

Scientific support for a plastic bag reduction law

This report was compiled by the [Scientist Action and Advocacy Network](#) and summarizes evidence from academic and government-commissioned studies. Sections 2 and 3 were curated by Professor Tatiana A. Homonoff of the R.F. Wagner School of Public Service at New York University. Dr. Homonoff is an expert on the behavioral effects of fees and incentives, and the lead author of two studies described here [1, 2]. For questions or comments, email info@scaan.net.

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Every year, New York City residents use and discard approximately 10 billion single-use plastic grocery bags at a disposal cost of \$12.5 million [3]. The total surface area of these bags would cover all five boroughs twice over and weigh over five times the Brooklyn Bridge (70,000 tons) [4, 5, 6]. In this report, we summarize scientific evidence for the environmental impact of single-use plastic bags and evaluate the efficacy of proposed policies designed to reduce single-use bag use.

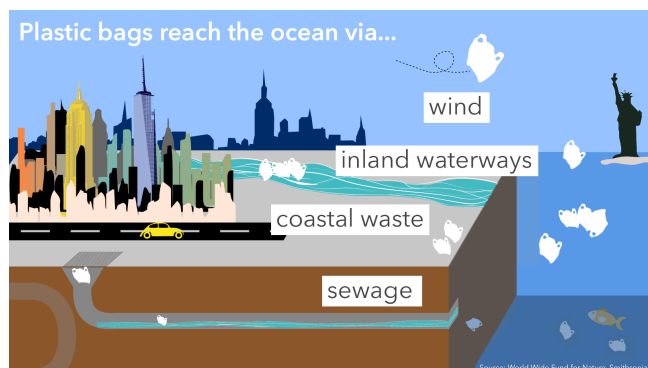


Figure 1: How plastic bags reach the ocean. (1) Dispersal by wind to inland waterways. (2) Dispersal along inland waterways (canals, rivers). (3) Direct coastal litter. (4) Dispersal by underground sewage [7, 8, 9]. Graphic created using piktochart.com.

1 Why minimize plastic bag use?

Plastic bags disperse widely without biodegrading.

- **Plastic bags act like sails in the wind, dispersing to waterways, lakes, and oceans,** particularly due to their light weight, shape, and durability [8]. As they enter waterways, they disperse to farther areas and, with no mechanism for removal, they harm ecosystems progressively farther away from urban centers [8, 10, 11].
- **Even the most remote areas of the world have seen drastic increases in plastic bag litter over the last decade.** Researchers stationed in the Arctic photographed 7710 pieces of man-made litter in a single square kilometer, deep in the Arctic Ocean, which signifies a 112% increase over 9 years. Most (59%) items photographed were plastic, with plastic bag pieces comprising the vast majority [11].
- **Plastics and the microparticles released from their manufacturing are highly concentrated in waterways near urban centers.** In just three days of sampling two rivers near Los Angeles, researchers measured 60 tons (2.3 billion individual pieces) of plastic particles floating towards the ocean [7, 12].
- **A single plastic bag will continue to impact the environment for centuries.** Over hundreds of years, a single plastic bag will break into progressively smaller pieces, with small plastic fragments

potentially posing an even greater danger to organisms of all sizes [8, 13].

The dispersal of plastic debris devastates wildlife.

Plastic bags, which float or accumulate on sea floors, pose a massive disruption to marine ecosystems; films and other plastic debris can kill animals at all levels of the food chain.

- **Endangered turtles can be killed by plastic bag ingestion.** Endangered sea turtles regularly eat plastic bags because they resemble jellyfish, a primary food source, often leading to death due to blockage of the intestines [12]. A study of endangered green sea turtles washed ashore in Florida found that 56% had man-made debris in their digestive tracts [14].



Figure 2: Endangered turtles consume plastic bags, mistaking them for jellyfish. Photo: <https://www.surfrider.org/>

- **Seabirds can be killed by plastic scrap ingestion** [15]. Approximately 50% of all seabird species are known to ingest plastic [12, 16, 17]. From a study of 186 seabird species worldwide, it was estimated that up to 90% of individual seabirds have ingested plastics [16]. White plastics are particularly harmful, as they are more easily mistaken for prey [18, 19]. Ingestion of plastic can cause intestinal blockage, hormonal abnormalities, and reproductive failure [15].
- **Plastic microparticles carry many chemical toxins and are consumed by small animals.** A single plastic pellet can absorb chemical pollutants up to 1 million times the concentration found in seawater. These particles are eaten by fish, zooplankton, and many other marine organisms near the bottom of the food chain, introducing them to

the bodies of larger animals [13, 17, 20]. These toxins have the potential to penetrate the cells and tissues of animals when ingested, including in humans [21].

- **Plastic bag accumulations smother organisms on the sea floor.** Experiments have shown that plastic bags—including the so-called “biodegradable” variety—prevent light and oxygen from reaching the ocean floor. This kills plants and small organisms on the sea floor, disrupting nutrient supply to the ecosystem [17, 22].

2 Fees and bans work

Across the country, different policies have been implemented with the goal of reducing the use of single-use plastic bags.

- A **fee** is a small charge for a single-use paper or plastic bag.
- A **ban** eliminates thin plastic bags but still allows for thicker ones.

Some places have introduced a ban on thin plastic bags in combination with a fee on remaining types of carryout bags (paper bags and thicker plastic bags).

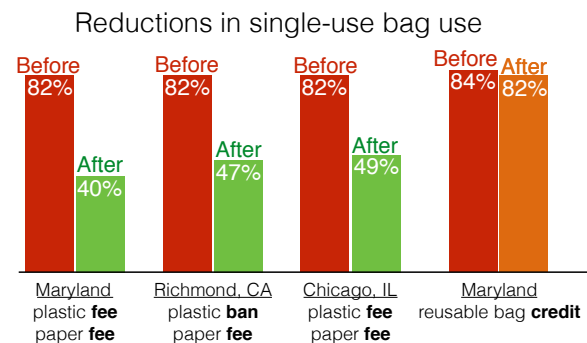


Figure 3: The percentage of customers using single-use bags drops in response to bans and fees, but not in response to reusable bag credits. Maryland data from Figure 3a in [1], Richmond data from Figure 1 in [23], Chicago data from page 2 of [2].

Fees effectively reduce plastic bag use.

Empirical studies convincingly show that even small fees are highly effective in reducing plastic bag use (Figure 3).

- **Montgomery County, MD:** A 5 cent fee on paper and single-use plastic bags reduced single-use bag use by **42 percentage points** (from 82% to 40%) [1].
- **Richmond, CA:** A ban on thin plastic bags and a 5 cent fee on other type of bags reduced single-use

bag use by **35 percentage points** (from 82% to 47%) [23].

- **Chicago, IL:** A 7 cent fee on both paper and single-use plastic bags reduced single-use bag use by **33 percentage points** (from 82% to 49%) [2].
- **San Jose, CA:** A ban on single-use plastic bags and a 10 cent fee on paper bags increased the percentage of bags that were reusable by **58.8 percentage points** (from 3.6% to 62.4%), and the percentage of customers using no bag increased by **24 percentage points** (from 19% to 43%) [9].
- **International:** Many international case studies have provided evidence for the effectiveness of plastic bag fees. In Ireland [24], Portugal [25], South Africa [26], and China [27], bans and fees resulted in usage reductions of **50 percentage points or more**.

We conclude that either of the following policies are effective in reducing single-use bag usage:

- A. A minimum **5 cent** fee on all single-use bags (plastic or paper), or
- B. A **ban** on single-use plastic bags, plus a minimum **5 cent fee** on all other bags.

Plastic bag regulations have immediate positive effects on the environment.

- **San Jose, CA:** Bag litter was reduced by 89% in the storm drain system, 60% in the creeks and rivers, and 59% in city streets just 1-2 years after banning single-use plastic bags (2011–12) (Figure 4) [9].
- **Ireland:** In Ireland, in the year after the introduction of a 15 euro cent fee on plastic bags (2002–3), the number of “clear” areas increased by 21% and the number of areas without “traces” increased by 56% [24].

The impact of plastic bag regulation on low-income communities is positive.

Do plastic bag fees harm low-income families? The evidence points to the opposite: small plastic bag fees of 5 to 7 cents are unlikely to negatively impact individuals, and are instead likely to have substantial positive effects on low-income communities:

- **Lower-income communities adjust to the fee effectively.** In Richmond, CA, customers of a dis-

count grocery store chain increased their rate of bringing reusable bags or no bags at all by 48 percentage points [23].

- **Plastic bag fees are expected to immediately reduce curb-side litter.** Immediate reductions in litter were observed in San Jose, CA [9], Austin, TX [28], and Ireland [24]
- **Air quality and public health are improved by a reduction in waste disposal.** As waste processing facilities are disproportionately located near low-income communities, these communities suffer the most from their presence due to toxic byproducts in the air and water [29].

Fees have extended positive effects

One might be concerned that a fee could agitate consumers and turn them against environmental policies. However, there is no evidence to support such a concern. Rather, it is likely that people will more strongly favor environmentally friendly practices:

- **Post-ban attitudes are more positive than pre-ban attitudes.** Consumers who were initially resistant towards a plastic bag ban in Australia were shown to be more in favor of the ban after it went into effect. Mere campaigning did not change their attitude or behavior, but the ban itself changed both [30].
- **Plastic bag fees increase support for related environmental policies.** A study on the plastic bag fee in England showed consumers were more supportive of introducing fees on plastic water bottles and excessive plastic packaging, along with other environmental protection fees after the plastic bag fee was put in place [31].
- **Reductions in plastic bag usage may lead to more environmentally friendly product choices.** A Harvard study that tracked grocery store purchases found that customers who brought their own bags tended to purchase more environmentally friendly products [32].

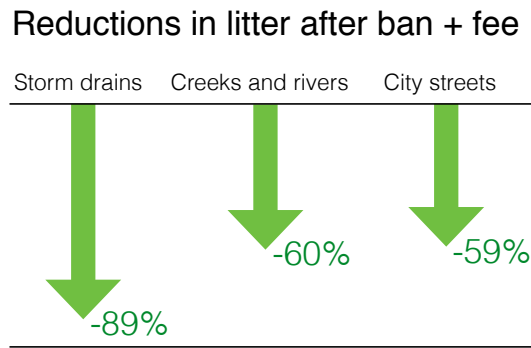


Figure 4: A ban on single-use plastic bags, combined with a minimum 10 cent fee on paper bags, was effective in reducing plastic bag litter in San Jose [9].

3 Ineffective policies

Here, we discuss policies that have not been shown to be effective, or that are demonstrably ineffective: a credit instead of a fee, a ban without a fee, recycling instead of reducing, and designing different plastic bags.

A credit instead of a fee is ineffective.

- **Giving a credit (reward) for bringing a reusable bag is ineffective.** A 5 cent credit barely reduced single-use bag use in Montgomery County, MD [1] (Figure 3: from 84% to 82%).
- This is consistent with established findings in psychology and behavioral economics: **Financial losses are felt more strongly than financial gains.** Nobel Laureates Kahneman and Tversky described this phenomenon, called “loss aversion” [33, 34]. It applies across a wide variety of product categories [35].
- **Thus, a 5 cent fee is expected to be more motivating than a 5 cent credit.** A credit would have to be (much) larger to achieve a similar effect to a 5 cent fee [1].

A ban without a fee is likely less effective than a policy with a fee component.

- In Austin, TX, estimates from clean-up events suggested that a ban on single-use plastic bags reduced the amount of such bags in litter; however, the city did not collect baseline data before the implementation of the ban [28].
- In Chicago, IL, a ban-only policy was perceived as ineffective, since retailers started giving thicker bags away for free. This later motivated the city to adopt a fee instead [2, 36].

- **Consumers notice when an item that they previously received for free now comes at a price** [37]. This suggests that a policy of a fee alone, and a policy that combines a ban with a fee are both more noticeable than a ban alone.

Recycling is no substitute for reducing.

Recycling is not an effective solution for the plastic bag problem:

- In New York City, plastic bags are not allowed in curbside recycle bins [38].
- Nationwide, only 11.5% of plastic bags are recycled [39].
- Plastic bags tend to jam sorting machines at recycling facilities [3].
- There is little market for recycled plastic bags, causing many to end up in landfills [3].

Designing different plastic bags is not a solution.

- A study of the physical dispersal properties of 8 commonly used plastic bag designs (varying in shape, thickness, and handle design) showed that no variation in weight or design can effectively prevent the dispersal of plastic bags; all current plastic bag designs are easily inflated by wind and disperse over long distances [8].

4 Conclusion

Based on evidence from environmental science, psychology, and economics, **we recommend a minimum 5 cent fee on both single-use plastic and paper bags, or a ban on single-use plastic bags combined with a fee on all other bags (paper or plastic).** Either measure is likely to have a large positive impact on: a) wildlife and the environment, b) the quality of life in communities of all socioeconomic levels, c) the efficiency of waste processing, and d) consumer attitudes towards the environment.

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