

Marine Plastic Pollution:

Sources, Impacts, Magnitude of the Problem

Plastic Pollution Prevention Summit
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CLEAN WATER ACTION

CALIFORNIA

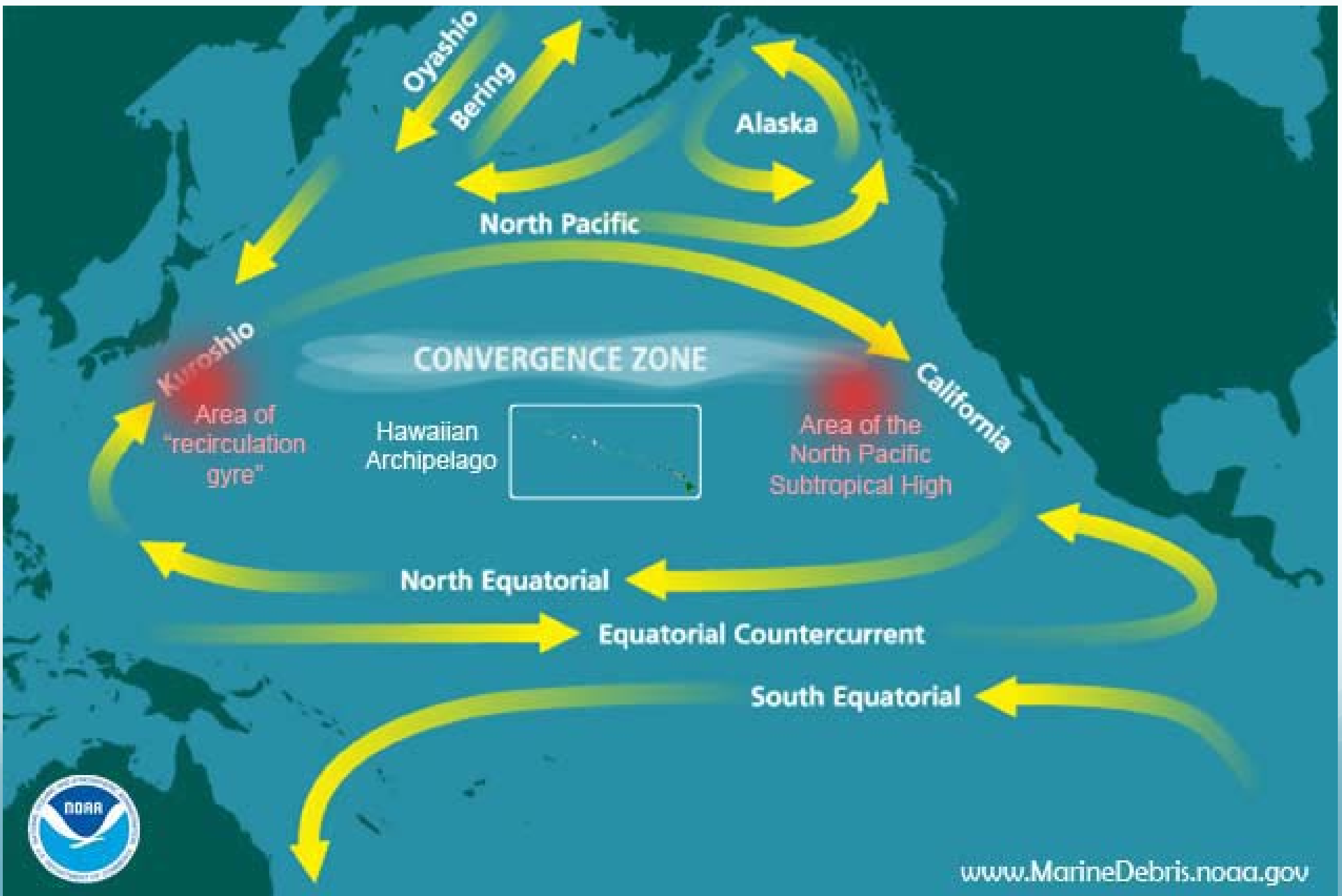
Overview

- Plastic pollution problem
- Magnitude of the problem
- Sources
- Impacts
- Composition



The problem: plastic persists in the marine environment for an unknown amount of time



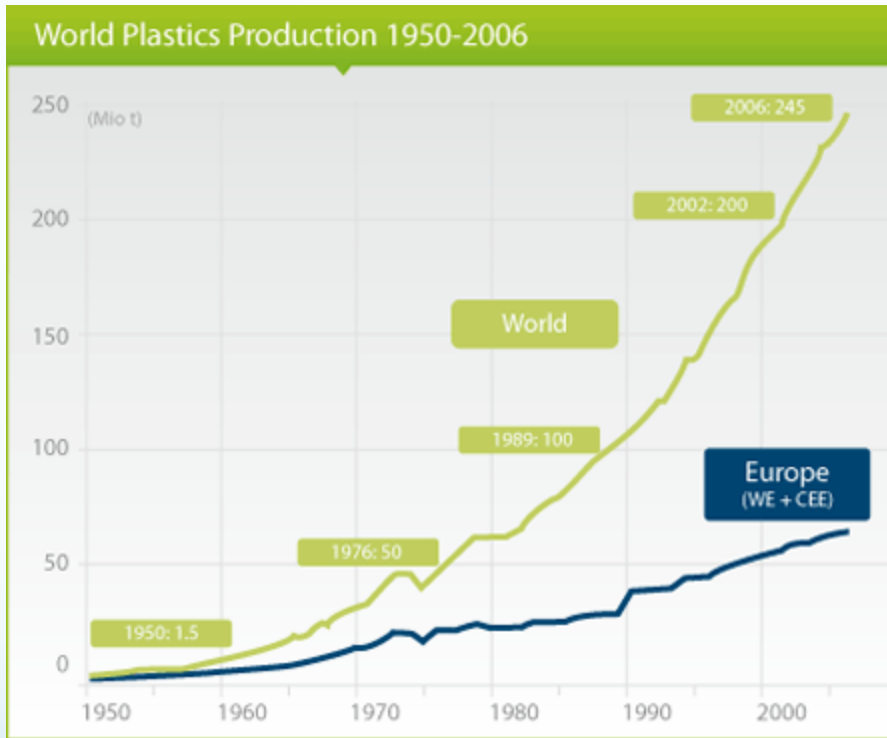




Magnitude of problem increasing

- Rapid and substantial increase in anthropogenic debris on the ocean surface and beaches over recent decades (Dixon & Dixon 1981; Derraik 2002; Barnes 2005)
- Off Japan's coast, floating particles of plastic debris increased 10-fold in 10 years from the 1970s through 1980s, and then 10-fold again every 2-3 years in the 1990s Ogi and Fukimot (2000) Fisheries Bulletin
- In the Southern Ocean, plastic debris increased 100 times during the early 1990s Copello and Quintara (2003) Mar Poll Bull
- Around the British Isles, surveys have shown a 3- to 4-fold increase in the volume of plastic fibers in seawater from the 1960s to the 1990s. The increase occurred during a worldwide quadrupling of plastic fiber production R. Thompson, et al (2004) Science

Are we surprised...?



Includes Thermoplastics, Polyurethanes, Thermosets, Elastomers, Adhesives, Coatings and Sealants and PP-Fibers. Not included PET-, PA- and Polyacryl-Fibers

Source: PlasticEurop Market Research Groupe (PEMRG)

- Global plastic production has increased from 5 million tons in the 1950s to over 250 million tons in 2006
- High volume coupled with durability results in widespread accumulation of discarded plastic in landfills and as litter in terrestrial and aquatic habitats worldwide

(JGB Derraik, 2002, Mar Poll Bull)



Plastics Throughout the Water Column

- Ocean floor: dominated by larger material, such as fishing gear and beverage containers.
- Water column: mostly plastic fragments, small enough to be suspended by ocean currents.
- Ocean surface: fragments and whole items of floating plastic trash.
- Beach environment: combination of different materials that differ in size and composition

Main Sources of Marine Debris

Approximately 80% comes from land-based sources:

- **Litter** (pedestrians, motorists, beach visitors)
- **Industrial discharges** (pellets and powders)
- **Garbage management** (containers, trucks, landfills)



Approximately 20% comes from ocean-based sources:

- Commercial fishing vessels
- Cargo ships (discharge of containers and garbage)
 - Pleasure cruise ships



Impacts: Entanglement

- 267 species (invertebrates, fish, turtles, seabirds, mammals) - entanglement, ingestion; 187 species shown to ingest large plastic pieces-(JGB Derraik, 2002, Marine Poll Bull)
- Once entangled, death rates differ among species
- More than 80 percent for Antarctic fur seals, 44 percent Australian sea lions, and 57 percent entangled New Zealand fur seals.
- Death rates could be even higher due to unobserved deaths.



Impacts of Fishing Gear

Coral reefs can be harmed via scouring, abrading, or breakage when marine debris snags or entangles coral



Ghost fishing—the entrapment of fish in lost or abandoned gear such as gillnets, traps, cages, and pots—is a widely acknowledged problem.



Impacts: ingestion

Hatchling turtle, with two pieces of plastic measuring approximately 3mm in diameter. The darker piece of plastic was lodged in the pylorus (the bottom of the stomach) like a plug, preventing the turtle from digesting food. Credit: Australian Seabird Rescue, Australia



100% of Carcasses have evidence of Plastic ingestion



April 2010- Puget Sound- California Grey Whale

Stomach contents: pants and golf ball, more than 20 plastic bags, small towels, duct tape and surgical gloves



Algalita Marine Research Foundation

N. Pacific Central Gyre voyage 2008

- 672 fish caught, 6 species
- 35% had ingested micro-plastic fragments



Plastic Ingestion



Record Holder - 84 fragments



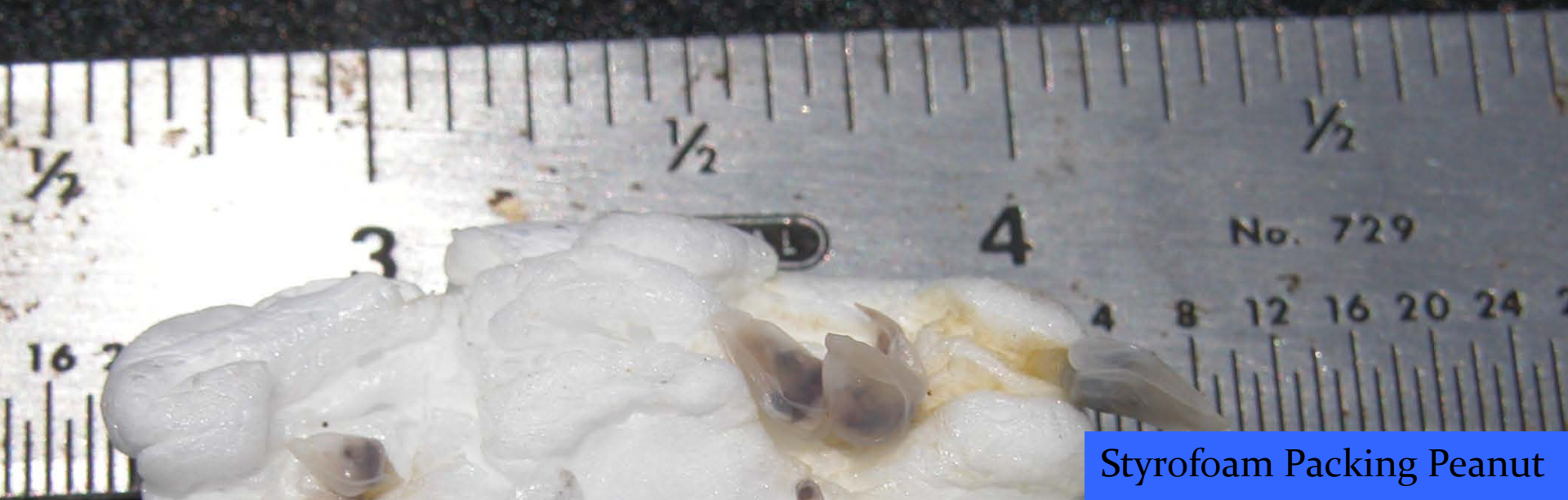


Impacts: spreads invasive species

Plastic facilitates biotic mixing via slow transportation of “rafting” organisms.



**A more effective method of dispersing invasive species
than ship ballast water**

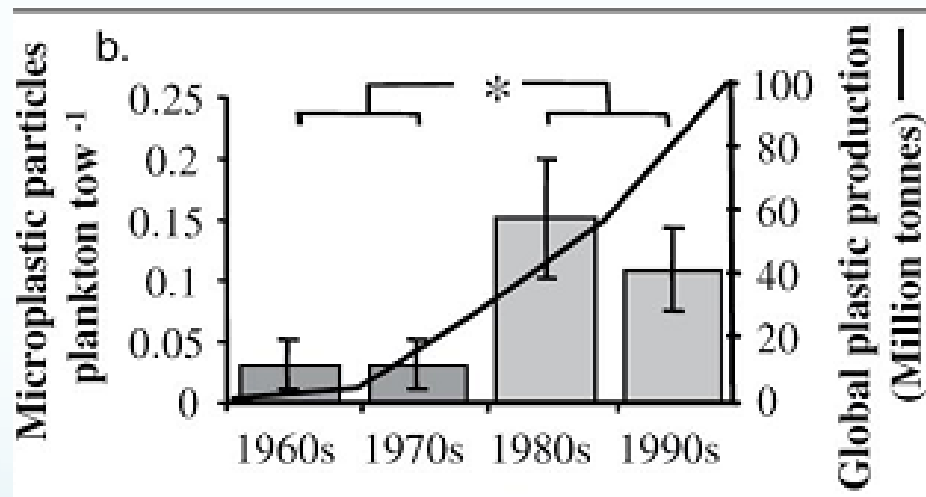


Styrofoam Packing Peanut



Micro-plastics

- Vast majority of plastics in the ocean (80%) are micro-plastics (> 1mm) Thompson et al 2004
- Abundance of microscopic plastics in the water column of NE Atlantic increased considerably over the last 40 yrs, consistent with the global rise in plastic production. Browne, Galloway, Thompson, Learned Discourses, 2007 SETAC



- Sources: Small particles used in cleaning products, and breakdown of larger pieces through photo-degradation, wave action, and abrasion Andrady and Gregory 2003

Migration of plastic additives

- Polymerization of the monomers that form plastics is never 100% complete
- Remaining monomer, such as styrene and bisphenol-A (BPA) along with residual catalysts, can leach out
- There are hundreds of additives- (UV stabilizers, softeners, anti-foggers, anti-microbials, flame retardants, non-stick compounds, and colorants)
- Many are used in very high concentrations- styrene and BPA
- Polycarbonate plastics, when exposed to the salts in seawater, show accelerated leaching of bisphenol-A monomer (Sajiki and Yonekubo, 2003)
- It is estimated that plastic products are composed 50% (by weight) of reinforcements, fillers, and additives (Colton et al, 1974).

Plastics contaminate the marine food chain

Ingested plastic has potential to transfer toxic substances to the food chain (Teuten et al. 2009)

First by migration of toxic additives:

- Many FDA migration studies show that **additives leach out of plastic packaging.**
- **Chemicals in plastic are harmful to wildlife-** the most widely used plasticizers impact mollusks, crustaceans, insects, fish and amphibians- impairing development, reproduction at concentrations that mimic environmental concentrations Oehlmann et al 2009 –



Second, from the ambient pollution in seawater:

- **PAHs, PCBs, PBA and other bioaccumulative contaminants in seawater adhere to surface and concentrate significantly – up to 100 times background levels** (Mato et al 2001, Teuten et al 2009)

Destroys nursery habitat

Floating and submerged trash interferes with or smothers inhabitants of the sediments (Katsanevakis et al., 2007; Uneputty and Evans, 1997; Goldberg, 1997)



Economic Impacts for California - Not Quantified

- Vessel damages
- Loss of coastal tourism
- Costs of cleaning beaches, streets, parks, highways
- Compliance with TMDLs, stormwater permits, etc.



Property damages, plus boating safety threatened

- In the US in 2005, floating and submerged objects caused 269 boating accidents (US Coast Guard)
- Resulted in 15 deaths, 116 injuries and \$3 million in property damages



Loss of tourism from littered beaches- in APEC region \$622 million/yr.
Damage to fishing, shipping and tourism in APEC= \$1.265 billion/yr



*Understanding the Economic Benefits
and Costs of Controlling Marine Debris
in the APEC Region*

April 2009

APEC Marine Resources Conservation Working Group





Marine Debris Composition: mostly plastic; mostly packaging

- 60-80% plastic; 90-95% in some areas (Derraik 2002)
- 90% of floating litter is plastic
- In 2005 Orange County beach debris study, plastic food and beverage packaging were second to resin pellets (SCCWRP)

Beach Debris Composition

60 percent of shoreline debris is composed of plastic.

Item	Amount*	Percent
1. Cigarettes/Cigarette Filters	309,891	38.4%
2. Food Wrappers and Containers	113,883	14.1%
3. Caps/Lids	60,016	7.4%
4. Cups/Plates/Forks/ Knives/Spoons	39,137	4.9%
5. Beverage Bottles (Glass)	33,289	4.1%
6. Bags	30,841	3.8%
7. Straws/Stirrers	30,594	3.8%
8. Building Materials	27,023	3.4%
9. Beverage Bottles (Plastic) ≤2 liters	25,353	3.2%
10. Beverage Cans	23,014	2.9%
Totals:	693,041	86.0%

* # of pieces collected during 2004 California Coastal Cleanup Day

Ballona Creek





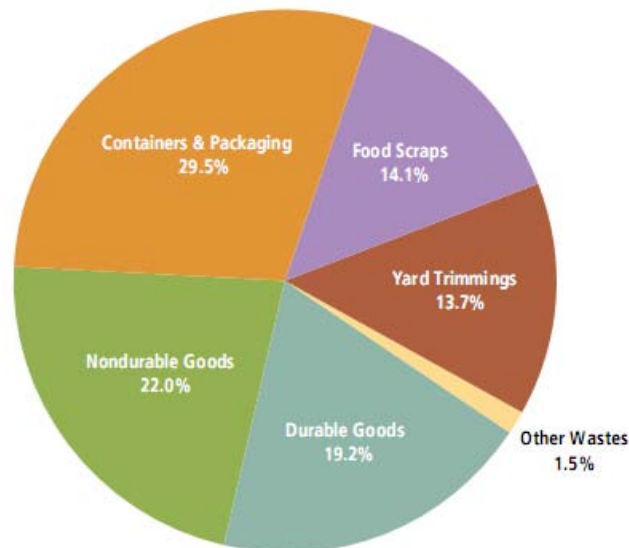
Seal Beach- Orange County, CA



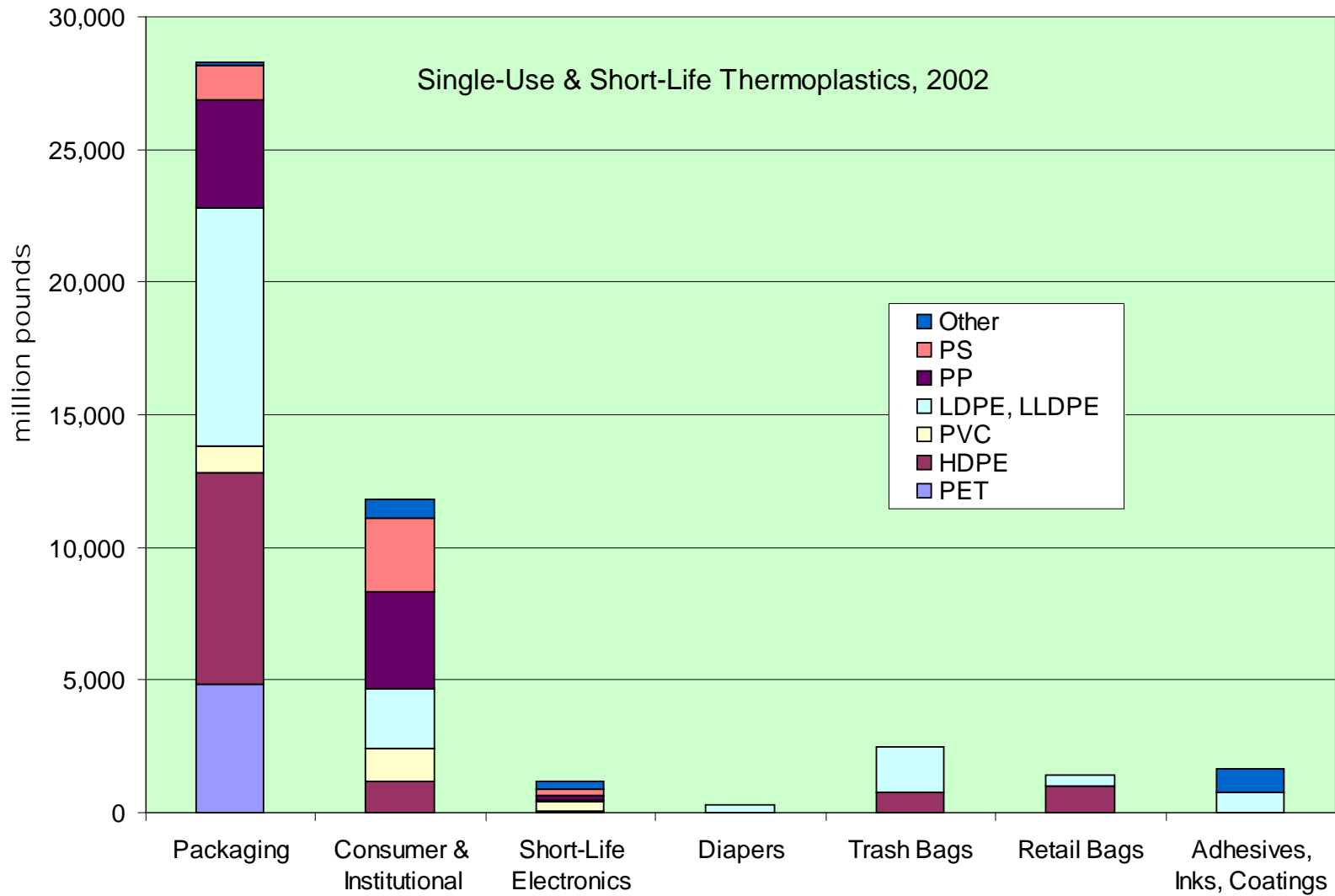
Packaging Waste

- Food and beverage packaging is most common form of street litter (Clean Water Action , Taking Out the Trash)
- Packaging waste increased in the US from 27,000 tons in 1960 to 79,000 tons in 2006 (US EPA).
- Food containers and packaging are the largest component of municipal solid waste- 29.5% in 2009, by weight (US EPA).

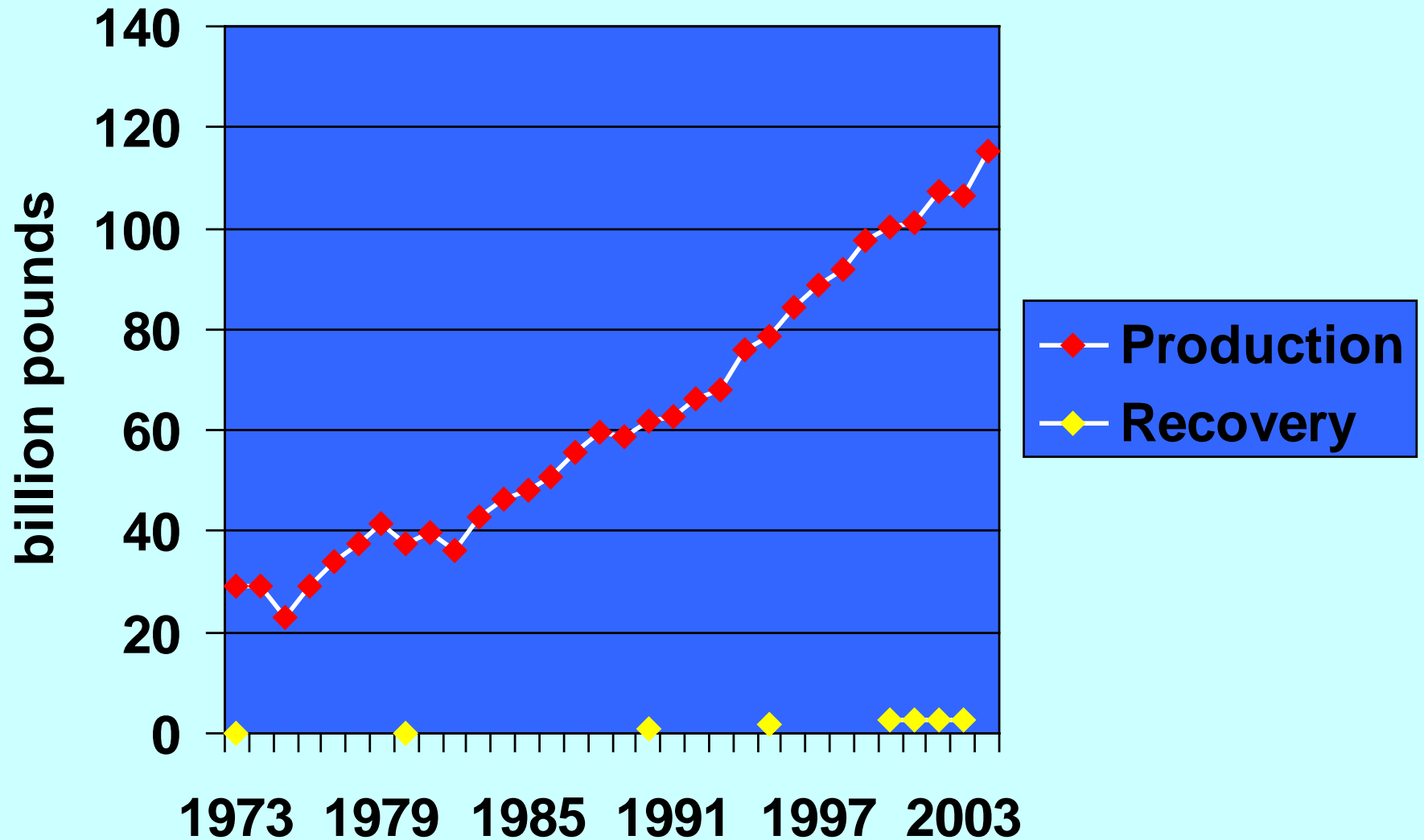
Figure 6. Total MSW Generation (by category), 2009
243 million tons (before recycling)



Most Plastics Manufactured in US to Make Packaging



Annual US Plastic Resin Production & Recovery



Resin production in 2004 was 115.2 billion pounds. In 1973 it was 29.2 billion pounds.

LIFE

MAGAZINE

The thesis of the article was that a housewife would be more efficient if she didn't have to spend time washing and putting away the dishes.

The idea that "WASTE SAVES TIME" was born, and has since firmly embedded itself in first world consciousness

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"Throwaway Living"

