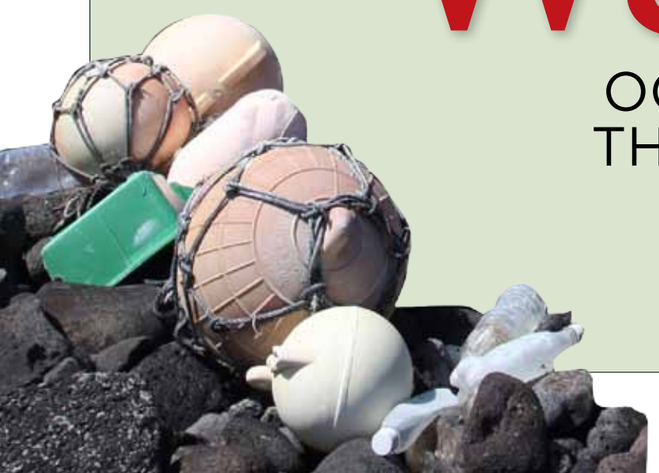
toxic waste

OCEANS OF PLASTIC THREATEN SEABIRDS

TEXT & PHOTOGRAPHS **PETER RYAN**



PLASTICS HAVE REVOLUTIONISED OUR LIVES. They are lightweight, durable and exhibit diverse structural properties, making them ideal for a wide range of applications. Currently we manufacture some 260 million tons of plastic each year, using roughly eight per cent of global oil production to do so. The problem is how best to manage used plastics, when their long lifespan counts against us. The past few decades have seen the accumulation of plastic litter worldwide, with serious implications for natural systems. Among birds, waterbirds and seabirds are particularly at risk. **Peter Ryan** reviews some of the recent findings and gives advice on how to be a responsible consumer of plastics.

PLASTICS ARE A DIVERSE GROUP of materials that can be moulded, spun, extruded or applied as a coating. Originally made from natural compounds, their manufacture really accelerated in the first half of the 20th century when synthetic plastics were developed. Now there are about 20 families of plastics, each containing numerous variants, and it is almost impossible to conceive of life without them.

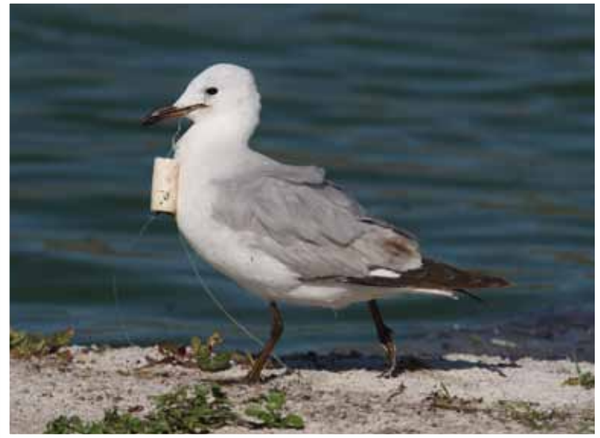
But many of the properties that make plastics so versatile also predispose them to becoming environmental pollutants. The low density of most plastics allows them to be readily dispersed by water or even the wind, carrying them far from their source areas. Added to this, synthetic polymers are largely impervious to biological decay, breaking down slowly only when exposed to ultraviolet radiation. Litter that is under water or buried may survive intact for hundreds or even thousands of years. As a result, plastics are accumulating in global ecosystems and are now ubiquitous from remote Antarctic beaches to the floor of the Arctic Ocean.

In Mike Nichols' classic film *The Graduate*, Mr McGuire advises Ben, 'There's a great future in plastics'. But the first inkling of the environmental problems caused by waste plastics was detected in 1960, seven years before *The Graduate* was released, when researchers in New Zealand recorded plastic in the stomachs of dead prions. By the mid-1980s almost all petrel and shearwater species sampled off southern Africa contained plastic. And as plastic fragments become ever more abundant at sea, they are even being recorded in the stomachs of species that are more selective foragers, such as penguins. Some of this plastic is probably obtained from their prey; filter-feeding fish can't discriminate small plastic fragments from zooplankton, and in some mid-ocean gyres plastic fragments are now several orders of magnitude more abundant than zooplankton!

ENTANGLEMENT AND INGESTION

But aesthetics aside, should we worry about the increase in plastic litter? What impacts does it have on wildlife? The most obvious threat is entanglement: birds and a host of other species sometimes get caught in litter, usually leading to a slow death unless they can be captured and freed. Discarded fishing gear is the most common culprit, but anything with a loop can cause problems, including bags, ropes and bands. Quite a few birds incorporate plastic litter in their nests, sometimes entangling their chicks. The recent death of a chick of a Bank Cormorant, an Endangered species, at Robben Island highlights this problem (Robinson et al. 2012, *Ornithological Observations* 3: 188–194). At present, entanglement is relatively rare, but it causes needless suffering and every effort should be made to limit the loss of fishing line and other materials likely to trap birds.

A few years ago a major South African fishing company (I&J) took the step of rewarding skippers for the amount of waste >



*Discarded fishing gear is often responsible for entangling birds, such as this juvenile Kelp Gull (*opposite*) and Hartlaub's Gull (*above*). However, any litter items that contain loops or even frayed edges can ensnare birds. A wide range of species is affected; I have even seen an African Darter with its bill enmeshed in a clump of steel wool. Such birds almost invariably die from starvation.*

LINDSAY YOUNG

A dead Laysan Albatross chick in Hawaii contains a plethora of plastic debris, lovingly fed to it by its parents. The North Pacific contains the highest concentrations of plastic litter of any ocean gyre, but there is worrying evidence that a similar 'garbage patch' is increasing in the South Atlantic.

OFF SOUTHERN AFRICA, **MORE THAN 90 PER CENT** OF GREAT SHEARWATERS AND BLUE PETRELS **CONTAIN PLASTIC FRAGMENTS IN THEIR STOMACHS**

plastic they returned to port, rather than for having clean ships. Such simple initiatives can make a big difference, particularly as fishing wastes contribute much of the entanglement risk at sea.

Plastic ingestion poses a more serious problem than entanglement, if only because it affects a much greater proportion of individuals. Off southern Africa, more than 90 per cent of Great Shearwaters and Blue Petrels contain plastic fragments in their stomachs. Ingested plastic has several impacts. It may block or damage the digestive tract, but this appears to be rare in seabirds, which are adapted to cope with spiny fish bones. In some groups, such as the petrels, plastic accumulates in their stomachs, reducing effective stomach volume and thus limiting the amount of food (and therefore nutrients) they can consume. This can be acute in species such as some North Pacific albatross chicks, which are fed so much plastic that they die. But probably the most significant problem is the toxins and other compounds that are carried by the plastics that birds eat.

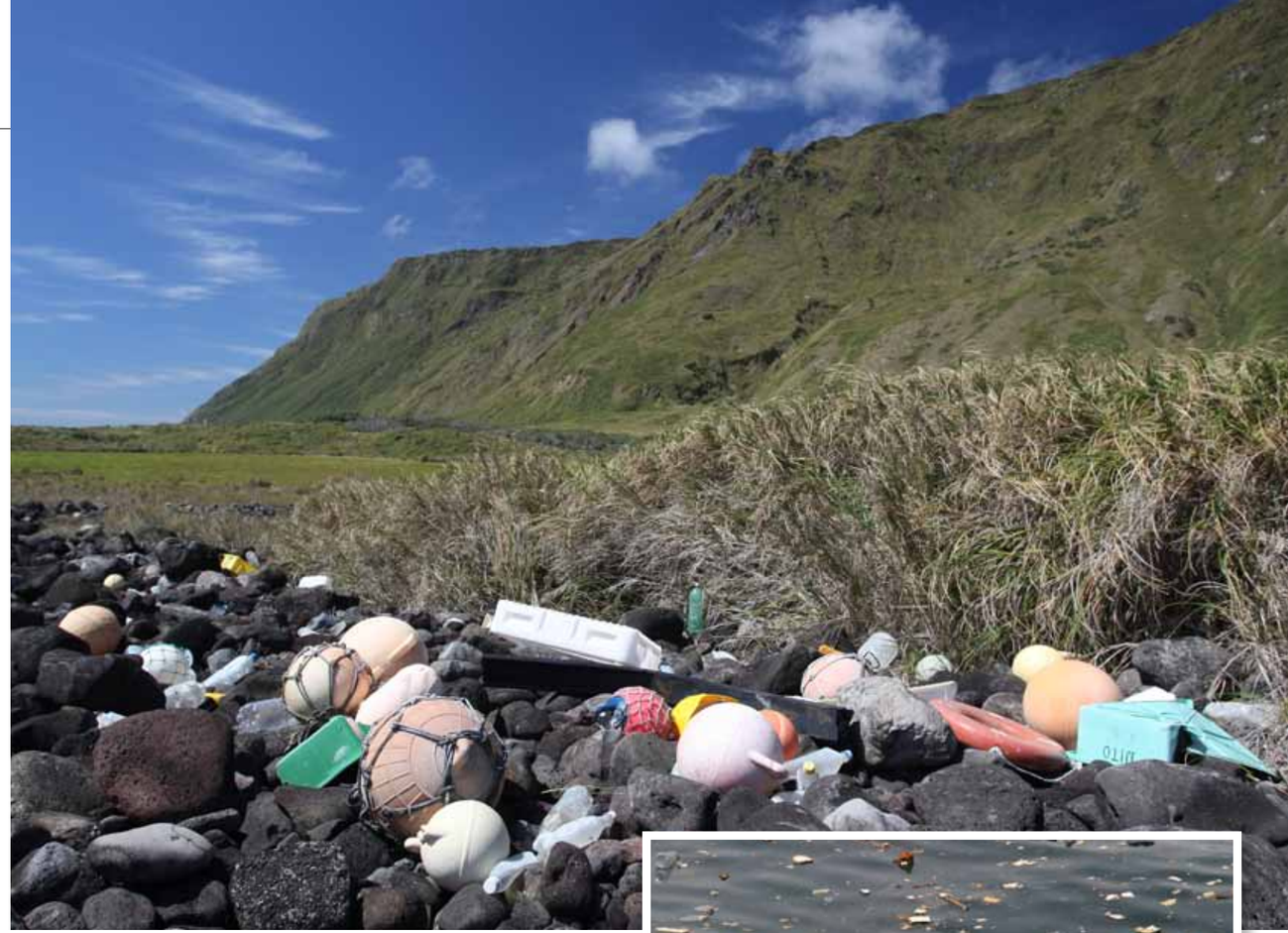
Most plastic polymers are physiologically inert, but depending on the application, plastic items may contain a variety of additives such as flame-retardants, plasticisers or colorants that can have deleterious impacts on animals. This has been an area of much recent research, given concerns about the impacts on humans. The results are worrying. Even very low concentrations of some substances can disrupt endocrine functions: phthalates behave as anti-androgens, bisphenol A (BPA) mimics oestrogen, and polybrominated diphenyl ethers (PBDE) and tetrabromobisphenol A (TBBPA) disrupt thyroid hormones. Seabirds face an additional problem, in that plastic fragments drifting at sea accumulate persistent organic pollutants, because many compounds such as polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethanes (DDTs) and hexachlorocyclohexanes (HCHs) prefer to adhere to plastics than to remain in seawater. When seabirds eat plastic fragments, this toxic cocktail is released by their digestive juices and assimilated into their bodies.

It's not just seabirds that face these problems. In freshwater systems amphibians are particularly susceptible to plastic-related toxins. And as plastics fragment into increasingly smaller pieces, they become accessible to a wide range of filter-feeding and detritus-feeding organisms. Smaller fragments have relatively larger surface areas, speeding the uptake of toxic compounds from water. Recent studies have demonstrated that a wide range of marine invertebrates obtain toxins from the plastic fragments they ingest, often with harmful impacts. And when these organisms are eaten by predators, there is biomagnification through food webs, with worrying implications for seabirds and humans alike.

DISTURBING LOCAL TRENDS

Although the amount of litter on South African beaches has increased over the past few decades, plastic loads in seabirds remained roughly constant from the mid-1980s to the mid-2000s. However, the composition of ingested plastic has shifted from a predominance of plastic pellets, the small bead-like objects that form the feedstock of the plastics industry, to fragments of manufactured items. It is unclear whether this reflects a decrease in the abundance of plastic pellets at sea or simply a much faster increase in other fragments. But the switch to fragments of manufactured items is likely to have increased the burden of toxic compounds.

The most recent news from Tristan da Cunha in the central South Atlantic is even less encouraging. In 2009 there was a sudden spike in plastic loads ingested by prions and storm petrels compared to the mid-2000s, suggesting an absolute increase in the amount of plastic at sea in this area. Tristan lies just south of the South Atlantic gyre, where floating plastic accumulates. If we continue pumping plastic into the environment, we might soon face a situation similar to the infamous North Pacific 'garbage patch' on our doorstep. Clearly there is a need to reduce the amount of plastic waste entering the sea. And although people like to place the blame on ships at sea, by far the majority of marine litter derives from land-based sources. We are all responsible, and can make a difference by changing the way we consume plastics and dispose of them.



REDUCE, RE-USE, RECYCLE...

'Paper or plastic?' is a common refrain in supermarkets in the United States, as shoppers are offered the option of taking paper or plastic bags for their purchases. (The correct response should be 'Neither', and presenting your own re-usable bag.) In 2000, Valli Moosa, then Minister of Environmental Affairs and Tourism, required retailers to charge consumers for plastic carrier bags. And although the funds generated may not have promoted recycling to the extent he envisaged, it certainly reduced the scourge of our 'national flower'. It is encouraging that current Minister of Environmental Affairs, Edna Molewa, recently announced a renewed commitment to tackling this issue.

But plastic carrier bags are merely flagships for the 'polluter pays' principle. Charging for bags set the precedent for making the costs of packaging explicit. Prior to 2000, the plastic carrier bags given away by retailers were not 'free'; the cost was simply hidden from consumers. Making the costs of packaging explicit would go a long way to reducing over-packaging. And if the post-consumer disposal costs were also incorporated we might finally start to make headway in tackling the mountains of waste generated in packaging and other one-use applications. Packaging comprises the majority of plastic litter items at sea, so reducing this at source can only help the situation.

Recycling plastics is challenging because of the many different grades, even within a specific type of plastic. And the large volume-to-weight ratio complicates transport and storage of >

top *Most litter stranded on Inaccessible Island comes from South America, 3 000 kilometres away – and almost all of it is plastic.*

above *Plastics also dominate litter in coastal waters. This astounding concentration of litter was seen out of sight of land in the Straits of Malacca off Kuala Lumpur.*

ALTHOUGH PEOPLE LIKE TO PLACE THE BLAME ON SHIPS AT SEA, BY FAR THE MAJORITY OF MARINE LITTER **DERIVES FROM LAND-BASED SOURCES**

*Beaches bear testimony to the amount and origins of much plastic litter. This collection of mostly small items (especially lids, straws and earbud sticks) was gathered from just 25 metres of a South African urban beach that is cleaned daily by municipal workers. Much of this litter comes from urban run-off: street litter is washed down stormwater drains (*inset*), and unless mechanically removed, ends up in wetlands and the sea.*

material for recycling. However, new technologies are being developed to aid the sorting and processing of used plastics. Recycling will become increasingly attractive as the cost of oil – and hence new plastics – continues to rise. Another economic incentive is provided by the escalating cost of landfill space. Most waste plastics end up in landfill sites and as we run out of suitable disposal sites close to urban centres there will be more pressure to reduce the waste stream at source.

One technological option that might pose more problems than it solves is the use of biodegradable plastics. Several such products have been manufactured, ranging from designing weak links into synthetic plastic polymers to developing fully degradable plastics from natural products such as cellulose or starch. The former only break down more rapidly, releasing many small plastic fragments into the environment, and the latter have to be treated with caution because they compromise initiatives to recycle waste plastics as a wood substitute (such as 'polywood').

It's important to stress that plastics are not inherently bad for the environment. In many applications they provide the greenest option available. However, due care must be given to their proper disposal. If they can't be re-used or recycled, they can be burnt to generate energy in specially designed incinerators or deposited in well-managed landfill sites. Uncontrolled release into the environment (littering) is the worst option, but despite endless educational campaigns, it remains rife, especially in developing countries where formal disposal options are often limited. Under these conditions, mechanical traps on stormwater conduits provide one useful option to prevent wastes from entering rivers and the sea. ◆

PETER RYAN is an associate professor at the University of Cape Town's Percy FitzPatrick Institute. In the 1980s he studied the impacts of plastic ingestion on seabirds for his MSc, and initiated programmes to monitor the amounts of marine litter around South Africa, which he continues to the present day.