

GUIDELINE:

How Municipalities Can Reduce the Use of Single-Use Plastics on a Local Level



Contents

Introduction to “Plastic Free Ocean”	3
About this Guideline.....	3
1 REUSABLE SOLUTIONS for Restaurants and Events	4
2 Enhancing NO-WASTE SOLUTIONS in the Daily Routine.....	7
3 Reducing CIGARETTE BUTTS.....	10
4 Reducing the Risk of Public FIREWORKS.....	13
5 The Threat of BALLOONS	15
6 Dog Waste BAGS.....	16
7 WASTE MANAGEMENT by the beach.....	17
8 CERTIFICATES and LABELS	19
9 Sustainable PUBLIC PROCUREMENT.....	21
10 AWARENESS Raising.....	22
11 Facilitating CLEAN-UP Events and Activities	25
REFERENCES.....	27

Coalition Clean Baltic

Address: Östra Ågatan 53, 753 22 Uppsala, Sweden

E-mail: secretariat@ccb.se

www.ccb.se



© Coalition Clean Baltic 2020

Researched and written by Isabelle Maus, Bund für Umwelt und Naturschutz Deutschland e.V. (BUND) - Friends of the Earth Germany, for Coalition Clean Baltic (CCB). Based on a Guideline developed by the subworking group on local provisions and BUND, published by the German Round Table for Marine Litter. The guide can be downloaded here: <https://www.muell-im-meer.de/Kommunen-Best-Practice>



With the contribution of the LIFE financial instrument of the European Community and the Swedish Postcode Foundation. The content of this document is the sole responsibility of CCB and can in no way be taken to reflect the views of the funders.

INTRODUCTION TO “PLASTIC FREE OCEAN”

Hazardous substances and marine litter, including micro plastics contamination, represent one of the top-three main threats (after eutrophication) to the Baltic Sea environment and marine life.¹ Different kinds of plastic, large and small, are present in the Baltic Sea although the problem is in parts smaller than in other sea areas because of limited tide and currents. Up to 80% of marine litter sources are estimated to be land-based due to: poor waste management in households, inadequate waste infrastructure, lack of or inadequate water treatment plants, dumping of industrial waste and littering from coastal cities and coastal tourism.²



CCB recognises a strong need for further knowledge and experience on that matter and fully supports a calling on an EU-wide ban of micro plastics added to consumer products in order to prevent pollution of the marine environment. According to UNEP³ expectations, plastic production was projected to increase by up to 40 per cent over the next 10 years, which made achieving a significant reduction in marine pollution by the year 2025, as reflected in the [Sustainable Development Goal 14](#), seem as distant as never before.

In 2017, CCB has implemented the project “[Plastic Free Baltic](#)”, which has significantly contributed to lifting up the agenda of microplastic and marine litter pollution in the Baltic Sea region, including the upstream catchment area.

In 2019, CCB started implementing a new project: “[Plastic Free Ocean](#)“. The project activities support the implementation of the EU Plastics Strategy and addresses the growing pollution in the Baltic Sea (and thereby – the world ocean) by single-use plastic items, primary and secondary microplastics and associated toxic chemicals through a combination of:

- policy-oriented measures
- awareness-raising public campaigns
- monitoring activities
- assistance to identified target groups ranging from the private to the municipal sector in switching to plastic-free alternatives (e.g. hotels, rural and eco-tourism houses, airlines, cruise ships, municipal organizations, public laundries, religious organizations and others).

ABOUT THIS GUIDELINE

This Guidebook forms part of the project’s outcomes and offers a total of 35 options of action including 65 best-practice examples on 11 topics for municipalities and other local actors on how to reduce the use of single-use plastic, which could therefore reduce the pollution of the Baltic Sea.

Each chapter focuses on a specific litter item commonly found on the beaches of the Baltic Sea or bearing a great threat to end up in the rivers and later on in the ocean. Every chapter offers a short introduction into the issue and a few facts, giving an overview on the extent of littering. The second part of each chapter summarizes the fields of action shortly describing the options of action to reduce the amount of plastic waste. Finally, the most interesting part consists of a collection of best practice examples on successful local projects, campaigns and strategies on reducing the use of single use plastic and thereby the amount of waste. These examples have not only been implemented by the local municipalities but could be adopted by them and therefore inspire all local actors.

1 REUSABLE SOLUTIONS for Restaurants and Events

Cups, dishes, drinking straws, cutlery and take-away packaging made of single-use plastic are easy to handle and therefore found in many restaurants, fast food chains, bakeries and other shops or at events. Especially in the seasonal gastronomy on the beaches, these items come in handy because of the often-missing water and wastewater connections. After an average use of 15 minutes, the single-use cups usually end up in garbage bins at the roadside or railway stations.⁴ These bins are rarely properly equipped for waste separation and therefore the waste mainly won't be recycled. Valuable resources such as wood and plastic as well as water and energy are used for the production of these disposable cups that due to hygiene reasons mostly consist of fresh paper fibre with a thin plastic layer of polyethylene on the inside. Unfortunately, recycled paper can generally not be reused in the food industry. Additionally, the plastic lids of to-go cups are usually made of polystyrene. The common disposable cups for cold drinks are primarily made of fossil plastic. Typical types of plastics here are polypropylene (PP), polystyrene (PS) and polyethylene terephthalate (PET).

Especially on urban beaches around the Baltic Sea the most common litter items found are drinking related items such as cups, caps and lids made of plastic.¹ But also on rural beaches these items come in third of the most frequent litter items.

Options of Action:

- **Return-and-refill-system and Reusable Alternatives**

Implementation of a return-and-reuse system for food and drink containers. Municipalities can enhance such an implementation by issuing a public call for tender for a system operator or issuing a recommended action addressed to restaurants and cafés.

- **Municipal Requirements**

Municipalities can formulate requirements on the use of reusable solutions during public events or on public grounds and adopt respective requirements as a municipal by law.

- **User Contract**

When issuing user contracts a clause prohibiting single-use plastics or stipulating reusable solutions can be included.

Best Practice Examples



CUPFORCUP

Cup for Cup is an open return-reuse system for coffee-to-go.

They offer solutions for business caterings, initiatives and festivals or municipalities and communities to reduce single-use coffee cups with a reusable and refillable cup.

Many bars and restaurants on the coast of the North Sea have changed from disposable drinking straws to reusable options. Some restaurants use engraved and reusable metal straws that can also be bought as souvenirs. Other owners use paper or "pasta" straws.



© My cup. Please RU

[My cup, Please](#) (St.Petersburg, Russia)

A movement that was born in Belarus and is now spreading across Russia. The initiative brings together coffee-to-go places in the city that promote bringing the own coffee cups. Many cafés offer a 10% discount or bonus as an incentive for the customers. There are already about 1,500 such places participating in Russia.

The German company [Recup](#) has implemented a countrywide share system for reusable cups. The cups are handed out in exchange for a deposit and can be returned in any other participating shop or restaurant where the deposit is then refunded.



© reCup GmbH

The [Packbuddy](#) campaign from Bremen, Germany, promotes bringing your own containers or cups from home when buying take-away food and drinks. Caterers who participate in the campaign label their establishment with a sticker to show customers that they refill BYO.



©Packbuddy



© reCIRCLE Deutschland / Elithero UG

[ReCircle from Switzerland](#) offers a deposit system for restaurants or grocery stores with reusable packaging for “Food-To-Go”. The system with the reusable boxes has been adopted in several countries, such as [Germany](#), [France](#), [Belgium](#), [Czech Republic](#) or [Dublin](#).

The Rostock & Warnemünde Tourist Centre will offer and test the [use of an industrial dishwasher](#) for interested beach gastronomers as part of the catering on the beach.

The § 2 of the Waste Regulations of the Hanseatic City of Rostock, refers to the avoidance of waste. The paragraph describes the exemplary role of the Hanseatic and University City of Rostock and demands the priority use of reusable tableware at events and in public spaces. If there is no possibility of waste water discharge (for example in the beach area), the use of biodegradable disposable tableware is permitted.



© Lisa Schill

The “[Spülbar](#)” is a mobile dishwashing station with an industrial dishwasher on a cargo bike. Students of the master’s degree Sustainability, Society and the Environment at the Christian-Albrechts-University of Kiel, Germany, designed the project, which made it possible to use reusable coffee cups and plates at the local farmers market. The required water for the dishwasher is provided from portable canisters, which allows a mobile and autonomous use of the “Spülbar” without any restrictions. The Kiel waste management company had sponsored 100 coffee cups for the project. Therefore, the project includes its own coffee cups but also offers to wash the returnable cups of participating market stalls.

NGO “Environmental Protection Club of Latvia” (“VAK”) implemented a campaign in Jurmala city «[Whatever you buy or taste, make no waste](#)» as pilot project for service providers caterers, merchants and tourist information centers. The aim of campaign was to encourage to reduce single-use products and promote environmentally friendly habits. By participating in the campaign, the merchant (cafe, shop, museum) placed the campaign materials on its site, informed its employees and its clients about the principles of environmentally friendly behavior in the context of their activities.

The idea of introducing deposit system for plastic glasses was supported by most of Jurmala cafeterias which were interviewed.

Some German municipalities have actively promoted the introduction of a returnable cup deposit system and supported it in various ways:

- The Hanseatic City of Greifswald spurred the introduction of a deposit cup system by paying the system fee for participating partners for a one-year test period. This made Greifswald a pioneer throughout Germany.

- The city of Hamburg had set itself the goal of introducing a city-wide returnable cup system in 2018 and was looking for a private operator. Companies were invited to submit their concept for a privately supported deposit-based cup system in a public tender. The start-up financing was a one-time payment of up to 30,000 euros. Important application criteria were, in addition to long-term economical operation, ecological and functional aspects.

- With the campaign “Refill instead of throwing away”, the Hanseatic and university city of Rostock calls on the locals and tourists to avoid waste and to make the city cleaner. For example, school canteens and the Rostock sailing club RSC 92 were equipped with reusable cups. The Rostock tram operator has also received 100 returnable cups from the city administration for the drivers in order to avoid disposable cups here too.

The Ministry of the Environment of Schleswig-Holstein tried to set incentives for the acceptance of reusable coffee cups. With a “[Recommendation for the filling of reusable containers with hot drinks in accordance with hygienic standards in bakeries, coffee houses, service areas and service providers in company catering](#)”, the government clearly advocates the simple use of reusable containers and provides clear instructions for the correct handling to entrepreneurs. With the publication, doubts and barriers on the correct handling can be reduced.

[Vilnius](#) bans plastic tableware in city festivities: Single-use plastic tableware will no longer be used during public festivities in Vilnius, the local council decided in the beginning of 2020. The amendment was initiated by Lukas Savickas, a representative of the opposition Lithuanian Farmers and Greens Union on the Vilnius Council and an adviser to Prime Minister Saulius Skvernelis

2 Enhancing NO-WASTE SOLUTIONS in the Daily Routine

In Germany, 18.7 million tonnes of waste were generated by packaging in 2017.⁵ The largest share, at around 8.3 million tonnes (44%), consist of packaging made of paper, cardboard or paperboard, followed by packaging made of wood (18%), plastics (3.1 million tonnes equal to 17 %) and glass (15%). Statistically every German produced an average of 37 kg of waste from plastic packaging in that same year. In Finland, 2012 10% of the country's waste composition consisted of plastic.⁶ In Poland the percentage of the plastic fraction in the country's waste composition was at 14,7 % and about 9% in Lithuania, but it accounted for 18.6% of the total waste in Latvia and 18.8% in Estonia. The percentage of the paper/cardboard fraction in the country's waste composition was even higher. For some of these packaging materials, manufacturers have to pay for the recollection and recycling through e.g. the dual systems (in Germany) or any other system of circular waste economy. Although recycling quotas might be in place, a big part of the waste still ends up in the environment and as a final sink in the oceans. There are already many alternatives to plastic packaging in particular, which bear a big potential for the reduction of plastic waste.

End consumers have generated almost half of all packaging waste in the private sector throughout the recent years. Fruit and vegetables are increasingly being sold packaged. However, this does not have to be the case. Unpackaged shopping enables consumers to portion the required food themselves. In addition, the self-dosed quantities promote needs-based shopping to reduce food waste at the same time. Purchasing, for example from farms or at farmers markets, supports this consumer behaviour and at the same time enables plastic-free shopping to protect the oceans.

Options of Action:

- **Retail Sector**

Municipalities can encourage local retailers to offer a broader segment of unpacked products and groceries or promote the establishment of zero-waste-shops and alternatives.

- **Fruit and Vegetable**

Most fresh produce, biological or conventional, are offered prepacked in stores. Municipalities can demand for more unpacked fruit and vegetables at local retailers and promote alternatives to industry packaging in the supply chain. Further subsidies for local and organic farmers can be included.

- **Deli Counter**

At the deli counter produce such as cheese, meat, antipasti or salads, are freshly packed. During this process, certain hygiene rules have to be met. By issuing detailed recommendations and guiding on the handling of reusable containers and packaging, the municipality can encourage entrepreneurs and customers either to implement an overall return-reuse system or to refill brought along containers of their customers.

- **Zero-Waste-Lifestyle**

Focussing on PR and events on how to reduce waste and single-use plastics in the everyday life. See also [chapter 10](#).

- **Tap Water**

Municipalities can enhance the infrastructure for an open access to tap water by installing public water fountains. Thereby the option to refill water bottles becomes easier and reduces single-use bottles.

Best Practice Examples



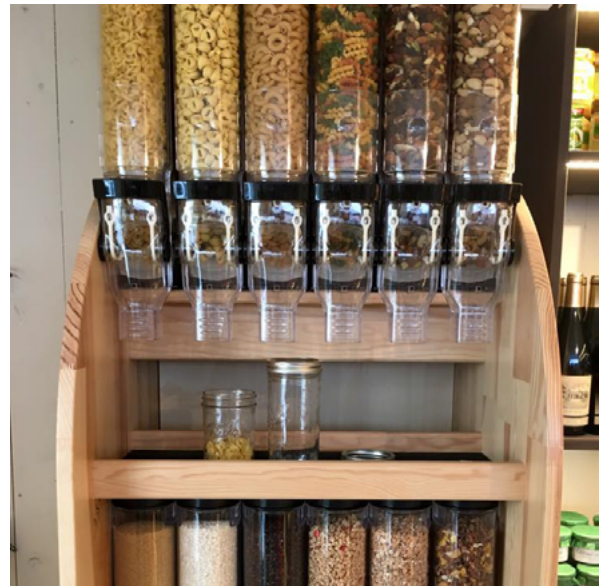
© BUND Germany

At many weekly or farmers' markets you can buy plastic-free produce. The food can be filled into containers or bottles that you have brought along. Often you can find herbs wrapped in paper or dairy products in reusable deposit jars. In addition, the fruit and vegetables can be packed loosely and directly into your own bag or net.

Official guidelines and trainings on how to correctly handle reusable/refillable containers and cups of customers in food services.

At the beginning of the Corona Pandemic in March 2020 the German Food Association has issued a short [Guide](#) on the correct handling of "Bring Your Own"-Containers. With an additional explanatory [video](#) they want to encourage restaurants and farmers/supermarkets to accept and refill their customers' boxes and cups.

Zero Waste Shops or segments at common Supermarkets allow customers to bring their own containers and boxes to fill at the store.



© BUND Föhr

[No Plastic Challenge 2019!](#) Was a challenge organized by Estonian Green Movement as a part of Plastic Free Ocean Project. The challenge aimed to educate participants on different topics around plastic and how to fade it out of their life. During the period of 22. November to 1. December 2019, the participants could discuss different topics about plastic and also propose challenges to take on on Facebook.

"[a tip: tap](#)" is a non-profit organization that campaigns against plastic bottles and promotes tap water. Within the framework of various projects, the association carries out educational work on the quality of drinking water, advises companies and creates public "drinking places". Following the successful pilot project "Wasserkiez" in Berlin, the project is now being continued in twelve water districts throughout Germany under the title "Wasserwende"

[Refill](#) is a non-profit organisation that is concerned with the reduction of plastic waste. Shops, restaurants or offices can use the “Refill-Station” sticker to indicate that they refill drinking bottles with tap water free of charge. All participants can be found online on an interactive map.



© Refill Deutschland

[Bag swap station](#) at supermarkets: You can leave your multi-use shopping bags at the counter of a store and customers who forgot to bring their own bag can take one from the collection

In 2018 the Gymnasium No. 19 in Minsk decided to abandon plastic as much as possible. In the new school year, [coolers with drinking water](#) connected to the central water supply system appeared in the gymnasium. So, they abandoned bottled water. Maintenance of the cooler does not require plastic containers; you only need to periodically change the filters. In total, 11 coolers with drinking water were delivered to the gymnasium; there are enough of them for 730 students and 70 teachers. Buying coolers requires a lot of initial investment, but, they hope, the system will pay off quickly, and most importantly - it is an environmentally friendly alternative to bottled water.



© Refill/Наполним заново

[Refill/Наполним заново](#) (St.Petersburg, Russia)

A community of sustainable small business (catering Places, shops, etc) that promote reduction of single-use plastics and pour water into own bottles for free. All the points of Refill can be found on [google-maps](#). It works also in Archangelsk and Severodvinsk cities in West-North Russia.

Belarus will officially allow to buy food in “Bring Your Own”-Containers. The right to purchase food in consumers’ containers will be enshrined in law. The Ministry of Health is now working on [updating the sanitary and epidemiological requirements](#) for retail facilities. Updated documents will allow to sell food products in customers’ containers.

In September 2019, Minsk hosted the presentation of Bea Johnson’s [book “Zero Waste Home”](#). The book was first translated and published in Russian thanks to the efforts of Greenpeace Russia and the publishing house Potpourri. Information on zero waste initiatives and projects that operate in the country has been added to copies sold in Belarus - the Center for Environmental Solutions was responsible for this part.

3 Reducing CIGARETTE BUTTS

In Germany alone, around 106 billion cigarettes are smoked annually.⁷ According to the World Health Organization, two-thirds of all cigarette butts are not disposed of properly. Worldwide, this corresponds to about 4.5 trillion cigarettes per year.⁸ The consequences are visible everywhere: Both, on urban beaches as well as on peri-urban beaches cigarette butts rank on the third place with regards to the ten most frequent items found at the Baltic Sea.¹ Looking at urban beaches, cigarette butts rank at the seventh place. These results are based on monitoring data from Denmark, Estonia, Finland, Germany, Lithuania, Poland and Sweden summarized by HELCOM.

In addition to that, also the cigarette packs belong to the top ten litter items according to their presence identified on all beach types in the Baltic combined. Throwing cigarette butts on the street seems to be socially accepted - to an extent that would hardly be conceivable with other types of waste. The distance from the road to the river and then to the sea is only a short one. The effects cigarette butts have on the sea are devastating and durable because they contain an essential and dangerous component: the filter. On the one hand, the filters are supposed to capture the up to 7,000 toxins of a cigarette of which 50 are proven to be carcinogenic substances.⁹ If the smoked cigarette butts get in contact with water, e.g. half of the nicotine is released into the water after only half an hour. Just one used cigarette filter can thereby contaminate up to 1,000 litres of water already causing damageable effects on small aquatic animals, such as water fleas.¹⁰ On the other hand, conventional filters are not made of paper, as often assumed, but of cellulose acetate. This nonflammable thermoplastic polymer made by acetylating cellulose, is used as the basis of artificial fibers and plastic mainly for cigarette filters. The material defibers easily in the environment and becomes microplastic. In 2018, microplastic particles of this material were even found in the Arctic sea ice.⁹

Options of Action:

- **Public Ashtrays**

Increasing the availability of public ashtrays or waste bins to facilitate the correct discharge of used cigarette butts.

- **Portable Ashtrays**

Giving out free portable ashtrays (with the option of including a refund system) as an interim solution until the next ashtray or bin comes in reach. The old cigarette butts can later be discharged at the next ashtray or bin.

- **Awareness Raising**

Campaigns and events help to raise awareness on the toxicity of cigarettes butts and their threat to the environment. They should reduce the social acceptance of recklessly throwing away cigarettes and induce a change in behaviour.

Best Practice Examples

Cone-shaped, biodegradable ashtrays were placed on 10 of [Larnaka](#) (Cyprus) region's most popular beaches as an alternative to disposing of cigarette ends in the sand, along with steel bins and full instructions on how to use them.

At the end of the season, the collected cigarette ends were counted and we were delighted to find that an astounding 84,300 cigarette ends (weighing a whopping 42.15 kg in total) were disposed of in the specially provided bins during June, July and August 2017.



© Lanarka Tourism Board

The City of [Nice](#), France, will be giving away 20,000 beach ashtrays during the months of July and August. The initiative will take place between the beaches of Castel and Carras, but also on those of Reserve and along the coastal path.

In addition, 270 ashtrays have already been installed on the south trottoir of the famous Promenade des Anglais at each beach entrance. Furthermore, a team composed of two cleanliness mediators and four seasonal cleaners will be raising awareness for the pollution with cigarette butts.

The [Postcard Beach Ashtray](#) from boodi provides a new way to advertise to people on beaches, whilst simultaneously preventing cigarette litter. It is two products in one - a Promotional Postcard and an effective Beach Ashtray.



© boodi eco litter solutions

[Pocketbox.ch](#) offers smokers in Switzerland to order free pocket ashtrays for their own use or for larger groups and events. On the initiative of British American Tobacco Switzerland SA, attention is thus drawn to the environmental problem of litter from cigarette butts. There is a regular cooperation with cities and authorities.



© British American Tobacco Switzerland SA

[Tobacycle](#) offers a collection system consisting of pocket ashtrays, larger buckets and bins for cigarette butts, which are then completely recycled - including ashes and toxins. A granulate is obtained from the waste which is then used to make new collection and storage containers. This creates a closed cycle of recyclable materials. In cooperation with smokers, companies, restaurants or cities and communities, awareness on the problem is raised.



© TobaCycle n.e.V.

In 2009 beach sections on the island of Rügen, Germany, were declared as [non-smoking beaches](#) for the first time. The Kurverwaltung (spa administration) of the [Baltic resort Göhren](#) works in close cooperation with the beach chair rental companies, who kindly point out the cigarette ban or distribute beach ashtrays on beaches without a smoking ban.



© EUCC-Office

Public Ashtrays as [Ballot bins \(UK\)](#).

The [Baltic Sea Ashtray](#) to combat the most frequent waste on the beaches of Warnemünde, Germany. The pilot project of the Küsten Union Deutschland e.V. (EUCC-D) and the Rostock and Warnemünde Tourist Office encourages smokers to put their cigarette butts in funny ashtrays at the beach access points. For this purpose, the possibility to “vote” with the cigarette butts encourages the beach visitors to dispose of their cigarettes properly. The ashtrays are headed with a question such as “Which soccer team plays better?” and there are two windows each for one possible answer. The questions are exchanged regularly and the public can even submit their suggestions online on the marine waste portal.



© Balticum-Verlag

In Neustadt, Germany, on the Baltic Sea, the [tourism service](#) and the [city marketing department](#) were also given six of these [ballot bins for cigarettes on the beach](#) and in the city centre. In addition, 15,000 portable beach ashtrays were distributed to visitors by the beach guard and the DLRG in the 2019 season.

4 Reducing the Risk of Public FIREWORKS

Fireworks in general and especially on New Year's Eve cause huge amounts of garbage. According to the German Federal Environment Agency, fireworks consist of 60 to 75 percent of casings, construction parts and packaging, for which cardboard, wood, clay and plastic are used.¹¹ These materials with residues of the pyrotechnic components often end up in the environment after ignition. In Germany, this generates 30 to 40 thousand tons of waste every year.

Furthermore, the explosion of the fireworks leads to a wide distribution of the packaging residues and plastic parts in an uncontrollable manner. Particularly in coastal regions, New Year's Eve waste thus ends up directly in the sea or on the beaches.

While the plastic waste remains in the environment for an indefinite period of time, substances such as black powder, made of potassium nitrate, charcoal and sulphur, or strontium, copper and barium compounds are gradually flushed out. The substances then enter the soil and groundwater via melt water or rainwater.

Options of Action:

- **Bans**

Municipalities can impose a general ban on fireworks in areas close to waters, in immediate distance to nature reserves and other protected areas. Heavy fines in case of violation can be included.

- **Central Firework**

As an alternative to several uncontrollable private fireworks, municipalities can offer a centrally organized firework and thereby ensure the safe distance to waters and concentrate the resulting pollution.

- **Clean-Up**

Organizing clean-up events on "New Year" can prevent the waste to spread while at the same time raising knowledge and awareness on the risks of fireworks.

Best Practice Examples

On the island of Usedom in the baltic sea, the three health and sea resorts "[Kaiserbäder](#)" of Ahlbeck, Heringsdorf and Bansin have had fireworks-free beach sections since New Year's Eve 2018. After 97 percent of the participants in an online survey agreed on not having private fireworks, the municipal council cleared the way for the project. A local advertising agency was responsible for marking the sections. The fireworks-free sections were very well received.

...

...

In addition, the beach visitors are motivated to dispose of their rubbish in the containers provided on New Year's Eve. For every kilogram of garbage in the bins on New Year's Eve, the Kaiserbäder company promised to donate 50 cents to the project "Oceans without plastic". Experience shows that about five tons of waste are collected at that night.

The National Park Administration of Schleswig-Holstein, Germany, developed a [guideline](#) for public presenters of fireworks together with the nature conservation authorities of the districts of North Frisia and Dithmarschen. Together they want to draw the organisers' attention to the effects on wildlife and protected areas. The information ranges from nature conservation requirements for planning to the approval and implementation of corresponding events.

For the city of Bremerhaven, Germany, a ban on firecrackers around the zoo at the seaside and on the dykes along the Weser was imposed for the first time in 2017. The Explosives Act is supplemented for certain areas by a general ruling of the Bremen Trade Supervisory Office. To protect the animals, it applies to a radius of 150 metres around the zoo grounds. Due to its direct location on the Weser River, the ban also prevents the waste from ending up in the river. The harbour areas as well as clinics, dormitories and churches are also among the prohibited areas. The city warns of controls and imposes a fine of up to 10,000 euros in case of violations.

Laser and light shows can serve as an alternative to fireworks. For example, the noise pollution can be reduced by technical aids for musical accompaniment as well as the amount of waste can be minimized. In this context, it is important to be considerate of nature and to avoid high and glaring, especially flashy light effects. Light sources, such as lasers and spotlights, should not be directed into protected areas and the sky. Energy used for technology should also come from responsible resources. A general shift towards silent, clean "fireworks" is not yet in sight, but perhaps local authorities will be inspired by current and future technical possibilities.

5 The Threat of BALLOONS

For many kinds of celebration balloons are often released into the sky in large numbers without considering their ecological consequences. In some cases, postcards requesting a return are attached to balloons filled with helium. However, these cards rarely find their way back. Often the balloons or parts of them end up in the ocean instead. Here there is a danger that marine animals will ingest them as supposed food. According to ROMAN et al (2019), balloons pose the highest risk in this respect. An Australian research team examined 1733 sea birds.¹² 32.1% of all the animals studied had ingested plastic - the equivalent of 557 seabirds. Although balloons made up only 2% of the plastic waste found, the soft plastic, balloons are made of, seems to be the deadliest. A balloon is 32 times more likely to kill birds, as the soft plastic clogs the gastrointestinal tract and the air supply much more easily than hard plastic. That is what make them so deadly. Sea birds just as other marine animals often confuse the balloon pieces with squid. In addition to that, marine animals can get caught in the knotted cords. According to the calculations of the Convention on the Protection of the Marine Environment OSPAR, balloons account for only about 1.4 percent of the garbage particles, but still they are on the list of the 15 most frequently found garbage particles in the North Sea.

Options of Action:

- **Bans**

Municipalities can either ban the use and release of helium filled balloons on their public grounds or step back from the use of balloons on public occasions.

- **Taking a Strong Position**

Public institutions and event locations involved in occasions with a common use of balloons (e.g. weddings, birthdays) can take a clear position on the issue and inform their customers on the consequences.

Best Practice Examples

On the event of the light market in Elmshorn, Schleswig-Holstein, Germany, balloons with Christmas wishes from children were to be launched during a public event in 2018. Following protests by environmental groups such as BUND, the city cancelled the event. Instead, the organizers of the event let foam clouds rise into the sky in place of the balloons.

Depending on the occasion, various alternatives can be used instead of balloons. For festive occasions, such as weddings and birthdays, city festivals or big company anniversaries, an environmentally friendly greeting could be sent into the sky with soap bubbles. So-called "seed bombs" or paper with incorporated flower seeds can be used to celebrate the occasion by planting flowers. Here, however, attention should be paid to native species. For decoration purposes, reusable paper lanterns can be used instead of balloons. Pom-poms made of paper also follow the decorative image of balloons.

6 Dog Waste BAGS

There are currently almost eight million dogs registered in Germany only. This means that every day, about 16 million times dogs and their owners leave behind a certain “track” in the city or the environment. These piles of dog poo often cause annoyance among the citizens. For cities and municipalities, they mean a great deal of cleaning effort. For several years now, dog owners have been encouraged to collect the remains of their dogs and dispose of them in garbage cans. As a convenience, many communities set up so-called “dog toilets” along common walk paths, which include a dispenser with bags for the dog excrement and a trash can for the disposal of the used bags.

With the plastic bags, a new problem was thus brought to the agenda. According to estimates, more than 500 million of these disposable bags are used throughout Germany every year. However, by no means, not all of the plastic bags are disposed of in the bins provided for them at the roadsides, but end up in the environment along with their contents. The city cleaning service in Wilhelmshaven, Germany assumes that 20 percent of the excrement bags are thrown into the environment and ultimately end up at fences, in hedges along the roadside, canals or directly in the sea. In the end, the long-lasting bags remain there for many years.

Options of Action:

- **Alternatives**

Municipalities can promote the use of alternative materials, such as cardboard containers or colourful plastic bags that make the indiscrete discharge of such bags more visual.

- **Bag Dispenser and Bin**

The installation of more public dog toilets facilitates the correct disposal of the used bags.

- **Regulatory Measures**

Warnings and fines for improper disposal with active prosecution of administrative offences and fines.

- **Awareness Raising**

Campaigns and actions help to draw attention on the consequences for the environment.

Best Practice Examples

The [PooPick](#) consists of a high percentage of recycled paper, but is completely plastic-free and can be composted as a dog excrement bag. By a certain folding technique the paper bag fits into any pocket before use and is available in two sizes.

In 2018, the island community of Wangerooge has replaced plastic dog excrement bags with the paper “PooPick”. At the start the PooPick was distributed free of charge to all guests arriving on the island with dogs. Also at the dog beach free PooPick are given out along with the beach chairs to encourage the visitors of correct disposal. The more environmentally friendly alternative can be purchased at the tourist information for a small fee. Also in the online shop of PooPick island vacationers get a discount.



© Natelimar UG

7 WASTE MANAGEMENT by the beach

On every type of beach at the Baltic Sea area, you will come across rubbish left behind by beach visitors on the one hand and rubbish washed ashore by the sea on the other. In both cases, coastal municipalities have to set up a regulated cleaning system of the beach and the disposal of the garbage. Between unsettled responsibilities and unsuitable waste bins, it is a common issue that the waste spreads on the beach and sooner or later ends up in the ocean. The lack of coordination between the different authorities and an insufficient information system is often critical regarding regular beach cleaning. Thus, the authorities involved tend to refer to third parties or are unable to provide well-founded information due to a lack of reliable data in many areas.

In addition to a clear assignment of responsibilities, the way of cleaning can also be an important mean. For example, cleaning can be done with machines designed for the purpose or done by hand thereby raising public awareness for the visitors on the beach.

Other problems arise when there are insufficient disposal facilities. This may be because there is no garbage bin within reach, the capacity of the bins does not correspond to the volume of waste, or the waste in the bins is not adequately secured. This can lead to increased wild disposal of the waste in the environment as well as to a spread of the waste from the bins by wind and animals. Even if pedestrians place the garbage “well meant” next to the full container. At this point, it is on the one hand the responsibility of the municipality to identify the problem areas and to prevent the wild disposal of waste accordingly. On the other hand, it is necessary to educate the beach visitors about the proper disposal of their own waste.

Options of Action:

- **Clear Responsibilities**

Achieving a more effective waste management by coordinating clear responsibilities within all stakeholders

- **Cleaning**

On beaches, but also streets, cleaning can be done by machine or by hand. While mechanical cleaning is faster and cheaper, targeted manual cleaning achieves a more thorough result with higher efficiency and a simultaneous increase in the awareness of passers-by.

- **Bins**

Adaptation of the design (fastening, opening, access for animals, etc.), the capacity and number of waste bins in public spaces can lead to significantly improved perception and use. In addition, the number of emptying bins should be adapted to the respective waste volume. The time of day when the bins are emptied can also raise public awareness through visibility.

Best Practice Examples

Types and availability of garbage bins: A solid and closed system prevents animals from pecking waste out of the bins. Even in windy conditions there is no waste blown out of the container.

Wyk, Föhr -Germany: Wooden garbage containers made in local carpentry workshops with a heavy metal lid. The garbage bins are installed at least every 50 meters on the beach and are emptied daily during the tourist season from Easter to October, throughout the rest of the year about three times a week.

Spiekeroog, Germany: Large rubbish bins which can be opened by a foot pedal with a separate section for cigarette butts.



© Hafenamts Wyk

For marine litter found on the beaches, such as fishing nets or containers, large rubbish bins so called “[beach waste boxes](#)” are provided at the beach entrances.

Following an example of the North Sea region, the boxes were set up around the Eckernförde Bay in the Baltic Sea, Germany. The big waste bins are administered by the Abfallwirtschaft Rendsburg-Eckernförde in cooperation with the Ministry for Energy, Agriculture, Environment and Rural Areas of the State of Schleswig-Holstein, the City of Eckernförde, the municipality of Waabs and the Schwedeneck Office.



© BUND Germany/ Dr. Georg Wietschorke



© inselverliebt Usedom

The seaside resorts of Ahlbeck, Heringsdorf and Bansin on the island of Usedom, Germany, had “beach garbage cans” (garbage containers in the form of huge fish tins) designed and installed on the beaches. In a humorous way, the guests are to be encouraged to dispose of rubbish in the corresponding containers.

8 CERTIFICATES and LABELS

Certificates and labels help to draw the consumers' attention to sustainability and environmental compatibility in their everyday decision-making. A certificate or label is often associated with a high recognition value. At the same time, it provides consumers with specific information about, for example, the manufacturing process of a product that is otherwise not immediately apparent. Ultimately, product labels can serve as a basis of information when making a purchase decision. Labels for "organic" and "fair trade" products are already widespread in the retail sector, but they are gradually becoming more popular in other sectors as well. Especially in municipalities near the coast, certificates and labels are used to highlight the commitment of individual companies to marine protection.

The allocation of labels is divided into different groups. State- issued certificates and labels are subject to compliance with certain regulations, as, for example, the use of individual words such as "bio" or "eco" is protected. Another group of labels is awarded by interest groups that certify according to specifically established rules and norm-regulations. Some products carry labels that were created by companies to highlight unique selling points and promote the marketing of the products and should therefore to be evaluated critically.

With the granting of a certificate, products or services were tested according to a fixed catalogue of criteria. Approved third parties independently verify compliance with these criteria and issue the corresponding certificates.

Options of Action:

- **Hospitality Sector**

Rating systems are already widely used in the hospitality sector. By offering and enabling a reward for environmental efforts and contribution to marine protection, an impulse for sustainable development can be created.

- **Sustainable Tourism**

By awarding labels and certificates for sustainable tourism, offers can be made transparent for guests with regard to their environmental impact. An award increases presence and attractiveness and highlights sustainable offers.

- **Water Quality**

Municipalities can obtain an additional award for waters if they strive for better water quality and cleanliness around municipal bathing areas and public waters.


- **Environmental Management Systems**

Even as a public institution, an environmental management system can be set up to reduce the environmental impact of the administrative entity.

Best Practice Examples



The [German Hotel and Restaurant Association](#) (DEHOGA) offers a transparent environmental check for the specific requirements of the hospitality industry. In the criteria energy and water consumption, waste (residual waste) and food (e.g. regional, fair trade, organic), businesses are awarded bronze, silver or gold.



The European Union's [EMAS](#) seal of approval certifies an audited standardised environmental management system for organisations of all kinds based on [EU-Regulation 1221/2009](#). The framework is clearly specified by the regulation and is checked in practice by environmental auditors.

The “[Blue Flag](#)” has been awarded to sport boat harbours, beaches and bathing areas or inland lakes in Germany since 1987. Every year the requirements for bathing water quality, environmental management, environmental communication, waste and wastewater disposal areas are reviewed and awarded the blue flag for one year.




In cooperation with the [National Park Partner Initiative](#) holiday apartments and holiday homes or guest rooms are awarded with the label “plastic-conscious accommodation” if they are equipped and furnished with a special awareness on of avoiding plastic. The three award levels bronze, silver and gold symbolize different degrees of plastic reduction from the first steps to an almost plastic-free accommodation.

9 Sustainable PUBLIC PROCUREMENT

Certificates and labels help to draw the consumers' attention to sustainability and environmental compatibility in their everyday decision-making. A certificate or label is often associated with a high recognition value. At the same time, it provides consumers with specific information about, for example, the manufacturing process of a product that is otherwise not immediately apparent. Ultimately, product labels can serve as a basis of information when making a purchase decision. Labels for "organic" and "fair trade" products are already widespread in the retail sector, but they are gradually becoming more popular in other sectors as well. Especially in municipalities near the coast, certificates and labels are used to highlight the commitment of individual companies to marine protection.

The allocation of labels is divided into different groups. State- issued certificates and labels are subject to compliance with certain regulations, as, for example, the use of individual words such as "bio" or "eco" is protected. Another group of labels is awarded by interest groups that certify according to specifically established rules and norm-regulations. Some products carry labels that were created by companies to highlight unique selling points and promote the marketing of the products and should therefore to be evaluated critically. With the granting of a certificate, products or services were tested according to a fixed catalogue of criteria. Approved third parties independently verify compliance with these criteria and issue the corresponding certificates.

Options of Action:

- **Setting an example**

Public administration can act as a model for any administrative sectors and show how the procurement division can reduce single-use plastics.

- **Publishing supporting guidelines**

Municipals can provide a guideline that helps to establish a plastic free procurement for administrations.

- **Catalogue of products**

Either a catalogue of wishful products for an active waste reduction in the administration or a list of negative examples can be presented by the municipal.

Best Practice Examples

The NGO "Zero Waste Europe" based in Brussels empowers communities to rethink their relationship with resources, operating as a knowledge network and as an advocacy group. They have developed a "[Guide on how to run a zero waste municipality programme](#)" to support municipalities and community stakeholders who are interested in zero waste. It provides an entry-level understanding on what zero waste is and how a zero waste strategy for communities can be designed and implemented by creating a common approach for zero waste municipalities across Europe to adopt and follow best practice examples

10 AWARENESS Raising

The issue of marine litter rarely affects the everyday life of the general public, but the actions of every individual citizen contribute significantly to the littering of the oceans, therefore it is necessary to familiarise a broad public with this and other environmental issues and reach as many citizens as possible. In order to create an incentive for sustainable action, the personal sense of responsibility towards the environment and ultimately the oceans must be strengthened.

By raising awareness, people's interest in environmental issues should be stirred up and they should be informed about critical environmental situations. At the same time, society should, to a certain extent, reflect on itself and be motivated to act by showing possible solutions. Communication can take various forms in addition to classical public relations work. A direct exchange of information takes place through consultation and education. Larger campaigns and events reach a broader audience.

When it comes to the topic of marine litter, international exchange is also of great importance, as the oceans know no borders and therefore all actors and countries must work together. In addition, this topic affects a wide range of sectors and requires active cooperation and communication between different stakeholders.

Options of Action:

- **Campaigns, Exhibits and Activities on Plastic Pollution**
- **Projects and Workshops in Educational Institutions**

Best Practice Examples

The “[Gdansk without plastic](#)” campaign aims to support a pro-ecological attitude and environmental protection by reducing the use of plastic in everyday life and a proper waste separation, which is particularly important as the city is located on the coast and its pollution is largely caused by plastic. The main message of the campaign are ten simple rules of conduct, which were promoted through different public displays

As part of the campaign, various types of activities were planned to remind and promote the assumptions and ecological activities of the campaign, such as art competitions for schoolchildren, pilot projects for families who want to change their habits and take plastic out of use, competitions in social media or picnics for local residents.



“[Let’s Clean Up Europe](#)” is a European initiative that brings together existing clean-up initiatives, activists, campaigns and alliances on the topic of littering in Europe and aims to encourage new players to get involved. The action period runs from the beginning of March to the end of May each year and ends with a European action weekend.

The city administration of Rostock and Warnemünde, Germany, advertises various projects for coastal and environmental protection under the campaign “Kein Plastik bei die Fische”. The projects are supported by the Office for Environmental Protection with public relations work and financing. The projects deal for example with the following contents:

Rostock’s largest organizer and market operator introduced its own reusable system for drinks at all its events. Further, they offer paper bags to retailers with their logo printed on the bag. On the municipal Christmas market, paper instead of plastic bags will also be obligatory for any purchases.



TOURISMUSZENTRALE
ROSTOCK
WARNEMÜNDE

www.rostock.de

rostock marketing
ROSTOCK & WARNEMÜNDE

Eine Umweltinitiative der Tourismuszentrale Rostock & Warnemünde und Rostock Marketing

Support campaigns like the International Coastal Cleanup or World Cleanup Day.

For more than 30 years, the environmental organisation Ocean Conservancy has been calling on volunteers once a year to take action on the [International Coastal Cleanup Day](#) and clean beaches from waste. Non-governmental organisations, companies, volunteers or local authorities register various actions on the platform and take over the local organisation. The data of the collected waste can be reported to Ocean Conservancy, so that the global results contribute to raising awareness. Through the worldwide cooperation and common “brand” a uniform public relations work is achieved.

The [World Cleanup Day](#) is set on the same date and brings together the numerous local initiatives at a worldwide level, even far from the coast. Here too, the global cooperation achieves great visibility and provides a platform for many volunteers to get involved.



Once a year, on the [Rhine CleanUp](#) Day over 100 cities in six countries realize clean-ups along the Rhine from its source to its delta. In the course of the clean-up campaign, awareness is created so that less waste is carelessly thrown away or avoided in the first place.

The portal of www.gewaesserretter.de offers a space for nature lovers and water sports enthusiasts to document and report waste in order to obtain important data on the waste load of domestic waters. Waste collection campaigns can be planned, advertised and finally evaluated on the platform. In addition, information and practical tips are provided on the topics of waste in water bodies, waste avoidance and resource conservation.

In Zingst, Germany, the topic of marine waste and waste avoidance was included as a central theme of the environmental photo festival “[horizonte zingst](#)”. During the festival there are excursions and garbage collection activities on the beach and an environmental matinée, which is also accompanied by a short film. Every evening the pictures of the day are presented at the “Bilderflut” on the beach. Special attention is paid to the correct disposal of cigarette filters. In addition, during the festival and beyond, requirements are imposed on the gastronomers to reduce disposable plastic.

Open exhibition on marine litter along the pier of Hel, Poland.



© BUND Germany

The exhibition was part of the initiative “[Plastik niefantastik](#)” by the students of the Illustrative Design Basics Studio at the Faculty of Graphics at the Academy of Fine Arts in Gdańsk, under the direction of Natalia Uryniuk M.A. and the Illustration Studio under the direction of Prof. Jadwiga Okras. aimed to make the citizens of Gdańsk aware of especially caused by micro plastics and to provide an incentive for visitors to reconsider their actions. Both exhibition partners worked together in cooperation with the students from the Institute of Oceanography at the University of Gdańsk for the scientific background. Later the outcome was added as a part of “Gdasnk without plastic” campaign and shown on several spots over the country.

Art projects using plastic waste to show the impact of marine litter on fish and other animals. Examples from Hel, Poland.



© BUND Germany

[CLEAN BEACH](#) international action

The campaign was launched in 2014 by three countries- Finland (Helsinki and Turku), Estonia (Tallinn) and Russia (Saint Petersburg and Leningrad region). This is not only the clean up, but also an educational quest, as well as marine litter monitoring.



11 Facilitating CLEAN-UP Events and Activities

A consistent, professional cleaning, in regular intervals, along the coast of the Baltic Sea and the banks of the inflowing rivers can hardly be achieved. In many places, a growing number of volunteers are joining forces in initiatives to voluntarily clean up certain sectors and areas from rubbish. In order to promote this commitment in the long term, local authorities can provide support in terms of organisation and infrastructure, for example by handling the waste disposal, providing equipment such as gloves and garbage bags or providing free refreshments. In addition to the actual clean-up, the goal of such a clean-up is to raise awareness and make the associated efforts visible to the public. Such clean-up campaigns should therefore not only be a “cleaning event”, but should also open up dialogue in society and raise awareness of the problems related to waste in the ocean and in the environment.

Options of Action:

- **Infrastructure**

Municipalities can offer a free discharge of the collected waste from clean-up events and even support clean-up initiatives by providing the necessary equipment such as gloves and garbage bags.

- **Support**

The voluntary support of locals can be supported by reimbursement for the expenses or even providing drinks and/or food for the volunteers during or after the event.

- **Events**

Organizing a public local or citywide clean-up event to raise awareness.

Best Practice Examples

The “[Grondstofjutters](#)” in the Netherlands are a collaboration of beach cafés, walkers, waste companies and the public sector working together as partners to clean the Dutch beaches of the participating municipalities (currently eight). Walkers can collect litter in a jute bag during their walk and hand it in at the beach pavilions. As a thank-you gift, the collectors receive an ice cream or coffee free of charge. The caterers cover the costs for this, while the local authority covers the project costs in form of planning, waste disposal and public relations.



© Fleut Beemster

The district of Stade in Germany supports voluntary clean-ups with the necessary garbage bags and a collection container on site. Spendings on catering or refreshments can be submitted with the receipt to the Stade District Office, Environmental Office, Waste Management/Soil Protection Department and will be refunded.

The [Baltic-Clean-Up-Cup](#) is an environmental tournament, which is held in the area of the Baltic Sea. Clean Games are team competitions on collecting litter and sorting it out. An exciting game with prizes, where participants solve environmental puzzles, search for artefacts, collect and sorting litter, getting points for it. Statistics of games are conducted in real time on the website and in the mobile application. In one day, there are ten games with an online rating in all countries that have coastlines along the Baltic Sea.

[GreenKayak](#) is an environmental NGO that aims to give as many people as possible the chance to engage with the fight against pollution. They offer volunteers free trips in their GreenKayaks in return for collecting trash from the water and sharing their experiences on social media with #greenkayak.



© Behörde für Umwelt und Energie Hamburg

GreenKayaks hold two people are stable and safe. There is no need of profound training before taking a kayak out. The NGO provides lifejackets and all the gear needed to paddle and pick up waste. They also have a mobile fleet of 10 GreenKayaks that are used to do activations and events with schoolkids and youth groups as they share knowledge on grassroots engagement with institutions like the European Environmental Agency. Currently they are working on building a global network of GreenKayaks. The kayakers can already be found in Denmark, Germany, Sweden, Norway and Ireland.

The voluntary and non-profit "[Cleanup Network](#)" created a platform for various initiatives in Germany, calling for clean-up campaigns on the one hand and raising awareness on waste avoidance on the other, according to the motto: "Cleanups are a form of protest in which you are part of the solution."

The project "[Fishing for Litter](#)" is designed to reduce the amount of marine litter in our seas by physically removing it and to highlight the importance of good waste management amongst the fleet. Participating vessels are given hardwearing bags to collect marine litter that is caught in their nets during their normal fishing activities.

Filled bags are deposited in participating harbours on the quayside where they are moved by harbour staff to a dedicated skip or bin for disposal. Operational or galley waste generated on board, and hence the responsibility of the vessel, continues to go through established harbour waste management systems.

The project provides the bags and covers all waste costs.

REFERENCES

- 1 HELCOM (2018): State of the Baltic Sea – Second HELCOM holistic assessment 2011-2016. Available at: <https://helcom.fi/baltic-sea-trends/holistic-assessments/state-of-the-baltic-sea-2018/reports-and-materials/>
- 2 Eunomia Research & Consulting Ltd (2016): Plastics in the Marine Environment. Available at: <https://www.eunomia.co.uk/reports-tools/plastics-in-the-marine-environment/>
- 3 UNEP (2018): United Nations Environment Assembly of the United Nations Environment Programme. Report of the first meeting of the ad hoc open-ended expert group on marine litter and microplastics. Available at: <https://papersmart.unon.org/resolution/uploads/k1801471.pdf>
- 4 Deutsche Umwelthilfe [German Environmental Aid] (2015), Background Document. Disposable Coffee Cups – Environmental Impact And Alternatives [German]. Available at: http://www.duh.de/uploads/tx_duhdownloads/DUH_Coffee-to-go_Hintergrund_01.pdf
- 5 Umweltbundesamt [German Federal Environment Agency] (2019): Verpackungsabfälle. Available at: <https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehlter-abfallarten/verpackungsabfaelle>
- 6 D-Waste (2012): Waste Atlas. Available at: <http://www.atlas.d-waste.com/>
- 7 Sherrington et al. (2017): Leverage Points for Reducing Single-Use Plastics – Background Research. Seas At Risk. Available at: <https://seas-at-risk.org/images/pdf/publications/SeasAtRiskBackgroundreportSingleuseplasticsandmarineenvironment.compressed.pdf>
- 8 WHO (2017): Tobacco and its environmental impact: an overview. Geneva. World Health Organisation. Available at: <https://www.who.int/tobacco/publications/environmental-impact-overview/en/>
- 9 Peeken, I.; Primpke, S.; Beyer, B.; Gütermann, J.; Katlein, C.; Krumpfen, T.; Bergmann, M.; Hehemann, L.; Gerdts, G. (2018): Arctic sea ice is an important temporal sink and means of transport for microplastic. Nature communications 9.1: 1505. Available at: <https://www.nature.com/articles/s41467-018-03825-5>
- 10 Roder Green et al. (2014): Littered cigarette butts as a source of nicotine in urban waters. Available at: <https://www.sciencedirect.com/science/article/pii/S0022169414004107?via%3Dihub>
- 11 Umweltbundesamt [German Federal Environment Agency] (2019): Background Document. Zum Jahreswechsel: Wenn die Luft “zum Schneiden” ist. Available at: <https://www.umweltbundesamt.de/publikationen/jahreswechsel-wenn-die-luft-schneiden-ist>
- 12 Roman et. Al (2019): A quantitative analysis linking seabird mortality and marine debris ingestion. Available at: <https://www.nature.com/articles/s41598-018-36585-9>