of their national regulations on this matter in order to ensure safe and unobstructed international transport of dangerous, hazardous and harmful cargoes, including environmentally hazardous substances (marine pollutants) and wastes, by sea (IMO, 2019). There are 9 types of dangerous substances listed (ICHCA, 2020), including: explosives, gases, flammable liquids, flammable solids, oxidizing substances and organic peroxides, toxic and infectious substances, radioactive material, corrosives. Most importantly to this project is chapter 9, which is on miscellaneous dangerous substances and articles (class 9) and environmentally hazardous substances (IMO, 1991). Plastics and plastic products are not included in the list for which class 9 would be most suitable.

3.1.9 International Maritime Solid Bulk Cargoes (IMSBC) Code

The International Convention for the Safety of Life at Sea, 1974 (SOLAS Convention) deals with various aspects of maritime safety. It provides the mandatory provisions governing the carriage of solid bulk cargoes and the carriage of dangerous goods in solid form in bulk. These provisions are amplified in the International Maritime Solid Bulk Cargoes Code (IMSBC Code) (IMO, 2008). The IMCBC deals with: general loading, carriage and unloading precautions (section 2), safety of personnel and ship (section 3), materials possessing chemical hazards (section 9) and the carriage of solid wastes in bulk (section 10). Furthermore, for substances it refers to the cargo categorised as 'dangerous goods in solid form in bulk' by SOLAS regulation VII/7 (IMO, 2008).

3.1.10 International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS)

The HNS Convention applies to:

- a. any damage caused in the territory, including the territorial sea, of a State Party;
- b. to damage by contamination of the environment caused in the exclusive economic zone of a State Party, established in accordance with international law, or, if a State Party has not established such a zone, in an area beyond and adjacent to the territorial sea of that State determined by that State in accordance with international law and extending not more than 200 nautical miles from the baselines from which the breadth of its territorial sea is measured;
- c. to damage, other than damage by contamination of the environment, caused outside the territory, including the territorial sea, of any State, if this damage has been caused by a substance carried on board a ship registered in a State Party or, in the case of an unregistered ship, on board a ship entitled to fly the flag of a State Party; and
- d. to preventive measures, wherever taken, to prevent or minimize such damage as referred to in (a), (b) and (c) above (HNS Convention, 2010).

3.1.11 Other international treaties

Other international treaties that were reviewed but were not regarded sufficiently relevant, include:

- *The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal* (SBC, 2020)
- *Convention on Biological Diversity (CBD)* (CBD, 2022b; CBD, 2013)
- *The International Convention for the Safety of Life at Sea (SOLAS)* (IMO, 1998)
- *The Stockholm Convention on Persistent Organic Pollutants (POPs)* (Stockholm Convention, 2022a)

3.1.12 Plastics Industry: Operation Clean Sweep

The plastics industry is well aware of the problem of pellet loss to the environment. It has developed a campaign including procedures to address the problem, entitled "Operation Clean Sweep". It is a voluntary free programme on international level aimed at improving awareness, promoting best practices and providing guidance and tools to support companies from the plastics value chain to address the problem of plastic pellets loss (Operation Clean Sweep, 2022a). To this end there is the Operation Clean Sweep manual with clearly defined actions, comprising five basic steps for managing pellet loss:

1. Commit to making "zero pellet loss" a priority
2. Assess the company's situation and needs
3. Make needed upgrades in facilities and equipment as appropriate
4. Raise employee awareness and create accountability
5. Follow up and enforce procedures (Plastics Europe, n.d.).

Plastic producing or handling companies that want to join have to show commitment first by signing a pledge document. Next actions like an assessment of the site, upgrading of facilities and equipment, trainings of staff, attention to loading, packaging and handling of plastics, and providing tools for limiting pellet loss have to be implemented. Attention to plastic dust and powder is paid as well (Plastics Europe, n.d.). The manual is written for implementation level and provides concrete and tangible actions. It is however implemented on a voluntary basis. A number of plastic producing and handling companies and their associations in the Nordic region have signed Operation Clean Sweep's pledge, thus implementing measures to limit pellet loss. Those include the Danish Plastics Federation (DK), Innovation and Chemical Industries (SE) and the European Plastic Pipes and Fittings Association (TEPPFA, NO) (PlasticsEurope, 2019).

3.1.13 Global level – summary and conclusions

As presented in this section the number of international agreements and policies at UN or international level on pollution is considerable. However, most of those do not address acute plastic pollution or are of a voluntary nature and not binding. Examples are the Global Partnership on Marine Litter (GPML) and at a smaller geographic level, G20's "Implementation Framework for Actions on Marine Plastic Litter" which encourages relevant stakeholders to take action. More strict regulations are included in UNCLOS Article 198 which is on: "Notification of imminent or actual damage" from one state to another and Article 202.b on: "Scientific and technical assistance to developing States" states that States shall:

provide appropriate assistance, especially to developing States, for the minimization of the effects of major incidents which may cause serious pollution of the marine environment. Consistent with the rights of other states, there are also obligations to monitor the risks or effects of pollution of the marine environment (Article 204). This provides a framework for cooperation, but does not address acute plastic pollution as such.

Of importance to imposing rules to prevent or cure pollution is the International Maritime Organization (IMO). The organization has a regulatory framework for the shipping industry, and its Marine Environment Protection Committee (MEPC) is of importance for environmental protection. The MARPOL convention is binding, but does not apply to plastics specifically but to other pollutants. However, in addition and rather recently, a number of developments have been initiated. During the 9th session of 28 January 2022 of IMO's Sub-Committee on Pollution Prevention and Response on the Follow-Up Work Emanating From The Action Plan To Address Marine Plastic Litter from Ships, several proposals were discussed, including:

- PPR/9/15/1: Proposed amendments to the criteria for the identification of harmful substances in package form – Classification of plastic pellets
- PPR/9/15/2: IMO guidelines on best practice related to clean-up of plastic pellets
- PPR/0/15/4: Safely managing the transport of plastic pellets at sea
- PPR/9/INF.20: Experience from the plastic pellets incident Trans Carrier, focusing on shoreline clean-up methods: included already at Trans Carrier

If pellets are labelled as dangerous goods in the various UN agreements and included (for example) in MARPOL, *The International Maritime Dangerous Goods (IMDG) Code* or *International Maritime Solid Bulk Cargoes (IMSBC) Code* or *The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*; acute plastic pollution could be addressed more stringently. In conclusion, there is no organisational framework on the coordination of activities in the chain that currently applies at UN level. Preparations for such a framework are underway by implementation of Resolution UNEP/EA.5/Res.14 that is entitled "*End plastic pollution: Towards an international legally binding instrument*". This will take time and it is not known whether acute plastic pollution will be included in the final version.

3.2 The European dimension: organisations and EU Directives

3.2.1 European Maritime Safety Agency (EMSA)

In the European Union there is a regulatory agency originated in the late 1990s alongside a number of other major European maritime safety initiatives. This agency, the European Maritime Safety Agency (EMSA) was established by Regulation (EC) No 1406/2002 (EMSA, 2023a). It was established in the wake of two major oil spill events and it aims on the prevention of pollution of ships in European waters (EMSA, 2023b). It deals e.g. with oil pollution response, underwater noise, ballast water and anti-fouling (EMSA, 2023b). It is intended as a major source of support to the Commission and the Member States in the field of maritime safety and prevention of pollution from ships, and subsequent amendments have refined and enlarged its mandate (EMSA, 2023a). The organisation works amongst other categories on shipping safety and sustainability, prevention of pollution by ships and operational pollution response services (EMSA, 2023c) but prevention and clean-ups of acute plastic pollution events are not part of its tasks yet.

3.2.2 Water Framework Directive (WFD)

An important example of European legislation that addresses water quality is the Water Framework Directive. It is a complex Directive that links to a large number of other environmental policy documents like e.g. the Marine Strategy Framework Directive and the Birds and Habitats Directives. The purpose of the Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. In terms of the definition of water bodies, there is overlap the Marine Strategy Framework Directive regarding "marine" transitional and coastal waters. Thus, this Directive applies to the marine environment as well. Stated in Article 1 of the Directive is that it:

- a. prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
- b. promotes sustainable water use based on a long-term protection of available water resources;
- c. aims at enhanced protection and improvement of the aquatic environment, *inter alia*, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;

- d. ensures the progressive reduction of pollution of groundwater and prevents its further pollution,
- e. contributes to mitigating the effects of floods and droughts and thereby contributes to:

"the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use, a significant reduction in pollution of groundwater, the protection of territorial and marine waters, and achieving the objectives of relevant international agreements, including those which aim to prevent and eliminate pollution of the marine environment, by community action under Article 16(3) to cease or phase out discharges, emissions and losses of priority hazardous substances, with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances." (EU, 2000)

Article 4 states that *"For surface water, Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water (...)"*. Furthermore, Article 4.5.b states: *"Member States ensure, for surface water, the highest ecological and chemical status possible is achieved, given impacts that could not reasonably have been avoided due to the nature of the human activity or pollution"*, (EU, 2000). River Basin Management Plans need to be established (that include transitional and coastal waters as well) and Plans of Measures need to be drafted. For the objectives it defines the characterisation of surface water body types, type-specific reference conditions for surface water body types, Quality elements of water types, Identification of Pressures, Assessment of Impact and the Ecological Status of Waters. This applies to both freshwater bodies (including groundwater) and transitional, coastal and marine waters. For the determination of the ecological and chemical quality status of waters, "other pollutants" are mentioned.

A Plan of Measures is obligatory of which an overview of requirements is provided in Annex VI of the Directive. There is a strong linkage to measures included under the following Directives: (i) The Bathing Water Directive (76/160/EEC); (ii) The Birds Directive (79/409/EEC) (1); (iii) The Drinking Water Directive (80/778/EEC) as amended by Directive (98/83/EC); (iv) The Major Accidents (Seveso) Directive (96/82/EC) (2); (v) The Environmental Impact Assessment Directive (85/337/EEC) (3); (vi) The Sewage Sludge Directive (86/278/EEC) (4); (vii) The Urban Waste-Water Treatment Directive (91/271/EEC); (viii) The Plant Protection Products Directive (91/414/EEC); (ix) The Nitrates Directive (91/676/EEC); (x) The Habitats Directive (92/43/EEC) (5); (xi) The Integrated Pollution Prevention Control Directive (96/61/EC (EU, 2000). However, more measures may be applied when needed, according to Annex VI.B (EU, 2000). There is overlap with the Marine Strategy Framework Directive regarding transitional and coastal waters and protected areas.

3.2.3 Marine Strategy Framework Directive (MSFD)

According to Article 1.1 of the Marine Strategy Framework Directive, it: "establishes a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest". For this purpose the Environmental Status needs to be assessed and Marine Strategies with associated Plans of Measures and Monitoring Programmes shall be developed and implemented to protect the marine environment and prevent its deterioration or when possible restore marine ecosystems when adversely affected. Also, it needs to be ensured that inputs into the marine environment are prevented and reduced to ensure that no significant impacts on risk to marine biodiversity, marine ecosystems, human health or legitimate uses of the sea occur. In defined marine regions (e.g. like Baltic Sea, North-east Atlantic Ocean, Greater North Sea including the Kattegat) cooperation between countries is encouraged. There are 11 descriptors of the marine environment defined of which descriptor 10 is on Marine Litter. Marine Litter is also included in Annex III, table 2 on Indicative Lists of Characteristics, Pressures and Impacts, under pressures and impacts, labelled "other physical disturbance" (EU, 2000). There is overlap with the Water Framework Directive regarding transitional and coastal waters and protected areas. Measures on addressing marine litter can be applied when needed in the framework of this Directive.

3.2.4 Other EU Directives

Other EU Directives that were reviewed but not considered sufficiently relevant to this study were:

- *Packaging Directive 94/62/EC (EU, 1994).*
- *Port Reception Facilities Directive (PRF) (EU, 2019a).*
- *Single Use Plastics Directive (SUP) (EU, 2019b).*
- *Waste Directive (WD) (EU, 2008b).*

3.2.5 European level – summary and conclusions

Karlsson et al. (2018) focusses in a report from the University of Gothenburg on pollution caused by industrial pellets production, and it states that there are no existing international frameworks or European (EU) laws that specifically address plastic pollution due to industrial spills. It is also rare that pellet spills are directly regulated on national levels. However, the report suggests that there is other legislation on environmental protection on international, European and national level that could be applicable, and exemplifies *inter alia* the EU's Packaging Directive and Marine Strategy Framework Directive and IMO's MARPOL Convention. The European Union has a number of Directives and Framework Directives that define how plans and measures to protect the environment have to be drafted, implemented and monitored. Important examples are the Water Framework Directive and the Marine Strategy Framework Directive. The EU Water Framework Directive describes measures to be taken for the protection of inland surface waters, transitional waters, coastal waters and groundwater. The Directive stipulates River Basin Management Plans and associated Plans of Measures for EU Member States. Article 3 is specifically on coordination of administrative arrangements within river basin districts, including cooperation between countries in so called River Basin Districts. There are lists of "Pollutants", "Priority Substances" and "Hazardous Priority Substances" that need to be addressed. Plastics are not part of any of those lists, and the way to address acute plastic pollution and the stakeholders that should be involved is not included either.

The Marine Strategy Framework Directive defines Marine Strategies, Plans of Measures and Monitoring Programmes, and includes a specific descriptor: "Marine Litter". Regarding measures for the longer term, Article 13 MSFD states:

8. Member States shall consider the implications of their programmes of measures on waters beyond their marine waters in order to minimise the risk of damage to, and if possible have a positive impact on, those waters.
9. Member States shall notify the Commission and any other Member State concerned of their programmes of measures, within three months of their establishment.

Thus, cooperation with, or at least informing, other states is included, but this is not on addressing acute (plastic) pollution which has no official status.

3.3 The regional dimension: regional policies and conventions on (plastic) pollution

The Nordic region is covered by two regional sea conventions, HELCOM and OSPAR. Two organisations involving the Nordic countries, the Arctic Council and the Nordic Council of Ministers, have maritime pollution on their agendas. In addition, there are regional agreements on cooperation in combatting marine pollution, the Bonn Agreement and the Copenhagen Agreement. All these organisations and instruments are described in this section. An initiative of an NGO is described as well.

3.3.1 Helsinki Convention (HELCOM)

The ***Convention on the Protection of the Marine Environment of the Baltic Sea Area***, also known as the Helsinki Convention, was signed in 1974 by all Baltic Sea coastal countries and entered into force on 3 May 1980. The Convention was updated in 1992 following the geopolitical changes and taking into account emerging environmental challenges in the region. The Convention was extended to ten Contracting Parties, namely Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. The updated Helsinki Convention entered into force on 17 January 2000. The Convention is amended whenever deemed necessary, the latest amendment is from 2014. The Convention aims at the protection of the Baltic Sea from all sources of pollution from land, air and sea. It also commits the signatories to take measures on conserving habitats and biological diversity and for the sustainable use of marine resources. It covers the whole of the Baltic Sea area, including inland waters as well as the water of the sea itself and the seabed. Measures are also taken in the whole catchment area of the Baltic Sea to reduce land-based pollution (HELCOM, 2022a).

Seven annexes are appended to the Helsinki Convention:

- I. Harmful substances
- II. Criteria for the use of Best Environmental Practice and Best Available Technology
- III. Criteria and measures concerning the prevention of pollution from land-based sources
- IV. Prevention of pollution from ships.
- V. Exemptions from the general prohibition of dumping of waste and other matter in the Baltic Sea Area
- VI. Prevention of pollution from offshore activities
- VII. Response to pollution incidents (HELCOM, 2022b).

Annex IV on the prevention of pollution from ships stipulates that the Contracting Parties shall co-operate within the IMO and in the effective and harmonized implementation of IMO rules. It includes a regulation on the mutual assistance in investigating violations of anti-pollution legislation (HELCOM, 2022c). Annex VII contains provisions on the mutual information/notification, cooperation and assistance between the coastal sea states in response to significant pollution incidents in the Baltic Sea (HELCOM, 2022d).

Pursuant to the Convention, the Helsinki Commission, HELCOM, was established. It meets annually to adopt recommendations and other key decisions in relation to the convention. Ministerial meetings are normally held every three years. The chairmanship rotates between the parties on a two-year basis. A secretariat, based in Helsinki, coordinates the work. There are also five permanent and three temporary working groups. Two of the working groups are of particular relevance in the context of this report:

- The Maritime WG works to prevent any pollution from ships – including deliberate operational discharges as well as accidental pollution.
- The Response WG works to ensure a swift national and international response to maritime pollution incidents and coordinates aerial surveillance of shipping in the Baltic Sea (HELCOM, 2022e).

A Baltic Sea Action Plan was adopted in 2007 and revised in 2021. It mentions several aspects of pollution from ships and of marine litter including plastics. The preamble "*stresses the continued need to safeguard the safety of navigation with a view to preventing accidents and thereby also minimize the risk of accidental pollution from ship*". One objective of the sea-based activities goal is "safe maritime traffic without accidental pollution" and the sea-based activities section includes several actions on maritime safety in general and on the prevention of pollution from ships:

- S10: Further develop regional preparedness and response-related services by e.g., investigating options for upgrading SeaTrack Web to include live data feed in order to improve oil spill trajectory prognoses no later than by 2027. Investigate options to prepare SeaTrack Web for integration with the Clean Sea Net satellite detection service
- S11: Conduct a feasibility study by 2022 for, and as appropriate, undertake a risk analysis for oil and hazardous and noxious substances (HNS) pollution of the marine environment in the Baltic Sea area by 2025. (Finland, Sweden, Denmark, and the secretariat are coordinating this work)
- S12: Develop a framework for holistic/integrated management of marine pollution incidents to enable coordinated response operations at sea and on shore by 2025 (HELCOM, 2021a).

The Ministerial Meeting in October 2021 also adopted a revised regional action plan on marine litter (RAP-ML), where plastic pollution from lost cargo is addressed in action RS4:

- *"Investigate the problem with cargo losses causing plastic littering of the marine environment and based on the findings, together with national competent authorities, consider developing a common guidelines for accident management taking into account ongoing work within the IMO and EU" and where the specific issue of plastic pellets is addressed in action RS5:*
- *"Investigate the problem caused by spills of plastic pellets from ships and based on the findings, consider developing common guidelines for accident management in such events" (HELCOM, 2021b).*

HELCOM has issued a manual to be used as guidance and help for bi- and multilateral co-operation and participation in joint actions. Focus is on spillages of oil and other harmful substances. The manual provides details on operational co-operation, as well as general arrangements in a joint operation, including national contact points, guidelines for co-operation, procedures for requesting and providing assistance and the administrative support a requesting party should be able to give, the pollution reporting system, information on aerial surveillance and oiled wildlife response, response exercises and exercise planning, evaluation and reporting, financial aspects, etc. (HELCOM, 2021c). Joint response exercises are taking place annually.

3.3.2 Oslo-Paris Convention (OSPAR)

OSPAR is the mechanism by which 15 governments and the EU cooperate to protect the marine environment of the North-East Atlantic. The fifteen governments are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom. OSPAR started in 1972 with the Oslo Convention against dumping and was broadened to cover land-based sources of marine pollution and the offshore industry by the Paris Convention of 1974. These two conventions were unified, updated and extended by the 1992 OSPAR Convention. Organized in a way similar to HELCOM, there is an OSPAR Commission who adopts binding decisions and recommendations and issues publications. The Commission holds annual meetings, less frequent ministerial meetings, it has several committees and working groups and it is coordinated by a secretariat in London. One of OSPAR's committees deals with the impact of human activities. Under this committee there is an intersessional correspondence group on marine litter (ICG-ML) (OSPAR, 2022a). Geographically overlapping with the Bonn Agreement, the OSPAR has a broader thematic scope. The two entities share the same secretariat in order to coordinate work and to avoid duplication.

On 1 October 2021, OSPAR's Ministerial Meeting adopted a new North-East Atlantic Environment Strategy (NEAES) 2030. One of its twelve strategic objectives, number 4, addresses marine litter: "*Prevent inputs of and significantly reduce marine litter, including microplastics, in the marine environment to reach levels that do not cause adverse effects to the marine and coastal environment with the ultimate aim of eliminating inputs of litter*".

This strategic objective is followed by operational objectives:

- an updated regional action plan on marine litter by 2022
- improved evidence base on the harm in relation to marine litter by 2023 with the aim of developing and agreeing actions and measures to reduce harm by 2025
- a 50% reduction by 2025 and a 75% reduction by 2030 of the prevalence of the most commonly found single-use plastic items and of maritime-related plastic items on beaches
- the development by 2023 of additional regionally coordinated quantitative reduction targets for all marine litter on beaches
- the adoption by 2025 of programmes and measures to control and, where appropriate, phase out plastic from materials placed at sea for the purposes of marine infrastructure developments
- the development by 2027 of measures to control, and where possible, phase out discharges of plastic substances, including microplastics, contained in chemicals from offshore sources
- the development by 2025 of approaches to prevent and reduce riverine marine litter inputs
- the development and implementation by 2025 of measures to substantially reduce marine litter from fishing and aquaculture gear (OSPAR, 2021).

In 2014 OSPAR adopted its first regional action plan on marine litter (RAP-ML). An updated plan was adopted and launched in June 2022 and is described as the main instrument to deliver strategic objective 4 of the NEAES and the related operational objectives. The action plan includes 25 actions subdivided into land-based sources, sea-based sources and cross-cutting issues. One action, C.1.1, addresses the acute plastic pollution issue: "*Prevent microplastic pollution resulting from plastic pellet, powder and flake loss*". The Netherlands and United Kingdom have the lead on this action, supported by Denmark, France, Germany, KIMO and Seas at Risk (OSPAR, 2022b).

In 2018, OSPAR presented a background document that described and quantified the problem of pre-production plastic pellet loss. The document also discussed measures to prevent the problem and suggested that "*it may be most effective to support the development and implementation of voluntary actions by industry, to be followed after a number of years by legislative action if voluntary action fails to*

effect change". As specific examples of areas where measures could be taken, the document suggested to adopt a supply chain approach, to introduce supply chain certification schemes, monitoring programmes, auditing schemes, training and awareness raising (OSPAR, 2018).

OSPAR is undertaking a project together with France (CEDRE) to improve knowledge on the impacts of spills of plastic pellets in the environment and on possible response techniques. The project is nationally funded by France. Plastic pellets are lost at every stage of the transport chain and authorities need information on their characterisation, behaviour, and recovery. Incidents such as MSC Zoe in 2019, Trans Carrier in 2020 and X-Press Pearl in 2021 has resulted in massive releases of plastic pellets into the marine environment. The project will address information exchange with manufacturers, a literature review, tests, adaptation of models and an inventory of plastic pellets incidents (Bonn Agreement, 2022b).

3.3.3 Arctic Council

The Arctic Council is the leading intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States, Arctic Indigenous peoples and other Arctic inhabitants on common Arctic issues. This concerns in particular issues of sustainable development and environmental protection in the Arctic. The council was formally established in 1996 and was preceded by the Arctic Environmental Protection Strategy (June 1991). Its members are Canada, the Kingdom of Denmark (including Greenland and the Faroe Islands), Finland, Iceland, Norway, Russia, Sweden and the United States. Six organizations representing Arctic Indigenous Peoples have a status as Permanent Participants (Arctic Council, 2022a).

There are six working groups in the Arctic Council, one of them called "Emergency Prevention, Preparedness and Response" (EPPR). Extreme climate conditions and limited infrastructure in the

Arctic call for international cooperation and careful pre-planning of prevention, preparedness and response actions. The group's main tasks are to:

- Develop guidance and risk assessment methodologies;
- Exchange information and best practices regarding prevention, preparedness and response to accidents and threats from unintentional releases of pollutants and radionuclides, and to natural disasters;
- Coordinate response exercises and training;
- Maintain the operational guidelines for two of the legally binding agreements negotiated under the auspices of the Arctic Council, agreements on Search and Rescue (SAR) and Cooperation on Marine Oil Pollution Preparedness and Response (MOSPA) (Arctic Council, 2022b).

Another working group, AMAP, the Arctic Monitoring and Assessment Programme, is now preparing the first monitoring plan on microplastics and litter in the entire Arctic ecosystem (Arctic Monitoring and Assessment Programme, 2022). The PAME working group (Protection of the Arctic Marine Environment) deals with shipping and marine pollution.

In May 2021, The Arctic Council's Ministerial Meeting adopted a Regional Action Plan on Marine Litter in the Arctic. The eight themes of the action plan are:

- I. Reducing Marine Litter Inputs from Fisheries and Aquaculture
- II. Reducing Marine Litter Inputs from Ships and Offshore Structures
- III. Improving Onshore Waste and Wastewater Management
- IV. Sustainable Materials Management in the Arctic Environment
- V. Cleaning Arctic Coasts
- VI. Strengthening Monitoring and Research
- VII. Outreach
- VIII. International Cooperation

There are no actions in the plan specifically addressing acute plastic pollution, although the plan mentions that "*accidents involving ships, which can include loss of containers, are also known sources of marine litter*" (Arctic Council, 2021).

3.3.4 Nordic Council of Ministers

In 2017, The Nordic Council of Ministers adopted a programme to reduce the environmental impact of plastic. One of the six strategic areas is called "*Co-operation on measures to stop plastic waste in the seas and find cost-effective clean-up solutions*". The objectives of this strategic area are mainly about enhancing knowledge. Knowledge about the sources of plastic waste in the seas in order to create a basis for targeted preventive measures. Knowledge about cost-effective and environmentally sound clean-up solutions and support to cleaning up Nordic coastal areas. Knowledge and exchange about the prevention of plastic littering by maritime industries in co-operation with these industries. The programme also expresses joint support for decisions and action plans adopted by e.g., the UN, HELCOM, OSPAR, the Arctic Council and the EU (Nordisk Ministerråd, 2017).

In April 2019, the Nordic Ministers for the Environment and Climate adopted a declaration on the call for a global agreement to combat marine plastic litter and microplastics. The text refers to UNEA resolutions 3/7 and 4/7 and SDG 14, stresses that strengthened action is urgently needed to prevent further discharge and reduce levels of marine plastic litter and microplastic in the marine environment and calls for the development of a global agreement to deal more effectively and comprehensively with the issue of marine plastic litter and

microplastics on a global level in an integrated manner (Nordisk Ministerråd, 2019).

3.3.5 Bonn Agreement

To limit acute oil or chemical pollution in the North Sea, all countries bordering the sea have concluded an agreement on mutual warning, assistance and environmental surveillance. The official name is 'Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances'. The agreement was signed in 1969 in Bonn by Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, and the United Kingdom. In 1983 the EU joined a revised agreement, in 1987 air surveillance was included. Ireland (2010) and Spain (2019) have also joined the agreement. The agreement itself outlines the legal basis for the organisation and its work. It stipulates the areas that the cooperation will cover and how Contracting Parties should act within the agreement in the case of pollution. (Bonn Agreement 2019)

In 2019 the Bonn Agreement celebrated its 50 Anniversary with its second Ministerial Meeting. Ministers adopted the Bonn Declaration and the Bonn Agreement Strategic Action Plan (BASAP) 2019–2025. The BASAP is regularly updated to meet new and anticipated challenges to the Marine Environment (Bonn Agreement, 2019).

To achieve its vision the Bonn Agreement has agreed the following Strategic Aims that are translated into concrete operational objectives:

- Prevention of illegal and accidental pollution by collaboration and collective enforcement of international maritime pollution rules and standards, including the compliance of MARPOL Annexes
- Promotion and establishment of efficient emergency preparedness
- Organisation of optimum response capacities

Operational objectives include adequate surveillance of shipping, common approaches in the compliance monitoring of MARPOL Annexes, efficient gathering of evidence in case of pollution incidents and ensuring awareness of national contingency systems and strategies. Furthermore, maintaining the adequate level of training of response staff and cooperation between combating units of the Contracting Parties and the preparedness for efficient multinational combating operations. In the Technical Addendum strategic actions are described, which e.g., includes maintaining contacts with HELCOM and OSPAR, enhancing readiness to receive/offer/transit international assistance making use of the EU Host Nation Support Guidelines and plan and undertake regional and sub-regional operational exercises and training and joint operational combat exercises in relation to regional strategic training needs (Bonn Agreement 2019).

Over the years, the Bonn Agreement has adopted several decisions to facilitate joint operations to combat pollution or to put the Bonn Agreement into practice.

These decisions and other practical information are contained in the Bonn Agreement Counter Pollution Manual. The Bonn Agreement technical working group OTSOPA keeps the Manual under review to ensure that best available technologies are being used. (Bonn Agreement 2022a) The Agreement does not aim at acute plastic pollution, but according to the summary from the technical OTSOPA working group meeting in Gent, 22–25 May 2022, "*discussions were held on emerging issues such as plastic pellets spills*" (Bonn Agreement, 2022b).

3.3.6 Copenhagen Agreement

The Nordic agreement about Cooperation concerning Pollution Control of the Sea after Contamination by Oil or other Harmful Substances, in short the Copenhagen Agreement, was signed in 1971 and in a revised form in 1993 by the governments of Denmark, Finland, Iceland, Norway and Sweden. Greenland and the Faroe Islands joined in 1998 as part of the Danish delegation. The agreement concerns cooperation in the areas of monitoring, investigation, reporting, production of evidence, pollution control, assistance, unhindered frontier crossing for rescue vehicles and equipment, reimbursement, compensation and exchange of information related to cases of pollution with oil or other hazardous substances "*which constitutes a serious and imminent threat to the essential interests of one or more Parties*" (Copenhagen Agreement, 1993). The Parties meet in annual plenary meetings and in a working group (Copenhagen Agreement, 2002a). The chairmanship and secretariat circulate between the countries. Norway will chair the cooperation for two years from October 2022. Finland is host of the secretariat in 2022 and 2023. The agreement is accompanied by a detailed manual, the plan for cooperation, which is a living document with guidelines for cooperation between two or more countries in operations to combat marine pollution as defined in the agreement (Copenhagen Agreement, 2022a).

The focus of the Copenhagen Agreement is "oil and harmful substances" (the latter sometimes called "chemical discharges" in the manual). However, at the working group meeting in 2021 Norway informed about the recent pellets and paraffin incidents, mentioned that legislation regarding harmful substances differs between the Nordic countries. This could lead to different approaches to reporting and compensation. Norway asked for the Copenhagen Agreement to take a closer look at definitions and implementation in national legislation regarding harmful substances other than oil (Copenhagen Agreement 2022b, agenda point 10.6).

3.3.7 Sub-regional response plans

Within some of the agreements mentioned above, there are also joint zones of responsibility where joint exercises between two or more countries are held under bilateral or trilateral agreements. Examples of such agreements are DENGERNETH between Denmark, Germany and the Netherlands in the North Sea and SWEDENGER between Sweden, Denmark and Germany in the Baltic Sea.

3.3.8 Cleanup cooperation on regional level

Nordic Coastal Cleanup is a collaborative project between eight Nordic partners who together aim to contribute to the work against marine litter in the Nordic region: CSR Greenland, Keep Denmark Tidy (Hold Danmark Rent), Keep Norway Beautiful, Keep Sweden Tidy, World Wide Friends (Iceland), Keep the Archipelago Tidy (Finland), Ruddy Føroyar (Faroe Island) and Städa Åland. The main aim of the Nordic Coastal Cleanup is to mobilize volunteers and pick litter from beaches along the coast and inland along rivers and lakes throughout the Nordic countries. One annual event is the Nordic Coastal Clean-up Day on the first Saturday in May. The organisation also seeks to fill the knowledge gap of the sources of marine litter in the Nordic countries by conducting beach monitoring and data collection (Nordic Coastal Cleanup, 2022).

3.3.9 Regional level – summary and conclusions

At regional seas level several concrete actions have been taken to address acute pollution, for example the Helsinki Convention's Annex VII is on the Response to pollution incidents (HELCOM, 2022b). However, this is not specific on acute plastic pollution. The same applies to the Baltic Sea Action plan. The problem is mentioned but actions focus on investigation of the problem of plastic spillage and the development of common guidelines for accident management. OSPAR included acute plastic pollution in its Regional Action Plan on Marine Litter. Again, the focus is on voluntary measures like in the 2018 background document on pre-production pellet loss.

Bonn Agreement, Copenhagen Agreement and the Arctic Council, in addition to the Helsinki Agreement, have very concrete plans for preparedness, international coordination and joint action in case of acute pollution. Although the focus of these plans is not on acute plastic pollution, they can help to inform the development of specific plans to address acute plastic pollution events and pellet spills.

3.4 National level: legislation and responsibilities

All countries in the Nordic region have regulations on oil pollution and pollution with hazardous substances, but the legislation is normally based on IMO/MARPOL definitions and therefore do not cover plastics. Subsequently, apart from Norway, the situation seems rather vague when it comes to responsibilities, preparedness and budget among national agencies to act swiftly in a case of acute plastic pollution. Individual municipalities will be in the frontline of clean-up operations, but their preparedness differs a lot and it is not very clear how and to what extent they can receive practical, financial or legal assistance from the national level in such cases. If a massive pellets pollution will take place, there is an obvious risk that the cleanup process will be delayed due to this lack of clarity.

The table below indicates, in a simplified manner, which legislation and which agencies that could be most relevant to focus on in the further discussions on responsibilities. For a more elaborate description of the situation in each country/autonomous region, please see annexes III.a-e.

Table 1. Presence at national level of experience of acute plastic pollution, most relevant legislation on marine pollution (oil/ hazardous substances), the agencies with responsibilities in oil prevention/ preparedness and agencies/actors with responsibilities in beach cleaning.

Country or autonomous region	Experience of acute plastic pollution	Most relevant legislation on marine pollution (oil/ hazardous substances)	Agencies with responsibilities in oil prevention/ preparedness	Agencies/ actors with responsibilities in beach cleaning
Denmark	N	Havmiljøloven (Maritime Environment Act) Søloven (Maritime Transport Act) Strandrensings-bekendtgørelsen (Beach-cleaning Regulation)	Forsvarskommandoen (Armed Forces Command) Miljøstyrelsen (Danish Environmental Protection Agency) Beredskabsstyrelsen (Danish Emergency Management Agency)	Kommuner (Municipalities) Naturstyrelsen (Nature Agency) Miljøstyrelsen (Danish Environmental Protection Agency) Forsvarsministern (Minister of Defence)
Faroe Islands	N	Søloven (Maritime Transport Act) (DK) Løgtingslóg um verju av havumhvørvinum (Maritime Environment Act)	Landsverk Marine Rescue Coordination Center (MRCC) Umhvørvisstovan (Faroese Environment Agency) Arktisk kommando (Arctic Command)	Kommuner (Municipalities)
Greenland	N	Act on Maritime Environment Protection	Arktisk kommando (Arctic Command)	Kommuner (Municipalities)
Finland	N	Ympäristönsuojelulaki/ Miljöskyddslagen (Environmental Protection Act) Merenkulun ympäristönsuojelulaki/ Miljöskyddslag för sjöfarten (Act on Environmental Protection in Maritime Transport)	Ympäristöministeriö/ Miljöministeriet (Ministry of the Environment) Rajavartiolaitos/ Gränsbevakningsväsendet (Border Guard)	Kunnat/Kommuner (Municipalities) Alueellista pelastuslaitosta/ Regionala räddningsverk (Regional rescue departments)
Åland	N	(see Finland)	Landskapsregeringen (Government of Åland)	Landskapsregeringen (Government of Åland)

Iceland	N	Lög um varnir gegn mengun hafs og stranda (Act on protection against pollution at sea and on the coast)	Umhverfisstofnun (Environment Agency of Iceland)	Umhverfisstofnun (Environment Agency of Iceland)
Norway	Y	Forurensingsloven (Pollution Act)	Kystverket (Norwegian Coastal Administration) Miljødirektoratet (Norwegian Environment Agency) Direktoratet for samfunnssikkerhet og beredskap (Norwegian Directorate for Civil Protection)	Kommuner (Municipalities) Interkommunale utvalg mot akutt forurensing (Inter-municipal committees against acute pollution) Statsforvalteren (County Governor)
Sweden	Y	Miljöbalken (Environmental Code) Lag om åtgärder mot förorening från fartyg (Act on measures against pollution from vessels)	Kustbevakningen (Swedish Coast Guard) Myndigheten för samhällsskydd och beredskap (Civil Contingencies Agency) Havs- och vattenmyndigheten (Swedish Agency for Marine and Water Management)	Kommuner (Municipalities) Länsstyrelser (County Administrative Boards)

4. Discussion and conclusions

4.1 Discussion

The discussion regarding the challenges met during the research is divided over the topics literature review and interviews.

4.1.1 Literature review

The literature research that was conducted showed that the estimates of the amounts of plastics present in the environment and the oceans differ considerably. The same applies to the estimated numbers of pellets present in the environment. Information on cases of pellet loss provided information on the magnitude of the losses and the approach to address these. The descriptions of the most important cases differed considerably leading to a difference in the presentation of the emphasis of measures taken and recommendations for the future provided. Those recommendations however, were complimentary to one another, and provide when combined information on both prevention (e.g. recommendations for adjustment of legal requirements prescribing technical measures for maritime container transport) and actions taken in the field. At UN and EU level, literature on legislation regarding pollution was rather easily retrieved. Due to the large number it was not always easy to find all treaties, policies and plans that apply. At regional and national levels legislation, practical measures and actions addressing acute pollution of oil and hazardous substances were in general easily accessible from the websites of relevant authorities. Despite the many national acts and organisations, however, not much to be found on these sites about how to deal with acute plastic pollution. An exception are the reports on lessons learned from the Trans Carrier, MSC Zoe and X-Press Pearl incidents.

4.1.2 Interviews

After consultation of the steering committee, e-mails were sent with an invitation for interviews to representatives of the regional agreements and relevant national agencies. The latter concerning all eight countries/self-governing territories and of some organisations involved in beach-cleaning. Most of these contacts led to an interview. The interviews were carried out between November 2022 and March 2023 (see annex I). Responses to the invitations for an interview often took a considerable time. Some of the potential interviewees declined or made it very clear in their answer that their organisation did not have a formal task related to acute plastic pollution nor the knowledge. Some suggested other interviewees for which the time did not always allow to follow up on. A few did not answer at all.

Information in writing was also received from some of those who were not available for an interview. There was an exchange of emails with the Norwegian chair of the IMO correspondence group. He did not have the time for an interview but kindly provided some insight to the discussions in the group. The report from this group is not published at the time of writing and is therefore not quoted here. Nonetheless, in general the interviews provided valuable information and complemented the picture that was created by the literature review.

4.2 Conclusions

The main research questions assessed and the answers to those are:

4.2.1 What is the nature and magnitude of plastic pollution, emphasizing the marine environment?

Recent estimates suggest that since 2019, about 22 million tonnes of plastic materials enter the environment each year. Of this amount between 6.1–8 million tonnes of mismanaged plastic waste enters the oceans every year and there is evidence of increasing quantities over time. It is estimated that there is over 150 million tonnes of plastics in the ocean today. Sources of plastic marine litter are diverse, and can be land-based, riverine, sea-based and even airborne. However, most of the sources of plastic waste are land-based, due to the fact that its production, consumption and dumping mainly takes place on land. The main pathways of marine litter are rivers.

4.2.2 What is acute plastic pollution and what is its nature and magnitude, emphasizing the marine environment?

In this report Acute Plastic Pollution (APP) is defined as “pollution caused by the sudden and unexpected release of a large amount of small plastic items that requires immediate response to protect human health and/or the environment”. A special type of plastic pollution and especially acute plastic pollution is caused by the loss of plastic pellets. Plastic pellets are a specific group of plastic items within the overarching group of marine plastic litter. Plastic pellets are made of refined crude oil and other additives, it can be a range of plastic types like e.g., polyethylene, polypropylene (PP), polyester, polystyrene, polyethylene-vinyl acetate, polyvinyl chloride and others. It is an industrial raw material for the manufacturing of plastic products. With regard to quantities lost, it is estimated that globally 230,000 tonnes of pellets enter the environment annually. The European Union alone produces between 58-70.6 million tonnes of plastic pellets per year. Furthermore, there is estimated that the three biggest sources of pellet losses are producers, intermediary facilities and converters/processors. The estimated total pellet losses in Europe amount annually between 16,888 to 167,431 tonnes.

4.2.3 What acute plastic pollution incidents of a relevant magnitude occurred at the Nordic countries and globally?

4.2.3.1 M/V Trans Carrier incident (Norway and Sweden)

23 February 2020 the container ship M/V Trans Carrier lost a part of 13.2 tonnes of pellets made of polypropene off the Norwegian and Swedish coast. In Sweden, an estimated 2.5 tonnes of pellets were cleaned up, while the amount in Norway was 4.2 tonnes.

4.2.3.2 Finnbirch incident (Sweden)

In November 2006, the container vessel Finnbirch sank in the Swedish part of the Baltic Sea between Öland and Gotland. The cargo consisted of hazardous goods, and 70 tonnes of polymer pellets on the main deck. No information was retrieved on the fate of the plastic pellets when the ship sunk. This case illustrates the long-time character of potential pollution from sea accidents.

4.2.3.3 MSC ZOE incident (the Netherlands and Germany)

In the evening of 1 and the morning of 2 January 2019, the Ultra Large Container Ship MSC Zoe lost 342 containers with an estimated amount of 3,257 tons north of the Dutch and German Wadden Sea Islands. The ship is one of the world's largest container ships and has a total theoretical container capacity of 19,224 TEU. One lost container contained 22.5 tons of pellets, with a diameter of 4 millimeters. Those washed up on the beaches after the event were difficult to remove from the environment due to their small dimensions.

4.2.3.4 X-Press Pearl (Sri Lanka)

One of the largest plastic pellets spills globally recorded so far was that of the X-Press Pearl, which occurred off the Sri Lanka coast on 20 May–17 June 2021. The vessel caught fire and sank eventually. Apart from other substances like oil, nitric acid, caustic soda and methanol, an estimated 1,680 tonnes of plastic pellets were lost. Those littered 300 km of shoreline. A considerable proportion of the stranded plastics on the shoreline were burnt fragments of various sizes. They were mixed with various types of debris from the ship and its cargo. The impact of the acute plastic pollution on the environment, local communities and economy were extensive.

4.2.4 What approach was applied during clean-up operations after acute plastic pollution incidents?

All four incidents described are of a maritime nature, involving pellet loss of ships at sea. The elements of the approaches include:

1. **Way of starting up and the organisation of clean-ups:** after the event was reported by the ship's crew or discovered by the authorities, clean-up operations started. Sometimes this was initiated by local authorities and citizens (Trans Carrier and MSC Zoe incidents) after which regional (the Netherlands, e.g. Safety Region as coordinator) and national authorities supported as well. Sometimes the military was sent to help (Netherlands). Other organisations such as companies, nature management organisations, NGOs and Academia were involved in clean-ups and research.
2. **Attributed status to the event:** some countries declared the disaster of national importance (Norway) or regarded it that way leading to regional or national coordination (Norway, the Netherlands and Sri Lanka). In Sri Lanka, the Cabinet of Ministers of Sri Lanka appointed an Inter-Ministerial Committee of senior government officials headed by the Minister of Justice for an overall coordinated response to the incident. Other countries did not regard the event of national importance (Sweden).
3. **Notification of other countries:** in some cases other countries were notified (Norway, The Netherlands) or the United Nations were asked for assistance (Sri Lanka).
4. **Addressing multiple environmental compartments:** clean-ups of the APP were conducted involving beach-clean ups (Norway, Sweden, Netherlands and Sri Lanka), collection of containers at sea (Netherlands and Sri Lanka) and measures to prevent the spread into a lagoon (Sri Lanka).
5. **Application of various clean-up methodologies:** clean-up methods of beaches involved sieving of sand, floatation in seawater, trommeling and beach graders (all in Sri Lanka), manual collection (Netherlands) and beach vacuum cleaners (Norway, Netherlands, Sri Lanka).
6. **Proper transport and storage of pellets:** transport and storage of the large amounts of pellets collected involved storage at the backshore of beaches which posed the threat of secondary pollution. This was due to losses caused during transport and at storage locations (Sri Lanka). Awareness of this could limit the issue.
7. **Banning of fisheries practices:** one country banned coastal fisheries due to the severity of the disaster and expected pollution effects on human health of fish consumption of fish caught in the affected area (Sri Lanka).
8. **Mapping the spread of the pollution:** mapping of the spread of the pollution was carried out (Norway and the Netherlands) using citizen science.
9. **Dealing with legal and financial consequences:** including liability and compensation claims (Norway, Netherlands, Sri Lanka).

10. **Conducting environmental impact assessments:** Assessment of the environmental impact and the current state of the marine and coastal environment (Norway, Netherlands, Sri Lanka).
11. **Definition of strategies for longer term clean-ups:** considering defining strategies for guiding the microplastic clean-up effort and help assess the environmental impact of clean-up techniques to determine when to stop cleaning and prevent additional environmental damage, and to develop a long-term plastic beach clean-up programme along the coastline to collect chronic beach pollution by plastic debris. This should include a community-based approach for waste collection (Sri Lanka, the Netherlands).

4.2.5 What relevant agreements and regulations are present that address acute plastic pollution?

4.2.5.1 Global level

The number of international agreements and policies at UN or international level on pollution is considerable. However, most of those do not address acute plastic pollution or are of a voluntary nature and not binding. Examples are the Global Partnership on Marine Litter (GPML) and at a smaller geographic level, G20's "Implementation Framework for Actions on Marine Plastic Litter" which encourages to take action. More strict regulations are included in UNCLOS. Of importance to imposing rules to prevent or combat pollution is the International Maritime Organization (IMO). The organization has a regulatory framework for the shipping industry, and its Marine Environment Protection Committee (MEPC) is of importance for environmental protection. The MARPOL convention is binding, but does not apply to plastics specifically but to other pollutants. However, there is an organisational framework on the coordination of activities in the chain underway by implementation of Resolution UNEP/EA.5/Res.14 that is entitled "*End plastic pollution: Towards an international legally binding instrument*". This will take time and it is not known whether acute plastic pollution will be included in the final version.

4.2.5.2 EU level

There are no existing international frameworks or laws present in the European Union that specifically address acute plastic pollution from industrial spills. It is also rare that pellet spills are directly regulated on national levels. However, the European Union has a number of Directives and Framework Directives that define how plans and measures to protect the environment have to be drafted, implemented and monitored. Important examples are the Water Framework Directive and the Marine Strategy Framework Directive. The EU Water Framework Directive describes measures to be taken for the protection of inland surface

waters, transitional waters, coastal waters and groundwater. The Directive stipulates River Basin Management Plans and associated Plans of Measures for EU Member States. Article 3 is specifically on Coordination of administrative arrangements within river basin districts, this also includes cooperation between countries in so called River Basin Districts. There are lists of "Pollutants", "Priority Substances" and "Hazardous Priority Substances" that need to be addressed. Plastics are not part of any of those lists, and the way to address acute plastic pollution and the stakeholders that should be involved is not included either. The Marine Strategy Framework Directive defines Marine Strategies, Plans of Measures and Monitoring Programmes, and includes a specific descriptor: "Marine Litter". Cooperation with, or at least informing, other states is included, but this is not on addressing acute (plastic) pollution since this has no official status.

4.2.5.3 The Regional level

At regional seas level several concrete actions have been taken to address acute pollution, for example the Helsinki Convention's Annex VII is on the Response to pollution incidents. However, this is not specific on acute plastic pollution. The same applies to HELCOM's Baltic Sea Action plan. The problem is mentioned but actions focus on investigation of the problem of plastic spillage and the development of common guidelines for accident management. OSPAR included acute plastic pollution in its Regional Action Plan on Marine Litter, where the focus is on voluntary measures such as are presented in the 2018 background document on pre-production pellet loss. The Bonn Agreement, Copenhagen Agreement and the Arctic Council, in addition to the Helsinki Agreement, have very concrete plans for preparedness, international coordination and joint action in case of acute pollution. Despite that their focus is not on acute plastic pollution, but the structure could be useful to address this. Adding one term "acute plastic pollution" to "oil spills" might almost make this work.

4.2.5.4 The National level

Every country in the Nordic Region has its own legislation on marine traffic and on pollution. Hazardous goods are defined according to international conventions. The responsibilities for preparedness and cleanup in cases of acute pollution with oil or chemicals are regulated. Several agencies are involved in each country and so are the municipalities. Acute plastic pollution is not explicitly mentioned in the legislation anywhere apart from Norway where individual incidents of plastic pollution can, after a concrete assessment, be considered acute pollution according to Section 38 of the Pollution Act. Apart from that, there is no clear responsibility defined for such situations, no preparedness, no trained staff nor funding. If a massive acute pellets pollution will take place, there is the risk that the cleanup process will be delayed because of this lack of clarity and absence of guidance.

4.2.6 What organisational structure(s) are present at regional and national level and what cooperation exists between countries to address acute plastic pollution?

At regional level, the Bonn Agreement, Copenhagen Agreement and the Arctic Council, in addition to the Helsinki Agreement, have very concrete plans for preparedness, international coordination and joint action in case of acute pollution. Despite that their focus is not on acute plastic pollution, but the structures could be very useful to address this. Within some of the agreements mentioned above, there are also joint zones of responsibility where joint exercises between two or more countries are held under bilateral or trilateral agreements. Examples of such agreements are DENGERNETH between Denmark, Germany and the Netherlands in the North Sea and SWEDENGER between Sweden, Denmark and Germany in the Baltic Sea.

4.2.7 What guidelines and measures could be considered to be used for addressing acute plastic pollution?

1. Use a commonly accepted definition for acute plastic pollution in any international and national pollution control acts and policies. This allows easier cooperation and to promptly designate the responsibility to the appropriate governmental agency in case of a pollution event.
2. Give plastic pellets a status within legislation dealing with dangerous goods. If they could be labelled as "dangerous goods" in the various UN agreements and included, like in MARPOL, *The International Maritime Dangerous Goods (IMDG) Code* or *International Maritime Solid Bulk Cargoes (IMSBC) Code* or *The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*; it could be addressed more stringently both during production by the industry and during transport and storage. Political lobby is needed for this.
3. As legal framework for preparedness, international coordination and joint action in case of acute plastic pollution, the Bonn Agreement, Copenhagen Agreement and the Arctic Council, in addition to the Helsinki Agreement could be used. Despite that their focus is not on acute plastic pollution, but the structures could be very useful to address this, while incorporating acute plastic pollution. These plans contain a large number of very concrete steps, in case those are deemed not covering all, point 4 gives additional measures of importance.
4. Prevention is key, hence, measures that could be considered regarding prevention of acute plastic pollution by ships that transport small plastic items like pellets in bulk are:

- a. Revise the existing technical and legal regulations for container ships regarding the design limits of cargo securing equipment, approved loading and stability conditions and the consideration of shallow water effects and speed on ship motions and resulting accelerations and forces.
 - b. Evaluate and assess possible technical solutions that can assist the captain/crew in the prevention and, if an accident happens, the detection of the loss of containers and to propose international standards for implementation of such solutions.
 - c. Raise awareness and develop guidelines for the Masters and Navigational Officers on risks and actions to be taken when cargo is lost when sailing with dangerous cargo near particularly sensitive areas.
5. Regarding preparedness and mitigating of the key risks of an acute plastic pollution spill, prepare a contingency plan including, how to:
- a. Organise the clean-up operations of acute plastic pollution and possibly a combined oil and chemical spill. The clean-up of APP should be led by the same governmental agency that is responsible for handling other forms of acute marine pollution. The approach and emergency plans used when working with larger oil spills also works with this kind of pollution.
 - b. Use one single contact point to communicate with the responsible polluters, insurance companies and other stakeholders. This makes it easier to establish common goals for the operation, secure compensation of cost, etc.
 - c. Inform and acquire information from the public, for this citizen science could be used.
 - d. Coordinate communication with and emergency support from neighbouring countries and other countries of relevance.
 - e. Implement surveillance and salvage of the wreck, containers and the area affected by acute plastic pollution.
 - f. Assess the environmental damage over the short and longer-term.
 - g. Support impacted economic sectors, particularly coastal fishing communities and the tourism industry.
 - h. Investigate legal and financial issues associated with the incident.
 - i. Address filing of compensation claims.

4.2.8 What gaps are present regarding prevention, emergency response and clean-up of acute plastic pollution?

4.2.8.1 Gaps according to literature

Gaps that were identified regarding prevention, emergency response and clean-up of acute plastic pollution, after analysis of the legislation and policies at UN, EU, Nordic Region and national level include:

1. The amounts of material released during acute plastic pollution events are not known well. Only rough estimates are present for the Nordic region, Europe and globally.
2. There is no easy way of cleaning-up pellet pollution from the environment, it is very difficult and "no one size fits all" solution exists.
3. The current legislation for more secure stowage of containers on containerships is not sufficient to prevent loss of small plastic items like pellets.
4. Technical measures like electronic inclinometers, sensors to measure accelerations to provide crew of containerships with real-time information nor video recordings are often not present.
5. Measures to reduce high acceleration forces that could cause damage to cargo of containerships are not always applied during the construction and operation of containerships.
6. There is not sufficient awareness of nor guidelines for the Masters and Navigational Officers of containerships on sailing with a high stability and the hydrodynamic phenomena in specific marine areas (like the sailing routes north of the sensitive Wadden Sea).
7. There are no general contingency plans present for addressing acute plastic spills and their environmental and economic impact.
8. There are international laws and conventions on waste and plastics, but none yet that address acute plastic pollution.
9. Plastic pellets/nurdles are not labelled as being of a "hazardous" nature, neither internationally, regionally, at EU-level, nor nationally in the Nordic Region.
10. Because acute plastic pollution is not included in any legislation, preparedness, coordination internationally and nationally of clean-ups, and liability or compensation when damage is caused are not present in provisions.
11. There is no organization nor organizational framework that from a legal perspective deals with acute plastic pollution, internationally, regionally, at EU-level, or nationally in the Nordic Region.

12. There are frameworks that comprise most if not all elements needed to combat acute plastic pollution (Bonn Agreement, Copenhagen Agreement and Helsinki Convention) but focus on other pollutants, specifically oil and harmful substances/chemical discharges.
13. There are organisations that address pollution of other hazardous substances such as oil (for example, EMSA at EU-level and MARFO in Norway), but those do not focus on acute plastic pollution at the moment.
14. There are, however, concrete measures at the level of OSPAR and the plastics industry (Operation Clean Sweep) that address pellet loss, but those are voluntary and will therefore have limited effect only.

4.2.8.2 Gaps according to interviews

Two main gaps are mentioned in many of the interviews (those are not presented before, hence the reference to interviewees and dates of the interviews are presented here):

1. the lack of legislation and rules on international level for the transport of plastic pellets and
2. the lack of clarity in each country on responsibilities in a potential case of acute plastic pollution.

On the first issue, international rules, many of the interviewees indicate that IMO has a crucial role. Classifying small plastic items transported in bulk, especially pellets, as hazardous goods would lead to stricter rules for packaging and for storing containers with pellets on board ships. Pellets would also automatically be covered by national legislation, which they are not currently.

1. "There are gaps in legislation and policies for addressing transport of plastic pellets. We need regulations that will make sure that leakages of plastic pellets are minimized during maritime transport through improved packaging and safe stowage, recognizing the hazardous nature of plastic pellets. This could include classification of pellets as harmful substances or other type of measures leading to necessary regulatory requirements in order to minimizing the environmental risk associated with their transport at seas. Also, we need regulations that trigger improved pollution preparedness in case of accidents." (Eriksson, Sweden).
2. "Work internationally to make the conventions cover this field". (Nyland & Strömqvist, Norway)
3. "Allocation of resources, securing capacity to target issues of concern and having a high frequency of onboard supervision are key factors to prevention and risk reduction of cargo loss." (Nyland & Strömqvist, Norway).

4. "Plastic pollution is addressed by the EU SUP Directive, which is a good approach with expectedly a good impact on the environment. However, plastic pellets are not addressed" (Pattinson, OSPAR).

The second issue, the lack of clarity around responsibility chains in each country for preparedness and control of pellet spills is connected to the fact that they are not classified as hazardous. Interviewees from many countries express similar views and concerns:

1. "There is no equivalent to the oil spill preparedness for plastic spills: an organisation that is ready and available and have got proper training and equipment" (Moe, Norway).
2. "The main gap is that we don't know how the authorities would approach it or finance the measures. It is not regulated, so we rely on the good will of companies and authorities" (Metcalfe, KIMO-Denmark).
3. "No one is responsible. There is no coordinating group, no routines, no preparedness and no budget. There are several agencies who could potentially have a role, but none of them has this task. There is not even a technical solution for a national map to be used" (Lachmann, Sweden).
4. "There is no official gap analysis, but in our view it would be better if plastic was included in the current legislation so there will be stricter rules on containers, stricter rules on those who use the pellets. It would be easier to implement if it was part of international law" (Bjarnadóttir and Einarsdóttir, Iceland).
5. "The fact that plastic pellets spills are not explicitly covered by legislation also means that no agency has a budget for dealing with it" (Lindgren & Lindgren, Sweden).
6. "There are many agencies involved and it would for example make sense if the Coast Guard would also be responsible for the long-term issues related to marine pollution" (Genestig, Sweden).
7. "There is a need for better coordination between national and local authorities and between different local authorities" (Jensen, Denmark).

Other comments from the interviews include:

1. the need for better reporting routines when an incident takes place:
 - a. "The Trans Carrier incident was reported only when the ship reached its destination and, due to a misunderstanding, the place for the incident was not correctly reported. That means we were taken by surprise when the pellets reached the coast. We lost valuable time there" (Bergstrøm, Norway).

- b. "The reporting system in cases of incidents needs to be evaluated. In the Trans Carrier case, the amount of lost pellets was not reported correctly." (Nyland & Strömqvist, Norway).
- 1. the system for reporting findings and clean-up of pellets on the shore:
 - a. "We have stressed that the reporting system we used during the Trans Carrier incident should be available for the entire country – it is a complement to MARFO's general marine litter maps" (Moe, Norway).
- 2. the lack of cooperation between the Nordic countries on preparedness and control:
 - a. "It would be good if countries could share knowledge more actively on how to deal with acute plastic pollution, on what kind of prevention we can do, on techniques for cleaning, on how important it is to clean as fast as possible, etc. It makes sense to use the same cooperation frameworks" (Bjarnadóttir and Einarsdóttir, Iceland).
 - b. "In the Trans Carrier case, we had close contact with Sweden, that was also affected. We had 4–5 meetings with the County Administrative Board in Västra Götaland and the Authority on Marine and Water Management. But they did not have the same approach – there was no national action in Sweden, it was only part of the ordinary beach cleaning. We asked for reports and numbers, but we never got any because they did not have that overview" (Bergstrøm, Norway).
- 3. the lack of knowledge:
 - a. "We do not know the amounts of lost pellets, so there is a need for better estimates to identify how big the problem is" (Nyland & Strömqvist, Norway).
- 4. difficulties regarding the liability of the polluter:
 - a. "Liability and compensation are restricted to the costs for the operation and do not cover long-term effects on the environment, on fisheries, on tourism, etc. There is no price tag for the environment" (Genestig, Sweden).
 - b. "National legislation is not always efficient when it comes to pollution from shipping. It is not easy to identify the polluter. A country can be affected by an incident or a crime taking place far away and the authorities cannot prove anything, cannot take any measures against the polluter. This is not an easy task for a municipality that is responsible for dealing with pollution on its coastline" (Lindgren & Lindgren, Sweden).
- 5. lack of ratification of international conventions:
 - a. "Sweden should ratify the HNS convention" (Genestig, Sweden).

5. Recommendations

Derived from the conclusions, the following recommendations are proposed which are divided over the international, regional and the national level. This has been done since each level differs in magnitude and the strategic approach needed to improve the situation.

5.1 Recommendations for the international level

1. Create by means of an assessment insight in the magnitude and locations of acute plastic pollution hot spots and especially those of pellet loss.
2. Decide on an internationally accepted definition for acute plastic pollution for application in international and national pollution control acts and policies. A proposal is presented in this report.
3. Classify pellets officially as hazardous goods at UN level, so that they are covered by stricter regulations for transport, for example how they are packaged and contained, how containers are labelled and maintained, how the carrier is notified so that containers containing plastic pellets can be identified, where the containers are stored on board the ship, etc. Including plastic pellets in international conventions would be helpful as it would automatically include them also in national legislation on dangerous goods.
4. A supply chain approach as proposed in detail by e.g. OSPAR (OSPAR, 2018), Fidra (Fidra, 2020) and others. It is important that all companies involved in making, using or transporting pellets need to commit to following specific and standardized guidelines that prevent pellet loss throughout all stages of making plastic products. The guidelines must be respected for which purpose these companies must report and be audited on how successfully they are implementing these guidelines. All potential measures should be combined with efficient monitoring programmes and accountability following unintentional plastic spills. Such mandatory guidelines can be based on the voluntary guidelines already existing in Operation Clean Sweep. They should be developed in close cooperation with the industry and other stakeholders, so that they are efficient, realistic, easy to follow and control and do not impose unnecessary costs or bureaucracy.
5. The reporting system on cases of incidents needs to be improved – from ship to port, from port to responsible agencies, as well as between agencies in different countries – to give the best possible conditions for containing the spill, predicting how the pellets will spread and preparing for coastal clean-up without losing valuable time.
6. General awareness of the pellets pollution problem should be raised,

transport companies and shipowners encouraged to take action also before legislation is in place, to train their staff properly. All companies in the plastics value chain should be encouraged to join the Operation Clean Sweep programme that must be regulated stringently.

7. The problem of APP should be recognized in European plastic strategies and in the upcoming Global Plastics Treaty.
8. Incorporate acute plastic pollution in a legal framework with concrete actions for preparedness, international coordination and joint actions. This could be included in the Bonn Agreement, Copenhagen Agreement, the Arctic Council or the Helsinki Agreement.
9. Prevention is key, hence, measures that could be considered regarding prevention of APP in the shipping industry are:
 - a. Revise the existing technical and legal regulations for container ships regarding the design limits of cargo securing equipment, approved loading and stability conditions and the consideration of shallow water effects and speed on ship motions and resulting accelerations and forces.
 - b. Evaluate and assess possible technical solutions that can assist the captain/crew in the prevention and, if an accident happens, the detection of the loss of containers and to propose international standards for implementation of such solutions.
 - c. Raise awareness and develop guidelines for the Masters and Navigational Officers on risks and actions to be taken when cargo is lost when sailing with dangerous cargo particularly near sensitive areas.
10. Encourage the development of improved clean-up technology of plastic pellets in water environments, on beaches and shores.

5.2 Recommendations for the regional (sea-basin) level

1. Research what the magnitude of the problem is in the regional sea basin. Include an overview of where plastic pellets are produced and the transport routes, more knowledge on the impact of spills to understand the severity of the problem better and to assess the risks. Existing cooperation frameworks like HELCOM or OSPAR could be good fora for exchange of knowledge on the problem and could work together on the issue.
2. Establish standardized disaster response protocols for acute plastic pollution incidents at regional sea basin level. The Bonn Agreement and the Copenhagen Agreement have protocols for international cooperation on emergency response to acute pollution of the marine environment. These protocols could possibly be applied broader and include plastic pollution. The organisations could be used for sharing best practice on emergency response and clean-up operations.

5.3 Recommendations for the national level

1. Prepare an acute plastic pollution contingency plan nationally, including how to:
 - a. Organise the clean-up operations of acute plastic pollution and possibly a combined oil and chemical spill. The clean-up of APP should be led by the one and same governmental agency that is responsible for handling other forms of acute marine pollution. The approach and emergency plans used when working with larger oil spills also work with this kind of pollution.
 - b. Communicate with the responsible polluters, insurance companies and other stakeholders. By using one single contact point. This makes it easier to establish common goals for the operation, secure compensation of cost, etc.
 - c. Inform and acquire information from the public.
 - d. Coordinate communication with and emergency support from neighbouring and other countries of relevance.
 - e. Implement surveillance and salvage of the wreck and containers (if present) and the area affected by acute plastic pollution.
 - f. Assess the environmental damage over the short and longer-term.
 - g. Support impacted economic sectors, particularly coastal fishing communities and tourism industry.
 - h. Investigate legal and financial issues associated with the incident.
 - i. Address filing of compensation claims.
2. When an acute pollution incident occurs, organise a rapid response, clean up the plastic before it relocates. This, in turn, requires preparedness to mobilize people on short notice. Ensure that responsible authorities have links to those structures and schemes for coastal clean-up that exist in each country, and that can mobilize local communities, associations, schools and volunteers on short notice. Promote and support such structures/schemes. Ensure that they know how to handle nurdle spills. In a clean-up operation it is valuable to hold regular meetings where the different stakeholders can share their knowledge of methods and experiences along the way.
3. Ensure that there is an interactive reporting system available to relevant actors and to the public where finds, photographs, material collected, etc can be entered.
4. There should be preparedness to analyse the plastics loss. There are many different types, some more harmful than others. The analysis is also an important part of finding the source of the. By analysing the plastic and through industry networks it is possible to see where it was produced.

5. Every country should ratify relevant conventions on pollution, including those that (will) address acute plastic pollution.

The Nordic countries should be in the frontline to spread best practice globally, and when possible introduce stricter regulations before international rules are in place.

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Annex I.

Overview of interviewees

Organisation	Name*	Position	Level	Region or Country	Date
Bonn Agreement	Dominic Pattinson	Executive Secretary	Sea Basin	Bonn Agreement Area	01.12.22
Copenhagen Agreement	Rune Bergstrøm	Senior Advisor (National Operational Manager Clean-up of Trans Carrier Incident)	Sea Basin	Copenhagen Agreement Area	23.11.22
Danish Maritime Authority	Therese Bornemann Christensen	Special Advisor	National	Denmark	23.11.22
Danish Ministry of Environment	Frank Jensen	Chief Advisor	National	Denmark	23.11.22
Government of Greenland, Department for Agriculture, Self-sufficiency, Energy and the Environment	Maja Heegaard	Policy Officer	National	Greenland/ Denmark	07.12.22
Icelandic Environment Agency	Halla Einarsdóttir	Policy Advisor	Interview	Iceland	13.12.22
Icelandic Environment Agency	Katrín Sóley Bjarnadóttir	Policy Advisor	National	Iceland	13.12.22

Local Authorities Environmental Organisation (KIMO-Denmark)	Ryan Metcalfe	National Coordinator	National Association	Denmark	21.02.2023
Norwegian Centre against Marine Pollution (MARFO)	Lise Maria Strömqvist	Communications Officer	National	Norway	08.12.22
Norwegian Centre against Marine Pollution (MARFO)	Ragnhild Nyland	Senior Advisor	National	Norway	08.12.22
Norwegian Coastal Administration (Kystverket)	Rune Bergstrøm	Senior Advisor (National Operational Manager Clean-up of Trans Carrier Incident)	National	Norway	23.11.22
Oslofjorden Recreation Council	Nicolay Moe	Senior Advisor	Regional	Norway	07.03.2023
OSPAR Commission	Dominic Pattinson	Executive Secretary	Sea Basin	OSPAR	01.12.22
Swedish Agency for Marine and Water Management, SwAM	Johanna Eriksson	Senior Advisor	National	UN, OSPAR and HELCOM and Sweden	13.12.22
Swedish Agency for Marine and Water Management, SwAM	Fredrik Lindgren	Senior Advisor	National	Sweden	15.12.22
Swedish Agency for Marine and Water Management, SwAM	Fredrik T. Lindgren	Legal Advisor	National	Sweden	15.12.22
Swedish Coast Guard	Johan Genestig	Response Diver Superintendent	National	Sweden	24.11.22

Swedish Environmental Protection Agency, European Affairs	Helén Klint	Policy Advisor	National	Sweden, EU	13.12.22
West Coast Trust	Florina Lachmann	Beach-cleaning coordinator	Regional	Sweden	07.03.23

*The list presented above is of the interviewees, more information was provided in written form. People that provided that information are included in the acknowledgements.

Annex II.a

Interview questions for international umbrella organisations

1. What gaps exist regarding legislation/policies regarding acute plastic pollution to your opinion?
2. What gaps exist regarding measures to your opinion?
3. What gaps exist in terms of definition of tasks to your opinion?
4. What gaps exist in terms of cooperation to your opinion?
5. What would in your opinion be the most efficient measures to prevent acute plastic pollution?
6. What would be the most urgent measures to strengthen preparedness for efficient control and cleanup?
7. Are there, among the countries in your region, examples of best practice in handling acute plastic pollution?
8. How much coordination is there between the Copenhagen agreement, the Bonn agreement/OSPAR and HELCOM (and the Arctic Council) on marine litter plans? On acute plastic pollution?
9. What recommendations would you give for further actions to address APP?
10. How much coordination is there between the Copenhagen agreement, the Bonn agreement/OSPAR and HELCOM (and the Arctic Council) on marine litter plans and on acute plastic pollution?
11. Do you have additional remarks that you want to share?

Annex II.b

Interview questions for governmental organisations of individual countries

Pollution Events & Main Polluters

1. Were there other relevant acute plastic pollution events in the Nordic region apart from the Trans Carrier incident (this includes marine, riverine and terrestrial event)?
2. What are the main polluters and sources of acute plastic pollution in the Nordic countries (riverine, terrestrial and marine)?

Legal regulations, responsibilities and gaps

3. What agreements/regulations on prevention of acute plastic pollution are there?
4. What agreements/regulations on emergency response of acute plastic pollution are there?
5. What agreements/regulations on clean-up of acute plastic pollution are there?

Responsibilities

6. How are the responsibilities for addressing acute plastic pollution defined for what organisation in your country?

Measures that address acute plastic pollution in the Nordic countries

7. What measures on prevention of APP incidents are present in the Nordic countries?
8. What measures on emergency response of APP incidents are present in the Nordic countries?
9. What measures on clean-ups of APP incidents are present in the Nordic countries?

Organisational frameworks that respond to and clean-up acute plastic pollution in the Nordic countries

10. What organisational frameworks that respond to and clean-up acute plastic pollution in the Nordic countries exist?
11. Which stakeholders are part of those frameworks per framework?
12. What are the roles & responsibilities of those stakeholders of those frameworks?
13. What is the structure organisationally of those frameworks?
14. What ways of cooperation exist in those frameworks?

General, regarding APP:

15. What gaps exist regarding legislation/policies regarding acute plastic pollution to your opinion?
16. What gaps exist regarding measures to your opinion?
17. What gaps exist in terms of definition of tasks to your opinion?
18. What gaps exist in terms of cooperation to your opinion?
19. What would in your opinion be the most efficient measures to prevent acute plastic pollution?
20. What would be the most urgent measures to strengthen preparedness for efficient control and cleanup?
21. Are there, among the countries in your region, examples of best practice in handling acute plastic pollution?
22. What recommendations would you give for further actions to address APP?
23. Do you have additional remarks that you want to share?

Annex III.a

An overview of national legislation and policies on (acute plastic) pollution in Denmark, Faroe and Greenland

Denmark has not experienced any major incidents of acute plastic pollution in recent years. The MSC Zoe spill never reached Danish water and the country only got a very small impact from the Trans Carrier incident. The biggest oil spill in Denmark happened in 2001 when an oil tanker collided with another ship south of Falster (Interview with Ryan Metcalfe, KIMO Denmark, on 21 February 2023).

Legislation

Søloven (the Maritime Transport Act) regulates maritime transport, including in chapter 10 the responsibility and liability in cases of oil pollution (Retsinformation, 2018). Transport of dangerous goods at sea is regulated more in detail by the *Danish Maritime Authority (Søfartsstyrelsen)*. Dangerous goods in packaged form must be carried in accordance with the provisions of the IMDG Code. (Søfartsstyrelsen 2022a). The authority receives notifications from ships in cases of maritime accidents, including cases where, because of damage to one or more ships, serious damage to the environment has occurred or there is a risk of serious damage (Søfartsstyrelsen, 2022b).

The *Maritime Environment Act (Havmiljøloven)* aims at preventing and limiting pollution of the sea and to ensure preparedness to control pollution. It establishes the responsibility for cleanup of the coast and of ports in cases of oil and chemical pollution, as well as the right to take various measures against ships to prevent or limit pollution. The Act also contains paragraphs on the liability of polluters (Retsinformation, 2019).

The *Beach-cleaning regulation (Strandrensningens bekendtgørelsen)* describes the distribution of costs for clean-up in cases of oil or chemical pollution (Retsinformation, 1999).

Policies

A national action plan on plastics was adopted in 2018. It contains 27 initiatives, including mappings and analyses, legal changes, new standards, information campaigns, financial support and international cooperation (Miljø- og Fødevarerministeriet 2018).

Preparedness

The Minister of Defense is responsible for preparedness, environmental surveillance, enforcement and pollution control at sea from oil and other hazardous substances. This responsibility is delegated to the *Armed Forces Command (Forsvarskommandoen, FKO)*. The Navy has four dedicated environmental ships. Other ships from the Navy and from the Marine Home Guard are prepared to assist in cases of pollution at sea. There is a marine environment section in the naval staff (Forsvaret, 2022).

The Danish Environmental Protection Agency DEPA (Miljøstyrelsen) has the task to control pollution from platforms. The agency also coordinates the municipal emergency plans for oil and chemical pollution (see below) (Copenhagen agreement, 2022a).

The Danish Emergency Management Agency DEMA (Beredskabsstyrelsen) has a general task to prepare society for and to prevent crises, accidents and disasters. This work includes analysis/data/research, crisis communication, education, as well as advice and administration of the regulations on the transportation of dangerous goods (Beredskabsstyrelsen, 2022a). DEMA has six state regional emergency centers (Thisted, Herning, Haderslev, Næstved, Hedehusene, Allinge) (Beredskabsstyrelsen, 2022b).

Clean-up

Municipalities are responsible for clean-up on the coast and in ports (Copenhagen agreement, 2022a). The *Nature Agency (Naturstyrelsen)* has a responsibility for clean-up in protected areas.

In 2008 *DEPA (Miljøstyrelsen)* issued guidelines for beach cleaning. Although focusing on oil pollution, it includes the general delegation of responsibility in case of pollution of the sea, of coasts, beaches and harbours. It gives guidelines for municipal contingency plans and describes the rules laid down concerning distribution of expenses for emergency preparedness and control measures between the authorities involved (Miljøstyrelsen, 2008). In pollution control at sea and in coastal waters as well as on beaches, there may be cooperation between several other state and municipal authorities and institutions. In the event of serious accidents, a special authority body *the Emergency Committee* is established under the *Ministry of the Environment and Energy*. *The Minister of*

Defence can take the lead on larger control and clean-up operations at sea as well as on the coast. (Copenhagen agreement, 2022a)

Regular beach cleaning is financed by the municipalities' own budgets. Many municipalities have put boxes along the coast where people can leave litter. If there is an acute pollution incident with oil or chemicals, the municipalities will still have the responsibility for the clean-up but can get reimbursement from the national budget according to the Beach-cleaning regulation (see above) (Interview with Ryan Metcalfe on 21 February 2023). It is unclear whether this regulation would apply in a case of acute plastic pollution (Interview with Frank Jensen on 23 November 2022).

There is no formal cooperation between municipalities on beach-cleaning. *Local Government Denmark (Kommunernes Landsforening)*, the association of Danish municipalities, has a limited scope on this. Nineteen coastal municipalities are members of *KIMO Denmark*, including the entire North Sea coast, three on the Kattegat coast and four on Zealand and Falster. The organisation is not directly involved in beach cleaning but is doing lobby work in marine litter issues on behalf of its members. It has also started a coastal lottery with the help of private sponsors to encourage citizens to collect litter. (Interview with Ryan Metcalfe on 21 February 2023)

Various NGOs are involved in beach-cleaning and marine litter. *Havmiljøvogterne* are sailors, divers, surfers, etc, almost 30 000 registered members, who have committed to help the Danish Navy with environmental surveillance and beach-cleaning (Havmiljøvogterne 2023). *Hold Danmark Rent (HDR)* and the *Race for Oceans Foundation* are other examples of organisations involved in beach-cleaning or awareness-raising, as well as *Plastic Change*, an international organization based in Denmark.

Faroe Islands

The Faroe Islands is a self-governing part of the Kingdom of Denmark. The country is not a member of the EU. In the Nordic Council, it is represented as part of the Danish delegation. It has its own parliament, *Løgting*, and its own government, *Landsstýrit*. The Faroe Islands is an associate member of IMO since 2002.

Legislation

Relevant legislation is found in the *Maritime Environment Act (Løgtingslóg um verju av havumhvørvinum)* (Lógasavnið 2005). The Danish act on maritime transport (*Søloven*) applies in part also to the Faroe Islands.

Preparedness and clean-up

The Government (Landsstýrit) has the overall responsibility for control of oil and chemical pollution in Faroese sea and fisheries territory as well as the cleanup of a coast. The task is delegated to an authority, *Landsverk*, where it is a responsibility for the Division of Infrastructure.

Municipalities handle pollution in a port and pollution emanating from land. There are agreements between the parties on mutual assistance in the operations.

The *Maritime Rescue Co-ordination Center (MRCC)* is responsible for communication with the ships during an operation and will also alert when it receives oil pollution reports.

The Faroese Environment Agency (Umhvørvisstovan) contributes with maps for the operations.

The Arctic Command of the Danish Armed Forces can also participate in pollution control on the initiative of MRCC (Copenhagen agreement, 2022a).

The NGO *Rudda Føroyar* organizes an annual clean-up day since four years, as part of World Cleanup Day. They have an online form where people can report litter (Rudda Føroyar 2023).

Greenland

Greenland is a self-governing part of the Kingdom of Denmark. The country left the EU in 1985. In the Nordic Council, it is represented as part of the Danish delegation. It has its own parliament, *Inatsisartut*, and its own government, *Naalakkersuisut*.

In Greenland there is no manufacturing of plastic products, so no pellets are transported there. Royal Arctic Line, a state-owned shipping company, has a monopoly on all goods transport to and from Greenland and between settlements in Greenland.

Legislation

The *Act on Maritime Environment Protection* prohibits the pollution with oil and hazardous substances. The act also stipulates the responsibility for clean-up (Inatsisiliorneq, 2017).

Policies

In May 2021, the Government of Greenland adopted an action plan to reduce the use of plastics. Focus area 4 in the plan deals with microplastics, including measures to reduce the spill to nature from artificial turf and from sewage water (Naalakkersuisut 2021). There is also an action plan on the reduction of lost fishing gear.

Preparedness

Greenland's government and the *municipalities* are responsible for handling pollution on the coast and in Greenland's sea territory (up to 3 nautical miles from land). In the Exclusive Economic Zone, from 3 to 200 nautical miles, the responsibility rests with the *Head of the Joint Arctic Command (AKO)*, a unit of the Danish Army (Copenhagen agreement, 2022a).

Clean-up

Greenland has a general marine litter problem with lost fishing gear. Its five municipalities are responsible for beach-cleaning and sometimes organise clean-up operations with volunteers. They can receive support from an environmental fund under Greenland's government (Interview with Maja Heegaard on 7 December 2022).

CSR Greenland has initiated a national clean-up day, Saligaatsoq, in June every year that engages companies, associations and private citizens. It has also elaborated a guide for the local communities on how to organise coastal clean-ups (CSR Greenland 2023).

Annex III.b

An overview of national legislation and policies on (acute plastic) pollution in Finland and the Åland Islands

Legislation

A full list of relevant laws can be found on the website of the Ministry of the Environment (Miljöministeriet, 2022a).

The *Environmental Protection Act* (527/2014, Ympäristönsuojelulaki/Miljöskyddslag) applies to activities which cause or can cause pollution of the environment. The responsible for such activities has a general duty to prevent and control pollution and to have the necessary preparedness. The act also regulates the tasks of various authorities. (Miljöministeriet, 2022b). The Environmental Protection Act does not apply to the activities referred to in the Act on Environmental Protection in Maritime Transport (1672/2009) or the Act on the Protection of the Sea (1415/1994).

The *Act on Protection of the sea* applies to marine areas *outside* Finland's territorial water. It states that Finnish vessels may not undertake measures that could cause pollution of the sea (Finlex 1415/1994).

The *Act on Environmental Protection in Maritime Transport* deals with prevention of pollution/discharges from ships by oil (Chapter 2), noxious liquid substances (Chapter 4), ship-generated sewage (Chapter 5), ship-generated garbage (Chapter 6) and air pollution (Chapter 7). It further refers to international commitments on anti-fouling systems and ballast water (Chapter 8). The act is elaborated in the government's regulation 76/2010. The act and the regulation do not mention acute plastic pollution or other solid substances (Finlex 1672/2009).

Compensation for personal and property damage as well as the costs of response and restoration work, is governed by the *Act on Compensation for Environmental Damage* (737/1994), instead of the general legislation concerning compensation (Miljöministeriet, 2022a). The Act on Compensation for Environmental Damage is not applicable to damages caused in transport situations.

The *Regulation on substances which are hazardous and harmful for the marine environment* prohibits the emission to lakes, rivers and the sea in Finland's territorial water and economic zone of dangerous substances according to a specific list based on the EU's water framework directive. It does not cover plastic pellets (Finlex 1022/2006).

The Ministry of the Environment of Finland is preparing a legislative project concerning post-spill cleanup and recovery operations for oil and chemical spills. The regulation aims to ensure that the tasks and responsibilities of the authorities and other parties involved in post-spill cleanup and recovery operations are clear, and sufficient preparations for the post-spill cleanup and recovery operations are made. In addition, the Ministry of the Environment of Finland is aiming to prepare legislation on the organisation of waste management in cases of exceptionally large oil and chemical spills. In these very exceptional situations, there is a need to organise the collection, transport, interim storage and treatment of waste in a flexible, systematic and controlled manner. A government proposal concerning the above-mentioned legislative matters is to be submitted to the Parliament in September 2024. (Miljöministeriet, 2022b). Finland is setting up an Environmental Damage Fund from which compensation will be paid for certain costs incurred in the prevention of environmental pollution and the restoration of polluted environments as well as for damage incurred when compensation cannot be recovered from the actual party responsible, for example due to insolvency or because the party responsible cannot be established. The Act establishing the Fund (Act on the Environmental Damage Fund 1262/2022) will come into force 1.1.2025. For example, the Fund will cover the costs incurred in the prevention of environmental pollution related to oil and chemical spills in certain situations. The Fund will replace the current Oil Pollution Fund (Act on the Oil Pollution Fund 1406/2004).

Preparedness and clean-up

The *Ministry of the Environment* is responsible for the preparation, coordination and implementation of matters concerning environmental risks and for preventing environmental risks from the perspective of environmental protection. While acute plastic pollution is not mentioned, the Ministry states on its webpage that it guides, monitors and develops post-oil spill cleanup and recovery operations and the prevention of chemical spills and post-spill operations for these within its sphere of activities (Miljöministeriet 2022a).

The practical responsibility for "oil and chemical spill response on open sea" rests with the *Border Guard (RAJA)*, and in coastal areas and inland waters and on land with the *regional rescue departments*. The rescue departments are composed of municipalities in so called rescue service regions (Finlex 379/2011). The boundary of management responsibility is agreed in detail in the joint plans of the Coast Guard Districts and regional rescue departments (Miljöministeriet, 2022b).

An area affected by environmental damage may require long-term restoration measures. This post-prevention is led by *municipalities* (RAJA, 2022b).

In practical cases of environmental damage, the *Finnish Environment Institute (SYKE)* and the *Centres for Economic Development, Transport and the Environment (ELY)* (one in each region) provide experts assistance to deal with the situation (Miljöministeriet, 2022a).

The *Ministry of the Interior* is responsible for the general guidance, monitoring and development of the prevention of oil and chemical spills at sea.

Other actors involved in the prevention of environmental damage include the *Finnish Defense Forces*, the *Finnish Transport and Communications Agency Traficom*, *Metsähallitus*, and private businesses with which the Finnish Border Guard has signed a service agreement. Voluntary actors also play an important role.

Keep the Archipelago Tidy (Pidä saaristo siistinä/Håll skärgården ren) is an NGO involved in many aspects of the marine environment, including waste management; communication; projects on marine litter monitoring, beach cleaning, etc.

Åland Islands

Åland is a self-governing region in Finland. It has its own parliament, *Lagtinget*, and its own government, *Landskapsregeringen*. Åland is, through Finland, a member of the European Union.

Legislation

Finland's *Act on Environmental Protection in Maritime Transport* applies also to Åland.

Preparedness and clean-up

The *Government of Åland* through its *infrastructure department* is responsible for the prevention of environmental damage. The government has one oil combat vessel for which Åland's Sea Rescue Service provides the crew. The government can ask for assistance from the Finnish Border Guard if needed and the Border Guard is obliged to assist. Åland is a demilitarized zone according to international agreements, which implies that no military forces from any countries are allowed to participate in the operations (Copenhagen agreement, 2022b).

Keep the Archipelago Tidy (see above) has expanded its activities from mainland Finland to Åland from February 2023. In 2019–2023, the project *Städa Åland* (Clean Åland) was carried out by the NGO *Ålands Natur & Miljö*.

Annex III.c

An overview of national legislation and policies on (acute plastic) pollution in Iceland

Legislation

The central legislation is the *Act on protection against pollution at sea and on the coast*. It covers both prevention and preparedness. It is a general act, so there is nothing specific on plastics. Acute pollution of ocean and beach is defined as pollution that happens suddenly and requires action. There is also a general law on pollution prevention with tools regarding permits and how to prevent pollution from industries. The law was changed in 2020 with stricter rules on single-use plastic. There is a law on environmental responsibility, regulating what will happen in cases of pollution. The law on waste management is also relevant (Interview with Katrín Sóley Bjarnadóttir and Halla Einarsdóttir on 13 Dec 2022).

Policies

An action plan on plastics was adopted in 2020. Six of the actions focus on plastics at sea: coordinated research on marine plastic pollution, improved sewage treatment, reduce the discharge of microplastics with surface water, restrictions on the marketing of cosmetics containing microplastics, cleaning Icelandic beaches, and better recovery of lost fishing gear (Umhverfis- og auðlindaráðuneytið, 2020).

Preparedness and cleanup

The Environment Agency of Iceland (Umhverfisstofnun, UST) is responsible for preparedness and response of acute oil and chemical pollution at sea and on the coast outside ports areas. The responsibility within port areas rests with the respective port director. Port directors can ask the UST for assistance and the UST may assume the leadership of an operation if deemed necessary (Copenhagen agreement, 2022b). The role of different authorities (Icelandic Coast Guard, Traffic Authority, and Police) is described in "Action plan for response to acute pollution outside port areas and the use of ship refuge (Environment Agency of Iceland, 2022). Beach cleaning is carried out in many places by NGOs, schools and sport clubs. A project will start in 2023, where organisations involved in beach cleaning can apply for grants. The environmental agency has rangers with local knowledge based in 10 different places around Iceland.

Annex III.d

An overview of national legislation and policies on (acute plastic) pollution in Norway

Legislation

A central piece of legislation is the *Pollution Act (Forurensingsloven, LOV-1981-03-13-6)*. Anyone who runs a business that can lead to acute pollution has a duty to establish preparedness against acute pollution that may arise from their own business. Strict concessions are given to a company who plans to start production. Chapter 6 of the Pollution Act deals with acute pollution. The purpose of this chapter is to establish the national preparedness system against acute pollution. In cases of pollution or the risk for pollution, the polluter must notify the authorities (§ 39). The polluter or potential polluter shall (§ 46) take action to prevent, detect, stop, remove and limit the effect of pollution. The polluter also has the duty (§ 47) to assist the municipality or the state when these levels take action to control the pollution (Kystverket, 2022b).

A chapter in the Pollution Act describes how state authorities, municipalities and private actors shall control acute pollution or risks for acute pollution. The roles and responsibilities in different phases of acute pollution incidents are also listed in the 'Administrative guidelines of the National Coastal Administration to municipalities and intermunicipal committees on acute pollution', first published in 2009 and later updated in 2012 and 2019. The publication covers preparedness, obligation to act, procedures in a national action, planning, health and safety, logistics including material resources, personnel, economic aspects and documentation (Kystverket, 2019).

Individual incidents of plastic pollution can, after a concrete assessment, be considered acute pollution according to §38 of the Pollution Act. An example is the discharge of plastic pellets from the vessel *Trans Carrier* in 2020. The Norwegian Coastal Administration then initiated a state action.

The *Notification on maritime spatial plans (Helhetlige forvaltningsplaner for de norske havområdene: Meld. St. 20 (2019–2020))* states that the risk of damage to the environment and the living marine resources as a result of acute pollution must be kept at a low level, and that it must be continuously sought to be reduced further. Furthermore, it has been established that the high level of security in sea transport must be maintained and strengthened. The state preparedness for acute pollution must be adapted and dimensioned based on the environmental risk

applicable at any given time (Klima- og miljødepartementet, 2021).

According to the *Act on Environmental Protection on Svalbard (Svalbardmiljøloven, LOV-2001-06-15-79)*, on Svalbard and in the territorial waters around Svalbard, the Governor ("sysselmesteren", before 2021 "sysselmanen") has the operational responsibility to act on acute pollution, while the National Coastal Administration has the overall responsibility and can take the lead in actions when this is considered appropriate (Kystverket, 2020b).

Preparedness

The state must ensure preparedness against a major case of acute pollution that is not covered by municipal or private preparedness. The overall national responsibility for dealing with acute pollution on Norwegian territory, in the territorial sea and at Svalbard rests legally with the *Ministry of Transport and Communication*. The *Norwegian Coastal Administration, NCA (Kystverket)* through its Department for Emergency Response exercises the practical responsibility for preparedness against acute pollution. In the event of acute pollution incidents, the Department shall ensure that the responsible polluter or local municipality implements the necessary response measures. Tasks include the coordination and training of private, municipal and government resources for preparedness in a national contingency system (Kystverket, 2022b). Chapter 6 of the Pollution Act deals with acute pollution. The purpose of this chapter is to establish the national preparedness system against acute pollution. In such situations, rules on the duty to notify, the duty to be prepared, emergency plans, the duty to take action and the duty to provide assistance therefore apply. In the municipalities, it is the fire service that takes care of preparedness against acute pollution, while state preparedness is taken care of by the Norwegian Coastal Administration.

Individual incidents of plastic pollution can, after a concrete assessment, be considered acute pollution according to Section 38 of the Pollution Act. An example is the discharge of plastic pellets from the vessel *Trans Carrier* in 2020. The Norwegian Coastal Administration then initiated a state actions. In line with the polluter pays principle, the Coastal Administration has demanded a refund from it legally responsible for the pollution.

A municipality must have emergency preparedness against minor cases of acute pollution which may cause damage within the municipality, and which are not covered by private emergency preparedness. All municipalities participate in *inter-municipal committees against acute pollution (Interkommunale utvalg mot akutt forurensing, IUA)*.

The *Norwegian Maritime Authority (Sjøfartsdirektoratet)* supervises Norwegian ships and foreign ships in Norwegian waters based on the Ship Safety Act (*Skipssikkerhetsloven, LOV- 2007-02-16-9*). When the directorate receives a report on risk for acute pollution from a ship, it will immediately alert the NCA and the Police, and will send its own inspectors to the ship.

The *Norwegian Environment Agency (Miljødirektoratet)* is an advisor to the NCA during government actions against acute pollution, and during actions where the Norwegian Coastal Administration supervises. It provides environmental assessments on the effects of the pollution on the environment, advice on environmental investigations and measures to counteract and reduce the extent of damage, and input for a monitoring plan following the action. The Environment Agency also assists the NCA with resources from the Norwegian Nature Conservancy (Statens Naturoppsyn, SNO) for mapping the spread of pollution and mapping and counting affected seabirds and wild game (Miljødirektoratet, 2022).

The *Norwegian Directorate for Civil Protection (Direktoratet for samfunnssikkerhet og beredskap, DSB)* is the general authority for incident preparedness. It can assist with rescue operations at sea and assist in the event of chemical pollution. It is responsible for the civil defense organization, which can assist the Coastal administration and the municipalities with capacities and competences (Kystverket, 2020b).

The *Directorate of Fisheries (Fiskeridirektoratet)* gives professional advice to the NCA. It will also inform the aquaculture and fishing industries in cases of incidents (Kystverket, 2020b).

The Armed Forces can offer support in rescue at sea, including towing operations (Kystverket, 2020b).

Clean-up

The County Governor (Statsforvalteren) represents the national government on regional level and has an important role in the connection between national and regional/local authorities. The Governors can give advice to the municipalities and the NCA in environmental issues and they have the overall responsibility for clean-up in each region (Kystverket, 2022b).

All the country's municipalities participate in inter-municipal cooperation through the 32 inter-municipal committees against acute pollution (IUA).

In the event of minor incidents, the municipality can implement measures on its own, but often uses the IUA to take care of the preparedness. Municipalities are obliged to assist in national operations (Kystverket, 2022b).

In the Oslofjord area, the coordinating responsibility is delegated from the County Governor to Oslofjordens Friluftsråd, a council made up of the regions and municipalities along the fjord. The council had the coordinating role in the cleanup after the Trans Carrier incident.

Regular beach-cleaning is performed by a mix of public, private and voluntary organisations. Skærgårdstjensten is a number of public organisations in different areas along parts of the Norwegian coast from the south all the way up to Möre og Romsdal who maintain recreation areas. Thanks to the amount of money available for cleaning, there is an increasing new market of private actors. Volunteers are

also important. (Interview with Nicolay Moe 7 March 2023)

The *Norwegian Centre against marine litter (MARFO)* is a government agency under the Norwegian Ministry of Climate and Environment. The Centre's primary objective is to ensure cleaner seas through the reduction of marine litter. It is based in Lofoten and is a leading centre of excellence on the incidence and clean-up of marine litter. It also works on the prevention of litter from sea-based sources. The main tasks of the centre are knowledge overview, coordinated clean-up operations, specialist advice and communication and international cooperation. Established in 2018 as the Norwegian Centre for Oil Spill Preparedness and Marine Environment (SOMM), it got its current name and tasks from 1 January 2022, when its responsibilities for oil spill preparedness were taken over by the Coastal Administration. In September 2022, MARFO established a national collaboration council against marine litter with expertise from government agencies, private sector and NGO's. The council will identify challenges and solutions for the clean-up of marine litter and ensure a more efficient use of the available resources (MARFO, 2022).

Keep Norway Clean (Hold Norge rent, HNR) started with a clean-up campaign in 1969 and was relaunched as a campaign in 2004. In 2014, HNR was established as a non-profit association and works together with volunteers, businesses and municipalities against littering. Many of these are members of the association themselves. The association invites the whole community to help against littering, both as a member organization and by mobilizing for national clean-up efforts. HNR also contributed to prevention through attitude creation, mapping of waste and identification of sources and causes of littering. HNR also offers advice to municipalities, including in the preparation of action plans against littering. Several years ago HNR developed an online portal for registering information for clean-ups. The data is transferred to the map tool "Rydde", and a new version was further developed by SOMM (now MARFO) in collaboration with HNR. HNR is responsible for user support and population research in Rydde. HNR administers a reimbursement scheme where actors who have expenses related to transport and treatment of collected ownerless marine litter can have these covered. HNR is also involved in international cooperation with similar organisations. HNR receives basic support from the Ministry of Climate and the Environment (Klima- og miljødepartementet, 2021).

A major source of finance is the Norwegian Retailers Environmental Fund (Handelens Miljøfond – HMF), who use money from every plastic bag sold in Norway for the Clean Norway (Rydd Norge) program launched in the autumn of 2020. The goal of the program is to clean 40 percent of the outer coast and prioritized waterways by the end of 2023. The country is divided into ten regions and there are tenders for the work, which has created a market for new actors. According to the website in March 2023 the program has so far used 400 million NOK to collect 1,980 tonnes of plastic from 15,000 km of coastline (Handelens Miljøfond, 2023).

Norway seems to be the Nordic country with the best preparedness for handling pollution, it became obvious when the Trans Carrier incident happened. There are systems for acute pollution in Norway. The challenge in this specific situation was to define this as acute pollution, and due to the geographical spread to define it as a state action under the auspices of the Norwegian Coastal Administration. . Some private persons discovered pellets on the beaches. Skærgårdstjensten started to clean-up and Oslofjordens Friluftsråd took the responsibility for coordination since someone had to do it. It took more than two months before it was classified as acute pollution, so that a national action was initiated and Oslofjordens Friluftsråd got the formal responsibility for coordination from the National Coastal Authority. In this case the clean-up operation was funded by the shipping company through their insurance. It would have been more complicated if the pellets would have come from an unidentified source or if the shipping company had not taken its responsibility (Interview with Nicolay Moe on 7 February 2023).

Any incident involving the release of pellets must be assessed individually as to whether it falls under the definition of acute pollution. In addition, it must be assessed in each case whether the action is to be coordinated nationally by the Norwegian Coastal Administration or the individual municipality. According to the Coastal Administration, the process of initiating a national action will be faster in the future, thanks to the experience from the Trans Carrier incident. It will not have to be negotiated between ministries, as was the case that time, but can be sorted out in a phone call between the Coastal Administration and the Environment Agency (Interview with Rune Bergstrøm on 23 November 2022).

Annex III.e

An overview of national legislation and policies on (acute plastic) pollution in Sweden

The northern part of the Swedish west coast has been severely affected by marine litter for several decades. The currents and the predominant wind direction transport large quantities of litter from the North Atlantic, the North Sea and the English Channel into Skagerrak, where it is washed ashore on the rocky coastline. The coastline was affected to some extent by the pellets from the Trans Carrier incident. These pellets were cleaned up as part of the regular beach-cleaning scheme and no compensation was paid by the shipping company in contrast to the situation in Norway.

Legislation

The *Environmental Code* regulates all handling of plastic pellets during the entire lifecycle, from pellet to product to waste. A set of rules of conduct (Chapter 2) require all operators independent of the actors size and type, to take precautionary measures, by e.g. getting sufficient knowledge about the risk for human health and the environment, locating their activity in a place causing the least environmental impact, adhering to the substitution principle through, when applicable, replacing chemical products and chemicals with alternatives that have fewer negative environmental impacts, and using best available technology (Karlsson et al., 2018; SFS 1998:808).

In the *Act on measures against pollution from vessels* (Chapter 1, 2§), 'hazardous substances' is defined as 'oil and other substances who, if they are released to the sea, any other water area or in the air, can imply risks to human health, harm to marine fauna and flora, harm to esthetic or recreational values or disturb other legitimate use of the sea or other water areas'. Chapter 7, 3§ states that emissions of hazardous substances shall be reported, and that it is mandatory to give necessary information on vessels and cargo to prevent and control emissions of such substances. Chapter 10 deals with liability issues. (SFS 1980:424) The act is further elaborated in the *Regulation on measures against pollution from vessels* (SFS 1980:789) and in the *Directions and General Advice on measures against Pollution from Vessels* from the Swedish Transport Agency (TSFS 2010).

The *Civil Protection Act* defines the different branches of society's rescue services and the responsibilities of each of the branches (SFS 2003:778).

Sweden has not yet ratified the HNS convention.

Preparedness

The *Swedish Transport Authority (Transportstyrelsen)* formulates regulations, examines and grants permits, as well as exercising supervision principally of Swedish and foreign vessels sailing in Swedish waters. The authority also analyses accidents and near-misses. The Swedish Transport Authority is the government agency responsible for the administration of ships registered in Sweden (Transportstyrelsen, 2022).

According to the *Regulation on Protection against Accidents*, the *Swedish Coast Guard (Kustbevakningen)* is responsible for environmental rescue at sea when oil or other harmful substances have reached the water or when there is an imminent risk for this. The responsibility concerns Sweden's maritime territory and economic zone, the three major lakes Vänern, Vättern and Mälaren as well as operations outside Sweden's maritime territory where Sweden has a responsibility according to international agreements (Copenhagen agreement, 2022b).

The Coast Guard's Program for Environmental Rescue at Sea describes more in detail the function and the national and international coordination. As preventive measures, the Coast Guard inspects hazardous goods in ports and perform maritime surveillance from vessels and from the air. The Joint Rescue Coordination Center (JRCC) in Gothenburg is standby 24/7 for rescue operations, and there are always several surveillance vessels and environmental protection vessels in operation at sea (Kustbevakningen, 2019).

The *Swedish Maritime Administration (Sjöfartsverket)* is responsible for saving people in distress at sea. In case of major accidents, where there are environmental risks involved, operations are coordinated with the Coast Guard. The *Civil Contingencies Agency (Myndigheten för Samhällsskydd och Beredskap, MSB)* supervises the coordination between national authorities involved in rescue services. It is involved in the planning of environmental rescue at sea, for example in the national coordination group for oil protection. The *Armed Forces* do not have a formal role in environmental rescue operations but can in certain circumstances provide staff and material resources. *Sweden's Meteorological and Hydrological Institute (SMHI)* can assist with prognoses for the proliferation of oil spills and other emissions at sea (Kustbevakningen, 2019).

The *Swedish Environmental Protection Agency (Naturvårdsverket)* coordinates Sweden's environmental work. The agency has developed a "Roadmap for the sustainable use of plastics", calling for global efforts to reduce plastic leakage to the nature (Naturvårdsverket, 2021).

The *Swedish Agency for Marine and Water Management (Havs- och Vattenmyndigheten)* implements a cohesive marine and water management policy on behalf of the Swedish government, working with issues of conservation, restoration and sustainable utilisation of lakes, watercourses, seas and fisheries resources (Havs- och Vattenmyndigheten, 2020).

County Administrative Boards (Länsstyrelserna) represent the national government in each of Sweden's 21 regions. For larger cleanup operations, involving several municipalities, the county administrative board can take the lead in the operation and coordinate the activities by the municipalities concerned. The Coast Guard also cooperates with the County Administrative Boards in regional planning issues, and during rescue operations in prioritization of valuable areas and objects (Kustbevakningen, 2019).

Clean-up

Cleanup operations on the coast and in ports are, according to the Regulation on Protection against Accidents, a responsibility for the *municipalities* (Copenhagen agreement, 2022b).

Due to the constant inflow of marine litter on the Swedish west coast, beach cleaning is a permanent activity in many coastal municipalities along this part of the coast. It is carried out with some national co-financing through the EPA (15 million SEK for the entire country in 2023). It is often organized with a few professionals helped by unemployed people or young interns and assisted by volunteer organisations. Approximately 200 tonnes of litter are collected every year on the Swedish west coast (Västkuststiftelsen, 2022a).

The West Coast Trust (Västkuststiftelsen) is a public organisation responsible for the maintenance of nature reserves in western Sweden. Since 2015 it coordinates twelve municipalities from the Norwegian border down to Kungälv south of Gothenburg in their work with beach-cleaning and in their applications for financing. Because of winds and currents, this is the part of Sweden's coastline most affected by marine litter. The trust provides a joint digital beach-cleaning map (Strandstädarkartan), organises exchange of experiences between municipalities and tries to lobby national authorities for financing (Interview with Florina Lachmann on 7 February 2023).

The Keep Sweden Tidy Foundation (Håll Sverige Rent) is a non-profit organization that promotes recycling and combats litter through public awareness campaigns and environmental education. The organisation has with support from Statistics Sweden and the Swedish Environmental Protection Agency developed methods for measuring litter in a number of environments, including beaches. It provides methods and tools to facilitate the strategic work of the municipalities. Håll Sverige Rent, together with sister organisations in the other Nordic countries, organizes the Nordic Coastal Cleanup Day, where people gather to help save the coasts from litter. Håll Sverige Rent has also initiated the Ocean Alliance, gathering companies and municipalities with the aim of reducing the use of plastics and restoring the sea from plastic pollution (Håll Sverige Rent, 2022).

There is no clear responsibility for acute plastic pollution. When the Trans Carrier incident happened, no agency had the responsibility, routines or budget to handle the acute problem. It was dealt with as part of the regular beach cleaning. No one

reported to the police. Subsequently, Sweden did not get any compensation from the shipping company (Interview with Florina Lachmann on 7 February 2023). According to a representative of the Coast Guard "*there is nothing about plastic pellet pollution in the regulations, but we would of course act if a release of plastic pellets would threaten important functions in society, for example risk to block the cooling water system of a nuclear power plant*" (Interview with Johan Genestig 24 November 2022).

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Michael Mannaart, Magnus Englebretsson and Arabelle Bentley

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