

Marine litter and microplastics

An overview on Finnish research

Tuuli Teittinen 8/2017, Ministry of Environment

Table of Contents

Summary	2
The projects of the Finnish Environment Institute SYKE	3
SEAWASTE project (MERIROSKA)	3
The occurrence of microplastics in the open sea fish in Finland	4
Microplastics in Finnish Waters (MIF)	4
Transport of plastics, microplastics and hazardous substances related to plastics from built environment to the Baltic Sea	6
Plastic waste pathways into the Baltic Sea (BLASTIC).....	6
Trash away! (RoskatPois!)	7
Microplastics and their effects in the soft sediments of the northern Baltic Sea	9
Evaluation of environmental hazards from new biodegradable plastic materials in the Baltic marine environment.....	11
Other SYKE's publications.....	11
Other projects	11
Underwater marine litter in the sea area of Helsinki – a pilot study	11
Micro litters in storm waters - A case study: City of Turku.....	12
HELCOM 2014, BASE project 2012-2014: Preliminary study on synthetic microfibers and particles at a municipal waste water treatment plant.....	12
MSc theses and other theses related to microplastics	13
The presence of microplastics in the benthic fauna of Helsinki.....	13
The presence of microplastics in coastal fish in Finland.....	14
Snow as a storage and transporter for small plastic litter.....	14
Microplastics and Harmful Substances in Urban Runoffs and Landfill Leachates - Possible Emission Sources to Marine Environment.....	15
International projects	15
MARLIN – Baltic Marine Litter	15
HELCOM SPICE - Implementation and development of key components for the assessment of Status, Pressures and Impacts, and Social and Economic evaluation in the Baltic Sea marine region	16
Microlitter in sewage treatment systems: A Nordic perspective on waste water treatment plants as pathways for microscopic anthropogenic particles to marine systems.....	17

Defining the baselines and standards for microplastics analyses in European waters (BASEMAN)	18
MARELITT Baltic.....	18
Other international reports.....	19

Summary

Marine litter and microplastics are relatively new topics in Finnish research. The Finnish Environment Institute SYKE is the leader of the research on marine litter and microplastics in Finland. SYKE does research on the amount and distribution of marine litter and microplastics, their effects in the Baltic Sea as well as the sources and transport routes of litter to the sea. SYKE also develops measures to reduce marine littering.

Microplastics are SYKE's speciality, and there are various research projects focusing on microplastics going on. The projects collect knowledge on the amount and quality of microplastics in open sea, sediments and marine organisms, such as plankton, benthos, mussels and fish. In addition, SYKE does experimental laboratory work to investigate the transport and effects of microplastics in the food web of the Baltic Sea. Together with the University of Eastern Finland the occurrence of microplastics in stormwater and Finnish freshwaters is studied, as well as together with Aalto University the occurrence of microplastics in wastewater and the removal of microplastics in wastewater treatment plants.

The research projects on marine littering and microplastics are listed below. Many of SYKE's projects are conducted together with Finnish universities or other partners, such as City of Helsinki Environment Centre, Natural Resources Institute Finland LUKE and Keep the Archipelago Tidy Association. There are also several international projects on marine litter and microplastics where Finland is taking part.

The projects of the Finnish Environment Institute SYKE

SEAWASTE project (MERIROSKA)

Start year: 2014
End year: 2017
Person in charge: Maiju Lehtiniemi (SYKE)
Other persons: Outi Setälä (SYKE), Pinja Näkki (SYKE), Stjepan Budimir (SYKE), Saana Railo (SYKE)
Financiers: Finland Ministry of Environment (YM TEAS 2014-2017)
Partners: Keep the Archipelago Tidy Association, Swedish Environmental Research Institute (IVL), City of Helsinki Environment Centre, Metsähallitus, Natural Resources Institute Finland LUKE

The MERIROSKA project was developed to increase the knowledge on marine litter (visible litter and microlitter). The project develops methods for monitoring and analysis of microlitter in free water and in sediments. The project aims to collect internationally comparable monitoring data.

The project investigates also the amount and quality of microplastics in animals at the higher levels of the food web. The focus is on commercially important species that are also relevant to human health. These species are herring, sprat, perch, three-spined stickleback and benthic animals. A small pilot study is done to investigate the amount of plastics in the stomachs of the Baltic ringed seal and sea birds. Also the movement and accumulation of microplastics in the food web is investigated.

Samples have been collected since 2013 from the Gulf of Finland and the Gulf of Bothnia:

1. Litter on the surface water
2. Litter in the sediments
3. Microlitter in organisms

Publications

Setälä, O., Magnusson, K., Lehtiniemi, M., & Norén, F. 2016. Distribution and abundance of surface water microlitter in the Baltic Sea: A comparison of two sampling methods. Marine Pollution Bulletin, 110(1), 177-183. <http://dx.doi.org/10.1016/j.marpolbul.2016.06.065>

ABSTRACT

Two methods for marine microlitter sampling were compared in the Gulf of Finland, northern Baltic Sea: manta trawl (333 µm) and a submersible pump (300 or 100 µm). Concentrations of microlitter (microplastics, combustion particles, non-synthetic fibres) in the samples collected with both methods and filter sizes remained <10 particles m⁻³. The pump with 100 µm filter gave higher microlitter concentrations compared to manta trawl or pump with 300 µm filter. Manta sampling covers larger areas, but is potentially subjected to contamination during sample processing and does not give precise volumetric values. Using a submerged pump allows method controls, use of different filter sizes and gives exact volumetric measures. Both devices need relatively calm weather for operation. The choice of the method in general depends on the aim of the study. For monitoring environmentally relevant size fractions of microlitter the use of 100 µm or smaller mesh size is recommended for the Baltic Sea.

Setälä, O., Norkko, J., & Lehtiniemi, M. (2016). Feeding type affects microplastic ingestion in a coastal invertebrate community. Marine pollution bulletin, 102(1), 95-101. <http://dx.doi.org/10.1016/j.marpolbul.2015.11.053>

ABSTRACT

Marine litter is one of the problems marine ecosystems face at present, coastal habitats and food webs being the most vulnerable as they are closest to the sources of litter. A range of animals (bivalves, free swimming crustaceans and benthic, deposit-feeding animals), of a coastal community of the northern Baltic Sea were exposed to relatively low concentrations of 10 µm microbeads. The experiment was carried out as a small scale mesocosm study to mimic natural habitat. The beads were ingested by all animals in all experimental concentrations (5, 50 and 250 beads mL⁻¹). Bivalves (*Mytilus trossulus*, *Macoma balthica*) contained significantly higher amounts of beads compared with the other groups. Free-swimming crustaceans ingested more beads compared with the benthic animals that were feeding only on the sediment surface. Ingestion of the beads was concluded to be the result of particle concentration, feeding mode and the encounter rate in a patchy environment.

The occurrence of microplastics in the open sea fish in Finland

Start year: 2015

End year: 2017

Phase: Active

Person in charge: Stjepan Budimir (SYKE)

Other persons: Maiju Lehtiniemi (SYKE), Outi Setälä (SYKE)

Financiers: Finland Ministry of Environment

Partners: Natural Resources Institute Finland (LUKE)

The study develops a method for isolating microplastic particles from fish digestion systems and evaluating the amount of microplastics in open sea fish, herring and sprat, used for human consumption. Fish samples will be collected from the Bothnian Sea, the Northern Baltic Sea and the Gulf of Finland in 2015 and 2016. The project is an essential part of the Meriroska project (see above).

The study produces new nationally important information on the presence of microscopic plastic litter in food web and helps evaluate the disadvantages caused by plastic litter for fish and, possibly, for people.

Microplastics in Finnish Waters (MIF)

Start year: 2016
End year: 2020
Person in charge: Maiju Lehtiniemi (SYKE)
Other persons: Outi Setälä (SYKE), Julia Talvitie (SYKE), Erika Zidbeck (SYKE), Arto Koistinen (UEF), Samuel Hartikainen (UEF)
Financiers: Academy of Finland
Partners: University of Eastern Finland (UEF), Swedish Environmental Research Institute (IVL), City of Helsinki Environment Centre, Keep the Archipelago Tidy, City of Kuopio

The pervasive presence of microplastics (MP) in aquatic systems has been demonstrated recently in several studies. Although ingestion of MP by various marine organisms has been verified, biological impacts are largely unknown. The pressures behind MP loads vary by region, and need to be assessed as such. The project will focus on some of the most crucial knowledge gaps that hinder efficient management of MP in urban areas: in stormwater and its impact on aquatic biota in Finnish coastal waters and freshwaters. The research consortium combines high-quality knowledge on the dynamics of Baltic Sea and Lake Kallavesi food webs, methodological expertise and newest infrastructure on material characterization. By assessing distribution and chemical characters of MP and experimentally following their uptake and transfer in food webs the consortium will establish nationally a unique platform for performing interdisciplinary research.

Publications

Setälä, O., Koistinen, A., Budimir, S., Hartikainen, S., Lehtiniemi, M., Näkki, P., Selenius, M., Talvitie, J. 2016. From the Sea to the Dining Table and Back to the Environment: Microlitter Load of Common Salts. In: Baztan, J., Jorgensen, B., Pahl, S., Thompson, R. C., & Vanderlinden, J. P. (Eds.) 2016. MICRO 2016: Fate and Impact of Microplastics in Marine Ecosystems: From the Coastline to the Open Sea. Elsevier.

Microplastics are widespread in marine environment from the coastlines to the open ocean. Salts originated from the sea may concentrate microplastics from large volumes of seawater and carry them back to land. In addition to the direct human consumption of table salts, various types of salts are also used for example in agriculture as preservatives and to complement animal nutrition. Furthermore, salts are widely spread on roads during winter to defrost snow and ice in the northern Europe. We analyzed and compared common sea salts, mineral salts and mountain salts which are available in Finnish supermarkets and manufactured around the world. Salts were dissolved in water and filtered through plankton nets (mesh size 300, 100, 50 and 20 µm). Particles caught on filters were examined using FTIR microscopy to characterize the material of the particles. Preliminary results show that all analyzed salt products contained microlitter, and most of these particles were fibers, including both organic and polymer fibers. This study reveals a potential pathway of microplastics relocation from one area to another and between marine and terrestrial environments.

Hartikainen, S., Bizjak, T., Gajšt, T., Leskinen, J., Pasanen, P., Koistinen, A. Sorvari, J. 2016. The City of Kuopio and Lake Kallavesi in the Finnish Lake District—A “Living Laboratory” for the Microplastic Pollution Research in Freshwater Lakes. In: Baztan, J., Jorgensen, B., Pahl, S., Thompson, R. C., & Vanderlinden, J. P. (Eds.) 2016. MICRO 2016: Fate and Impact of Microplastics in Marine Ecosystems: From the Coastline to the Open Sea. Elsevier.

The effects of microplastic pollution in freshwater basins remain generally understudied in Finland. The majority of lakes in Finland are located to the Finnish Lake District in the eastern part of Finland. The hilly landscape of the lake plateau is dominated by glacial remnants of drumlins and by long sinuous eskers. Terminal moraines trap networks of thousand lakes separated by hills and forested countryside. There are 187,888 lakes in Finland. With an area of 4728 km², Lake Kallavesi is the tenth largest lake and is located in the region of Northern Savo in eastern Finland. It belongs to the Vuoksi main catchment area, which covers an area of 16,270 km². Vuoksi is the largest freshwater catchment area in Finland. Lake Kallavesi surrounds the City of Kuopio, which is the eighth biggest city in Finland with population of 112,000. The aim of this research is to turn the City of Kuopio into a “living laboratory” focusing on how urban waste and drainage waters and littering affect freshwater ecosystems such as Lake Kallavesi. The “Living laboratory of Kuopio” together with the state-of-the-art analytical laboratories at the Kuopio campus of the University of Eastern Finland provides opportunities to carry out on-site research of sources, fate and effects of microplastics in Lake Kallavesi. Furthermore, the research aims to assess the effect of stark contrasts of four seasons on the abundance and distribution of microplastics in Lake Kallavesi. For almost 5 months the lake Kallavesi is covered with ice which could retain the otherwise floating particles on the surface. Our preliminary results of the ice samples confirm the presence of microplastic in Lake Kallavesi with a substantial amount of fibers.

Transport of plastics, microplastics and hazardous substances related to plastics from built environment to the Baltic Sea

Start year: 2015

End year: 2017

Person in charge: Päivi Fjäder (SYKE), Outi Setälä (SYKE)

Other persons: Maiju Lehtiniemi (SYKE), Petrus Kautto (SYKE), Julia Talvitie (SYKE/Aalto University) and several other persons

Financiers: SYKE

Partners: Aalto University

The project develops methods for evaluating the amount of microplastics from both sludge and bio-based soil improvers. In addition, the environmental risks associated with the use of sewage sludge are considered, taking into account microplastics. The project provides information on the environmental load caused by microplastics and plastic-related harmful substances in the Baltic Sea catchment area, and especially the problems associated with the use of recycled bio-based soil improvers.

Publications

Kilponen, J., Pulkkinen, M., Fjäder, P., Setälä, O., Talvitie, J. 2016 Mikromuovit ja haitalliset aineet hulevesissä ja kaatopaikan suotovesissä. Ympäristö ja terveys 2016; 47 (6): 30-35.

Plastic waste pathways into the Baltic Sea (BLASTIC)

Start year: 2016
End year: 2018
Person in charge: Outi Setälä
Other persons: Maiju Lehtiniemi, Pinja Näkki
Financiers: European Union, Central Baltic Programme 2014–2020
Partners: Keep Sweden Tidy Foundation (Sweden), coordinator; Keep the Archipelago Tidy (Finland); Stockholm Environment Institute Tallinn Centre, (Estonia); IVL Swedish Environmental Research Institute (Sweden); Foundation for Environmental Education Latvia, (Latvia); City of Turku (Finland); Tallinn City Government (Estonia)
Web page: <https://www.blastic.eu/>

The BLASTIC project aims at reducing plastic waste and thereby hazardous substances inflow into the Baltic Sea by mapping and monitoring amounts of litter in the aquatic environment.

BLASTIC project demonstrates how plastic waste in urban areas finds its ways to the Baltic Sea and becomes marine litter. Land-based sources count for most of the marine litter while rivers are major pathways feeding the sea with litter. In practice the project takes regional and national strategies into use on a local level and also produces updated local action plans. The project also provides a methodology for mapping the most important sources and pathways of marine plastic litter and monitoring litter in rivers and coastal waters/areas. As a result the project compiles a list of sources and pathways with recommendations that are closely linked to resource efficiency in waste and water sector. The methodology is implemented in 3-4 urban areas and the concept is further promoted in other areas.

As a result of the project the amount and inflow of plastic marine litter and hazardous substances are reduced in the Central Baltic area and the Baltic Sea. The outcomes that lead to overall result are real data and a new methodology that suit the pilot areas as well as general guidelines with list of identified and prioritized sources with focus on plastic waste and urban areas. This project is built to expand after the project is completed, which provides conditions that ultimately contribute to the reduced hazardous substances and toxins' inflow into the Baltic Sea.

BLASTIC 2016-2018 is financed from The Central Baltic Programme 2014-2020. The total budget of the project is 1 016 555,50 euros of which ERDF is 784 522,46 euros.

Trash away! (RoskatPois!)

Start year: 2017
End year: 2018
Person in charge: Outi Setälä (SYKE)
Other persons: Sanna Suikkanen (SYKE), Anna Kukkola (SYKE), Helena Dahlbo (SYKE), Hanna Salmenperä (SYKE), Emmi Nieminen (SYKE), Antti Lappalainen (LUKE), Mirja Ikonen (Trafi) and several other persons
Financiers: European Maritime and Fisheries Fund (EMFF)
Partners: Natural Resources Institute Finland (LUKE), Finnish Transport Safety Agency (Trafi)

Trash away! -project aims to identify sources of littering in the marine environment, to determine the current status and to reduce the amount of littering.

The first phase of the project will carry out a comprehensive survey of the amount of litter on the shores and in the marine environment, as well as assessing the most significant sources and pathways of litter. The project will take into account litter of all size and quality and its presence in different parts of the marine ecosystem in both the marine environment and the organisms. The project also assesses the disadvantages and impacts of littering on marine organisms and the health risks for humans.

The project aims to encourage the development of ideas and innovations that could be processed into more permanent actions and business activities. The main objective of the project is to set up a road map towards a litter-free marine environment.

Occurrence of microplastics in wastewater, the removal in the wastewater treatment plants and effects in the receiving water body

Start year: 2014

End year: 2017

Person in charge: Julia Talvitie (Aalto University, SYKE)

Other persons: Anna Mikola (Aalto University), Outi Setälä (SYKE), Arto Koistinen (UEF), Mari Heinonen (HSY), Saana Railo, (HY)

Financiers: Maj and Tor Nesslingin Foundation

Partners: Aalto university, University of Eastern Finland (UEF), Helsinki Region Environmental Services Authority HSY

In this interdisciplinary PhD project the role of municipal wastewater treatment plants for the marine microplastic load is investigated. Also, the impacts of microplastic litter to marine life is studied. The research is done in cooperation between Aalto University and Finnish Environment Institution (SYKE). Most of the work is done at the Viikinmäki wastewater treatment plant.

The research investigates how the microscopic litter and especially microplastics behave in the wastewater treatment process and how well different treatment phases remove litter from the wastewater. Also the amount of microplastics in the wastewater treatment sludge is studied. The methods of sampling and analysis needed in wastewater analysis and, in particular, the methodology of microplastic material recognition are developed during the project.

Publications

Talvitie, J., Mikola, A., Setälä, O., Heinonen, M., & Koistinen, A. 2017. How well is microlitter purified from wastewater?– A detailed study on the stepwise removal of microlitter in a tertiary level wastewater treatment plant. Water Research, 109, 164-172. <http://dx.doi.org/10.1016/j.watres.2016.11.046>

ABSTRACT

Wastewater treatment plants (WWTPs) can offer a solution to reduce the point source input of microlitter and microplastics into the environment. To evaluate the contributing processes for microlitter removal, the removal of microlitter from wastewater during different treatment steps of mechanical, chemical and biological treatment (activated sludge) and biologically active filter (BAF) in a large (population equivalent 800 000) advanced WWTP was examined. Most of the microlitter was removed already during the pre-treatment and activated sludge treatment further decreased the microlitter concentration. The overall retention capacity of studied WWTP was over 99% and was achieved after secondary treatment. However, despite of the high removal performance, even an advanced WWTP may constitute a considerable source of microlitter and microplastics into the aquatic environment given the large volumes of effluent discharged constantly. The microlitter content of excess sludge, dried sludge and reject water were also examined. According to the balance analyses, approximately 20% of the microlitter removed from the process is recycled back with the reject water, whereas 80% of the microlitter is contained in the dried sludge. The study also looked at easy microlitter sampling protocol with automated composite samplers for possible future monitoring purposes.

Talvitie, J., Heinonen, M., Pääkkönen, J. P., Vahtera, E., Mikola, A., Setälä, O., & Vahala, R. 2015. Do wastewater treatment plants act as a potential point source of microplastics? Preliminary study in the coastal Gulf of Finland, Baltic Sea. Water Science and Technology, 72(9), 1495-1504.

ABSTRACT

This study on the removal of microplastics during different wastewater treatment unit processes was carried out at Viikinmäki wastewater treatment plant (WWTP). The amount of microplastics in the influent was high, but it decreased significantly during the treatment process. The major part of the fibres were removed already in primary sedimentation whereas synthetic particles settled mostly in secondary sedimentation. Biological filtration further improved the removal. A proportion of the microplastic load also passed the treatment and was found in the effluent, entering the receiving water body. After the treatment process, an average of 4.9 (± 1.4) fibres and 8.6 (± 2.5) particles were found per litre of wastewater. The total textile fibre concentration in the samples collected from the surface waters in the Helsinki archipelago varied between 0.01 and 0.65 fibres per litre, while the synthetic particle concentration varied between 0.5 and 9.4 particles per litre. The average fibre concentration was 25 times higher and the particle concentration was three times higher in the effluent compared to the receiving body of water. This indicates that WWTPs may operate as a route for microplastics entering the sea.

Microplastics and their effects in the soft sediments of the northern Baltic Sea

Start year: 2017

End year: 2020

Person in charge: Pinja Näkki (SYKE)

Other persons: Outi Setälä (SYKE), Maiju Lehtiniemi (SYKE)

Financiers: Walter and Andrée de Nottbeck foundation

Partners: University of Eastern Finland, University of Helsinki (Tvärminne zoological station)

The PhD research focuses on the interactions of microplastics, benthic invertebrates and hazardous substances on the seafloor. The study examines how the microplastics sinking from the water column into the sea bottom move between the layers of the sediment both passively and transported by the benthos. In addition, the accumulation of harmful environmental chemicals in microplastics in sediment is studied as well as whether microplastics transport harmful substances to the organisms on the bottom. The results of the project will help to evaluate the potential disadvantages of microplastics in marine ecosystems both in the Baltic Sea and in other marine areas.

Publications

Näkki, P., Setälä, O. & Lehtiniemi, M. 2017. Bioturbation transports secondary microplastics to deeper layers in soft marine sediments of the northern Baltic Sea. Marine Pollution Bulletin 119(1): 255–261. <https://doi.org/10.1016/j.marpolbul.2017.03.065>

ABSTRACT

Microplastics (MPs) are observed to be present on the seafloor ranging from coastal areas to deep seas. Because bioturbation alters the distribution of natural particles on inhabited soft bottoms, a mesocosm experiment with common benthic invertebrates was conducted to study their effect on the distribution of secondary MPs (different-sized pieces of fishing line < 1 mm). During the study period of three weeks, the benthic community increased MP concentration in the depth of 1.7–5.1 cm in the sediment. The experiment revealed a clear vertical gradient in MP distribution with their abundance being highest in the uppermost parts of the sediment and decreasing with depth. The Baltic clam *Macoma balthica* was the only study animal that ingested MPs. This study highlights the need to further examine the vertical distribution of MPs in natural sediments to reliably assess their abundance on the seafloor as well as their potential impacts on benthic communities.

Emissions of microplastics from household to the sewage system: quantification and reduction measures

Start year: 2016
End year: 2017
Person in charge: Markus Sillanpää (SYKE)
Financiers: Maa- ja vesitekniikan tuki ry

The project studies microfibers released from households, focusing on microplastic fibers released from textiles. Also microplastics in cosmetic products are subject to research.

Publications:

Setälä O., Kautto P., Lehtiniemi M. and Sillanpää M. (2017) Mikromuovit – uhka merille ja kiertotaloudelle (In Finnish). Ympäristö ja terveys 48/4, p. 18-22.

Setälä O., Fjäder P., Hakala O., Kautto P., Lehtiniemi M., Raitanen E., Sillanpää M., Talvitie J. and Äystö L. (2017) Microplastics – a growing environmental risk. SYKE Policy Brief.

Available at:

https://helda.helsinki.fi/bitstream/handle/10138/177566/SYKE_PolicyBrief_mikromuovi_FI_web.pdf?sequence=1

Sillanpää M., Sainio P. 2016. Release of polyester and cotton fibers from fabrics in machine washings. (Submitted manuscript)

Evaluation of environmental hazards from new biodegradable plastic materials in the Baltic marine environment

Start year: 2017
End year: 2019
Financiers: Finland ministry of Environment

The Finnish Environment Institute has got funding for the new project to investigate the environmental load from new biodegradable plastic materials in the Baltic marine environment.

Other SYKE's publications

Setälä, O., Lehtiniemi, M., Haaksi, H. ja Gustafsson, J. 2017. Roskapostia – Kansalaisen tietokirja meren roskaantumisesta. (In Finnish) Available at: <http://www.pidasaaristosiistina.fi/files/2373/Roskapostia.pdf>

Roskapostia book collects existing information about littering and opens up special features of the sensitive ecosystem in the Baltic Sea. The work aims to overcome the current misconceptions of the state of the Baltic Sea and to tell about the side effects of littering. The project wants to make an interesting non-fiction book for all citizens and provide tools to solve the problem. The book has received EUR 20,000 from the Ålandsbanken's Baltic Sea Project. With the Baltic Sea project Ålandsbanken wants to encourage actions to improve the state of the Baltic Sea by providing funding.

Other projects

Underwater marine litter in the sea area of Helsinki - a pilot study

Year: 2015
Responsible organisation: City of Helsinki Environment Centre

Majaneva, S. & Suonpää, A. 2015. Underwater marine litter in the sea area of Helsinki – a pilot study (In Finnish). Publications by City of Helsinki Environment Centre. Available at: <https://www.hel.fi/static/ymk/julkaisut/julkaisu-02-15.pdf>.

The objective of this pilot study was to map the amount and quality of the macrolitter on the seabed in the sea area of Helsinki, testing diving as a possible method for mapping. The EU Marine Strategy Directive (MSD 2008), aimed at achieving healthy sea areas in the EU's territorial sea by 2020 (EC 2008), requires Member States to monitor and research littering. Based on the results of the study, a more detailed and broader inventory of macrolitter can be planned, which can be carried out regularly on the Finnish coast.

Litter was found in all research lines in each research area (Eläintarhanlahti, Eiranranta-Hernesaari, Kulosaari and Uutela). Glass bottles, glass bottle fragments and aluminium cans were the most common types of litter. Also unidentified pieces of plastic (size approx 10-30 cm) were found much in all research areas. The dive method is suitable for macrolitter mapping with certain constraints; poor visibility may weaken or hinder quantitative research. Monitoring of underwater litter is important in order to better understand, what kind of danger the litter forms and to map out the various sources of litter.

Micro litters in storm waters - A case study: City of Turku

Year: 2015

Responsible organisation: City of Turku

Partners: Aalto University, Turku University of Applied Sciences

Regmi, B., Talvitie, J., Salminen, P. & Klingstedt, F. 2015. Micro litters in storm waters - A case study: City of Turku. City of Turku Environmental Publications 2/2015. Available at: https://www.turku.fi/sites/default/files/atoms/files//micro_litters_in_storm_waters_web.pdf

The main aim of the study was to monitor the quality of the storm waters and to examine the types and amount of micro litters in the storm waters in the city of Turku. The results of the study showed that there are significant amount of micro litters present in storm waters. Most of the micro litters were found repetitively in both of the sampling rounds. Some of the micro litters were analyzed using the FTIR technique. According to the analysis, the particles were found to be plastic polymers that are normally used in daily utilities such as packaging, bottles, insulation, geo membrane etc. The most common types of plastic found were poly ethylene, polyester, polyvinyl chloride, and polypropylene. Some complex forms of plastic polymers were also found such as alkyd resin that is commonly used in interior coatings and paintings in industries.

Furthermore, the results also showed high amount of fibers in the samples located in the city centre. Most of the fibers resembled synthetic when examined under the light microscope. Although, the fiber samples were picked for material analysis using FTIR machine, due to their tiny sizes and lack of resources, the fiber samples were not analyzed.

HELCOM 2014, BASE project 2012-2014: Preliminary study on synthetic microfibers and particles at a municipal waste water treatment plant

Start year: 2012

End year: 2014

Responsible organisation: Helsinki Region Environmental Services HSY

Partners: State Unitary Enterprise "Vodokanal of St. Petersburg"

Talvitie, J. & Heinonen, M. 2014. Preliminary study on synthetic microfibers and particles at a municipal waste water treatment plant. BASE project 2012-2014. Available at: <http://www.helcom.fi/Lists/Publications/Microplastics%20at%20a%20municipal%20waste%20water%20treatment%20plant.pdf>

Public and scientific interest in micro-sized plastic waste in marine environment has increased considerably in recent years, but relatively little is known about the sources of microplastics. Also the lack of standardized methods of sampling and analyzing microplastics has complicated the comparability of results gained from the few studies carried out. Helsinki Region Environmental Services Authority HSY has developed a microplastic sampling method targeted at wastewaters and was willing to share its knowledge and experience of microplastic research with colleagues at the State Unitary Enterprise Vodokanal of St. Petersburg in this HELCOM BASE project.

The objective of this project was to study the amount of microplastic litter arriving at the Central Wastewater Treatment Plant (WWTP) of St. Petersburg and the effect of the purification process. The study was performed in co-operation with HSY and Vodokanal of St. Petersburg. The procedures and methodology for studying microplastics in wastewaters were presented to Vodokanal employees for Vodokanal of St. Petersburg to continue microplastic research independently. In addition, all of the equipment acquired for this study was left in the possession of Vodokanal.

The amount of microplastic was studied by sampling the wastewater at the beginning of the process and during and after the purification process. In the sampling process, water was filtered through different mesh-sized filters using a specific filter device. All samples were inspected under a light microscope and microplastics were identified and counted. The methodology has been successfully used in a pilot study at Viikinmäki WWTP (in 2012 and 2013).

The results of this study show that the WWTPs may operate as a point source of microplastic litter into the aquatic environment. However, the reduction of the microplastic load is also remarkable in scale. Due to the preliminary status of this project, results gained in this study are only indicative. In order to evaluate the actual role of WWTPs on the total microplastic load of the marine environment, a more detailed investigation is needed into the amount and types of microplastic litter in wastewaters and in natural waters. Furthermore, extensive studies of other possible sources are needed.

MSc theses and other theses related to microplastics

The presence of microplastics in the benthic fauna of Helsinki

Start year: 2017

End year: 2018

Person in charge: Anna-Riina Mustonen (SYKE, HY)

Other persons: Maiju Lehtiniemi (SYKE), Outi Setälä (SYKE)

Financiers: Finland ministry of Environment, Nottbeck foundation

Partners: Emil Vahtera, Marjut Räsänen (City of Helsinki Environment Centre)

The study shows how many microplastics occur in invertebrate organisms of soft bases. Samples will be collected from the Helsinki water area during the summer of 2017. The work is related to a study carried out by the City of Helsinki Environment Center in 2017 on harmful substances in benthic fauna and sediments. The work is part of the Meriroska project funded by the Ministry of Environment. The work provides valuable information on the amount of microplastics and plastic-related harmful substances in benthic organisms.

The presence of microplastics in coastal fish in Finland

Start year: 2017

End year: 2018

Person in charge: Erika Zidbeck (SYKE, HY)

Other persons: Maiju Lehtiniemi (SYKE), Outi Setälä (SYKE), Anna-Riina Mustonen (SYKE)

Financiers: European Maritime and Fisheries Fund (EMFF), Academy of Finland

The work is related to two research projects of the Finnish Environment Institute (RoskatPois! and MIF), which investigate the occurrence of microlitter and their possible disadvantages in Finnish territorial waters.

The purpose of the work is to produce national information on the behavior of microscopic plastic litter in the aquatic environment, and to identify the disadvantages to fish and, possibly, to humans.

Microplastics in Northern Baltic Sea bivalves

Start year: 2016

End year: 2017

Person in charge: Saana Railo (SYKE, HY)

Other persons: Julia Talvitie (Aalto University), Maiju Lehtiniemi (SYKE), Outi Setälä (SYKE)

Financiers: Walter and Andrée de Nottbeck Foundation, Maj and Tor Nessling Foundation

Partners: Aalto University, University of Eastern Finland

The aim of the MSc thesis is to investigate the microplastic contents of wild *Mytilus trossulus* and *Macoma balthica* found in the Baltic Sea. The work is carried out jointly at the University of Helsinki and the Finnish Environment Institute SYKE.

Snow as a storage and transporter for small plastic litter

Start year: 2016

End year: 2017

Person in charge: Kaisa Pikkarainen (HY)

Financiers: University of Helsinki and HELEN ltd

The snow that is poured into the sea can act as a route of plastics to waterways. Kaisa Pikkarainen from University of Helsinki studies in her master's thesis how snow works as a route for litter to the sea. The research questions are how much snow collected from different types of urban areas contains litter and whether there are differences in the amount and properties of the litter.

Microplastics and Harmful Substances in Urban Runoffs and Landfill Leachates - Possible Emission Sources to Marine Environment

Person in charge: Juho Kilponen (Lahti University of Applied Sciences)

Year: 2016

Partners: SYKE

Available at: <http://urn.fi/URN:NBN:fi:amk-2016061713159>

A B S T R A C T

Knowledge and studies on the occurrence of microplastics and certain harmful substances in urban runoffs and landfill leachates is still scarce. The aim of this pilot study was to estimate the simultaneous occurrence of plastics and plastic related pollutants in urban runoffs and leachates in an old and closed landfill located close to the shoreline. In addition, the role of urban runoffs and landfill leachates as an emission source to marine environment was estimated. Samples were taken from two locations in western Helsinki in December 2015 and in April 2016. The first sampling point represented urban runoff alone and the second sampling point mainly leachates from a former landfill. The urban runoff and leachates are discharged directly into the environment. Microplastics as well as certain PAHs, PCBs, phthalates, PBDEs and PFASs were analyzed from these samples. Microplastics and harmful substances were detected in all the samples. Considering microplastics, fibres were found more in the urban runoff samples than in the Mätäjoki brook next to the former landfill, where, on the other hand, the concentration of synthetic particles was higher. The former landfill turned out as a source of PAHs, PCBs and PFASs to the environment, whereas PBDEs and phthalates were detected with higher concentrations in the Mätäjoki brook. The amount of organic and solid material may affect on the concentrations of certain substances of lower water solubility especially in the runoffs. Moreover, the influence of heavy rain especially to the concentrations of leachates can be significant. Certain PAH compounds exceeded certain limit values in the urban runoff of Haaga and the Mätäjoki brook next to the former landfill.

International projects

MARLIN – Baltic Marine Litter

Start year: 2011

End year: 2013

Financiers: EU Interreg IVA Central Baltic, Stiftelsen Håll Sverige Rent, Keep the Archipelago Tidy Association

Responsible party: Håll Sverige Rent

Partners: Keep the Archipelago Tidy Association, Hoia Eesti Merd Virosta, Fee Latvia

The aim of Baltic Marine Litter Project MARLIN was to increase the knowledge of marine litter in the Baltic Sea by introducing a harmonised monitoring method in combination with opinion building activities to raise awareness of marine litter among the public and policy makers. For the very first time a comprehensive and comparable picture of litter in the Baltic Sea is presented. 23 reference beaches in Sweden, Finland, Estonia and Latvia has been identified and monitored during two years (138 assessments). The amounts of litter range from 75,5 items/100 m at rural beaches to 236,6 items/100 m at urban beaches. Cigarette butts are counted separately and is the most common type of litter with 301,9 cigarette butts/100 m at urban beaches. Plastic accounts for 62% of the litter at urban beaches and 54% at rural beaches. The most common type of litter, except from cigarette butts, is unidentified pieces of plastic, meaning broken down products from larger plastic items or items that doesn't fit under any other category in the protocols used. Other common litter items found at the top 10 list are glass fragments, plastic bottle caps and lids, plastic bags, foamed plastic, food containers and candy wrappers.

The main outcomes of MARLIN is the implementation of a monitoring method based on UNEP/IOC monitoring guidelines adapted for the Baltic Sea; a structure that involves local stakeholders in the actual monitoring; and an open database and quality control. In combination with opinion building activities MARLIN can provide a good starting point for future national and regional strategies for marine litter in the Baltic Sea such as the Marine Strategy Framework Directive and a HELCOM regional action plan that is supposed to be ready by 2015.

Publications

MARLIN 2013. Final Report of Baltic Marine Litter Project MARLIN – Litter Monitoring and awareness raising 2011-2013. Available at:
http://www.pidasaaristosiistina.fi/files/1994/Marlin_Final_Report_2014.pdf

HELCOM SPICE - Implementation and development of key components for the assessment of Status, Pressures and Impacts, and Social and Economic evaluation in the Baltic Sea marine region

Year: 2017

Responsible organisation: HELCOM

Partners: Finnish Environment Institute (SYKE), Swedish Agency for Marine and Water Management (SwAM), University of Tartu, Estonia (EMI), Polish Institute of Meteorology and Water Management (IMGW) and Stockholm Environment Institute Tallinn Centre, Sweden (SEI Tallinn)

Funding: HELCOM, EU

SPICE is a HELCOM coordinated project that is co-financed by the EU. The project is designed to contribute directly to the finalization of the 'Second HELCOM Holistic Assessment of Ecosystem Health in the Baltic Sea ' that is carried out by HELCOM through the HELCOM HOLAS II project. The assessment will cover the whole Baltic Sea marine region and will provide information on the overall environmental status of and pressures on the Baltic Sea as well as social and economic aspects that are linked to the status of the Sea and the human activities impacting upon it. The assessment is developed to follow-up the goals and objectives agreed by all coastal countries and EU in the HELCOM Baltic Sea Action Plan (BSAP) as well as to be used for the 2018 reporting

under the EU Marine Strategy Framework Directive (MSFD) as agreed by those Contracting Parties of the Helsinki Convention that are also EU Member States.

The SPICE project will specifically contribute to:

- Theme 1: finalizing and quality assure the thematic assessments on biodiversity, eutrophication, hazardous substances as well as pressures and impacts and support the final collation of data and the visual presentation of results,
- **Theme 2: developing marine litter indicators towards operationalization and prepare a proposal for the assessment of marine litter in the 2nd holistic assessment,**
- Theme 3: further developing and implementing the economic and social analyses at the Baltic Sea regional scale,
- Theme 4: developing guidelines for assessments of cumulative impacts and thresholds related to pelagic and seabed habitats.

Dedicated workshops will be organized for experts from HELCOM countries as well as other Regional Seas Conventions to take part in the development and testing of the project components.

The project will be carried out in 2017 by HELCOM and the five additional partners: Finnish Environment Institute (SYKE), Swedish Agency for Marine and Water Management (SwAM), University of Tartu, Estonia (EMI), Polish Institute of Meteorology and Water Management (IMGW) and Stockholm Environment Institute Tallinn Centre, Sweden (SEI Tallinn).

Micro litter in sewage treatment systems: A Nordic perspective on waste water treatment plants as pathways for microscopic anthropogenic particles to marine systems

Start year: 2014

End year: 2015

Responsible organisation: Nordic Council of Ministers, Nordic Council of Ministers Secretariat, Havgruppen (HAV)

Finnish participant: Outi Setälä, SYKE Marine research Center

Funding: the Marine Group (HAV) under the Nordic Council of Ministers

The aim of the project was to investigate the significance of effluent water from sewage treatment plants (STPs) as gateway for microliter and other microscopic anthropogenic particles (MAPs) to the marine and aquatic environment. Further, to investigate the occurrence of these particles both in the biotic and abiotic compartment of the receptor. STPs from Sweden, Finland and Iceland with different sewage treatment methods were included in the study. Different SPT treatments were chosen to investigate the importance of sewage treatments on microparticle retention in STPs.

Publications

Magnusson, K., Jörundsdóttir, H., Norén, F. Lloyd, H., Talvitie, J., Setälä, O. 2016. Micro litter in sewage treatment systems. A Nordic perspective on waste water treatment plants as pathways for microscopic anthropogenic particles to marine systems. TemaNord 2016:510. <http://dx.doi.org/10.6027/TN2016-510>

ABSTRACT

The report presents results from a study on the role municipal sewage treatment plants (STPs) have as entrance routes for microplastics and other microlitter particles to the marine environment. Microlitter concentrations were analysed in waste water before and after treatment in the STPs, and in the recipient waters where the treated waste water is discharged. Municipal waste water was found to contain a substantial amount of microlitter, but in STPs equipped with chemical and biological treatment most of the litter particles were retained in the sewage sludge. This reduces the impact on the recipient water, but if the sludge is used as fertilizer on farm land the microlitter will still reach the environment. Efforts to reduce the microlitter concentrations should therefore preferably be done in households and other locations where the waste water is originally being formed.

Defining the baselines and standards for microplastics analyses in European waters (BASEMAN)

Start year: 2016

End year: 2018

Project coordinator: Gunnar Gerdts, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

Finnish participant: Outi Setälä, Finnish Environment Institute (SYKE)

Web page: <http://www.jpi-oceans.eu/baseman/main-page>

Although microplastics are recognized as an emerging contaminant in the environment, currently neither sampling, extraction, purification nor identification approaches are standardised, making the increasing numbers of microplastics studies hardly -if at all- comparable. BASEMAN is an interdisciplinary and international collaborative research project that aims to overcome this problem. BASEMAN teams experienced scientists (from different disciplines and countries) to undertake a profound and detailed comparison and evaluation of all approaches from sampling to Identification of microplastics

BASEMAN's project outcomes will equip policy makers with the tools and operational measures required to describe the abundance and distribution of microplastics in the environment. Such tools will permit evaluation of member state compliance with existing and future monitoring requirements.

MARELITT Baltic

Start year: 2016

End year: 2019

Responsible organisations: SWEDEN: Simrishamn municipality (Leader), KeepSwedenTidy, ESTONIA: Keepthe Estonian Sea Tidy, Estonian Divers Association, GERMANY: WWF Germany, POLAND: WWF Poland, Maritime University in Szczecin, Kołobrzeg Fish Producers Association, Institute of Logistics and Warehousing
Outside Marelitt budget: FINLAND: SYKE (Finnish Environmental Institute) – if gets financing

Web page: <http://www.marelitt.eu/?s=16&sub=33>

MARELITT Baltic project's focus is to reduce the impact of marine litter in the form of derelict fishing gear in the Baltic Sea. Derelict fishing gear, often referred to as "ghost nets", is a global issue but not many are aware of the problem and its consequences. MARELITT Baltic is the first transnational initiative working specifically with the problem and will result in far-reaching proposals for minimizing the problem and an enhanced international readiness to act.

Other international reports

Blidberg E., Bekken A. L., Bäckström A., Haaksi H., Hansen L. M., Skogen M. H., Lembrecht Frandsen B., Thernström T., Ångström J. 2015. Marine Littering and Sources in Nordic Waters. Nordic Council of Ministers 2015.

SUMMARY

Marine litter is a global environmental problem that endangers sensitive marine ecosystems and wildlife. It also has major socio-economic and aesthetic impact and is strongly connected to a sustainable society. Most marine litter consists of plastic material and it is generally accepted that 80% of marine litter comes from land-based sources. Identifying these sources is an important key to proposing cost-effective measures. The background to this project is a joint interest by Nordic NGOs to collaborate and expand upon their current activities e.g. clean-up campaigns and monitoring of beach litter. A model for litter categorisation from a product perspective is introduced in order to identify targeted measures to reduce marine litter.

The pilot studies in the project are based on pick analyses of litter items collected during clean-up campaigns or in connection with beach litter monitoring. The results confirm that the most common types of litter found on beaches in all Nordic countries are made of plastic and polystyrene. Short-life items and packaging were the most common product types, strongly linking littering to individual consumers, although it should be noted that the litter can originate far beyond the borders of the Nordic countries. Consequently, marine litter is largely a product of modern production and consumption. By contrast, litter from the beach studied in Norway had a higher proportion of industrial packaging from, for instance, the fishing and agricultural sectors, as well as packaging related to the transport of goods.

The project has shown that it is feasible to obtain further information on litter items from both monitoring surveys and beach cleanups. To ensure high quality data, information from monitoring surveys is preferable but the statistical basis may become less. NGOs and grassroots level organisations have an important role in the collection, analysis and storage of such information. Measures relating to policy targets for waste recycling are discussed along with the proposed changes to the Waste Framework Directive. Producers are charged with greater responsibility and expected to support prevention and clean-up initiatives financially. Suggested goals include a 30% reduction in the ten most common beach litter items and fishing industry waste found at sea by 2020. It is concluded that the plastics and packaging industry has an important role in this context. Raising public awareness by arranging beach litter clean-up events is further suggested as an important measure in the reduction of marine litter.

Even if the regional action plans in HELCOM and OSPAR support cooperation between riparian states, it would be beneficial if the Nordic countries could continue to share data. This includes identification of both litter composition and origin, for the dissemination and sharing of national knowledge and experience. Other measures include cooperation around clean-up activities, e.g. by arranging a Nordic Beach cleanup

day. In this way, Nordic NGOs can be even more successful in their work against marine litter.

UNEP, 2016. Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change. United Nations Environment Programme, Nairobi. Available at: <https://wedocs.unep.org/rest/bitstreams/11700/retrieve>.

The report presents both short- and long-term approaches to the problem of marine plastic debris and microplastics. It provides an overview of the latest science and experiences, identifies priority areas of action, and points out areas requiring more research. The report is accompanied by a stand-alone set of policy recommendations. They are intended to guide decision makers to take action that can be adapted to different local, national, regional and global contexts. The report is divided into four main sections: Background, Evidence Base, Taking Action, and Conclusions and Key Research Needs.