06.2018

NATIONAL GEOGRAPHIC

PLANET OR PLASTIC?

18 billion pounds of plastic ends up in the ocean each year. And that's just the tip of the iceberg.

POLLUTION

The Plastic Apocalypse

BY **SUSAN GOLDBERG**

In Dhaka, Bangladesh, a man adds to a mountain of discarded plastic bottles. With this issue, National Geographic invites other institutions to join us in reducing plastic use. Watch this space for updates.

SOME PEOPLE DENY CLIMATE CHANGE, BUT THERE ARE NO OCEAN PLASTIC DENIERS. THE PROBLEM'S IN PLAIN SIGHT.

It's hard to get your head around the story of plastic. The facts and figures are so staggering as to seem almost fantastical.

Can it really be true that half the plastic ever made was produced in the past 15 years? That a trillion plastic bags are used worldwide each year, with an average "working life" of just 15 minutes? And that estimates for how long plastic endures range from 450 years to forever?

The answer, unfortunately, is yes—those grim facts, and more, are all true. That's why we asked writer Laura Parker and photographer Randy Olson to put this global crisis in perspective.

Plastics, of course, are a great thing. As Parker writes, they helped the Allies win World War II, "eased travel into space, and revolutionized medicine... In airbags, incubators, helmets, or simply by delivering clean drinking water to poor people in those now demonized disposable bottles, plastics save lives daily." And yet, as Olson's jaw-dropping photos show, we have created a plastic apocalypse. Developed nations off-load waste from our convenient lifestyle and foist the cleanup on some of the planet's most vulnerable people.

The good news is, this can be fixed, and National Geographic wants to do its part. That's why, if you're a U.S. or U.K. subscriber, this month's issue arrived in a paper rather than plastic wrapper. This change will save more than 2.5 million single-use plastic bags every month.

And that's just the beginning. National Geographic is committed to making an impact on this topic. We're working to revamp plastic usage across our businesses and to recruit other groups and individuals to join us.

Will a paper wrapper save the planet? Well, no. But it's an example of the kind of relatively easy action that every company, every government, and every person can take. And when you put it together, that adds up to real change.

RANDY OLSON

150 years ago we created a lightweight, strong, and inexpensive material.

Today this miracle material helps keep hearts beating and planes in the air.

We made it. We depend on it. We're drowning in it.

More than 40 percent of it is used just once, then tossed.

Some 9 million tons of it end up in the ocean each year.

Plastic

BY **LAURA PARKER** PHOTOGRAPHS BY **RANDY OLSON**

The "working life" of a plastic bag is 15 minutes.

STEVE GALLAGHER

Plastic bottles choke the Cibeles fountain, outside city hall in central Madrid. An art collective called Luzinterruptus filled this and two other Madrid fountains with 60,000 discarded bottles last fall as a way of calling attention to the environmental impact of disposable plastics.

PREVIOUS PHOTO

After sheets of clear plastic trash have been washed in the Buriganga River, in Dhaka, Bangladesh, Noorjahan spreads them out to dry, turning them regularly—while also tending to her son, Momo. The plastic will eventually be sold to a recycler. Less than a fifth of all plastic gets recycled globally. In the U.S. it's less than 10 percent.

If plastic had been invented when the Pilgrims sailed from Plymouth, England, to North America—and the *Mayflower* had been stocked with bottled water and plastic-wrapped snacks—their plastic trash would likely still be around, four centuries later.

If the Pilgrims had been like many people today and simply tossed their empty bottles and wrappers over the side, Atlantic waves and sunlight would have worn all that plastic into tiny bits. And those bits might still be floating around the world's oceans today, sponging up toxins to add to the ones already in them, waiting to be eaten by some hapless fish or oyster, and ultimately perhaps by one of us.

We should give thanks that the Pilgrims didn't have plastic, I thought recently as I rode a train to Plymouth along England's south coast. I was on my way to see a man who would help me make sense of the whole mess we've made with plastic, especially in the ocean.

Because plastic wasn't invented until the late 19th century, and production really only took off around 1950, we have a mere 9.2 billion tons of the stuff to deal with. Of that, more than 6.9 billion tons have become waste. And of that waste, a staggering 6.3 billion tons never made it to a recycling bin—a figure that stunned the scientists who crunched the numbers in 2017.

No one knows how much unrecycled plastic waste ends up in the ocean, Earth's last sink. In 2015, Jenna Jambeck, a University of Georgia engineering professor, caught everyone's attention with a rough estimate: between 5.3 million and 14 million tons each year just from coastal regions. Most of it isn't thrown off ships, she and her colleagues say, but is dumped carelessly on land or in rivers, mostly in Asia. It's then blown or washed into the sea. Imagine five plastic grocery bags stuffed with plastic trash, Jambeck says, sitting on every foot of coastline around the world—that would correspond to about 8.8 million tons, her middle-of-the-road estimate of what the ocean gets from us annually. It's unclear how long it will take for that plastic to completely biodegrade into its constituent molecules. Estimates range from 450 years to never.

Meanwhile, ocean plastic is estimated to kill millions of marine animals every year. Nearly 700 species, including endangered ones, are known to have been affected by it. Some are harmed visibly—strangled by abandoned fishing nets or discarded six-pack rings. Many more are probably harmed invisibly. Marine species of all sizes, from zooplankton to whales, now eat microplastics, the bits smaller than one-fifth of an inch across. On Hawaii's Big Island, on a beach that seemingly should have been pristine—no

To ride currents, seahorses clutch drifting seagrass or other natural debris. In the polluted waters off the Indonesian island of Sumbawa, this seahorse latched onto a plastic cotton swab—"a photo I wish didn't exist," says photographer Justin Hofman.

JUSTIN HOFMAN

In *Life* magazine in 1955, an American family celebrates the dawn of "Throwaway Living," thanks in part to disposable plastics. Single-use plastics have brought great convenience to people around the world, but they also make up a big part of the plastic waste that's now choking our oceans.

PETER STACKPOLE, LIFE PICTURE COLLECTION/GETTY IMAGES

paved road leads to it—I walked ankle-deep through microplastics. They crunched like Rice Krispies under my feet. After that, I could understand why some people see ocean plastic as a looming catastrophe, worth mentioning in the same breath as climate change. At a global summit in Nairobi last December, the head of the United Nations Environment Programme spoke of an "ocean Armageddon."

And yet there's a key difference: Ocean plastic is not as complicated as climate change. There are no ocean trash deniers, at least so far. To do something about it, we don't have to remake our planet's entire energy system.

"This isn't a problem where we don't know what the solution is," says Ted Siegler, a Vermont resource economist who has spent more than 25 years working with developing nations on garbage. "We know how to pick up garbage. Anyone can do it. We know how to dispose of it. We know how to recycle." It's a matter of building the necessary institutions and systems, he says—ideally before the ocean turns, irretrievably and for centuries to come, into a thin soup of plastic.

IN PLYMOUTH, UNDER THE GRAY gloom of an English autumn, Richard Thompson waited in a yellow slicker outside Plymouth University's Coxside Marine Station, at the edge of the harbor. A lean man of 54, with a smooth pate rimmed with gray hair, Thompson was headed for an ordinary career as a marine ecologist in 1993—he was working on a Ph.D. on limpets and microalgae that grow on coastal rocks—when he participated in his first beach cleanup, on the Isle of Man. While other volunteers zoomed in on the plastic bottles and bags and nets, Thompson focused on the small stuff, the tiny particles that lay underfoot, ignored, at the high tide line. At first he wasn't even sure they were plastic. He had to consult forensic chemists to confirm it.

There was a real mystery to be solved back then, at least in academic circles: Scientists wondered why they weren't finding even more plastic in the sea. World production has increased exponentially—from 2.3 million tons in 1950, it grew to 162 million in 1993 and to 448 million by 2015—but the amount of plastic drifting on the ocean and washing up on beaches, alarming as it was, didn't seem to be rising as fast. "That begs the question: Where is it?" Thompson said. "We can't establish harm to the environment unless we know where it is."

This 19th-century billiard ball was made from celluloid, an early plastic that replaced elephant ivory—which was already growing scarce.

MARK THIESSEN, PHOTOGRAPHED AT SMITHSONIAN INSTITUTION, NATIONAL MUSEUM OF AMERICAN HISTORY

In the years since his first beach cleanup, Thompson has helped provide the beginnings of an answer: The missing plastic is getting broken into pieces so small they're hard to see. In a 2004 paper, Thompson coined the term "microplastics" for these small bits, predicting—accurately, as it turned out—that they had "potential for large-scale accumulation" in the ocean.

When we met in Plymouth last fall, Thompson and two of his students had just completed a study that indicated it's not just waves and sunlight that break down plastic. In lab tests, they'd watched amphipods of the species *Orchestia gammarellus*—tiny shrimplike crustaceans that are common in European coastal waters—devour pieces of plastic bags and determined they could shred a single bag into 1.75 million microscopic fragments. The little creatures chewed through plastic especially fast, Thompson's team found, when it was coated with the microbial slime that is their normal food. They spat out or eventually excreted the plastic bits.

Microplastics have been found everywhere in the ocean that people have looked, from sediments on the deepest seafloor to ice floating in the Arctic—which, as it melts over the next decade, could release more than a trillion bits of plastic into the water, according to one estimate. On some beaches on the Big Island of Hawaii, as much as 15 percent of the sand is actually grains of microplastic. Kamilo Point Beach, the one I walked on, catches plastic from the North Pacific gyre, the trashiest of five swirling current systems

Found on Kamilo Point Beach, Hawaii: "plastiglomerate," a type of rock formed when plastic debris—perhaps in a campfire—fuses with sand, rock, shells, and coral. Geologists think it may become an enduring marker of our impact on the Earth.

JEFF ELSTONE

IDENTIFIED BY CHARLES MOORE, PATRICIA CORCORAN, AND KELLY JAZVAC

that transport garbage around the ocean basins and concentrate it in great patches. At Kamilo Point the beach is piled with laundry baskets, bottles, and containers with labels in Chinese, Japanese, Korean, English, and occasionally, Russian. On Henderson Island, an uninhabited coral island in the South Pacific, researchers have found an astonishing volume of plastic from South America, Asia, New Zealand, Russia, and as far away as Scotland.

As Thompson and I talked about all this, a day boat called the *Dolphin* was carrying us through a light chop in the Sound, off Plymouth. Thompson reeled out a fine-mesh net called a manta trawl, usually used for studying plankton. We were close to the spot where, a few years earlier, other researchers had collected 504 fish of 10 species and given them to Thompson. Dissecting the fish, he was surprised to find microplastics in the guts of more than one-third of them. The finding made international headlines.

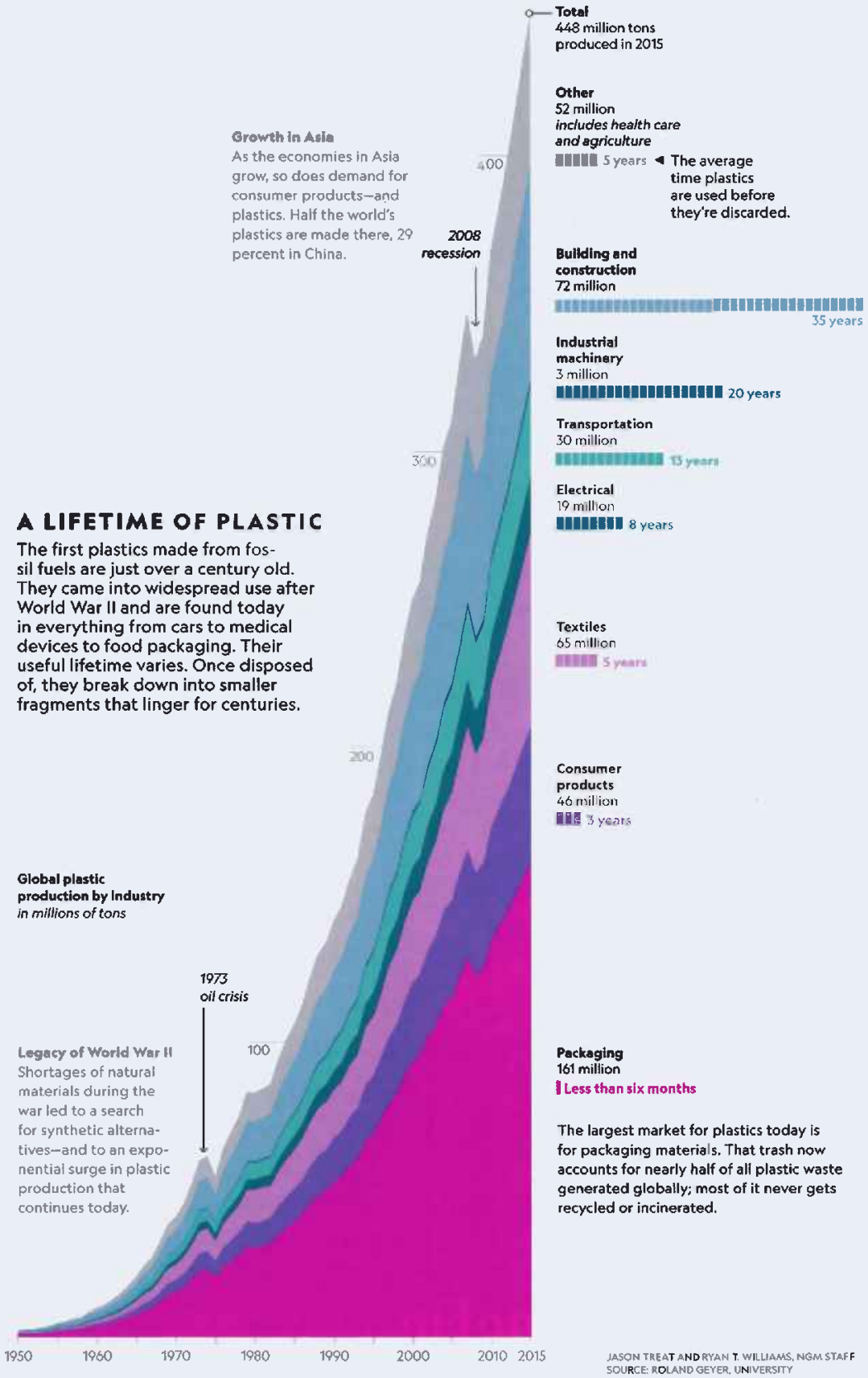
After we'd steamed along for a while, Thompson reeled the manta trawl back in. There was a smattering of colored plastic confetti at the bottom. Thompson himself doesn't worry much about microplastics in his fish and chips—there's little evidence yet that they pass from the gut of a fish into the flesh we actually eat. (See article on page 84.) He worries more about the things that none of us can see—the chemicals added to plastics to give them desirable properties, such as malleability, and the even tinier nanoplastics that microplastics presumably degrade into. Those might pass into the tissues of fish and humans.

"We do know the concentrations of chemicals at the time of manufacture in some cases are very high," Thompson said. "We don't know how much additive is left in the plastic by the time it becomes bite-size to a fish.

"Nobody has found nanoparticles in the environment—they're below the level of detection for analytical equipment. People think they are out there. They have the potential to be sequestered in tissue, and that could be a game changer."

Thompson is careful not to get ahead of the science on his subject. He's far from an alarmist—but he's also convinced that plastic trash in the ocean is far more than an aesthetic problem. "I don't think we should be waiting for a key finding of whether or not fish are hazardous to eat," he said. "We have enough evidence to act."

HOW DID WE GET HERE? When did the dark side of the miracle of plastic first show itself? It's a question that can be asked about many of the marvels of our technological world. Since helping the Allies win World War II—think of nylon parachutes or lightweight airplane parts—plastics have transformed all our lives as few other inventions have, mostly for the better. They've eased travel into space and revolutionized medicine. They lighten every car and jumbo jet today, saving fuel—and pollution. In the form of clingy, light-as-air wraps, they extend the life of fresh

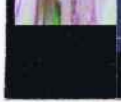


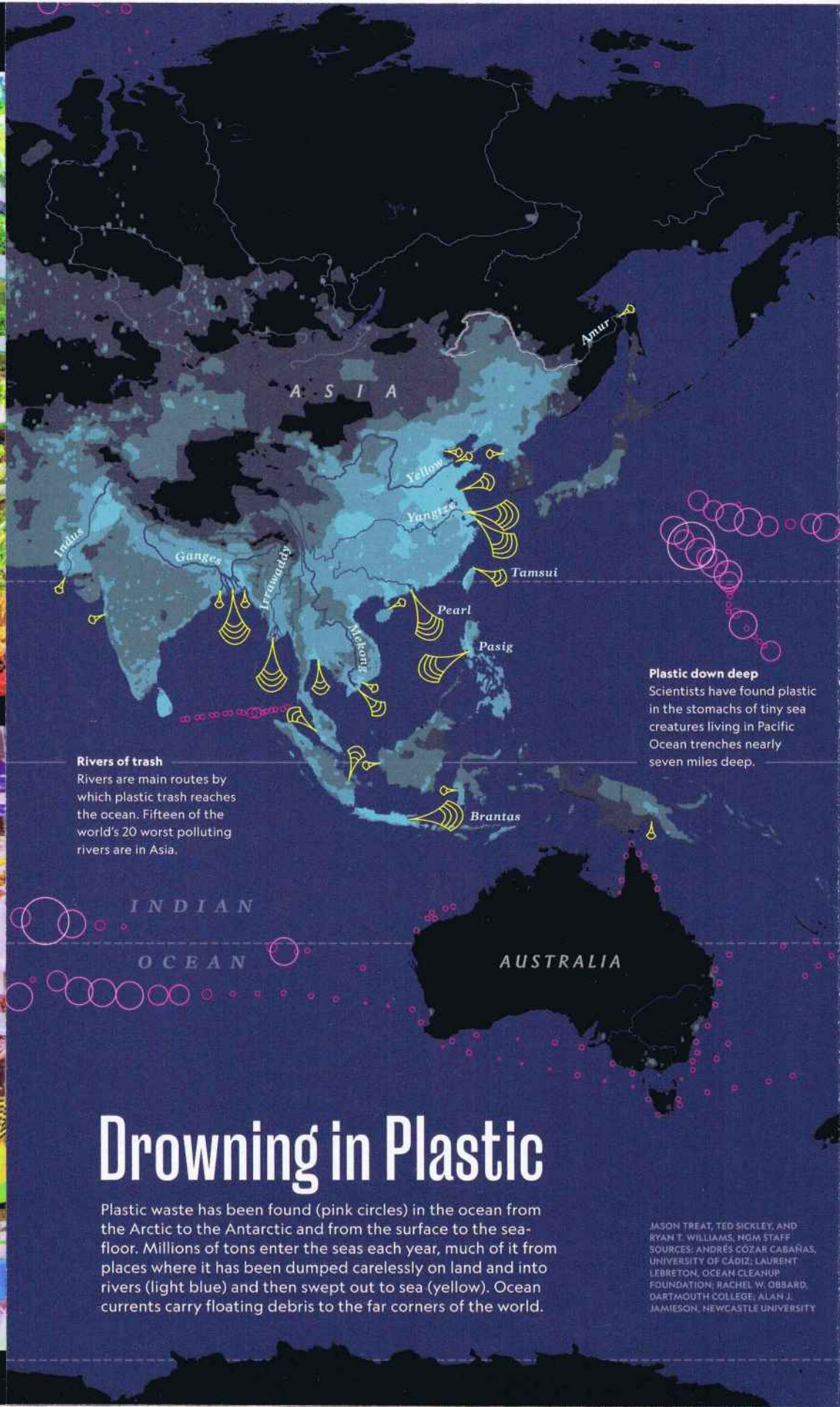
JASON TREAT AND RYAN T. WILLIAMS, NGM STAFF
SOURCE: ROLAND GEYER, UNIVERSITY OF CALIFORNIA, SANTA BARBARA

The World Capital of Everyday Plastic

Yiwu International Trade City, in the eastern Chinese province of Zhejiang, is the world's largest wholesale market for small commodities—and a plastic feast for the eyes. More than 70,000 booths, housed in a series of connected buildings, sell everything from inflatable pools to cooking utensils to artificial flowers. To photographer Richard John Seymour, the market felt both utterly familiar, because its goods are found everywhere, and completely foreign, because of the mind-boggling volume. China is the largest producer of plastic—it accounts for more than a quarter of the global total—much of it exported to the world.

RICHARD JOHN SEYMOUR (ALL)





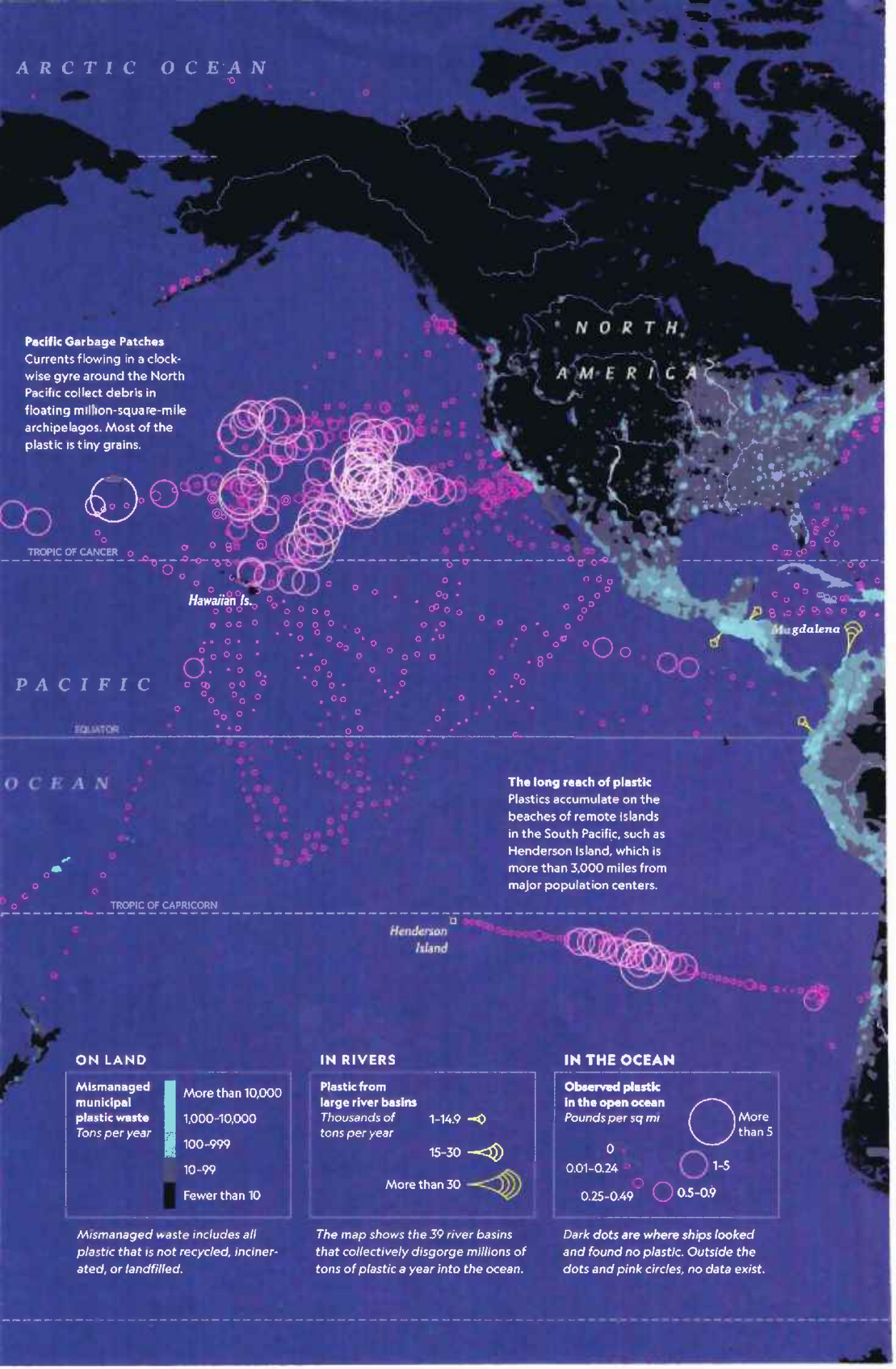
Rivers of trash
Rivers are main routes by which plastic trash reaches the ocean. Fifteen of the world's 20 worst polluting rivers are in Asia.

Plastic down deep
Scientists have found plastic in the stomachs of tiny sea creatures living in Pacific Ocean trenches nearly seven miles deep.

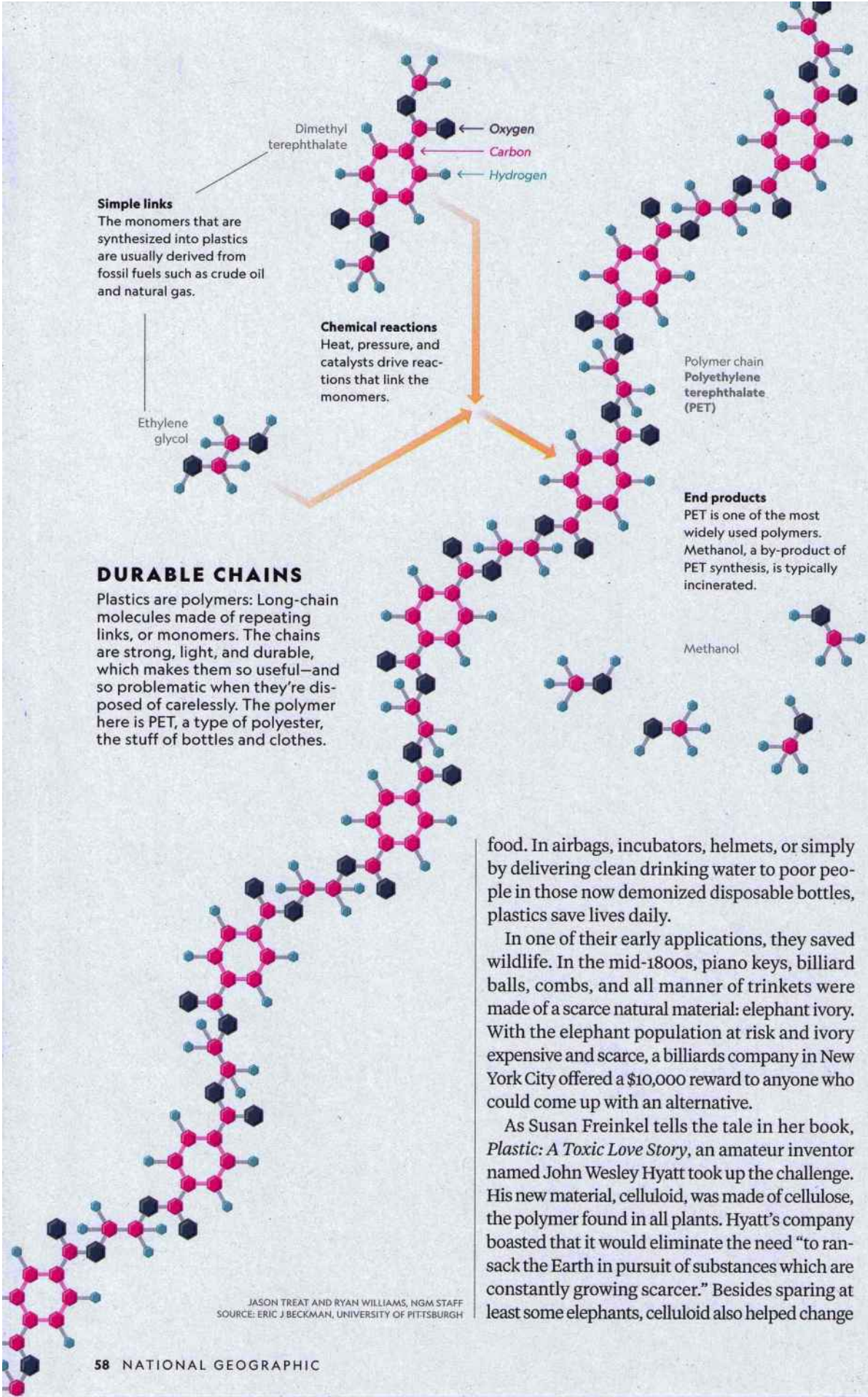
Drowning in Plastic

Plastic waste has been found (pink circles) in the ocean from the Arctic to the Antarctic and from the surface to the sea-floor. Millions of tons enter the seas each year, much of it from places where it has been dumped carelessly on land and into rivers (light blue) and then swept out to sea (yellow). Ocean currents carry floating debris to the far corners of the world.

JASON TREAT, TED SICKLEY, AND RYAN T. WILLIAMS, NGM STAFF
SOURCES: ANDRÉS CÓZAR CABAÑAS, UNIVERSITY OF CÁDIZ; LAURENT LEBRETON, OCEAN CLEANUP FOUNDATION; RACHEL W. OBBARD, DARTMOUTH COLLEGE; ALAN J. JAMIESON, NEWCASTLE UNIVERSITY


ARCTIC OCEAN
NORTH AMERICA
Pacific Garbage Patches
Currents flowing in a clockwise gyre around the North Pacific collect debris in floating million-square-mile archipelagos. Most of the plastic is tiny grains.
TROPIC OF CANCER
Hawaiian Is.
Mugdalena
PACIFIC
EQUATOR
OCEAN
The long reach of plastic
Plastics accumulate on the beaches of remote islands in the South Pacific, such as Henderson Island, which is more than 3,000 miles from major population centers.
TROPIC OF CAPRICORN
Henderson Island
ON LAND
Mismanaged municipal plastic waste
Tons per year
More than 10,000
1,000-10,000
100-999
10-99
Fewer than 10
Mismanaged waste includes all plastic that is not recycled, incinerated, or landfilled.
IN RIVERS
Plastic from large river basins
Thousands of tons per year
1-14.9
15-30
More than 30
The map shows the 39 river basins that collectively disgorge millions of tons of plastic a year into the ocean.
IN THE OCEAN
Observed plastic in the open ocean
Pounds per sq mi
More than 5
1-5
0.5-0.9
0
0.01-0.24
0.25-0.49
Dark dots are where ships looked and found no plastic. Outside the dots and pink circles, no data exist.


ARCTIC OCEAN
ARCTIC CIRCLE
Plastic in the Arctic
Microplastics drifting in from lower latitudes have accumulated in Arctic sea ice. But as the ice melts, the trapped plastics are released back into the water.
Rhine
EUROPE
AFRICA
ATLANTIC
Orinoco
Amazon
Niger
OCEAN
SOUTH
AMERICA
Missing plastic
Researchers found just one percent of the plastic they expected floating at the sea surface—the rest was missing. One reason: Plastic breaks down into tiny pieces, which are less visible but may greatly affect marine life.
Fragmentation
Sunlight, waves, and bacteria break plastic into microplastics.
Predation
Microplastics are ingested by animals of all sizes, from plankton to whales.
Sinking
Plastic that's dense or weighed down by marine life sinks through the water.
Shore deposition
Plastic fragments are transported by currents and tides back to the shore.
ANTARCTIC CIRCLE



DURABLE CHAINS

Plastics are polymers: Long-chain molecules made of repeating links, or monomers. The chains are strong, light, and durable, which makes them so useful—and so problematic when they're disposed of carelessly. The polymer here is PET, a type of polyester, the stuff of bottles and clothes.

JASON TREAT AND RYAN WILLIAMS, NGM STAFF
SOURCE: ERIC J BECKMAN, UNIVERSITY OF PITTSBURGH

food. In airbags, incubators, helmets, or simply by delivering clean drinking water to poor people in those now demonized disposable bottles, plastics save lives daily.

In one of their early applications, they saved wildlife. In the mid-1800s, piano keys, billiard balls, combs, and all manner of trinkets were made of a scarce natural material: elephant ivory. With the elephant population at risk and ivory expensive and scarce, a billiards company in New York City offered a $10,000 reward to anyone who could come up with an alternative.

As Susan Freinkel tells the tale in her book, *Plastic: A Toxic Love Story*, an amateur inventor named John Wesley Hyatt took up the challenge. His new material, celluloid, was made of cellulose, the polymer found in all plants. Hyatt's company boasted that it would eliminate the need "to ransack the Earth in pursuit of substances which are constantly growing scarcer." Besides sparing at least some elephants, celluloid also helped change

billiards from solely an aristocratic pastime to one that working people play in bars.

That's a trivial example of a profound revolution ushered in by plastic—an era of material abundance. The revolution accelerated in the early 20th century, once plastics began to be made from the same stuff that was giving us abundant, cheap energy: petroleum. Oil companies had waste gases like ethylene coming out the stacks of their refineries. Chemists discovered they could use those gases as building blocks, or monomers, to create all sorts of novel polymers—polyethylene terephthalate, for example, or PET—instead of working only with polymers that already existed in nature. A world of possibilities opened up. Anything and everything could be made of plastic, and so it was, because plastics were cheap.

They were so cheap, we began to make things we never intended to keep. In 1955 *Life* magazine celebrated the liberation of the American housewife from drudgery. Under the headline "Throwaway Living," a photograph showed a family flinging plates, cups, and cutlery into the air. The items would take 40 hours to clean, the text noted—"except that no housewife need bother." When did plastics start to show their dark side? You might say it was when the junk in that photo hit the ground.

Six decades later, roughly 40 percent of the now more than 448 million tons of plastic produced every year is disposable, much of it used as packaging intended to be discarded within minutes after purchase. Production has grown at such a breakneck pace that virtually half the plastic ever manufactured has been made in the past 15 years. Last year the Coca-Cola Company, perhaps the world's largest producer of plastic bottles, acknowledged for the first time just how many it makes: 128 billion a year. Nestlé, PepsiCo, and others also churn out torrents of bottles.

The growth of plastic production has far outstripped the ability of waste management to keep up: That's why the oceans are under assault. "It's not surprising that we broke the system," Jambeck says. "That kind of increase would break any system not prepared for it." In 2013 a group of scientists issued a new assessment of throwaway living. Writing in *Nature* magazine, they declared that disposable plastic should be classified, not as a housewife's friend, but as a hazardous material.

In recent years the surge in production has been driven largely by the expanded use of disposable plastic packaging in the growing economies of Asia—where garbage collection systems may be underdeveloped or nonexistent. In 2010, according to an estimate by Jambeck, half the world's mismanaged plastic waste was generated by just five Asian countries: China, Indonesia, the Philippines, Vietnam, and Sri Lanka.

"Let's say you recycle 100 percent in all of North America and Europe," says Ramani Narayan, a chemical engineering professor at Michigan State University who also works in his native India. "You still would not make a dent on the plastics released into the oceans. If you want to do something about this, you have to go there, to these countries, and deal with the mismanaged waste."

Production of plastic has come at a breakneck pace: Virtually half of the plastic ever manufactured has been made in the past 15 years.

THE PASIG RIVER ONCE FLOWED majestically through downtown Manila, capital of the Philippines, and emptied into pristine Manila Bay. It was a treasured waterway and civic point of pride. It's now listed among the top 10 rivers in the world that convey plastic waste to the sea. As many as 72,000 tons flow downstream each year, mostly during the monsoon. In 1990 the Pasig was declared biologically dead.

The Pasig River Rehabilitation Commission, established in 1999, is working to clean up the river, with some signs of success. Jose Antonio Goitia, the commission's executive director, says he is optimistic that the Pasig could be restored someday, although he acknowledges he has no easy way of doing that. "Maybe the best thing to do is ban plastic bags," he says.

The remaining challenges are clearly visible every day. The river is fed by 51 tributaries, some of them overflowing with plastic waste from squatter settlements that cantilever precariously over creek

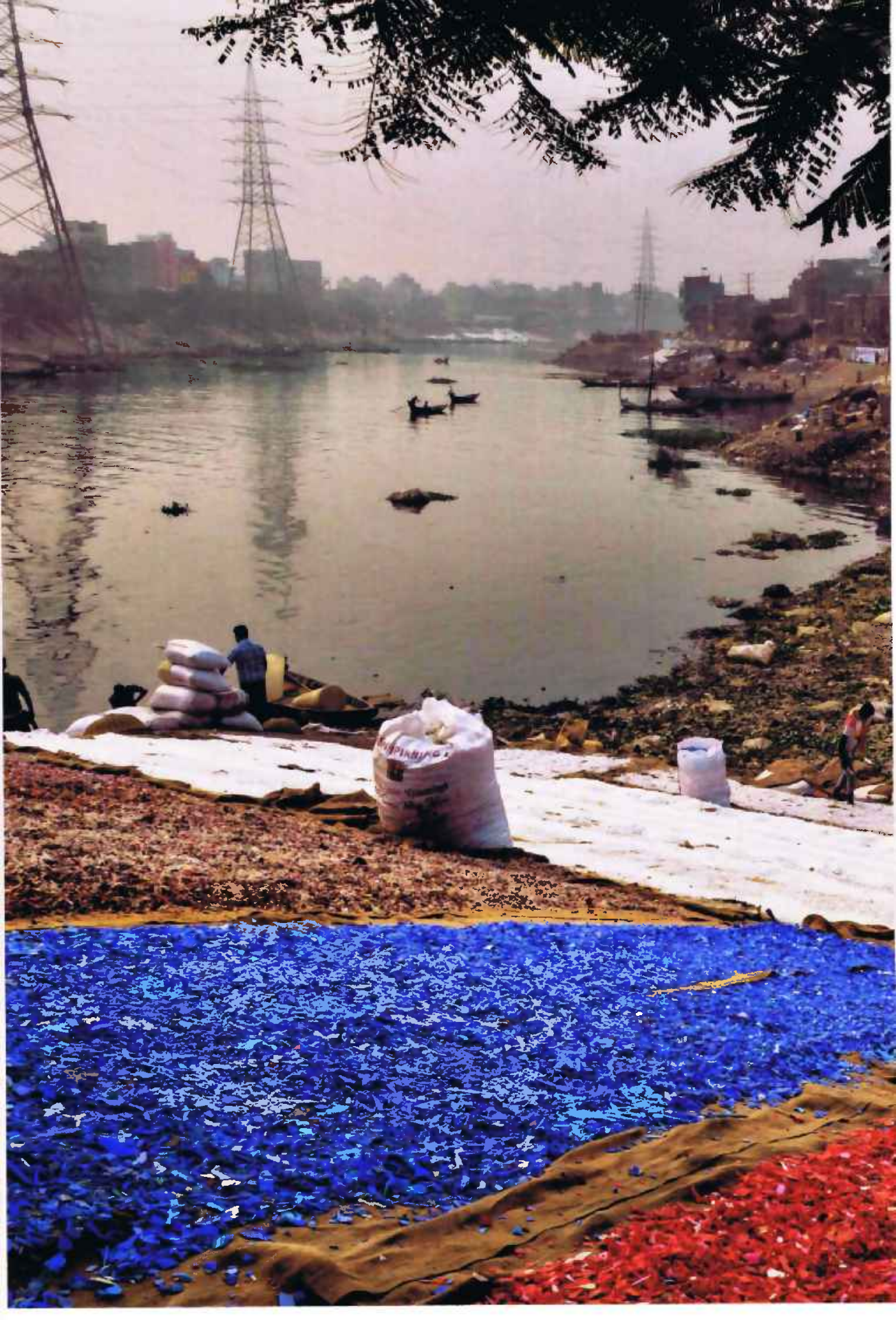
Trucks full of plastic bottles pull into a recycling facility in Valenzuela, Philippines. The bottles were plucked from the streets of metropolitan Manila by waste pickers, who sell them to scrap dealers, who bring them here. The plastic bottles and caps will be shredded, sold up the recycling chain, and exported.

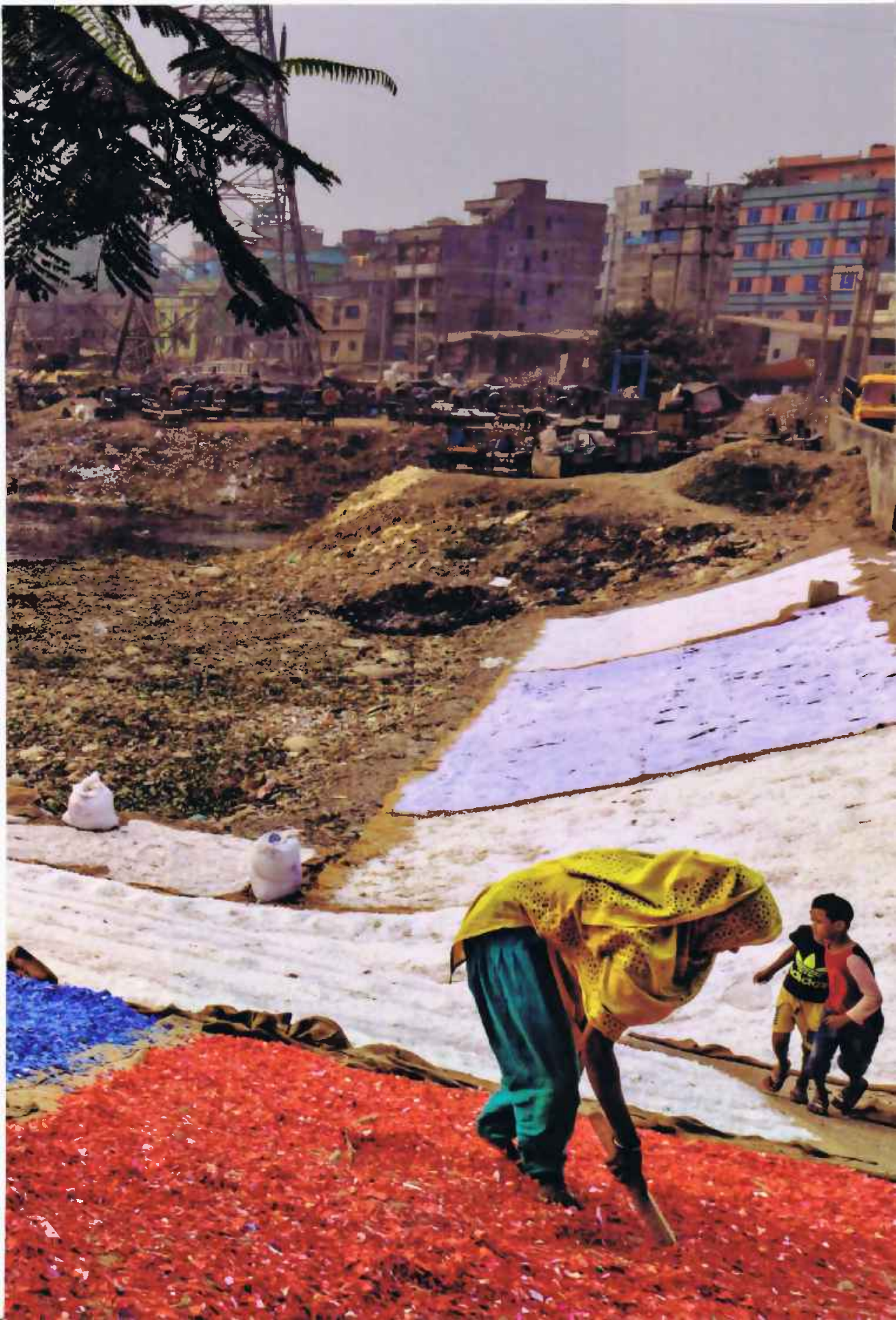
PREVIOUS PHOTO

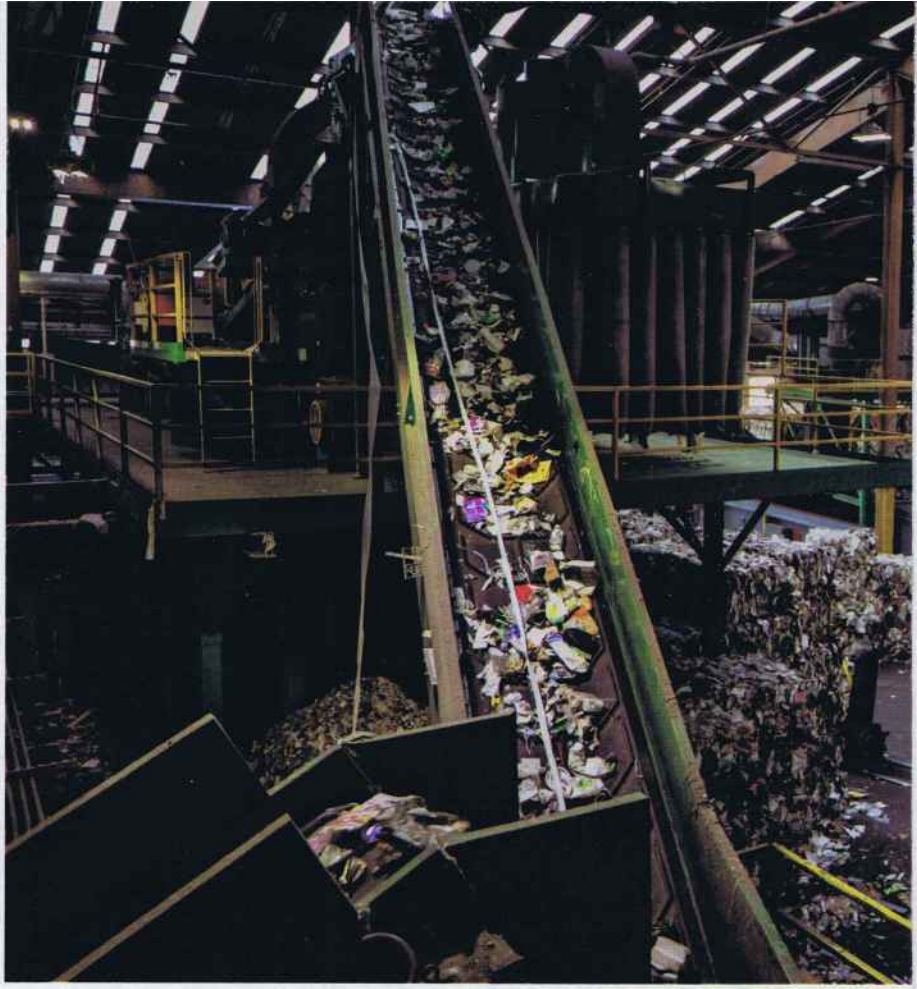
Under a bridge on a branch of the Buriganga River in Bangladesh, a family removes labels from plastic bottles, sorting green from clear ones to sell to a scrap dealer. Waste pickers here average around $100 a month.

NEXT PHOTO

Colored chips of plastic—collected, washed and sorted by hand—dry on the banks of the Buriganga. About 120,000 people work in the informal recycling industry in and around Dhaka, where 18 million inhabitants generate some 11,000 tons of waste a day.







RIGHT

Recology's largest San Francisco recycling plant handles 500 to 600 tons daily. One of the few plants in the U.S. that accept shopping bags, it has more than doubled the tonnage it recycles in the past 20 years. The conveyor belt is carrying mixed plastic to an optical sorter.

BELOW

Nestlé Waters, which supplies 11 percent of the world's bottled water, says it has reduced the plastic in its half-liter bottles by 62 percent since 1994. The Poland Spring plant in Hollis, Maine, is the company's largest in North America.

banks. A tributary near Chinatown, where rickety shanties are wedged between modern buildings, is so choked with plastic debris you can walk across it, forgoing the footbridge. Manila Bay's beaches, once recreational respites for greater Manila's 13 million residents, are littered with garbage, much of it plastic. Last fall Break Free From Plastic, a coalition including Greenpeace and other groups, cleaned a beach on Freedom Island, which is advertised as an ecotourism district; volunteers picked up 54,260 pieces of plastic, from shoes to food containers. By the time I visited a few weeks later, the beach was littered again with bottles, wrappers, and shopping bags.

The scene in Manila is typical of large, overcrowded urban centers across Asia. The Philippines is a densely populated nation of 105 million people that is still struggling with the most basic public health issues, including waterborne diseases such as typhoid and bacterial diarrhea. It's no surprise that it has trouble managing the explosion of plastic garbage. Manila has a metropolitan garbage collection system that stretches across 17 separate local governments—a source of chaos and inefficiency. In 2004 the region was already running out of land to safely dump garbage. The shortage of landfill space, and thus the crisis, continues today.

A small part of the slack is taken up by Manila's informal recycling industry, which consists of thousands of waste pickers. Armando Siena, 34, is one of them. He and his wife, Angie, 31, have lived their entire lives surrounded by trash. They were born on Smokey Mountain, an internationally notorious dump that was officially closed in the 1990s. They now live with their three children near Manila's waterfront in a one-room flat lit by a single bulb, furnished with a pair of plastic chairs, and lacking plumbing, bedding, or refrigeration. The flat is in a garbage-filled slum named Aroma, next to another slum named Happyland.

Every day Siena rides a rickety bicycle beyond Aroma's boundaries, scanning the streets for recyclable rubbish that he can stuff into his sidecar. Plastic soup containers are high-value finds, paying 20 pesos (38 cents) a kilogram. Siena sorts and sells his load to a junk shop owned by his uncle, who trucks the waste to recycling plants on the outskirts of Manila.

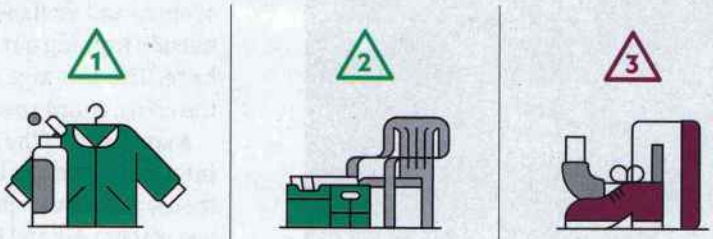
Waste pickers like Siena are part of the solution, some activists argue; they just need a living wage. In the Baseco waterfront slum in Manila, a tiny recycling shop operated by the Plastic Bank of Vancouver, British Columbia, pays a premium for bottles and hard plastic collected by waste pickers. It then sells that plastic at a higher price to multinationals, which market their recycled products as socially responsible.

Siegler, the Vermont economist, has worked in enough countries and run enough numbers to be skeptical of such schemes. "There is not enough value in plastics to make that work," he says. "It's cheaper to fund a solid waste management system than to subsidize collecting plastic."

The waste that clogs Manila's beaches and waterways reinforces Siegler's point. Much of it consists of sachets—tear-off packets that once held a single serving of shampoo, toothpaste, coffee, condiments, or other products. They are sold by the millions to poor people like Siena and his family, who can't afford to buy more than one serving at a time. Sachets blow around Manila like leaves falling from trees. They're not recyclable, so no waste picker will retrieve them. Crispian Lao, a member of the National Solid Waste Management Commission, says, "This segment of packaging is growing, and it has become a

THE CHALLENGE OF RECYCLING

Globally, 18 percent of plastic is recycled, up from nearly zero in 1980. Plastic bottles are one of the most widely recycled products. But other items, such as drinking straws, are harder to recycle and often discarded.



1 PET
Polyethylene terephthalate

Beverage bottles, food jars, clothing and carpet fiber, some shampoo and mouthwash bottles

11%

2 HDPE
High-density polyethylene

Detergent and bleach bottles, snack boxes, milk jugs, toys, buckets, crates, plant pots, garden furniture, trash bins

14%

3 PVC
Polyvinyl chloride

Credit cards, window and doorframes, gutters, pipes and fittings, wire and cable sheathing, synthetic leather

5%

*Ease of recycling by type**

- Easy
- Manageable
- Difficult
- Very difficult

Percentage of global plastic waste, 2015

*Ease of recycling varies by region; North America shown. Not all plastics are recyclable.

real challenge for solid waste management."

When Greenpeace cleaned the Freedom Island beach, it posted a tally of the brand names of the sachets its volunteers had collected. Nestlé ranked first, Unilever second. Litterbugs aren't the only ones at fault, says Greenpeace's Abigail Aguilar: "We believe that the ones producing and promoting the use of single-use plastics have a major role in the whole problem." A Unilever spokeswoman in Manila told me the company is developing a recyclable sachet.

AFTER MALAYSIA AIRLINES FLIGHT 370 disappeared from radar screens in March 2014 while on its way from Kuala Lumpur to Beijing, the search for it extended from Indonesia to the southern Indian Ocean. It captivated a global audience for weeks. No sign of the wreckage appeared. On several occasions, when satellite images revealed collections of objects floating on the sea surface, hopes soared that they would turn out to be aircraft parts. They weren't. It was all trash—pieces of broken shipping containers, abandoned fishing gear, and of course, plastic shopping bags.

Kathleen Dohan, a scientist and the president of Earth and Space Research in Seattle, saw opportunity in the horror: The images from space were pushing a problem into view that had long been neglected. "This is the first time the whole world is watching," she told me at the time. "It's a good time for people to understand that our oceans are garbage dumps." Dohan sensed a tipping point in public awareness—and the events since suggest she may have been right.

The most heartening thing about the plastic waste problem is the recent explosion of attention to it, and even of serious, if scattered, efforts to address it. A partial list of the good news since 2014 would include, in no particular order: Kenya joined a growing list of nations that have banned plastic bags, imposing steep fines and jail time on violators. France said it would ban plastic plates and cups by 2020. Bans on plastic microbeads in cosmetics (they're exfoliants) take effect this year in the U.S., Canada, the U.K., and four other countries. The industry is phasing them out.

Corporations are responding to public opinion. Coca-Cola, which also produces Dasani water, announced a goal to "collect and recycle the equivalent of" 100 percent of its packaging by 2030. It and other multinationals, including PepsiCo, Amcor, and Unilever, have pledged to convert to 100 percent reusable, recyclable, or compostable packaging by 2025. And Johnson & Johnson is switching from plastic back to paper stems on its cotton swabs.

Individuals are making a difference too. Ellen MacArthur, a British yachtswoman, has created a foundation to promote the vision of a "circular economy," in which all materials, including plastics, are designed to be reused or recycled, not dumped. Actor Adrian Grenier has lent his celebrity to the campaign against the plastic drinking straw. And Boyan Slat, 23, from the

ART: RADIO
SOURCES: ASTM INTERNATIONAL; ASSOCIATION OF PLASTIC RECYCLERS; ROLAND GEYER, UNIVERSITY OF CALIFORNIA, SANTA BARBARA

LDPE
Low-density polyethylene

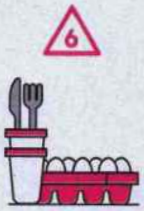
Packaging film, shopping bags, bubble wrap, flexible bottles, wire and cable insulation

20%

PP
Polypropylene

Bottle tops, drinking straws, lunch boxes, insulated coolers, fabric and carpet fiber, tarps, diapers

19%



PS
Polystyrene

Plastic-foam cups, egg boxes, meat trays, packing peanuts, coat hangers, yogurt containers, insulation, toys

6%

OTHER

Nylon fabrics, baby bottles, compact disks, medical storage containers, car parts, watercooler bottles

24%

Netherlands, is charging ahead with his teenage vow to clean up the largest garbage patch in the North Pacific. His organization has raised more than $30 million to construct an ocean-sweeping machine that is still under development.

All of these measures help at some level—even beach cleanups, futile as they sometimes seem. A beach cleanup hooked Richard Thompson on the plastic problem a quarter century ago. But the real solution, he now thinks, is to stop plastic from entering the ocean in the first place—and then to rethink our whole approach to the amazing stuff. "We've done a lot of work making sure plastic does its job, but very little amount of work on what happens to that product at the end of its lifetime," he says. "I'm not saying plastics are the enemy, but there is a lot the industry can do to help solve the problem."

There are two fundamental ways industry can help, if it wants or is forced to. First, along with academic scientists such as Jambeck, it can design new plastics and new plastic products that are either biodegradable or more recyclable (see article on page 88). New materials and more recycling, along with simply avoiding unnecessary uses of the stuff, are the long-term solutions to the plastic waste problem. But the fastest way to make a big difference, Siegler says, is low tech. It's more garbage trucks and landfills.

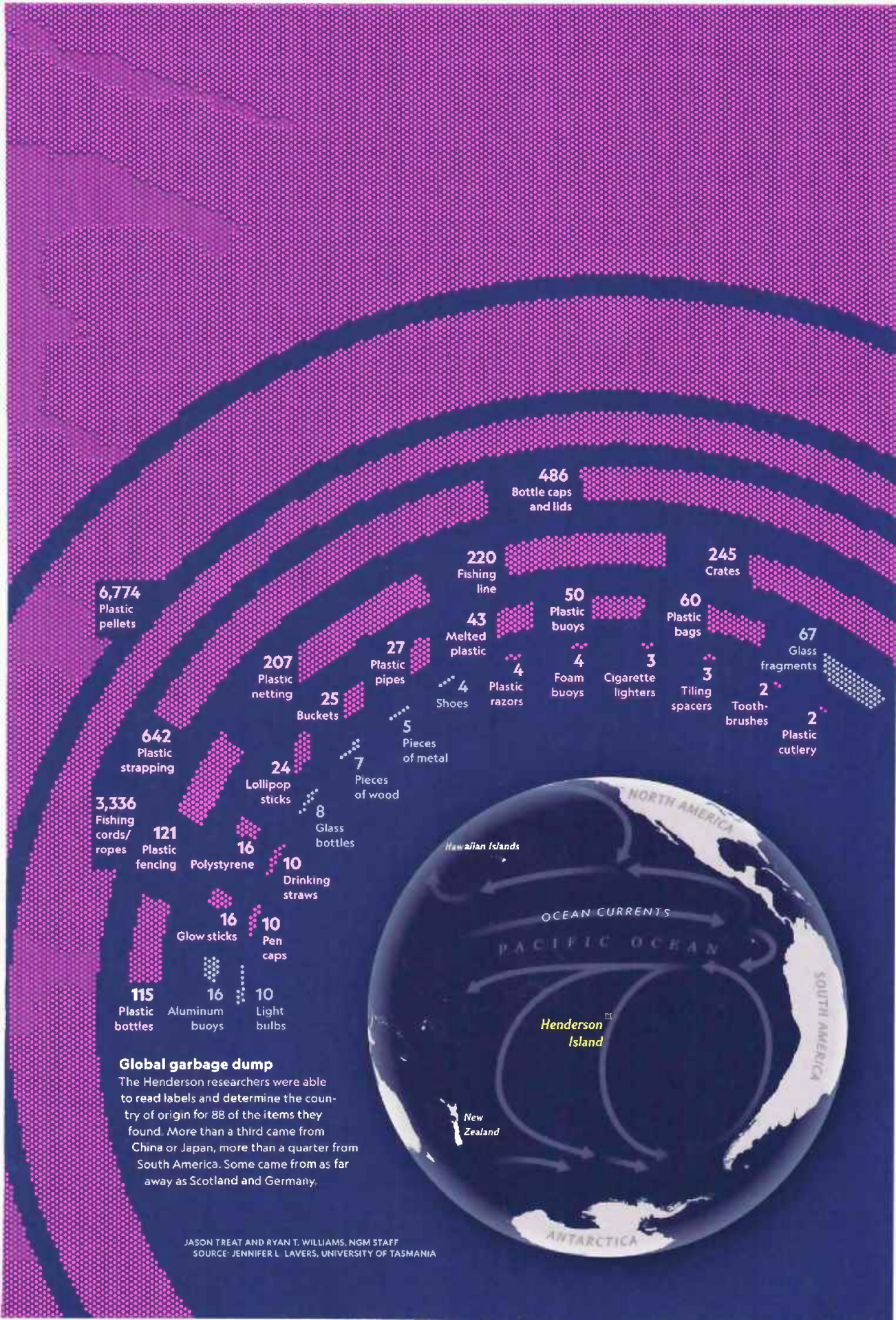
"Everyone wants a sexy answer," he says. "The reality is, we need to just collect the trash. Most countries that I work in, you can't even get it off the street. We need garbage trucks and help institutionalizing the fact that this waste needs to be collected on a regular basis and landfilled, recycled, or burned so that it doesn't end up going all over the place."

That's the second way industry could help: It could pony up. Siegler has proposed a worldwide tax of a penny on every pound of plastic resin manufactured. The tax would raise roughly six billion dollars a year that could be used to finance garbage collection systems in developing nations. The idea never caught on. In the fall of 2017, though, a group of scientists revived the concept of a global fund. The group called for an international agreement patterned after the Paris climate accord.

At the Nairobi meeting in December, 193 nations, including the U.S., actually passed one. The United Nations Clean Seas agreement doesn't impose a tax on plastic. It's nonbinding and toothless. It's really just a declaration of a good intention—the intention to end ocean plastic pollution. In that way it's less like the Paris Agreement and more like the Rio de Janeiro treaty, in which the world pledged to combat dangerous climate change—back in 1992. Norway's environment minister, Vidar Helgesen, called this new agreement a strong first step. □

Staff writer **Laura Parker** and photographer **Randy Olson** last worked together on a feature on the vanishing Ogallala aquifer, which was published in the August 2016 issue.


Each dot represents a single piece of trash cataloged on Henderson Island in 2015. Pink dots (•) indicate plastic trash; gray dots (•) represent all other trash.
48,121 ▸
Plastic fragments
PLASTIC PARADISE
Plastic is turning up in our planet's most remote areas, such as uninhabited Henderson Island in the South Pacific. In 2015 researchers found it awash in trash, mostly plastic. They cataloged 53,000 pieces in a sample area and put the island's total at 38 million.



Global garbage dump

The Henderson researchers were able to read labels and determine the country of origin for 88 of the items they found. More than a third came from China or Japan, more than a quarter from South America. Some came from as far away as Scotland and Germany.

JASON TREAT AND RYAN T. WILLIAMS, NGM STAFF
SOURCE: JENNIFER L. LAVERS, UNIVERSITY OF TASMANIA

When photographer Mandy Barker returned to the English beach where she collected shells as a child, she found a baby's car seat and a refrigerator among piles of plastic waste. She also noticed an air of indifference: It seemed to her that people weren't fazed by seeing a beach strewn with litter.

So she changed the context. By collecting pieces of plastic waste and photographing them on a plain background, Barker found that the trash became shocking again. "I wanted to create something that would resonate," she says.

That impulse has led to a series of photographic projects that illuminate plastic's ubiquity as well as its reach—how printer cartridges that spilled off a ship in the Atlantic Ocean, for example, washed up on beaches from North Africa to Norway. Or how discarded bottle caps, from the hundreds of billions of plastic bottles that are manufactured each year, turn up on beaches—and in birds—around the world. Barker crowdsourced a global collection to show that.

She plans her projects in collaboration with marine scientists. The photos "give science a visual voice," she says, conveying plastic's impact on the natural environment in a way that scientific research papers can't. Barker feels in her gut the reality that no area in the world is free from plastic anymore, "from the poles to the Equator, from the sea surface to the ocean floor." She wants the rest of us to feel it too.

—Natasha Daly

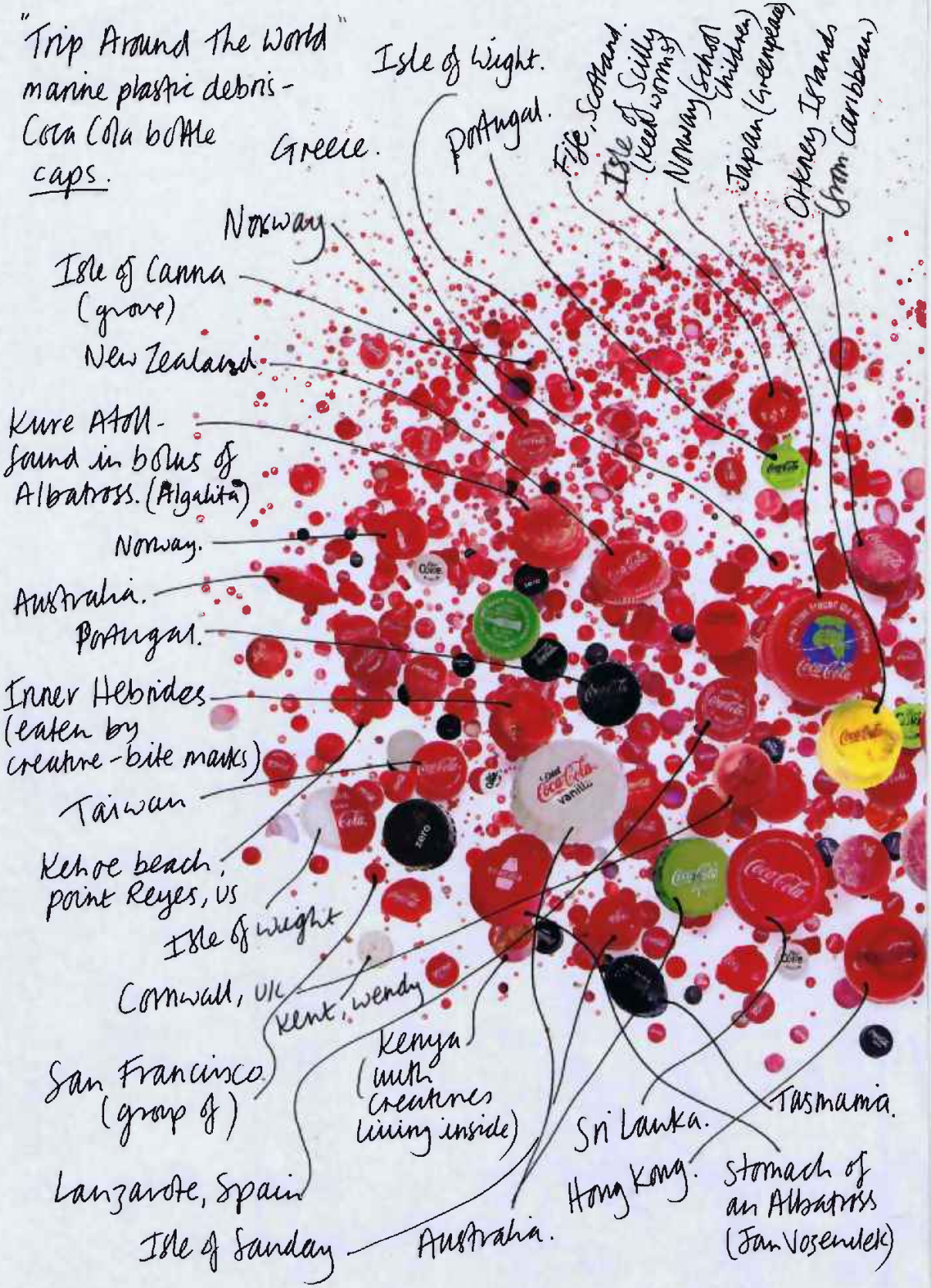
Every piece of plastic here was found in the stomach of a single albatross chick. Laid bare outside the bird it killed, the plastic pieces—from the bottle caps in the top row to the tiny fragments along the bottom—all represent "parts of something we could have once used," photographer Mandy Barker says.

The National Geographic Society, a nonprofit working to conserve Earth's resources, helped fund this project.

The Art of Plastic Pollution

Using trash from the sea and birds' stomachs, Mandy Barker's work forces us to face our waste.

It took Barker only a few hours on an English beach to collect the 500 pieces of plastic seen in this photograph.



To illustrate the ubiquity of ocean-plastic trash, Barker asked people to collect and send her an iconic kind: Coca-Cola bottle caps. She received more than 3,000 from beaches around the world. Some had creatures living inside them.

COMPOSITE OF 51 LAYERED IMAGES

PLACE-NAMES DO NOT NECESSARILY REFLECT *NATIONAL GEOGRAPHIC*'S MAPPING CONVENTIONS.

Among the five trillion bits of plastic floating around the ocean are weird curlicues like these—shavings from various fabrication or drilling processes. To Barker they resemble seahorses and other marine creatures. She spent five years collecting them on far-flung beaches.

COMPOSITE OF FIVE IMAGES

Printer cartridges have been washing up on European beaches since early 2014, after they spilled off a ship during an Atlantic storm. Over time, cartridges break down into smaller pieces that animals can ingest. Barker's artful vortex evokes the energy—and potential impact—of a single spill.

COMPOSITE OF EIGHT IMAGES

A Toll on Wildlife

Animals eat it, get stuck in it, and die from it. For them, plastic is turning the ocean into a minefield.

ON A BOAT OFF COSTA RICA, a biologist uses pliers from a Swiss army knife to try to extract a plastic straw from a sea turtle's nostril. The turtle writhes in agony, bleeding profusely. For eight painful minutes the YouTube video ticks on; it has logged more than 20 million views, even though it's so hard to watch. At the end the increasingly desperate biologists finally manage to dislodge a four-inch-long straw from the creature's nose.

Raw scenes like this, which lay bare the toll of plastic on wildlife, have become familiar: The dead albatross, its stomach bursting with refuse. The turtle stuck in a six-pack ring, its shell warped from years of straining against the tough plastic. The seal snared in a discarded fishing net.

But most of the time, the harm is stealthier. Flesh-footed shearwaters, large, sooty brown seabirds that nest on islands off the coasts of Australia and New Zealand, eat more plastic as a proportion of their body mass than any other marine animal, researchers say: In one large population, 90 percent of the fledglings had already ingested some. A plastic shard piercing an intestine can kill a bird quickly. But typically the consumption of plastic just leads to chronic, unrelenting hunger.

"The really sad thing about this is that they're eating plastic thinking it's food," says Matthew

An old plastic fishing net snares a loggerhead turtle in the Mediterranean off Spain. The turtle could stretch its neck above water to breathe but would have died had the photographer not freed it. "Ghost fishing" by derelict gear is a big threat to sea turtles.
JORDI CHIAS

Savoca, a marine biologist with the National Oceanic and Atmospheric Administration. "Imagine you ate lunch and then just felt weak and lethargic and hungry all day. That would be very confusing." Fish such as anchovies, Savoca has found, eat plastic because it smells like food once it's covered with algae. Seabirds, expending energy their malnourished bodies don't have, roam farther in search of real food, only to drag back plastic waste to feed their young.

What makes plastic useful for people—its durability and light weight—increases the threat to animals. Plastic hangs around a long time, and a lot of it floats. "Single-use plastics are the worst. Period. Bar none," Savoca says, referring to straws, water bottles, and plastic bags. Some 700 species of marine animals have been reported—so far—to have eaten or become entangled in plastic.

We don't fully understand plastic's long-term impact on wildlife (nor its impact on us). We haven't been using the stuff for very long. The first documented cases of seabirds ingesting plastic were 74 Laysan albatross chicks found on a Pacific atoll in 1966, when plastic production was roughly a twentieth of what it is today. In hindsight, those birds seem like the proverbial canaries in a coal mine. *—Natasha Daly*

ABOVE

Some animals now live in a world of plastics—like these hyenas scavenging at a landfill in Harar, Ethiopia. They listen for garbage trucks and find much of their food in trash.

BRIAN LEHMANN

BELOW

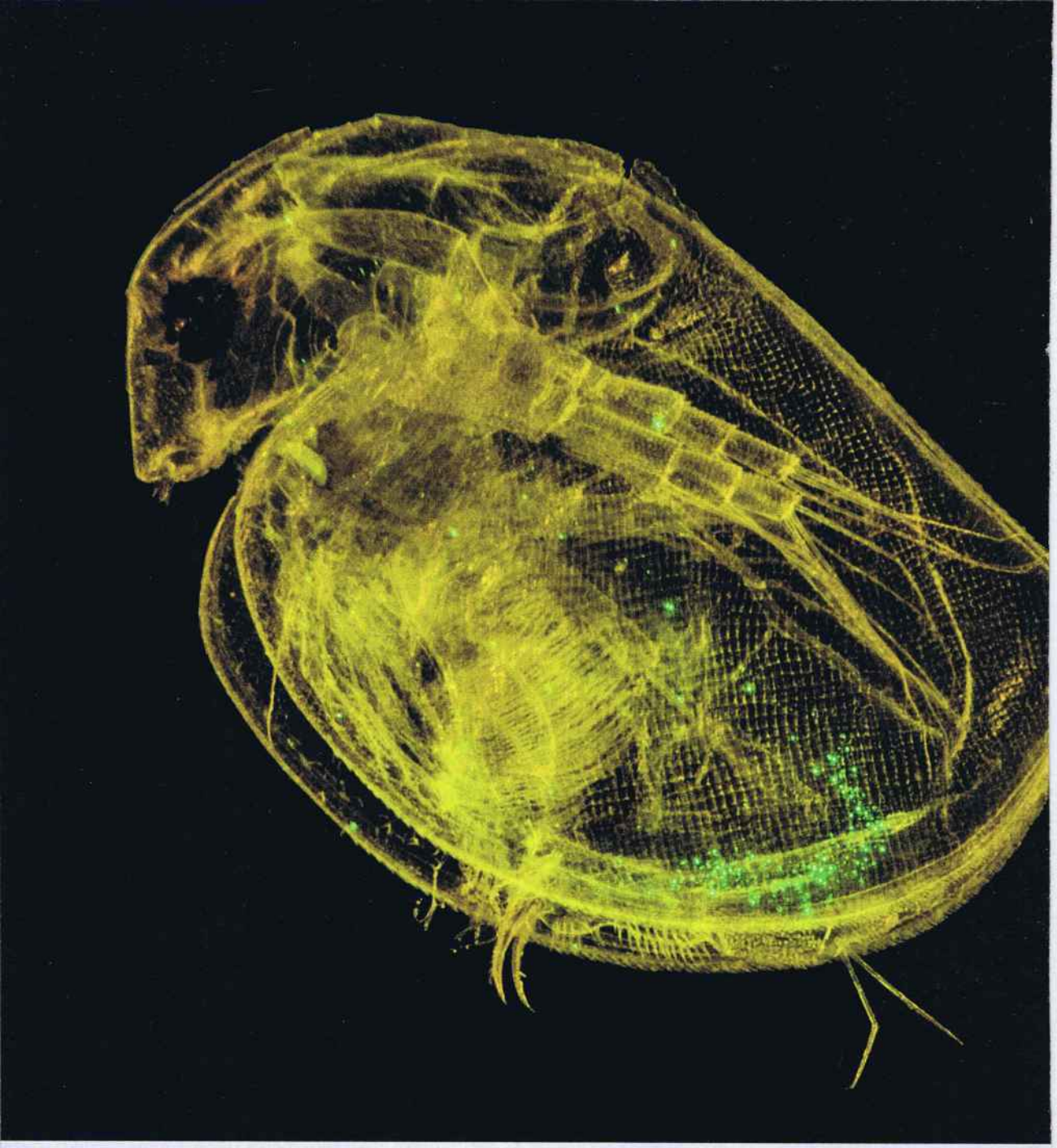
On Okinawa, Japan, a hermit crab resorts to a plastic bottle cap to protect its soft abdomen. Beachgoers collect the shells the crabs normally use, and they leave trash behind.

SHAWN MILLER

RIGHT

The photographer freed this stork from a plastic bag at a landfill in Spain. One bag can kill more than once: Carcasses decay, but plastic lasts and can choke or trap again.

JOHN CANCALOSI



PLASTIC: HUMAN HEALTH

A Threat to Us?

Tiny bits of plastic harm marine life, including the fish and shellfish we eat. Do they harm people? Scientists are racing to find out.

Microplastics ingested by a water flea that's three millimeters long glow green. In a lab, fleas were exposed to round beads and irregularly shaped fragments in amounts higher than in nature. The irregular pieces pose a greater threat because they can clump and get stuck in the gut.

MARTIN OGONOWSKI AND CHRISTOPH SCHÜR, DEPARTMENT OF ENVIRONMENTAL SCIENCE AND ANALYTICAL CHEMISTRY (ACES), STOCKHOLM UNIVERSITY

IN A LABORATORY AT Columbia University's Lamont-Doherty Earth Observatory, in Palisades, New York, Debra Lee Magadini positions a slide under a microscope and flicks on an ultraviolet light. Scrutinizing the liquefied digestive tract of a shrimp she bought at a fish market, she makes a *tsk*-ing sound. After examining every millimeter of the slide, she blurts, "This shrimp is fiber city!" Inside its gut, seven squiggles of plastic, dyed with Nile red stain, fluoresce.

All over the world, researchers like Magadini are staring through microscopes at tiny pieces of plastic—fibers, fragments, or microbeads—that have made their way into marine and freshwater species, both wild caught and farmed. Scientists have found microplastics in 114 aquatic species, and more than half of those end up on our dinner plates. Now they are trying to determine what that means for human health.

So far science lacks evidence that microplastics—pieces smaller than one-fifth of an inch—are affecting fish at the population level. Our food supply doesn't seem to be under threat—at least as far as we know. But enough research has been done now to show that the fish and shellfish we enjoy are suffering from the omnipresence of this plastic. Every year five million to 14 million tons flow into our oceans from coastal areas. Sunlight, wind, waves, and heat break down that material into smaller bits that look—to plankton, bivalves, fish, and even whales—a lot like food.

Experiments show that microplastics damage aquatic creatures, as well as turtles and birds: They block digestive tracts, diminish the urge to eat, and alter feeding behavior, all of which reduce growth and reproductive output. Their stomachs stuffed with plastic, some species starve and die.

In addition to mechanical effects, microplastics have chemical impacts, because free-floating pollutants that wash off the land and into our seas—such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals—tend to adhere to their surfaces.

Chelsea Rochman, a professor of ecology at the University of Toronto, soaked ground-up polyethylene, which is used to make some types of plastic bags, in San Diego Bay for three months. She then offered this contaminated plastic, along with a laboratory diet, to Japanese medakas, small fish commonly used for research, for two months. The fish that had ingested the treated

plastic suffered more liver damage than those that had consumed virgin plastic. (Fish with compromised livers are less able to metabolize drugs, pesticides, and other pollutants.) Another experiment demonstrated that oysters exposed to tiny pieces of polystyrene—the stuff of take-out food containers—produce fewer eggs and less motile sperm.

The list of freshwater and marine organisms that are harmed by plastics stretches to hundreds of species.

IT'S DIFFICULT TO PARSE whether microplastics affect us as individual consumers of seafood, because we're steeped in this material—from the air we breathe to both the tap and bottled water we drink, the food we eat, and the clothing we wear. Moreover, plastic isn't one thing. It comes in many forms and contains a wide range of additives—pigments, ultraviolet stabilizers, water repellents, flame retardants, stiffeners such as bisphenol A (BPA), and softeners called phthalates—that can leach into their surroundings.

Some of these chemicals are considered endocrine disruptors—chemicals that interfere with normal hormone function, even contributing to weight gain. Flame retardants may interfere with brain development in fetuses and children; other compounds that cling to plastics can cause cancer or birth defects. A basic tenet of toxicology holds that the dose makes the poison, but many of these chemicals—BPA and its close relatives, for example—appear to impair lab animals at levels some governments consider safe for humans.

Studying the impacts of marine microplastics on human health is challenging because people can't be asked to eat plastics for experiments, because plastics and their additives act differently depending on physical and chemical contexts, and because their characteristics may change as creatures along the food chain consume, metabolize, or excrete them. We know virtually nothing about how food processing or cooking affects the toxicity of plastics in aquatic organisms or what level of contamination might hurt us.

The good news is that most microplastics studied by scientists seem to remain in the guts of fish and do not move into muscle tissue, which is what we eat. The United Nations Food and Agriculture Organization, in a thick report on this subject, concludes that people likely consume only negligible amounts of microplastics—even those who eat a lot of mussels and oysters, which are eaten whole. The agency reminds us, also, that eating fish is good for us: It reduces the risk of cardiovascular disease, and fish contain high levels of nutrients uncommon in other foods.

Fish caught by children who live next to a hatchery on Manila Bay in the Philippines live in an ecosystem polluted by household waste, plastics, and other trash. Whether microplastics ingested by fish affect humans is unknown, but scientists are looking for answers.

That said, scientists remain concerned about the human-health impacts of marine plastics because, again, they are ubiquitous and they eventually will degrade and fragment into nanoplastics, which measure less than 100 billionths of a meter—in other words, they are invisible. Alarmingly these tiny plastics can penetrate cells and move into tissues and organs. But because researchers lack analytical methods to identify nanoplastics in food, they don't have any data on their occurrence or absorption by humans.

RANDY OLSON

And so the work continues. "We know that there are effects from plastics on animals at nearly all levels of biological organization," Rochman says. "We know enough to act to reduce plastic pollution from entering the oceans, lakes, and rivers." Nations can enact bans on certain types of plastic, focusing on those that are the most abundant and problematic. Chemical engineers can formulate polymers that biodegrade. Consumers can eschew single-use plastics. And industry and government can invest in infrastructure to capture and recycle these materials before they reach the water.

IN A DUSTY BASEMENT a short distance from the lab where Magadini works, metal shelves hold jars containing roughly 10,000 preserved mummichogs and banded killifish, trapped over seven years in nearby marshes. Examining each fish for the presence of microplastics is a daunting task, but Magadini and her colleagues are keen to see how levels of exposure have changed over time. Others will painstakingly untangle how microbeads, fibers, and fragments affect these forage fish, the larger fish that consume them, and—ultimately—us.

"I think we'll know the answers in five to 10 years' time," Magadini says.

By then at least another 25 million tons of plastic will have flowed into our seas.

—Elizabeth Royte

How We Can Stem the Tide

Plastic can be made more biodegradable or recyclable. But we still need to recycle much more—and use a lot less.

IN A WORLD THAT CAN SEEM overwhelmed by potentially eternal plastic waste, are biodegradables the ultimate solution? Probably not. But it's complicated. The industry is still debating what "biodegradable" actually means. And some plastics made of fossil fuels will biodegrade, while some plant-based "bioplastics" won't.

Biodegradable plastics have been around since the late 1980s. They initially were marketed with the implied promise that they'd somehow disappear once they were disposed of, just as leaves on the forest floor are decomposed by fungi and soil microbes. It hasn't quite worked out that way.

Biodegradables don't live up to their promise, for example, in the dark, oxygen-free environment of a commercial landfill or in the

A quart jar holds two years' worth of Kathryn Kellogg's unrecyclable, uncompostable waste. She blogs about the zero-waste lifestyle from a 300-square-foot home she shares with her husband in Vallejo, California. The waste is her own.

TIMOTHY ARCHIBALD

Norway now recovers 97 percent of its plastic bottles—a big part of beach trash. Its trick: high deposits and machines at most supermarkets that ingest bottles and spit out refunds.

cool waters of the ocean, if they should end up there. You can't throw them in your backyard compost either. To break down, they require the 130-degree heat of an industrial composter. Many industrial composters accept only plastics that meet certain standards, ensuring they will leave no fragments behind that can harm the environment or human health. And if you throw some biodegradables in with recyclables, you might ruin the latter, creating a mix that can no longer be relied on to make durable new plastic.

In 2015 the United Nations Environment Programme wrote off biodegradables as an unrealistic solution that will neither reduce the amount of plastic flowing into the oceans nor prevent potential chemical or physical harm to marine life. It concluded that the label "biodegradable" may actually encourage littering.

Some engineers are looking for ways around these obstacles. Jenna Jambeck and her colleagues at the University of Georgia's New Materials Institute are using polymers synthesized by microbes to make packaging they hope will compost readily and biodegrade in the ocean. Corn chip bags are their first target.

Polymateria, a British firm, is taking a different approach, developing chemical additives to help biodegrade any plastic—bio based or synthetic—more quickly. The firm aims to be the "Tesla" of biodegradable plastics; CEO Niall Dunne says the goal is a product that will "harmonize plastics with the biosphere."

It's a tall order. Even the best biodegradable product won't magically disappear. A plastic container robust enough to carry a gallon of milk can't decompose like paper. A flowerpot, one of Polymateria's experimental products, could take up to two years to dissolve if tossed in a ditch, Dunne concedes. Biodegradables, some critics say, don't address the fundamental problem: our throwaway culture.

"What is it that we are promoting?" asks Ramani Narayan, a Michigan State University chemical engineering professor. "Throw it away, and eventually it will go away?" The more responsible approach, he says, is a "circular economy" model, in which everything is reused or recycled and "any 'leakage' into the environment, whether biodegradable or not, is not acceptable."

Norway has shown how far the recycling of plastic bottles—a big part of beach trash—can go. It now recovers 97 percent of them. Its trick: deposits as high as 2.5 kroner (32 cents) and machines, found at most supermarkets, that ingest bottles and spit out refunds.

But recycling can go only so far. Part of the solution, many say, must be to use less disposable plastic in the first place. The "zero waste" movement, which dates to the mid-1990s, is gaining favor. Hundreds of communities worldwide are embracing it—including the downtrodden industrial town of Roubaix, France, where the success of a citizens' campaign shows that zero waste is more than an affectation of wealthy liberals.

On the contrary, the idea seems to have a cross-cutting, almost spiritual appeal. In the U.K., the Church of England asked its flock to give up plastic packaging and disposables for Lent this year. Conservative Prime Minister Theresa May called for supermarkets to set up plastic-free aisles, where food is sold in bulk. She's also considering a tax on single-use plastics such as take-out containers. It's all part of her government's campaign to rid the country of plastic waste within 25 years.

China is providing motivation. For nearly three decades it has bought about half the world's recyclable plastic. But this year it called a halt to most scrap imports. Recyclables are now piling up in the countries that generated them. "That pushes the question upstream," Jambeck says. "We hope it will push towards more circular management."

—Laura Parker

PRODUCTS THAT COULD HELP REDUCE PLASTIC WASTE

Toothbrush with a replaceable head

Reusable food wrap made from beeswax and cotton

Metal, reusable straw

Compostable six-pack ring made from brewery waste by the company E6PR

MARK THIESSEN (ALL)

SIX THINGS YOU CAN DO (AND FEEL NO PAIN)

1 GIVE UP PLASTIC BAGS

Take your own reusable ones to the store. A trillion plastic shopping bags are used worldwide every year, and 100 billion in the United States alone—that's almost one per American per day. The average Dane, in contrast, goes through four single-use bags *per year.* Denmark passed the first bag tax in 1993.

2 SKIP STRAWS

Unless you have medical needs, and even then you could use paper ones. Americans toss 500 million plastic straws every day, or about 1.5 per person.

3 PASS UP PLASTIC BOTTLES

Invest in a refillable water bottle. Some come with filters if you're worried about water quality. A handful of cities, including Bundanoon, Australia, and San Francisco, have banned or partially banned bottled water. But around the world, nearly a million plastic beverage bottles are sold every minute.

4 AVOID PLASTIC PACKAGING

Buy bar soap instead of liquid. Buy in bulk. Avoid produce sheathed in plastic. And while you're at it, give up plastic plates and cups. The French are (partially) banning the stuff.

5 RECYCLE WHAT YOU CAN

Even in rich countries, recycling rates are low. Globally, 18 percent of all plastic is recycled. Europe manages 30 percent, China 25—the United States only 9.

6 DON'T LITTER

The Ocean Conservancy has run beach cleanups for 30 years. Of the top 10 types of trash they find, the only non-plastic item is glass bottles. Worldwide, 73 percent of beach litter is plastic: cigarette butts (the filters), bottles and caps, food wrappers, grocery bags, polystyrene containers. In 2016 the conservancy collected 9,200 tons of trash in 112 countries—around a thousandth of what enters the ocean each year.