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Policy Brief

Baltic Sea Centre

Stockholm University

Microplastics in marine life
– precautionary principle urges action

We still do not know exactly how harmful microplastics are to marine life. But a growing number of studies show that these particles potentially worsen reproduction and survival of many marine animals.
Current knowledge – and the risk of permanent damage to the ecosystem – justifies robust political measures in order to cut the flow of microplastics to the marine environment.

Today, plastics are found in all oceans around the world, and most of this plastic is not biodegradable. It is estimated that all conventional plastics that have ended up in the oceans remain there, and will do so for hundreds of years, maybe even longer.

Sources of microplastic particles (smaller than 5 millimetres) include the washing of synthetic fabrics, car tyre wear and tear, artificial turf, anti-fouling paint, cosmetics, and many others. Together with land-based plastic debris, these particles reach the marine environment by storm water, wastewater, rivers, and air. Once in the water, large items of plastic break down into microplastics as the result of sunlight and mechanical wear and tear.

The quantities of microplastics in the oceans, their sources, and their impacts on marine organisms are recent research fields, and the knowledge is still fragmentary. At the same time, the discharge of plastics into the marine environment is not abating, and once there plastics will be very difficult to get rid of. This gives cause for concern – and reason to seek to limit the discharge of plastics to the marine environment by political means.

RECOMMENDATIONS

Seek to reduce the discharge of microplastics from both land- and sea-based sources.

Standardise the difference between compostable, degradable, and biodegradable plastics. Plastics that are industrially compostable may take a long time to break down in the marine environment.

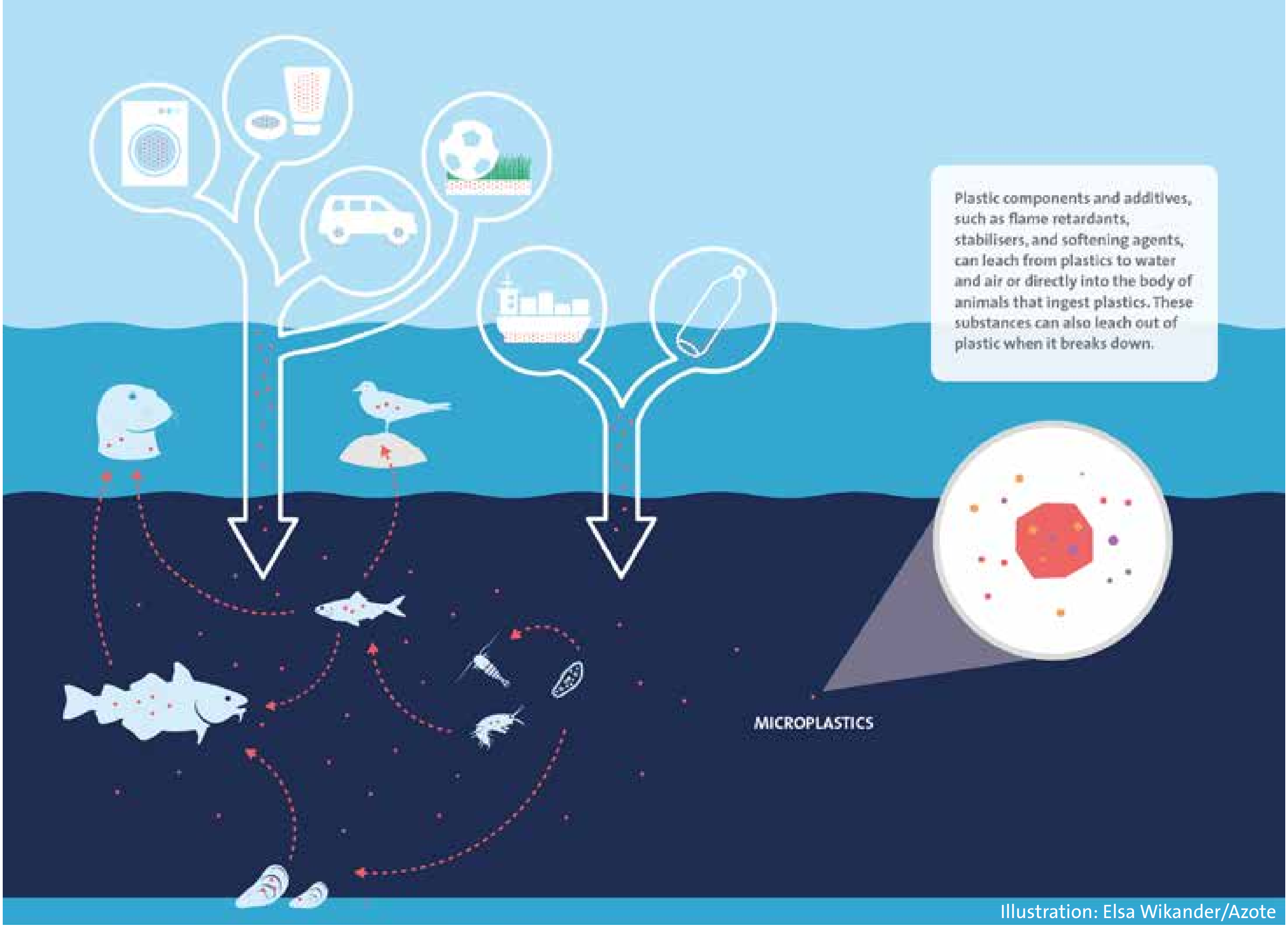
Ban microplastics in cosmetics and hygiene products. Microplastics should be banned in rinse-off products, but also in leave-on products where they can be replaced because of their risk of ending up in wastewater from showering and washing clothes.

Regulate similar chemicals found in plastics on a group basis instead of one-by-one in order to ensure greater efficiency. In the review of REACH, the chemicals' decomposition products in the marine environment should be taken into account, because these can also be harmful.

Allow the precautionary principle to be paramount in achieving Good Environmental Status in accordance with the Marine Directive. Because plastics and highly persistent chemicals take a very long time to degrade, the problem is largely irreversible once it has been detected.

Photo: Zandra Gerdes

The zooplankton Daphnia with ingested microplastics.



Microplastics are found in all oceans of the world, and animals at all levels in the marine food web are exposed to plastic particles. How this affects the marine animals is still largely unknown. But scientific experiments have shown several harmful effects, such as impaired survival, food intake and reproduction.

Many marine animals ingest plastics

Globally, marine animals are exposed to plastic particles that are ingested at all levels of the food web; from zooplankton, mussels and worms to fish, birds and marine mammals. Animals ingest plastics by mistaking them for food and eating them or taking them up through their gills.

Experiments have shown that microplastics can also be transported upwards in the food web from one species to another, for example, from mussels to shore crabs. It is likely that microplastics are also transferred between species higher up in the food web. Predatory fish and seals can ingest microplastic particles both via water intake and their prey.

Impaired reproduction and food intake

To date, most experimental studies aimed to establish whether microplastic particles are harmful have been carried out using higher concentrations than those found in the marine environment.

In such experiments, it has been shown that high concentrations of microplastics impair zooplankton survival, food intake, and reproduction.

But harmful effects have also been observed in experiments using lower concentrations, that are more similar to concentrations found in the marine environment:

- Oysters' reproductive ability was severely impaired after ingesting microplastics, and their progeny had poor chances of survival.
- Langoustines exposed to microplastic fibres over eight months lost weight and were in poor nutritional condition.
- Fish accumulated microplastics in the liver, gills and gut, and exhibited toxic effects in the liver.

This gives cause for concern of harmful effects of microplastics on marine organisms. More studies are needed on how different kinds and shapes of microplastics affect different species, and in lower concentrations. Additionally, there is a lack of knowledge to establish links between the impact and exposure of microplastics at population levels, because a negative impact is often caused by a combination of different environmental factors.

Hazardous substances leach from plastic to animals

Plastic is manufactured by combining many tiny building-blocks, so-called monomers, to form a long chain called a polymer. In many cases, various chemicals and additives such as stabilisers, flame retardants, and softening agents, are added to give the plastic desired properties. The manufacturing process is never perfect, which means that free monomers and unbound additives can leach from plastic and into the water or air, or directly into the body of animals that ingest the plastic. The substances in the plastic can also leach out during degradation in the environment.

Examples of hazardous substances in microplastics are the endocrine-disruptive additive bisphenol A (BPA) and various phthalates, which are used to soften plastic. Another example of harmful substances often used in plastics, especially in electronics, is brominated flame retardants, which are toxic, highly persistent, and accumulate in organisms.

Field studies indicate that hazardous substances in plastics can be released and accumulate in marine animals. For example, concentrations of flame retardants in South Atlantic lantern fish increased with increasing concentrations of plastic debris in the water. In the case of albatross chicks, a link has been reported between the amount of plastic debris in their stomachs and their poor state of health.

The endocrine-disruptive substance nonylphenol, an additive in plastics, has also been found in mackerel in areas of the Pacific Ocean with the largest concentrations of plastic debris. Nonylphenol does not normally spread far from its source, and its presence in fish in remote areas is a sign that nonylphenol has been transported there with plastics.

Hazardous substances via plastics – a concern?

Microplastics can attract fat-soluble and hazardous substances in the marine environment. The properties of plastics mean that they are able to bind and contain concentrations of environmental pollutants up to a million times higher than that of seawater.

According to the EU list of priority pollutants, 61% of environmental pollutants on and in plastic debris in the oceans are classified as hazardous, because they cause genetic damage and can be carcinogenic or endocrine disruptive.

Research shows that environmental pollutants are generally more easily released from plastics when in the digestive tracts of animals rather than in seawater. This increases the risk of transfer of hazardous substances for animals that ingest plastic. In addition, pollutants are more easily released from plastics in the stomach of warm-blooded animals, such as birds or mammals, compared with fish and crustaceans.

However, other studies indicate that in most marine habitats the contribution of hazardous substances from microplastics is minor compared to what animals take up through their food, water, and sediment. But these studies could potentially underestimate the risk associated with plastics ingestion by not taking into account that truly tiny microplastic particles can translocate from the digestive system to cells, tissue, and blood, where they remain for a prolonged time. In such cases, animals would be exposed to hazardous substances for a longer time than if the particles only pass through the stomach and intestine.

Further studies are needed to understand the significance of both additives and environmental toxins on and in plastics ingested by marine organisms compared to the uptake of these substances via food, water and sediment.

The concentration determines the impact ...

The animals worst affected by microplastics are probably those exposed to the highest concentrations. Exposure depends on where animals live, how they search for food, and how long the plastic remains in their bodies.

A considerable challenge for research is that we do not yet know the quantities of microplastics in the marine environment. Studies measuring concentrations in the marine environment have mainly collected plastic particles ranging in size from a third of a millimetre up to five millimetres and larger.

But there is reason to believe that higher concentrations of microplastics would be found in the marine environment should the particles collected be smaller than those commonly collected today. For example, a study using a filter for catching particles as small as 0.01 millimetres found concentrations of microplastics to be a thousand to a hundred thousand times higher than the concentrations measured using a filter for catching particles no smaller than 0.3 millimetres in size.

EXAMPLES OF MARINE ANIMAL INGESTION OF MICROPLASTICS

- Microplastics were found in the stomachs of almost one in three mackerel and one in ten flounder caught in the Baltic Sea and one out of three cod caught in the English Channel.
- Out of 120 examined langoustines in Scotland, 83 percent had plastics in their stomachs, mainly plastic fibres from fishing gear.
- Microplastics have been found in farmed blue mussels and oysters from the North Sea and the Atlantic respectively.
- Seabirds, such as petrels and albatrosses, ingest more plastic than many other bird species, because they use their sense of smell when looking for food. When algae start growing on them, microplastics in the sea can have the same smell as zooplankton. The birds then eat the microplastics thinking that they are zooplankton.

Microplastics have been found in the stomach of one in ten flounder caught in the Baltic Sea.

... and the concentration is increasing

At the same time, we know that global production of plastics is increasing exponentially and that plastics are found today in all corners of the world's oceans. It is estimated that between 4.8 and 12.7 million tons of plastic debris end up in the world's oceans every year. It is likely that most of these plastics will break down over time into microplastic.

Making the precautionary principle a reality

In recent years, the issue of microplastics in the marine environment has been raised in both public debate and politics. Various targets for limiting the effect of microplastics in the marine environment have been incorporated into several political goals such as the Marine Strategy Framework Directive and the UN Sustainable Development Goal number 14.

The Marine Directive states that member states should act when environmental damage caused by microplastics occurs in coastal and marine environments. As previously raised, one problem is that it is difficult to distinguish the impact of microplastics from other stress factors in the marine environment.

> *How tough should measures be when we still have scarce knowledge?*

At present, it is difficult to estimate the cost and provide evidence of the environmental damage created by plastics at population and ecosystem levels. The precautionary principle, therefore, needs to be paramount, and it constitutes no legal obstacle since it is incorporated in the Treaty of the Functioning of the European Union and in the Marine Directive.

If there is a risk of serious or irreversible damage, a lack of complete knowledge should not be used as a reason for not implementing measures for prevention or improvement. Monitoring programmes and programmes of measure under the Marine Directive should therefore include plastics of all sizes, and better measurements of the impact on marine organisms are needed.

What can be done?

To achieve Good Environment Status under the Marine Directive, the plastic problem needs to be addressed on land, as early as at the production and consumption stages. Plastic is ubiquitous in our daily life. But an overall reduction in the use of disposable plastic products is needed, rather than maintaining current consumption patterns with "degradable" alternatives or increased recycling.

One way to reduce the negative impacts of plastics on the environment is to limit the number of dangerous additives used in production. This, in combination with phasing out and regulating chemicals with similar properties on a group basis instead of one-by-one, would be a more effective way of tackling the chemicals problem. Seen from a circular economy and lifecycle perspective, these measures would also facilitate the recycling of plastic. Today, for example, only 40 % of all plastic collected in Sweden is recycled. This low level of recycling is due to different sorts of plastics, chemicals, and colours being mixed, both in plastic items and in the recycling process, making it difficult to recycle the plastic effectively with retained quality.

Another measure is to replace plastics with biodegradable alternatives. This approach can work where there is an absence of effective recycling. Bioplastics made from biologically produced raw materials may be part of the solution, and they may be degradable, at least in an industrial environment. However, there are few bioplastics on the market today that degrade in an acceptably short time in a cold dark sea such as the Baltic. Therefore, future legislation should include definitions of what is meant by degradability and the length of time considered acceptable for degradation.

Proposals to ban microplastics in cosmetics and hygiene products have currently focused on rinse-off products, such as scrubs, shampoo, and toothpaste. However, future bans need to include leave-on products, such as sun screen, powder, and mascara, otherwise microplastics in such products will likely end up in wastewater as well, through bathing or laundry. Therefore, bans should also include leave-on products, where better environmental alternatives are available to replace microplastic.

Measures are also needed to reduce the risk that plastics already in circulation end up in the marine environment. The risk of marine pollution must be taken into account when upgrading land-based waste- and water-management services to minimise inputs of hazardous particles to the environment in sludge and wastewater.

This policy brief is based on the full report *Exposure and Effects of Microplastics on Wildlife* by Anna Kärrman, Christine Schönlau and Magnus Engwall at Örebro University.

BALTIC EYE – BRIDGING THE GAP BETWEEN SCIENCE AND POLICY

This policy brief is produced by Baltic Eye, a part of the Stockholm University Baltic Sea Centre.

Baltic Eye is made up of a team of scientists, policy, and communication experts who analyse and synthesise scientific research on the Baltic Sea - and communicates it to stakeholders in the decision-making process.

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