Managing Plastic Waste

D. Hettinger - Living Web Farms - 2018

Living Web Farms Biochar Facility

2017 and 2018 Goals:

Developing tools for a “Circular Economy”

- Looking at wastes as resources: materials, feedstocks, energy
- **Biochar Production**: forest and sawmill wastes > Powerful, carbon negative soil amendment AND Energy
- Mill waste and Shipping wastes: Cardboard and sawdust briquettes > Emergency energy source
- Excess food wastes > BSFL - High Fat/Protein poultry and fish feed
- Plastic Waste > useful and beautiful plastic products

Plastics are everywhere…

Some things are only possible because of plastics polymers and the contributions of polymer scientists.

“Commodity” plastics are low cost, low weight and ideal for many applications, especially packaging

Ah! But therein lies the problem! Plastics are everywhere!

Mostly, very low recycling rate in USA. Economically, still not incentive enough to prioritize recycled materials - when you buy a product, you buy it’s packaging

Not everyone has our standards: Open air dumps common throughout the world

Toxicologically speaking, there are plastics that are widely assumed to be safe.

We don’t know what we don’t know: Bpa is only of fairly recent concern, Microplastics in ocean is only of recent widespread concern.

Landfill Facts:

Nearly all landfills in USA are ‘sanitary’ landfills.

Very little decomposition

Paper is the dominant recyclable material filling landfills

North Carolina (2007) 32% landfill space is used building materials

Recycled Materials in NC Landfills

Commodity	Tonnage Generated	Percent Recovered	Tonnage Remaining in Waste Stream
Paper**	2,092,298	17.3%	1,730,268
Glass	319,956	18.6%	260,413
PET	74,349	18%	60,995
HDPE	51,070	16.7%	42,534
Aluminum Cans	42,602	13%	37,036
Steel Cans (Bi-Metal)	65,105	13.9%	56,065

Source: RE3.org from NC DEACS

Ocean and Microplastics

UNEP: 2014 global production of plastics - 311M tons. 4.8-12.7M tons entered oceans

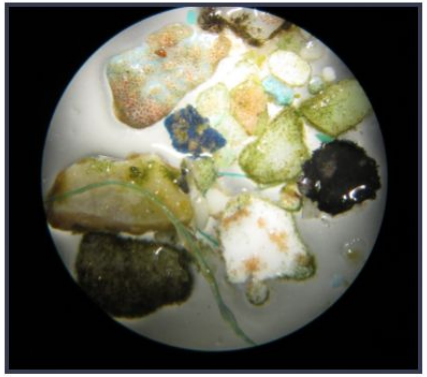
Poor waste management, wastewater, or illegal dumping are all causes

Plastics don't fully mineralize, or biodegrade, but rather break down over time into increasingly smaller bits

<5mm "Micro-Plastics", <50 microns "Nano-Plastics"

"debris is more like flecks of pepper floating throughout a bowl of soup, rather than a skim of fat that accumulates (or sits) on the surface" - NOAA marine debris program

Plastic debris accumulates water borne pollutants - "acting like a floating version of sediments – absorbing and concentrating pollutants from seawater"



Microplastics skimmed from the North Pacific Ocean.
Photo courtesy of J. Foley, C-MORE.

TOP 15 MARINE DEBRIS ITEMS

RANK	MARINE DEBRIS ITEM	TOTAL COLLECTED	FUN FACT
1	Cigarette Butts	2,043,470	That's enough cigarettes that when laid end to end, they are the same length as 4,257 school buses. Did you know these butts (the filters) are actually made from type of plastic called cellulose acetate?
2	Food Wrappers	1,685,422	Did you know that most food wrappers, including chip bags and candy wrappers are actually plastic? (See Marine Debris Composition to learn more.)
3	Plastic Beverage Bottles	940,170	That's enough beverage bottles to give every fan attending the Super Bowl 11 sodas.
4	Plastic Bottle Caps	847,972	That is enough bottle caps that when laid end to end, they would cover 3 football fields.
5	Straws/Stirrers	555,007	In the United States alone, 500 million straws are used and thrown away every single day. **(www.ecocycle.org/bestrawfree).**
6	Plastic Grocery Bags	441,493	That's enough grocery bags that when combined, they weigh more than a pickup truck.
7	Glass Beverage Bottles	394,796	All glass bottles can be beautiful and are great for reusing as vases or for other craft projects.
8	Other Plastic Bags	389,088	These include garbage bags, sandwich bags, clothing store bags, newspaper bags and more.
9	Paper Bags	368,746	It is estimated Americans consume more than 10 billion paper bags each year **(www.inteplast.us/lbs/InteGreen/facts.html)**. That's a lot of bags!
10	Beverage Cans	339,170	Did you know once recycled, an aluminum can becomes a new can in as little as 60 days **(www.kab.org/site/PageServer?pagename=recycling_facts_and_stats)**?
11	Plastic Lids	312,996	This category includes lids for to-go drinks such as soda and coffee.
12	Metal Bottle Caps	304,638	Metal bottle caps are great for crafts. Collect metals caps to use as decorations for picture frames or games like checkers.
13	Plastic Cups and Plates	282,743	That is enough cups and plates to host a block party for every single person in Newark, New Jersey.
14	Plastic Takeout Containers	234,692	Next time, think about reusing these to-go food containers for storing things such as baseball cards or craft supplies.
15	Other Plastic/Foam Packaging	233,595	This category includes plastic tarps, crates, fishing bait containers and the foam packaging that surrounds new appliances and electronics. While it may seem crazy, even foam is a type of plastic!

Source: 2013 International Coastal Cleanup.
Please visit www.oceanconservancy.org/our-work/international-coastal-cleanup/ for the most up to date Top 10 List or www.coastalcleanupdata.org to find out your local top debris items found.

Source: NOAA marine debris program: Talking Trash and Taking Action

#1 PETE *Polyethylene terephthalate*

Predominantly Polyester Fibers and Beverage and food containers

Robust market for recycled material: US recycling rate: 31%

Physical: Clear and rigid. Brittle or tough, depending on additives and thickness.

Lightweight, and Strong - major factor in convenience packaging

Low Gas and moisture permeability

Does not contain Phthalate plasticizers or BPA

Additives often used for improved clarity, prevention of thermal degradation

Recycling Methods: 80% of Recycled #1 containers are used in fibre production (UNEP,2018)

Challenging for DIY recycle. Higher process temps, requires drying process

#1 PETE *Polyethylene terephthalate*

Environmental: Antimony used in the manufacture of PETE, detectable after manufacture. Potentially exceeds recognized safe levels after microwaving, boiling, long shelf storage.

Beware tricky legislation: 2010: Antimony found in Fruit Juice bottles in EU exceeds safe drinking water levels.

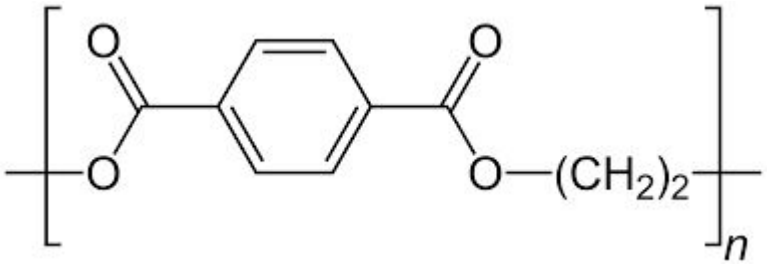
Unintended Consequences: Recycled material: Abrasion from wear and washing contributes significantly to microplastics pollution

Single Use drinking bottles are of the most common ocean plastics: photodegradation breaks down material into smaller fragments. Inconclusive reports on timeline: 1 yr to 450 years!

Some microbes have been shown to digest it.

Alternatives: Reusable water bottles! Bulk purchasing!

Washington machine waste water filters for fiber microplastics



Bio-Plastics: PLA Water Bottles

Corn (mostly) based plastic material

Can be composted (Must be composted)

3-6 months in industrial composting facility

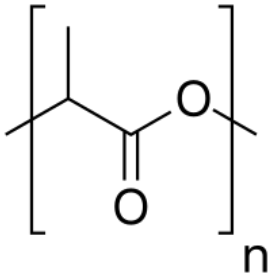
Undeniably less toxic - production and incineration

Conventionally Non-Recyclable

Criticized for fouling batches in recycling centers

(Likely) Less energy input, less GHGs associated

"A step in the right direction"



#2 HDPE *High-Density Polyethylene*

Bottles - laundry soap, shampoo, motor oil. Some Pipe, Plastic Lumber, some shopping Bags,Tyvek housewrap, milk jugs.

Physical: High Strength to Density ratio. Tough and semi-flexible somewhat hard and waxy, scratchable surface. Good chemical resistance.

Robust market for recycled material. Plastic lumber is common.

Environmental:

Widely considered one of the most safe plastics.
Breaks down in UV light - will not decompose, floats in water.
FDA guidelines “no dyes or other additives harmful to humans”
UV stabilizers commonly added: some are known allergens, endocrine disruptors.
Additives may leach over time, in part determined by what’s stored in containers
Acidic foods, motor oils,


+110°c
– 20°c
CAPACIDAD
±1500 ml.
05
PP


FIREHOUSE
SUBS
FRESH
KOSHER
PICKLE SPEARS


INSPIRED ITALIAN
CLASSICO
FRESH
FOUR CHEESE


YEARS OF BAKING SUCCESS
Gold
MEDAL
SINCE 1880
PURPOSE
RICHED FLOUR
BLEACHED · PRE-SIFTED
25 LB (11.3 kg)
PRICE
PRICE
1-533

Designed with Reuse in Mind

Smithsonian Am. History


Ball
Plastic Storage Caps
REGULAR MOUTH
Plastic Storage Caps
BPA free
For versatile storage
8 REUSABLE PLASTIC STORAGE CAPS


Ball
MASON
Farmhouse Products

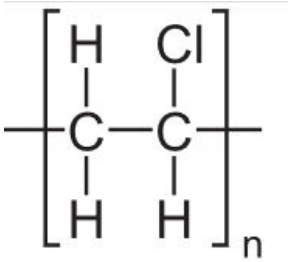
#3 PVC

PolyVinyl Chloride

Rigid PVC or Flexible PVC
Low cost, and corrosion resistant. Widely Produced, little gets recycled.

Rigid: Pipes and Window frames. Vinyl Siding. Non-food packaging.
Flexible: ‘Vinyl’ records, medical tubing, vinyl floor tiles

Physical: Rigid PVC or uPVC is very brittle and relatively dense with good rot and chemical resistance.
PVC can be made more soft and flexible with the use of plasticizer additives (10-50% typical).



Recycling Methods: Rigid and PVC plastic can be recycled together, end product will have shared properties. When burned releases toxic and corrosive hydrochloric acid - most DIY recyclers won’t go near it - best to leave it to the pros.

Environmental: Concerns are in a large part related to the manufacturing of PVC, primarily in countries with lax environmental regulations.
Cumulative effects of exposure to plasticizers and other additives are concerning.

Phthalate Plasticizers

Used primarily for softening PVC: adding flexibility, durability and transparency

Concerns over endocrine disruption

FDA has limits on children’s products: infants are at highest risk (hand to mouth, vinyl flooring)

Problems with lab animals reproductive systems, Primates shown to metabolize Phthalates

Concern is with cumulative risks

Industry is moving towards higher molecular weight phthalates that are less likely to leach

#4 LDPE *Low-Density Polyethylene*

Physical: Flexible and tough and lightweight. Soft to the touch An ethylene polymer, Similar to HDPE, but with branching (instead of long chain) molecules. Not as strong as HDPE, more sensitive to temperature.

Widely used for agricultural and packaging films. Trash bags, toys, some electrical wire insulation, lining on tetrapak containers.

Recycling Methods: HDPE and LDPE are *miscible* - they can be mixed to form objects like plastic lumber.
Bags and films can not be recycled in conventional domestic collection centers, will clog shredding equipment

Environmental: like HDPE, will float and is subject to photo-oxidation where it will comparatively quickly breakdown to ocean-borne microplastics.
Bags and films can block waterways, hold water to create unsanitary conditions.

Bio-Plastic Films

Enviplast®□ - Bio-Plastic Films and Bags

- Made from non-edible part of Cassava Plant
- *Easily* Biodegradable
- Processed on conventional, existing equipment
- Excellent oxygen barrier qualities - medical applications
- Good Static dissipation - electronics shipping

Evoware®□ - Seaweed-Based Packaging

- Optimal for very small single use food packaging
- Dissolves in warm water
- 2 year shelf life

#5 PP

Polypropylene

Physical: Rigid, heat resistant, brittle when cold. Similar in feel to HDPE, often seen as ‘copolymer’ with PE. Resistant to glues

Often Opaque and colorized

Outdoor furniture, car battery cases, many injection molded objects, food containers, Sweat wicking athletic apparel, non-woven fabrics, diapers, bottle caps

Environmental: Used in many durable goods - additives are common
Otherwise generally safe
As with PE, subject to aggressive photo-oxidation

#6 PS *Polystyrene*

Physical: Hard, rigid, brittle, sometimes transparent. Low cost, high level of detail in molded products.
Used in CD cases, some vacuum formed packaging.
Expanded PolyStyrene (EPS) - carry out containers, disposable cups, packing peanuts, custom foam packaging
Extruded PolyStyrene (XPS) - Blue Board insulation

Chemically inert, but easily dissolved by organic solvents.

Environmental: Very long decomposition times due to resistance to photo-oxidation
Litter is persistent, floats on water and animals can mistake it for food
Foams manufactured with HFCs - gases recognized for their massive global warming potential
Low density of foams make for challenging recycling economy

https://ecovativedesign.com/how-it-works

Other Thermoplastics:

ABS: “a copolymer of acrylonitrile and styrene, toughened with polybutadiene”

A tough, amorphous copolymer with high impact resistance at low temperatures

Legos, automotive trim and bumper bars, electrical appliances

Polycarbonates: Strong, Tough, Easily Molded. High impact resistance. Heat and Fire resistant. BPA is starting material for production.

Safety Glasses, “bullet-proof glass”, compact discs, Rigid Greenhouse material, Helmets, Faux-Glass drinkware

BPA: Bisphenol-A

Used in the production Polycarbonate. BPA epoxies in lining of canned foods.

Current FDA bans on BPA baby bottles, infant formula packaging, etc. No other active bans.

Notorious for its Estrogen Activity - it mimics the hormone, estrogen, in the body

Linked to reproductive organ abnormalities, infants/children are of especially high concern.

Many other plastics have been shown to have EA qualities. Controversy around human-health effects

FDA: Ok to consume in small amounts: but avoid UV light exposure and heating. Ask yourself: will you actually do this?

Activists: Best to avoid plastic food packing until industry becomes more transparent

Bright side: non EA plastics are possible, avoiding plastic food packing IS possible

Services available for testing, certification and product design assistance for EA free plastics

“Monstrous Hybrids”

Review: Plastics are Complicated!

Plastic Materials have truly made many things possible that would otherwise be impossible, impractical or very expensive. Plastics have been said to have a “democratic leveling effect”

Polymer science is an advanced discipline that is not easily understood, yet its impacts are very widespread in our society

When polymer additives are undisclosed, there is uncertainty about the safety. Where there is little uniformity, recycled products will always be ‘downcycled’ from original

Plastics health and environmental concerns are amplified by its ubiquity

Most offensive: Single use plastics: made from oil that took millenia to form, are used sometimes for only a few minutes, and will take millenia to breakdown.

Resources

UNEP: Single Use Plastics

UNEP: Marine Plastic Debris and Micro Plastics

30 ways to use 5 gallon buckets

Appropedia Plastics Recovery Manual

Cradle to Cradle Certified Products Registry