THE PROBLEM

Packaging can be a real danger to the environment and the creatures within it if it is littered or not disposed of properly. Glass, plastic, and other durable packs are often strong, may last for many years and are sometimes made into shapes that may pose dangers to some animals. Plastic packaging, in particular, provides safe, sanitary, lightweight, tamperproof and economical transportation of much of our consumer products. However, it sometimes ends up in the wrong place, such as in waterways, creating an environmental burden.

Source: Ocean Conservancy

According to the Ocean Conservancy, "The tidal wave of ocean debris is a major pollution problem of the 21st century. Marine debris kills. Every year, thousands of marine mammals, sea turtles, seabirds, and other animals are sickened, injured, or killed because of trash in the ocean. Animals choke or become poisoned when they eat trash, and drown when they become entangled."

What can the Packaging Scientist do to help this situation? As a Packaging Scientist you are trained to see the entire life cycle of packages and what can be done to help them move through the world as responsibly as possible. By applying Chemistry, Biology and Physics to the problem you can find a way create a package that will satisfy the environment, your customers and your company.

In this lesson you will see how plastic six-pack rings have been modified to make them less dangerous to birds and wildlife. When animal entrapment became a concern after the introduction of the ring carriers, a UV photodegradable material was developed that degrades with exposure to sunlight, creating a brittle material with minimal risk. For more than 20 years, the material has degraded in sunlight, even in water, where it floats and still is exposed to UV light. The carrier material is completely non-toxic so when degraded, it is inert and harmless.

A real world lesson...

Six-packs are sold every day that aren't held together with plastic. Paperboard and shrink wrap carriers are often used to transport bottles. So why don't all six- packs come in paperboard or shrink wrap? As Plastic Scientist, you look at the entire life cycle, cradle to grave, when evaluating the environmental cost of plastic ring carriers.

In this case, equivalent paperboard packaging may use a renewable resource, but take up much more space and weight, hence the energy to transport and warehouse the product increases along with the cost. Also, not all paperboard is recyclable due to the paperboard treatment and inks used. Shrink wrap creates more solid waste, and weighs more as well as uses more energy and emits more greenhouse gasses in its creation than ring carriers in many applications.

Source: Ocean Conservancy

Six-pack carriers are also used because there is a strong preference for packages that are easy to carry and open, convenient for storage and that generate less waste for disposal. Minimal packaging is typically a lower-cost alternative. Six-pack carriers won't degrade in water like paperboard nor lose their capability to hold the pack together when opened like shrink wrap.

TOP TEN MARINE DEBRIS ITEMS

RANK	DEBRIS ITEM	NUMBER OF DEBRIS ITEMS	PERCENTAGE OF TOTAL DEBRIS ITEMS
1	Cigarettes/Cigarette Filters	3,216,991	28%
2	Bags (Plastic)	1,377,141	12%
3	Food Wrappers/Containers	942,620	8%
4	Caps, Lids	937,804	8%
5	Beverage Bottles (Plastic)	714,892	6%
6	Bags (Paper)	530,607	5%
7	Straws, Stirrers	509,593	4%
8	Cups, Plates, Forks, Knives, Spoons	441,053	4%
9	Beverage Bottles (Glass)	434,990	4%
10	Beverage Cans	401,412	4%
▶	**Top 10 Total Debris Items**	**9,507,103**	**83%**
▶	**Total Debris Items Worldwide**	**11,439,086**	**100%**

Source: Ocean Conservancy/2008 International Coastal Cleanup

MARINE WILDLIFE FOUND ENTANGLED IN MARINE DEBRIS

	BALLOONS	BEVERAGE BOTTLES	BEVERAGE CANS	BUILDING MATERIALS	CRAB, LOBSTER, FISH TRAPS	FISHING HOOKS	FISHING LINE	FISHING NETS	PLASTIC BAGS	RIBBON/STRINGS	ROPE	SIX-PACK RINGS	TIRES	WIRES	TOTAL WILDLIFE
Amphibians	0	1	0	0	0	0	0	2	1	0	1	1	1	0	7
Birds	1	4	1	0	0	3	57	4	9	5	13	1	0	1	99
Fish	0	16	10	0	21	4	70	33	24	2	9	4	1	3	197
Invertebrates	0	12	4	1	35	1	12	24	11	4	9	3	4	2	122
Mammals	0	2	0	0	0	0	2	2	0	1	1	0	0	0	8
Reptiles	0	0	0	0	0	0	2	2	2	0	3	1	0	0	10
▶ Total Debris Items	1	35	15	1	56	8	143	67	47	12	36	10	6	6	443

Source: Ocean Conservancy/2008 International Coastal Cleanup

Figures shown in above charts were gathered from International Coastal Cleanups conducted by the Ocean Conservancy.

Currently plastic packaging is perceived as waste because the End-Of-Life Options are underdeveloped and much of it ends up as waste. To change this, engineers and the community can work to expand collection programs from exclusive recycling-focused to include recovery for energy also. The petroleum used in plastic production is 80% recoverable as energy. Proactively encouraging recycling of packaging products are steps that can be implemented.

BIOLOGY

Scientific Inquiry

Standard B-1: The Student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers and develop solutions.

Indicators:

B-1.1 Generate hypothesis based on credible, accurate and relevant sources of information.

Hi-Cone, the leading manufacturer of six pack rings in the country makes this claim on its website:

Photodegradable: Hi-Cone carriers are manufactured with materials that degrade in ultraviolet light, such as sunlight. Over time, they become brittle and breakdown into smaller, inert, nontoxic pieces.

(http://www.hi-cone.com/index.php?id=58)

B-1.2 Use appropriate laboratory apparatuses, technology and techniques safely and accurately when conducting a scientific investigation.

B-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each instrument.

Measurements can be made of the length and width of six pack ring at beginning of experiment to determine if change of size occurs.

Digital cameras can be used to document the degradation of the plastic.

Scales can be used to determine if a reduction in weight occurs.

Tests can conducted to determine the differences in tensile strength between the exposed and unexposed six pack rings.

B-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including dependant and independent variables), and evaluate the design of sample investigations.

Place half of a six pack ring outside with full exposure to sun. Place the other half inside of a shoe box beside the exposed 6 pack ring.

B-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics, graphs, models, and or technology.

Mathematics-Measurements in size and weight differences can be compared mathematically.

Graphs-The differences in tensile strength can be compared on a line graph at various time intervals throughout the experiment.

Technology-Differences in appearance can be documented photographically.

B-1.6 Evaluate the results of a controlled scientific experiment in terms of whether they refute or verify the hypothesis.

B-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time and materials).

Cost-How much extra cost do the photodegradable components add to the cost of a six pack ring?

Does adding the photodegradable component slow the manufacturing process?

Does the six pack ring still function acceptably with the photodegradable component included?

B-1.8 Compare the processes of scientific investigation and technological design.

B-1.9 Use appropriate safety procedures when conducting investigations.