To Watch a Fulmar Die: Facts and Formulations about Plastic in the Ocean

By Guri Sogn Andersen

Sample Translated by Olivia Lasky © 2019

Contact: Editor in chief Nina Castracane Selvik

E-mail: nina@spartacus.no, Telephone: +47 2313 6943

**Contents**

INVITATION

PLASTIC IN THE OCEAN

 Fantastic plastic

 How much is there, and where does it come from?

 180 Q-tips in the stomach

 The vulnerable

 Where does it end?

 Development over time

MICROPLASTIC

 From macro to micro to nano

 Decomposition?

 Plastic biology

 The Poisoned Cup

CAN IT BE FIXED?

 Consumption and reuse

 Circular economy

 Management

 Decomposition for the future?

 You and I are a part of the solution

WHAT CAN YOU AND I DO?

 Clean and register

 Recycle and redistribute

 Switch from disposable plastic to reusable gadgets

 Wash less and wash smart

THANKS

NOTES

REFERENCES

**Invitation**

It’s painful to watch a fulmar die. Wrapped in fishing line, lying on remote beach far away from people, its stomach filled with human garbage. Dead birds’ gaping beaks silently, but clearly, tell us something about the world we live in – a world that is slowly but surely being clogged up with garbage that doesn’t disappear. Plastic doesn’t break down quickly enough and doesn’t enteral the natural cycle in which waste is converted into new resources at a rate that can keep up with the supply. Plastic in nature first gets broken down until the pieces are so small they’re impossible to handle. Then, the process of splitting the pieces up into their individual components begins – in other words, the process we call decomposition. Garbage in nature takes lives every single day, but our knowledge about its effects on populations and ecological systems is still lacking. At the same time, plastics are exceptional materials. They are often the only solution where other materials are too heavy, too brittle, too flexible or use up too much of our limited natural resources to be produced. The society we live in depends on plastic, and that’s how it’s going to be for a long time to come. We therefore have to try to find solutions that will make this dependency sustainable.

 I’m convinced that there are solutions, and that’s what this book is really about. However, these solutions can’t just center around slowing down or stopping consumption and cleaning up after ourselves. We all have to find a way to a future where plastic is used and taken care of as a valuable resource – without compromising either nature or human health. Together, we – consumers, producers, researchers and administrators – need to figure out how this can be done. But first, we need to know what the problem really consists of. How much plastic waste is there in nature? How much is in the ocean? Where does it come from, and how much damage does it do? In this book, I address seemingly established knowledge about plastic in the ocean and try to separate myths and speculations from facts. If we’re going to come up with good solutions, we need to start there – with the facts.

**Plastic in the Ocean**

Have you ever walked along a beach and seen a torn and deteriorating stump of rope sticking out of the sand? Maybe you’ve seen a stranded plastic bag with a colorful print faded by sun, salt and sand? Have you tried picking up this kind of garbage and felt tiny rope fibers sticking into your hands and arms, or the thin plastic bag crumbling between your fingers and disintegrating into the sand? For most beach-cleaners, the answer will be yes. At the same time, most beach-cleaners have an ambivalent and perhaps slightly hazy relationship with plastic. We know that plastic can be useful just as much as we know that a lot of plastic ends up in places it doesn’t really belong. Yet few of us have a clear picture of what plastic is. Not just purely chemically and physically – but what does it *really* mean to us?

**Fantastic Plastic**

"Despite having names of Greek shepherds (Polystyrene, Polyvinyl, Polyethylene), plastic, the products of which have just been gathered in an exhibition, is in essence the stuff of alchemy.” This quote comes from the essay “Plastic” in the book *Mythologies*, written by Roland Barthes (1915-1980) in 1957. The French essayist and philosopher writes about plastic as a relatively new element of everyday life. Plastics’ various forms have supplied us with materials that offer extreme formability, reshability, flexibility and rigidity and have therefore provided the basis for innovation and products we would have otherwise seldom seen. It must have been incredibly exciting when plastic products made their first real entrance into ordinary households (in the 50s and 60s) in the form of nylon stockings, insulation, flexible hoses, unbreakable bottles, durable toys, vinyl records, floor coverings and much more. In 1953, the first plastic Norwegian boat saw the light of day, and plastic boat production became an important industry for several communities in Norway. During the 1960s, prices had become so low that even plastic packaging was commonplace. Today, we’re still intrigued by attractive consumer goods that promise an easier and more efficient life, which is why plastic consumption continues to increase.

How many plastic objects can you look at right now? At the very least you’re holding a book or tablet to read this text. Even books usually have covers or jackets that contain plastic. At this very moment, I can count well over 100 items that contain plastic in my office – which is smaller than 10 square meters. Plastic is used in aids that both save and improve human life, as in heart-lung machines or prostheses. It’s a prerequisite for today’s space technology and for the technology that encompasses most of the means of transport we use; planes, helicopters, cars, buses, trains, trams, boats and submarines are all built with essential plastic parts. In a passenger gar, plastics make up about 15 percent of the weight, and for a Boeing Dreamliner, that figure is closer to 50 percent.

Barthes had only seen the beginning, but his description still strikes me as pertinent: “The Idea, the pure Substance to be regained or imitated: an artificial Matter, more bountiful than all the natural deposits, is about to replace her, and to determine the very invention of forms.” At the same time, access to such a material facilitates over-consumption at the expense of other values. Based on today’s society, it’s easy to interpret these lines from this viewpoint: “A luxurious object is still of this earth, it still recalls, albeit in a precious mode, its mineral or animal origin, the natural theme of which it is but one actualization. Plastic is wholly swallowed up in the fact of being used: ultimately, objects will be invented for the sole pleasure of using them. The hierarchy of substances is abolished: a single one replaces them all: the whole world can be plasticized, and even life itself since, we are told, they are beginning to make plastic aortas.”

 Plastics are a man-made organic polymer; they are synthetic. In this context, the word “organic” is somewhat misleading, but in fact stems from a historical classification of chemical substances. Early on, the world of chemistry was divided into substances that are a part of life – the organic compounds – and other substances – the lifeless inorganic compounds. In the 19th century, organic compounds were believed to possess a special vital force. Later, it was possible to produce such “vital substances” in laboratories, and the definition gradually changed. Today, the term “organic” is used to refer to all carbonaceous compounds except for the very simple (such as carbon oxides, carbonates and carbides).

 In 1907, an American chemist by the name of Leo Hendrik Baekeland mixed phenol and formaldehyde and exposed it to both high temperature and high pressure – and in doing so launched the trillion-dollar machine we call the plastics industry. This product was *bakelite*, the first plastic that was resistant to fire, heat and chemicals, and which was also moldable through heat treatment. Among its many uses was in the old black phones that are frequently featured in movies from the film noir era. However, this wasn’t actually the first plastic material. Others had also dallied with early polymerization efforts; in 1855 a British man named Alexander Parkes applied for a patent on a substance he called *Parkesine*, which really *was* the first plastic. Today, there are a myriad different types of plastics, and in Europe the demand is greatest in packaging production (which accounts for about 40 percent of use). Bakelite, and all the plastics that have come after it, contains long carbon chains and is therefore characterized as an organic compound.

We’ve made ourselves dependent on a resource we ourselves created. I think Barthe’s concept of “alchemistic substance” is apt. At the same time, plastic’s excellent properties make this cornerstone of our society a serious threat to the environment we humans exist in. Its durability and resistance to degradation make plastic last for many years, and its low density makes it easy to spread via wind and water. These are some of the reasons why plastic can be found even in the most remote and inaccessible places on Earth (such as several thousand meters beneath the surface of the ocean). Plastic represents an environmental problem that spans from oil consumption and greenhouse gas emissions to effects on organisms through physical damage and emissions of substances we don’t know the impact of. At the same time, plastics are so characteristic of the present day – that is, the part of the Earth’s history we call the *Anthropocene* – that geologists consider plastic content in deposits to be one of the most striking features of the era.

**How much is there, and where does it come from?**

Several marine enthusiasts, including American marine biologist Sylvia Earle (the first female chief scientist in NOAA, the US governmental agency for research, dissemination and advice related to the ocean and atmosphere) has pointed out at the Earth has in reality been given a slightly misleading name: “It should have been called planet Ocean, not planet Earth.” It’s not clear exactly who said this first, but that’s not really what’s important here. There are probably more people who have thought the same thing independently, and the reason for this is quite simple: Most of the Earth’s surface (over 70%) is covered by oceans, and observed from space, the planet we live on is also predominantly blue. Most marine areas are relatively inaccessible to humans, and yet are still affected by our way of life. The ocean is affected by climate change, which is now beyond a shadow of a doubt partly man-made. In addition, garbage, particles and chemicals we dump out on land end up in the ocean as well. Pollution is transported in the air that ends up by the coast, or through water that is passed through piping systems or via rivers and streams out into the deep blue. On top of this, people have long used lakes, rivers and seas as waste-disposal systems. While plastics aren’t inherently more dangerous when in wet environments compared to on land, it *is* much more difficult to clean up underwater.

 American researchers have estimated that by 2015, 8.3 billion tons of plastic had been produced. Up until that same year, about 6.3 billion tons were taken out of use, of which only 9% was recycled. 12% was burned, while a staggering 79% has been accumulating in garbage heaps, trees, shrubs, grasses, streams, lakes, oceans, and even you and I. Stop for a moment and let the following sink in: If today’s production and waste management continues as is, about 12 billion tons of plastic garbage will have piled up or disappeared somewhere in nature by the year 2050 – that is to say, roughly double the amount in the year 2015.

When Thor Heyerdahl attempted to cross the Atlantic in the papyrus boat “Ra” in 1969, garbage was apparently a common sight on the surface, even far offshore. That same year, the journal *The Auk* published a short article on plastic discoveries in albatross stomachs. On an island by Hawaii, plastic pieces were documented (with pictures) in the digestive systems of 74 out of 100 baby albatross. They died before they could even fly. The first signs that plastic garbage in the ocean could be real trouble were now being revealed. In 1971, there was a report from the North Sea on plankton samples with high concentrations of synthetic fibers, and in 1972, scientists from Woods Hole Oceanographic Institution published two articles in the journal *Science* thatprovided even more grist for the mill. They reported high densities of small plastic fragments in surface water from the Sargasso Sea. Even then, experts were concerned about the damage such small pieces of plastic could inflict on organisms. There was talk of disruptions to nutrient intake and of potentially toxic additives used in plastic production. The understanding that plastic garbage in general was common and harmful to the marine environment was gradually supported by several studies and research throughout the 70s and 80s. Plastic was found in prions in New Zealand and petrels in Newfoundland, in puffins, fish stomachs, sea turtles and marine mammals. An increasing number of reports of animals found wrapped in plastic packaging, beer can holders, plastic bottles, fishing lines and nets, ropes and other junk were of grave concern to zoologists. In 1977, British scientist and ornithologist William R. P. Bourne warned against the use of durable polymers in fishing gear. Sustainable fishing gear is a good thing when in use, but not when lost, and functions as marine death traps that continue a meaningless catch over many years.

 Plastic isn’t just found on the surface of the ocean, either. Even some of the most inaccessible places on Earth – the deep sea – show signs of human plastic addiction. For example, studies suggest that the concentrations of plastic fibers and particles in sediments may be higher in deep-sea areas than in shallower parts of the ocean. Deep-sea coral with a light sprinkling of blue, black, green, red, pink, purple and turquoise plastic isn’t a particularly uplifting thought. Plastic has even been found in Antarctica, and in far greater quantities than local research stations and visiting ships could have been responsible for.

 It’s impossible to determine the total amount of plastic in the ocean, since the Earth’s seas are so large, so deep, so different and so unexplored. It’s also difficult to navigate the existing literature on the subject, since figures of uncertain origins have taken root as truths, including among researchers. For example, it’s been customary to claim that 10% of all plastic waste in existence ends up in the ocean, and that 70% of this sinks to the bottom. If you try to find sources for these numbers, you quickly end up on a road that leads to nowhere. The conclusion is that no one really knows if these numbers are even anywhere close to the truth. Some figures, however, are well-founded enough to give us a realistic picture of the extent of the waste. In an article published in *Science* in 2015, American researchers estimated that the amount of plastic that “leaks” out into the ocean each year is between 4.8 and 12.7 million tons. Others have put it in this context: This is equivalent to a garbage truck dumping a full load every single minute, every single day, all year round. I’m skeptical of this account. There’s considerable variation in the data foundation and uncertainty in the estimates, and the difference between 4.8 and 12.7 million tons is also *quite* large. If the smaller number is closer to the truth, it means that the plastic garbage that found it way from land to ocean during *one year* weighed more than every single car in Norway (based on an average weight of about 1,450 kg and a passenger car stock of 3,162,714 registered cars in 2017, according to Statistics Norway). That’s a lot. The wide-ranging projections (and the difference between them) also means that the total amount of plastic garbage in the sea could be far greater than previously estimated.

 Based on assumptions about waste management and increases in consumption, it’s been estimated that the ocean could contain about 250 million tons of plastic waste by 2025. The research group that worked with these figures used population size estimates in areas extending 50 kilometers inland from the coast as well as the quality of waste management and infrastructure in the same areas in order to calculate the “leakage” of plastic waste from land. In this process, a number of generalizations have been made that aren’t necessarily valid. The need for slightly more specific assumptions has been pointed out by for example The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), an expert body that provides scientific advice and assessments to the UN on the production and preservation of marine areas. Their calculations indicate that the twenty countries listed in the article (in which the United States ranks 20th) account for a total of 83% of the plastic garbage that ends up in the ocean from coastal areas. The causes are naturally quite different. Some countries have very high populations, others produce a great deal of garbage per capita, some lack the infrastructure and systems for dealing with garbage, some countries receive large quantities of garbage from others (Western Europe and the United States, for example) without having the capacity to properly manage it, and some countries perform poorly in all categories. It should also be mentioned that garbage transported by rivers from areas further than 50 kilometers inland was not included in these calculations. The order and quantity calculations must therefore be adjusted considerably in the years to come, but can still be useful. After all, it points out some areas that the international community must work together to find realistic solutions for. At the top of the current list is an excess of Asian countries, with the top five being China, Indonesia, the Philippines, Vietnam and Sri Lanka.

 In 1975, annual emissions of plastic waste from shipping were estimated to be about 5.8 million tons a year. This figure was based only on data for dumping from cargo ships, military vessels and shipwrecks. Since then, dumping from ships has been regulated by the international convention MARPOL (1978 Protocol on the International Convention for the Prevention of Pollution from Ships, 1973, with annex [MARPOL 73/78]), which came into force in 1983. In 2018, 174 countries (representing more than 98% of the world’s ships) have already joined this convention. However, pollution and waste disposal from ships continues, and the US Navy has for example dumped large quantities of garbage and chemicals overboard even after 1983 and the ratification of MARPOL.

 Annex V of MARPOL deals with dumping garbage from ships. The revised Annex V entered into force on January 1, 2013 and contains some important changes. Where it was initially allowed to dump waste as long as it was explicitly prohibited, it is now the other way around; it is forbidden to dump waste unless explicitly *permitted*. Even though regulations to limit emissions from the marine sector are gradually being put into place, enforcing them is still a challenge. This is especially true for ships traveling across national borders. Within national maritime boundaries, local authorities have the right to conduct investigations to determine whether the requirements set by MARPOL are being observed. In international waters, however, only the country in which the ship is registered is allowed to follow up. For many players, this in practice means that the rules can be broken without punishment.

Lost fishing equipment accounts for a significant proportion of the garbage removed from the ocean each year. Since the 1980s, the Directorate of Fisheries has been conducting annual expeditions to extract lost equipment from Norwegian waters. Twenty thousand nets have been fished up during this period, and if you put these nets together, they reportedly amount to around 550 kilometers – roughly the difference between Norway and the Faroe Islands. However, no one knows how much is still out there among the diving seabirds, fish and crabs rummaging around the seabed. There are estimates from several areas of the globe, but the figures are quite uncertain. Some are based on reported losses or discoveries, but these are likely quite low compared to the actual quantities. Other figures come from systemic fishing for lost equipment, and then both the collection method and the areas surveyed affect what and how much is found. Making more extensive generalizations (extrapolating) from this data – at least when it’s done on a global scale – is quite simply wrong.

Globally, the largest sources of marine plastic waste might not come from dumping off ships, loss of fishing equipment or shipwrecks. It’s been commonplace to estimate that over 80% of marine waste ended up in the ocean without having made its way there by ship, but the background for this estimate is uncertain. I haven’t been able to trace it back to a specific scientific source, and since so many elements that have not yet been quantified are included in the calculation, I don’t trust it.

 The type of garbage found in bodies of water, on the shoreline or on the seabed shows some predictable patterns. On beaches and in bodies of water, you mainly find garbage with a net weight that’s low enough for it to float or for it to take a long time to sink to the bottom. Such objects can be carried far by waves, currents and winds and are easily washed ashore. On the seabed, the proportion of objects with high net weight is likely greater. Regionally, there are also considerable differences that are in and of themselves equally predictable. For example, the excess of plastic garbage along the coastline in northern and western Norway comes from fishing and agriculture. Large jumbles of nets, floats and trawling equipment are common discoveries in beach cleaning efforts in the area around Tromsø. Farther south in Norway, for example in the areas around the Oslo Fjord, plastic garbage primarily originates from local households and recreational activities such as fishing, boating and trips to the beach. I used to live in a beach community close to Oslo and became an avid beach cleaner, and as such have nurtured a distinct hate for Q-tips, tampons and cigarette butts. It’s incomprehensible to me that people still throw these things in the toilet and flush without thinking about where the garbage ends up. If you’re in doubt, a lot of it goes through the treatment plants and ends up in the fjord. The regional differences are due to the differences in the intensity and extent of the various activities, but also to the different patterns of the ocean – currents and winds that transport objects from afar carry things further, or keep local supplies trapped in the same place they originated.

 Although plastic garbage in the sea is itself well documented, it’s still difficult to pinpoint specific sources or allocate responsibility. Plastic objects floating around the ocean are broken down into ever-smaller pieces, eventually fragmenting when they’re exposed to waves and UV rays from the sun. For researchers, even tiny pieces are often recognizable as plastic, but determining the type of object they originated from is in most cases almost impossible. This means that the sources of all these small pieces are essentially impossible to trace. For recognizable things such as a fishing net or a rubber duck, it’s easier to identify the source, but it’s still difficult to hold anyone accountable. Various regions are affected to various degrees, but the responsibility is rarely only local. The innocent are hit the hardest, since it is ultimately non-human species that end up bearing the biggest brunt.

**180 Q-tips in the stomach**

As a master’s student in the early 2000s, I spent some time wandering around Svalbard. I was working on completing a degree in marine biology, and a course at the University Center in Svalbard (UNIS) was going to make a bigger impression on me than I’d expected. During the course, we had the chance to visit Ny-Ålesund, a small research village on the south side of Kongsfjorden on the Brøgger Peninsula on Spitsbergen. The village is also the northernmost settlement in Svalbard, and the surrounding landscape feels wild and untouched – that is, once you look away from the remains of abandoned mining efforts, which are quite clear close to the settlement. As in the rest of Svalbard, the landscape around Kongsfjorden is dominated by beautiful, snow-covered mountains. Precisely because they’re virtually inaccessible to those of us without wings, the steep and inhospitable mountainsides are well suited as nesting places and residences for seabirds. Along the rocky beach there on the south side of Kongsfjorden, beneath a blue sky with the cawing of birds in my ears, I wandered off. I was surprised at how much garbage I saw lying between stones and woven into rotting strands of algae. At the same time, birds were circling over my head. I stood there for a long time, staring at a delicate bird skeleton with its wings unfolded lying beside rocks, pieces of rope and a plastic jug that small boats use for drinking water. I’m quite sure it was a northern fulmar. I don’t know how it died, but the images of dying birds with their beaks and wings tangled in fishing line or dead birds with stomachs full of plastic pieces immediately came to mind.

 The fulmar (*Fulmarus glacialis*) is a bit larger than a regular gull and can be found along large stretches of the coast of Norway. In evaluations made in 2006, the Norwegian fulmar populations were considered viable – that is, not in danger of extinction. In 2010 and 2015, however, new figures were put on the table. These figures showed that the population associated with mainland Norway may have been halved or perhaps even further reduced (with a possible decline of 80%) over the last fifty years. The species is therefore now listed on the Norwegian Red List as severely threatened (international category EN), which means it is in imminent danger of disappearing from Norway altogether.

 The fulmar can often be seen gliding between wave crests in search of food across large parts of the North Atlantic. If it catches sight of a potential snack dipping beneath the ocean’s surface, it’s quick to dive under to snatch it up. It’s hardly able to distinguish nutritious food from useless garbage such as scraps of rope, plastic bags, soda bottle tops and Q-tips, and plastic is therefore often found in the bird’s stomach. On a beach a long way into the mighty Kongsfjorden, I couldn’t help but think of the following facts:

* In a survey conducted by Lista in Norway, 98% of dead seabirds found on the beach had plastic in their stomachs.
* The average amount was 0.33 grams.

0.33 grams doesn’t sound like a lot, but how does it look in relation to the fulmar’s bodyweight? The one that just flew past me was medium-sized, so let’s assume it weighs approximately 600 grams. A stomach content of 0.33 grams therefore constitutes about 0.05% of the bird’s body weight. In comparison, I weigh approximately 65 kilos. 0.05% of my body weight equals about 36 grams – the equivalent of around ten soda bottle tops or 180 Q-tips. Soda bottle tops and Q-tips are completely useless to my body. In the stomach, they take up space that would otherwise be filled with carbohydrates, proteins and fats, and in addition they’re quite difficult to get rid of.

 The monitoring of plastic in fulmar stomachs is used to examine development over time – whether the amount of plastic waste available to fulmars has increased or decreased over the course of several years. OSPAR is a body named after the OSPAR Convention (1992). The convention is a merger of the Oslo Dumping Convention (1972) against the dumping of waste from ships and the Paris Convention (1974), which covers land-based sources and waste from offshore activities. OSPAR’s goal is to reduce the number of fulmars with more than 0.1 grams of plastic in their stomach to less than ten percent (when examining the stomach contents of 50 to 100 dead fulmars that are washed ashore over the course of one winter). We humans have decided that an amount of 0.1 grams of plastic in the stomach is acceptable for a seabird. Based on the fulmar that flew past me on Svalbard, this corresponds to 0.017% of its body weight. For my own part, I wouldn’t be all that thrilled to walk around with 11 grams of garbage (about 0.017% of my own body weight) – which equals about 60 used Q-tips – in my stomach. However, in light of the latest results from OSPAR monitoring, even this goal seems unattainable in the near future:

* 93% of fulmars examined in the North Sea had plastic in their stomachs.
* 58% of these fulmars had more than 0.1 grams of plastic in their stomachs (48% more than the target).
* The average amount of plastic was 0.31 grams per bird stomach.
* About 80% of the plastic pieces come from consumer articles, and 20% from industrial waste – small plastic balls or “pellets” that are fused together and formed into plastic articles.
* The amount of plastic decreased northward and was lowest in Arctic waters.