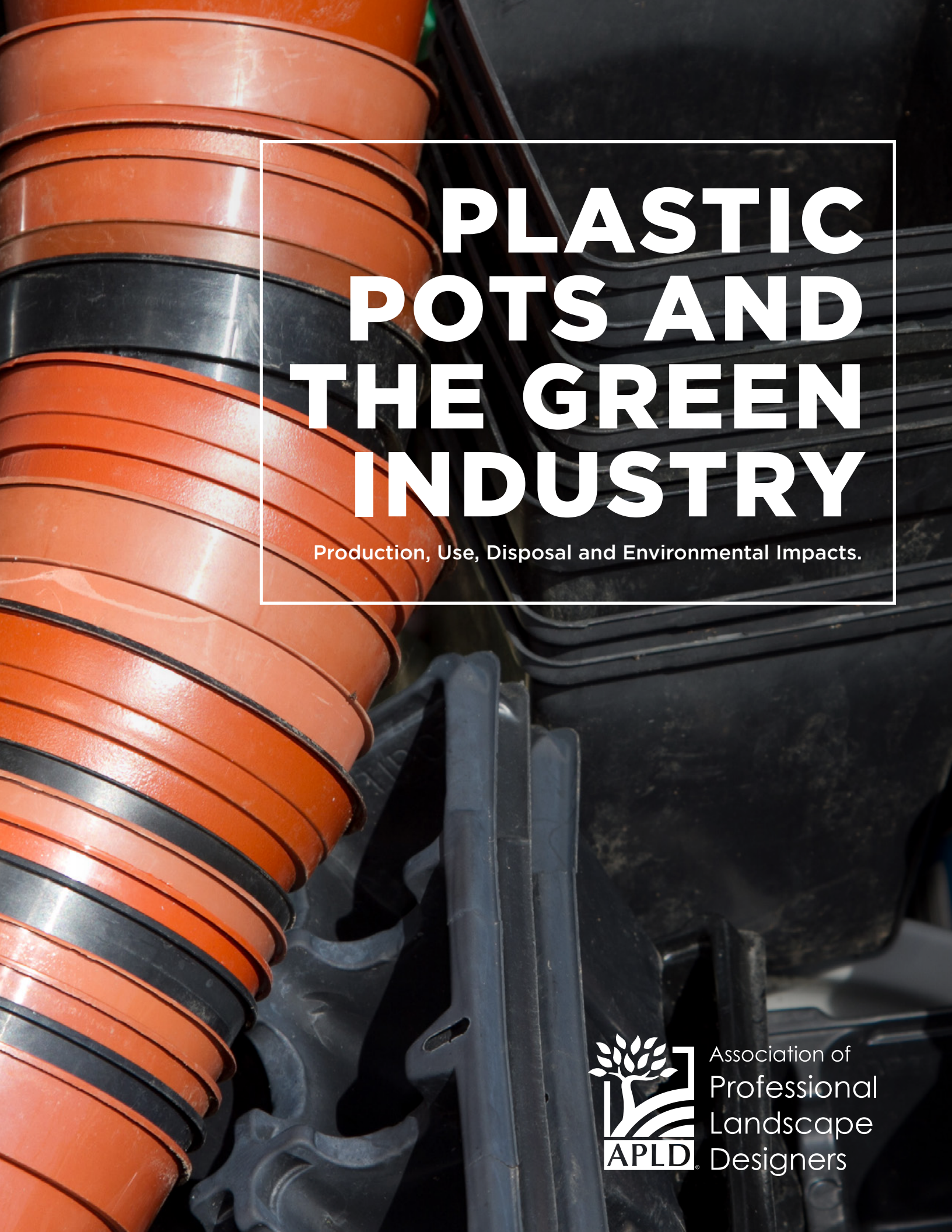

PLASTIC POTS AND THE GREEN INDUSTRY

Production, Use, Disposal and Environmental Impacts.

Association of Professional Landscape Designers

APLD

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SUMMARY

The green industry is the driver of plastic plant pot production and use. This report describes the development of this industry, its phenomenal growth and successes, and the resulting significant negative ecological effects from the accumulation of used pots. Largely single-use, the majority of plastic horticultural pots are disposed of in landfills. Although the materials are potentially recyclable, the product is difficult to recycle due to contamination, and the predominantly black material results in frequent inability of scanners to distinguish the resin content and enable sorting. On top of this, markets for this type of low-quality recycled material have plummeted, resulting in an ever-increasing cache of used material in the United States and Canada. At the same time, production of plastic products using virgin content has increased dramatically. Although numerous producers are engaged in developing alternative pots, matching the economy and durability of plastic pots has been challenging, and growers have been hesitant to adopt them. This paper presents the consequences of increasing production and use of these pots without a solution to the problems of disposal.

INTRODUCTION

Every landscape project is different; however, if planting is part of it, there is a common denominator: plastic pots. Usually black, these are the containers in which plants are grown and shipped, and later discarded after installation. The adoption and use of plastic pots has facilitated efficient production and shipping and contributed substantially to the growth of the landscaping industry.

Completed projects, however, yield vast numbers of used pots each year, generating an avalanche of horticultural plastic waste that is difficult to manage. Options include reuse – often costly and impractical on a commercial scale; recycling – if there is a facility that accepts them; incineration – if that capacity exists; or – if all else fails – burial in a landfill. If sustainability requires a closed loop, such that the material for producing the pot can be endlessly re-used, then achieving that critical goal through existing methods seems unlikely. Plastic pots' features such as durability, flexibility, variety of sizes and shapes and low cost,[1] coupled with changes in markets for recycled goods, results in plastic pots continuing to accumulate.

Landscape designers recognize that we are indirect consumers of these pots, via our projects, and therefore help to perpetuate the demand for these products. The Sustainability Committee of the Association of Professional Landscape Designers (APLD) wants to understand the scope of the problem. How many of these plastic pots are manufactured and used in the United States and Canada? How many are actually recycled? And, if recycled, is there a strong market for that material? Are they accumulating, with nowhere to go? As long as they are out there, what sort of impact do they have on the environment and human health?

These are among the questions this research seeks to answer. APLD has joined with the Missouri Botanical Garden, a leading public garden in St. Louis, Missouri (which began blazing this trail with its own ambitious initiative to recycle plastic pots) to find the facts and to compile them in this report. Here we share what we have learned about the production, use, disposal, and environmental impact of horticultural plastics.

PLASTICS IN THE GREEN INDUSTRY

A growing outcry against single-use plastic and the burgeoning amounts impacting our world are catching people's attention. Plastic bags, utensils, straws and cups are some examples of what gets used once and discarded. In the green industry, there are a variety of plastic products in use. For the purposes of this research, the focus is on plastic horticultural pots (referred to as "plastic pots" going forward).

Where these single-use plastic pots end up remains largely under-reported. Those of us in the green industry go through hundreds if not thousands of them each season. We rely on people in the nursery or recycling industries to process them appropriately. Others stockpile them in yards or storage containers waiting for the opportunity to recycle them. Whether it is on a large or small scale, plastic pots have become an industry-wide problem, with up to 98 percent of them ending up in landfills.[2]

Unlike many other goods that are packaged and sold, plants are products that are living things requiring special containment to not lose their integrity or value. Before plastic containers were used, farmers sold and shipped plants bare-root, usually covered in a clay-based slurry to keep the roots moist. Alternatively, they were balled and burlapped by hand. Later, growers used ceramic pots, even though they were heavy, prone to breakage and not easy to transport. They were reliable vessels for getting a plant to wholesalers and retailers. Also, in the 1940s and '50s, the use of tar paper and commercial food cans used by restaurants were commonly used as containers.

After the brief recession following World War II had passed, people had money in their pockets and the home construction market grew at an unprecedented rate. The demand for beautiful home landscapes soon followed, resulting in fast growth of the green industry to supply the needed plant material. The developing plastics industry soon saw this as an opportunity and moved to meet the need for containers.[3]

The plastics industry was developing rapidly prior to WWII, and was given extra impetus by the war effort. Plastics were vitally important in the development of armaments, aircraft components and a host of related materials. Within months of the end of the war, thousands of people lined up to get into the first National Plastics Exposition in New York, a showcase of the new products made possible by the plastics that had proven themselves in the war. After two decades of scarcity, the show offered an exciting preview of the promise of polymers. By that time, different types of plastics were being developed, along with the technology and machinery to mass-produce from raw plastic powders or pellets.[4]

As research and development continued, plastics steadily penetrated numerous markets. The material's durability, strength and design flexibility were useful for unique and innovative applications in numerous sectors. Between 1950 and 2017, 8.3 billion metric tons of plastic was produced.[5]

Once plastic pots hit the market, the green industry became one of the fastest growing industries in modern history. Plastic pots enabled growers to expand production. By the 1980s, plastic pots had become the predominant container type in the United States' greenhouse and nursery industry.[6]

Polymers' long molecular chains allow plastic to be pressed, rolled, stretched and molded into every conceivable shape. This versatility was an impetus to designs that brought numerous advancements in efficiency in the growers market such as automated irrigation, optimized handling and shipping logistics and mechanization of filling, seeding and plug transplanting. As technology improved, plastic container manufacturers developed a variety of different container types, expanding the numerous methods of forming the versatile material into useful products.

The production of plastic pots typically involves the use of four different types of resins (plastics). They include: high-density polyethylene (HDPE #2), low-density polyethylene (LDPE#4), polypropylene (PP #5) and high-impact polystyrene (PS #6). For recycling purposes, each has a designated number indicating the recyclability.[7] Table 1 summarizes these types of plastics, their uses, recyclability, and the sorts of products they may become.

Black plastic pots are made from a variety of recycled plastics.

PLASTICS USED IN HORTICULTURE

Plastic	Resin Identification Code	Pros	Cons	Recycled Uses
High Density Polyethylene (HDPE)	#2	Rigid durable plastic used for outdoor trees and shrubs. Resists breakage, does not degrade quickly under UV light; thermally and chemically resistant.		Plastic timber, picnic tables, railroad ties.
Low Density Polyethylene (LDPE)	#4	Relatively inexpensive; used to cover greenhouses; mulching material.	Requires special recycling if in contact with pesticides; some companies offer wash line systems for cleaning.	Plastic composite lumber for decks; floor tiles; reusable grocery bags; compost bins and trash cans.
Polypropylene (PP)	#5	Plant containers for greenhouse production; durable; lightweight and resists breakage; not prone to leaching.	Yield losses are pretty high and standardized packaging in PP is low.	Typically not recycled.
High Impact Polystyrene (HIPS)	#6	Flats and trays for seedlings and small plants; inexpensive and lightweight.	Most often discarded or recycled rather than reused.	Can be recycled back into trays.

Table 1

The decades of the 1970s and '80s were a time of rapid increase in plastic pot production. Plastic pots were gaining momentum in the marketplace and the plant industry had unprecedented gains. The massive new market contributed to the unprecedented success of the green industry. By 2018, it provided 2,315,357 jobs and contributed $348 billion dollars to the US economy.[8]

The rise of large retail chain stores with garden departments has made plants and other horticultural products more readily available to consumers than ever before. They are now available in nearly every community in the US and Canada. To meet the growing demand of retail clients and the green industry workforce (nursery and greenhouse production, landscape services and horticultural product distribution) the demand and value of plants has skyrocketed. Driven by such a strong consumer market, growers produce an unprecedented variety and volume of plants (both ornamental and nursery). In 2018, the United States had 7,210 nursery and floriculture production businesses and 3,404 nursery and florist wholesalers.[9]

To illustrate this market growth, in the US between 2015-2018:

- The number of floriculture producers increased from 5,913 to 6,386.[10]
- The wholesale value of floriculture crops (for all growers with $10,000 + of sales) of herbaceous plants sold in pots increased by 9 percent from $4.37 billion to $4.77 billion.[11]
- The number of herbaceous perennial plants sold in pots increased from 124,386,000 to 146,619,000.[12]
- The number of annual/bedding plants sold in pots increased from 153,616,000 to 180,516,000.[13] [Note that numbers for annuals and perennials do not represent every plant sold in pots, nor do they represent every seller. Totals are based on a sampling of selected popular species. Operations reporting had annual sales of $100,000+.]

And that is not all:

- In 2017 the US nursery industry (trees and shrubs) was valued close to $6 billion.[14]
- Canada currently has 1,159 retailers and nurseries and 351 wholesale growers.[15]
- Ornamental horticulture represents the largest horticulture (flower, plant and nursery) sub-segment crop in Canada, C$2.3 billion.[16]

The widespread acceptance and use of plastic pots made possible the growth and efficiency of the green industry.

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Most plants are now sold in single-use, petroleum-based plastic pots. Large growers and nurseries each process tens of millions of plastic pots in one season. As we have seen, in 2018, 180,516,000 potted annuals and 146,619,000 potted perennials were sold.[17]

Based on USDA data from 2009, 4 billion container/plant units were produced by the container crop industry that used 1.66 billion pounds of plastic.[18] Unfortunately, data showing the quantity of plastic used has not been calculated since, but it is reasonable to assume that it has continued to increase.

Since 1964, plastics production has increased twenty-fold, reaching 311 million metric tons in 2014. Plastics production is expected to double again in 20 years and almost quadruple by 2050.[19] In fact, production is reported to have risen by an average of 8.5 percent every year since 1950, soaring from 2.3 million tons to 448 million tons by 2015,[20] a higher rate of sustained growth than any other industry.[21] In addition, over 90 percent of plastics produced are derived from virgin fossil feedstocks. This represents about 6 percent of global oil consumption, which is equivalent to the oil consumption of the global aviation sector.[22]

ENVIRONMENTAL IMPACTS AND SUSTAINABILITY ISSUES

In general, the increasing amounts of plastics being produced are having real, adverse impacts on the health of all living things and our global ecosystem. Due to its molecular makeup, a single plastic item can take hundreds to thousands of years to completely decompose. As it does, it degrades the natural systems around it through leakage of chemical substances such as additives and stabilizers used during the manufacturing process.

On a global basis, the production of plastic feedstocks from fossil fuels, emissions from the manufacturing process, and the disposal of used plastics are posing increasing environmental and health issues. Greenhouse gases and other pollutants are emitted into the air during both manufacturing and incineration. On the manufacturing end, the negative environmental impact is two-fold: 90 percent of plastics are derived from virgin fossil feedstocks and they emit considerable greenhouse gases. A wide variety of toxins have also been shown to be associated with the oil and gas industry. These toxins have direct and documented impacts on skin, eyes, and other sensory organs; the respiratory, nervous, and gastrointestinal systems; and on the liver and brain.[23]

Significant amounts of degraded plastics are ending up in fresh and marine waters, as well as in secure and unsecured disposal sites (landfills) on land. As these plastics gradually break down into smaller and smaller particles, polymers and associated additives find their way into organisms and all parts of the environment, including our food supplies. In the span of time it takes for plastics to decompose in landfills, chemicals are released into the soil, ground water and ultimately our waterways.

In recent decades, as the magnitude of our use of resources has become clear, the need for sustainability of these resources has become a central concern. Combustion of fossil fuels is clearly a major driver of climate change which threatens economic and social systems globally. For many in the energy industry, a transition to using fossil fuels for manufacturing of materials such as plastics, rather than energy generation, would be a preferable way forward. However, to achieve a more sustainable circular economy, there is a need to ensure that any such products are also recyclable to the maximum extent possible.

Significant amounts of degraded plastics are ending up in fresh and marine waters, as well as in secure and unsecured disposal sites on land.

THE 3Rs OF WASTE MANAGEMENT: REDUCE, REUSE, RECYCLE

The waste management industry has come under increasing pressure to better manage how society deals with waste. The most common approach is to use a hierarchy or order of priority of actions to be taken to reduce waste and manage the amount produced. This hierarchy is known as the 'Reduce—Reuse—Recycle' approach and has been widely promoted as a logical approach to dealing with this issue. Society and industry are being urged to first try to reduce or decrease the amounts of waste materials, then to reuse materials to the maximum extent, and finally to recycle as much of the remaining waste as possible. Each of these approaches can be applied to our situation with horticultural plastics.

REDUCE

Although the green industry has adopted multiple ways to advance environmental sustainability (Integrated Pest Management, enhancing water use efficiency, reducing pesticide use and runoff, improving energy efficiency) reducing the number and volume of plastic pots has not yet been a major focus. Many consumers now view the use of nonrenewable plastic products as an unsustainable practice. In response, some manufacturers of plastic pots and growers are exploring ways to make their businesses more 'green,' both in terms of environmental impact and public perception.[24] Reducing the use of plastic pots by switching from petroleum-based plastic containers to eco-friendly alternative types is a highly visible means to meet this consumer demand for sustainable products.[25, 26] Research shows consumers are willing to pay an additional charge for recyclable, plantable and compostable pots vs. traditional plastic.[27, 28] A Nielsen Company survey conducted in October 2018 found 81 percent of global responders said it was extremely important for companies to roll-out initiatives to improve the environment.[29] Along with the demand for products that are environmentally sustainable, the public is also looking for those that are produced and marketed using sustainable methods, such as recycled or waste product materials.[30] As a result, garden centers, container manufacturers, nurseries, etc. are looking to expand environmentally-sound options. Studies have indicated that container type is an important determinant of consumer product preference.[31]

Environmental sustainability and carbon footprint concerns have driven the development of three types of alternative containers: plantable, compostable, and bioplastics. Alternative containers can be made from a variety of materials (see Table 2).[32]

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TYPES OF ALTERNATIVE POTS			
Type	**Description**	**Benefits**	**Constraints**
Plantable • Can be planted directly into the soil. Designed to stay intact during short-term production; within 3-12 months can be planted directly into soil.	• Mostly made from peat, cow manure, rice hulls, wood pulp, coconut coir, paper and/or hemp.	• Allows roots to grow through the walls of the pot as it decomposes in the landscape • no need to remove a container • Cleanup and disposal costs are drastically reduced • Rate of decomposition is influenced by weather, soil type and irrigation.	• Appearance • Durability • Degradation is possible during production process. • Large nursery production concerns
Compostable • Pots designed for the plants to be removed when planted.	• Made from rice hulls, recycled paper, cardboard, poultry feathers, bamboo or other natural fiber waste products.	• Some types (such as molded fiber and rice hull containers) are available in sizes for production of larger nursery crops.	• They are either backyard compostable or industrial compostable (composting that involves heating it to a high enough temperature that allows microbes to break it down.)
Bio-Plastics • Plastic material produced from renewable biomass sources. • https://en.wikipedia.org/wiki/Bioplastic	• Made from plant or other biological material (such as extracting sugar from corn or sugarcane to a polyactic acid (PLA)) instead of petroleum.	• Can be re-used or recycled and some will disintegrate with time • Durable, lasts 10-15 years • Can withstand fairly wide range of temperatures. #21a • Reduced carbon footprint compared to containers made strictly from petro-chemicals. #2	• Must be sent to a landfill, industrially composted or recycled like most petroleum-based plastics

Table 2

Most alternative containers differ from virgin petroleum-based plastic containers in that they are intended to be either plantable or compostable. Typical components are plant-based or organic materials that are naturally fibrous or are chopped or ground.[33] They are produced using a range of natural materials typically derived from feathers, manure, rice hulls and straw.[34] Consumers are drawn to products that can be used multiple times and those that do not create waste and pollution. Many variations exist and multiple companies are trying to gain a foothold in the market.

Experiments have been conducted comparing alternative pots to ones that are petroleum-based. In one evaluation, researchers from multiple states worked on a USA Specialty Crop Research Initiative project to evaluate alternative containers during and after greenhouse production as well as above-ground and pot-in-pot nursery production. A wide variety of brands such as CowPot, StrawPot, NetPot, Jiffy-pot, Fertil Pot and SoilWrap were evaluated. Some were found to require more water than others, and some had algal and/or fungal growth and became fragile. Still others, however, exhibited good durability under typical growing conditions.[35] Another multistate evaluation looked at plant growth and water use in plastic vs. alternative pots. Results showed that generally plants grown in fiber containers used more water than those in plastic. The researchers evaluated wood pulp, recycled paper, fabric, keratin and coir fiber. Porosity and environmental conditions had significant impacts.[36, 37] Plant growth in plastics and alternatives was similar; however, water use was greater in alternative pots.

A recent study entitled, "Horticulture Industry Adoption of Biodegradable Containers," discovered that the majority of growers and landscape service providers had little knowledge about biodegradable containers available on the market.[38] The results indicate that more education is needed amongst all potential users, consumers included.

A third alternative, that does require industrial composting or recycling but does not contain the same amount of plastic as traditional pots, is bioplastic. Bioplastic refers to plastic made from plant or other biological material instead of petroleum. It is also often

called bio-based plastic. Bioplastics are similar to traditional plastics and are created either from biopolymers (non-petroleum based) or a blend of bio- and petrochemical-based polymers.[39] An advantage is that they can be produced on existing plastics-processing equipment and can be made from materials that are 99 percent renewable. They also have a much smaller carbon footprint compared to containers made only of petroleum-based plastic. The global bioplastics market had a market valuation of more than $4 billion in 2017 and is expected to be almost $15 billion by 2023.[40]

The question remains as to whether manufacturers will find it possible to routinely produce alternative pots in significant volumes.

In response to growing public concern about plastic pollution and excessive plastic waste generation, many companies are making high profile, global commitments to make their products recyclable, reusable or compostable. Large brand companies are committed to using more Post Consumer Resin (PCR). The producers of horticultural pots have begun to be more environmentally conscious and are producing more eco-friendly containers. “Sustainability” is a term they are eager to couple to their products. As a matter of fact, the position “Sustainability Manager” is a title that is quite common now. Companies that have started manufacturing biodegradable and compostable containers are trying to meet the demands of millennials who are particularly aware of how their purchasing and use of products impacts the environment.

East Jordan Plastics, a major manufacturer of pots, trays and containers in East Jordan, MI, collects pots they have manufactured and recycles them into new plastic pots. In doing so, they create their own feed stream with the potential to recover (through a closed loop system) upwards of 60 percent of the energy used in pot production. East Jordan Plastics has the capacity to recycle over 10 million pounds of plastic material annually.[41]

Manufacturers such as Poppelmann in Canada have been seeing a steadily increasing demand for sustainable pot alternatives. They report that consumers are willing to pay more for pots that they know are 100 percent recyclable and made from post-consumer recycled material. Three years ago, they launched a corporate initiative to try to close the material loop, by putting post-consumer plastic waste back into the production of new pots. They noted that just because a pot is marketed as being made from recycled material, does not mean it is 100 percent recyclable. According to Poppelman, the product must satisfy three conditions to close the material loop: it must be recyclable, it must be made from post-consumer recycled plastic and it must return to the same point in the recycling process from where the source material was acquired.[42]

The question remains as to whether manufacturers will find it possible to routinely produce alternative pots in significant volumes. The cost must be more competitive with plastic to make them an acceptable routine choice for commercial use. Characteristics like durability, good appearance, strong plant growth, porosity and acceptable price points are key to their marketability.

Aside from environmental sustainability purposes, manufacturers, producers and retailers may find it valuable to grow the alternative pot market based on maintaining a customer base that is increasingly aware of environmental issues. Each producer needs to evaluate the costs and benefits of alternative containers for their individual business and market. Hopefully in the future, it would be helpful in marketing alternative pots if the slightly more expensive cost for the alternative products could be justified by landscapers and other users who will have lower labor costs (collection, cleaning) and lesser concerns about transportation.

REUSE

One might argue that pot reuse should be at the forefront of our efforts because of the reduction in material and energy use that pot reuse would afford. However, several factors make this difficult to achieve:

- UV light degradation reduces the flexibility of plastics and makes them more breakable and harder to handle.
- Worn pots are less attractive to the consumer, and so affect sales.
- Collection of the pots is challenging due to the variety of pot sizes, shapes and variety of resins.
- Pots may be contaminated with pesticides or plant pathogens and must be cleaned. A failure to do so deems them unrecyclable and raises legal liability issues.
- The logistics of getting used pots back to the grower for reuse can be difficult.
- The low cost of new pots and their ready availability in the market make them the preferred choice for growers who are justifiably focused on their bottom line.

Despite these concerns and constraints, some efforts are being made at the local level to try to promote reuse and address sustainability. One such effort based in Ontario, Canada, is at a large grower of specialty ornamental plants that reuses and re-purposes pots multiple times. The owner uses HDPE pots that are durable and can withstand multiple cycles of cleaning. This grower has contracts with municipalities whereby they install his plants and return the plastic pots to his nursery. This removes the cost of collection and having them cleaned by a third party. There are likely others like this, but they are not generally known and therefore, not well-documented as a model for others.

Other efforts are being made to manufacture products that have increased durability and longevity:

- QuickPot trays are crafted from durable polystyrene film; the average tray lasts between 8-10 years.[43]
- Resin-based products made from linear low density polystyrene (LLDPE) have been demonstrated to last for years. They are composed of 100 percent post-consumer recycled material.[44]
- On a local level among consumers, plastic pots can be repurposed for community plant sales or shared amongst local growers and farmers.

At the individual gardener level, some pots can have multiple purposes: waiting stations for plants that need to be transplanted, weeding buckets, yard waste holders, transporter of soil or mulch, etc.

RECYCLE

Although reduction and reuse are important, the focus for handling the large volumes of plastic horticultural waste remains on recycling.

Fossil fuel-based plastic has countless uses and is produced very cheaply. Plastic recycling has largely been underappreciated because, in the developed world at least, our waste is carted away from our homes and has often been shipped overseas. And, to an extent, this remains true: out of sight, out of mind.

However, in 2017, China banned imports of 24 types of solid waste, mainly plastics, and since then other Southeast Asian countries have followed suit. This revealed the extent to which developed countries had been sending their waste problem elsewhere. In the US and Canada (and many other countries) this led to recyclables being stockpiled, landfilled or sent to countries ill-equipped to handle them. China and Hong Kong went from purchasing 60 percent of plastic waste exported by G7 countries during the first half of 2017, to taking less than 10 percent during the same period a year later.[45]

To get a sense of the magnitude of just the US volume of plastic waste, data from the EPA reveals that in 2017, 35.4 million tons of plastic waste was produced, and 26.8 million tons of that was landfilled. Analyzing these numbers from percentages, EPA reports that of the total amount of plastic material generated, 8.4 percent was recycled, 15.8 percent was incinerated in waste-to-energy processes, and 75.8 percent went to landfills.[46]

But how much of that was plastic pots? We don't have a precise number. The EPA does report numbers for plastic containers and packaging, and it defines those items as products that are assumed to be discarded the same year the products they contain are purchased. They make up a major portion of municipal solid waste (MSW).[47] If plastic pots fit that definition, then we can assume

their numbers are included in the data for packaging and containers. In 2017, 14.49 million tons of plastic packaging and containers were generated. Of that, 2.47 million tons were incinerated using waste-to-energy processes, and 10.13 million tons were landfilled. Only 1.89 million tons were recycled.[48]

On a global scale, it is estimated that approximately 15 percent of plastic waste is recycled, somewhat more is incinerated, and the rest is discarded.[49] Cities and towns that used to get money back for exporting their recyclables are now paying several times that amount for their recycling programs. Essentially, US recycling processors and the companies making plastic are placing the cost of managing recycling on cities and towns. This is because used plastic products have nowhere to go. The demand does not exist. Waste haulers continue to collect and sort our recycling, but they have no way to dispose of it. As our recycling continues to pile up, so does the cost of its collection. In the US, recycling centers charge municipalities higher fees when recycling is mixed with trash and, while they could previously receive revenue from recycling programs, now most have to pay haulers to dispose of the material instead. For example, in 2017, Stamford, CT, made $95,000 by selling recyclables; in 2018, it had to pay $700,000 to have them removed.[50]

Plastics are made of a variety of polymers that impact their recyclability. The better plastics can typically be recycled once because polymers break down. For example, #2 HDPE recycled plastic bottles and jugs can be recycled into plastic pots. It is a standardized type of plastic that recyclers can obtain a usable quantity of plastic from.

Efforts to recycle petroleum-based horticultural plastics have had mixed results. Some localized efforts have shown success, but most areas of the country do not have sufficient capacity or the capability to handle large quantities. Every grower uses a different assortment of pots to suit its own products along with growing methods. Such lack of standardization makes it difficult to assemble enough of any single kind of plastic to make it worth recycling.

On the environmental front, when post-consumer plastic had greater value because there was a demand for it (petroleum products were more expensive), less energy was being used and fewer emissions were produced. As prices for oil and gas have decreased significantly, plastic pots manufacturers have found it more cost effective and very convenient to purchase virgin plastic. According to data from the Environmental Protection Agency, recycled plastics account for far less environmental impact than their virgin counterparts.

Until recently, the cost of making plastic products from recycled flakes was cheaper than relying on virgin plastics made using fossil fuels, so the economics made it easy to choose the sustainable option.[51] At present, however, there is little to no incentive to recycle plastic. Producers have sharply increased virgin plastic production, further driving down prices. In large part, the market for recycled plastic has disappeared.

In contrast, the global recycling rate for paper is about 58 percent and iron and steel is approximately 70-90 percent; they can be recycled multiple times.[52] Glass and some other metals can be recycled indefinitely. Plastic, however, can only be recycled once or twice since the polymers break down in the recycling process.[53]

In Canada in 2008, Landscape Ontario started a system for recycling horticultural plastics that was adopted by more than 50 garden centers in eight provinces, and ultimately run by the Canadian Nursery Landscape Association. The program came to a halt when China decided to stop receiving any plastic. Other methods of recycling were explored, but all proved too expensive to be viable. More than one-third of the plastics are

created for single-use products or packaging.[54] In June of 2019, the Canadian federal government announced that they would seek to ban "harmful" single-use plastics in the country by 2021 and make companies responsible for handling the waste from their plastic packaging or products.[55] The federal government plans to work with Canada's provinces, territories and industry to develop consistent standards for extended producer responsibility (EPR) programs. These are programs that shift the responsibility upstream, away from municipalities and regional waste authorities to the companies that produce the products. Whether or not plastic pots are considered one of the products, time will tell. About 86 percent of Canada's plastic waste ends up in landfill, while only 9 percent is recycled. The rest is burned to create energy, with associated emission concerns, or the plastic enters the environment as litter.[56] In 2019, the Economic Study of the Canadian Plastic Industry indicated that Canada throws away 87 percent of its plastics, valued at $7.8 billion dollars.[57]

Representatives of the Canadian plastics industry believe the solution to plastic proliferation is in better recycling. Joe Hruska,V.P. of Sustainability for the Canadian Plastics Industry Association (CPIA) (personal communication), has stated, "The answer to plastic in the environment is anti-littering education and enforcement and implementing harmonized recycling and recovery programs across Canada to manage all materials." [58]

Landscapers in Canada are as affected by the issue of how to handle plastic pots as are those in the US. With a focus on sustainability and innovative alternatives, the owner of a landscape services company called Quiet Nature based in Ayr, Ontario, shared the following: "Our experience with recycling pots and trays has always been a challenge. We looked into plastic recycling facilities at one point, specific for three different plastic types: HDPE #2, PP #5, and HIPS #6. We found a facility in Hamilton, but then would need to have all the pots cleaned, sorted, shrink-wrapped, and trucked out to that location. It was $200 just for shipping, and probably the equivalent of three people taking two days of labor to complete. It was not very practical and quite expensive."[59] This is one of the most common dilemmas.

The current recycling technology for plastic pots is burdensome, and the process of preparing them for recycling is cumbersome, complicated and cost-prohibitive.

Plastic pots are light-weight which makes them inexpensive to ship and easy to display. Companies have a plethora of options to increase the marketability of their products with different colors and labeling. However, such variability often leads to unidentified materials and the potential for obstructing the recycling process. The current recycling technology for plastic pots is burdensome, and the process of preparing them for recycling is cumbersome, complicated and cost-prohibitive:

- Most optical readers used at recycling facilities cannot identify black plastic pots, so they immediately end up in the landfill.
- It is expensive and time-consuming to prepare the pots for recycling.
- Not all pots are alike. Many are composed of mixed resins. This complicates the collection and recycling processes. Different resins melt at different temperatures. Some may not melt at all and risk contaminating the batch and grinding processes.
- All contaminants and residues need to be removed. Pesticide residue lessens the value of plastic. Companies can be liable for poorly sanitized pots. This results in high collection and sanitation costs.
- Many recycling stamps on the pots are difficult to identify. Often the print is extremely small and its location may vary. It is therefore possible for unidentified resins to be mixed into a batch of different resins.
- Ultraviolet light degradation reduces flexibility and breaks polymers apart rendering the pot unrecyclable.
- There is limited access to recycling centers and collection costs are high.[60]
- Used plastic containers are primarily disposed of in landfills.[61]
- Plastics generally do not get recycled more than one or two times.[62] Recycled plastic is largely used in lower value products that in turn are not recyclable.

INITIATIVES TO ADDRESS PLASTIC POTS

In response to the numerous concerns raised about waste plastics in the green industry, there are several important initiatives being pursued by groups, industries, coalitions and consumers.

In 1997 the Missouri Botanical Garden (MOBOT) began the most extensive horticultural plastic recycling program in the United States. Starting as a grassroots recycling effort, the first year they collected 10,000 pounds of used plastic pots and trays from consumers. Grants from local recycling agencies and Monrovia Growers allowed the program to expand. In 2008, they collected over 160,000 pounds of horticultural plastic from gardeners in metro St. Louis. Satellite stations were subsequently established to meet the increasing demand, placing collection trailers at garden centers throughout the St. Louis region. Gardeners were responsible for sorting their plastics at the drop-off point to keep plastic types separate, while garden centers committed to supporting this effort.[63]

A key element for MOBOT was production of a product from pot plastics collected. A series of local partnerships produced landscape timbers and – most successfully – extruded plastic lumber sold as raised bed garden kits. Program leaders recognized the importance of a system that "closed the loop" on manufacturing a viable product from this plastic waste stream, in order to both sustain and expand the experience of processes in St. Louis.[64]

In 2017, MOBOT turned program equipment and connections over to local company Central Paper Stock (CPS) to continue collection of garden pots. CPS has been in the recycling business since 1946 and invested in equipment to process horticultural plastic more effectively. CPS resources sustained the program beyond the Garden's capacity to function as a recycling center, serving regional garden centers and green industry businesses. While CPS maintains this capability, local pot collection was suspended in spring 2020, due to issues with plastic commodity values and concerns about material transmission of COVID-19, the virus fueling an on-going pandemic.[65]

In California, a proposed ballot initiative, the California Recycling and Plastic Pollution Reduction Act, is in process of preparation. If and when passed, the Act will potentially provide funding for composting facilities, grants to farmers and ranchers for healthy soil and water-smart practices, and other recycling and cleanup initiatives. Funding is proposed to come from a one-cent fee on single-use plastics products (such as plastic pots) sold in California.[66]

In 2016, the MacArthur Foundation released *The New Plastics Economy: Rethinking the future of plastics*. The report provided for the first time a vision of a global economy in which plastics never become waste, and outlines concrete steps towards achieving the systemic shift needed. The report acknowledges that while plastics and plastic packaging are an integral part of the global economy and deliver many benefits, their value chains currently entail significant drawbacks. Plastic packaging is used only once; 95 percent of the value of plastic packaging material, worth $80-120 billion annually, is lost to the economy.[67]

On June 16, 2020, The Plastics Waste Reduction and Recycling Act (HR 7228) was announced directing federal agencies and offices to work towards supporting plastic recycling with enhanced research and development, the creation of standards, and modernization of technologies. The major goal is to reduce plastic waste and bolster plastics recycling.[68]

CONCLUSIONS

Over the last century, and especially since WWII, the global plastics industry has vastly expanded, with major effects on virtually every industrial sector. However, this rise has been accompanied by significant environmental impacts due to the manufacture, use and disposal of plastic products. This has become an increasingly important issue, both globally as well as in North America. Used plastics now form a major part of our society's waste stream, much of which goes into landfills as well as being dispersed into the land and water environment.

This is especially true for the green industry, which has seen the rapid adoption of plastics throughout the agricultural and horticultural sectors.

The green industry produces significant amounts of plastic waste in the form of plastic pots and trays, most of which (estimated at over 95 percent) is deposited in landfills. Relatively little of this waste is reused or recycled.

While it is possible for our industry to reduce and recycle, doing it on a large scale is extremely challenging. Recycling has not worked well. Plastic pots require a tremendous amount of effort and expense to collect, clean and transport. The number of facilities available to recycle them are inadequate. Once they do reach a facility, most used pots do not even reach the conveyor belt; they are rejected at the sorting stage. Until facilities on a larger scale invest in new technologies, black pots, the majority of types, will be rejected. Re-use of plastic pots is also exceptionally limited, due to difficulties in collecting and cleaning pots, degradation of the plastic, and risks associated with leaching after multiple uses.

With time, alternative pots may become mainstreamed, particularly on the commercial level, but more needs to be learned. Pot manufacturers have begun to sell products that contain less plastic and more organic material. However, they are not yet available at a scale or a price which makes them competitive with plastic pots, despite studies showing consumers are willing to pay more for sustainable materials.

The same properties — durability and resistance to degradation — that make plastics so versatile in innumerable applications also make it difficult or impossible for nature to assimilate.

Single-use plastic pots may eventually be identified, along with straws, bags, and other types of plastic packaging, as villains of plastic pollution. Members of the green industry, although concerned, are stymied by the lack of feasible options. In 2019, a survey conducted by APLD asked the members what they do with nursery pots once a job is completed. A little over 34 percent recycle them and 30 percent return them to a nursery. Another 30 percent commented that it is hard to find recyclers and nurseries that will take the pots, so the designers donate them to an arboretum; 6 percent throw them away. "They have to put them in a landfill because they can't be recycled, and facilities are limited."[69] All these efforts (other than those that involved donation or reuse) most likely ended with the majority going to a landfill.

Some alternative pots might be able to come to the rescue, but results from a survey in Georgia showed that 83 percent of horticultural growers do not purchase biodegradable containers, largely due to a lack of knowledge and familiarity with the products.[70]

With this information in hand, it is time to ask: have single-use plastic pots created an unsustainable culture of waste that the green industry needs to address? The same properties — durability and resistance to degradation — that make plastics so versatile in innumerable applications also make it difficult or impossible for nature to assimilate. Thus, without a well-designed and tailor-made management strategy for end-of-life plastics, we will continue to build pyramids of waste plastic.

GLOSSARY

biodegradable
A "biodegradable" product has the ability to break down, (in optimal conditions) safely and relatively quickly, by biological means, into the raw materials of nature and disappear into the environment.

bioplastics
Bioplastic, often called bio-based plastic, refers to plastic made from plant or other biological material instead of petroleum. Bioplastics are similar to traditional plastics and are created either from biopolymers (non-petroleum based) or a blend of bio- and petrochemical-based polymers.

climate change
When we burn fossil fuels for energy, their sequestered carbon is released into the air as carbon dioxide. And when large amounts of CO2 enter the atmosphere, as has been going on for the past 200 years, this causes the *greenhouse effect*, i.e., the physical cause of global warming.

The greenhouse effect occurs when the sun warms the Earth's surface and not enough of that heat can escape through the atmosphere to let the planet cool off. (See Sue Reed and Ginny Stibolt, *Climate-Wise Landscaping: Practical Actions for a Sustainable Future* (New Society Publishers, 2018), 6.)

closed-loop system
A closed loop system is technically the production process of circular economy – allowing for the recycling of products and packaging into new ones. Instead of dumping waste or used materials into a waste bin or in landfills, these are processed and made into the same type of materials or repurposed as new products.

compostable
A product that is "compostable" is one that can be placed into a composition of decaying biodegradable materials, and eventually turns into a nutrient-rich material.

green industry
The U.S. environmental horticulture industry, or green industry, is comprised of wholesale nursery, greenhouse, and turfgrass sod producers, landscape design, construction and maintenance firms, and wholesale and retail distribution firms such as garden centers, home stores, mass merchandisers with lawn/garden departments, brokers and re-wholesale distribution centers, and allied trades suppliers of inputs to the industry. (See Charles R. Hall, Alan W. Hodges, Hayk Khachatryan, and Marco A. Palma, "Economic Contributions of the Green Industry in the United States in 2018," *Journal of Environmental Horticulture*, in press, June 2020.)

feedstocks
A raw, unprocessed material used to produce goods.

floriculture
The cultivation and management of ornamental and especially flowering plants.

herbaceous plants
An herbaceous plant is an annual, biennial or perennial plant with leaves and a stem. Herbaceous plants die back every year when the weather gets cold.

horticulture
Horticulture is an application science – the science developed by horticulturists is applied to plant production, improvement, marketing and the enhancement of earth's human and animal life.

oil feedstocks
Crude oil, i.e., the condition of oil at the point of extraction and prior to processing in refineries.

polyctides
The miscellaneous plastic includes all the remaining plastic types such as acrylic, polycarbonate, nylon, butadiene, polyctide, fiberglass, etc. These types of plastic are non-recyclable.

polymers
Natural or synthetic macro-molecules composed of many repeated sub-units bonded together; plastics are typically organic polymers." (See World Economic Forum and the Ellen MacArthur Foundation, "The New Plastics Economy: Rethinking the future of plastics," January 19, 2016.)

sustainability
Sustainability means practicing environmental stewardship.

sustainable landscape design
The design, installation and management of landscapes and landscape features which encourages, creates and maintains a healthy and thriving environment, including providing habitat and ecosystem services, both within and outside the particular landscape; and uses energy and material resources appropriately and efficiently, and contributes to conservation so that future generations will have options for the use of those resources. (See www.apld.org/design-sustainability/.)

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