

# Science for Environment Policy

## Biodegradable, oxo-degradable and compostable bags observed over three years in the sea, open air and soil

**European scientists have conducted the first ever long-term study into the breakdown of alternative plastic bags compared to conventional plastic bags, across multiple habitats — open air, soil and sea.** Oxo-degradable, compostable and biodegradable bags are often marketed as being recycled back into nature more quickly than normal bags; however, the long-term environmental studies to back this up are lacking and there is concern regarding microplastic pollution from these alternative plastic bags.

**Single-use plastic bags, made from polyethylene, were introduced in the 1970s and have become common in daily life worldwide.** In 2010 alone an estimated 98.6 billion bags were placed on the European market, which equates to 198 plastic bags per year for the average European<sup>1</sup>. Europe produces 25 million tonnes of plastic waste every year and only 30% is recycled, with a huge 70% going to landfill or being incinerated<sup>2</sup>. Lots of end-of-life plastics end up in the environment, with a large amount finding its way into the oceans and terrestrial habitats. If current production trends continue by 2050 there could be more plastics in the sea than fish.

Accumulation of plastic debris in marine habitats has been identified as a major issue by the UN Environment Assembly and in the G7 leaders' declaration. Within nine weeks in the ocean, sunken plastic bags can reduce oxygen levels in sediment, lowering numbers of invertebrates; during the examination of 50 dead sea turtles, plastic bags were the main debris ingested by the animals. Polyethylene is used to make plastic bags and is a water-repellent molecule, meaning it is not subject to biodegradation. It is unknown how long it would take to completely degrade a plastic bag — so this creates a big waste problem.

The European Union has recently banned the use of oxo-degradable plastics because of a lack of consistent evidence about speed of breakdown in the environment, and fears that false claims around this are misleading consumers<sup>3</sup>. The [directive 2019/904](#)<sup>4</sup> came into force on 3 July 2019 and has to be transposed by the Member States by 3 July 2021. In addition, there are concerns that the 'biodegradable' label could lead to more littering, as consumers are more relaxed about discarding bags, rather than reusing them, assuming they will break down and pose no threat to the environment.

Five different types of plastic bag available from UK high-street retailers at point of sale were used in this study; this included two types of oxo-degradable bag (Oxobio1 and Oxobio2), one biodegradable bag, one compostable bag and one high-density polyethylene (HDPE) carrier bag. Sixteen bags of each type were obtained from retail stores around Plymouth, UK, with a maximum of two bags obtained from any one store on a single occasion (to ensure a range of production batches). Repeat store visits were separated by at least two weeks. Each bag was cut into 15 x 25-millimetre strips.

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1. European Commission (2013). *Commission Proposes to Reduce the Use of Plastic Bags*. Press Release [https://europa.eu/rapid/press-release\\_IP-13-1017\\_en.htm](https://europa.eu/rapid/press-release_IP-13-1017_en.htm).

2. Directorate-General for Environment (European Commission) (2018). *Changing the way we use plastics* <https://publications.europa.eu/en/publication-detail/-/publication/e6f102e3-0bb9-11e8-966a-01aa75ed71a1/language-en/format-PDF>.

3. European Commission Communication (2018). *A European Strategy for Plastics in a Circular Economy*. <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN>.

4. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0904>.

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*(continued)*

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Four sample strips of each carrier-bag type were tested to assess surface area, tensile stress, surface texture and chemical structure. Three strips of each carrier-bag type were then placed into a mesh pouch with five equal-sized slots, to allow exposure to external elements. Each slot was loose to allow movement of the strips. Each pouch was then attached to a permanent panel placed in one of four different environmental mediums:

- soil — buried at University of Plymouth's Skardon garden at a level of 0.25 metres,
- air — Plymouth's Skardon garden on a south-facing wall,
- marine — submerged on a beam at Queen Anne's Battery marina to a depth of approximately 1 metre,
- control samples — placed in a darkened box in a controlled-temperature lab at the University of Plymouth.

The samples were put in position on 10th July 2015 with three subsequent sampling dates: 6th April 2016 (9 months), 6th January 2017 (18 months) and 6th October 2017 (27 months). In addition, whole bags of each type were placed in mesh in each environment and used for visual inspection over a three-year period, finishing on 23rd August 2018.

At each sampling date, four strips of each type of bag were taken for testing from each of the four environments, washed in distilled water, air-dried and then tested within 48 hours of removal. Deterioration was recorded as visual loss of surface area, and more subtle changes in tensile stress, surface texture and chemical structure were assessed.

The biodegradable, oxo-degradable and conventional plastic bags all stayed functional in the marine environment and soil for the three years of the study and could hold 2 kilograms of groceries in them without breaking. The researchers highlight that the compostable bag remained intact in soil but was the only type of bag that completely disappeared from the marine pouch within three months. In air, the bags became brittle and formed smaller particles visible to the naked eye. Collectively, the results showed that none of the bags could be relied upon to show any substantial breakdown over a three-year period across all of the environments. The oxo-degradable or biodegradable formulations do not show sufficiently advanced rates of breakdown to have a clear advantage in terms of reducing marine litter compared to conventional bags.

The researchers suggest that it is imperative to have appropriate standard tests against which to assess the environmental breakdown of alternatives to polyethylene bags. They also say that these standards would need to incorporate the variability of natural environmental conditions (e.g. temperature/pH/light), an appropriate timescale of deterioration, and assurances that no potentially harmful degradation products, such as microplastic fragments, are left over. They say that labelling statements on bags should be linked to the standards described above, indicating the degree to which each type of bag degrades, over what timescale and in what environmental medium.

The researchers note that, in order to ensure that products reach the appropriate waste stream, appropriate infrastructure and sufficient understanding among consumers to correctly separate their waste are essential. They suggest that there is a need for more evidence on degradable plastics, to support policies such as the recent EU ban on the use of oxo-plastics. This study also highlights the need for further innovation in plastic development.

