

AN OCEAN

The world's waste has formed a vast floating garbage dump that's twice the size of Texas – and it's working its way up the food chain. By Kitt Doucette

WELCOME TO THE FUTURE," SAYS CAPT. Charles Moore, the commander of a 25-ton research vessel called *Alguita*. He's standing in Kewalo Basin Harbor on the south shore of Oahu, holding up a jug filled with murky yellow liquid. Tiny bits of debris swirl in the jug, a cloudy mass of trash. Most of it is plastic. ♦ "This is what our oceans look like now," Moore continues in a mariner's drawl. "This sample was taken in the Pacific about 1,000 miles west-southwest of Los Angeles. But I need to emphasize that this is not just one place – this is the whole ocean." The liquid in the jug resembles a gutter puddle in Manhattan more than the placid blue of the Pacific.

It was Moore who, in 1997, made a discovery about the ocean that raised alarms around the world. Returning home to California after a sailing race to Hawaii, he plotted a course through the North Pacific Gyre, an area known to sailors as the "doldrums." Encompassing some 10 million square miles, the gyre is home to trade winds and circular currents that

tend to keep whatever meanders into it without self-propulsion for months, years, even decades at a time. There, near the center of the slow, deep, clockwise currents that form this oceanic eddy, Moore came across a vast mass of floating debris that has become known as the Great Pacific Garbage Patch.

The first thing you need to know about the Great Pacific Garbage Patch is that its name, which conjures up images of an animated Charlie Brown special, is disgustingly inappropriate. In reality, the "patch" is a swirling vortex of plastic soup, an immense, fetid swamp of debris where tiny bits of decaying plastic outweigh surface zooplankton – one of the most prolific and abundant organisms on the planet – by a ratio of six-to-one. Nobody knows its exact size or if it has any boundaries at all: Its location and shape vary depending on factors such as water temperature, season and major weather events like El Niño.

Scientists estimate it is twice the size of Texas – maybe even larger – and contains some 10 million tons of waste.

"At first you see blue water stretching to the horizon," says Mary Crowley, director of the Ocean Voyages Institute. "That makes it seem like everything is quite all right. But then, when you really look into the water, you see this never-ending plastic confetti. We usually gather individual pieces of plastic at a rate of 200 to 300 every 30 minutes – and that's just in our immediate vicinity." Since the study started, researchers have not found a single sample in the gyre devoid of plastic.

Because most of the debris consists of "microplastics" – larger chunks of waste that have been reduced to tiny bits of polymer by the combined effect of waves, wind and sun – it poses an especially dire threat to wildlife. Particulated plastic is more likely to be eaten by birds and fish – and can contain concentrations of toxic chemicals, including DDT and PCBs, as much as a million times greater than the surrounding seawater. On Midway Atoll, albatross chicks are dying from starvation, their bellies full of plastic. Sea turtles mistake buoyant plastic bags for jellyfish, one of their main sources of prey, and choke to death. In a recent sample of 670 myctophids, a major

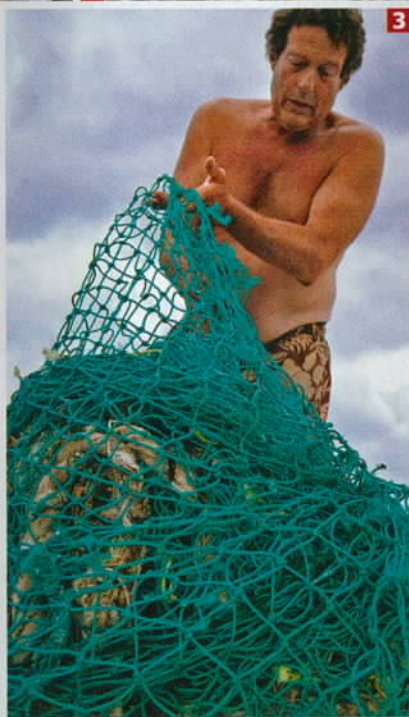
KILLER TRASH
Forty percent of albatross chicks on Midway Atoll (right) die from being fed bits of plastic waste that float ashore.



OF PLASTIC



RICK LORRIS/LOS ANGELES TIMES



'Every Bit of Plastic Remains'

In some areas, 95 percent of seabirds have plastic debris in their stomachs, averaging 44 pieces per bird (1). By the time waste reaches the Pacific Garbage Patch, most of it has been reduced to toxic "microplastics" by the elements (2). Charles Moore stumbled across the patch in 1997, returning from a race (3).

source of food for larger fish, the crew of *Alguita* found 1,298 pieces of plastic. "It's becoming the new diet," says Moore. "We're putting everything in the ocean on a plastic diet."

IT'S HARD TO BELIEVE PLASTIC has only been around for a century. In 1909, a Belgian-born chemist named Leo Hendrik Baekeland introduced the first completely synthetic plastic, a phenol-formaldehyde compound he called Bakelite, to the world at a conference of chemists in New York. Bakelite, first synthesized in Baekeland's barn in Yonkers, New York, was made by mixing carbolic acid and formaldehyde. It had the near-mystical property of being malleable when heated under pressure, while becoming rigid and insoluble when cooled. Highly moldable, more durable than ceramics, lighter than metal and made entirely in the lab, the new composite was also electrically nonconductive and heat-resistant, quickly earning it the title "material of a thousand uses."

First it was nylon, which hit the market in 1940, later causing riots at department stores as women stampeded over one another for a pair of stockings. Mass production of other plastics came after World War II with the advent of polyethylene, polypropylene and polystyrene, which serve as key ingredients in products like Saran Wrap, disposable milk jugs, Hula-Hoops and Styrofoam. By the 1960s, plastics were a ubiquitous part of American life and the very picture of modernity. By 1979, the annual volume of plastic produced in the U.S. overtook that of steel.

Writer KITT DOUCETTE traveled to Hawaii to report on the Pacific Garbage Patch. This is his first piece for RS.

Lauded as the "miracle" behind modern life, today plastic is everywhere. It's in our clothes, computers, cellphones, cars, furniture and refrigerators. Airplanes, hospitals and laboratories depend upon it, but mostly, it ends up in our trash cans. Next year, the world will pump out close to 300 million tons of plastic, well more than a third of it falling into the category of "minimal use," meaning it will be discarded anytime within a few seconds to one year. In the United States, 25 billion pounds of plastic go unaccounted for each year. Where does it go? Where does a relatively indestructible material go in a finite world? "Except for a small amount that's been incinerated, every bit of plastic we've put in the oceans still remains," says Anthony Andrady, a leading research scientist who specializes in plastics. "It's still somewhere in the marine environment."

When was the last time you spent an entire day without using a piece of disposable plastic? It surrounds us, inundates us. It gathers in the gutters of cities, washes up on every coastline in the world and floats in the oceans themselves. The United Nations Environment Program estimates that plastic debris kills more than

100,000 marine mammals and 1 million seabirds every year. Even small organisms like jellyfish, lanternfish and zooplankton have started to ingest tiny bits of plastic. These species, the very foundation of the oceanic food web, are becoming saturated with plastic, which may be passed farther up the food chain. "The concern is what the plastic is carrying and releasing into organisms that ingest it," says Holly Bamford, who is launching a study of marine debris for the National Oceanic and Atmospheric Administration. The bottom line is: It's all our own shit, and we're quite literally starting to eat it.

Even though plastic disintegrates over time, leaching chemicals like bisphenol-A and phthalates into the environment, most of it never disappears; the synthetic polymers that form its building blocks remain intact. In its tiniest, most particulated state, Andrady explains, "plastic is still plastic. The material still remains a polymer. Polyethylene – the most pervasive type of disposable plastic – is not biodegraded in any practical time scale. There is no mechanism in the marine environment to biodegrade that long a molecule."

When fish and mammals ingest microplastics from the Great Pacific Garbage Patch, the chemical toxins concentrated in the waste lodge themselves in the animals' fatty tissues, accumulating at ever-increasing levels the higher you go up the food chain. It isn't clear yet if these chemicals are reaching humans, but PCBs and DDT are known to disrupt reproduction in marine mammals. In humans they have been linked to liver damage, skin lesions and cancer. "The possibility of more and more creatures ingesting plastics that contain concentrated pollutants is real and quite disturbing," says Rich-



ard Thompson, a British marine biologist who has been studying microplastics for 20 years.

Wayne Sentman, a field biologist with the San Francisco-based Oceanic Society, has spent three years on Midway Atoll conducting field research on dead albatrosses. During that time, he has found a wide array of marine debris inside the bellies of dead birds, including "six lighters in one chick, a complete syringe with the needle, a small flashlight, various small light bulbs, combs, toothbrushes, parts of

Gyre is only one of five major gyres in the world's oceans. "Half of the world's oceans are accumulators – these high-pressure gyres that bring stuff into themselves," he says. "And every single one of them is full of plastic."

The question now is what, if anything, can we do about it? Some researchers are exploring ways to clean up the plastic by using an emerging technology to convert the oceans of plastic waste into fuel. One of the principal ingredients of plastic, after all, is crude oil – four percent of the

The problem is that extracting a single liter of fuel takes one kilogram of plastic and 100 grams of coal, which doesn't exactly make the process ecofriendly. What's more, there is currently no practical method to capture the liquid graveyard of waste floating in the Pacific. "The biggest task we now face is how to catch it," says Doug Woodring, the co-founder of a study of the Great Pacific Garbage Patch called Project Kaisei. "That is where the technology is uncertain."

The only viable way to stop the spread of plastic into the world's food chain, say those studying the danger, is to reduce the amount of plastic we use. "There's no way you can clean all this shit up – it's impossible," says Capt. Moore. "Right now we're catching all this stuff with a small net. What are you going to do – drag these nets through the entire ocean?"

Moore, who stumbled across the Great Pacific Garbage Patch by accident, looks more like a sailor than a scientist, and his language is as salty as his thick head of curly hair. Unlike other researchers, used to the measured talk of scientific conferences, Moore cuts to the heart of the matter. "All this bullshit about going out there and scooping this stuff up – you can't scoop this stuff up!" he says. "No way in hell you're going to get that out of there – it's just not feasible! The idea that there's this 'convergence zone' in the gyre, and the plastic waste all goes there – well, if it's all going there, it's coming from other places and screwing up those parts of the ocean too. If the input is constant, then that just makes the whole ocean fucked up."

Moore pauses, looking out over the Pacific. "No matter where you are, there's no getting over it, no getting away from it," he says. "It's a plastic ocean now." **©**

"There's no getting over it," says Moore. "We're putting everything in the ocean on a plastic diet."

flip-flops and fishing tackle." On British coastlines in the North Sea, a study of fulmars found that 95 percent of the seabirds had plastic in their stomachs, with an average of 44 pieces per bird. A proportional amount in a human being would weigh nearly five pounds.

THE DATA ABOUT PLASTIC debris in the oceans is still in its nascent stages, and scientists with the National Oceanic and Atmospheric Administration stress that more research is needed to determine whether plastic has become a toxin in the food chain. But the evidence is mounting, and the amount of debris continues to double each decade. The threat extends well beyond the Great Pacific Garbage Patch: As Capt. Moore is quick to point out, the North Pacific

world's entire supply, to be exact, or about 3.4 million barrels of oil a day at our current levels of consumption. If the energy in plastic could somehow be released, the thinking goes, it could simultaneously solve the waste problem while easing energy demand.

"Plastic is made from crude," says Alka Zadgaonkar, head of the department of applied chemistry at the G.H. Raisoni College of Engineering in Nagpur, India. "If you break it down, what you get is liquid hydrocarbon." With a loan from the State Bank of India, Zadgaonkar says she has developed a system that, with the aid of a secret catalyst, can turn "one kilogram of waste plastic into one liter of hydrocarbon." The hydrocarbons can then be distilled into a rough gasoline suitable for powering machinery, motorcycles and heating systems.