AN OCEAN FREE OF PLASTIC

Water is the basis of life on Earth. Through water, all life on Earth is in some way or another connected to seas and oceans. People around the sea profit in many ways from the richness of the sea: eating its fish for food, enjoying the beautiful beaches, and using it as a medium for global transportation. Many seas around the world is under increasing stress from a multitude of human activities such a shipping, fishing, oil and gas production, and intensive agriculture. Plastic litter has recently become an arch-threat adding to existing stress factor for the marine environment.

Plastic, being a versatile, strong and lightweight material, benefits society in many ways. The negative side effects of society's growing dependence on plastic, however, are not equally shared. Due to its extreme persistence, disposed and abandoned plastic does not fully degrade. In the marine environment it only breaks down into smaller particles, thus making them available for ingestion to an ever-larger group of animal species. Plastic does not only spread over the surface of the waters, it also ends up on the seafloor, in sediments, is ingested by sea animals and stranded on beaches. Plastics can contain additives, sometimes up to half of their weight, and some of these additives are toxic. These additives, embedded in the plastic, also find their way to the marine environment. Moreover, plastics particles can attract already present chemicals from the seawater and thus have the potential to concentrate toxicants. Plastics, in their larger sizes, can cause direct ecological and economical damage, or in their smaller pieces (microplastics), can indirectly give rise to potentially large, global impacts.

Ingestion of microplastics by sea animals has a direct negative bearing on healthy feeding of higher animals such as human himself. Seabirds ingest plastic because it resembles prey, or because it is already present in the gut of the prey. It has furthermore been shown that plastics can be passed on to their chicks (van Franeker *et al*., 2011).

Toxics substances transported by plastics could accumulate through the food chain in consumption fish, making it unsafe to eat. Plastics, in this scenario, add to the toxic loads that are already present in different areas. Another cause for concern is that the combined effects of overfishing and climate change cause a change from a fish-dominated to a jellyfish-dominated ecosystem (Mills, 2001). Such a transition will be reached quicker if essential species are weakened or killed by plastic. It is effects like this that justify the conclusion that plastic marine litter poses an unknown, but potentially large risk for human health and the availability of food from the sea. Observed effects of ingestion of plastic marine litter are starvation or weight loss of birds, caused by satiation (the plastic accumulating in their stomach creates a false sense of fullness) or by blockage of the digestive tract and damage to delicate internal tissues through sharp objects, leading to infection, pain or death. Again, these are all physical effects. In one case, clues have been found for hormonal disruption in fulmar birds (Van Franeker, 2011).

The world is now threatened by the deadly consequences of ocean plastics. Many governmental bodies and NGOs have held conferences, constantly asking the question ‘what is the way out?’.

In order to make plastic waste a thing of the past, solutions are required on many different levels. Following the linear life cycle of a plastic product from production via usage to end-of-life, we seek the ways in which plastic usage can become more sustainable. While these measures might be expected to steadily decrease the amount of plastic litter ending up in the oceans, the existing marine litter will not disappear. Therefore, also restoration activities should be considered.

To close the plastic product chain, rethinking is required early in the manufacturing stage. This means that the end-of-life stage of a material product is taken into account from the very first design phase: the design should not only consider the usage phase, but also include a design for reuse and recycling. Also, the business model could reflect a cyclic way of thinking about a

product, including e.g. leasing instead of buying. How do these general concepts apply to plastic materials and products? For plastic products, this means a smarter usage of resources: it includes doing more with less plastic (resource efficiency), but also making constructions such that materials can be easily separated at the end of their lifetime (resource effectiveness) An important aspect is furthermore to designing for a longer lifetime. If products are easily repaired, valuable resources stay longer in the loop. It could also simply mean designing something so beautiful or useful that people rather keep it than throw it away.

In conclusion, we propose that a coalition of scientists, representatives from the plastic industry, governments and NGOs establish concrete projects to work on solutions for plastic marine litter. Together they form a program with a roadmap aiming at an almost plastic-free Sea. They should aim at innovation on land towards a circular economy for plastics as well as habitat restoration, and are supplemented with research ("increase knowledge") and policy development. These themes all interact, require the combined efforts of all stakeholders involved and are linked to broader developments in resource and waste management. To guarantee societal support for the development and implementation of effective policies for plastic marine litter, a broad international and Sea coalition has to be built and a collective agenda has to be set, in cooperation with other initiatives where possible.

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