Should Plastic-Coated Paper Products be Allowed in Materials Collected for Composting ?

Woods End Laboratories INCORPORATED

eco·cycle®
Working to Build Zero Waste Communities

Overview

New research shows:

- Many US compost collection programs accept plastic-coated paper products.
- When composted, these products produce plastic fragments that do not biodegrade.
- Plastic fragments can make their way from compost-treated soils into the larger environment, and may be ingested by living organisms.
- Plastics fragments accumulate Persistent Organic Pollutants and can transfer these chemicals to living organisms.

Reaching Zero Waste

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Increasing the amount of organic material diverted from the waste stream

US Compost Collection Programs

According to the December 2009 issue of BioCycle:

- 85 programs in the US have residential food waste collections

According to further investigations by Eco-Cycle:

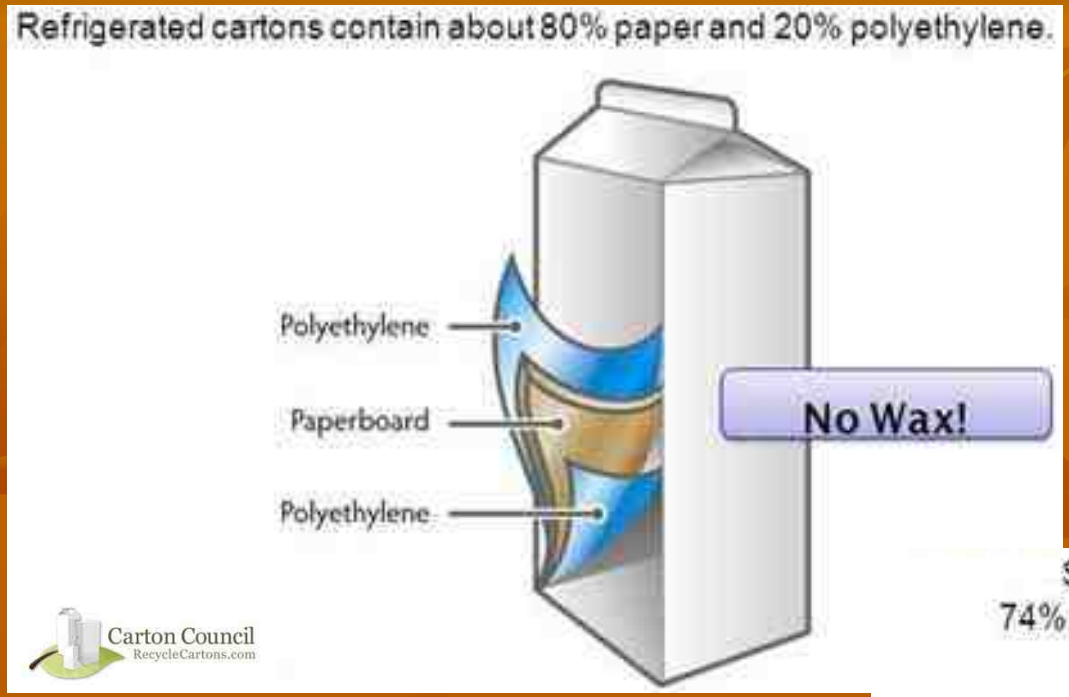
- 41 of these (30 of which are in King County, WA) do not accept plastic-coated paper products
- 44 do accept some or all of these products

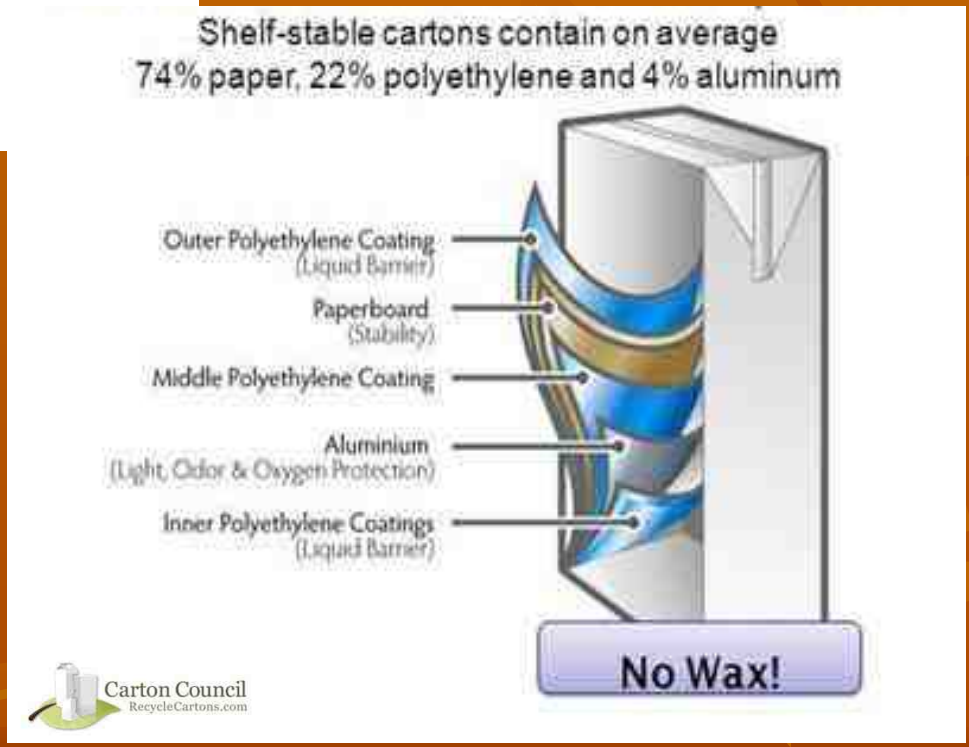
Plastic-Coated Paper Products

Many organics collection programs in the US allow:

- milk and juice cartons
- hot and cold paper drinking cups
- paper plates (some clay, some PE)
- frozen food containers
- plastic-lined paper bags
- take-out containers

Composition of Cartons





Polyethylene (PE) is present in both refrigerated and shelf-stable cartons

Petroleum-Based Plastic is Not Biodegradable

- Most plastic-coated paper products are coated with polyethylene (LDPE)
- PE has not been shown to biodegrade in reasonable time
- PE (pellets or film) is the standard "negative control" in the ASTM 6400 test to determine compostability of any product

Plastic coating from freezer box after 1 year in backyard compost

Testing by Woods End Laboratories

- Woods End Laboratories is a Biodegradable Products Institute (BPI) approved ASTM D6400 test facility
- Employed ASTM D 6400 §6.2 : product disintegration to less than 10% @ 2mm in 12 weeks.
- Study extended to 180 days
- Employed ASTM D 5338 "Test Method for Determining Aerobic Biodegradation of Plastic Materials under Controlled Composting Conditions" (a subset of ASTM D 6400 compost biodegradability tests)


58C incubation


2mm sieving

Materials Examined

Criteria for tested product packages:

- coatings that are typical in the food packaging industry
- often included in compost collection programs
- commonly available to the consumer

Sample Name	Type of Paper Product	Coating *
1 Tropicana	Carton, Juice	LDPE + Other Resins
2 Nesquik	Carton, Milk	LDPE
3 Minute Maid	Carton, Juice	LDPE + Nylon or Ethyl Vinyl Alcohol
4 Dixie	Paper Cold Cup	LDPE
5 Dixie	Paper Plates	80% Clay, 20% Acrylic
6 Walgreens	Paper Cold Cup	LDPE
7 Walgreens	Paper Plates	Kaolin, Synthetic Latex, Calcium Carbonate
8 Stouffer's	Ovenable Tray	PET
9 Stouffer's	Freezer Paperboard	LDPE
10 Food Boat	Food Boat	Clay
11 Control	Printer Paper	None

Information on the composition of the coatings listed above was obtained through interviews with paperstock and product manufacturers by Eco-Cycle, Inc.

30x digital microscopy of peeling and fragmenting process

Microscopic Images After 5 Weeks of Biodegradation

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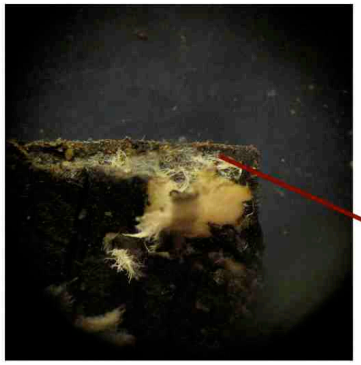
Food Boats/Clay

Natural clay material disintegrating normally.

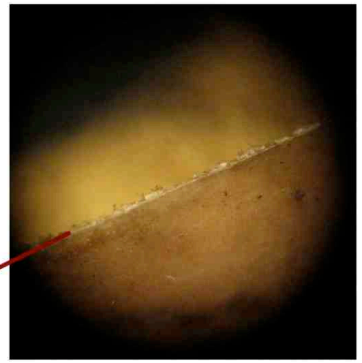


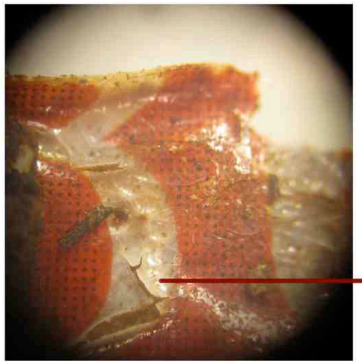
Stouffer's Tray/PET

Inside paper layer (now soft & pulpy) against black coated, intact plastic layer (no degradation).

Minute Maid/LDPE & Nylon

Some delamination. Sharp, intact plastic edge. No visible signs of degradation.





Stouferr's Box/LDPE

Plastic layer cracking and peeling away from ink layer. No obvious degradation.

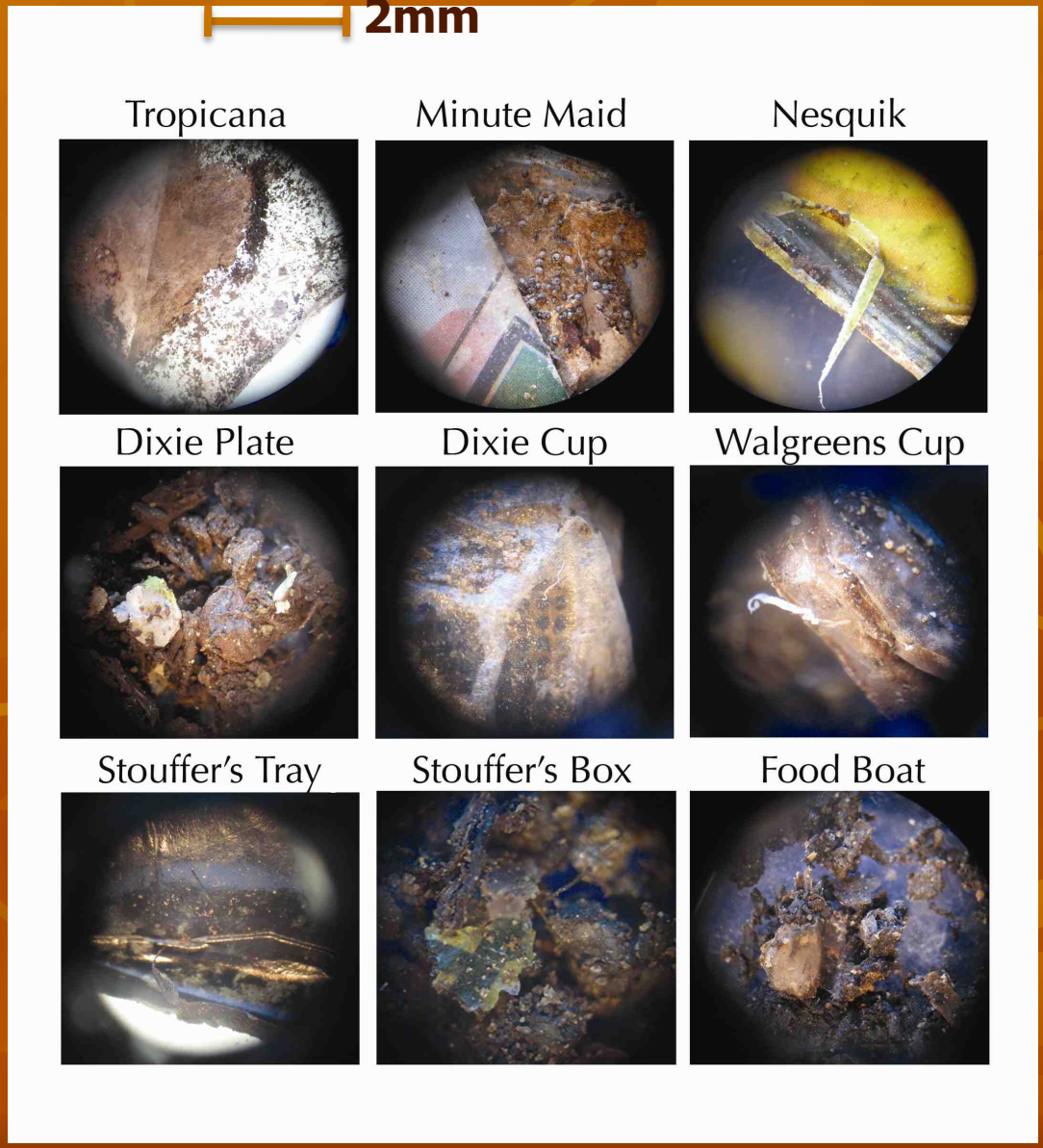
Nesquik/LDPE

Intact plastic layer (no degradation) being peeled back from inside paper layer (soft & pulpy).

Tropicana/LDPE Blend

Intact plastic layer being peeled away from paper layer (now soft & pulpy).

Residual Fragments in Compost at 30-100x

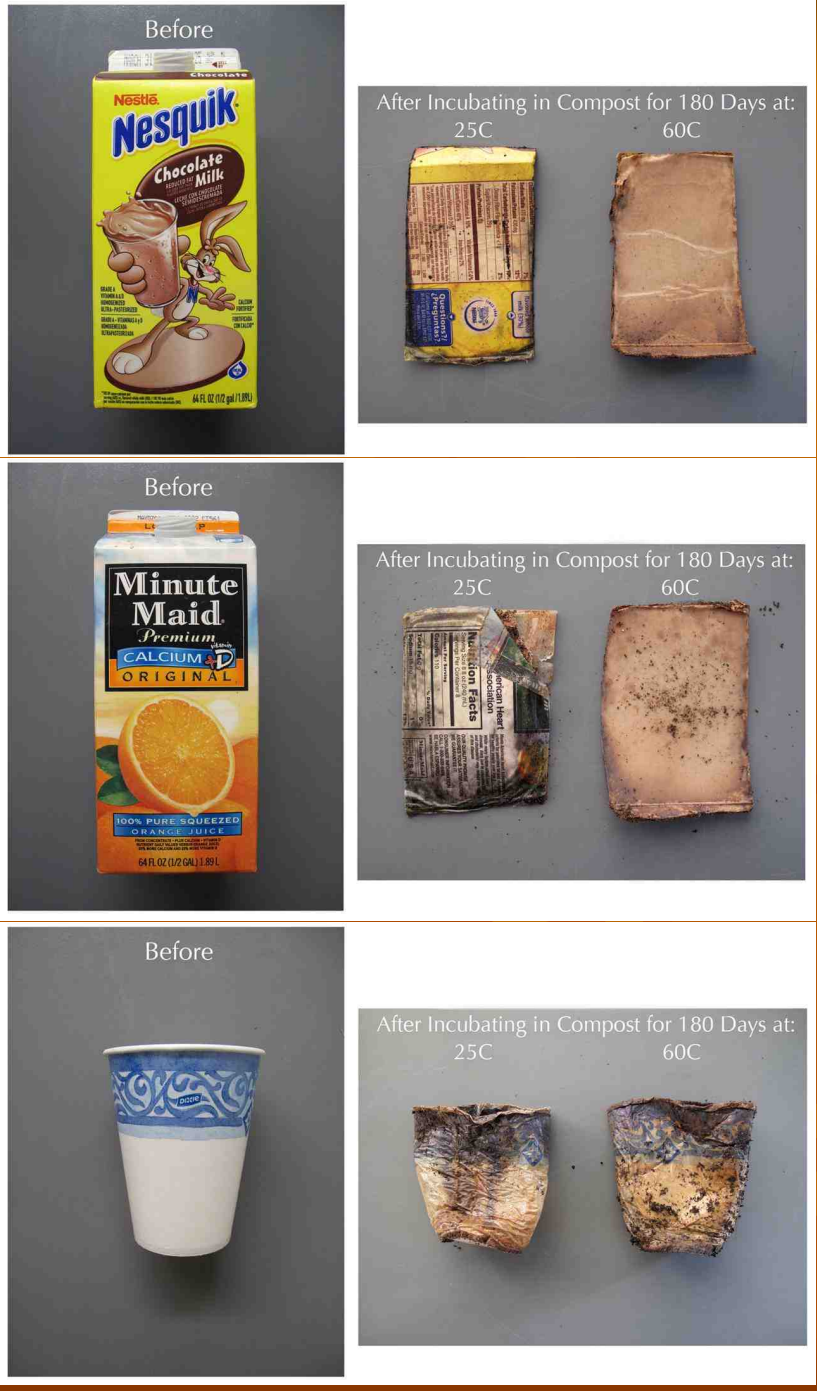


Conclusions

- Plastic coatings did not biodegrade.
- Coatings retarded the biodegradation of the paper layer.
- When coated on both sides, little degradation occurred.
- Micro-plastic fragments were shed from all of the plastic-coated samples, *including* those that remained largely intact due to double-sided coatings.

Milk Carton
Juice Carton
Paper Cup

PE coatings on both sides of paperstock almost entirely inhibited the biodegradation process.



Before and After 180 days of composting at 25°C and 60°C

Paper Plates

Before and After 180 days of composting at 25°C and 60°C

- Usually clay-coated. One sample contained 20% acrylic mixed with the clay. Acrylic fibers were evident in finished compost.
- Approximately 10% (according to industry sources) are coated with PE, and would be expected to shed micro-plastics in the same way as other PE-coated samples.

Freezer Box
Oven-able Tray

- Freezer box (single-LDPE coated) almost passed disintegration test at 58°C and did pass at 25°C
- Material likely to pass through screen and end up as visible plastic contaminant in compost

- Oven-able tray is double-PET coated and likely to be screened out as an entire fraction

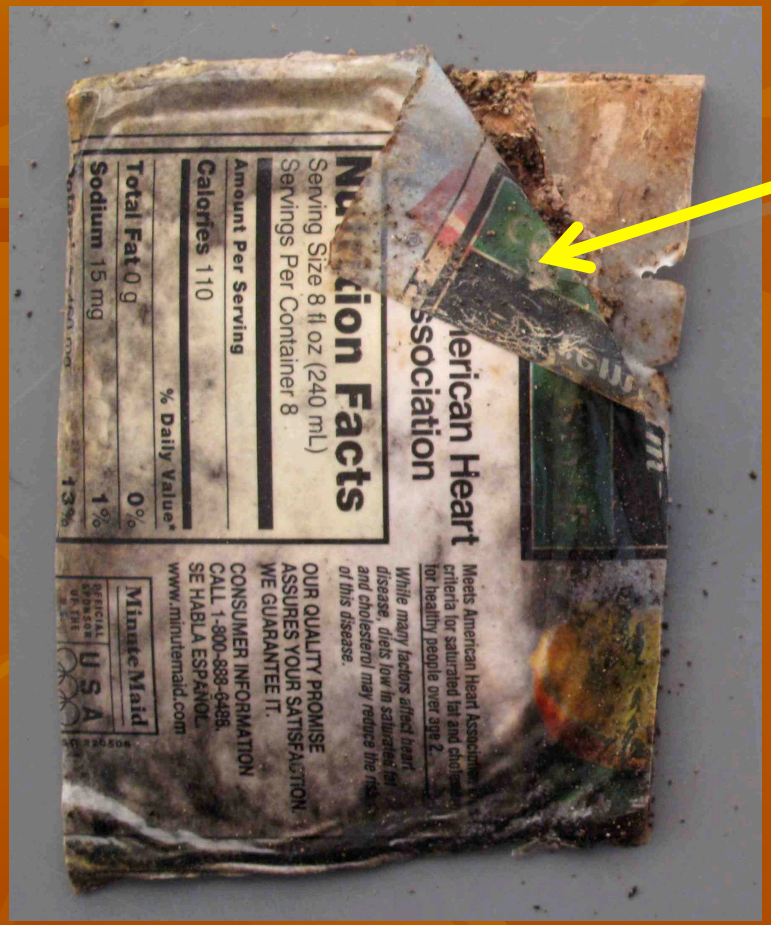
Further Findings

- Obvious delaminating took place. The plastic-coating layers, originally injected into the paperboard, began to separate off of the carrier material.
- Some coatings were brittle, and therefore caused fragmentation. Others were less so.
- Plastic fragments smaller than ½ inch (about 12mm) remaining after 12 weeks would likely pass through into the final compost. Composters do not generally sieve finer than this. At best, under suited, dry conditions, a 3/8 inch (9mm) sieve may be used.

HOUSEHOLD FOOD SCRAP COLLECTION

- Cartons, coated cups and trays *are not made to be composted*
- 20% of a carton is PE
- Many programs accept cartons with food scraps
- Each half gallon carton (pictured) has ~15g of pure PE
- 15g of PE in ~3 lbs food scraps per carton = a potential 0.01% of PE in compost

Delamination Process

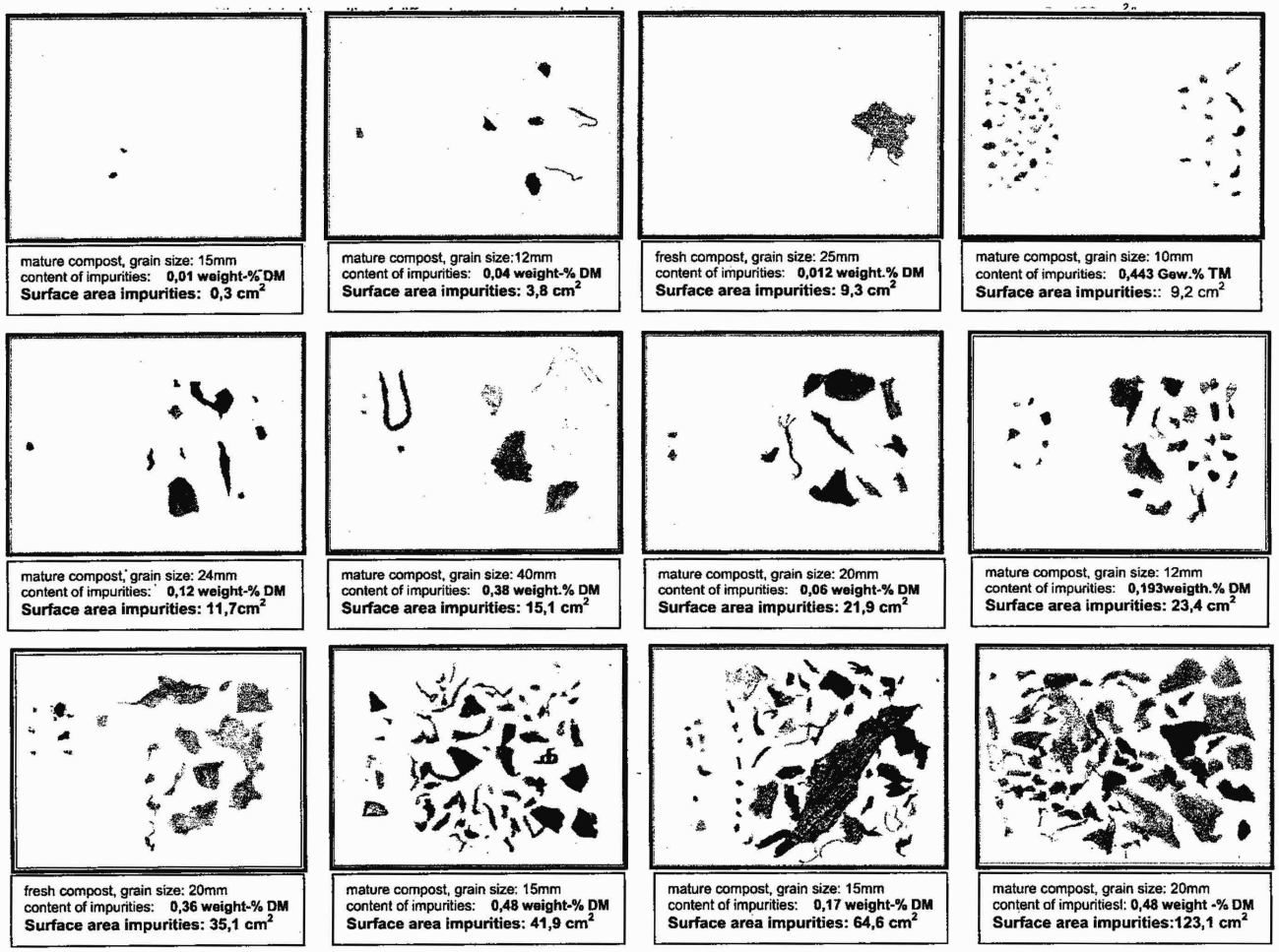


- Peeling and delamination during non-agitated composting
- Turning machines may exacerbate peeling and fragmentation
- Composting concentrates non-degradables

Woods End Laboratory data

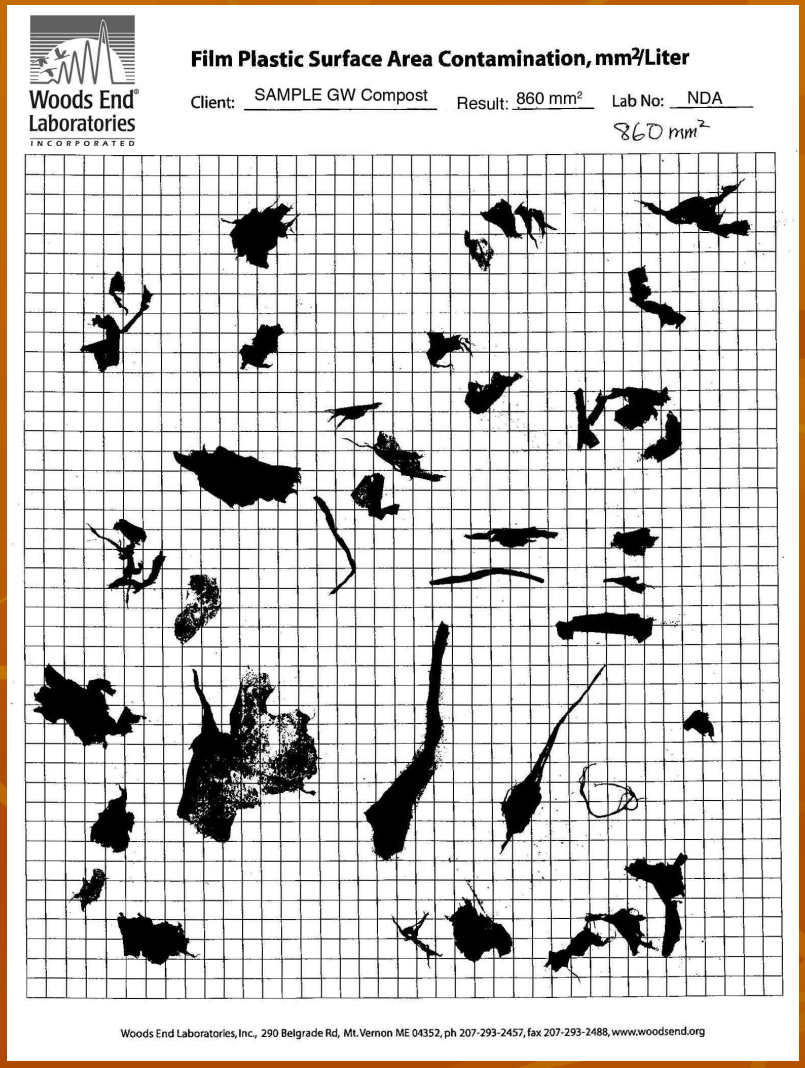
Visual Scale of Plastic Contamination in Composts all containing less than 0.5% foreign matter

Example of scanning finished compost for non-degraded plastic residues that have high surface area relative to weight (SA:W). All samples chosen had < 0.5% plastic by weight.



Reference: Thelen-Juengling, M (2006) New Method for evaluation of impurities in compost. ORBIT, Weimar

New Lab Technique to Quantify Surface Area (SA) by Scanning Plastic > 2mm in Composts



< 0.1% by weight in green-collection composts

This sample exceeds the EU clean compost standard of 800 mm^2/SA liter compost.

800 mm2 / liter =

35 sq. inches per cu. ft. compost

15g PE from carton after delaminating would be as much as **387 sq. inches** of plastic.

Source: Woods End Laboratories

Economics – Why Does it Matter

	Per ton cost
Transport to facility	$ 10
Grinding/mixing	$ 4
Active Composting	$ 20
Screening	$ 2
Transport to Landfill	$ 10
Landfill Cost	$ 85
Cost for ton to process uncompostable items	$131
Revenue for ton	$ 40
Lost per ton including lost of product to sell $9	$100

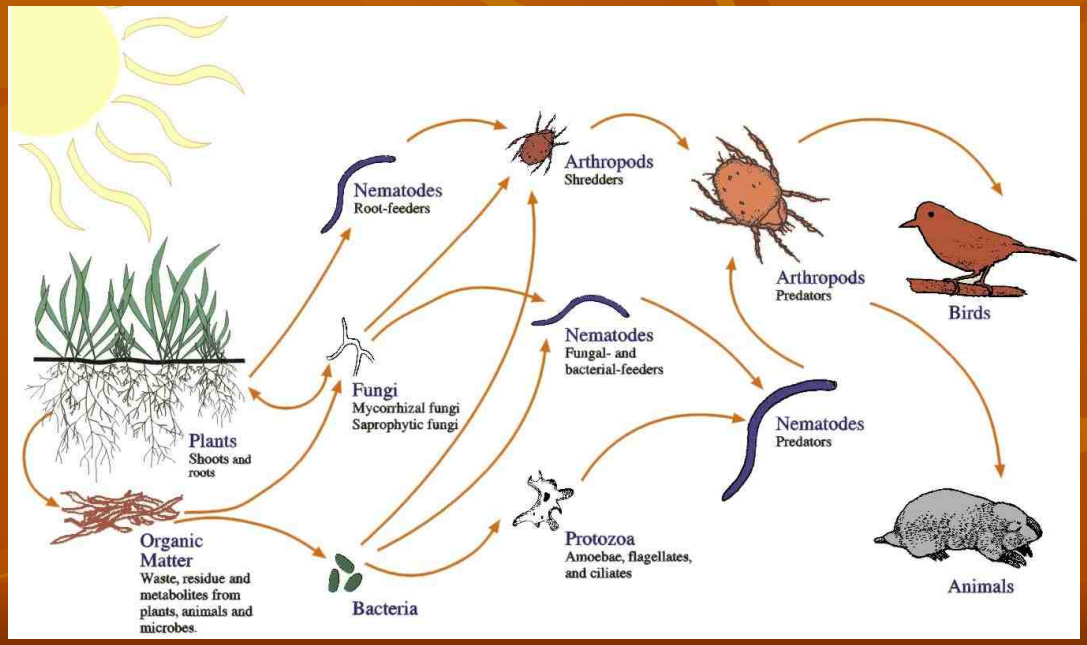
Slide courtesy of Jerry Bartlett, Cedar Grove Composting

Does it matter? Cost, marketing, and…

From Compost to the Environment

"There is good evidence that both the micro and macro-plastic fragments found in compost applied to the soil will exacerbate the problem [of plastic pollution] as [the fragments] are carried by wind and surface run-off into stream and river waters, and eventually into marine environments." (Page & Leonard, 2002)

What consequences do the plastic fragments have for ecosystems and human health?



The detrimental effects of macro-plastics on wildlife are well documented, particularly in aquatic environments.

Seal entangled in plastic Photographer unknown

Albatross chick ingesting plastic

[Jeanne Gallagher] photographer, Cynthia Vanderlip

Snapping turtle deformed by plastic

[Jeanne Gallagher] unknown--Courtesy of Algalita Marine Research Foundation

Including:

Suffocation

Entanglement

Starvation

[Jeanne Gallagher] Courtesy of Algalita Marine Research Foundation

"Plastic debris is accumulating in terrestrial and aquatic habitats worldwide. This debris is progressively fragmenting into smaller pieces… The abundance in the water column has increased considerably over the last 40 years, and this trend mirrors the global rise in plastic production." (Browne, Galloway & Thompson, 2009)

Microscopic plastic particles

Plastics Fragments Ingested by Marine Organisms

Microplastic in the digestive tract of an amphipod

Salp ingestion of plastic

[Jeanne Gallagher] **Courtesy of Algalita Marine Research Foundation**

"…filter-feeding animals, such as mucous web feeding jellies and salps, were…heavily impacted by plastic fragments… Filter feeders are at the lower end of the food chain, …fifty species of fish and many turtles are known to eat them… accumulating plastic in their stomachs." (Tamanaha & Moore, 2007)

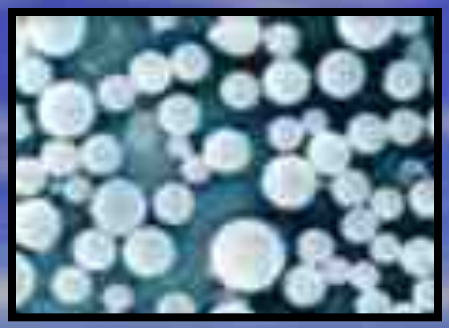
Study by Browne, Dissanayake, Galloway, Lowe & Thompson (2008):

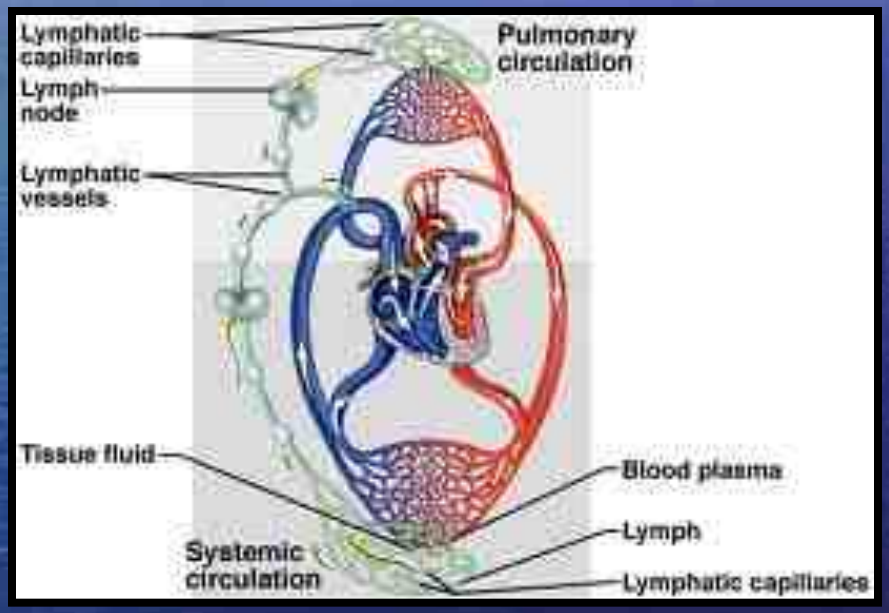
Micro-plastics translocated from the gut to the hemolymph of a species of mussel (*Mytilus edulis)* persisted for over 48 days

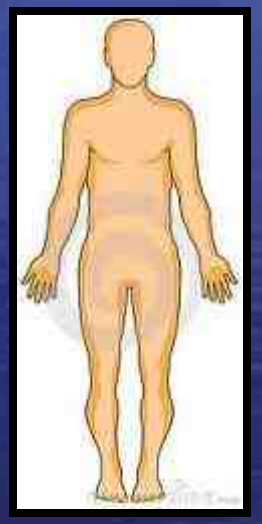
Predators of mussels:

- birds
- crabs
- starfish
- predatory whelks
- ***humans***

Micro-particles of plastic

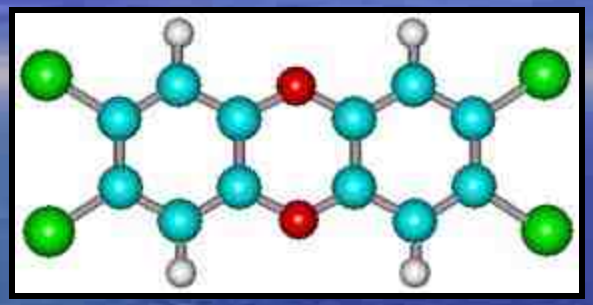






"…medical studies on both rodents and humans have also shown that particles of polyvinylchloride and polystyrene less than 150 µm can translocate from the gut cavity to their lymph and circulatory systems." (Browne et. al., 2008)

Plastic Fragments Concentrate Persistent Organic Pollutants (POPs)



"… plastic has been shown to adsorb and concentrate hydrophobic contaminants, including polychlorinated biphenyls, dichlorodiphenyl trichloroethane, and nonylphenol, from the marine environment at concentrations several orders of magnitude higher than those of the surrounding seawater." (Mato et al., 2001)

"If plastics are ingested, they could act as a mechanism facilitating the transport of chemicals to wildlife. This may be particularly relevant for microplastics since they will have a much greater ratio of surface area to volume than larger items..." (Browne et. al., 2009)

"…calculations and experimental observations consistently show that polyethylene (PE) accumulates more organic contaminants than other plastics such as polypropylene (PP) and polyvinyl chloride (PVC)." (Teuten et. al., 2009)

More research needs to be done to see how micro-plastics affect soil and freshwater ecosystems.

D. Dindal, Ph. D., Professor Emeritus of Soil Ecology, State University of New York, conducted research on sand-sized plastic incorporated into soil and compost (1983 and 1990). When earthworms were added, they ingested polyethylene particles, many of which penetrated their gut tissue causing death.

The Precautionary Principle

- "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically"
  (source: http://www.sehn.org/state.html#w)
- Referenced in UN and EU treaties and protocols since the 1990s
- Adopted by several US communities throughout the 2000s
- Applied to fields such as nanotechnology, GMOs, threats to biodiversity and the introduction of new chemicals
- Questions if the harm is necessary, if benefits outweigh potential risks and if better alternatives exist.

Better Alternatives

- New recycling markets for cartons
- Coatings for paper products that are truly compostable

Our recommendation:

- include plastic-coated products on lists of prohibited materials
- US Composting Council (USCC) disseminate the following information :
  - "highest and best use" for cartons is recycling, not composting
  - only certified ASTM 6400 or EN 13432 tested products, or Biodegradable Products Institute (BPI) approved products allowed in food waste collection programs
- American Plastics Council, Sustainable Packaging Coalition and major packagers work to develop clear symbols for consumers to determine whether a container is compostable, recyclable or must be landfilled
- packaging industry held responsible to verify that packaging labeled compostable is truly compostable according to the above standards
- encourage the use of durable, reusable food-ware whenever possible

Contact information:

- Dan Matsch
  Eco-Cycle, Inc.
  Boulder, CO
  www.ecocycle.org
  303.444.6634
  dan@ecocycle.org
- Will Brinton
  Woods End Laboratories, Inc.
  Mt. Vernon, ME
  www.woodsend.org
  207.293.2457
  compost@woodsend.org

www.ecocycle.org/microplasticsincompost