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SCIENCE NEWS

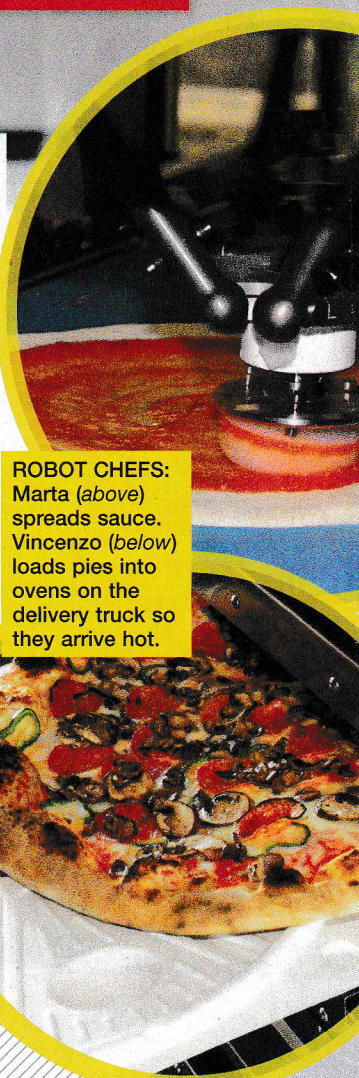
ENGINEERING: ROBOTS

PIZZA BOT

At a food-delivery company based in California, robots work alongside human employees to serve up piping-hot pizzas. Inside the kitchen of Zume Pizza, a robot called Doughbot flattens balls of dough into circles in nine seconds. Another, called Marta, spreads tomato sauce. And a bot named Bruno loads the pizzas into the oven. Together, robots and cooks can churn out 372 pizzas per hour.

Zume aims to fuse cooking and automation—technology that allows machinery to operate without assistance. The idea isn't limited to pizza making. Robots and people are working together in many industries, says John Bubnikovich of ABB Robotics, which created Marta and Bruno. Robots generally take over simple, tedious tasks, while humans handle the complex ones. —Cici Zhang

ROBOT CHEFS: Marta (above) spreads sauce. Vincenzo (below) loads pies into ovens on the delivery truck so they arrive hot.



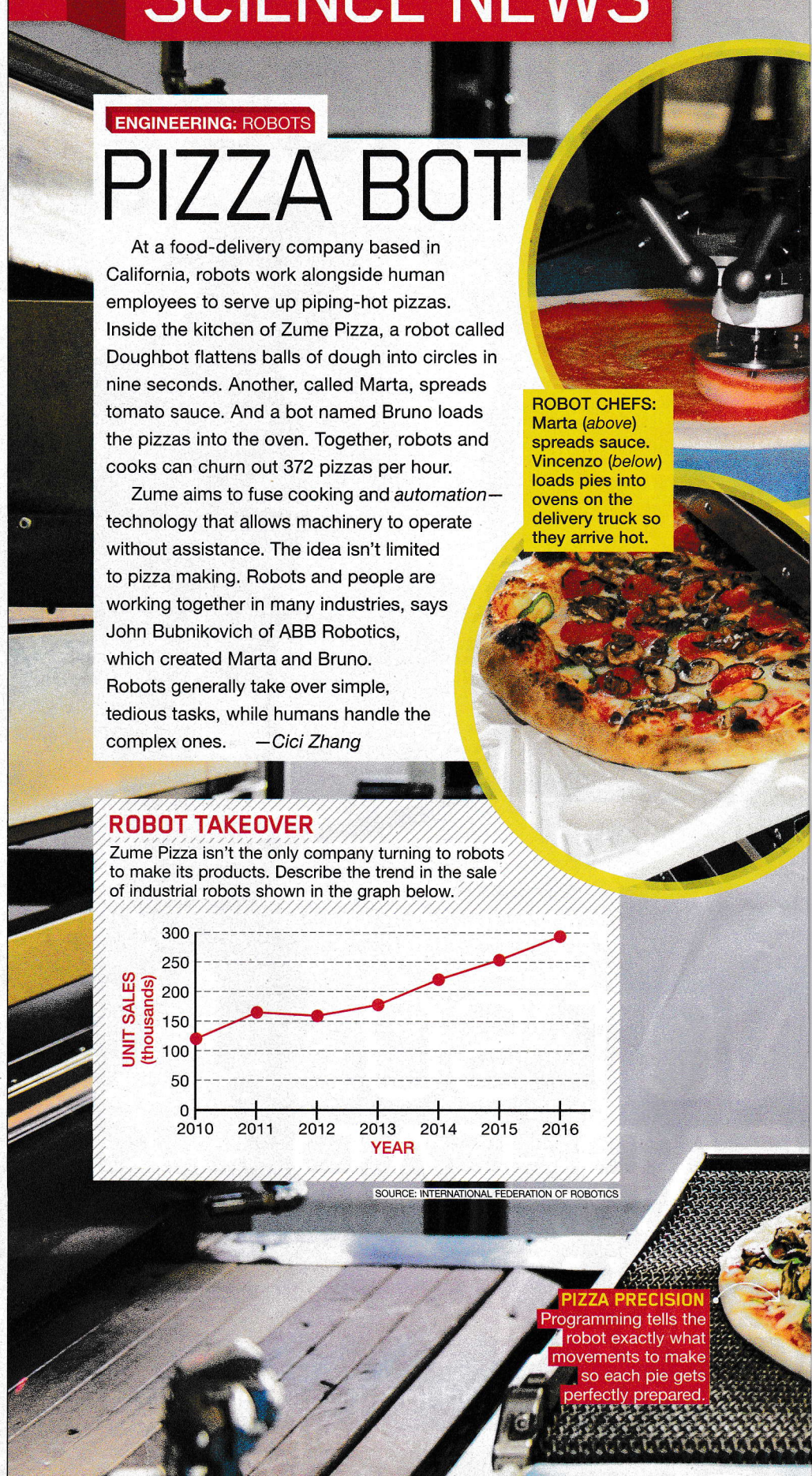
ROBOT TAKEOVER

Zume Pizza isn't the only company turning to robots to make its products. Describe the trend in the sale of industrial robots shown in the graph below.



SOURCE: INTERNATIONAL FEDERATION OF ROBOTICS

PIZZA PRECISION Programming tells the robot exactly what movements to make so each pie gets perfectly prepared.





OVEN LOADER
Bruno the robot loads pizzas into the oven at Zume's kitchen.

TWIST AND TURN
Six rotating joints like this one allow Bruno to do its job.

COURTESY OF ZUME PIZZA (ALL PHOTOS)

SKIN TONES
Squid may have gained the ability to change their skin color from bacteria.

BIOLOGY: GENETICS

Color Change

Octopus, squid, and cuttlefish have special skin that allows them to change color to blend in, stand out, and even communicate. But scientists say these *cephalopods* may not have developed this ability alone. Recently, scientists studied the origins of a *protein*—a large biological molecule—called *reflectin* that's responsible for the animals' color-changing ability. They

think bacteria living in ancient cephalopods transferred their reflectin-making *genes*, units of hereditary information, to their hosts.

"Such gene transfers can change species' characteristics over long periods of evolution," says biologist Can Xie, who worked on the study at Peking University in China. —Hailee Romain

FEELING BLUE:
A bobtail squid in the Indian Ocean turns blue.



SAY NO? Think about asking for digital receipts instead of paper.

CHEMISTRY: COMPOUNDS

Risky Receipts?

You might want to say "No thanks" the next time a cashier asks if you want your receipt. Handling these paper slips may allow harmful chemicals to enter your body through your skin.

Printed receipts often contain *bisphenol A*, or BPA. The chemical is sometimes used to make plastic products, like bottles. BPA can cause health problems in children, affecting brain development and disrupting *hormones*—chemical messengers in the body. But absorbing BPA through your skin may actually be more harmful than consuming it, says Jonathan Martin, a chemistry professor at Stockholm University in Sweden.

Martin and his team found that ingested BPA usually leaves the human body within 24 hours. But traces of BPA absorbed through the skin can remain in the body for up to a week. That results in prolonged exposure to the chemical, which could have serious implications for health. "We are not just what we eat, but also what we touch," Martin explains. —Hailee Romain

NEW HUE:
White-colored streets may help cool down urban areas.

PHYSICS: LIGHT

COOL STREETS

On hot days, temperatures can soar in Los Angeles, California. The black asphalt that's used to pave streets absorbs the sun's rays, making the city even hotter than less-developed areas nearby. To battle this *heat island effect*, Los Angeles is trying a new solution—painting its streets white.

More of the sun's rays *reflect* off, or bounce off, white-colored pavement than black asphalt. The city's white streets absorb less heat, lowering surface temperatures. Los Angeles's Bureau of Street Services recently painted 15 city blocks white. Early results suggest that streets painted white were 10 degrees cooler. Officials hope to expand the program next summer. —Cici Zhang

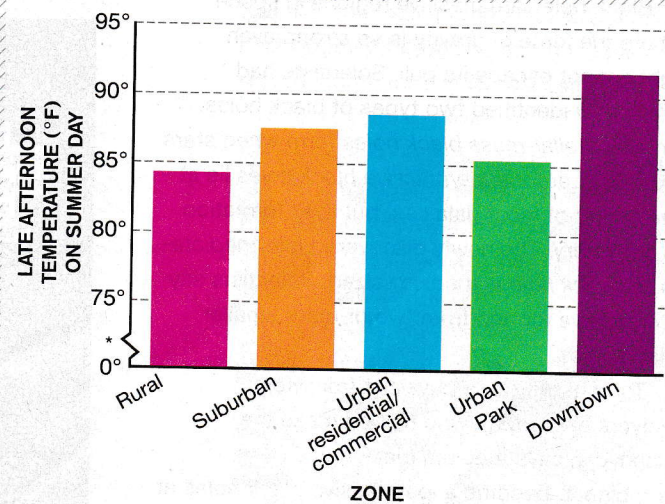
PAGE 4: MASAO USHIODA/SEAPICS.COM (TOP); NIGEL MARSH/SEAPICS.COM (INSET); ISTOCK/GETTY IMAGES (RECIPT); PAGE 5: LOS ANGELES BUREAU OF STREET SERVICES



SPECIAL PAINT:
This reflective white coating was developed by the military to help hide spy planes from heat sensors.

HEAT ISLAND

This graph shows a typical change in temperature in and around a small city due to the heat island effect. What's one way, other than painting streets white, to cool down city centers?



*DENOTES BREAK IN SCALE. SOURCE: HEAT ISLAND GROUP, LAWRENCE BERKELEY NATIONAL LABORATORY

DISTORTED SPACE
A simulated view of a black hole shows how it bends space and light around it.

EARTH SCIENCE: SPACE SCIENCE

BLACK HOLE DISCOVERY

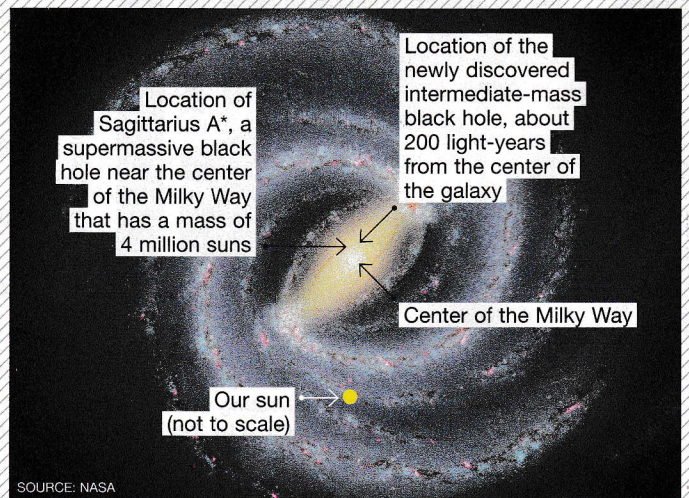
Scientists have spotted something hiding in a cloud of gas at the heart of the Milky Way. The Milky Way is the *galaxy* (collection of stars) that contains our solar system. Researchers think the distant cloud surrounds a new type of *black hole*.

Black holes are massive regions in space where the force of gravity is so strong even light cannot escape its pull. Scientists had previously identified two types of black holes. Smaller *stellar-mass black holes* form when stars explode. Larger *supermassive black holes* lie at the center of most galaxies, but their formation is a mystery. The newly discovered *intermediate-mass black hole* is medium-sized. Scientists say it may have formed from two or more smaller black holes.

Tomoharu Oka, a physicist from Keio University in Japan who helped make the discovery, says medium black holes may combine to become supermassive black holes at the center of galaxies. —Jeanette Ferrara

HIDDEN IN THE GALAXY

Researchers think a gas cloud 200 light-years from the center of the Milky Way may hide a new type of black hole.



SOURCE: NASA



STAY AWAY:
These tiny turtles may harbor harmful bacteria.

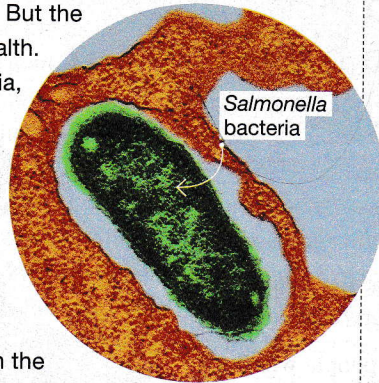
BIOLOGY: HEALTH & DISEASE

Toxic Turtles

Tiny pet turtles may seem harmless. But the cute reptiles can pose a risk to your health. The animals can carry a harmful bacteria, called *Salmonella*, that may cause diarrhea and make people seriously ill.

The U.S. Centers for Disease Control and Prevention (CDC) determined pet turtles to be the cause of a recent salmonella outbreak. It sickened nearly 40 people in 13 states.

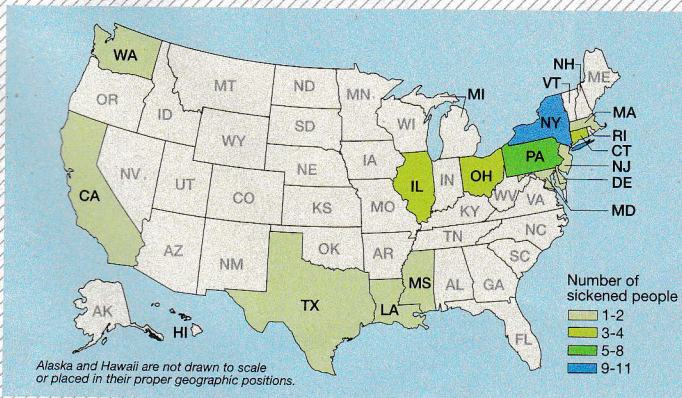
Salmonella bacteria commonly live in the intestines of many animals. The germs can also be found in the animals' poop and in their environment, such as a turtle tank. Small turtles are particularly dangerous because young children can easily pick them up and put them in their mouths. For this reason, buying and selling them is illegal. "Hand washing is the best way to prevent illness," says Megin Nichols, a CDC veterinarian. "Do not purchase—or give as a gift—turtles with a shell length of less than 4 inches in size." —Jeanette Ferrara



Salmonella bacteria

SALMONELLA OUTBREAK

This past summer, dozens of people across the U.S. were infected with a strain of the disease-causing bacteria called *Salmonella* Agbeni. Which state had the most sickened people?



SOURCE: CDC

NUMBERS IN THE NEWS



\$1 million

The prize **Coca-Cola** is offering for the development of a new low- or no-calorie sugar replacement.

300

The number of different ways the molecules that make up ice can be arranged, according to a new study.

119

The atomic number of a possible new element scientists in Japan will start trying to create in their lab this month.



21

The total months that **NASA** astronaut **Peggy Whitson** has spent in space—a record length for any female astronaut.

4

The number of kneecaps an **ostrich** has—more than any other animal.

A new study suggests the bird's anatomy may help it straighten its legs faster while running.



kneecaps

ALAIN RIZUELLO/IFAP/PMC/CNRS (BLACK HOLE); NASA/JPL-CALTECH (MILKY WAY); JEFF GREENBERG/IGUA GETTY IMAGES (TURTLES); DR. KLAUS BOLLERSPOSCIENCE SOURCE (SALMONELLA); ISTOCK/GETTY IMAGES (SODA); NASA (PEGGY WHITSON); KLEIN & HUBERT/NATUREPL.COM (OSTRICH); JIM McMAHON/WAPMAN® (MAP)



STAR WARS: ON LOCATION

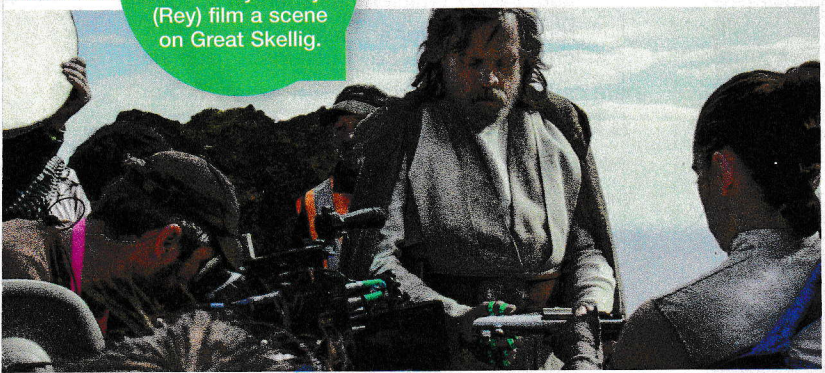
Earth's geology and habitats have a starring role in the Star Wars saga's fictional settings

ESSENTIAL QUESTION: What places on Earth do you think have features that could be found on other planets? Explain?

On December 15, millions of people will flock to theaters to see the newest Star Wars movie, *Episode VIII: The Last Jedi*. This and the other films in the series rely heavily on special effects, like computer animation, to create the stunning planets the characters visit. But the series' creators also use real-life locations on Earth as stand-ins for some of the films' most beautiful alien landscapes. Discover the science behind three of the amazing places on your own planet that set the scene for this epic space saga.

BEHIND THE SCENES

Mark Hamill (Luke Skywalker), and Daisy Ridley (Rey) film a scene on Great Skellig.



1 ISLAND FORMATION

STAR WARS LOCATION: Ahch-To

REAL-WORLD LOCATION: Skellig Islands, Ireland

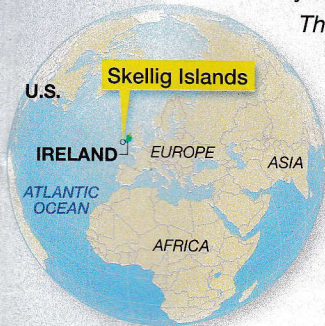
You've probably seen 2015's *The Force Awakens*, but if not . . . spoiler alert! The movie ends with a cliffhanger, when the film's protagonist, Rey, tracks down Jedi Master Luke Skywalker. She finds him on an isolated, rocky island on the water-covered planet of Ahch-To. Previews for *The Last Jedi* hint that Skywalker trains Rey in this beautiful hideaway, safe from the clutches of the villainous First Order.

The island that serves as a refuge for the movie's heroes is, in reality, another type of *sanctuary*: one for seabirds. Great Skellig, an island off the southwest coast of Ireland, is home to one of the world's largest gannet bird colonies, says John O'Halloran, an *ornithologist* who studies birds at University College Cork in Ireland. About 20,000 pairs of gannets breed there.

Great Skellig and neighboring Little Skellig are part of the Valentia Slate Formation, the region's oldest rock formation. It formed about 385 million years ago, as the area's ancient *tectonic plates* collided with one another. These giant, slowly moving slabs of rock make up Earth's *crust*, or surface. Huge amounts of heat and pressure were created as the plates smashed together. Over time, these forces transformed soft *sedimentary rock*—made up of tiny pieces of sediment cemented together—into hard *metamorphic rock*.

Metamorphic rock protects the islands from being *weathered*, or gradually broken down, by the powerful ocean. "The Skellig Islands are constantly battered by waves from the Atlantic Ocean," says Bettie Higgs, a geologist also from University College Cork.

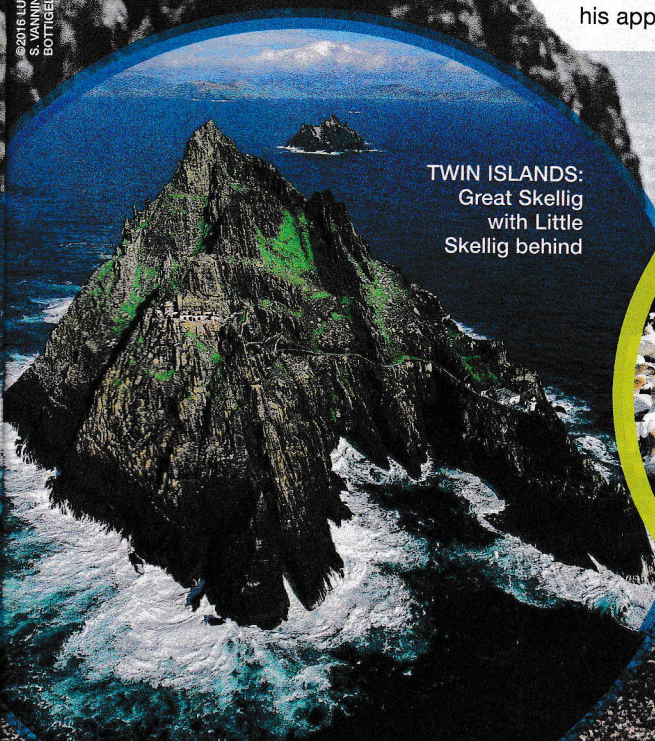
The ancient rock also gives Great Skellig its jagged, imposing landscape—a breathtaking setting for a Jedi Master to teach his apprentice the ways of the Force.



USE THE FORCE: Luke Skywalker and Rey on an island on the planet Ahch-To.



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TWIN ISLANDS: Great Skellig with Little Skellig behind



BIRDS OF A FEATHER: Gannet birds gather on Great Skellig.



FOREST FRIENDS
The movie's heroes team up with the native Ewoks on Endor.

2 OLD-WORLD FOREST

STAR WARS LOCATION: Endor

REAL-WORLD LOCATION: Redwood Forest, California

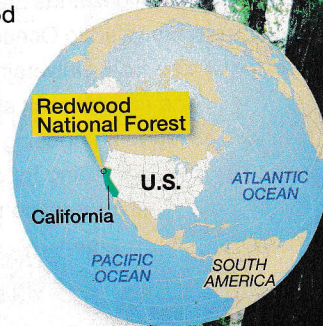
The final battle scene from 1983's *Return of the Jedi* takes place on the forest-covered moon of Endor. The Rebels, with the help of their furry Ewok friends, face off against Darth Vader's Galactic Empire.

Filming for some of the scenes took place in the Redwood National and State Parks in Northern California. "It's a very ancient, primeval-looking place," says Mike Poole, one of the park's rangers. The oldest known coast redwood tree in the park is more than 2,000 years old. These gigantic trees can grow more than 10 stories tall and can have a diameter of almost 9 meters (30 feet).

The park is an *old-growth forest*. Trees in old-growth forests tend to vary in age and height, creating a staggered *canopy*. The uneven treetops allow sunlight to reach the ground, so a lush blanket of shrubs and ferns can grow on the floor.

California's redwood forest is rare in that during its long life it hasn't suffered any severe damage from fires, logging, disease, or insect infestations. It's not the mystical power of the Force that protects these trees, though. Redwoods have developed *adaptations* that shield them from their natural enemies, explains Poole. These adaptations include thick, damp bark that makes the trees fire-resistant and sap that consists mainly of water instead of the sticky, flammable resin found in most trees. Finally, a chemical called *tannin*, which gives the trees' bark its red hue, wards off fungal growth and insect infestations.

Because of their incredible ability to survive, Poole says, these redwoods were given the Latin name *Sequoia sempervirens*—meaning "ever green" or "ever living." These forests are also home to hundreds of animal species . . . but, unfortunately, no Ewoks.



ANCIENT FOREST: The redwood forest in Northern California has survived for thousands of years.

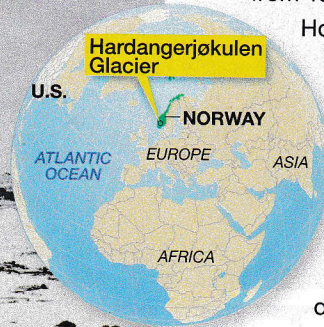
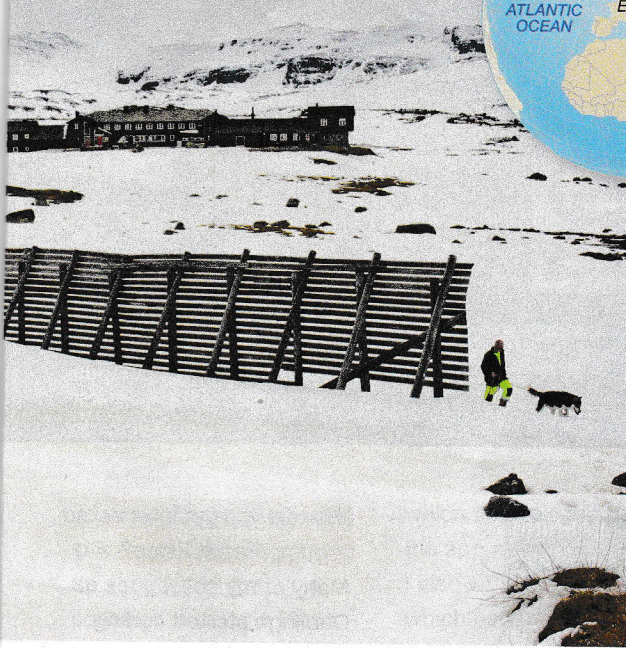
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3 GLACIER FORMATION

STAR WARS LOCATION: Hoth

REAL-WORLD LOCATION: Hardangerjøkulen, Norway

FROZEN FUN:
People vacation at this lodge, located on the glacier where *The Empire Strikes Back* was filmed.



The Battle of Hoth is undoubtedly one of fans' favorite scenes from 1980's *The Empire Strikes Back*. It takes place on

Hoth, a planet covered in snow and ice. Filming for the epic conflict between the Rebel Alliance and the Empire took place on the Hardangerjøkulen (har-dan-ger-yoh-koo-len) glacier in Norway.

This slowly moving mass of snow and ice is located in the southern part of the country. It is 1,863 m (6,112 ft) above sea level—the highest altitude in the region. At those heights, snow doesn't melt, explains Richard Alley, a geologist at Penn State University in Pennsylvania who studies glaciers. Instead, snow builds up and flattens out.

"As fresh snow piles up in the highest, coldest area in the glacier's center, the weight of the snow forces it to spread outward like pancake batter on a griddle," says Alley. He explains that if you were to put *GPS markers*—devices that can track an object's position on Earth—near the center of the glacier, you could observe the markers spreading out over time.

This movement is responsible for variations seen in the glacier's appearance, says Alley. As the fresh, white snow at the glacier's center moves outward from higher to lower elevations, the snow melts. The melting creates big *crevasses*, or gaps. It also makes the ice at the glacier's edges gray and blue. "The variation of the landscape would have made it an ideal location for filming," says Alley. ❄️

—Andrew Klein

SNOW BATTLE

The Empire's AT-AT vehicles attack on the ice planet Hoth.



CORE QUESTION

Choose a planet from the Star Wars movies not mentioned in the text. Research to see if it was filmed in an actual location on Earth. Then explain what makes that place unique.

COMPUTER CODER

CODE EXPERT: Karin Tsai writes computer code for the language-learning app Duolingo.

Karin Tsai is helping develop a popular app that allows people to learn new languages

Studying a new language, like French, German, or Japanese, has gone digital. Karin Tsai aims to help people learn just about any language on the planet—from Czech to Vietnamese—right on their smartphones, tablets, or computers.

Tsai works for Duolingo, a company in Pittsburgh, Pennsylvania, that makes interactive language-learning software. As a *computer programmer*, she writes *code*, or instructions, that allows the app to function. *Science World* spoke with Tsai about how she became interested in computer science, what it's like to develop software, and the current push to get more young people—particularly girls—into coding.

MOBILE LEARNING
The Duolingo app helps users learn new languages on the go.

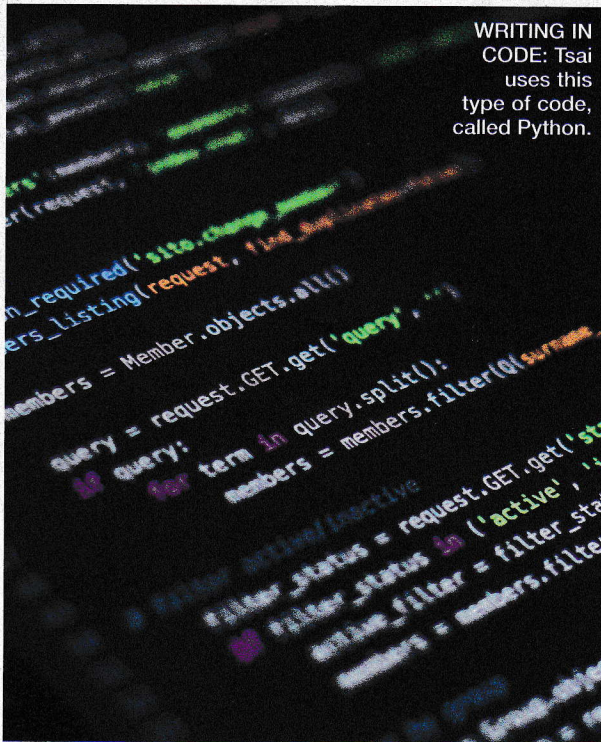
How did you get interested in computer science?

Many of my colleagues at Duolingo started coding early in their lives, but I didn't know anything about computer science until my freshman year of college. When I started college at Princeton University in New Jersey, I originally wanted to be a doctor. But then I took a required computer class and it set me on an entirely different path. I was drawn to the problem-solving aspect of coding. It was fascinating to see what you could create through code. I switched my major to computer science and enrolled in graduate school to get my Ph.D. in the same field.

How did you come to work at Duolingo?

My Ph.D. adviser,





WRITING IN CODE: Tsai uses this type of code, called Python.

Luis von Ahn, and a fellow student started Duolingo as a project in graduate school at Carnegie Mellon University in Pittsburgh. I worked on it along with other students. The project eventually became the Duolingo app, and von Ahn became the company's CEO. I now work for the start-up. I like that it gives me an opportunity to work on something educational to make a difference in people's lives. Duolingo's mission is to provide free language education to anyone. Today, more than 200 million people use the program.

What is it like to work as a coder?

My main goal each day is to create awesome software that helps people. I write *back-end code*,

which controls the data the app needs to function. I also write *front-end code*, which enhances how easily a person can interact with and navigate software. We call that the *user experience*.

One of the most satisfying and impactful projects I've worked on is the Duolingo Language Incubator. This part of the app lets volunteers suggest translations or new sentences to be considered for language courses that are still in development at Duolingo. It also aims to revive dying languages, such as Irish, and even brings fictional languages, like Star Trek's Klingon, to real life.

What do you like best about your job?

I love hearing positive stories from users about how our app helped them. Some say learning a new language allowed them to have a better time visiting another country. Some users even say that they were able to get a better job by learning a new language through Duolingo.

What's it like being a female software engineer?

I've been fortunate that my company is extremely inclusive, but only 18 percent of software engineers are women. That's not enough. I'd like more companies to make it a priority to hire more women coders. Even though my industry has come a long way, we have so, so much further to go.

It's also important that we start teaching girls to code when they're young—in elementary school or even sooner (see *Girls Who Code*, below). Parents and educators need to make sure that girls know that science, technology, engineering, and math (STEM) fields are not exclusively for men. Even though the software industry is starting to be more aware of it, we have a lot of work to do. ✨

—Katherine Bagley

GIRLS WHO CODE

Despite the rapid growth of the technology industry over the past several decades, women make up a smaller share of the computing field today than they did in the 1980s. Five years ago, an initiative was launched to spark girls' interest in coding at an early age. The project, called Girls Who Code, runs after-school programs in all 50 U.S. states. It encourages female students, from elementary to high school, to use coding to solve local and global problems. So far, the program has helped more than 40,000 young girls learn to code.



CODING CLUB: High school students in New York City attend a Girls Who Code club.



A SECRET SALT MINE

Enter a strange and beautiful world of salt hidden beneath the Great Lakes

ESSENTIAL QUESTION:

Why do you think salt is applied to roads in the winter in some parts of the U.S.?

Each winter, cities and towns throughout the U.S. scatter nearly 20 million tons of salt on snowy roads and walkways. The salt helps melt ice-coated streets and sidewalks, making it safer for people to drive and walk. But where does all that salt come from? A lot of it is mined from a vast salt deposit beneath Lake Erie, one of the Great Lakes (see *Salt Sources*, right).

The Morton Salt Mine lies near the town of Fairport Harbor, Ohio, just 48 kilometers (30 miles) east of Cleveland. Few people besides the mine's workers have ever seen inside its shimmering white caverns and tunnels. In fact, many locals aren't even aware the mine exists.

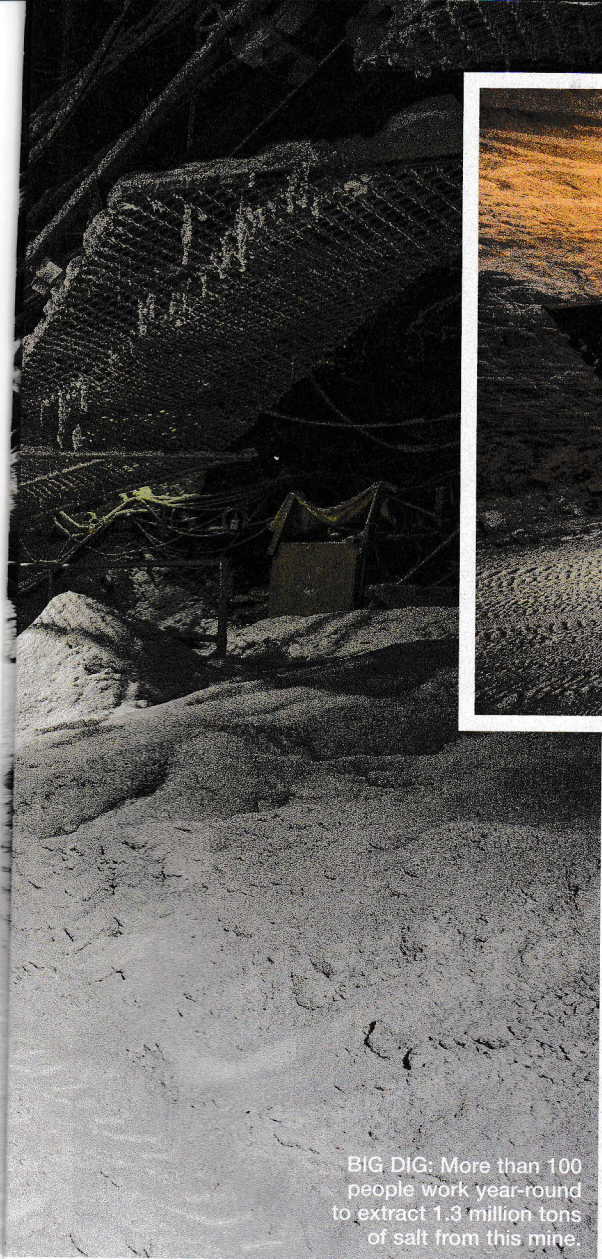
To reach the salt deposit, workers and engineers take a four-minute elevator ride,

descending about 610 meters (2,000 feet) underground. There, miners use explosives to blast away at massive walls of solid salt. Huge machines drill, crush, and transport the salt up to the surface. Each move is carefully planned to ensure that the mine's ceiling—and the rock and water above it—doesn't come crashing down.

ANCIENT FORMATION

The Great Lakes region didn't always look as it does today. During the *Paleozoic era*—from about 544 million years ago to 245 million years ago—much of the land that is now North America was covered in a shallow, salty sea.

Because the sea was so shallow, huge rings of coral reefs sometimes rose above the water and formed massive, bowl-shaped basins. The



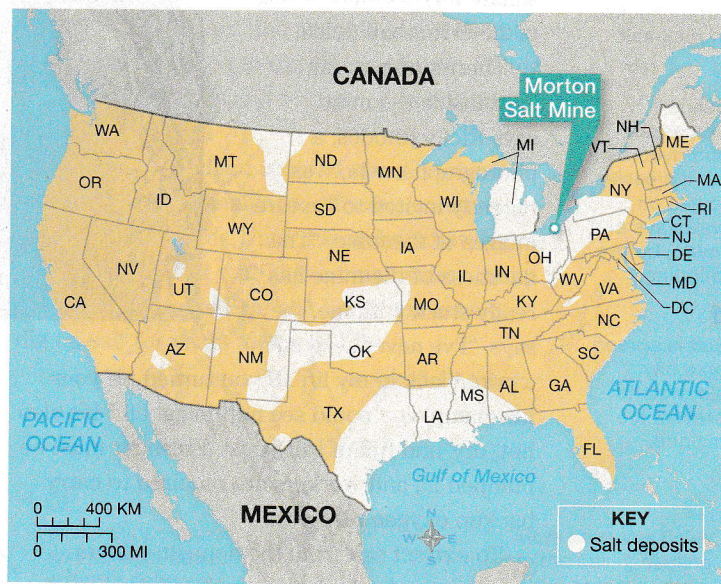
BIG DIG: More than 100 people work year-round to extract 1.3 million tons of salt from this mine.



EXCAVATION: Workers use huge machines to move rock salt blasted from the walls of the mine.

SALT SOURCES

There are several major *salt basins* buried around the U.S., including one beneath the Great Lakes.



air was hot and dry, causing the salt water caught within those basins to *evaporate*. As the liquid water turned to vapor, salt deposits were left behind on the seafloor. These deposits were largely composed of a *compound* called sodium chloride (NaCl). A compound is a substance made of two or more elements that are chemically combined. Sodium chloride also makes up ordinary table salt, which Morton extracts from other mines in North America.

The process of evaporation and the accumulation of salt deposits on the seafloor continued for millions and millions of years (see *Salty Buildup*, p. 17). "Over time, a tremendously thick deposit of *halite*, or rock salt, formed," says Randall Schaeztl, a professor of geography at Michigan State University. "It's

amazing how extensive these salt deposits are. They go on for miles."

HIDDEN WORLD

The Morton salt mine under Lake Erie is the deepest salt mine in North America. More than 1 million tons of salt per year comes from the

Continued on the next page →



1

FROM MINE TO STREET

1

A machine breaks down large chunks of rock salt.

2

Salt is processed and dyed blue (so it's easier to see on walkways and roads) before shipping.

3

Salt is spread on a city sidewalk to prevent ice buildup.

mine, which has been in operation since the late 1950s. The mine spans nearly 13 square km (5 square mi)—about the size of 2,500 football fields.

There's no natural light inside the mine, says Ricky Rhodes, a photographer who was recently invited to capture images of the mine. "The darkness of the mine has really stuck with me," he says. "I've never seen such a pure black in my life. If you turned off your headlamp, you could see nothing at all." It's also hot, dry, and full of salty dust. Fresh air must be pumped in, and workers are required to carry backup oxygen reserves.

To extract salt from the deposit, miners use a method called *room and pillar mining*. Using explosives and large machinery, they blast out large chambers from the solid rock salt. Removing too much salt could risk a mine collapse. So engineers make sure to leave behind gigantic pillars of salt to support the weight of the rock above before blasting out another chamber. This method leaves behind a collection of empty caverns, many of which are used to store broken mining equipment too large to remove from the mine. (To get machinery



3

down into the mine in the first place, workers must bring it below ground piece by piece, where they then assemble it.)

Once the salt from a chamber is collected, it's crushed into smaller pieces and transported above ground for processing at a plant in Fairport Harbor. All the salt from the Morton Salt Mine is used for road salt. While table salt is chemically identical to road salt, it requires further processing to remove impurities. Road salt, however, doesn't need to be as pure.

ON THE ROAD

Road salt prevents ice from forming on streets by lowering water's *freezing point*. The freezing point is the temperature at which a substance changes from a liquid to a solid.



Road salt saves lives by preventing slippery driving conditions. But it might also have negative effects on the environment, says Mark Green, a *hydrologist* (water scientist) at Plymouth State University in New Hampshire. He's found that the use of road salt can increase the *salinity*, or saltiness, of streams and other water sources near roads. This can negatively affect fish and amphibians in the water, as well as people who drink it. Soil near major roads can also become salty over time, which can damage plants and crops.

Road salt also takes a toll on infrastructure, such as bridges, in areas that receive a lot of snow. That's because

salt is *corrosive*. Under certain conditions, it causes damage to things it touches, like iron (Fe) in the steel used to build bridges. Salt speeds up *oxidation*, the process in which iron rusts when exposed to oxygen and water. Fixing salt-damaged roads and bridges costs billions of dollars each year.

Despite the hidden costs of using road salt in the winter, it remains an effective solution to keeping roads safer. Until researchers develop a better way to deal with this annual winter issue, miners under Lake Erie will likely continue to dig up salt for years to come. ❄️

—Jacob Batchelor

📌 CORE QUESTION

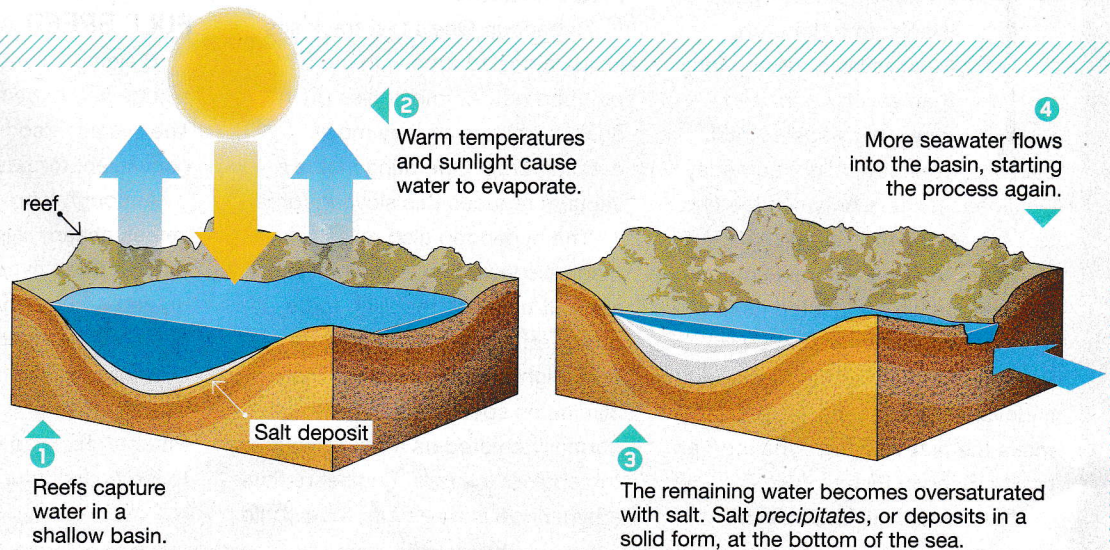
Describe the solutions workers use to prevent cave-ins and safely remove salt from the Morton Salt Mine.

Water normally turns to ice at 0°C (32°F). When salt is added to water, though, temperatures need to dip much lower for it to freeze. Water that is 5 percent salt, for example, freezes at -3°C (27°F). Water that is 15 percent salt freezes at -11°C (12°F).

Salt also helps to melt snow and ice already on the road. As long as temperatures aren't too low, salt grains dissolve snow and ice. The resulting *brine*, or salty water, will spread and help melt more frozen water. This brine eventually becomes *diluted*. Added meltwater reduces the concentration of salt, and more salt is needed to stop more ice from forming.

SALTY BUILDUP

Millions of years ago, a shallow sea covered much of North America. Salt water trapped in basins evaporated over time, leaving behind salt deposits.



RICKY RHODES (MINER, SALT MOUND); ISTOCK/GETTY IMAGES (SALT SPREADER); FLYING CHILL LTD (DIAGRAM)



ALL ABOARD!

A new ultra-speedy train aims to revolutionize how people travel

ESSENTIAL QUESTION: How does transportation infrastructure affect our daily lives?

The drive from Chicago, Illinois, to Pittsburgh, Pennsylvania, takes more than seven hours. But a new high-speed train, called a hyperloop, might someday whisk passengers between the two cities in about 45 minutes.

This year, the California company Hyperloop One conducted its first test run of a hyperloop on a track in the Nevada desert. The company is developing its technology to make the first working hyperloop a reality. Shervin Pishevar, co-founder of Hyperloop One, believes the

transportation system will “transform how our cities operate.”

FAST TRACK

Hyperloop One’s test track sits inside a sealed tube with the air pumped out. Air molecules push against objects as they move, creating *drag*. Operating inside a vacuum reduces this slowing force.

The hyperloop also relies on magnetic levitation, or *maglev* for short. It uses the repelling force of powerful magnets to float train cars slightly above a track. That eliminates speed-reducing *friction*, normally created as a train’s wheels rub against the rails. Engineers think a hyperloop in a vacuum tube could

go 1,200 kilometers (750 miles) per hour—three times as fast as today’s speediest trains.

FULL SPEED AHEAD

Building a hyperloop route will be a huge and expensive undertaking. The system also has to be safe and convenient for passengers to ride.

Although there are many challenges ahead, Hyperloop One plans to have three hyperloop systems up and running by 2021. So far the company has identified 10 possible hyperloop routes around the world, including the one from Chicago to Pittsburgh. Read on to find out about these trains’ futuristic features. ✨

—Greg Uyeno



PASSENGER PODS

Instead of linked-up cars, a hyperloop would use individual pods that travel separately along the track. Pods would carry riders and could also deliver freight and packages.



CORE QUESTION

Explain the design elements that would allow a hyperloop to travel faster than a typical train.

VACUUM TUBE

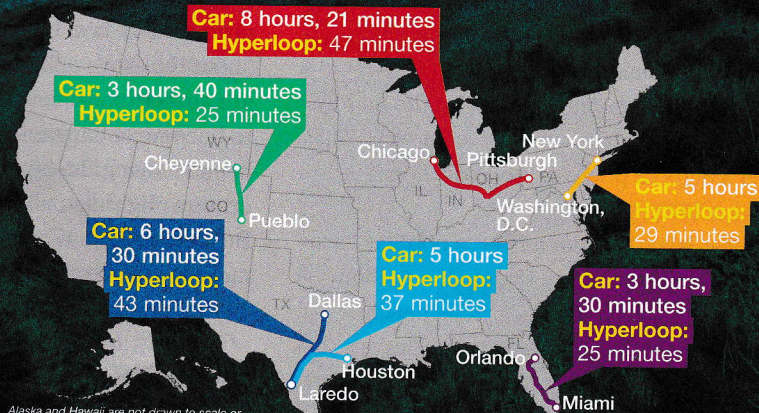
The hyperloop would glide through a tube emptied of air. That would reduce drag so the train could go faster.

MAGNETIC TRACK

Powerful magnets in the track would repel magnets on the train. That would make the train float, reducing the slowing force of friction.

SPEEDY TRIPS

Hyperloop routes have been proposed for Mexico, England, Canada, India, and the U.S. Here are some routes that could slash travel time in America and how long engineers think the trips would take.



Alaska and Hawaii are not drawn to scale or placed in their proper geographic positions.

ONECRBYTE/3D TRAINING/HYPERLOOP ONE (PASSENGER PODS); JIM MCMAHON/WIREIMAGE.COM

SAVED BY SELFIES?



LOOK FAST:
A quokka jumps toward a visitor's camera.

Tourists flock to an Australian island to take photos with adorable animals called quokkas. Are they helping or hurting the wildlife?

ESSENTIAL QUESTION:
Can social media alter people's interactions with wildlife?

A few years ago, visitors to the tiny Australian island of Rottnest began snapping selfies alongside some of the island's locals—small furry animals called quokkas (*KWAH-kuhz*). Images of people posing with the cuddly, happy-looking creatures quickly went viral. That sparked a quokka photo craze and a boost in tourism on Rottnest.

Rottnest Island has long been a popular vacation spot. Each year, more than half a million people visit the island to bask on its beaches and dive in the surrounding waters. Tourism often brings new development that can destroy animals' habitats and spell trouble for native species. Around the world, many animals are

kept in inhumane conditions so that tourists can interact with them.

Quokkas roam Rottnest freely and are protected by law, but scientists still worry about tourism's effects on the animals, which are already considered *vulnerable*, or likely to become endangered. Local scientists have been studying the issue, and so far, it seems the critters might actually benefit from the crowds. But researchers wonder what will happen as more tourists travel to the island in the hope of capturing their own quokka selfies.

HARD TIMES FOR QUOKKAS

Quokkas are cat-sized relatives of kangaroos and wallabies. Like their larger cousins, quokkas



SMILE! A fan poses for a selfie with a quokka.

are *marsupials*. These types of mammals carry their young in pouches (see *Meet the Marsupials*, p. 22). Quokkas eat plants, get around by hopping, and are usually *nocturnal*, or active mainly at night.

Quokkas were once widespread on mainland Australia. But the arrival of Europeans starting in the 1830s brought significant changes that made life tough for quokkas. Settlement reduced the land available to quokkas by about 50 percent (see *Shrinking Habitat*, right).

Another big change was the introduction of *invasive* predators from other parts of the world. Australia once had no cats. Sailors brought cats with them to keep rats under control on their ships and released many cats into the wild. Other settlers brought red foxes to the continent to be hunted for sport. The foxes multiplied and thrived. Foxes and cats hunted quokkas on the mainland until just a few small scattered groups remained. “They’ve been virtually annihilated,” says Veronica Phillips, a wildlife ecologist at the University of Western Australia.

On Rottnest Island, 18 kilometers (11 miles) off the coast, things are different. The island has no foxes or cats to kill its quokkas. As a result, it hosts the world’s largest remaining quokka population—about 8,000 animals. In fact, the island takes its name from its abundant quokkas: *Rottnest* is Dutch for “rat’s nest.” Early European visitors mistook the quokkas for giant rats. The animals’ image has come a long way since then.

TOURIST HOT SPOT

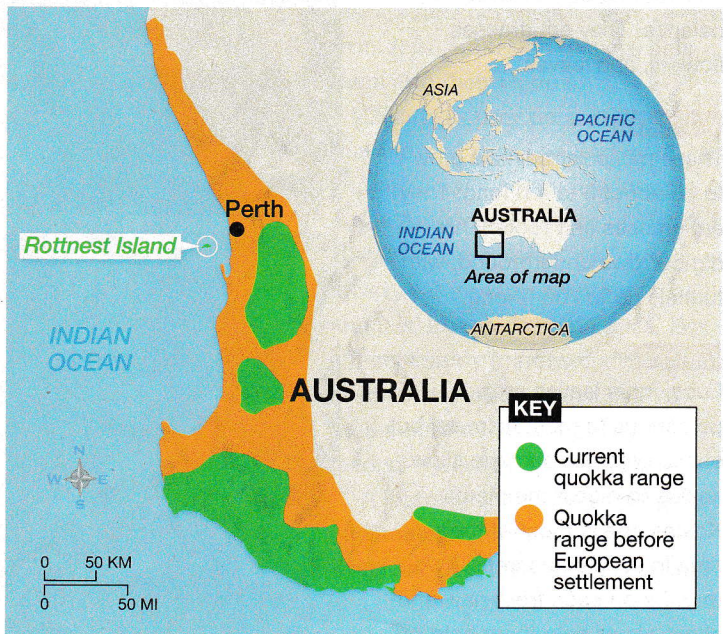
Phillips recently examined how Rottnest Island’s quokkas are faring as development has grown. She studied the quokka population by trapping and releasing the animals. She gave each quokka that she trapped an ear tag and a microchip implant so it could be identified if it got caught again.

The study revealed several surprises. There are more quokkas per acre in areas of the island dominated by hotels, restaurants, and golf courses than in wild habitats like dunes and grasslands. Quokkas in developed areas had larger bodies and reproduced earlier in the year than those in wilder regions. And their babies, called *joey*s, were more likely to survive.

Continued on the next page →

SHRINKING HABITAT

Quokkas’ current range is about half the size of the territory the animals covered before European settlement in the region.





WATCH OUT! Touching quokkas is illegal, but sometimes the animals can't contain their enthusiasm.



BABY ON BOARD
A mother quokka with her joey

↓
CORE QUESTION

What are some of the pros and cons of social-media-fueled tourism for quokkas?

Quokkas also behaved differently in tourist-filled areas: They were usually more active during the day, particularly around the times people dine and were likely to drop bits of food. Feeding quokkas is illegal because the foods people eat can be unhealthy for them, but the animals still manage to scavenge scraps.

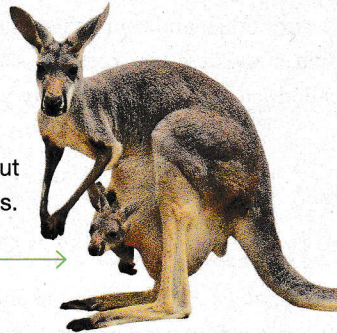
The effects of tourism on quokkas probably aren't all good, though. Phillips is concerned

about the animals' health from eating food that's not part of their natural diet, though this hasn't been studied yet. And the long-term effects of their habitat shifts and altered behavior aren't yet well understood. Also, denser populations of quokkas tend to lead to more fighting for mates, which can result in injuries.

For now, it's hard to say whether tourism will help or hurt quokkas in the long run, says Phillips. "When we started our study, I was expecting it might be bad. But it turned out they might benefit overall," she says.

MEET THE MARSUPIALS

When born, marsupial babies aren't fully developed. The tiny infants continue to grow inside a protected pouch on the mother's body for weeks or months. Check out a few of Australia's iconic marsupials.



KANGAROOS →

These powerful jumpers can leap 30 feet in a single bound. Their strong tails provide balance. They eat grasses, flowers, and leaves.



WOMBATS →

These muscular animals grow to be about 3 to 4 ft long. They eat grasses and roots. They dig burrows underground, with tunnels up to 700 ft long.



KOALAS →

Eucalyptus leaves are poisonous to most animals, but specialized gut bacteria allow koalas to digest the plants. Koalas spend most of their time in eucalyptus trees. Two thumbs on each front paw and sharp claws help them hold on.

CHALLENGES AHEAD

While tourism may be helping Rottnest's quokkas today, their mainland cousins face a big future danger: climate change. These quokkas rely on *wetlands*, where they feed on rich vegetation that grows in marshy areas. On the mainland, where predators are a concern, wetlands provide some of the best hiding spots. But climate change is threatening this habitat.

"Climate change is drying out this part of Australia and reducing the damp areas quokkas rely on," says Merril Halley, regional species conservation manager for the World Wildlife Fund. A warmer, drier climate also leaves quokkas more susceptible to wildfires. In 2015, a huge fire on mainland Australia struck an area with more than 500 quokkas. It wiped out about 90 percent of them.

Halley and Phillips hope that the attention quokkas receive online will help promote conservation, both on Rottnest Island and on the mainland. "Ideally, increased awareness of quokkas on social media could help people understand the need to support our threatened species," says Halley. "And that's definitely a good thing." ❁

—Jennifer Barone

Bird-Eating Bug

When hummingbirds stop to sip nectar from a bird feeder, they're expecting a sweet treat—not to become one themselves! But that's exactly what happened to this unlucky bird when a praying mantis caught it for a meal. Tom Vaughan, a retired National Park Service ranger, captured the gruesome moment on his back porch in Colorado.

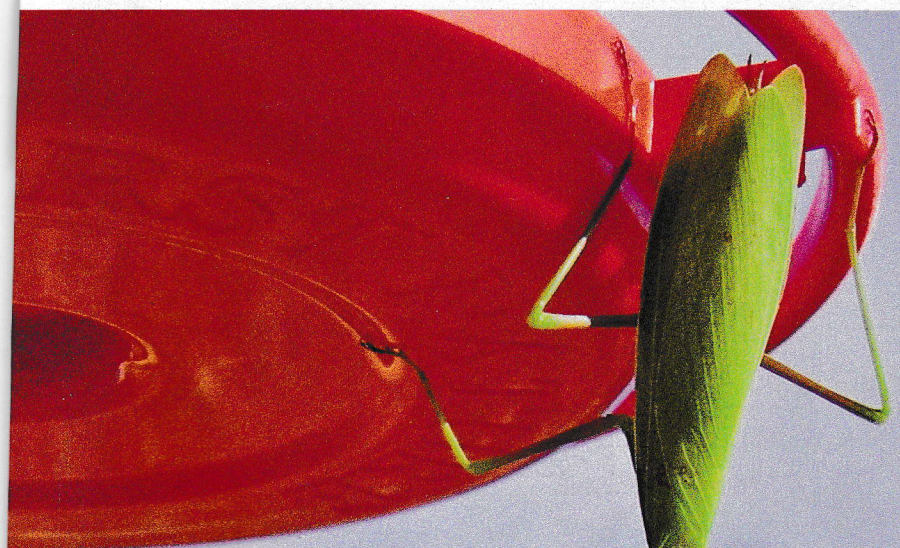
"At first I thought it was a hummingbird hanging upside down, which I had seen before," says Vaughan. "Then I saw the mantis hanging on to it, munching away on its scalp." Once it was done eating, the mantis repositioned itself on the rim of the feeder. It seemed like the insect was lying in wait for its next unsuspecting victim, says Vaughan.

That makes sense because most mantises are *ambush predators*. They sit and wait for prey to get close, and then they strike. The insects fling out their large, powerful front legs. Spikes on the legs help them grip their victims.

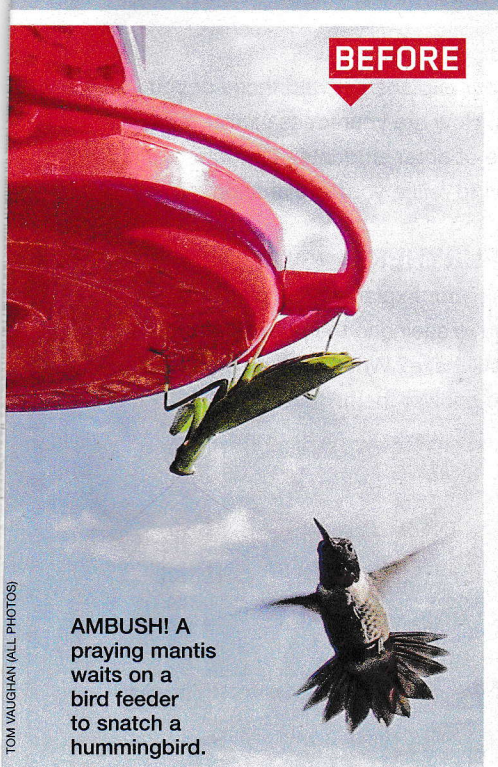
"Mantises prey on anything that moves," says Lou Sorkin, an *entomologist* who studies insects at the American Museum of Natural History in New York City. They mostly eat insects and other small animals, like spiders and mice. But a recent study found some reported cases where birds—mostly small hummingbirds drinking at bird feeders—were on the menu too.

"Others have been recording this phenomenon for some time," says Vaughan. "But for me, this is a once-in-a-lifetime picture!"

—Jeanette Ferrara



AFTER



BEFORE

AMBUSH! A praying mantis waits on a bird feeder to snatch a hummingbird.

TOM VAUGHAN (ALL PHOTOS)

EXPLAIN THIS!



DIRECTIONS: Follow these steps to form an explanation for what's going on in this photo.

1 INQUIRE

Closely examine the photo above. What do you notice about the image? What stands out to you? What ideas do you have that might explain what's going on in the photo?

2 EXPLAIN

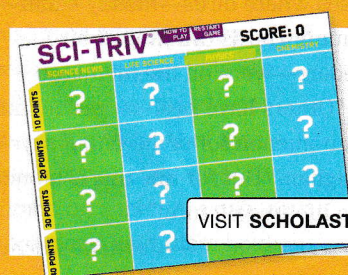
What do you already know that could help explain what you see? What evidence in the photo can you use to support your explanation? Write down ideas or draw sketches to express your thinking.

3 DISCUSS

Compare your explanation with those of your classmates. How are your ideas similar to or different from those of other students? Use information from the discussion to refine your explanation.

4 TAKE IT FURTHER

Do you think your explanation is plausible for what you're seeing in the photo? What questions do you still have? Write them down and then do research to answer them.



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