TOP TEN PLASTIC ITEMS FOUND ON US BEACHES:

Estimating US Consumption of Beach Litter Items

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Estimating US Consumption

BACKGROUND

The Ocean Conservancy contracted with DSM Environmental Services, Inc. (DSM) to provide updated United States estimates of quantities of the top ten items littered and found during beach cleanups, and the corresponding quantities of plastics consumed in the United States for each of these items. These items are listed below with descriptions for each contained in this summary report:

- PET Beverage and Food Bottles
- Plastic Food Wrappers
- Plastic Bottle Caps
- Beverage Cup Lids (Coffee and Fountain Drinks
- Straws
- Plastic Carryout Bags
- EPS Cups and Clamshells
- Plastic Cutlery
- Plastic Cups
- Cigarettes

DSM created estimates of the number of units and total weight for each category using the following primary sources:

- American Chemistry Council, 2022 Resin Review, which provides CY 2021 data for key resins except for PET;
- US EPA 2018 (most recent) Sustainable Materials Management mass balance data for materials generation, recycled and disposed in the U.S.;
- NAPCOR 2019 PET bottle rate report data;
- 2021 Beverage Container data from Breezeway Consulting (B. Dietly); and
- Published articles that contained data and estimates.

DSM also conducted internet searches to augment the published data. Finally, DSM weighed items (e.g., coffee cup lids, fountain soda and coffee cups, PET beverage bottles, straws, plastic eating utensils, and food wrappers) where unit count data were the only data available to convert units to mass or where estimates of mass were available but not unit counts.

The reader is cautioned that the final numbers contained in this report are rough estimates at best. Except for some categories (for example, PET bottles, where national published data are available for mass but not units), DSM had to make rough estimates as to what percent of the plastic resin reported by ACC as used for "packaging" was used for the specific item. In these cases, DSM researched the beach clean-up items on the internet in an effort to provide a best professional estimate of the quantities for the specific item and then compared this with the ACC data.[1]

A description of each item category followed by a brief summary of the data used to develop estimates of the units and mass for each of the top ten categories is provided below. This is followed by a table presenting best estimates of the units and mass of plastics used for each item category. While 2021 is the base year,

[1] Note that the data included in this report represents virgin resin used only, and in most cases does not include recycled resin, although for most packaging recycled resin represents a relatively small fraction of the total (typically less than 10 percent) which is within in the range of accuracy of DSM's estimates.

published data on many items comes from earlier years and no projections have been made for 2021.

DESCRIPTION OF ITEMS AND METHODS APPLIED TO MAKE ESTIMATES

PET Bottles

This estimate includes all types of PET Bottles, with the vast majority used to package beverages including water and soft drinks. DSM reviewed the 2018 estimates published by the US EPA for the total weight of "PET Bottles and Jars" generated as part of the municipal solid waste stream. DSM then used 95% of the 2019 estimate found in the NAPCOR rate report since 2019 EPA data were not yet available. DSM assumed the average PET bottle weighed 0.76 ounces (21.6 grams) or 21 PET bottles to a pound to develop an estimate of the PET bottle unit count of roughly 127 billion per year. DSM then reviewed this unit count with Breezeway Consulting (who specializes in PET beverage waste and recycling) to ensure it was a reasonable estimate.

Food Wrappers

This was an especially difficult category because the ACC resin review provides data for "food packaging film" for Low Density Polyethylene (LDPE) and Linear Low-Density Polyethylene (LLDPE), as well as Oriented Film Polypropylene (PP). The ACC does not provide data on PET, yet the literature also includes thin oriented films made of PET for food packaging.

An internet search for key words related to "snack food packaging", "chip bag packaging" and "candy bar wrappers" all result in the conclusion that Biaxially Oriented Polypropylene (BOPP) is the primary material used in all of these packages due to its moisture barrier properties as well as the fact that "PP has an operating temperature of 255 degrees F, which is ideal for its use in the packaging of prepared foods that require long-term unrefrigerated hermetical sealing".[2]

According to an internet search, the Polypropylene (PP) layer is bound to the interior layer of aluminum using PE (LDPE or LLDPE). As such, based on the internet searches carried out by DSM of uses of Low-Density Polyethylene (LDPE) and Linear Low Density Polyethylene (LLDPE) it is assumed that Polyethylene (PE) used for snack food is not greater than for PP. Therefore, we have carried quantities of PE similar to PP for snack foods based on all the other uses of PE for food packaging including, flexible bags for frozen foods, lids on rigid containers, the lining of steel cans and of fast-food paper packaging, and skin film (such as for frozen salmon).

For purposes of this analysis, DSM has assumed that 50 percent of the oriented film PP carried in the ACC resin review for 2021 is used for snack food packaging, and then has carried similar combined amounts of LDPE and LLDPE as placeholders for the inner layer. We have ignored PET as DSM does not have access to data on PET other than for bottles; but based on the internet searches it is likely that it is a small sub-set of PP and PE for film packaging.

Bottle Caps

Bottle caps on plastic bottles are assumed to be plastic only – typically PP. For this estimate DSM added 10% to the PET bottle unit count to account for other types of non-PET plastic bottles (mainly HDPE and PP). Bottle cap weights were found in the literature as well as

[2] https://www.leaf.tv/articles/how-are-snickers-candy-bars-made/

confirmed by DSM (by field testing) to develop a total weight estimate from the unit count.

Beverage Lids

Coffee Lids – DSM assumed that all coffee cups used (sold) also had a plastic lid and that any "biodegradable" lids consumed were included in the total estimate. Internet research yielded an estimate of 50 billion coffee cups used annually with circular references dating back to an estimate in 2010.[3] For the 50 billion lids, a combination of primarily, PP and PLA for hot coffee, and PET and PS for iced coffee, at an average weight of 4.5 grams, roughly 248,000 tons of coffee lids are generated each year.

Fountain Beverage Lids – For fountain beverage lids, DSM assumed that roughly 95% of fountain cups used would have a lid and made an estimate based on cups consumed. This estimate was made using the number of gallons sold of carbonated soft drinks for use as fountain beverages found in Beverage Digest. Assuming a 95% lid use (as some cups are refilled) and a 20-ounce cup and accounting for some additional sale of non-carbonated fountain beverages (such as teas, lemonade, fruit punches, and iced coffee) roughly 10.3 billion cups were used for fountain drinks that had a plastic lid. The lids can be made from a number of plastic resins, including PET, PP, and PS. Based on some field weight data, DSM estimates that typical fountain soda and iced coffee lids weigh 10 grams each for an estimated 114,000 tons (rounded) of fountain lids consumed each year.

Straws

While the estimate of 500 million straws a day for Americans is widely cited, it was made by a 9-year-old after calling three straw companies in 2011, and has been widely cited since. However, a lower and more reliable estimate was made in 2016 by Technomics (a firm specializing in the food service industry) whose most recent study of disposable food service packaging (which looked at over 30 different categories of packaging) included an estimate that Americans used 172 million straws each day.

The most recent projection assumed a growth rate of 2–3 percent per year in the straw market (even with bans) and estimated that somewhere around 175 million straws were consumed each day in the US in 2018. This totals roughly 64 billion straws a year at an estimated 0.42 grams a straw, or nearly 30,000 tons of straws.

Plastic Bags

Plastic bags, wraps and sacks totaled 4.2 million tons in 2018 according to EPA estimates. Plastic retail or carry out bags represent a share of this total. DSM attempted to estimate current retail bag use and waste generation in the U.S. with estimates ranging widely due to the institution of bag bans and fees in many states and municipalities.

Travis Wagner's research (University of Maine) on plastic bag use and bans cites a US International Trade Commission (USITC) estimate of national annual per capita consumption of single-use plastic shopping bags at 319.5 for the year 2014, "which includes bags consumed at grocery, drug, convenience, department, specialty retail, discount stores, and restaurants." This would put total USA consumption at 103.5 billion plastic shopping bags in 2014. The research also cites a decline in future demand for plastic shopping bags primarily because of increased use of reusable

[3] Plaine Products estimated that 2.5 billion coffee cups are consumed per day globally making the US estimate roughly 5 percent.

bags and the increased imposition of local bans, fees, and taxes (USITC, 2016). However, Mordor Intelligence report on the "North America Retail Bags Market – Growth, Trends, Covid-19 Impact, and Forecasts (2022-2027)" projects a Compound Annual Growth Rate of 5.57% from 2020 – 2027 for North America.

In addition, the pandemic reversed some of the trend toward eliminating retail plastic bags supposedly for health reasons - and in some cases even regulations – to switch to single-use plastics as a perceived safer alternative to reusable bags that can be washed. For instance, the Governor of New Hampshire issued a health order requiring stores to use single-use plastic or paper bags (Tabuchi, 2020[34]). The evidence to support this push from a public health perspective is, however, weak (Laubinger and Varghese, 2020[35]).

For example, New York started enforcing its ban on plastic bags in October 2020, after a seven-month delay (Associated Press, 2020[88]); and Freedonia market research estimated that usage of retail bags was down in 2020, but costs were up with thicker mil, more reusable bags sold, and that bag market growth would continue.

In the end, DSM could not identify a recent estimate of retail bag consumption (without purchasing market research data), but with statewide bans of retail bags enforced, estimates that roughly 100 billion retail bags were likely still used in 2021 even with the bans in place in many states and municipalities.[4] At an estimated 7 grams per bag that would equal 770,000 tons a year.

EPS Foodservice - Cups and Clamshells

The ACC Resin Review provides estimates of the tons of Polystyrene (PS) used for domestic consumption in food packaging and food service. Expanded Polystyrene (EPS) is a subset of this material. PS is used in cups and clamshells, plates, bowls, trays and platters as well as in cutlery and other items.

As with retail bags, many municipalities and some states have banned the use or sale of EPS for, especially food service items. According to research by Wagner, as of December 2019, there were 249 local bans in the USA covering 12.85% of the nation's population. He also found that a small percent (9.6%) restrict distribution only on government and public property while 65.9% ban distribution by restaurants and food providers with another 8.8% also banning EPS food packaging use by grocery stores. Finally, 15.7% were said to have adopted an expanded ban that includes the full ban but also bans other single-use plastic food ware related items including the selling or distributing of EPS coolers and single-use plastic utensils, straws, stirrers, lids, cups, plates, and containers.[5]

The ACC 2022 Resin Review data shows that PS use in "Food Packaging and Food Service" fell from 2,758 thousand pounds in 2017 to 2,390 thousand pounds in 2021 or almost 14%. This still represents 1.2 million tons of PS used in food packaging and food service in 2021.

Because of the difficulty of teasing out EPS from other food service PS, DSM used recent research conducted by Travis Wagner[6] which

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[4] https://www.plasticstoday.com/packaging/despite-bans-demand-retail-bags-forecast-grow

[5] Wagner, Travis. *Policy Instruments to Reduce Consumption of Expanded Polystyrene Food Service Ware in the USA*. Detritus / Volume 09 - 2020 / pages 11-26.

[6] Wagner, Travis. *Policy Instruments to Reduce Consumption of Expanded Polystyrene Food Service Ware in the USA*. Detritus / Volume 09 - 2020 / pages 11-26

estimated 36.4 billion cups used and 12 billion clamshells for 2019 consumption.

Using an average weight of 10 grams per cup and 36.4 billion cups (Wagner, 2019) and 7 grams per clamshell, DSM estimates that nearly 500,000 tons of EPS cups and clamshells are consumed annually.

Cutlery

Most counts of disposable cutlery include all types of cutleries sold - some of which is PLA, World Centric/biobased, and even bamboo – of which all are included in this estimate. The most cited estimate for disposable cutlery use is 40 billion pieces (2018)[7] which is an updated estimate made from an earlier estimate of 32 billion (Clean Air Council, Trent). Other estimates are for 100 million pieces a day in the United States or a total of 36.5 billion per year. This lower estimate was the unit estimate used by DSM.

Plastic cutlery is estimated to have an average weight of about 3.8 grams per item totaling almost 150,000 tons of disposal cutlery per year. An estimated 90% is assumed to be made of lighter weight polystyrene.

Plastic Cups

The estimate of disposal plastic cups (exclusive of EPS cups) was difficult as no recent reliable data specific to the US could be found without the purchase of expensive market reports. The U.S. was estimated to use about 108 billion disposable cups in 2013 according to the Technomic disposables study. About half of those cups were plastic or foam and half were made of paper. Some plastic cups are made from PET as well as from more expensive PP.

A more recent estimate found that there were 120 billion disposal cups used each year however there is no reference to the percentage made from paper versus plastic. Finally, another reference point are global estimates – at 500 and 580 billion - when reporting on disposable cup consumption. Using the 120 billion figure and the estimate made for PS/EPS cups, roughly 83 billion cups are made of materials other than PS/EPS. Finally, EPA estimates that only 210,000 tons of non-PS/EPS plastic cups and plates were disposed in 2018 excluding PET cups.

With these data, DSM made a conservative estimate of disposable plastic cup use at 55 billion of which roughly 18.6 billion plastic cups are made primarily of non-EPS PS, PET, and PP. This includes those used for fountain drinks, picnics and parties as well as for lab specimens and other uses. This represents an estimated 684,000 tons of all plastic cups and 283,000 tons made of resins other than PS/EPS.

Cigarettes

The 2019 Federal Trade Commission Cigarette Report estimates that 202 billion cigarettes were sold in 2018. Cigarette filters are primarily made of plastic and weigh about .2 grams for roughly 45,000 tons of cigarette filters being disposed each year. Since most cigarettes are currently consumed outside, this plastic item may be the most widely littered and any estimate of cigarette litter may be largely undercounted.

MARKET SHARE

Introduction

As agreed, in DSM's Scope of Work, this section represents a cursory overview based on Google

[7] See : https://calbizjournal.com/the-quest-to-develop-alternatives-to-single-use-plastic-utensils/ https://www.forbes.com/sites/lauratenenbaum/2019/07/16/plastic-cutlery-is-terrible-for-the-environment-and-we-dont-need-to-have-it-delivered/?sh=3384a36f4019

searches of the primary brand owners producing/using the ten items analyzed above. In many cases this section will not surprise anyone observing US culture.

PET Beverage Bottles

It is somewhat difficult to tease out the largest producers of bottled beverages in the US because the majority are also very large producers/distributors of snack foods as well. In general, the largest include:

- Coca-Cola – largest producer of carbonated beverages in the U.S
- Pepsi-Cola – total sales exceed Coca-Cola because Pepsi also produces such a large share of salty snacks including especially Doritos
- Nestle – water and candy
- Monster – energy drinks
- Keurig Dr Pepper

Food Wrappers

According to Statista[8] 68 percent of Americans consume sweets and candy bars, 60 percent chips and crisps, 49 percent nuts, and 40 percent cookies.

This type of packaging encompasses several key categories including candy and "salty snacks". The top candy producers are, in order of annual sales[9]:

- Mars (Snickers, Twix, Dove, 3 Musketeers) - $1.1 billion
- MM's – $712 million
- Reese's - $412 million
- Hershey - $394 million
- Nestle (Kit Kat) - $345 million
- YS Candies (Twizzlers) $264 million
- Skittles - $261 million

The top "salty food snacks" is dominated by Frito-Lay (a division of Pepsi) with 36 percent of this market[10]. Other larger chip producers include, in order of sales[11]:

- Ruffles
- Pringles
- Utz
- Kettle Brand
- Cape Cod
- Herr's
- Wise

Beverage Lids, Straws, Plastic Cups

DSM has elected to combine these three categories because they essentially all are related primarily to fast food and convenience store consumption.

The top ten fast food retailers, shown in order of number of stores in the US, are[12]:

- Subway – 22,190 stores
- Starbucks – 15,328 stores
- McDonalds – 13,862 stores
- Dunkin – 9,083 stores
- Burger King – 7,029 stores
- Taco Bell – 6,329 stores
- Pizza Hut – 6,561 stores
- Dominos – 6,355 stores
- Wendy's – 5,881 stores
- Dairy Queen – 4,361 stores

[8] https://www.statista.com/forecasts/1093504/most-popular-kind-of-snacks-in-the-us

[9] https://www.zippia.com/advice/largest-candy-brands/

[10] https://www.forbes.com/sites/greatspeculations/2014/06/27/frito-lay-dominates-u-s-salty-snacks-but-rising-cracker-sales-could-stall-growth/?sh=3fb7ddaa4225

[11] https://potato-chips-machine.com/chips-making-news/top-10-bestselling-potato-chips-brand.html

[12] https://www.qsrmagazine.com/content/americas-50-biggest-fast-food-chains

Note that PepsiCo owns both Taco Bell and Pizza Hut, as well the 12th ranked fast food retailer, KFC.

The top convenience store chains in the US are[13]:

- 7-Eleven – 9,364 stores
- Mac's Convenience Stores (owned by Alimentation Couche-Tard) – 5,933 stores
- Speedway – 3,900 stores
- Casey's General Stores – 2,281 stores
- E.G. America (store names include Cumberland Farms, Quik Stop, Mini Mart) – 1,679 stores
- Murphy USA – 1,489 stores
- GPM Investments (numerous store names) – 1,489 stores
- BP America – 1,017 stores
- Extra Mile Convenience Stores – 942 stores
- Wawa – 880 stores

Note that three of these top ten are owned by companies based outside of the US: 7-Eleven (Japan); Mac's (Canada); and E.G America (England).

Plastic Bags

A list of the top plastic bag manufacturers is probably not very useful as they are not household names and typically produce retail bags together with other bags, including garbage bags, industrial bags and sacks, as well as many other types of plastic bags.

Retailers providing retail plastic bags include, especially, convenience stores (listed above), grocery stores, and pharmacies.

The largest grocery store chains in the US include, in order of $ sales[14]:

- Walmart
- Amazon (including Whole Foods)
- Costco
- Kroger
- Albertsons
- Ahold Delhaize
- Publix
- H-E-B
- Meijer
- Target

The largest pharmacy retailers that are not affiliated with the large grocery chains listed above are[15]:

- Walgreens – 9,323 stores
- CVS Health – 9,900 stores
- Rite Aid Corp. – 2,732 stores

[13] https://www.zippia.com/advice/largest-convenience-store-chains/

[14] https://www.foodindustry.com/articles/top-10-grocers-in-the-united-states-2019/

[15]https://en.wikipedia.org/wiki/Pharmacies_in_the_United_States

FINDINGS

Based on the data DSM has been able to acquire without purchasing market research reports; combined with DSM's internet research and field weighing, results in the estimates shown in Table 1 below. Table 1 presents DSM's best estimate of unit counts and mass for each of the top ten items found in beach cleanups.

As illustrated by Table 1, the US consumed roughly 874 billion (rounded) plastic items found in the top beach cleanup materials in 2021 with a total mass of 5.7 million tons.

Table 1. Estimated Units and Mass of the Top Ten Materials Found in US Beach Cleanups

	PLASTIC ITEM	Units	Unit Weight (grams)	Total Weight (tons)
1	**PET Bottles**	126,981,750,000	21.60	3,023,375
2	**Food Wrappers**	76,735,763,737	3.50	295,850
3	**Bottle Caps**	139,679,925,000	1.42	218,639
4	**Beverage Cup Lids**			
	Coffee Cup Lids	50,000,000,000	4.50	248,020
	Fountain Beverage Cup Lids	10,336,000,000	10.00	113,935
5	**Straws**	63,875,000,000	0.42	29,572
6	**Plastic Carryout Bags**	100,000,000,000	7.00	771,619
7	**EPS cups and clamshells**	48,395,000,000		493,754
	Cups	36,387,000,000	10.00	401,098
	Clamshells	12,008,000,000	7.00	92,656
8	**Disposable Cutlery**	36,500,000,000	3.80	152,891
	EPS	32,850,000,000	3.50	126,738
	Other	3,650,000,000	6.50	26,152
9	**Plastic Cups**	55,000,000,000		
	EPS cups (above)			
	All Other	18,613,000,000	13.79	282,958
10	**Cigarettes**	202,900,000,000	0.20	44,732
	TOTAL	**874,016,438,737**		**5,675,345**

Note that the US EPA estimates that 14.53 million tons of plastic were used in containers and packaging in 2018. The ten items in Table 1 represent roughly 39 percent of the US EPA total. Excluding cigarettes, these items also make up 39% of containers and packaging by weight.

Finally, as an aside, while not a top ten beach cleanup item currently, masks are becoming an increasingly littered item. It is estimated that 52 billion masks were produced globally in 2020, and roughly 1.56 billion entered oceans that same year, amounting to between 4,680 and 6,240 metric tonnes of plastic pollution from masks alone.[16]

[16] Phelps Bondaroff, Teale, and Cooke, Sam. (2020, December). "Masks on the Beach: The impact of COVID-19 on marine plastic pollution." OceansAsia.