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SPECIAL EARTH DAY ISSUE

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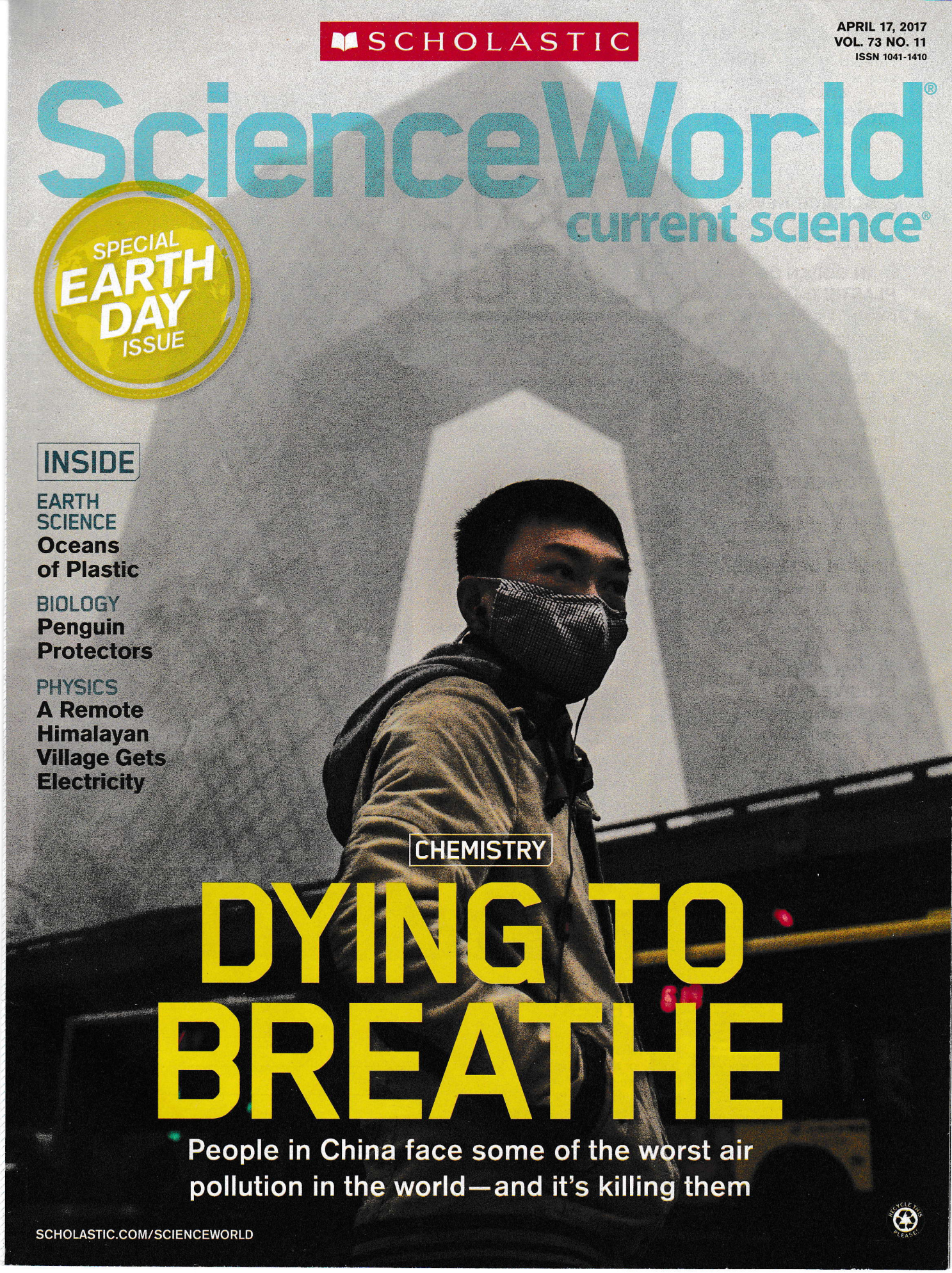

CHEMISTRY

DYING TO BREATHE

People in China face some of the worst air pollution in the world—and it's killing them

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SCIENCE WORLD APRIL 17, 2017 VOL. 73, NO. 11 **Editorial Director:** Patricia Janes **Senior Editor:** Jennifer Barone **Associate Editor:** Jacob Batchelor **Contributing Editor:** Andrew Klein **Editorial Consultant:** Cody Crane **Education Editor:** Matt Friedman **Online Editor:** Catherine Wilshusen **Senior Art Director:** Sarah Irick **Photo Editor:** Els Rijper **Production Editor:** Allan Molho **Senior Copy Editors:** Ingrid Acardi, Suzanne Bilyeu **Copy Editor:** Troy Reynolds **Digital Imager:** Vanessa Irena **Media Editor:** Marie Morreale **Executive VP, Scholastic:** Hugh Roome **Creative Director:** Judith Christ-Lafond **Design Director:** Felix Batcup **Executive Director of Production and Operations:** Barbara Schwartz **Executive Editorial Director, Copy Desk:** Craig Moskowitz **President, Chief Exec. Officer, and Chairman of the Board of Scholastic Inc.:** Richard Robinson. **POSTAL INFORMATION:** *SCIENCE WORLD* (ISSN 1041-1410; in Canada, 2-c no. 55948) is published 12 times annually; biweekly: September, October, March; monthly: November, December, January, February, April, May; by Scholastic Inc., 2931 East McCarty St., P.O. Box 3710, Jefferson City, MO 65102-3710. Periodical postage paid at Jefferson City, MO 65102 and at additional mailing offices. POSTMASTERS: Send notice of address changes to *SCIENCE WORLD*, 2931 East McCarty St., P.O. Box 3710, Jefferson City, MO 65102-3710.

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SCIENCE NEWS

BIOLOGY: CONSERVATION

COSTLY CATCH

A $650,000 price tag for a single tuna might seem outrageous. But that's what a sushi restaurant owner paid for a monster-sized tuna at an auction in Japan this past January.

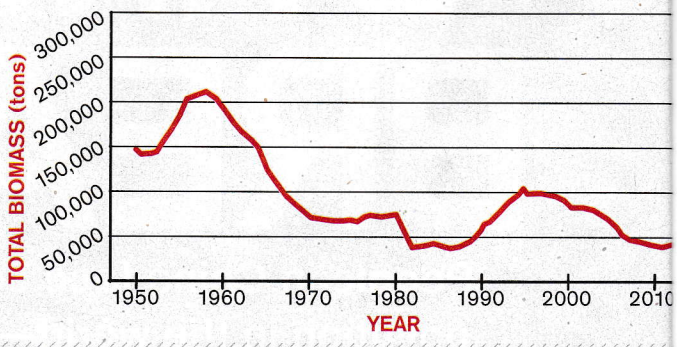
Sushi's popularity has led tuna to become an expensive commodity. Its popularity has another downside, too. "The Pacific bluefin tuna population has dropped by more than 97 percent due to decades of *overfishing*," says Jamie Gibbon, a tuna conservation expert at the nonprofit Pew Charitable Trusts.

Most bluefin are caught before they have a chance to reproduce, making it hard for the population to bounce back. If fishers and sushi lovers want tuna to survive over the long run, stricter limits need to be set on how many tuna can be caught each year, says Gibbon.

—Jeanette Ferrara

UNDER THREAT

The graph at right shows the *biomass*, or total estimated weight, of bluefin tuna living in the ocean over the years. What is the overall trend in bluefin biomass over the past several decades?



SOURCE: INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA-LIKE SPECIES IN THE NORTH PACIFIC OCEAN

BIG FISH: The head of a 470-pound tuna sold in January

FOR SALE: Buyers inspect frozen tuna at a Tokyo market.

IN THE WILD: A Pacific bluefin tuna off the coast of Japan

KYODO NEWS VIA GETTY IMAGES (GIANT TUNA); BEHROUZ MEHRI/AFP/GETTY IMAGES (HEAD); NAOKI NISHIMURA/AFLO VIA ZUMA PRESS (MARKET); SEAPICS.COM (SWIMMING)

AND 2016

ENGINEERING: MACHINES

Jetpack for Sale

People can now strap on their own jet-powered backpacks and blast off into the sky—if they have $250,000 to spare, that is. That's the hefty price tag for the new JB10 jetpack being sold by California-based company JetPack Aviation.

Two jet engines power the JB10. A person uses one hand to control the pack's *throttle*—a device that increases or decreases the flow of fuel to the engines. The wearer's other hand controls the direction the jetpack moves. The pack can reach speeds of up to 100 kilometers (60 miles) per hour and carries enough fuel for a 10-minute flight, says David Mayman, a pilot and CEO of JetPack Aviation. He and lead designer Nelson Tyler have been working on the device for more than a decade.

People who buy the pack can't take flight until they visit the company's training facility. There, they'll learn how to operate the jetpack safely.

—Kathryn Free

BIOLOGY: HUMAN-ANIMAL INTERACTION

So Long, Circus

After 146 years, the Ringling Bros. and Barnum & Bailey Circus is taking down its tent for good. Known as "The Greatest Show on Earth," the circus will hold its final performance this May.

In recent years, ticket sales to circuses like Ringling Bros. have declined. That's in part because of growing public concern about the welfare of circus animals. Many animal-rights activists believe it's wrong to confine wild animals for long periods as they travel and to force them to perform—even if they are otherwise well cared for.

After Ringling Bros. retired its elephants last year, ticket sales continued to decline, eventually resulting in the company's closure.

—Hailee Romain

FINAL BOW: Ringling Bros. stopped using elephants in 2016.

NATURAL FILTERS: The 860-square-foot wall of plants absorbs noise and pollution.

ENGINEERING: CIVIL ENGINEERING

LIVING WALL

COVER UP: The greenery hides unsightly scaffolding.

QUIET, PLEASE! The plants could reduce construction noise by up to 90 percent.

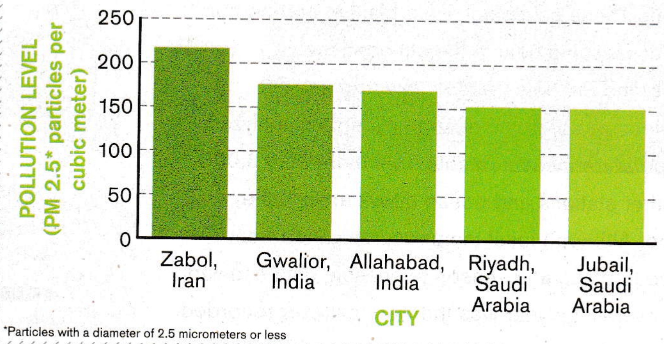
City construction usually means two things: ugly scaffolding and a lot of noise. To solve both problems, a Swedish company specializing in greenery partnered with a British architectural firm. Together the two companies created a vertical garden known as a "living wall" at a construction site in London, England.

The firms covered traditional scaffolding with grasses, strawberry plants, and wildflowers. Not only does the vegetation look nice, it may also help absorb noise and air pollution. The living wall has been outfitted with sensors to collect data about its impact on noise and local air quality. If it proves successful, similar walls may start popping up at other construction sites.

—Jeanette Ferrara

IN NEED OF CLEAN AIR

Living walls could help improve air quality in cities. The graph below shows cities with the highest average concentrations of particulate pollution. How do pollution levels in Zabol, Iran, compare with those in Jubail, Saudi Arabia? (For more on air pollution, see p. 12.)



*Particles with a diameter of 2.5 micrometers or less

SOURCE: WHO, 2016

THIN ICE: A researcher dips his hand into the Arctic Ocean off the coast of Alaska.

EARTH SCIENCE: CLIMATE

HOTTEST YEAR

Last year was the hottest on record, according to NASA. It's the third year in a row to set a new high for the yearly average temperature on Earth.

Since the late 1800s, temperatures on Earth have increased by about 1.1°C (2°F). "The whole planet is warming up," says Gavin Schmidt, director of NASA's Goddard Institute for Space Studies in New York.

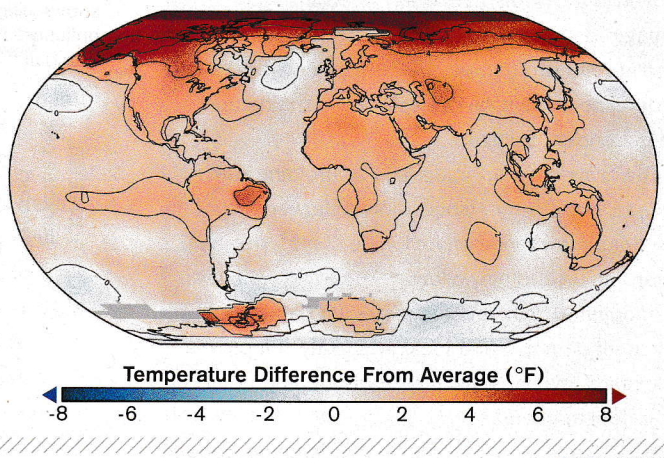
The vast majority of scientists agree that the recent warming is human-made. As we burn *fossil fuels*—such as coal, oil, and gas—carbon dioxide and other *greenhouse gases* are released into the air. These gases act like a blanket around our planet, trapping heat in the atmosphere.

To find out how 2016 stacked up against previous years, Schmidt and colleagues analyzed temperature measurements from more than 6,000 weather stations and ocean buoys around the globe. Although local temperatures varied from place to place and season to season, data showed that overall the year was the warmest ever recorded.

—Kathryn Free

HEATING UP

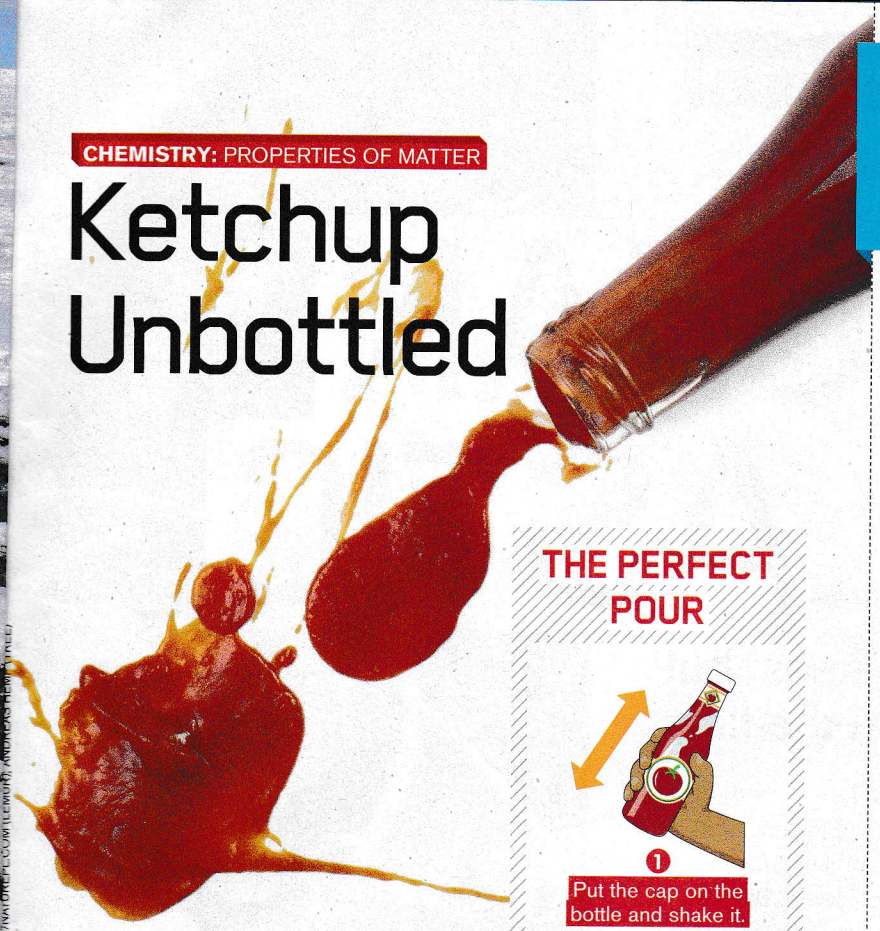
The map below shows how temperatures in 2016 differed from the average temperature recorded from 1950 through 1980. The darker red an area appears, the warmer it was compared with the average. Was the U.S. warmer or cooler than average?



SOURCE: NOAA, NASA

CHEMISTRY: PROPERTIES OF MATTER

Ketchup Unbottled



Calling all ketchup lovers! If you struggle getting this condiment out of its glass bottle, fret no more. Anthony Stickland, a chemical engineer at the University of Melbourne in Australia, recently found a simple solution to get ketchup unstuck. The secret is in the pour (*see The Perfect Pour, right*).

"Ketchup is classified as a soft solid," says Stickland. That's because particles of tomato pulp bind the sauce together. So instead of flowing like a liquid, ketchup moves only when the right amount of force is applied.

The downward pull of *gravity* often isn't strong enough to get ketchup moving, which is why some people recommend tapping the 57 on the neck of a Heinz bottle. "That's one way to apply force, but hitting the bottom also works," says Stickland.

In other ketchup news: Scientists in Boston are working on a promising new bottle design that would allow ketchup to slide right out—no special pouring tricks needed!

—Hailee Romain

THE PERFECT POUR

NUMBERS IN THE NEWS

15,285 Depth in feet to which scientists in Iceland drilled into a volcano to access heat energy. The hole is the deepest of its kind ever made.

10,000 Age in years of a mastodon skeleton recently unearthed during an expansion of the Los Angeles subway system.

2,200 Approximate number of ring-tailed lemurs remaining in the wild, according to new studies. The population has declined 95% since 2000.

265 Height in feet of Africa's tallest known tree, recently found on Mount Kilimanjaro.

125 Number of years since the founding of the Sierra Club, the largest outdoor recreational and environmental organization in the U.S.

AN OCEAN OF PLASTIC

Plastic is polluting the seas, but there's still time to turn the tide

ESSENTIAL QUESTION: How might plastic trash affect the ocean environment?

From the ice-covered Arctic to the tropical waters of the Pacific, all of Earth's oceans share one thing in common: plastic pollution. Discarded plastic bags, cups, and bottles make their way into the sea. Today, it seems that no part of the ocean is safe from plastic trash.

In recent years, oceanographers have searched in vain for a pristine marine environment. They've found plastic everywhere they've looked. "It's a global problem," says Chelsea Rochman, a marine ecologist at the University of Toronto in Canada. "We can't point to a single habitat or location with no plastic."

Plastic harms wildlife and introduces dangerous chemicals into marine *ecosystems*—communities of organisms interacting with their surroundings. Once plastic enters the environment, it lasts a long time (*see Garbage Breakdown, p. 10*). Researchers are working to prevent plastic pollution from entering the sea.

INTO THE OCEAN

When people litter, or when trash is not properly disposed of, things like plastic bags, bottles, straws, and foam beverage cups get carried to the sea by winds and waterways (*see From Shore to Sea, p. 11*). About 80 percent of ocean plastic originates on land. The rest comes from marine industries such as shipping and fishing.

In 2015, engineer Jenna Jambeck at the University of Georgia and other researchers calculated that at least 8 million tons of plastic trash are swept into the ocean from coasts every year. That's the equivalent of a full garbage truck of plastic being dumped into the sea every minute. If current trends in plastic production and disposal continue, that figure will double by 2025. A report published by the World Economic Forum last year predicts that by 2050, ocean plastic will outweigh all the fish in the sea.

TANGLED UP: Plastic netting can be deadly for sea turtles and other animals.

NOT-SO-FANTASTIC PLASTIC

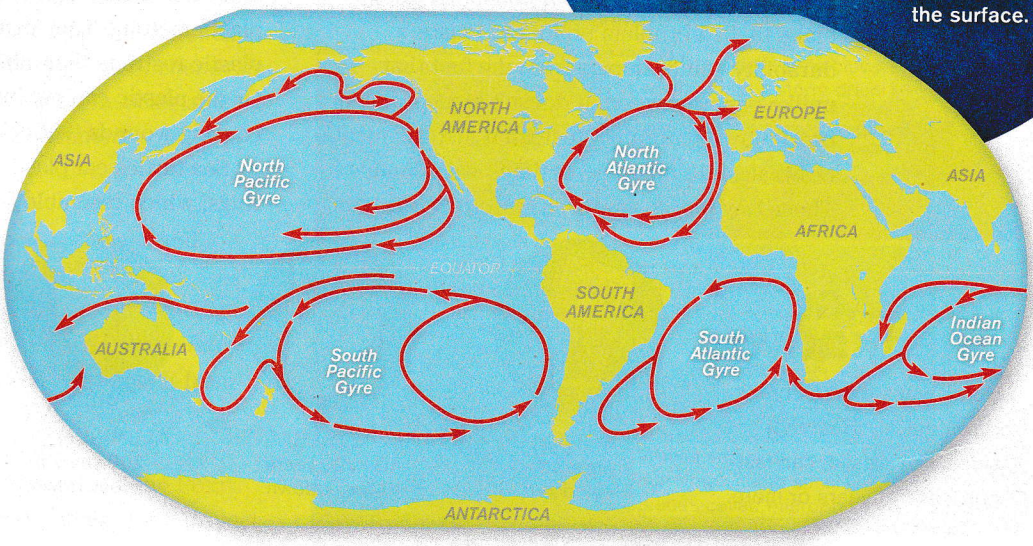
In today's world, plastic is everywhere. It's found in shoes, clothing, household items, electronics, and more. There are different types of plastics, but one thing they all have in common is that they're made of *polymers*—large

Continued on page 10 →

FLOATING TRASH: Some plastics float, some sink, and some remain suspended in the water beneath the surface.

SWIRLING PLASTIC

Floating plastic often ends up trapped in swirling *gyres*, giant loops formed by ocean currents. There are five major ocean gyres, each with a "garbage patch" at its center. There, microplastic litters the water like confetti.



JORGE CHAS/NATUREPL.COM (SEA TURTLE); NOAA (TRASH); JIM MCMAHON/MAPMAN® (MAP)

BANNED Plastic microbeads, which were often used in body scrubs, were outlawed in the U.S. in 2015.

MICROPLASTIC A sample of microplastic pollution in seawater

DEADLY MEAL Plastic eaten by a young albatross is visible in its remains.

molecules made up of repeating units. Their chemical structure gives them a lot of advantages: They're cheap and easy to manufacture, lightweight, water-resistant, durable, and can be molded into nearly any shape.

Unfortunately, some of the same properties that make plastics great for consumer goods make them a problem pollutant. Plastic's durability comes in part from the fact that unlike paper or wood, it doesn't *biodegrade*, or break down naturally. "Instead it just fragments, or breaks into pieces over time," says Jambeck. Those tiny pieces, known as *microplastic*, can potentially stick around for hundreds or perhaps even thousands of years.

Another problem with plastics is the other chemicals they contain, like dyes and flame retardants. When plastic isn't disposed of properly, those additives end up in the environment.

Plastic also tends to absorb harmful chemicals from its surroundings. "It's like a sponge for *persistent organic pollutants*," says Jambeck. These long-lasting, toxic substances include pesticides and industrial chemicals. If plastic absorbs the chemicals, and marine organisms eat the plastic, they may be exposed to higher concentrations of these contaminants.

WILDLIFE AT RISK

One of the biggest impacts of plastic pollution is its effect on sea life. Seals, sea turtles, and even whales can become entangled in plastic netting. They can starve to death if the plastic restricts their ability to move or eat. Or the plastic can cut into the animals' skin, causing wounds that develop severe infections.

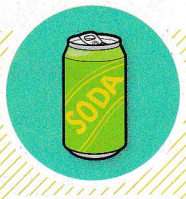
Sea turtles eat plastic bags and soda-can rings, which resemble jellyfish, a favorite food.

GARBAGE BREAKDOWN

Some types of trash break down quickly. But other types, like plastic, can last hundreds of years or more.

NEWSPAPER 6 weeks to break down

PLASTIC BAG 10 to 20 years to break down



ALUMINUM CAN 200 years to break down

PLASTIC BOTTLE 450 years to break down

OCEAN AMBASSADOR This sculpture of a parrotfish is made of plastic trash collected from beaches.

KEITH LANE FOR THE WASHINGTON POST VIA GETTY IMAGES (FISH ART & INSET); PETER SUCHESKI (DIAGRAM)

Seabirds eat bottle caps or chunks of foam cups. And microplastic pieces can resemble *plankton*, small organisms that many marine animals consume. Plastic pieces may make an animal feel full, so it doesn't eat enough real food to get the nutrients it needs. Plastic can also block an animal's digestive system, making it unable to eat. A 2015 study found that nearly 700 marine species have been observed entangled with or eating plastic.

Plastic and its associated pollutants can even make it into our own food supply. Rochman and other scientists recently examined fish and shellfish bought at markets in California and Indonesia. They found plastic in the guts of more than a quarter of samples purchased in both locations. In organisms that people eat whole, such as sardines and oysters, that means we're eating plastic too. In larger fish, chemicals from plastic may seep into their muscles and other tissues that people consume.

TURNING THE TIDE

One way to keep the ocean cleaner and healthier is through cleanup efforts. A lot of plastic waste caught in ocean currents eventually washes up on beaches (*see Swirling Plastic, p. 9*). Removing it can prevent it from blowing out to sea again. "Beach cleanup is ocean cleanup," says Rochman.

Oregon-based artist Angela Haseltine Pozzi recently teamed up with volunteers for a project called Washed Ashore. They gathered plastic from beaches on the northwest coast of the U.S. Pozzi used it to make sculptures of marine life to help raise awareness of plastic pollution.

Cleanup efforts can't reach every corner of the ocean or track down every bit of microplastic. That means it's critical to cut down on the amount of plastic that reaches the sea in the first place. Scientists are working toward new materials that are safer for the environment.

For example, Jambeck and her colleagues are currently testing a new polymer that breaks down more easily in seawater.

"Individual actions make a big difference," says Jambeck. Disposing of plastic properly for recycling or trash collection is a key step. "And simple things like reusable water bottles, mugs, and bags really cut down on waste," she says. Skipping straws or using paper ones helps too.

Ocean pollution can seem overwhelming, but it's something everyone can help address. "This is a problem we can really do something about," says Rochman.

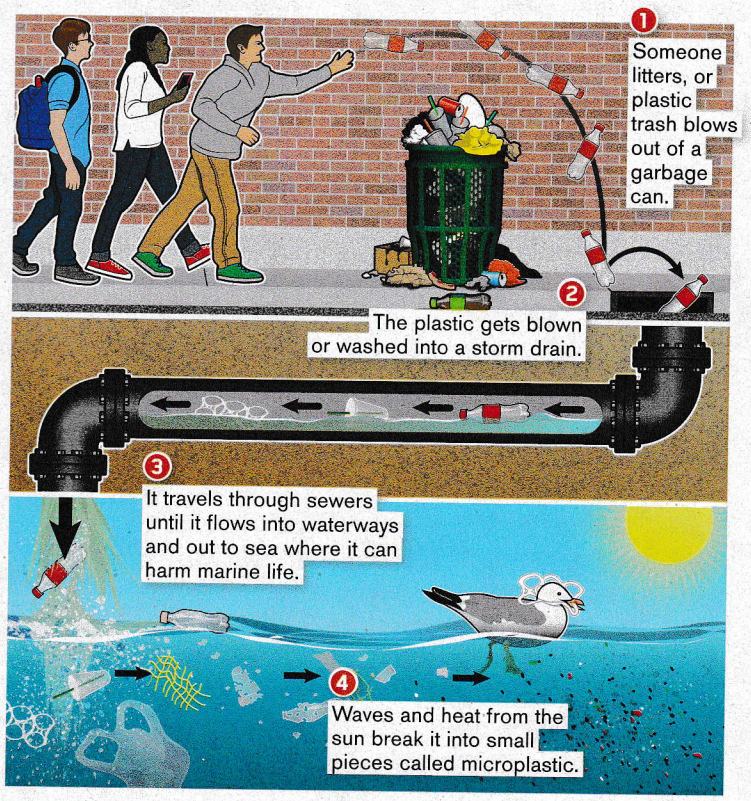
—Jennifer Barone

CORE QUESTION

What are some properties of plastic that make this versatile material a problem pollutant? Cite evidence from the text.

FROM SHORE TO SEA

Here's a common path by which trash ends up in the ocean.



TOXIC AIR ALERT!

China's air pollution is among the worst in modern history—and its people are suffering because of it

ESSENTIAL QUESTION: What factors might make one region more likely to have worse air pollution than another?

A gray haze hangs over many cities in northern China. The smog can be so thick, people can't see more than a few blocks ahead.

The air quality in this part of China is among the worst in the world and is responsible for about 1.6 million deaths each year—an average of 4,400 deaths per day! The desperate situation is being dubbed an "airpocalypse." Find out what's behind China's smog and what's being done to reduce it.

POLLUTION WARNING

Last December, the Chinese government issued a "red alert" for 23 cities. This is the highest level of China's air-quality warning scale. It lasted for five days. During that time, schools were closed, the government advised people to stay indoors, and most vehicles were banned from roadways (*see How Small is Smog?, right*).

"On some days, it's like living next door to a wildfire," says Loretta Mickley, about China's poor air quality. Mickley is an atmospheric chemist at Harvard University in Massachusetts.

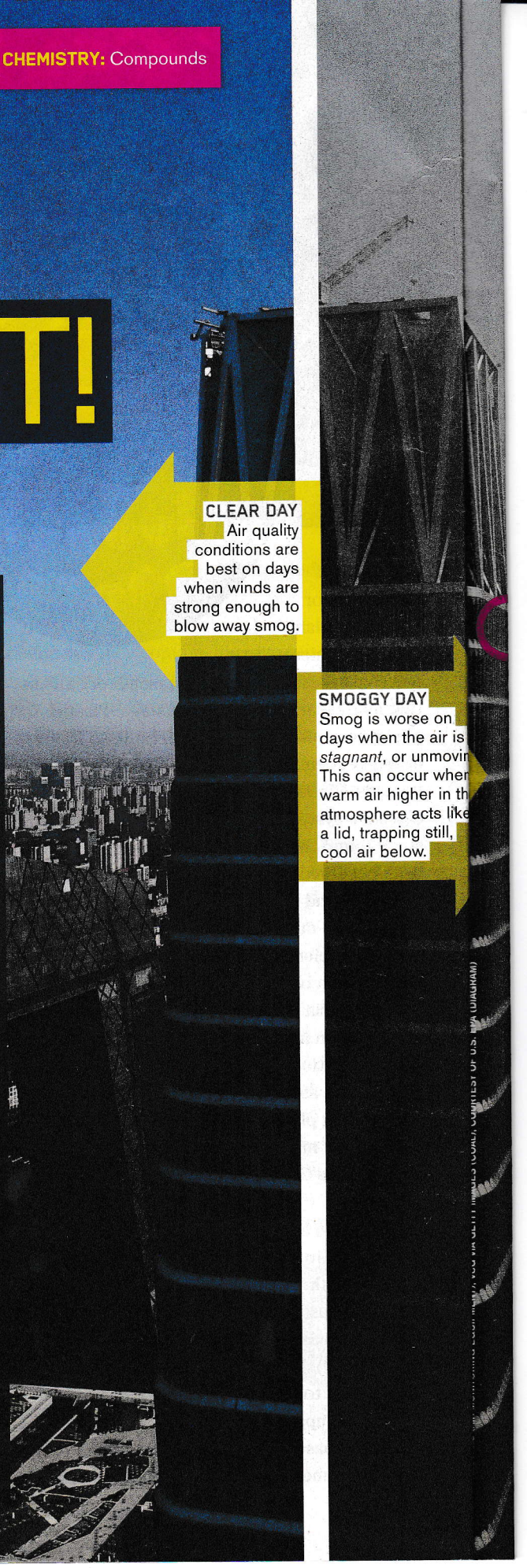
In winter, much of China's pollution comes from burning coal for heat. Another cause is the country's booming economy that has created more factories and power plants that produce air pollution.

SMOG LAND

China's government plans to spend $320 billion through 2020 to reduce air pollution. But the government has only just started to seriously regulate emissions from power plants and factories so they contain fewer pollutants, says Mickley.

The U.S. has been regulating air pollutants since 1970, thanks to a law enforced by the Environmental Protection Agency called the Clean Air Act. Mickley believes China's efforts are a promising start to tackling the country's deadly air pollution problem.

—Andrew Klein



CLEAR DAY
Air quality conditions are best on days when winds are strong enough to blow away smog.

SMOGGY DAY
Smog is worse on days when the air is *stagnant*, or unmovin This can occur when warm air higher in th atmosphere acts like a lid, trapping still, cool air below.

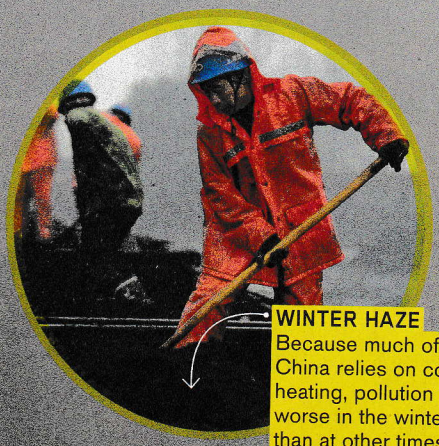
AIR MASKS China's government recommends that people wear tight-fitting masks with air filters on red-alert days.

AIR MONITORING Air monitoring equipment collects data on air quality. Back in 2016, government officials were caught tampering with the devices to falsify readings—an action that is now illegal.

CORE QUESTION

Explain why air pollution in northern China is especially high.

INDOOR ESCAPE During air quality alerts, authorities advise people to stay indoors.



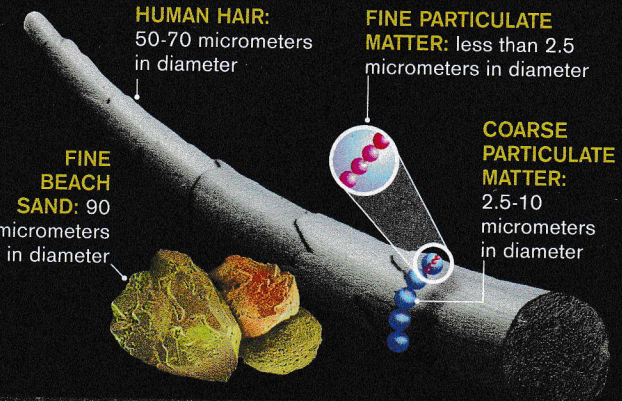
WINTER HAZE Because much of China relies on coal heating, pollution is worse in the winter than at other times.

WIDESPREAD PROBLEM About 90 percent of cities in China don't meet air quality standards set by the World Health Organization.

HOW SMALL IS SMOG?

The particles in smog are smaller than a grain of sand. They're even littler than the diameter of a human hair!

Smog contains tiny particles called *coarse particulate matter*. It also has microscopic particles called *fine particulate matter*—so small that they can make their way deep into people's lungs. This can lead to respiratory diseases, like asthma and chronic bronchitis, cardiovascular disease, and even death.



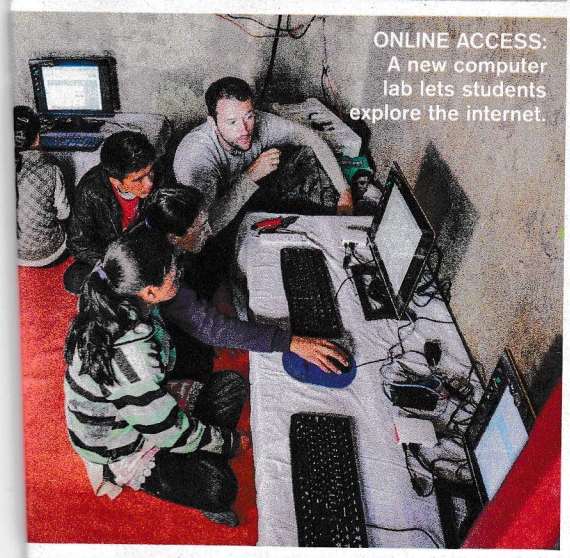
POWERED

LIGHTS ON: Buddhist monks clap as the first electric lights in their monastery are switched on.

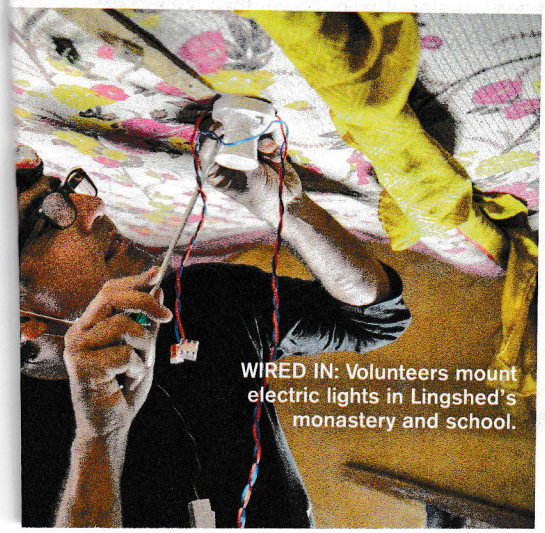
UP

A remote Himalayan village gets electricity for the first time

SOLAR INSTALLATION: Engineers set up solar panels that generate electricity for Lingshed.



ONLINE ACCESS: A new computer lab lets students explore the internet.

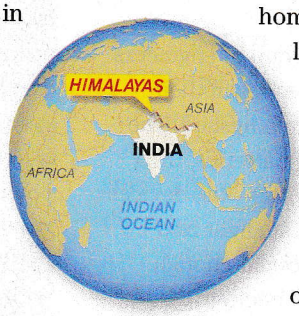


WIRED IN: Volunteers mount electric lights in Lingshed's monastery and school.

ESSENTIAL QUESTION: How is electricity created and brought to homes, schools, and local businesses where you live?

High up in the mountains of the Himalayas in northern India, a line of 17 volunteers and 55 horses and donkeys walked along a narrow trail. For two days, they scaled peaks and crossed rivers. Finally, they arrived in Lingshed, a 1,000-year-old village nestled deep in the mountains.

Lingshed is so remote that its inhabitants don't have electricity. A man named Paras Loomba wanted to change that. "There are basic amenities that everyone in the modern world should have: food, water, shelter, and electricity," says Loomba. He's the founder of an organization called the Global Himalayan Expedition, located in India. It electrifies villages in the area using *solar power*—a way of generating electricity by harnessing the sun's rays. On August 15, 2016, Loomba and a group of volunteers switched on the lights in Lingshed for the first time.



ENERGY ACCESS

Life in remote villages like Lingshed hasn't changed much in centuries. Most people there are farmers. The village is home to Lingshed Monastery, where Buddhist monks have lived and people from the surrounding area have worshipped since 1440. The monks have relied on candles and kerosene lamps for light: Like about half the people in the Himalayas, they live without electricity.

In recent years, people in Himalayan villages have begun to abandon their ancient homes and way of life, says Loomba. As younger generations grow up, they move away to cities, where there are more opportunities.

Loomba thinks electricity can help villages like Lingshed better survive in the modern world. Not only does electricity provide access to light and computers, but it also gives the people who live there an income.

"Once we electrify villages, tourists come to stay in the homes there," Loomba says. "They eat meals, they charge their phones and e-readers, and they pay the villagers for these services." Since 2013, the Global Himalayan Expedition has managed to light up 25 villages.

Continued on the next page →

OFF THE GRID

Most electricity in the world is produced in power stations that burn *fossil fuels* to heat water. Steam from the boiling water turns the gigantic blades of *turbines* to produce electricity. A network of power lines carries this electricity to homes and businesses. But these electricity supply systems often don't extend to faraway places like Lingshed.

To tackle the problem, the Global Himalayan Expedition teamed up with the IEEE Smart Village initiative, based in New Jersey. They decided to bring electricity to distant areas using a system of *solar microgrids* (*see Energy From the Sun, below*). These local sources of electricity are shared among a group of people. In Lingshed, it would light up the monastery and a school, as well as power a small computer lab.

CURRENT CLASH

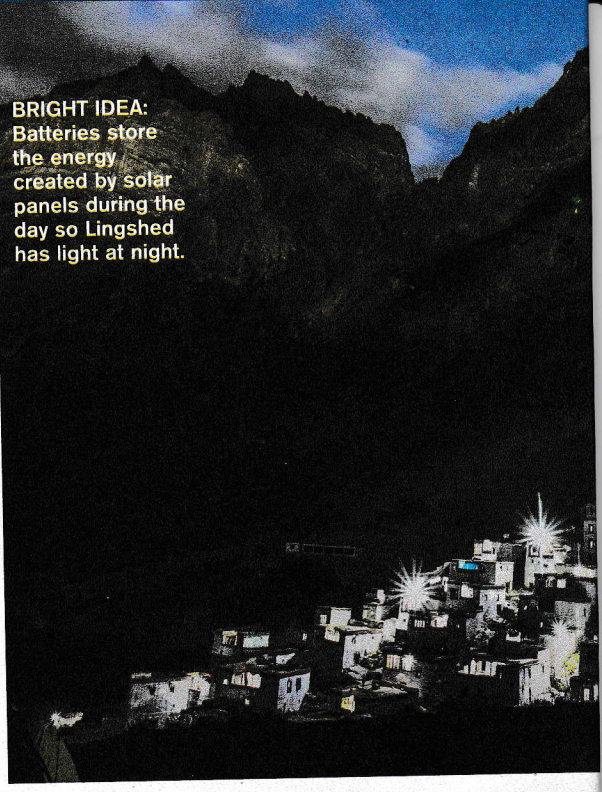
Last August, a group of engineers and other volunteers began their journey to power up Lingshed. The team carried wires, batteries, LED bulbs, and *solar panels*—the devices that would convert sunlight into electricity. They brought enough supplies to build 14 microgrids.

The team's microgrids would use *direct current (DC)*, a form of electric current that flows in only one direction. It's different from an *alternating current (AC)*, which changes the electric current's direction 60 times per second.

The AC system is more often used to transmit power over long distances. That's because it's easier to *step down*, or reduce, the large amount of electricity needed to send the power a long way. It's necessary to step down the current so that it's safe enough to flow through wall outlets and into homes.

The solar panels in Lingshed wouldn't generate too much electricity or have far to go, making DC power the better choice. DC systems also lose less energy than AC systems. That's because electricity is lost as the electric current in AC power alternates. So the DC setup would be more efficient, too.

"We can light up a whole house with exactly the same amount of power that you would use for one light bulb in America," says Loomba.



BRIGHT IDEA: Batteries store the energy created by solar panels during the day so Lingshed has light at night.

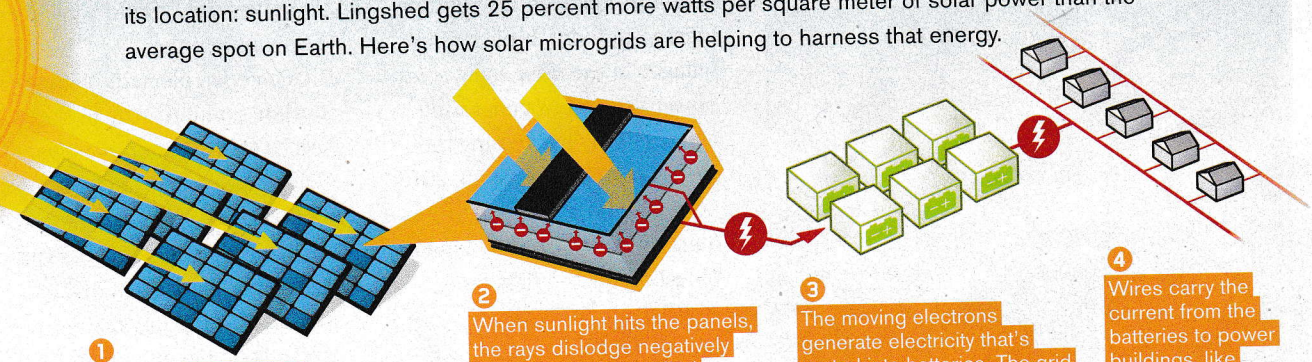
ELECTRIC EXPERIMENT

When the group finally arrived in Lingshed, a long line of villagers, monks, and schoolchildren greeted them. The local people pitched in to help the volunteers string wire and tap nails into the monastery's walls. With no electricity for power tools, they had to install the entire system by hand.

In a small building near the school's dormitories, electrical engineer Dave Goldsmith, from Seattle, Washington, assembled Lingshed's

ENERGY FROM THE SUN

Lingshed is too remote to access electricity from the regular power grid. But there's one advantage to its location: sunlight. Lingshed gets 25 percent more watts per square meter of solar power than the average spot on Earth. Here's how solar microgrids are helping to harness that energy.



1. Lingshed's microgrids are made up of several solar panels.
2. When sunlight hits the panels, the rays dislodge negatively charged particles called *electrons* from the atoms that make up the material's surface.
3. The moving electrons generate electricity that's routed into batteries. The grid can run off this stored energy even when it's not sunny out.
4. Wires carry the current from the batteries to power buildings, like Lingshed's monastery and school.

LIGHTING LESSON: Volunteers explain how the monastery's and school's new LED lights will work.

TOUGH TREK: Heavy equipment had to be carried over mountains to reach Lingshed.

new computer lab. Most computers use far more energy than the solar-powered system could supply. So Goldsmith came up with a smart solution: a network of five small, inexpensive, low-power computers called *Raspberry Pis*. "A standard desktop computer runs on about 400 *watts*," he says. "Raspberry Pis use only about 12 watts." Watts are units that measure power, or how much electricity is being used by a device.

Goldsmith connected the computers to the internet using a satellite link. But paying to get online would be expensive for villagers. So he also connected the computers to an offline *server*—a computer where information is stored that's connected to a network of other computers. This server downloads educational material, like online encyclopedias, when connected to the internet. Then kids can access the stored information even when they are offline.

"It was so cool to see the kids play with the computers. Some of them had never seen one before in their lives," says Goldsmith. "They couldn't stop smiling!"

A BRIGHTER FUTURE

After two days of hard work, the microgrids were ready for their debut. In the darkness, the monks stood around in silence, waiting for the magic moment. The volunteers took a deep breath and flipped the switch. Bright-white light suddenly filled the monastery.

"Monks are usually calm and silent. But they were clapping and jumping around," says Loomba. "I've never seen a monk jumping before!"

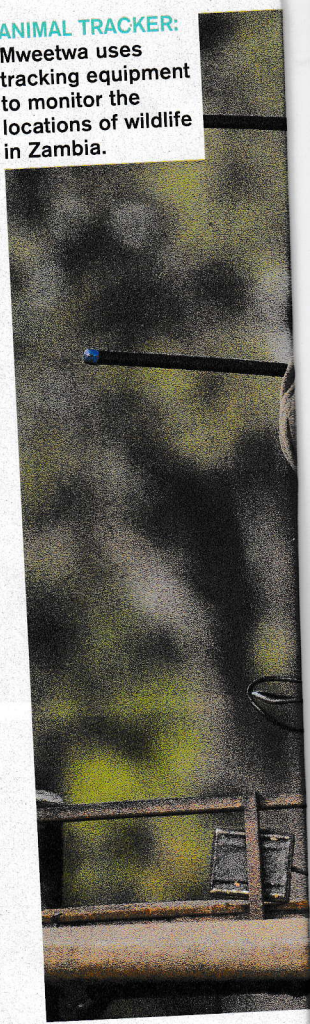
Loomba is hopeful that Lingshed's new lights will help keep the centuries-old village alive well into the future. Loomba says: "Light means a lot to people—especially when they have stayed in darkness for years and years."

—Stephanie Warren Drimmer

CORE QUESTION

Why does Loomba believe that bringing electricity to Lingshed will improve the lives of villagers there?

CARNIVORE CARE: Thandiwe Mweetwa examines a lioness in Zambia.



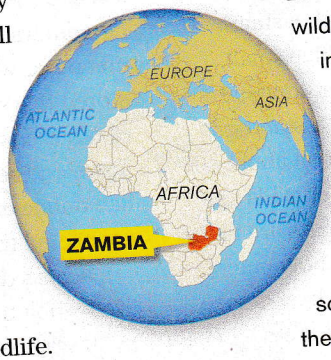
ANIMAL TRACKER: Mweetwa uses tracking equipment to monitor the locations of wildlife in Zambia.

LION DEFENDER

Thandiwe Mweetwa works to save big cats and other wild animals in Africa

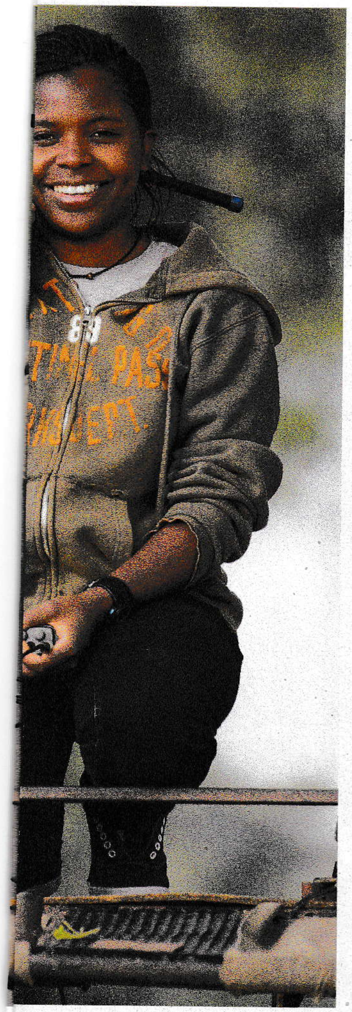
When Thandiwe Mweetwa (tahn-DEE-way moo-EE-too-AH) was 12 years old, she moved from a medium-sized town in southern Zambia in Africa to a rural village in the northern part of the country. For the first time, she came face-to-face with wildlife she'd only heard about: gazelles, giraffes, and mighty lions. She quickly fell in love with the animals.

Today, 29-year-old Mweetwa is a *wildlife ecologist*—a scientist who researches the relationship between organisms, their environment, and people. She studies lions, leopards, hyenas, and other *carnivores*, or animals that only eat meat, as part of the Zambian Carnivore Programme. Mweetwa tracks these animals to study their populations and help the species survive. *Science World* spoke with Mweetwa to find out about how she helps protect Zambia's amazing wildlife.



What was it like moving to a rural village in Africa?

The village I moved to was so remote it didn't have electricity or running water. Before I moved, the only wildlife I saw was on TV or in books and magazines. In the village, the first animal I saw was a baboon eating a mango. It was such a thrilling moment for m But the villagers were so used to seeing wildlif they couldn't understand why I was so excited.



I've woken up to see an elephant just outside my bedroom window. We had to beat drums to keep them from coming too close to our house. We didn't want them to lean on the building and topple it!

What's a typical day like working with the Zambian Carnivore Programme?

I get up early in the morning to look for different populations of local carnivores: lions, leopards, hyenas, and wild dogs. We have fitted some animals in each group with electronic collars. They emit a signal, which allows me and the other researchers to track the animals' locations.

We drive around looking for the animals. When we encounter them, we take photos and get a head count. We record any activity, like if they are mating or if there are new individuals. We follow the group to see where they go and what they eat. This helps us understand any threats to their safety and how well they are surviving.

What kinds of threats do the carnivores in Zambia face?

The threats are mostly *anthropogenic*, or human-related. The most serious threat is competition for land between people and carnivores. As the human population grows, people move into areas where wildlife lives, so some animal species are running out of space.

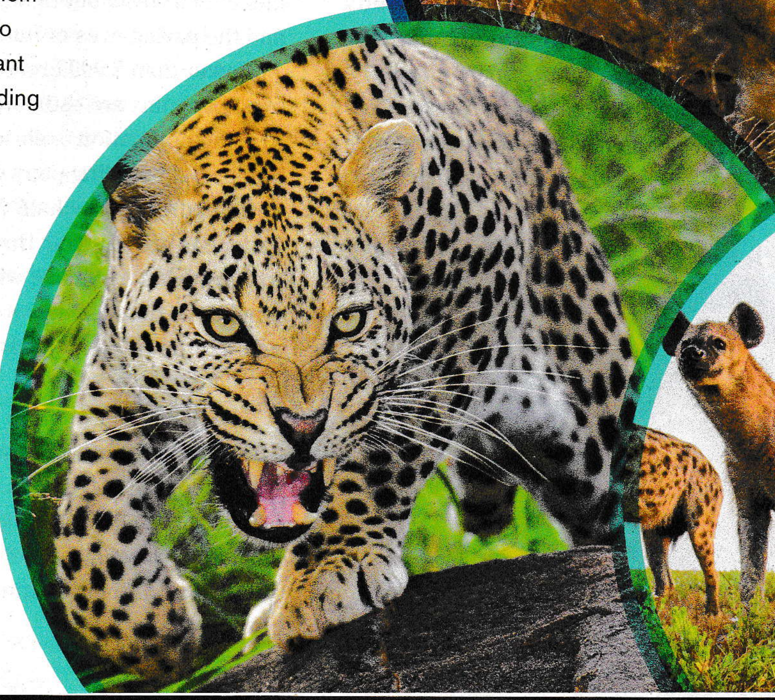
People also *poach*, or illegally hunt, smaller animals that larger carnivores rely on for food. Poachers often set wire snares to trap the animals—but can catch carnivores by accident. Part of our job is to rescue carnivores trapped in snares.

Have you seen your work benefit the wildlife around you?

I started working for the Zambian Carnivore Programme in 2009. At the time, there was one lioness that was about a year old. In 2010, she was reported trapped in a snare. We found her and got her out safely. Then in 2015, we saw that she raised her first litter of cubs. Seeing this lioness we helped rescue go on to have her own babies and add to the lion population was quite a rewarding experience.

—Stephanie Warren Drimmer

WILD BUNCH: Lions, leopards, and hyenas are some of the animals Mweetwa studies.



HELPING AN ELUSIVE BIRD

CAN SCIENTISTS SAVE THE RAREST PENGUIN ON EARTH?

ESSENTIAL QUESTION: Why might it be difficult for scientists to study penguins?

The dense, wild undergrowth of a New Zealand forest might be the last place you would expect to find a penguin. But this environment is home to the mysterious yellow-eyed penguin (*Megadyptes antipodes*)—the rarest species of penguin in the world.

The yellow-eyed penguin lives only in certain parts of New Zealand and on several smaller islands in the sub-Antarctic (*see map, right*). There, it nests hidden in thick, low-lying shrubs. That *habitat*—an organism's natural home—is different from that of most penguins (*see Penguins Compared, p. 22*).

Many penguin species, like Emperor penguins, nest in open areas and live together in large colonies. But yellow-eyed penguins prefer privacy. They make their nests out of sight from each other and the prying eyes of humans.

ONLY 18 PERCENT OF CHICKS SURVIVE THE FIRST YEAR

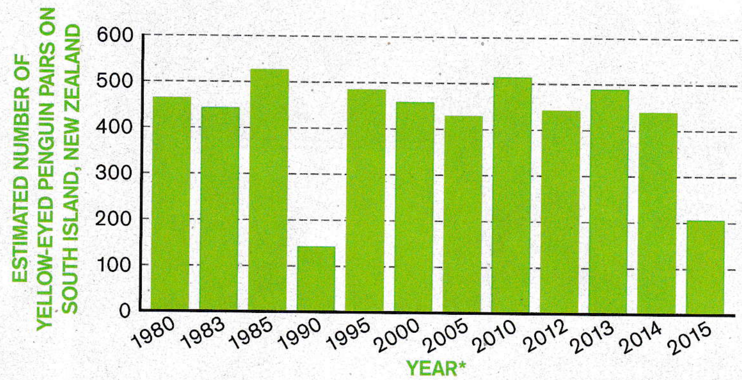
Fewer than 2,000 breeding pairs of yellow-eyed penguins are estimated to live in the wild. And the population is shrinking. In 2015, the number of breeding pairs on mainland New Zealand dropped by half. Scientists and conservationists are studying threats to the penguins to learn what may have wiped out such a large number of them. Many worry that the endangered birds could soon face extinction.

A THREATENED EXISTENCE

Life is hard for the yellow-eyed penguin. Only 18 out of 100 chicks survive their first year. While that's about average for a seabird, those that do survive must endure many threats over the course of their lifetime.

FALLING NUMBERS

In the 1990s, yellow-eyed penguin populations on South Island, New Zealand, hit their lowest levels ever recorded. Biologists worry that a recent decline could signal that the penguins' numbers are headed for an even bigger drop.



*Data was not collected for certain years. SOURCE: YELLOW-EYED PENGUIN TRUST

Even though yellow-eyed penguins nest in dense vegetation, they spend most of their time in the ocean, diving 40 to 120 meters (131 to 394 feet) below the water's surface. There they catch fish and other prey. But life at sea can be dangerous for the birds. Commercial fishermen accidentally catch yellow-eyed penguins in their nets. Another consequence of fishing is that some species of fish are being hauled up faster than the populations can reproduce. This is causing some fish to decline in numbers. *Overfishing* forces penguins to compete with other predators for food.

ALSO KNOWN AS HOIHO, OR NOISE SHOUTER, DUE TO THEIR SHRILL CALL

The fish yellow-eyed penguins rely on are also responding to *climate change*. Ocean temperatures have risen by about 0.07°C (0.13°F) per decade over the past century. Warming waters can drive fish deeper or farther out to sea where it's cooler—away from the penguins' nesting grounds. As a result, biologists hypothesize that yellow-eyed penguins must expend more energy when they hunt. At the same time, they're catching fewer or less-nutritious fish. This results in the penguins having a *caloric deficit*—the burning of more calories than are consumed.

Life on the shore isn't any easier for yellow-eyed penguins. People have cleared land for farming, destroying much of the bird's forest habitat. People have also introduced *invasive*, or non-native, animals like ferrets and stoats into the yellow-eyed penguins' habitat. These predators often eat the penguins' eggs. And stressed-out, malnourished penguins are highly susceptible to diseases, like *avian diphtheria*—a deadly type of bacterial infection in birds.

"They're facing a suite of problems on land and at sea," says Trudi Webster, a science adviser for the Yellow-eyed Penguin Trust, an organization in New Zealand devoted to protecting yellow-eyed penguins. "And there are interactions between all of these problems that just make it worse."

Some combination of these factors led to one of the steepest drops in yellow-eyed penguin populations in recorded history. From 2014 to 2015, the number of breeding pairs on South Island, New Zealand, fell from approximately 439 to just 205 (*see Falling Numbers, above*). If scientists don't come up with solutions fast, the bird may soon die out completely. Luckily, no one is giving up yet.

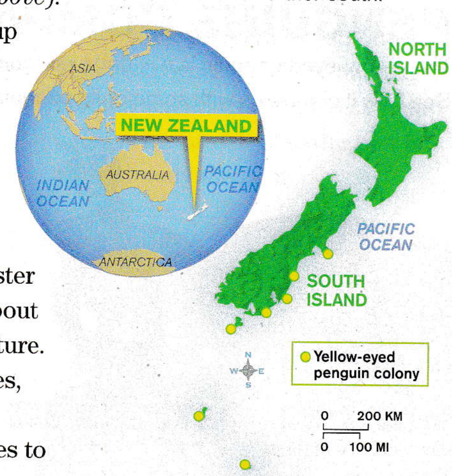
NEW HOPE?

Researchers like Webster are cautiously hopeful about yellow-eyed penguins' future. Over the past two decades, scientists and volunteers have dedicated themselves to protecting the birds.

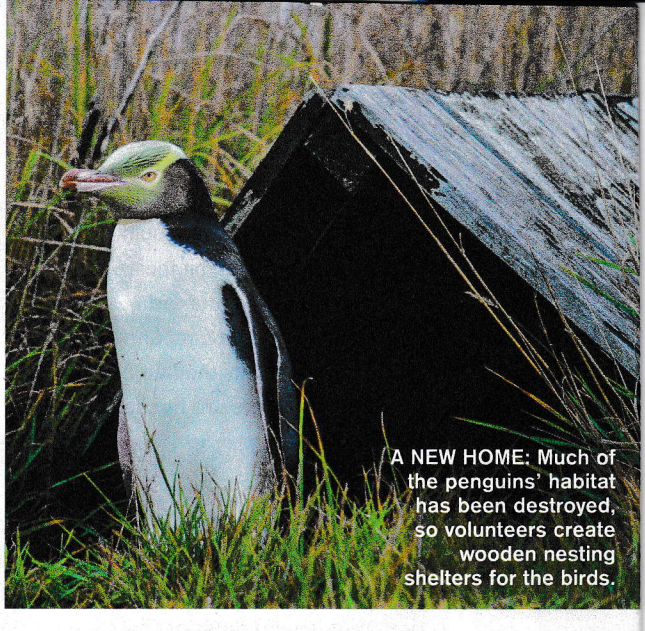
Continued on the next page →

YELLOW-EYED COLONIES

Yellow-eyed penguins live only in a few colonies spread across South Island, New Zealand, and some smaller islands farther south.



ATTENTION, TOURISTS: Tourism helps raise money and awareness for penguins, but too much foot traffic around breeding grounds can stress the birds.



A NEW HOME: Much of the penguins' habitat has been destroyed, so volunteers create wooden nesting shelters for the birds.

Many successful programs involve local citizens and conservation groups trapping and killing invasive animals that prey on penguin eggs and chicks. Other organizations have set up rehabilitation facilities that take in underweight penguins to feed them and provide medical treatments.

One of the most exciting projects starts at the nest. Yolanda van Heezik, a wildlife biologist at the University of Otago in New Zealand, and her students are working to identify yellow-eyed penguin "superbreeders." These are penguins that naturally produce more, and healthier, chicks than average. Their chicks also have a higher rate of survival and often go on to become superbreeders themselves.

Van Heezik says that figuring out what makes these penguins superbreeders could be a key to encouraging higher breeding rates among other yellow-eyed penguins. Genetic studies will try to determine if there are specific *genes*, or units of hereditary material, that influence breeding and survival rates. In addition, researchers are studying the parenting habits of superbreeders to get ideas on how to increase the number of chicks that survive their first year. For instance, researchers will see if superbreeders feed their chicks in a way that's more beneficial to the chicks' health.

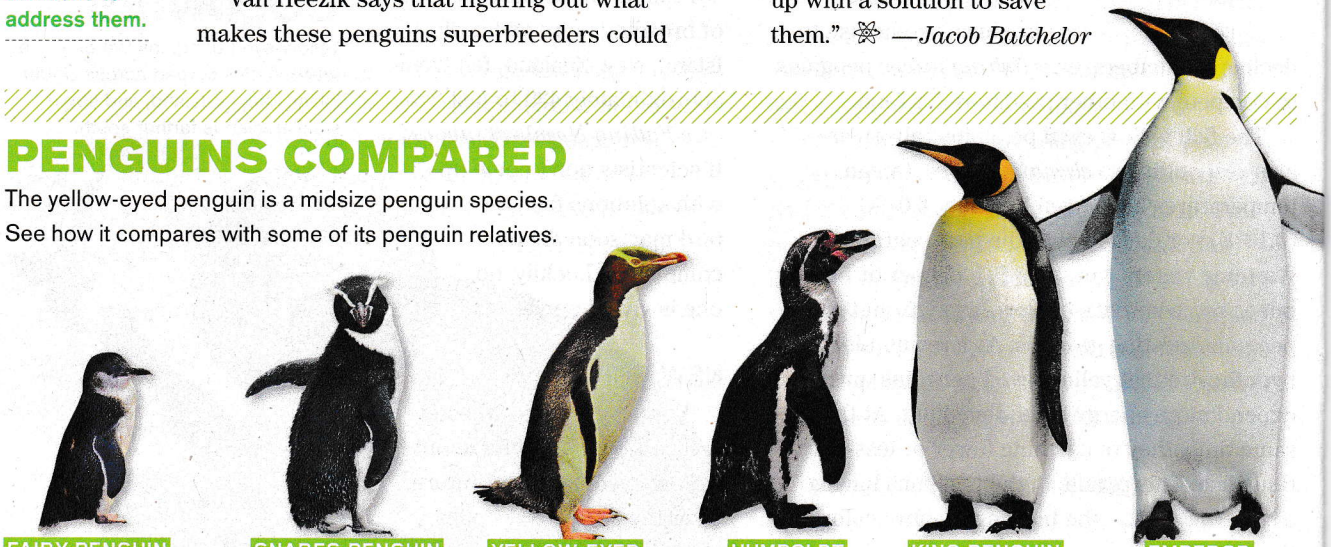
Yellow-eyed penguins will still face many obstacles. But these research, breeding, and conservation programs could give them a fighting chance. "They're a fantastic penguin," says Van Heezik. "I just hope we can come up with a solution to save them." —*Jacob Batchelor*

CORE QUESTION

Cite three factors affecting yellow-eyed penguins, and brainstorm possible solutions to address them.

PENGUINS COMPARED

The yellow-eyed penguin is a midsize penguin species. See how it compares with some of its penguin relatives.



FAIRY PENGUIN
HEIGHT: 12 inches
LOCATION: Australia and New Zealand

SNARES PENGUIN
HEIGHT: 24 in.
LOCATION: Islands south of New Zealand

YELLOW-EYED PENGUIN
HEIGHT: 26 in.
LOCATION: New Zealand

HUMBOLDT PENGUIN
HEIGHT: 28 in.
LOCATION: Peru and Chile

KING PENGUIN
HEIGHT: 35 in.
LOCATION: Antarctica

EMPEROR PENGUIN
HEIGHT: 50 in.
LOCATION: Antarctica

SEE-THROUGH FROG

There's no doubting that this frog has guts. That's because you can see them! A glass frog's heart, intestines, and lungs are visible right through its belly. Glass frogs are so named because looking at them from underneath is like looking through glass.

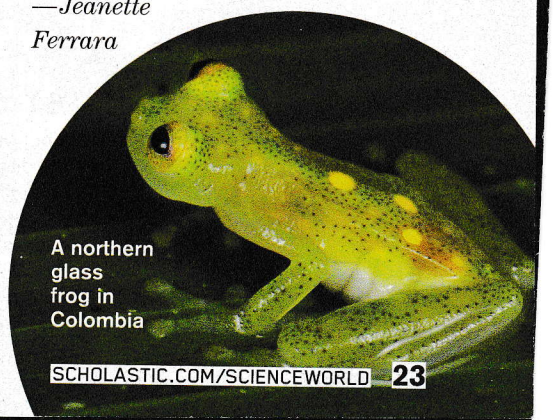
More than 150 species of glass frogs live in the tropical rainforests of Central and South America. Most have green skin—except for on their abdomens. This area of their body lacks *pigmentation*, or color. Some scientists believe this strange adaptation might help the frogs *camouflage* themselves to stay hidden from predators, says Santiago Castroviejo-Fisher. He's a biologist at the American Museum of Natural History in New York City.

Most green frogs blend in with the leaves they're sitting on. But sunlight hitting the animal creates a dark shadow on the leaf that predators can see from below. "If the frog is partially translucent, light can more easily pass through it," says Castroviejo-Fisher. That makes its shadow lighter and harder to notice.

There are drawbacks to translucent skin, however. Pigmentation normally blocks *ultraviolet (UV) light* from the sun. UV light can damage body tissues. Since light can pass through the skin of a glass frog's abdomen, UV rays could potentially harm its organs.

This isn't the only threat to glass frogs. They're also susceptible to *chytrid fungus*—an infection that has wiped out many frog populations. Widespread deforestation is also destroying the frogs' habitat, leading scientists to fear that some species are at risk of extinction or have already died out.

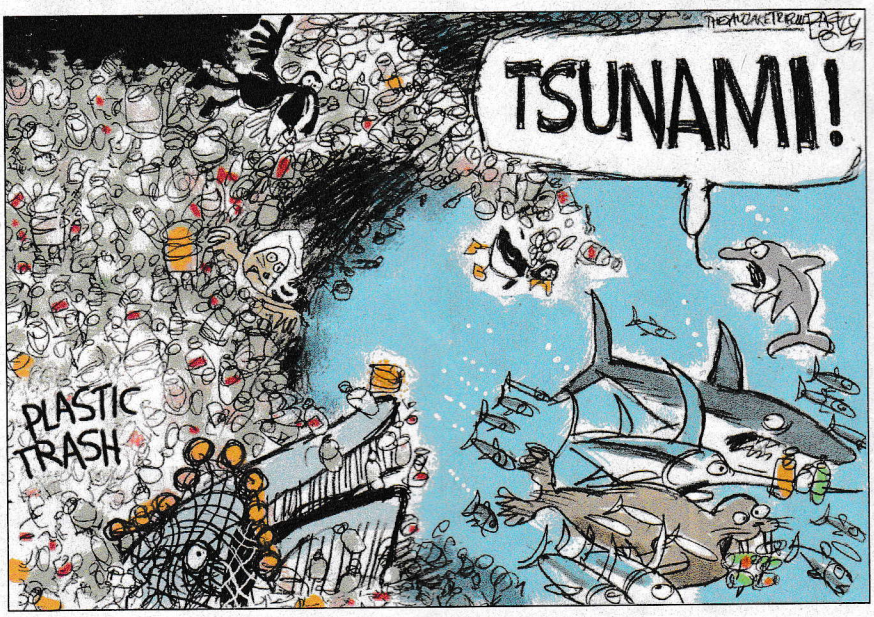
—*Jeanette Ferrara*



A northern glass frog in Colombia

A SEA OF GARBAGE

After reading "An Ocean of Plastic" (p. 8), analyze these cartoons to answer the following questions.

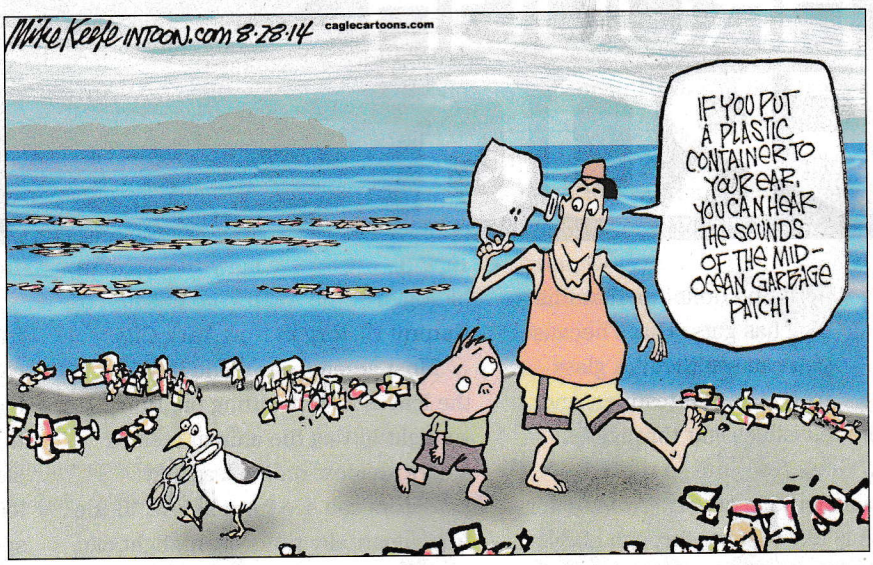


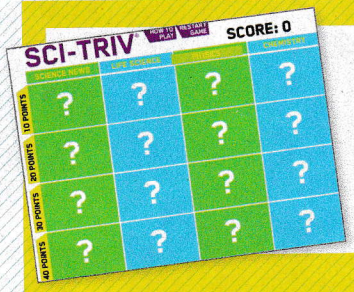
1 A tsunami is a large wave of water in the ocean. What is the word being used to indicate in the top cartoon?

2 What *analogy*—comparison between two things—is the artist making with the jug in the bottom cartoon?

3 What message is each cartoon trying to convey to readers? Do they succeed?

4 What techniques—like humor, exaggeration, labels, symbols, or analogies—do the cartoonists use to make their points?





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