



## ”Sources of Marine Litter”

-Workshop report from WP 1.2  
in the MARP<sup>3</sup> project





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MARP<sup>3</sup> -**MAR**ine **P**lastic **P**ollution in the Arctic: origin, status, costs and incentives for **P**revention.

The goal of this project is to strengthen the knowledge base on marine plastic debris in the Barents Sea and provide management-relevant research to increase awareness and recommend measures that can guide sustainable practices of human activities currently contributing to marine waste pollution in the region. Norut is project manager and SALT is responsible for a Marine Litter Workshop and dissemination.

The objective of this workshop was to collate experts from relevant industries to determine the degree to which it is possible to precisely identify marine litter and examine the sources, causes of loss, and ages of different pieces of debris.

Firstly, we concluded that without the help of experts we wouldn't have been able to read much out of the waste. In this case the fishers were our key experts as there are few people living in this region, but a large fishery around Svalbard and adjacent areas. Fisheries related waste and waste from other marine activities is therefore dominating what is found along the beaches of Svalbard.

From the fishers we learned how we could tell if fishing equipment had been lost or dumped, they could also tell us what items belong under deck and therefore could not have been washed overboard in bad weather. What was more difficult to say, was the origin of the fishing equipment that was found, as this is traded internationally and is used on vessels of different nationalities.

But there was not only fishing related litter in the pile of waste we looked through. Large amounts of household packaging tells us that a variety of actors contribute to the waste that is found. Due to the large size of some of this packaging, it is likely that some of this comes from larger vessels. While we found a number of packages of Norwegian origin, such as Idun tomato sauce and mustard, a large number of nationalities were represented in the waste.

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**Background:**

The MARP<sup>3</sup> project - MARine Plastic Pollution in the Arctic: Origin, Status, Costs and Incentives for Prevention - held its startup meeting in Longyearbyen, Svalbard September 4<sup>th</sup>-6<sup>th</sup>, 2016.

A workshop was also held in conjunction with this startup meeting as part of work package (WP) 1.2 “Sources of Marine Litter”. The objective of this workshop was to collate experts from relevant industries to determine the degree to which it is possible to precisely identify marine litter and examine the sources, causes of loss, and ages of different pieces of debris. The practical part of the workshop was held at the local solid waste disposal center –RenoVest utilizing marine litter originating from Clean up Svalbard, collected from beaches on the northwest coast of Svalbard July 2016. This is pioneering work and we want to establish an efficient and reliable method to identify sources of marine litter. SALT organized the workshop.

The team comprised persons with hands-on knowledge from industries expected to contribute to marine litter in Svalbard. Fisheries representatives included Stein Bjarne Kristiansen, captain of a Norwegian purse seiner, Ingvi Thor Georgsson from the Icelandic Fishery organization, and Nikolai Demianenko, Chief Captain working for the Fishing Industry Union of the North. Two scientists from the University of Svalbard (UNIS) helped identify scientific equipment from various Arctic expeditions. Representatives from the office of the Governor of Svalbard contributed with knowledge from prior cleanup expeditions on Svalbard. A representative from the mining industry identified remnants from mining related activities.

In addition to the invited experts, people from MARPs advisory-board, all whom have extended experience with marine litter, also acted as waste experts. This advisory board includes Lise Guldbrandsen from “Keep Norway Beautiful”, Torleif Paasche from the Norwegian Fishermen’s Association, Bjørn Einar Grøsvik from The Institute of

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Marine Research. Bo Eide from Tromsø municipality- a passionate and experienced communicator on marine litter topics and the project leader of “clean coast” that organize beach cleaning in the Tromsø region, also participated in the workshop.

The scientists of MARP attended the workshop as observers or secretaries of the different expert groups.

### Clean Up Svalbard

Clean Up Svalbard is a local collaboration between tourists, Spitsbergen Travel and the Governor of Svalbard. Annually, for the last 16 years, a number of beaches and shores along the coast of Svalbard have been cleaned up. The Governor of Svalbard organizes the cleanup events. In July 2016, a team contributed on two separate cleanup expeditions to a large number of remote islands and coastlines (Fig. 1). The cruise aboard “MS Polarsyssel” started in the north in Woodfjord-Wijdefjord and continued to Nordaustlandet, collecting a total of 93 m<sup>3</sup> of marine litter. All litter was transported to the local solid waste disposal center. Due to a lack of storage capacity, only 50 m<sup>3</sup> of the litter was withheld for the workshop.

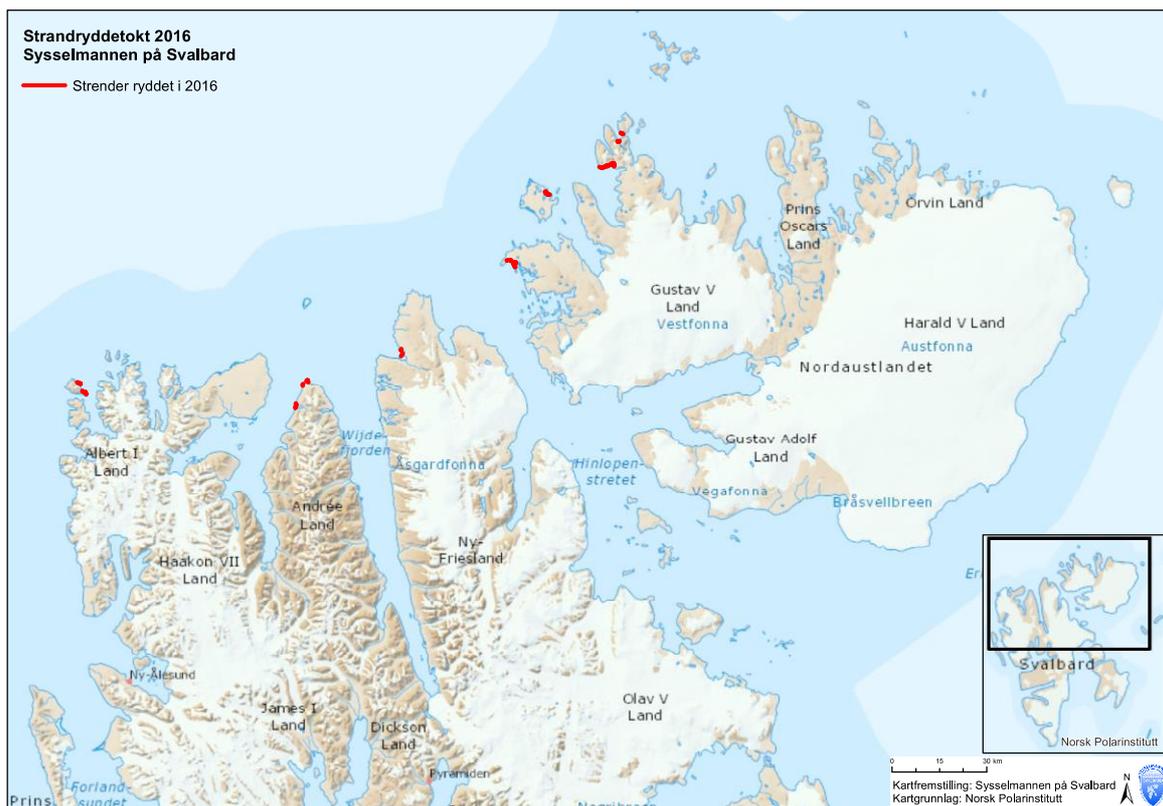


Figure 1: Map displaying the northern areas of Svalbard. The red marks indicate the Clean Up Svalbard's cleanup events in 2016 (Map: Governor of Svalbard).

The Atlantic Current splits to the west and the east off northwestern Svalbard (Fig. 2); long-distance waste typically ends up on these northwestern shores.

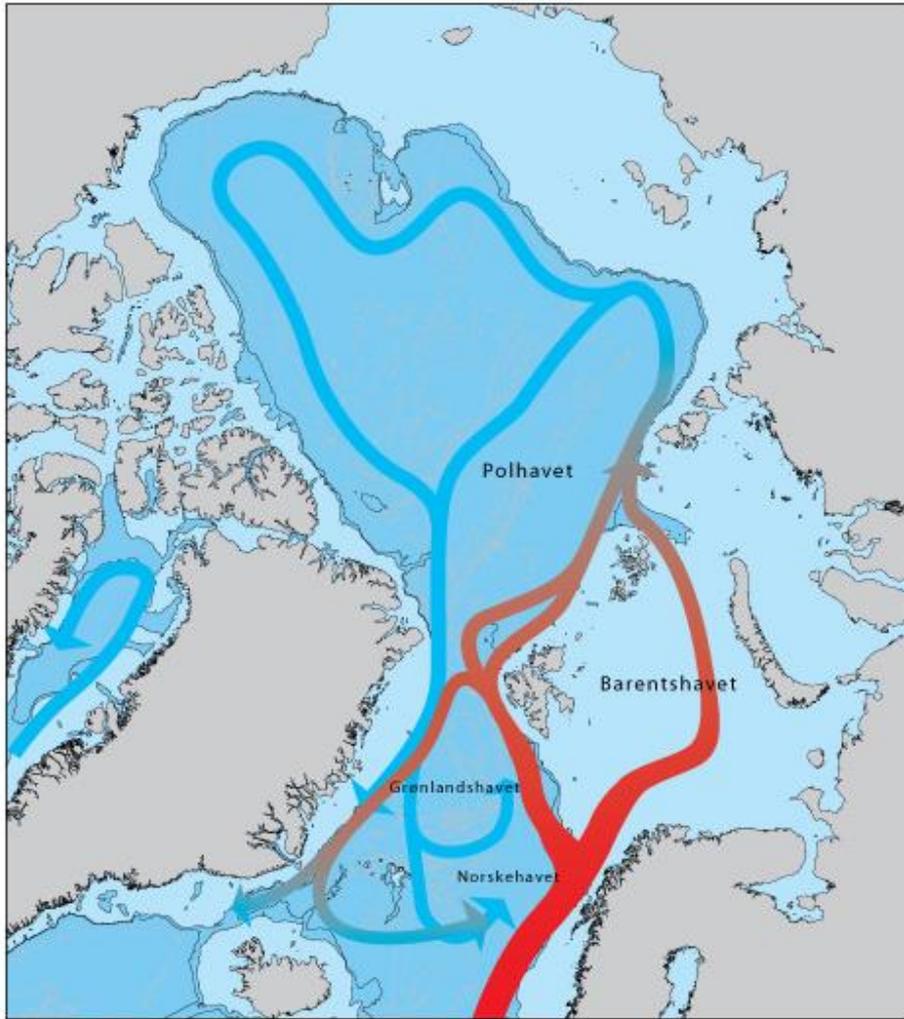


Figure 2: The main ocean currents in the Arctic.

### Fishing areas around Svalbard

The Svalbard Fisheries Protection Zone (SFPZ), established in 1977, defined an area of 200 nautical miles around Svalbard (Fig. 3) with the objective of preserving resources and avoiding uncontrolled fisheries (fisheries.no). Vessels from Norway, Russia, EU and the Faroe Islands are permitted to fish in this zone.

Norwegian vessels account for the largest fisheries in the area; the majority of which are large, oceangoing vessels. Trawl fisheries are the most common, although purse seining and line fishing also occur. Trawl vessels landed approximately 146,000 tons total in 2015, 88,000 of which were landed by Norwegian vessels (The Norwegian Directorate of Fishing, 2015). Cod constitutes the largest fishery with nearly 115,000 tons landed in 2015; two thirds of this was landed by Norwegian vessels. 31,000 tons of haddock and 20,000 tons of shrimp were landed total in 2015. Of which 21,000 and 10,000 tons were landed by Norwegian vessels, respectively. Spain and Great Britain also fish a great deal of cod in this zone. Approximately 10,000 tons each annually for both nations (Norwegian Directorate of Fisheries).

Given the prevalence of trawl fisheries in the SFPZ it is likely that a large proportion of lost fishing gear along the shores of Svalbard originate from trawl vessels.

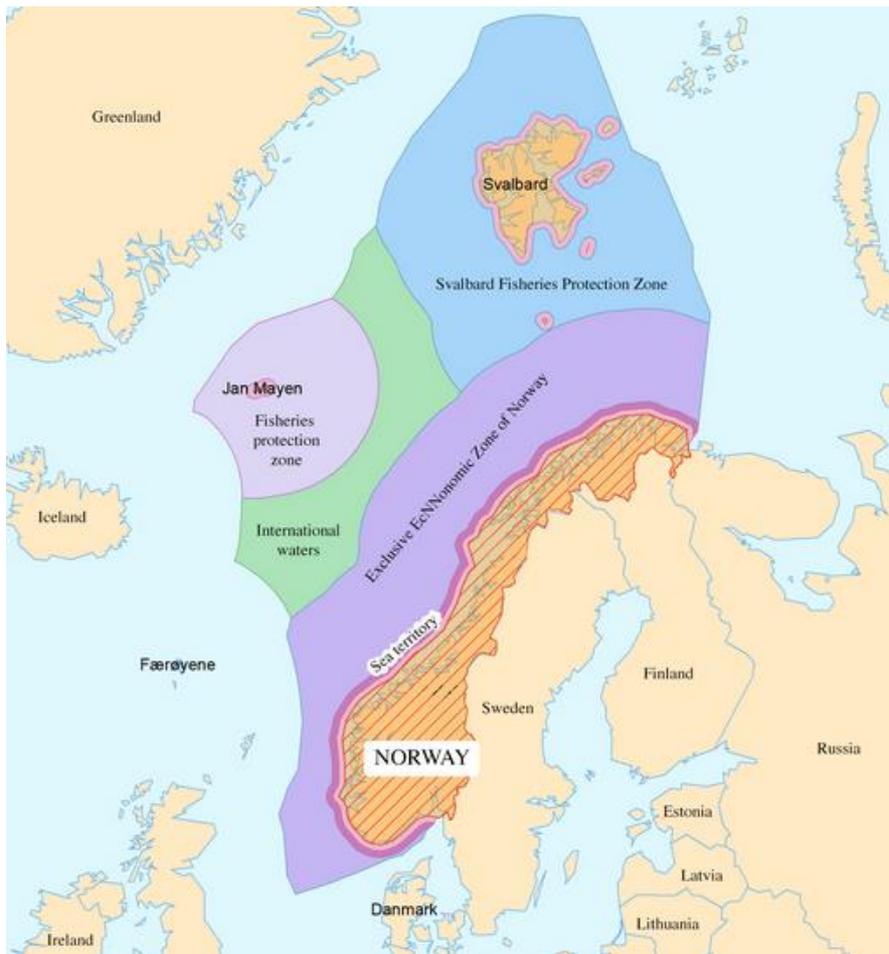


Figure 3: Map illustrating the Svalbard Fisheries Protection Zone (SFPZ) and surrounding areas in the Norwegian Arctic areas (Statkart.no).

### Sources of Marine Litter

A large proportion of the debris from Clean Up Svalbard originated from various maritime activities. Due to Svalbard's low numbers of inhabitants and beach-visiting tourists given the inhospitable climate, there is reason to believe that litter found on these shores originates off-shore. In other parts of the world the composition of marine litter is typically more influenced by poor land-based waste management.

Maritime industries and activities relevant for Svalbard include shipping, fishing, cruise ships and scientific expeditions. Relevant land-based industries include mining, construction, science and tourism.

In order to implement targeted management measures, there is a need to establish the sources of marine litter. This requires identification of the origin of the waste by industry and country of origin when possible. The age of objects can also provide relevant information; comparison of new versus old losses and that littering is still ongoing. By using a waste expert team even more details can be revealed. The cause of loss is furthermore a vital aspect, which can reveal ignorance, bad habits, lack of good waste management routines, and non-anthropogenic causes such as extreme weather events.

## Methods

The approach taken was somewhat exploratory given the investigative nature of the project and the primary objective of improving methodologies for source identification of marine litter. The key and novel feature of the approach was the utilization of solid waste experts to determine if their participation facilitates the identification process.

Three independent groups were formed and tasked with qualitatively assessing a sample of marine litter. Each group included representatives from the fishing industry, natural and social sciences, as well as persons with prior expertise from marine litter cleanups or local representatives from the community of Svalbard (i.e., the Governor of Svalbard, mining and cruise industries, and scientific expeditions). One participant from each group was responsible for recording data, the expert team contributed with knowledge of the industries they represent, and the scientists functioned as observers and secretaries.

Data were collected by type of object, with similar objects grouped subjectively (e.g., large and small buoys). For each object category, its suspected industrial origin, nationality, source details (i.e., information about the source industry), size (mostly qualitatively), age, and presumed cause of loss were recorded (See waste registration forms pg 18-23). The latter was a particularly important and interesting parameter and categorized as either accidental losses or intentional disposal, although only in a few distinct cases could an object's cause of loss be unambiguously confirmed.

Repetitive findings of objects were recorded, but not analyzed quantitatively given the highly qualitative nature of litter categorization. Unidentifiable broken parts of plastic in a multitude of shapes, sizes and colors were found in abundance and not further recorded. While the litter processed did not reflect a true volume of marine debris given its high prevalence along the shores of Svalbard, it is assumed that these were representative sub-samples in terms of composition.

Such qualitative assessments do not offer accurate accounts of all sources of marine litter, but experts can generally recognize most debris resulting from their respective industries (e.g., a fisheries expert can recognize most debris related to fisheries). Identification of nationality and age of objects is challenging and depends largely on proof in the form of writing or expiration dates, although in some cases experts can age objects subjectively based on, for example, whether use of a particular item has been discontinued and when.

There was no set protocol beyond group composition and data collection forms. This was an important component of the project and intended to encourage exploration and optimization of litter processing strategies, and to facilitate observations of techniques that work well and those that do not. Two of the three groups chose to superficially sort their litter to get an overview of the findings prior to recording data; the third group processed objects one by one.

## Results

Almost a hundred different object categories of marine litter were registered in total. Photo 1 shows the two heaps of litter. The litter composition varied in these two heaps. Some sorting had already been done after the beach cleanup. This contributed to variations in the registrations in the three waste groups. The group registration in the heap displayed in the lowest photo (Photo 1) thus ended up with more fishing nets.

It was not always possible to distinguish between industrial sources. Ropes, for example, were ubiquitous, but served a variety of different functions and came in a range of lengths, dimensions, materials and colors, making it challenging to distinguish a rope used for shipping from one used for fishing. Some exceptions were small parts of rope and nets with a knot tied in one end; these most certainly originated from the fishing industry from when a rope or net needed a small repair. The condition of a rope or fishing net *can* indicate how it was lost; a clean edge at the end of a rope indicates it was cut, and then the damaged part of the rope or net was discarded or not properly secured and thereby ended up in the ocean.

As the approach was primarily qualitative in nature, accurate quantitative data are not available. Repetitive findings were partially recorded to give an indication of prevalence of each object category, but this was not done systematically and so it is not possible to accurately estimate the contributions of each type of litter in terms of frequency of occurrence, weight or volume. Despite this, however, the partial frequency data gave a reasonable indication of relative importance of each debris category, and it was clear that objects related to fishing activities are overall the most abundant. Big fishing nets, cans, barrels and trawl bobbins occupied large amount of space in the waste containers.



*Photo 1. The two heaps of litter. Two groups registered litter from the heap above and one group registered litter from the heap below.*

### Most abundant litter: fisheries related items

Most fishing gear originated from trawlers. Nets, or parts of nets, are frequently ripped following entanglement in various bottom formations, such as coral reefs, shipwrecks, garbage or other lost gear. Netting from both cod and shrimp trawls were found, but for some nets it was impossible to determine the fishery in which they were used. Trawl nationality was also difficult to distinguish due to an international marked for fishing equipment, although in some cases the color and mesh size can inform about the country of origin. A number of trawls were found more or less intact, in which case they were most certainly not lost intentionally given their value. A trawl net was found with big knots tied along their entire length. The reason for making these knots on a net is unknown. Parts of trawl nets that were clean-cut as part of repairing, was in a number of cases regarded by the fishers as being dumped. Given the hazard these trawl nets represents, there is a need to investigate further why they end up in the ocean, either due to being insufficiently secured to avoid being washed overboard during regular fishing operations or extreme weather events, or due to dumping.



*Photo 2: Trawl net in abundance.*

Trawl bobbins are used on both pelagic and bottom trawls. These bobbins are nowadays typically made of plastic, although some older versions are made of metal. Several of the trawls found had large amounts of bobbins attached; most of which were intact and could be reused, although some are cracked and filled with water. Damaged ones attached to parts of cut rope had most certainly been discarded intentionally.



*Photo 3: Bundles of packing band.*

Large bundles of plastic packing bands might originate from production trawl vessels where packing machines experience tangles of packing band. Also other types of offshore and land-based activities use these bands so it might be other sources than fisheries responsible for this littering (pers. comm. Torleif Paasche). While many vessels have good waste management routines and deliver waste when in port, others seem to discard these bundles and other

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waste overboard. These bands have been used for at least two decades and they degrade slowly and can therefore be difficult to age. Russian trawl vessels still use these packing bands. Norwegian vessels use packing band with different dimensions (pers. comm. Norwegian trawler personnel). It is also reasonable to assume that nations in the EU still use these packing bands. How the waste regulations and routines are carried out in practice is unknown. Bundles of these bands discarded in for example the Bay of Biscay might theoretically end up on the shores of Svalbard due to the ocean currents.



*Photo 4: Some of the most abundant objects related to fisheries. Top left: different fish crates, bottom left: trawl bobbins, right: oilcans.*

Fish crates are used primarily on trawl vessels, but other vessels may use these for different purposes as temporary storage etc. They are still in use but are being phased out. Intact fish crates are valuable and therefore most likely not discarded intentionally; damaged ones on the other hand, might be thrown overboard. These fish crates originated from different fishmongers in Norway, Denmark, Spain, Great Britain, Iceland and the Faroe Islands. Crates tend to circulate among vessels and countries, and are rarely returned to its original owner.

25 L cans are multipurpose containers used in various maritime activities, such as for holding solvents, detergents and water. Both intact and broken cans were found; some cans contained unknown liquids. Their age and country and industry of origin are generally impossible to determine.

**Most abundant litter: non-fisheries related items**

Hundreds of beverage containers of varying sizes and nationalities were collected. The origin and age of most of the bottles was undeterminable; as was the cause of loss, although it is likely that in most cases bottles are discarded intentionally.



*Photo 5: Some of the most abundant objects. Top left: beverage containers, bottom left: bottles of detergents and fabric softeners, top right: ketchup bottles, bottom right: plastic cans.*

Household plastics, such as bottles and containers for ketchup, dish soap, chlorine, shampoo, detergents, fabric softeners, etc. was also abundant sources of marine litter. The frequent occurrence of these containers presented a bit of a mystery. Some food containers were also found, but not in the same extent as other household plastics. The sizes of the majority of food containers indicated that they originated from commercial kitchens onboard larger vessels. As it is uncommon to use such containers on deck it is likely these are discarded intentionally.

## Discussion

Several different maritime activities contributed to the big heaps of waste collected along the shores of Svalbard. In many cases, however, it was impossible to determine the responsible activity beyond it being of a maritime nature. Household plastics, for example, could originate from any kind of maritime activities, although sizable ones might originate from a large vessel with a commercial kitchen. Ropes could also originate from any number of maritime activities.

Most of the objects identified in this waste workshop were associated with fishery related activities, and most of the identified fishing gear originated from trawlers. This is due both to trawling being the dominant method of fishing, and to higher rates of gear loss from trawlers compared to other fishing vessels. One reason for high losses is that the species exploited in the SFPZ mostly require the use of bottom trawls, which can get caught on benthic structures, such as coral reefs, garbage, etc. and tear. These trawl nets float and will easily be washed ashore. Vessels using other fishing gear less prone to snagging may lose less gear, and once lost they may be less buoyant, thus sinking to the sea floor, rather than being washed ashore (pers. comm. Kenneth Lyster, Selstad AS). Other identified fishery related waste included trawl bobbins, fish crates, strapping band bundles and various buoys.

Other industries and activities also contributed to the waste. Some objects were related to scientific work and expeditions; examples are road markers (for ice observations and experiments), meteorological balloons, and sensors for hydrological studies (CTD sensor or navy phosphorous flare). Certain tubes of various dimensions, road markers and plastic tarpaulins seemed to originate from land based activities. Poor weather conditions and insufficient mooring are the most obvious reasons for the loss of these objects. Only one item was recognized by the mining industry; a plastic cubic bag. There might have been more waste originated from mining, but no more typical mining related waste was registered. Due to snow melting, waste from such land-based activities can be transported with rivers and eventually end up on shores.

Many registered objects had bite-marks, which could originate from a hungry polar bear or fox. Objects can contain unknown and possibly poisonous substances, which could be harmful or even lethal to wildlife. One plastic bottle with bite-marks contained oil samples from bunker oil.

The supervisor at RenoVest reported four dead reindeer in one of the trawl nets found during the annual Svalbard Clean Up in July 2016. Their antlers were tangled in the net and the animals had likely suffered a long and painful death. This is unfortunately a common occurrence.

### **What is lost and *how and why*? And what is discarded intentionally?**

Too much waste ends up in the ocean either through being lost or discarded. In order to prevent marine littering, there is a need to better understand *how and why* these objects were lost at sea, and of particular interest is whether they were lost accidentally or discarded intentionally. This workshop illustrated that in most cases this is unknown and only speculations can be made. However, by using experts within the industry we can get more information out of the waste as they are familiar with operations and type of products used within their industry. While the methodology needs to be refined, this workshop documented possible mechanisms behind marine plastic pollution. For

example, a clean edge at the end of a rope or part of a trawl net indicates it was cut and likely discarded, either on deck and then to sea, or directly to sea.

Vessels, in general, should be prepared for any kind of weather, and act safely for the sake of the crew, instruments and (fishing) gear onboard. All loose objects on a vessel should be moored properly; this also applies for waste handling. Fishing gear can get entangled, trapped or torn apart in high seas and challenging weather conditions, and fishermen may have to cut ropes, lines or nets to prevent accidents. The latter are legitimate reasons to intentionally discard gear. The best precaution is to act to prevent the loss of fishing gear and accidents. However, other items are unlikely to be discarded due to safety concerns or accidentally, and a number of items were classified by the experts as being intentionally discarded.

Vessels have discarded waste overboard through the ages. Historically this waste was typically organic and degradable. Unfortunately, the tradition of discarding waste overboard did not cease as the nature of the waste changed with the emergence of plastics and other slow or non-degradable and/or toxic materials. Some of the reasons for this lag are probably tradition, lack of knowledge, and poor waste management onboard and in ports. However, apart from Chen and Liu 2013 <sup>1</sup>from Taiwan, there are no studies documenting waste management practices and attitudes on ships and in ports.

Lack of knowledge could be one reason vessel personnel intentionally discard waste. It has long been a commonly held belief that such waste disposal have few consequences and that waste that enters the ocean simply disperses, never to be seen again. It is important to raise awareness of the consequences of poor waste management to current and future generations earning a living at sea.

Insufficient practical waste management solutions onboard, where vessels lack proper routines for handling waste and/or adequate waste storage systems, might be another reason many discard their waste overboard.

The lack of a global, international waste handling in most ports is likely to be a bottleneck for a functional waste management system. Many ports and harbors have either dysfunctional waste management systems or none at all, making the development and implementation of effective solutions crucial. This is a comprehensive task, but the effects will be vital towards cleaner oceans and shorelines. Fortunately, there is ongoing progress to improve waste management in ports. In the EU, European Maritime Safety Agency (EMSA) has established legislation on Port Reception Facility Directive (PRF) Directive 2000/59/EC) ([www.emsa.europa.eu](http://www.emsa.europa.eu)).

### Country of Origin:

Determining the country of origin of pieces of marine litter is often challenging due to the international nature of markets. Some solid waste experts can recognize hallmarks of certain products, such as fishing gear. A person working in fishing gear industry, for example, can in many cases distinguish country of origin and species fished by net color and mesh size.

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<sup>1</sup> Chen, C. and T. Liu (2013). "Fill the gap: Developing management strategies to control garbage pollution from fishing vessels." *Marine Policy* 40: 34-40.

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The most certain way to determine an object's country of origin is if it is labeled with producer or other writings. It can nonetheless be difficult to determine if an object's origin is the nation where it was produced as objects aren't necessarily discarded or lost at the production site. For example, South Korean produced plastic packing is almost certainly discarded or lost elsewhere. Similarly, the original owner of a fish crate often labels it with the name of the fishmonger, yet these crates tend to be moved across regions and even borders, never to reach its original owner again.

Some of the object's countries of origin are listed below.

Iceland (fish crate, household plastics)  
Russia (household plastic, buoy from crab fishing, Vodka bottle)  
Norway (Shoe, 12 L oil cans, milk container)  
Faroe Islands (fish crate, household plastics)  
Estonia (water bottle)  
Denmark (fish crate, Coke can)  
Spain (fish crate)  
Israel (fish crate, fruit basket)  
England (seismic sensor, fish crate, basket from bakery)  
USA (fish crate)  
South Korea (plastic container/bag)

### Age:

Most items found were relatively new, and many objects are still in commercial use today. Objects with visible serial numbers, expiry or production dates were easy to age. Knowledge of the history and use of objects also facilitates the dating process (e.g., recognizing objects that are obsolete and knowing when they went out of production and got replaced). The condition of an object is also telling of its age; exposure to weather, sun and salt water contributes to degradation over time. Without such tell-tale signs the aging of objects is impossible.

Out-dated (old) versions of objects still in use are the easiest to age; good examples include:

- Old buoy from purse seine fishing; have not been in use for decades.
- Metal trawl bobbins (rusted)
- Metal buoys
- Ketchup bottles
- Chlorine bottles

### Special objects:

When trying to identify sources of marine litter it can be interesting to document the unusual and strange findings. Mapping them might result in trend observations. Some of the more remarkable findings from the waste workshop are outlined below.

Fish sorting conveyer belts – Broken parts from conveyer belts on large trawl vessels are probably discarded intentionally. Country of origin and age are often difficult to determine.

Eye drops – Unclear if these are lost at a beach or onboard a vessel.

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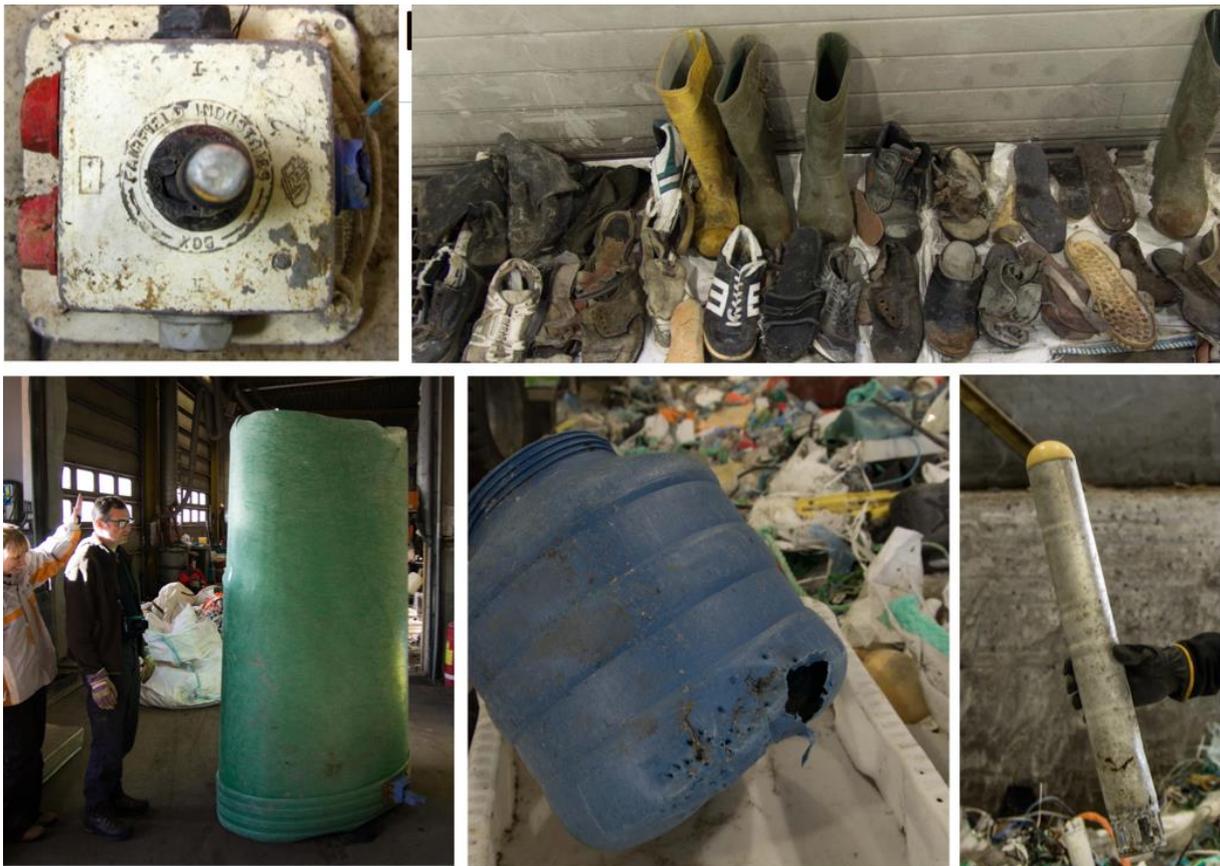
2 m tall plastic funnel 1,5 m in diameter (Photo 6) – This funnel is most certainly a large garbage chute used to remove waste from heights on construction sites. It is difficult to determine its origin, and why it was found on a shore in Svalbard.

Golf ball – Svalbard has a golf club and tournaments have been arranged here, yet the golf balls used in Svalbard are orange as the fields are white. The white golf ball found, might thus originate from golf activities onboard a cruise ship.

Meteorological weather balloons – Several research stations are situated in Svalbard and surrounding islands. Every day these meteorological weather balloons are launched into the air and many of them are picked up on shores and the meteorological instruments they carried lost.

Seismic sensor (Photo 6) (Fairfield Industries) – Following some detective work, the producer could reveal that this was a seismic sensor used in activities related to the oil industry. The serial number on the sensor revealed it was produced in 2002.

Unidentified metal cylinder (Photo 6) – This is one of few objects which identity was ambiguous. It was either a CTD sensor (scientific use) or a phosphorus flare (marine/navy use).



*Photo 6: Special findings; Top left: seismic sensor, top right: shoes, bottom left: waste chute/funnel, middle: objects with bite-marks and bottom right: metal cylinder (sensor or flare)*

Objects with bite marks (Photo 6) – Several objects had obvious bite marks. A dog food can, for example, had multiple bite marks, possibly because a hungry polar bear or fox smelled the food. This example seems rather harmless, but bite-marks found on a flask

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used for bunker oil samples can become a great concern if a hungry animal gets poisoned.

Shoes (Photo 6) – Over 30 single shoes were recorded. Only a few seemed to originate from typical fishing related activities, such as rain boots. Most shoes had no visual label and were of poor quality. Remarkably many shoes had the same design.

Road markers – These are most often used for their original purpose and end up in the marine environment when accidentally taken by snowplows and included in an ocean snow dump. The experts on scientific equipment could tell that these markers are used in abundance for snow and ice marking during scientific polar expeditions.

### Most of it is plastic

Plastics constitute the most abundant material in the marine litter analyzed during this workshop. Plastic is an extremely useful and versatile material, and irreplaceable in most industries today were it has been used to replace existing, organic materials for a variety of applications. In maritime industries, this requires that the old habit of discarding waste overboard be terminated as plastic does not degrade in the same manner as organic materials.

The condition of plastic objects recorded varied greatly. Some objects showed clear signs of physical degradation and appeared almost dissolved. Thin plastics, such as ropes and plastic bags (polyethylene, PE), rapidly break into countless smaller parts, eventually ending up as micro plastics. Hard plastics, such as the high density PE (HDPE) in many trawl bobbins and fish crates, are not as harmful in the short-term, although eventually the plastic objects will break down to micro plastics, which is harmful for micro organisms and also for humans –when the food chain accumulates toxins from the micro plastic (Rochman et al. 2013).

Future research based on the results and observations from this workshop will be completed in WP 3.2 – Waste Pyramid and Managements Options, which will investigate the potential for these items to enter a circular economy and evaluate management measures to reduce marine plastic pollution.



*Most of it is plastic...*

## Method evaluation

The objective of WP 1.2 was to identify sources of marine litter. The workshop was pioneering given its approach –by using waste experts, and the method developed is a good starting point for establishing a tool for identifying sources of marine litter. However, to raise this to a standard protocol an evaluation and subsequent modifications are necessary.

The workshop was held in a small work hall at the solid waste disposal center, which was too small for the nearly 30 participants in attendance, especially given the additional space needed for observers. As the sampling method was unestablished and under development, the ability for participants to make running adjustments to both the protocol and datasheets was vital, and as a result the three groups made different choices during data processing; two conducted a superficial sorting to obtain an overview, while the last group registered objects one by one. The most effective approach is likely to have the entire team conduct an initial sorting to facilitate the registration process of different categories of litter and make identification more efficient.

The solid waste experts, particularly from the fishing industry, shared valuable insights into waste related to fisheries, and their knowledge and experience proved crucial in the identification work. The combination of experts within the same field, but of different nationalities improved the success factor as this also allowed some further distinction of products or objects by nationality.

## Utilizing the method in future workshops

The most efficient modification to the method will be to include more solid waste experts from the industries contributing the most to marine litter (as previously documented or expected). An expert on fishing gear, such as an equipment dealer, should also be present at these types of workshops as they are highly knowledgeable of both historical and present fishing gears, and often better able to distinguish country of origin than fishermen. A combination of producers and fishermen may give the most reliable answers. All experts make objective assessments on causes of loss, based on knowledge and experience. It might therefore be useful that all experts examine the same material to test the differences and variations in their assessments.

To best utilize time and expertise, the number of participants should be reduced and those present should receive specific and unambiguous instructions concerning the workshop's program, data processing and recording protocols. The workshop may also last longer to make time for further investigations on sources or other aspects, and to make better photo documentations for additional identification work.

Determining the cause of loss is the most difficult part of the source identification process. Inaccurate assumptions of why and how objects enter the ocean presents a significant source of errors, yet in many cases educated guesses are all that is possible; this may change as more workshops and bigger data sets allow more accurate conclusions to be drawn.

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WASTE WORKSHOP  
REGISTRATION FORM

Object	Origin (industry)	Industry (details)	Size kg	Nationality	Dating	Cause of loss (and other comments)	Repetitive findings
Part of trawl net	Trawl	Fisheries	Small	Unknown	Still in use	Most probably torn off by accident	
"Net"	Land based	Unknown	Medium	Unknown	Still in use	Looks like a net from a football net or from blasting work	II
Rope	Maritime	Unknown		Unknown	Still in use	Both accidentally lost and deliberately -some ropes have clear cut off marks	
Conveyer belt parts	Trawl	Fisheries	5-10 cm	Unknown	Still in use	Small broken parts, probably discarded. Produced in Iceland	2
Line	Line fisheries	Fisheries	10 m	Unknown	Still in use	Bundle -with different ropes. Maybe lost	I
Cans	Maritime	Unknown	20 L	Unknown	Still in use	Some cans with content. The whole cans are probably lost by accident	35
Weather balloons	Science	Meteorology		Unknown	Still in use	These are released daily for research purpose	II
Computer wire	Unknown	Unknown		Unknown	Still in use	Probably discarded deliberately	I
Trawl bobbins	Bottom Trawl	Fisheries	Various	Unknown	Still in use	Bobbins containing water og with cracks are most certain discarded deliberately. Some bobbins are attached to trawl nets. This is probably due to accidents	4 m2

Report WP 1.2  
Sources of Marine Litter

WASTE WORKSHOP  
REGISTRATION FORM

Group number	Origin (industry)	Industry (details)	Size kg	Nationality	Dating	Cause of loss (and other comments)	Repetitive findings
Buoy	Purse seine	Fisheries		Unknown	Older	Most ones are destroyed when the seine in pulled out of the ocean	11
Fishing crates	Production	Fisheries		Various	New and older	Whole ones and some in part. The whole ones are probably lost by accident (valuable), parts are probably discarded. Denmark, England, Faro Islands, Norway, Spain and Iceland	21
Drinking bottles	Unknown	Household or leisure		Various	New and old	Various shapes and sizes. All plastic	100
Bottles and containers	Household	Household or leisure		Various	New and old	Various shapes and sizes. All plastic	
Strips -single	Unknown	Unknown		Unknown	New	Applied inn all kinds of maritime activities.	
Strips -bundles	Production	Fisheries		Russian?	Still in use	Still in use i russian vessels	20
Buoys in metal	Fisheries	Fisheries		Unknown	Older	No longer in commercial use. Some are still in use	10
Houshold plastic	Commercial kitchen	Maritime		Various nationalities		Probably from a commercial kitchen onboard large vessels. Due to size of containers etc	A lot
Road markers	Roads and for science	Roads and for science		Probably norwegian	Still in use	Possibly from snow plowing but also from ice marking in polar expiditions.	6

Report WP 1.2  
Sources of Marine Litter

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REGISTRATION FORM

Origin	Origin (industry)	Industry (details)	Size kg	Nationality	Dating	Cause of loss (and other comments)	Repetitive findings
White "light weight" spade	Maritime	Unknown		Unknown	New	Might be norwegian. Broken and thus discarded.	1
Shoes and soles	Various	Unknown		Various	New and older	Many of poor quality, without brands.	30
Helmets	Various	Unknown		Various	New	One recognized as russian, the others of unknown nationality	6
Large black tubes	Probably land based	Unknown		Unknown	New	Bad weather, loss, some are probly discarded	3
"Shrimp buckets"	Fisheries	Various		Unknown	New	Multifunctional, broken ones are probably discarded	4
Styrofoam	Unknown	Maritime		Unknown	New	Might originate from buoy and pontoons. Not much styrofoam found in workshop.	
Fruit cases	Commercial kitchen	Various		Various	New	Whole ones are probably lost and broken are discarded. One case has hebraic letters.	6
Snus boxes	Leisure	Leisure			New	Probably discarded deliberately	
Lighters	Leisure	Leisure			New and old	Probably discarded deliberately	5
Q-tips	Household	Household		Unknown	New	Probably discarded deliberately	20
Glas bottle	Various	Unknown		Russian	New	Bottle of Vodka, probably discarded	

Report WP 1.2  
Sources of Marine Litter

WASTE WORKSHOP  
REGISTRATION FORM

Object	Origin (industry)	Industry (details)	Size kg	Nationality	Dating	Cause of loss (and other comments)	Repetitive findings
Oil cans	Maritime	Unknown	12 L	Norwegian	Still in use	Dynoplast. Norwegian producer. Most are broken and probably discarded.	20
Trawl/net	BottomTrawl	Fisheries		Unknown	Still in use	Probably lost by accident	20
Plastic can	Unknown	Unknown	250 gr	Faro Islands	New	Sour cream, probably discarded	
Small plastic tube	Probably Land based	Unknown	0,50 m	Unknown	New	Probably Norwegian	4
Eye drops	Household	Household		Unknown	New	Probably discarded deliberately	
Packing bag	Unknown	Unknown	20 kg	S. Korea	2014	Produced in South Korea	
Big bag 1 m2	Mining		200-500 kg	Unknown	2012	Probably lost in bad weather	2
Trawl bag	Pelagisk	Shrimp			New	Probably lost by accident, expensive nets	
Package plastic	Mining		30*80 cm		New	Accident? Used to cover conveyer belts	
Big water bottle	Unknown	Unknown	5 L	Estonia	Still in use	Probably discarded deliberately	
watering jar?	Household	Gardening	10 L	Norwegian	Older	Pesticide?	
Plastic container	Commercial kitchen	Unknown	8 L	Unknown		Food container, probably discarded	
Take awaycontainers	Unknown	Unknown		Unknown	New	Probably discarded deliberately	
Floating rope	Purse seine	Fisheries	10 m	Norwegian ?	Still in use	Probably Norwegian, lost by accident	
Drinking carton	Unknown	Unknown	250 l	Norwegian	2016	Probably discarded deliberately	
Coke can	Unknown	Unknown	330 ml	Dansk	2016	Probably discarded deliberately	
Food cage	Food Industry	Food Industry		English	Older	Bakery in England	
Package plastic	Construction	Land based		Norwegian	Still in use	Probably lost in bad weather	
Buoy in plastic	Purse seine	Fisheries		Russian?	Unknown	Entangled buoys and line	
Blue plastic sheets	Production vessel	Fisheries		Unknown		Sheets between layers of fish	
Trawl bobbins metal	BottomTrawl	Fisheries		Unknown	Old	Stuck in bottom	10

Report WP 1.2  
Sources of Marine Litter

WASTE WORKSHOP  
REGISTRATION FORM

Object	Origin (Industry)	Industry (details)	Size kg	Nationality	Dating	Cause of loss (and other comments)	Repetitive findings
Big buoy	Crab fisheries	Fisheries		Russian	New	New tropes, russian writings, broken. Probably discarded deliberately	
Trawl bag	Pelagic, shrimp or capelin	Fisheries		Unknown	New	Big, probably lost	
Trawl bag	BottomTrawl	Fisheries		Unknown	New	Big, with knots. Probably lost by accident.	
Trawl bag	BottomTrawl?	Fisheries		Unknown	New	Cut and discarded	
Trawl bag	BottomTrawl	Fisheries		Unknown		Big, probably lost	
Buouy with light	Unknown	Maritime		Unknown		Styrofoam and metal, broken	
Light buoyouy from life boat	Maritime	Maritime		Unknown		Broken	
Trawl bag	BottomTrawl	Fisheries		Unknown	New	Big, with ropes. Probably lost by accident	
Brass holster	Hunting	Leisure		Unknown	Unknown	Probably discarded deliberately	
Plastic holster	Hunting	Leisure		Unknown	Unknown	Plastic, from shotguns	
Trawl bag	Pelagic	Fisheries		Unknown	Unknown	Probably lost	
Cable fiber	Unknown	Unknown		Unknown	Unknown	Probably lost in bad weather	
Tube	Land based?	Land based?		Unknown	Unknown	Sewer tube? Probably lost in bad weather	
Brush	Maritime	Maritime		Unknown	Old	Discarded deliberately, for brushing off fish shell?	
Bottles	Household	Household		Unknown	Unknown	Probably discarded deliberately	
Ropes and net parts	Trawl	Fisheries		Unknown	Old	Parts of trawl net and rope, probably discarded	
Mooring rope	Maritime	Maritime		Unknown	Old	Torn in one side and cut on the other side -discarded	
Lids	Various	Various		Unknown	Unknown	Probably discarded	
Valve	Household	Household or leisure		Unknown	Unknown	Valve from bag in box	
Cutting board	Maritime	Maritime		Unknown	Unknown	Probably lost, not broken	
Explosive fuse and wire	Landbased?	Land based?		Unknown	New	Probably lost by accident	
Cork buoyouy, small	Fisheries	Fisheries		Unknown	Old	Probably discarded	
Golfball	Tourism or leisure	Tourism or leisure		Unknown	Old	Tourist industry. Broken, discarded	
Trawl bag	Shrimp or capelin	Fisheries		Unknown	New	Probably lost by accident, exspensive nets	
Bottom traw	Trawl	Fisheries	Small	Unknown	Old	Brittled, probably discarded	

Report WP 1.2  
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Object	Origin (Industry)	Industry (details)	Size kg	Nationality	Dating	Cause of loss (and other comments)	Repetitive findings
Bottles bunker oil samples	Maritime	Maritime	0,5 L	Dansk	New	Small plastic bottles for bunker oil sampling. Bitemarks. Discarded.	2
Bottles household	Maritime	Maritime		Various	New and old	Chlorine, Salmiac etc. Discarded	50
Lid from oil can	Maritime	Maritime		Unknown	New	Probably discarded	5
Can dog food	Land based	Land based		Norwegian ?	New	Bitemarks	1
Ketchup/mustard	Household or leisure			Most norwegian	New and old	Discarded	20
Rubber gloves	Various	Fisheries		Various	New	Discarded	10
Water filter	Maritime	Maritime		Various	New	Discarded	3
Buoy	Fisheries	Fisheries		Unknown	Old	Sliced buoy in cork or styrofoam	6
Sensor	Research?	Research?		Unknown	Unknown	CTD, magnetometer, Phosphours flare?	
Seismic sensor	Research	Oil and gas		English	2002	Fairfield Industries with serial number	
Rope	Unknown	Fisheries		Unknown	Old	Special rope with nylon core, from winch, purse seine fishing?	

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# salt science - fresh ideas

