Sources and causes of marine litter collected near Qaqortoq and ideas for next steps

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In dit rapport staan de resultaten van een gedetailleerde bronanalyse van marien zwerfafval dat in 2022 werd verzameld op verschillende locaties langs Qaqortup Kangerlua (Julianehåbsfjord), nabij Qaqortoq, Zuid-Groenland. De resultaten tonen aan dat het grootste deel van het afval van lokale oorsprong is en kan worden herleid tot commerciële en recreatieve visserij en zeer waarschijnlijk ook tot de gemeentelijke afvalvoorziening ten zuiden van Qaqortoq, waar een deel van het afval kan verwaaien en onbedoeld in zee terecht kan komen. De analyse vond plaats tijdens een interactieve Litter-ID-sessie met lokale stakeholders en experts in september 2022.

This report presents the results and findings of a detailed source analysis on beach litter that was collected from several locations along Qaqortup Kangerlua (Julianehåbsfjord), near Qaqortoq, South Greenland. The results show that most of the litter is of local origin and can be traced back to outdoor activities such as commercial and recreational fishing and most likely also to the municipal waste facility south of Qaqortoq, where, under the influence of wind, stored waste may unintentionally end up in the sea. The analysis took place during an interactive Litter-ID session with local stakeholders and experts in September 2022.

Keywords: Marine litter, beach litter, beach litter monitoring, plastic soup, Litter-ID, Greenland.

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Contents

Preface

Plastic marine pollution is a worldwide phenomenon, even in the remote and sparsely populated Arctic. This causes a variety of risks and challenges for marine species, coastal communities and sea-based activities in the region. To mitigate plastic pollution and to find solutions to reduce its harmful effects, a better understanding of its sources and pathways is needed.

The WWF Greenland program involves actions around Greenland to raise awareness to (marine) plastic pollution and find solutions to tackle it. As part of their ongoing work on this topic, WWF has asked Wageningen Economic Research to gain more insight into the sources, causes and solutions to marine plastic pollution in Greenland and to provide recommendations to prevent this in the future.

As part of that assignment, a Litter-ID session took place in September 2022 in Qaqortoq. This report contains the results and recommendations of the session. We hope that the results and recommendations can lay the foundation for further work by WWF and other stakeholders in Greenland to tackle marine litter on the local and national level.

We are thankful for the collaboration and support of all the people and organisations involved in this research effort, specifically Pipaluk Lynge-Rasmussen, Allan Olsen, Mette Frost and Kaare Winther Hansen from WWF in Greenland, staff and students of Campus Kujalleq, Arnaq Bjerge Petersen and Therkild Poulsen. We hope that the findings and recommendations in this report can be used as input to refine and further strengthen ongoing initiatives and policies in Greenland and beyond.

Ir. C. (Olaf) Hietbrink
Business Unit Manager Wageningen Economic Research
Wageningen University & Research

Summary

S.1 Key findings and recommendations

In September 2023, an in-depth source analysis took place of 339 kilos of beach litter collected on several locations along the shoreline of Qaqortup Kangerlua (Julianehåbsfjord), near Qaqortoq, South Greenland. The key findings are as follows:

- Judging by the composition and external characteristics of the litter collected on the shoreline of Qaqortup Kangerlua and local community knowledge, the three main sources of marine litter in the fjord are of local origin: 1) consumer waste and building material waste litter ending up on the streets of Qaqortoq, 2) outdoor activities such as fishing and hunting in the fjord and 3) the local waste management site, south of Qaqortoq.
- Since most of the litter is of local origin, the positive side to the situation is that this also means that measures taken in Qaqortoq and the adjacent Qaqortup Kangerlua can substantially reduce the severity of the issue in Qaqortup Kangerlua.
- Because it was suggested by participants that the municipal waste management site is an important source of litter in the fjord, the research team has made a visit to the site to assess the situation. The waste management site faces the sea, where waste lays exposed, and unprotected from the elements. Under the influence of wind and rain, waste might (unintentionally) enter the fjord and then spread over the fjord, before being washed ashore. This could explain the type of litter commonly found on the shoreline of Qaqortup Kangerlua.
- In terms of fishing nets, both gillnets and trawl nets were collected from the shoreline of the fjord. A further examination of both types of netting resulted in the conclusion that most gillnets are likely used in local fisheries, and either lost or discarded. All trawl nets are used outside of the fjord and potentially in areas much further offshore by fishing vessels with other homeports than Qaqortoq. All the trawl nets were cut-off pieces, which are produced during repair and maintenance (mending) work of nets on deck and could be prevented from becoming marine litter by improving waste management procedures on deck.
- Along with the source analysis, the research team examined each litter item for traces or clues on the interaction with the local ecosystem. One such interaction is fouling (of plants and animals attached to litter items). As floating litter may carry fouling organisms over long distances, this may result in risking of the introduction of new (non-indigenous) species to Greenland. Due to the low number of items with such organisms in this study, this risk was considered to be low. Bite marks from birds and canines, such as dog or Arctic fox, were found on several items. Ingestion of plastic by these animals can potentially lead to internal damage, blockage of the digestive system or a feeling of fullness which leads to the animal not eating sufficiently and eventually starvation. In terms of fishing nets, no interaction (e.g. entanglement) was observed, but specifically gillnets can act as ghost nets, which continue to fish after having been lost or abandoned. The environmental risk of trawl nets is the entanglement of (marine) mammals, the risk of gillnets is the entanglement of fish, birds and (marine) mammals.

Based on the key findings above, we recommend the following actions:

- Further assess the role of the municipal waste management site as a source of marine litter in Qaqortup Kangerlua, and look into practical, on-site mitigation measures to prevent waste from entering the sea.
- Engage with local community groups, fishers and hunters to start a dialogue on the causes for litter in the fjord and incentives or measures to prevent littering within Qaqortoq.
- Set up municipal awareness programmes on the issue of marine litter in the area.
- Look into the option of making Qaqortoq a 'Plastic Smart City'. The Plastic Smart Cities initiative was initiated by WWF and supports cities and coastal centres in taking action to stop plastic pollution. Steps in the process include:
  1. A declaration of intent with stakeholders
  2. Conducing a baseline assessment to better understand a city's waste flow
  3. Developing and implementing an action plan.

S.2 Methodology

This report and the activities it describes, are part of a collaboration project between WWF, Wageningen University & Research (WUR) and Leeways Marine. The aim is to find solutions to marine litter in Greenland, based on an analysis of the sources, causes, and its environmental interaction.

The findings presented in this report are based on a Litter-ID session that took place from 6-8 September 2022 in Qaqortoq, Greenland. Preparatory actions ahead of the session were carried out by the WWF Greenland program, Wageningen University & Research and Arnaq Bjerge Petersen. Together with Therkild Poulsen, Arnaq collected 339 kg of litter on the shoreline of Qaqortup Kangerlua (Julianehåbsfjord), near Qaqortoq in the south of Greenland. During the session, all litter was sorted and analysed and included a stakeholder workshop, where local students and local citizens participated to discuss the sources, causes and solutions.

1 Introduction

1.1 Collaboration between WWF, WUR and Leeways Marine

This report and the activities it describes, are part of a collaboration project on marine litter in Greenland between WWF, Wageningen University & Research (WUR) and Leeways Marine. The aim of the project is to create a higher awareness on the sources, causes, environmental interaction and solutions to marine litter in Greenland. The results can be used as input for actions and strategies in Greenland to tackle marine litter on the local, regional and national scale. Measures taken could benefit biodiversity, human well-being, and economic activities in the region.

The project is centred around two activities:

1. A Litter-ID session, which took place in Sisimiut in November 2019 (Strietman et al., 2021).
2. A Litter-ID session in Qaqortog, which took place in September 2022.

WWF and Wageningen University & Research jointly prepared each session, where WWF took the lead in the local preparations (e.g. contacting and inviting stakeholders to the sessions, involving local schools, coordinating the logistics regarding the litter to be analysed together with local partners, organising a location for the session), and Wageningen University & Research (with support by Leeways Marine) took the lead in the coordination of each (3-day) Litter-ID session, the analysis and reporting.

This report focuses on the Litter-ID session that took place in Qaqortoq. Its results can be used by stakeholders for further actions to tackle the sources of marine litter around Qaqortoq and beyond.

1.2 Background

1.2.1 Marine litter and Greenland

Greenland is the world's largest island, located between the Arctic and Atlantic oceans. With a population of 56,562 (Statistics Greenland, 2022), it is one of the least densely populated regions in the world. Even though the population density is relatively low, human influence is visible along its shoreline, where marine litter can often be found, taken there by wind, waves and ocean currents.

1.2.2 Risks to the Greenlandic environment

The presence of plastics in the marine environment poses a threat to wildlife in Greenland. Animals of all sizes, ranging from the tiniest species of zooplankton to seals and even the largest species of whales, can be affected. For example (Werner et al., 2016; Vlachogianni et al., 2018; Thiel et al., 2018; Van den Heuvel-Greve et al., 2021; Ladewig et al., 2021):

- Smaller pieces of plastic can be ingested, pieces of rope and netting can cause entanglement of bird and mammal species.
- Bio-accumulation and bio-magnification of toxics can also occur, either being released from plastic items or adsorbed and accumulated on plastic particles.
- Fouling organisms such as algae or barnacles that do not naturally occur in the area and which attach themselves to floating pieces of litter, can be transported via ocean currents from faraway places and disrupt the local food web.
- Marine litter may also damage benthic habitats and communities.

Figure 1.1 *Examples of wildlife affected by marine litter*
Photos: Sysselmannen (left) and W.J. Strietman (right).

1.2.3 Threats to economic activities and quality of life

In addition to the environmental threats, marine litter may also affect economic activities including fisheries, shipping and quality of life.

In terms of fisheries, longlines and gillnets may continue fishing after having been lost or abandoned. This 'ghost fishing' may furthermore affect commercial fish stocks and marine mammals impacting the livelihoods of Greenlandic fishers and hunters (in Greenlandic there is even a word for areas where fishers may risk getting their long lines stuck in old nets on the sea floor: 'nasinnartut').

Certain marine litter items, especially nets, ropes and strapping band may also pose a serious safety risk to ships and their crews because such items can get caught up in ships' propellers. Such safety risks are even higher in the Arctic, including many areas around Greenland, as these have very limited means of communication or safety and rescue capacity (UNEP 2005, 2011).

In addition to this, local living conditions for local citizens and tourists may be affected by the off-putting sight of littered beaches in these otherwise pristine areas (Wyles et al., 2015; Hallanger and Gabrielsen, 2018).

Reducing the amount of litter in Greenland, is therefore vital to secure the health of the ecosystems and quality of life of people living in Greenland and people visiting Greenland.

1.2.4 Taking action in Greenland: a collective effort

In recent years, Greenland has seen a steady increase in societal and political awareness on the issue of plastics in the environment. Local community-based efforts, scientific research, NGO-led projects, industry efforts and municipal and national government actions have so far all contributed to a higher awareness and more effective actions to tackle this issue. This culminated in the development of two new government action plans addressing the use of plastic and lost fishing gear in 2020 (Naalakkersuisut, 2020a; Naalakkersuisut, 2020b). The results of the Litter-ID session in Sisimiut provided input to the action plan on lost fishing gear.

1.2.5 Ongoing beach litter monitoring efforts in Greenland

In terms of scientific research, beach litter monitoring can help to provide insights into the composition and sources of marine litter. In Greenland, a slightly adapted version of the internationally applied OSPAR Beach Litter Monitoring Guideline (OSPAR, 2010) is applied. This adapted version also includes subcategories for 'typical' Greenland items (e.g. melted pieces of plastic, detonation cords and sanitary toilet bags) and has been applied as part of the Survey of Marine Litter in Greenland (SUMAG) project since 2016. The SUMAG project is coordinated by Aarhus University in collaboration with Pinngortitaleriffik/Greenland Institute for Natural Resources and individuals living in communities throughout Greenland.

The SUMAG monitoring activities include 1-2 yearly surveys at shoreline locations around Greenland, including outer shoreline locations in the Qaqortoq region, all chosen for being located facing the sea at some distance to (and potentially under less influence from) local communities and settlements. As a result of these monitoring efforts, the SUMAG project has gained important insights into the type, amount, composition and general sources of beach litter present around Greenland's coast (Strand et al., 2018; Strand, 2020 pers. comm.).

Especially in 2016, the first year with surveys, a special focus of the project was the origin of collected litter items, with the aim of assessing to which extent local sources contributed to the litter on the shorelines. After 2016, the survey protocol did not include recording of the origin anymore (Strand et al., 2018; Strand, 2020 pers. comm.).

1.3 Reading guide

In Chapter 2 we present the results of the Litter-ID session. In Chapter 3 we focus on the results of the analysis that looked into species. In Chapter 4 we reflect upon the results and provide recommendations.

2 Methodology

2.1 A deeper understanding of the sources

A deeper understanding of the sources and causes of beach litter could be helpful to stakeholders in Greenland to better address the issue. The Litter-ID method (Strietman et al., 2021), used for this project, provides such in-depth knowledge. On the one hand by analysing litter in each OSPAR category in more detail (in terms of composition, origin, source and age) and on the other hand by actively involving stakeholders in the analysis. Litter-ID sessions are designed to be used as a supplement to ongoing beach litter monitoring efforts.

As part of Litter-ID sessions, local and national stakeholders are invited to participate in the analysis and discussion of previously collected litter, creating a deeper understanding on where the litter is coming from, what is causing it and what can be done to solve it. Such stakeholders usually include policymakers, local citizens, fishers, clean-up volunteers and employees of NGOs. Accordingly, such sessions are designed to create a common understanding within this diverse group of stakeholders of the origin, sources, and causes of beach litter and the interaction of such litter with the local environment. Based on such an understanding, stakeholders know where to take action and with whom. In this way, Litter-ID sessions are designed as a catalyst for change and action.

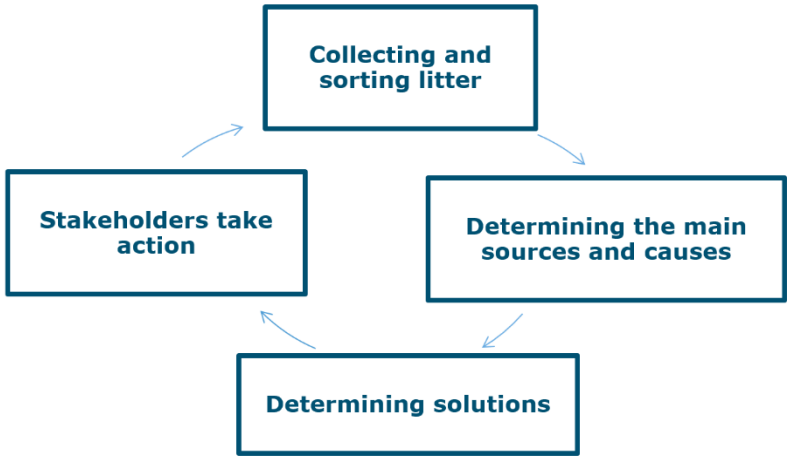

Figure 2.1 *The Litter-ID methodology (through interactive Litter-ID sessions, stakeholders are actively involved in the determination of sources, causes and solutions)*

The additional analysis steps to determine origin, sources, and causes are effectively 'detective work' and often a challenge because it is not always clear what the origin or source of the beach litter is. This is, however, why the involvement[1] of local stakeholders is crucial to the process: they may recognise items and their (local) use (based on external characteristics, label texts or other recognisable clues) and the reasons why such items may have entered the sea. Based on such an analysis, stakeholders are able to identify solutions.

[1] The method to carry out an in-depth analysis of previously collected beach litter with local stakeholders is inspired by the 'deep dive' method developed by SALT (Norway), with whom the research team collaborated on Svalbard in 2017 and 2018 (Falk-Andersson and Strietman, 2019).

Along with the source analysis, the research team also checks each litter item for traces or clues on the interaction with the local ecosystem. Litter washed ashore can interact with the local ecosystem in various ways. For example, animals can become entangled in debris, swallow the debris, or introduce new species through fouling on the floating material (e.g. Van den Heuvel-Greve et al., 2021) (see Figure 2.2).

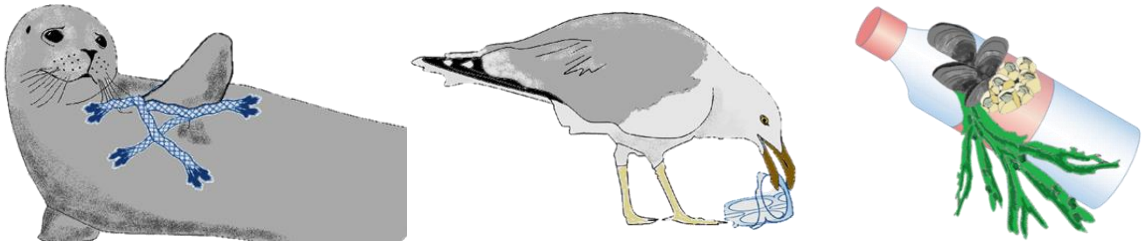

Figure 2.2 *Three ways in which marine litter can affect the ecosystem: entanglement (left), ingestion (centre) or the introduction of new species through fouling (right)*
Illustration: Anneke van den Brink.

2.2 Litter-ID-session in Qaqortoq, September 2022

2.2.1 Preparation phase

In the run-up to the Litter-ID session in Qaqortoq, local stakeholders were contacted by WWF and a location for the session was found at (and with the help of) Campus Kujalleq.

An estimated 30 people took part in the Litter-ID session. Apart from students and local citizens, other stakeholders (such as the local municipality, national government or fishers) were also invited but could not attend the session. Therefore, the session did not include all stakeholder groups that are usually present during a Litter-ID session. Due to this, the last step in the Litter-ID cycle, where stakeholders know where to take action and with whom, could not be fully taken.

To help out with litter collection, Arnaq Bjerge Petersen (who monitors litter for the SUMAG project) was contacted by WWF. In preparation of the session, Arnaq together with Therkild Poulsen, collected 339kg of litter along the shoreline of several locations along Qaqortup Kangerlua (Julianehåbsfjord), near Qaqortoq.

2.2.2 The Litter-ID session

The Litter-ID session in Qaqortoq took place in September 2023 for four days, where litter was sorted, discussed with stakeholders, counted, weighed and photographed.

On the first two days of the session, all items were sorted and categorised separately into OSPAR beach litter item categories and subcategories where relevant: for example, items within the plastic drinks category were further divided into larger clusters of specific items that were identified such as Faxe Kondi, Cola bottles or other soft drink brand bottles). Pre-sorting took place in a location near to the city harbour. Further sorting took place on a square next to Campus Kujalleq, with the help of students from Campus Kujalleq. The sorted litter resulted in a clear and structured overview of the litter (see Figure 2.3).

Figure 2.3 *Sorting the litter next to Campus Kujalleq*
Photo: W.J. Strietman.

On the third day, the stakeholder session took place, where local students and stakeholders were invited to discuss and determine the origin, sources, and causes. And, based on that analysis, potential solutions. The stakeholder session was divided into two parts:

1. In the morning, an interactive session with students from Campus Kujalleq took place After a round of introductions, the students were divided into smaller groups and instructed to analyse the waste for each category, considering sources, causes and solutions. The results of each group were then discussed in a plenary session, with participants invited to comment on each other's conclusions. This led to an open discussion in which ideas were exchanged and participants gained insight into the most important - most likely - sources, causes and solutions of marine litter in the area.
2. In the afternoon, a session with local citizens of Qaqortoq took place, where in a similar plenary session, the results of the analysis were discussed and ideas exchanged on sources, causes and solutions.

Figure 2.4 *The Litter-ID stakeholder session in Qaqortoq*
Photo: E. Leemans.

On the fourth day, all items were counted, weighed and photographed and the results were entered into datasheets (Excel) for further statistical analysis. During this part of the analysis process, the research team also checked each litter item for traces or clues of interaction with the local ecosystem, such as entanglement, attachment of (non-native) plants and animals, and bite marks. For this purpose, visual observations of litter items were carried out and close-up photos were taken of all items where this occurred.

3 Litter composition and analysis

3.1 Introduction

In this chapter we describe the results of the Litter-ID session in Qaqortoq. The findings include the quantitative results (main litter categories based on numbers and weight) and the qualitative results (sources, origin and solutions). The qualitative results are presented for the main litter categories.

3.2 Stakeholder engagement

An estimated 30 people took part in the Litter-ID session, which included students and local citizens. These participants actively engaged in a discussion about each litter category, where the most likely sources and causes were discussed. The results of this qualitative assessment, in combination with a quantitative assessment (based on weighing and counting of the items) provided input to the results presented in this chapter.

Other stakeholders (such as the local municipality, national government, fishers and researchers) were also invited but could not attend the session. Therefore, the session did not include all stakeholder groups that are usually present. This prevented a more thorough discussion on sources, causes and (especially) on solutions and next steps that could be taken collectively or by each stakeholder group.

3.3 Composition of the litter

As part of the Litter-ID session, all items were counted and weighed. In total, 1.301 items were sorted and analysed, with a combined weight of 339 kg. This part of the analysis reveals the composition of the litter and the main litter categories.

3.3.1 Main litter items in numbers

Figure 3.1 provides an overview of the main litter item categories in terms of numbers and their general source (coloured in grey, green, blue, red or orange).

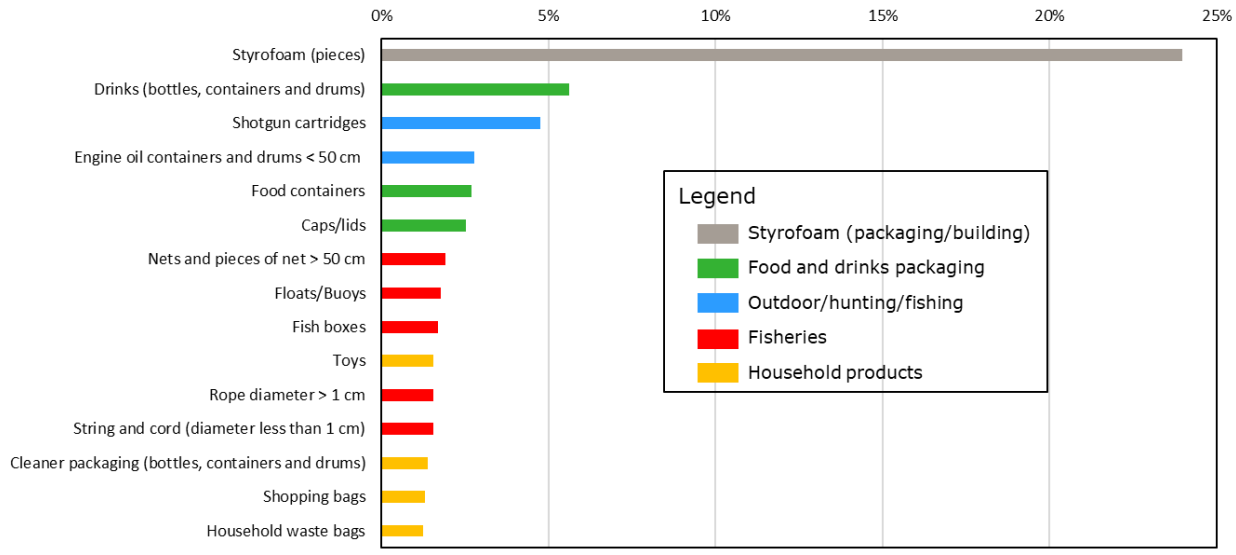

Figure 3.1 *The most common identifiable categories of litter in numbers*

The above figure shows that, in numbers, the item category most encountered on the shoreline is (smaller) styrofoam pieces. Most other items are drinks and food packaging, fisheries related litter, and household items.

3.3.2 Main litter items in weight

Figure 3.2 provides an overview of the main litter item categories in terms of weight and their general source (coloured in grey, green, blue, red or orange).

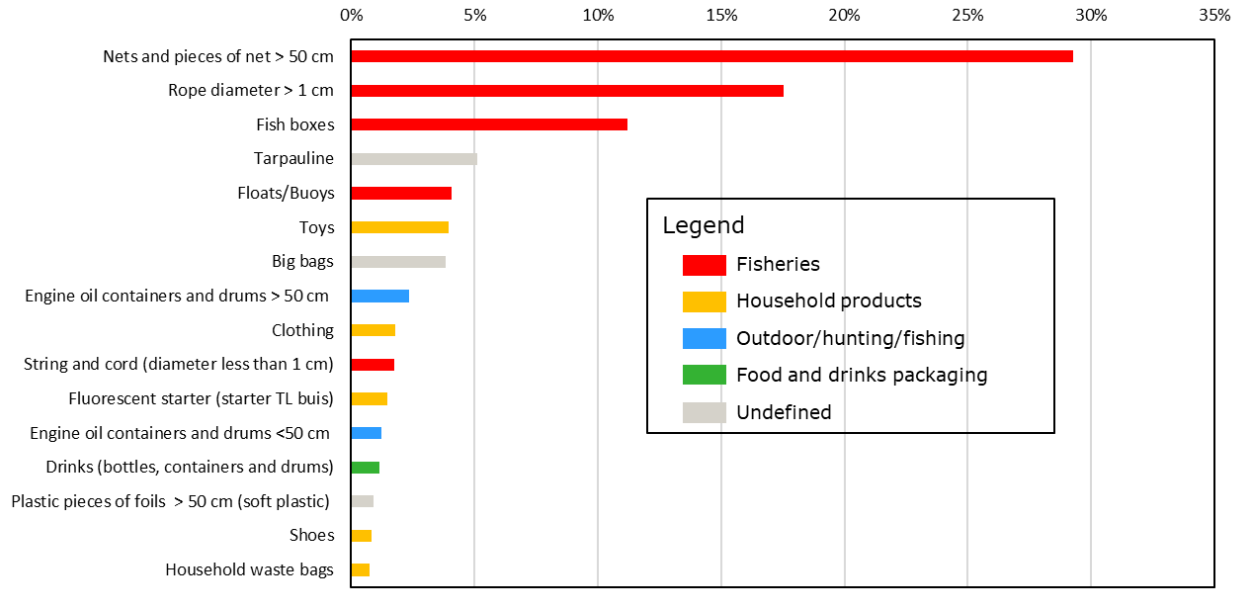

Figure 3.2 *The most common identifiable categories of litter by weight*

The above figure shows that, in weight, fisheries-related items dominate and to a lesser extent household items.

In the following sections, we provide more information for each of these source clusters in terms of origin, sources, and causes.

3.4 Styrofoam

In terms of numbers, styrofoam is most often encountered on the shoreline of Qaqortup Kangerlua. Styrofoam is widely used for packaging, food containers, disposable products and as building or insulation material. Because the pieces of styrofoam encountered were all broken-off and worn pieces, its original use could not be determined.

Figure 3.3 *Styrofoam pieces*
Photo: W.J. Strietman.

Styrofoam pieces could originate from building activities in Qaqortoq, from the municipal waste management site southwest of Qaqortoq or have been transported into the fjord from other places under the influence of wind and currents.

3.5 Drinks and food packaging

3.5.1 Drinks packaging

The participants of the Litter-ID session recognised almost all of the soft drink bottles as being of local origin (as in: products that can be purchased in local supermarkets). Based on Icelandic text visible on one particular label, one bottle could potentially be traced back to Iceland (provided that it entered the sea in Iceland and not in Greenland).

Of the plastic juice jerrycans, roughly half of them had been cut into two (see Figure 3.4). The reason for doing so is that such halves are used on small vessels to scoop out water from the hull. Perhaps these items were discarded after use or flushed overboard in rough weather. The other half may either have been blown into the sea or have been broken loose from a gillnet (because of their shape, such jerrycans are often used as floaters for gillnets).

Figure 3.4 *Soft drink bottles, water bottles, and juice jerrycans*
Photos: W.J. Strietman.

3.5.2 Candy, crisps and other food packaging

Similar to the drink bottles, the participants of the session recognised most of the candy and crisps packaging as being of local origin (as in products that can be purchased in local supermarkets). In fact, 6 out of 8 of these items had Danish text written on the labels. In terms of age, all looked recent. The other plastic food packaging consisted mostly of sauce bottles. These looked old and worn. No text was visible on the labels. The origin of these latter items could not be determined based on external characteristics. Candy, crisps and other food packaging are examples of household waste that either were discarded on the streets of Qaqortoq or originate from the municipal waste management site south of Qaqortoq.

Figure 3.5 *Candy, crisps and other food packaging*
Photo: W.J. Strietman.

3.6 Household waste

3.6.1 Cleaner bottles

None of the cleaner bottles showed text or labels and could thus not be directly traced back to their likely origin, although it was suggested that the municipal waste management site south of Qaqortoq could be the likely source of this type of litter.

Figure 3.6 *Cleaner bottles*
Photo: W.J. Strietman.

3.6.2 Shopping bags

Of the 17 shopping bags, several contained logos or text that made it possible to determine the most probable origin. After careful analysis and consultation with the participants of the session, all bags were likely of local (or perhaps regional) origin; none were foreign.

Figure 3.7 *Plastic shopping bags*
Photo: W.J. Strietman.

3.6.3 Clothing

In total, 16 pieces of clothing, and shoes were analysed. The type of clothes and shoes analysed are usually used in wintertime. Based on external characteristics, their origin could be local (see Figure 3.8). The exact origin is unknown, but according to the participants, these items could also likely originate from the municipal waste management site southwest of Qaqortoq.

Figure 3.8 *Clothing, shoes and a mattress*
Photo: W.J. Strietman.

3.6.4 Toys

Interestingly enough, quite a few of the litter items were toys, including footballs and even two children's bikes (see Figure 3.9). Based on external characteristics, the exact origin could not be determined by the participants. However, these items could also (very) likely originate from the municipal waste management site southwest of Qaqortoq, having been blown or swept into the adjacent fjord.

Figure 3.9 *Toys*
Photo: W.J. Strietman.

3.7 Hunting and fisheries

Besides drinks packaging, food packaging and household waste, litter which can be traced back to outdoor activities such as hunting and small-scale fisheries also makes up a significant part of the litter found along the shoreline of Qaqortup Kangerlua.

Shotgun shells and ammunition holders

Gillnets (salmon, halibut and cod)

Two-stroke and four-stroke engine oil containers

Larger engine oil containers

Figure 3.10 *Examples of items related to outdoor activities*
Photos: W.J. Strietman.

Based on an assessment by the participants of the session, the consensus was that the most likely origin of these items is local, used by people active in small-scale fisheries and hunting: the two-stroke and four-stroke engine oil containers are typically used for outboard engines on small, open boats, used for fishing and hunting. The multi-coloured shotgun shells are typically used in bird hunting. In total, 16 gillnets were analysed, all of which were quite large in size and weighed 88 kg in total. According to the participants, based on mesh sizes of the gillnets, these are used in fishing for salmon, halibut and cod.

3.7.1 Rope, string and cord

All rope, strings and cords (65 kg in total) were sorted into the following subcategories: 0-3 mm diameter, 3-10 mm diameter, 10-30 mm diameter, and 30-100 mm diameter.

Figure 3.11 *Rope, string and cord sorted by diameter: 0–3 mm, 3–10 mm and 10–30 mm*
Photos: W.J. Strietman.

The participants did not have expertise in the type of rope being used in which kind of fisheries. However, a similar analysis was carried out in Sisimiut, where it was concluded that rope with 0–3 mm in diameter is likely used as longlines in small-scale halibut fishery. Ropes of 10–30 mm are typically used to tie smaller vessels to the dock and could potentially include vessels operating in the fjord.

3.7.2 Floats and buoys

The small floats shown below (at the right) are typically used in gillnet fisheries, the donut buoys and larger buoys are typically used in trawl fisheries. The origin of which could not be determined.

Figure 3.12 *Larger buoys, donut buoys and small floats*
Photo: W.J. Strietman.

3.7.3 Fishing nets

Introduction
As part of the analysis, both gillnets and trawl nets >50 cm were analysed in more detail. The aim was to identify the type of fisheries involved and the likely origin of the nets.

In total, 19 fishing nets were analysed, of which 12 were gillnets and 7 trawl nets. As part of the examination procedure, all nets were disentangled where possible, measured in terms of length, width and mesh size. If a net could not be untangled, only the mesh size was measured.

Gillnets

Twelve gillnets were examined, 4 of which could be disentangled. The ones that could be disentangled were all close to 6m in length. The mesh sizes vary from 140 mm to 280 mm. According to the participants and a fisher who passed by when the nets were examined, the target species of the gillnets are salmon, cod, halibut and Lumpfish. These type of fisheries take place in and around the fjord and are most likely of local origin. According to the participants, these nets could have either been accidentally lost or discarded out at sea or on the shoreline after use.

Figure 3.13 *Examining the total size of a gillnet and the mesh size of another*
Photos: E. Leemans.

Trawl nets

This category consisted of 7 nets, 3.6 kg in total, all of which were pieces. Such cut-off pieces are produced during repair and maintenance (mending) work of nets on deck. If not collected and stored on board, such pieces will end up in the sea. According to the participants, trawl fisheries take place outside of the fjord or in places much further away. Accordingly, (pieces) of trawl net are likely not of local origin.

Figure 3.14 *Examples of (pieces of) trawl nets*
Photos: W.J. Strietman.

3.8 Tarpaulins and big bags

In terms of weight, tarpaulins and Big Bags make up a significant part of the litter found along the shoreline of Qaqortup Kangerlua (Figure 3.15).

Figure 3.15 *Tarpaulins and Big Bags*
Photo: W.J. Strietman.

According to the participants, hunters, fishers, boatowners and builders use the tarpaulines a lot, for example to protect drying meat from rain, or to cover a boat or building material (on land) to protect it from snow rain and storms. Under the influence of wind, tarpaulins may end up in the sea and thus on the shoreline of the fjord. The same goes for Big Bags, which are often used for storing building material or waste.

Both tarpaulins and Big Bags may potentially also end up in the sea at the municipal waste management site under the influence of wind.

4 Visit to the municipal waste site

Because it was suggested by the participants of the session that the municipal waste management site could be an important source of litter in the fjord, the research team made a visit to the site to qualitatively assess the situation. As can be seen from the pictures below, the waste management site is adjacent to the sea, where waste lays exposed and unprotected from the elements. Under the influence of wind and rain, such waste could easily enter the fjord system.

Figure 4.1 *The edge of the municipal waste management site faces the sea. Waste can be seen close to the edge of the water*
Photo: W.J. Strietman.

Figure 4.2 *Big Bags and other waste at the municipal waste management site*
Photo: W.J. Strietman.

Figure 4.3 *The cliff-edge of the municipal waste management site, facing the sea*
Photo: W.J. Strietman.

An example of the way in which household waste may enter the fjord is pictured below (Figure 4.4).

Figure 4.4 *A torn household waste bag on a jetty in the harbour*
Photo: W.J. Strietman.

5 Beach litter – species interactions

5.1 Introduction

As part of the Litter-ID session, each litter item was examined to determine whether it showed signs of fouling (attachment of plants or animals), bite marks or other signs of interaction with the (local) marine environment. In the sections below we describe fouling species and bite mark signs on beach litter items from all three locations combined.

5.2 Fouling

During the Litter-ID session, fouling was found on one item (Table 5.1). Fouling consisted of a calcifying tube worm that was attached to a rather worn-down shotgun cartridge (Figure 5.1). As fouling is a sign of being in the water for a longer period, this may suggest that the item has been transported from further away, having its source of origin from outside Greenland, or it could have stayed in the fjord for a longer period of time (and be of local origin).

Table 5.1 *Biological fouling identified on shoreline litter*

Item description	Total # with fouling	# with Annelida (calcifying tube worms)	# with Arthropoda (barnacles)	# with Bryozoa (moss animals)	# with algae and/or seaweed
Shotgun cartridges	1	1			
TOTAL	**1**	**1**			

Figure 5.1 *A shotgun cartridge (category 43A) with a calcifying tube worm attached to it. Qaqortoq, 2022 Photo: M. van den Heuvel-Greve.*

5.3 Bite marks

During the Litter-ID session, several types of bite marks were found on 16 items (Table 5.2). Nine items (foam/sponge) contained bite marks of birds, whereas shotgun cartridges and sauce bottles showed signs of chewing or biting by canines, for instance dogs or Arctic foxes.

Table 5.2 *Bite marks identified on beach litter from Qaqortoq*

Item #	Item description	Total # with bite marks	Additional information
45B	Foam/sponge	6	birds
20A	Toys (tyre of a bike)	1	birds
43A	Shotgun cartridges	3	
6C	Sauce bottles	4	
37A	Plastic small floats	2	birds
TOTAL		**16**	

Source: Wageningen Economic Research, 2020.

Figure 5.2 *Foam/sponge with bite marks of birds. Qaqortoq, 2022*
Photo: M. van den Heuvel-Greve.

Figure 5.3 *Tyre of a children's bike with bite marks, probably of birds. Qaqortoq, 2022*
Photo: M. van den Heuvel-Greve.

Figure 5.4 *Shotgun cartridges with bite marks. Qaqortoq, 2022*
Photos: M. van den Heuvel-Greve.

Figure 5.5 *Sauce bottles with bite marks. Qaqortoq, 2022*
Photos: M. van den Heuvel-Greve.

Figure 5.6 *Plastic small floats (category 37A) with bite marks, probably of birds. Qaqortoq, 2022*
Photo: M. van den Heuvel-Greve.

6 Discussion and recommendations

6.1 Introduction

Since Qaqortoq is located on the southern tip of Greenland, where ocean currents pass by, the hypothesis was that a substantial amount of the litter analysed would be from places further away, including locations outside Greenland. However, as it turned out, most of the litter seems to be of local origin. Only a handful of items were found that could have been of foreign origin. In the following sections, we will discuss the main findings and provide recommendations for next steps.

6.2 Most of the litter is of local origin

Judging by the type of litter collected on the shoreline and expert judgment by the participants of the Litter-ID session, the two main sources of marine litter on the shoreline of Qaqortup Kangerlua fjord are the local waste management site south of Qaqortoq, activities in Qaqortoq (litter ending up on the streets and from there in the sea), and outdoor activities such as fishing and hunting in the fjord.

The results of the Litter-ID session provide additional weight to the findings of the SUMAG project (DCE – Danish Centre for Environment and Energy, Aarhus University), where it was assessed that local sources (and not long-range transport of litter items from places much further away) are the main contributors to marine litter found on the shoreline of Greenland. The results also further underline the need to tackle the sources of litter in Greenland locally, as stipulated in the Government of Greenland plan introduced in 2020 (ESANI, 2020).

6.3 Species interaction

One litter item carried had a calcifying tube worm attached to it (‘marine fouling organism’). As floating litter may carry fouling organisms over long distances, there may be the risk of the introduction of new (non-indigenous) species to Greenland. Due to the low number of items with attached organisms in this study, this risk was considered to be low.

Bite marks from birds and dog or Arctic fox were found on several items. Ingestion of plastic by these animals can potentially lead to internal damage, blockage of the digestive system or a feeling of fullness which leads to the animal not eating sufficiently and eventually starvation.

6.4 Recommendations

Since the session did not include all potential stakeholder groups that are usually present during a Litter-ID session, the last step in the Litter-ID cycle could not be taken fully: the step where, based on a mutual understanding of the sources and causes of the problem, stakeholders know where to take action and with whom. The recommendations below therefore reflect this, still to be taken, step.

During the Litter-ID session, it was concluded that most of the litter is of local origin. The positive side to this is that it means that local solutions could substantially reduce marine litter in Qaqortup Kangerlua fjord. Based on this finding, in combination with the need to further understand the sources and causes, we recommend the following actions:

- Further assess the role of the municipal waste management site as a source of marine litter in Qaqortup Kangerlua fjord through litter monitoring in the fjord and an assessment of leakages into the environment from the site location. Assess which practical, on-site mitigation measures could be taken to prevent waste from entering the sea (perhaps in collaboration with Campus Kullajeq?).
- Engage with local community groups, fishers and hunters to start a dialogue on the causes for litter in the fjord and incentives or measures (solutions) to prevent this.
- Set up municipal awareness programmes on the issue of marine litter in the area.
- Look into the option of making Qaqortoq a 'Plastic Smart City'. The Plastic Smart Cities initiative was initiated by WWF and supports cities and coastal centers in taking action to stop plastic pollution. Steps in the process include making a declaration of intent with stakeholders, conducing a baseline assessment to better understand a city's waste flow, developing and implementing an action plan:

Figure 6.1 *The Plastic Smart Cities concept*
Source: WWF (2023).

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The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 7,600 employees (6,700 fte) and 13,100 students and over 150,000 participants to WUR's Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.