

Oceans of plastic

Decades of using the world's seas as a convenient dumping ground may be starting to catch up with us. **Fran Molloy** reports on some alarming implications along the food chain.

Ancient mariners spoke of 'the doldrums' in hushed tones. These windless zones in the ocean spelled agonising delays for sailors becalmed and low on food and water. Occasional rain showers – and fresh fish for the taking – were life-saving resources.

But two years ago, adrift in the North Pacific on his way from Los Angeles to Hawaii, scientist Marcus Eriksen found those fresh fish may no longer be a viable food source.

Dropping a line in the ocean from the *Junk*, a raft he made from an old Cessna cockpit and a pontoon of around 15,000 old plastic bottles tied with old fishing nets, Eriksen pulled out a 25-cm rainbow runner – a restaurant favourite in the US. "I filleted the fish and was about to cook it when I opened the stomach out of curiosity – and found 17 particles of plastic." He tipped the fish fillets back into the ocean.

Concerns about toxins in fish have been slowly gaining ground, with the discovery that swordfish and other oily fish can accumulate heavy metals like mercury from the ocean. But scientists are just beginning to realise another worrying trend: plastic entering marine ecosystems so pervasively it could have devastating effects from ocean to plate.

The hidden cost of a disposable culture

In the 1950s, an explosion of plastic products made from polypropylene, polyethylene and styrofoam were adopted by consumers seeking convenient throw-away options for their everyday needs. In the decades since, billions of tonnes of plastic rubbish have been discarded, mostly into landfill, but masses have also made it into waterways and out to the sea.

Until more recently, no one thought much about ocean-bound plastic, a vestige of an 'out-of-sight, out-of-mind' mentality, until environmentalists raised concerns about turtles and other marine creatures mistakenly eating plastic bags and being caught in stray fishing lines. But the 1997 discovery of the Great Pacific Garbage Patch by Captain Charles Moore revealed a problem of epic proportions.

Moore, a long-time American sea dog, had founded a non-profit organisation, called the Algalita Marine Research Foundation, in 1994. In Hobart the following year he launched his research vessel, *Algalita*, designed and built in Australia. The maiden voyage was a research trip to test water quality along Australia's eastern seas. "We did see some debris off the coast of Australia in 1995. We knew the problem was growing but didn't realise then just how big it really was," Moore says.

Returning to California from Hawaii after an ocean race in 1997, Moore, on a whim, detoured through the centre of the North Pacific gyre – one of the world's five continuous giant whirlpools. Gyres are windless, high-pressure zones created by global ocean currents. They tend to accumulate flotsam – drifting tree-branches, seaweed, dead fish and birds – which slowly breaks down into a kind of oceanic compost, providing nutrients for marine life.

When Moore passed through the North Pacific gyre he was appalled to see the water turn into a thick slurry of bottle-caps, bags and fishing floats as far as he could see. "In the middle of the ocean, there was no water that wasn't full of plastic," he recalls.

Thousands of kilometres from land, bobbing around him were so many plastic bags, bits of tarp, nets, ropes and plastic bottles that he could have been at the tip. Moore was in the midst of a concentrated zone of man-made rubbish, an area he estimates is more than twice the size of the US state of Texas.

Horrified, he returned to land with a new mission for the Algalita Foundation. Completing the science degree he'd started many years before, he recruited fellow scientists to help tackle the issue – and in the ensuing 12 years, the researchers have uncovered increasingly worrying information.

According to the Algalita Foundation, as much as 100 million tonnes of plastic debris is spread across the oceans, much of it densely accumulating in the North Pacific gyre. (Research on plastic pollution in the other gyres is underway.) In this remote part of the Pacific Ocean, billions of tiny pieces of plastic are suspended throughout the ocean depths, forming a confetti-like highway stretching across thousands of kilometres. "The plastic soup we've made of the ocean is pretty universal," says Moore. "It's just a matter of degree."

This plastic will never disappear from the seas. Unlike organic material, plastic does not biodegrade; instead sunlight hastens its »



» disintegration into smaller and smaller pieces that remain plastic molecules right to the end. “Only we humans make waste that nature can’t digest,” Moore says. “There’s no way we can claim that we’ve got a chance to eliminate the scourge of plastic we’ve delivered to the ocean in half a century.”

In some areas, these plastic particles are now thought to be six times the concentration of zooplankton – microscopic animals that serve as a food source for larger marine creatures like dolphins and whales, as well as fish that end up on our dinner plates. “It’s more prevalent than anyone is willing to admit,” Moore says. “We don’t even have methods to look at the tiny nanoparticles out there. That’s where we need to go. We have to have new methods to analyse ocean water to find out its plastic content.”

Marcus Eriksen’s subsequent expeditions to the gyre confirmed his fears of the amount of plastic in the ocean. On a research trip in 2008, the team caught and analysed nearly 700 of the fish that came from the ocean depths to forage on zooplankton at night. “A third of the fish we pulled up in night trawls turned out to have plastics in their stomachs,” he says.

They also found the amount of plastic trash on the ocean’s surface had doubled within the last 10 years. And fish are not the only ones affected. Seabirds and other marine animals mistakenly eat plastic, a habit that often causes early death by starvation, when their plastic-filled stomachs cannot absorb nutrients.

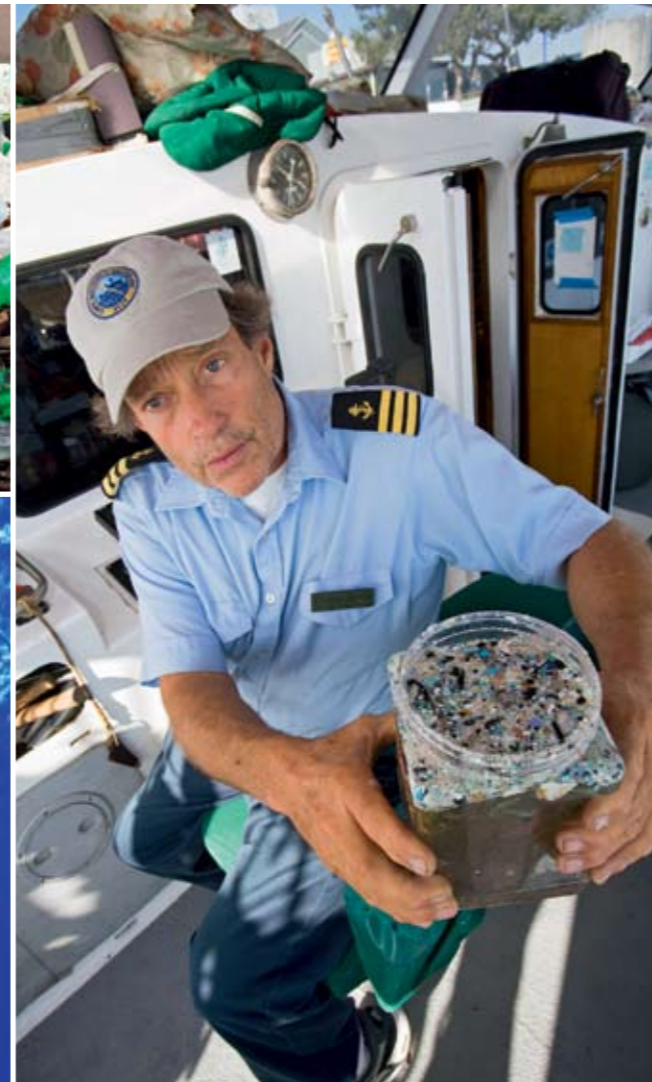
About a fifth of the plastic particles in the ocean are probably marine debris, fallout from the world’s heavily-trafficked shipping routes, often from luxury cruise liners; the rest is human litter, washed downstream and out to sea, swept along far from land for thousands of kilometres by ocean currents.

“At the very top of the headwaters in Lake Itasca in Minnesota, 2,000 miles [3,219 km] from the Gulf of Mexico, the first thing I saw was a plastic bottle. Every human being lives in a watershed and all of our debris is rolling downhill. You can’t get more downhill than the ocean,” says Eriksen.

The plastic food chain

Until recently, over-fishing and oil spills were seen as the greatest human threat to the marine environment. Now green groups are increasingly concerned with the effects of plastic pollution.

The Marine Stewardship Council is a large, independent not-for-profit group, spawned by the World Wide Fund for Nature, which promotes sustainable fishing through a certification and labelling program. With an active Australian branch and



How you can make a difference

- * Encourage legislators to ban styrofoam and plastic bags.
- * Don’t buy disposable plastic items.
- * Support the installation of nets across rivers and screens in front of stormwater drains to prevent plastics entering the ocean.
- * Refuse plastic containers and plastic bags.
- * Don’t buy poor quality plastic toys or other items that will break quickly.



Top left: Seabirds often mistakenly eat plastic, as the stomach contents of this albatross attest. Left: Captain Charles Moore with a startling sample of plastic “soup”. Above: This fish, caught by Marcus Eriksen in the North Pacific, contained 17 pieces of plastic in its belly.

“I find it ethically unacceptable to see [bio-polymers] as a solution to careless behaviour that results in littering when at a global scale there is insufficient land to grow crops for food.”

Thompson himself adopts the best-practice consumer habits he recommends. “I have changed the way I buy what I eat. I choose goods that are packaged in minimal quantities of packaging, in packaging that is readily recyclable, and I avoid using disposable bags to take my food home in.”

A local perspective

It’s not all bad news; the Australian Antarctic Division (AAD) regularly monitors marine debris levels and has not yet found a major increase in litter. “There’s far less marine debris in the Southern Ocean than there is in all the other oceans on the planet,” says AAD scientist Martin Riddle.

“The beaches of the sub-Antarctic islands, Heard Island and Macquarie Island, are very exposed and act as collecting points [for debris] and it’s largely fishing debris that gets washed up there. It’s very, very, rare that we would see anything on the coastline of the Antarctic that you wouldn’t be able to track back to very local activity.”

Fishmonger George Costi, part of the De Costi family seafood empire, says he’s been cutting up fish for over 25 years and has never seen any plastic inside one. “We see fish hooks – that’s pretty common – and lots of little fish that have been eaten by bigger fish, but I’ve never once seen any plastic.”

Costi says that the fresh fish that he cuts up is all from Australia and occasionally New Zealand; however, he can’t vouch for imported fish, which arrives frozen and already filleted. »

thousands of certified fisheries worldwide, the blue MSC certification label assures shoppers that the producer adheres to sustainable fishing practices. But the Council has no process for identifying fish stocks that may have consumed plastics – largely because of a dearth of scientific information.

Moore believes the effect of plastic will leave no fish untouched.

“You can buy certified organic produce,” he says. “But no fishmonger on Earth can sell you a certified organic wild caught fish.”

If the effects on global fish stocks are indeed as bad as Moore fears, then that could spell disaster for seafood-reliant nations, which are often poor. The sea provides a critical human food source: in 2007, global fish production reached 143.6 million tonnes, or 17 kilograms a year per person – that’s around 15 per cent of the global population’s intake of animal protein.

Most concerning is recent research indicating that disintegrating plastics like polystyrene can leach potentially toxic chemicals into seawater. Plastics can also attract heavy metals and other pollutants that are sometimes carried in seawater, which, when consumed by fish, could accumulate in the food chain – and possibly back to the humans who created it in the first place.

Richard Thompson of the School of Marine Science at the University of Plymouth, UK, is a world leader in research into the breakdown of plastic compounds in the marine environment.

CHRIS JORDAN/KOPEKIN GALLERY; JODY LEMMON/ALGALITA MARINE RESEARCH FOUNDATION

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He says that there’s been no investigation yet into the extent that plastics from ocean pollution are transferred up the food chain to humans; but there is evidence that plastics will absorb and concentrate persistent organic pollutants (POPs) from seawater – and that these chemicals are transferred on to organisms that eat plastic.

Indeed, Moore’s research revealed that the livers of seabirds that ingested plastic had high levels of DDT and PCBs (polychlorinated biphenyls) from the plastic within 30 days. So it’s not a stretch of the imagination to assume that fish would equally be affected – fish that could be bound for our dinner plates.

“We know that over 160 species of marine organisms ingest plastic and some of these species are eaten by humans,” Thompson says. Though he believes the number of people affected is low at the moment, Thompson warns that many of the millions of tonnes of plastic manufactured each year are discarded within a year of production. He predicts a marked rise in the quantity of plastic waste in the environment in coming decades, as production of disposable plastics continues to rise.

While some environmentalists advocate switching from petroleum to plant products as the base for plastics manufacture, Thompson says it would be better to focus on reducing the quantity of plastics and designing them to be easily recyclable.

» Nationally, we consume around 400,000 tonnes of seafood a year, with nearly half the fish we eat imported.

It seems there's no visible sign of plastic debris making its way to the plates of Australian consumers at this stage. But it may be what we can't see that affects us the most – the millimetre-sized plastic particles distributed throughout the ocean, and the toxic chemicals that tend to accumulate on plastic that is consumed by animals and passed up the food chain.

Plastics and human health

There's growing evidence that plastics may not be the innocuous materials we first thought. Bisphenol A (BPA) is a common plastic additive used in most food and beverage containers. A 1999 study by the US Centre for Disease Control found BPA in the urine samples of 93 per cent of participants.

Charles Moore recently edited a special issue of the journal *Philosophical Transactions of the Royal Society B* on the theme "Plastics, the Environment and Human Health", published by the UK's national academy of science. He points out that researchers are starting to link exposure to the compounds found in plastics to the developed world's epidemic of diabetes and obesity. "Even if you buy canned organic peas from a health food store, the can is still lined with an epoxy liner that leaches BPA into food; it's one of the most commonly used industrial chemicals – and it alters human physiology."

In April 2008, Canada became the first country to announce a proposed ban on baby bottles containing BPA to minimise the potential risks from exposure.

Another component of many plastics causing health concerns is the group of compounds known as phthalates. These are found in a huge range of products including pill coatings, glues, toys, textiles, cosmetics and cleaning materials.

Shanna Swan is an epidemiologist and professor of environmental medicine at the University of Rochester, New York. She published a groundbreaking study in 2005 showing a definitive link between prenatal exposure to phthalates and abnormal genital development of human male babies.

Swan is very concerned about the long-term effects on human fertility from plastic, and the likelihood of plastic waste in marine environments entering our food chain.

"Data published over the past 10 years demonstrates increasing threats to the growth and fertility of multiple species – mammalian, human and other."



Fast facts:

- * Oceans cover 70 per cent of the Earth's surface.
- * About a billion tonnes of plastic is produced globally each year.
- * About 10 per cent of all plastic is thought to end up in the ocean.
- * Global fish production in 2007 was almost 144 million tonnes, or 17 kg on average per person.
- * Fish constitutes 15 per cent of the global intake of animal protein.
- * The Australian fishing industry is worth \$2 billion per year.
- * Australians consume around 400,000 tonnes of seafood a year, half of it imported.



JOEL PASCHAL/GALITA MARINE RESEARCH FOUNDATION; PETER BENNETT/AMBIENT IMAGES

But one type of plastic in particular is her biggest concern – polyvinyl chloride, or PVC. "The primary source of human exposure to diethylhexyl phthalate and dibutyl phthalate – which are the phthalates of greatest concern because of their reproductive toxicity – is from foods that have been processed in, stored in, heated in or have otherwise come in contact with PVC," says Swan.

Although it's pretty grim news, there is a positive side. Unlike lead or dioxins, phthalates leave the body quickly, Swan says. "Once we stop using them, we have eliminated exposure."

Since starting this research, Swan has changed her own consumer habits. "I try to reduce exposure by eating organic, unprocessed foods, not storing or cooking in plastic and trying to buy as few plastic items as possible."

Moore's Algalita Foundation has now produced a significant body of research documenting the extent, and exploring the consequences, of plastic litter in the ocean, which complements Swan's findings. In response, Moore is calling on consumers everywhere to refuse plastic bags and bottles.

"I think you could say that we have entered the plastic age without anyone looking at our plastic footprint," Moore says. "Our plastic footprint right now is worse than our carbon footprint. It is killing hundreds of thousands of marine animals, millions of seabirds, and untold numbers of fish every year." **G**

FRAN MOLLOY is a Sydney-based journalist and regular G writer who was shocked to learn about the plastic soup our oceans have become.