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GEOGRAPHIC

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LONGER—
AND
BETTER

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CHANGE THE WAY WE AGE



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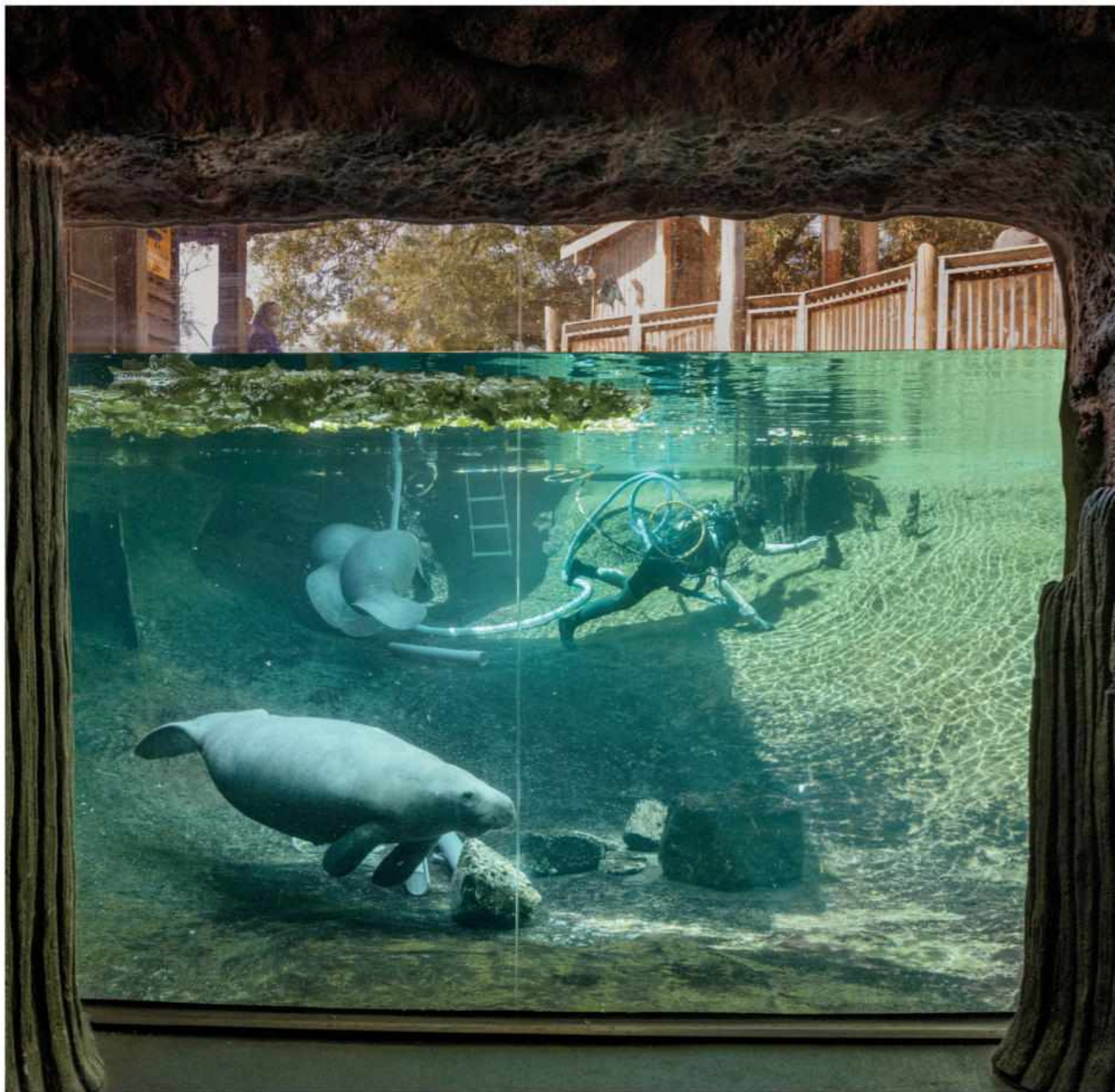
Living to the Limits

Actor Chris Hemsworth tempts death to test ways of lengthening life, for a new National Geographic series.

BY JACQUELINE CUTLER

ALSO

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FEATURES

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For centuries, humans have chased dreams of eternal youth. Since 1900, our life expectancy has more than doubled. There’s even talk of “curing” aging, but no scientist has cracked the code—yet. BY FRAN SMITH PHOTOGRAPHS BY JASPER DOEST, DAVID GUTTENFELDER, NICHOLE SOBECKI, AND MELANIE WENGER.....P. 34

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ABOVE: A viewing window at Florida’s ZooTampa at Lowry Park lets visitors watch rehabbing manatees while staff complete tasks such as vacuum-cleaning the tank. ERIKA LARSEN

THE SCIENCE
OF LONGEVITY

What Longer Life Could Mean

BY NATHAN LUMP

AS I WRITE, it's one year to the day since my father died, at the age of 79. When I was growing up, my dad was my role model, my best friend, my teacher, my confidant. His passing happened quickly, a bout of pneumonia turning within days into systemic organ failure.

It shook me. My family has been blessed with some good longevity—I knew my father's grandparents, who lived to nearly a hundred, and both my mother's parents lived well into their 90s—so perhaps I took it for granted that my dad had more time too.

Science has made tremendous progress in helping us live longer. Since the dawn of the 20th century, human life expectancy has more than doubled, but for much of that time, research and medical advances have mostly focused on mitigating and treating disease. It's only more recently that attention has turned to aging itself and whether there are things we can do to slow down, reverse, or otherwise change the process. In this issue's cover story, "Living Longer and Better," you'll learn about everything from recombinant growth hormone treatments to cellular reprogramming, fascinating work that shows promise—in the foreseeable future—to extend lives by decades.

I used to be a little dismissive about those who seek to "cure" aging, but now I'm not so sure. As I get older myself, I'd love to think I have not only more time but also higher quality years ahead of me. Youth might not exactly be wasted on the young, but I know there are lots of things I'd appreciate more deeply for experiencing them later in life.

And particularly when I contemplate this past year without my dad, I think about what a longer life could have meant for him and for those of



us who loved him. All the things he could have done and that we could have shared. Ten more years of conversations with my dad? Heck, I'd take even one.

We hope you enjoy the issue.

My father, Edward Lump, often traveled to Washington, D.C., for his work, and I never missed an opportunity to tag along when I could. Those trips were a great education, and they count among my happiest childhood memories. Here we are, sometime in the 1980s, outside the Supreme Court building.

FROM THE CEO
OF THE
NATIONAL
GEOGRAPHIC
SOCIETY

Embracing Ingenuity, Constantly Evolving

IN 1929, A TEAM carrying a sun compass and a National Geographic Society flag soared above the Antarctic wilderness in an extraordinary scientific feat. Explorer Richard E. Byrd led the perilous first flight over the South Pole, and photographed at least 150,000 square miles of Antarctica along the way.

Nearly a century later, glaciologist and National Geographic Explorer Alison Criscitiello embarked on her own arduous journey, harnessing technology in grueling conditions to unlock secrets of the Earth’s past and insights about today’s climate challenges. She and her team ascended Canada’s highest peak and excavated an ice core containing perhaps 30,000 years of data, as part of the National Geographic and Rolex Perpetual Planet Mount Logan Expedition. The feat broke barriers for women and science: “No deep ice core ... has ever been drilled anywhere near an altitude like this one,” Criscitiello says.

As the Society celebrates its 135th anniversary this month, I’m reflecting on the magazine’s cover story topic: longevity. Decade after decade, how does National Geographic continue to push the boundaries of knowledge? I believe the key to our staying power is our ongoing commitment to tackling big challenges, harnessing the grit and vision of our Explorers, and embracing the power of human ingenuity.

Guided by the Society’s strategic plan, NG Next, here are three ways we’re moving into the future:

- We’re investing in Explorers working to address and solve the global crises of our time, such as climate change and biodiversity loss. Several of them are featured in this issue: Luján Agusti, using photojournalism to raise awareness about fragile landscapes (page 22); and James “Buddy” Powell, Erika Larsen, Jason Gulley, and Gena Steffens, using science, photography,



and storytelling to seek protection for threatened manatees (page 70).

- We’re making exploration more inclusive. We’re tapping scientists, educators, and storytellers in more than 140 countries; amplifying the voices of Explorers who are Black, Indigenous, and other people of color; and working with local communities. Half of our 2022 grants were awarded to women and more than 60 percent to recipients working outside the United States.

- We’re making exploration more participatory, encouraging involvement from global audiences—in citizen science and journalism, live events, educational efforts, youth programs, and more.

As National Geographic greets 2023, we’re advancing science and inspiring curiosity in hundreds of millions of people worldwide. Please join us and help shape the next 135 years and beyond.

Jill Tiefenthaler, CEO
National Geographic Society

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EXPLORERS,
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OF HUMAN
INGENUITY.

LIVE BETTER LONGER



LIMITLESS

WITH CHRIS HEMSWORTH

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P R O O F



NATIONAL GEOGRAPHIC

VOL. 243 NO. 1

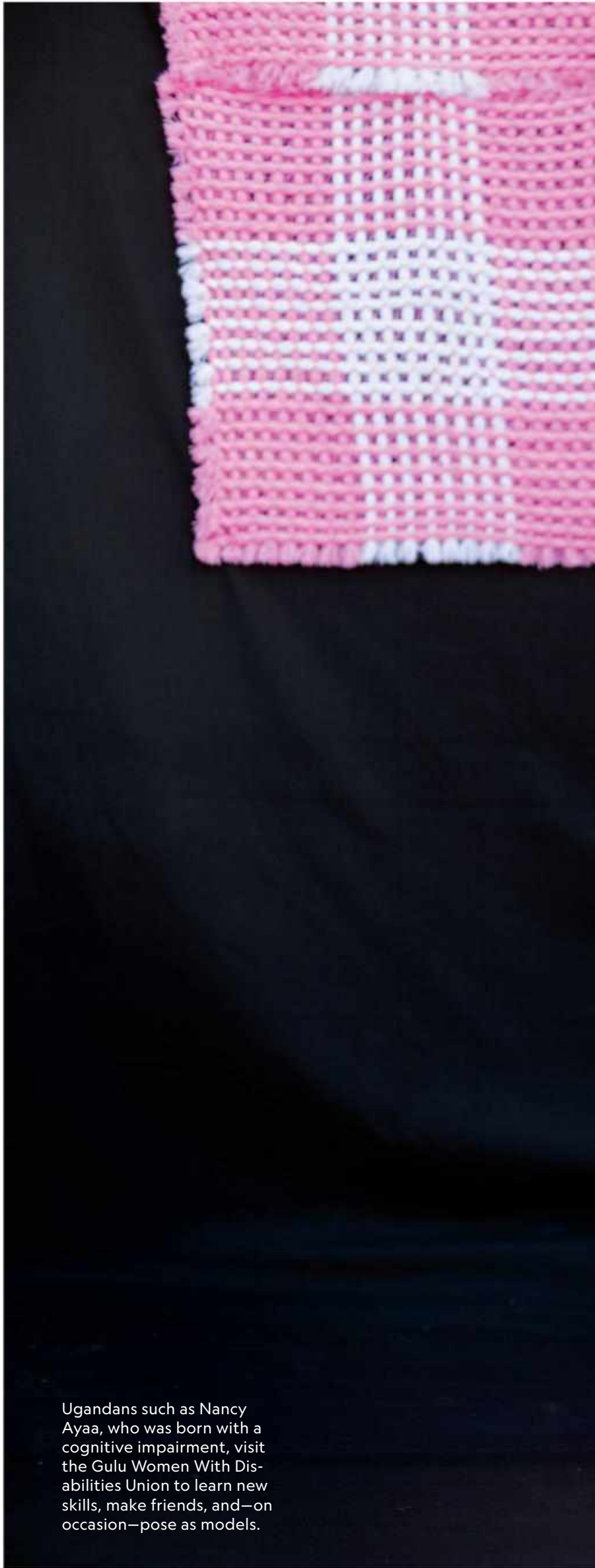
PORTRAITS THAT TRULY SEE THEM

PHOTOGRAPHS BY
ESTHER RUTH MBABAZI

In Uganda, a photographer collaborates with women who have special needs to showcase their individuality and creativity.

**LOOKING
AT THE
EARTH
FROM
EVERY
POSSIBLE
ANGLE**

Ugandans such as Nancy Ayaa, who was born with a cognitive impairment, visit the Gulu Women With Disabilities Union to learn new skills, make friends, and—on occasion—pose as models.







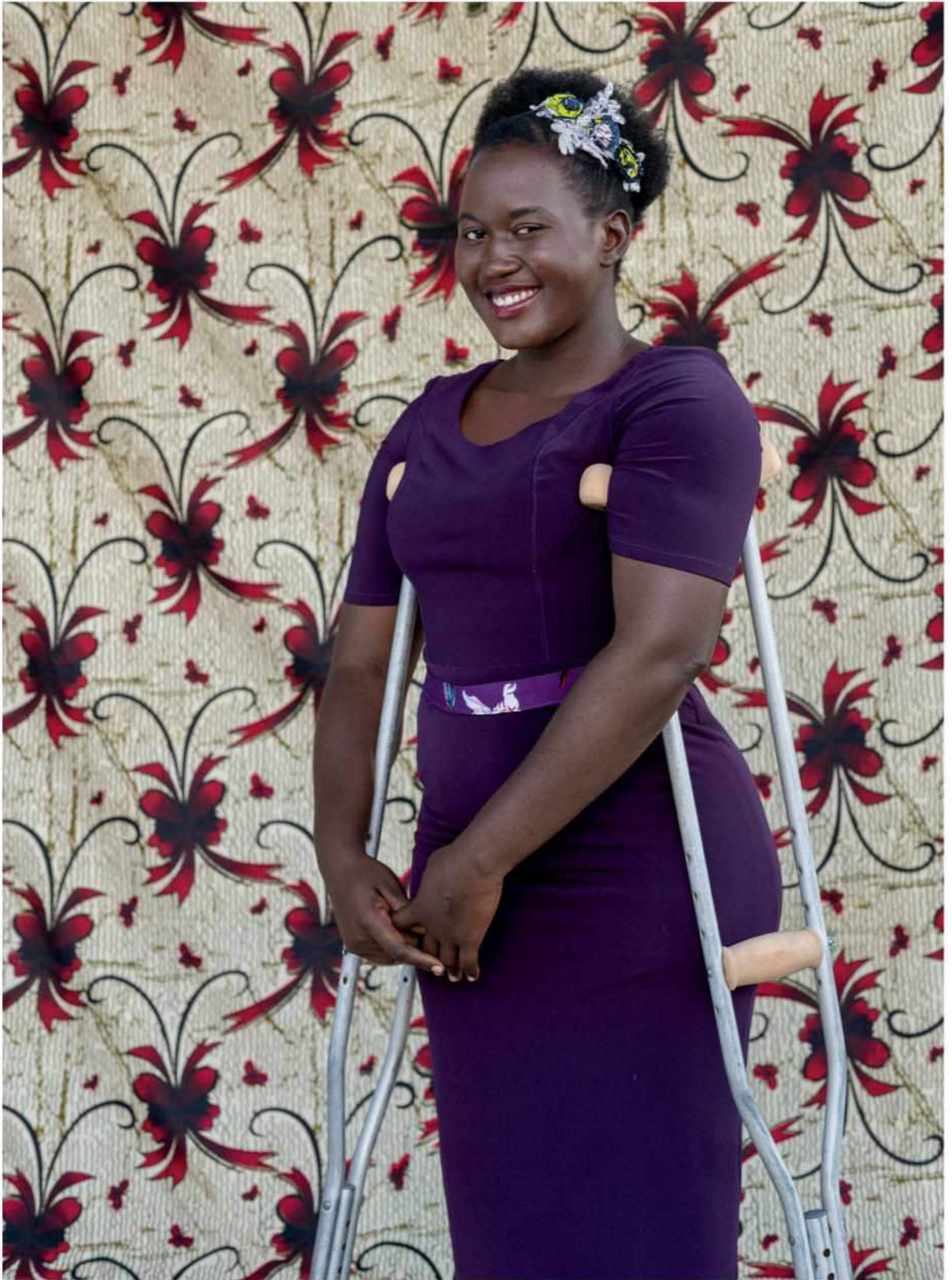
At the age of four, Florence Akwede lost her ability to talk and hear. She takes great interest in getting to know people, and her children help her interact with others by using sign language.



Joyce Auma (top), who uses a wheelchair, and Faith Lagum, who is blind, have had to navigate a world built for nondisabled people. "It has been a very hard life," says Lagum, but she finds joy in recording songs and performing locally.



A bout of childhood malaria left Miriam Apio with impaired cognitive abilities, and she has battled depression. Apio discovered a sense of purpose through knitting sweaters for the community in a project run by the union.



Since age five, Flavia Lanyero has endured 11 surgeries for an infection that attacks her leg and arm bones. Though she fears her condition will keep her out of the job market, she studied banking with the hope of finding employment.

THE BACKSTORY


A PHOTOGRAPHER AND A GROUP OF WOMEN WITH DISABILITIES UNITE TO COMBAT STEREOTYPES.

FOR SEVERAL YEARS, “fly on the wall” was Esther Ruth Mbabazi’s approach to photography. Be invisible. Don’t influence the scene. Then, in 2019, the 28-year-old Ugandan had an opportunity to do just the opposite.

That’s when Mbabazi learned of the Gulu Women With Disabilities Union, a vocational and social center in a small city in Uganda’s north. Over one year, she made four trips to Gulu and photographed women she met, including a land mine survivor missing a leg, a deaf mother of four, and a blind musician. They posed in custom dresses, created

by a Kampala-based designer, against backdrops of art and handiwork they had made. When Mbabazi asked the women how they wanted to be seen, they told her: as capable, equal, intelligent. In other words, accorded the dignity that Ugandans with special needs often are denied.

On her last trip to Gulu, Mbabazi delivered large, framed copies of the portraits to those who posed for them. Mbabazi hopes the photos will be exhibited publicly, to help change how the women are seen, and treated, by others. —NINA STROCHLIC

 The National Geographic Society has funded the work of photographer Esther Ruth Mbabazi since 2019. Learn more about its support of Explorers at natgeo.com/impact.



Mbabazi, at left, chats with Ayaa in front of the makeshift photo studio in Gulu, Uganda.



Red, White, and Blue Zones

EARTH'S LONGEST-LIVED PEOPLE DWELL IN FIVE 'BLUE ZONES'—BUT THEIR HEALTHY WAYS OF EATING CAN BE FOUND IN PARTS OF AMERICA.

BY DAN BUETTNER

W

WHAT'S THE SECRET to living an extra 10 years? It's never one thing. Rather, it's a set of environmental factors that reinforce each other and that keep people reflexively doing the right things and avoiding the wrong things for long enough not to develop chronic diseases. For the past 20 years writing for *National Geographic*, I've identified and studied the world's longest-lived areas, which I call blue zones. These places—Okinawa, Japan; Sardinia, Italy; Ikaría, Greece; Nicoya, Costa Rica; and the Seventh-day Adventist communities in Loma Linda, California—have the most centenarians and the highest middle-age life expectancy. Why? Residents live purposeful lives in walkable settings that keep people naturally active and socially connected. And they eat a diet that's largely plant-based whole foods.

In 2019, as the COVID pandemic set in, photographer David McLain and I hatched the idea of searching for an American blue-zones diet. Thinking that

our great-grandparents may have eaten similarly to people in the original blue zones, we searched for dietary surveys conducted in the early 1900s. To our dismay, we found that our own ancestors (who immigrated from northern and central Europe) brought their cows, pigs, and pickles with them.

Determined to find what food traditions other cultures, Indigenous and immigrant, had brought to the American table, we crisscrossed the country to find people who could tell us about these foods.

Here's what we discovered: There is another American diet, one that could actually increase your life expectancy by up to 10 years and, in some cases, reverse disease. It's not a fad diet invented by a South Beach doctor, a paleo diet marketer, or a social media influencer. This diet was developed by ordinary Americans, is widely affordable, is sustainable, and has a lower carbon footprint than a meat-heavy diet. Most important, it is hearty and delicious, developed over centuries by fusing flavors from the Old and New Worlds in ingenious and uniquely American ways.

WE START IN NEW ENGLAND, looking at the traditional foods of the Wampanoag Native Americans. Their ancestors played a role in history in 1621 when they encountered recently arrived colonists. One man, Tisquantum, taught colonists how to plant corn, a local food. Carolyn Wynne, a Mashpee Wampanoag elder and Otter Clan mother, and her friend, food anthropologist Paula Marcoux, re-create an early 17th-century meal for us using typical Wampanoag foods.

As Wynne cooks over an open fire, she seems to be impervious to the heat. In the coals, she roasts squash stuffed with hazelnuts, dried blueberries, and maple syrup. In a pot off to the side, she boils nasaump, a cornmeal soup. In a third pot, she poaches pumpkin slices in sassafras tea. Though the Wampanoag hunted game and collected mussels and oysters, 70 percent of their diet came from plant sources.

Marcoux tends cast-iron pots hanging over another fire. In one, there is bubbling *msickquatash*, a Wampanoag staple stew of hominy, beans, and squash, which Marcoux gussies up with green beans, onions, and herbs. The Wampanoag might also add Jerusalem artichokes, acorns, chestnuts, and walnuts (the nuts sometimes powdered to serve as thickeners). "My particular obsession with history affords me the fun of networking with long-dead cooks in their long-gone kitchens through archival and archaeological sources," Marcoux says. "It's a thrilling privilege to conjure their wisdom through fire."

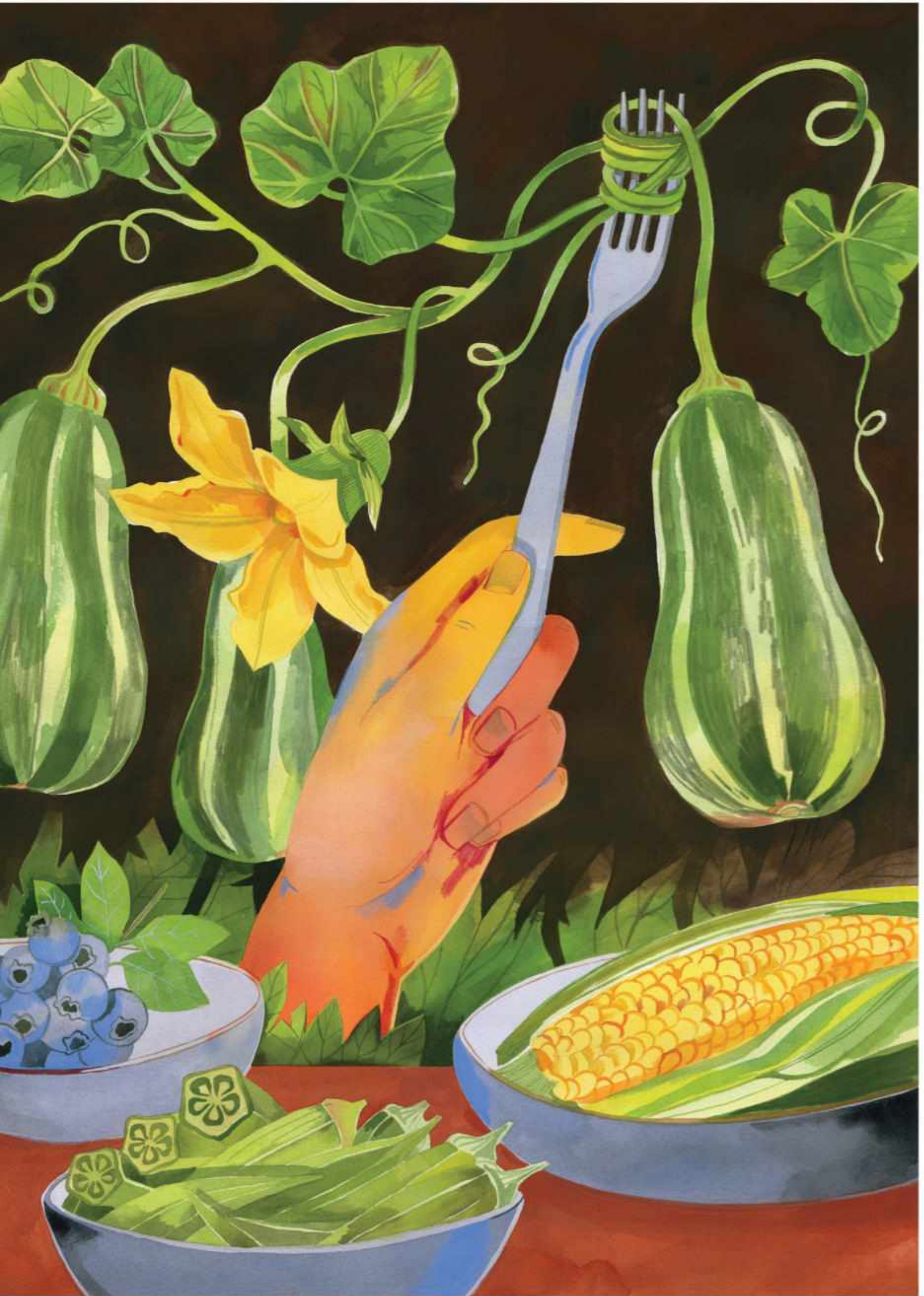
ON THE OTHER SIDE of the United States, at the northern tip of Hawaii's Big Island, we see another version of Native ingenuity on the farm where Scott Harrison's family has been cultivating native plants for three generations. It abounds with produce eaten here for hundreds of years: sweet potatoes, bananas,

Toll of a 'typical American' diet

If you're eating like a typical American, you're probably going to die prematurely. This year more than 678,000 Americans will die from diseases or conditions associated with what they eat. These include common conditions such as high blood pressure, high blood sugar (type 2 diabetes), and high cholesterol. Collectively, we'll spend more than four trillion dollars on health care, 20 percent on diseases linked to unhealthy diet choices, according to one study. It's been estimated that we lose at least 13 years by eating a typical U.S. diet.

This may not come as a shock when you consider that each year the average American consumes a total 264 pounds of beef, veal, pork, and chicken; 123 pounds of sugar and caloric sweeteners, including some 39 gallons of soda pop; 16 gallons of milk; and more than 40 pounds of cheese, some of which tops our annual 46 slices of pizza. Seventy percent of our calories come from processed foods, containing thousands of artificial food additives, many of them known to cause cancer. —DB





pineapples, papayas, mangoes, and breadfruits. In a neatly tended patch, Harrison reaches into the shallow water and extracts a taro plant, holding it up like a trophy: “You can eat the leaves like spinach and boil the stalks like asparagus,” he says. “Mostly we survived off of the root, which we mash into a paste that we eat every day.”

To the west, on the island of Oahu, in suburban Honolulu, 95-year-old Ruth Chang is preparing lunch. “I cook every day,” she tells me as she minces root vegetables. “Once you stop, you lose it.”

Chang’s demographic may be the longest-lived on Earth. Chinese American women living in Hawaii enjoy about 90 years of life expectancy, and the diet of Chinese Americans living there supports such longevity.

Since Southeast Asians began arriving in Hawaii over 170 years ago as agricultural workers, each ethnic group has introduced its own flavors and ingredients. The Chinese brought leafy cabbage, soybean products, and teas. The Japanese, miso and their own version of tofu. The Filipinos, tender tips of many plants such as squash and pumpkin. This melding of foods and cooking techniques has made Hawaii *the* place to experience Asian fusion cuisine that’s primarily plant based.

AFRICAN AMERICANS LIVING in the Deep South have a long tradition of eating blue-zones-type foods. What began as a largely plant-based West African diet morphed with local Native American and European influences to produce a unique and vividly delicious cuisine. Dietary surveys going back to the 1890s indicate that most foods eaten by southern African Americans were vegetables and grains. Aside from salt pork added for flavor, animal products played a minor role.

On a steamy morning in Charleston, South Carolina, we’re in chef-historian BJ Dennis’s home, huddled around a pot of okra soup. Okra, garlic, onion, butter beans, tomato, thyme, searingly hot Scotch bonnet peppers, and the splendid funk of fermented benne (sesame) seeds fuse New and Old World flavors. My first bite delivers a tsunami of umami followed by eye-watering heat and a blush of pure happiness.

Dennis is on a mission to bring back the cuisine of his rice-growing ancestors. Captured from places such as Senegal and Liberia, his forebears were brought to the Low Country of South Carolina and

Georgia to cultivate Carolina Gold rice. Because of their expertise, some of the enslaved Africans were allowed gardens where they grew African staples and local ingredients. “We took the rustic soul of the Africans and the Native American techniques and made this special mash-up,” says Dennis.

The traditional West African diet consisted mostly of greens, root vegetables, black-eyed peas, okra, benne seeds, herbs and spices, and cereals like millet; meat was eaten only occasionally. When captured Africans were shipped to America, the plants and seeds of their homeland foods came with them. They entered into cultural exchanges with Native Americans, who shared some similar farming practices and food staples; both cooked with corn, sweet potatoes, and local bean varieties. The result was a blended, innovative cuisine.

ON ANOTHER DAY, IN TEXAS, we’re with chef-historian Adán Medrano as he destroys the myth of Tex-Mex cooking. In his Houston kitchen he stirs a savory posole in one pot and in another a tomato-stewed rice, both dishes flavored with the Texas Mexican trio of garlic, cumin, and black pepper.

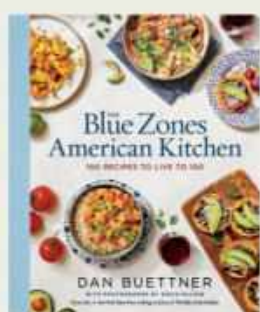
“Greasy, cheesy Tex-Mex food was largely an Anglo invention,” Medrano tells me. “Our traditional enchiladas were not slathered with cheese. We fill ours with carrots and potatoes.”

Born in San Antonio, in south-central Texas, Medrano, 74, grew up eating cactus, beans, corn, chilies, potatoes, onions, mushrooms, portulaca, amaranth, various berries, and occasionally game. These were the authentic foods of Texas Mexican cuisine, a far cry from Tex-Mex culinary corruptions like chicken fajitas or extra cheesy quesadillas. These types of whole, plant-based foods are also typical of other Latin American cuisines.

~ ~ ~

As we traveled the United States, we found the historical diets of these Indigenous and immigrant cultures being interpreted by a new guard of chefs and food pioneers. As they re-create traditional dishes, they are not only opening a treasure trove of largely overlooked culinary genius but also offering new expressions of the standard American diets—which may actually help us get that extra 10 years. □

Dan Buettner is a National Geographic Explorer, award-winning journalist, and best-selling author whose latest book for National Geographic is *The Blue Zones American Kitchen*.



Forebears' foods

Author **Dan Buettner** uncovers the lost American diet of longevity with striking photography, and shares wisdom from culinary experts, chefs, and cooks in *The Blue Zones American Kitchen: 100 Recipes to Live to 100*. It's available now wherever books are sold.

'BIG, BLINDING, BREATHTAKING'

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FROZEN

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INNOVATOR

LUJÁN AGUSTI

BY JORDAN SALAMA

PHOTOGRAPH BY REBECCA HALE

She trains her lens on the beauty of the underappreciated.

“When I want to feel at peace,” says Luján Agusti, “I think of a Patagonian landscape.” Vast and sometimes inhospitable, Argentina’s Patagonia is miles of steppe and desert stretching from the Atlantic to the Andes. A National Geographic Explorer, Agusti photographs this region and the people who make it their home from her base in Ushuaia in southernmost Argentina.

Agusti zooms in on stories deeply rooted in place. She has documented women in Tierra del Fuego weaving with sustainably sourced local wool, spent time with Indigenous Mapuche women trying to preserve ancestral practices, and visited solitary gauchos living in the steppe and the peatlands—wetland systems with accumulations of partly decayed plants.

These spongy areas are the focus of her latest project, supported by the Climate Pledge—companies aiming for net-zero carbon emissions by 2040—and by the National Geographic Society. Agusti will document the beauty of peatlands on four continents and their role in storing huge amounts of carbon. People tend to avoid these boggy ecosystems, she says. “I want to show the peatlands as landscapes that have always been disregarded but are now so important for humanity’s survival.” □

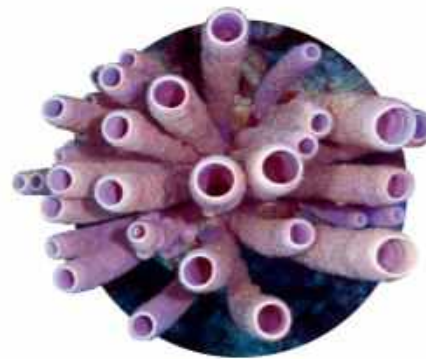
 The National Geographic Society has funded the work of Luján Agusti since 2018. Learn more about its support of Explorers at [natgeo.com/impact](https://www.natgeo.com/impact).



DISPATCHES
FROM THE FRONT LINES
OF SCIENCE
AND INNOVATION

Hidden DNA is a tracking tool

By capturing ambient air, swabbing flower petals, and wringing out sea sponges (right), scientists are finding reservoirs of environmental DNA—trace genetic material shed by living things. The eDNA can be used to spot elusive species, monitor their interactions, and even track the spread of disease. —ELIZABETH ANNE BROWN



ANIMAL COGNITION

DREAM WEAVERS, IN REM

AT NIGHT, WHEN JUMPING SPIDERS ARE ASLEEP, IT SEEMS THEY SEE THINGS IN THEIR DREAMS.

Turns out the sandman may visit arachnids too. When ecologist Daniela Roessler at the University of Konstanz, Germany, observed jumping spiders at night, they mostly were immobile, suspended upside down on a silk thread with their eight legs curled inward. But periodically their spinnerets—the silk-producing organs on their rumps—would wiggle, or a leg would jerk. It reminded Roessler of how a dozing puppy's foot may twitch. Could the spiders be dreaming?

Investigating that is made easier by jumping spider anatomy: For the first 10 days of life, the babies' heads are see-through, so Roessler could look straight in. Using magnifying glasses duct-taped to night-vision goggles, she watched the spiderlets' retinas flickering back and forth during bouts of movement. It suggested they were experiencing visual dreams—the first time REM-like sleep has been observed in an animal without a backbone. The more we learn about jumping spiders' cognitive abilities, the less alien they seem and the more worthy of respect, Roessler contends. "If they dream, I mean, what can you do? You cannot smooch a spider that dreams." —EAB

BIOENGINEERING

From crab shells to batteries

As demand for electronics and electric vehicles raises that for batteries, a new one has been made with a sustainable material: seafood waste. A substance, chitosan, can be rendered from the hard shells of crabs, shrimps, and lobsters. "You can find it on your table," says scientist Liangbing Hu, part of the research team. Chitosan can be made into a biodegradable electrolyte for zinc batteries, a potential alternative to lithium ones.

—HICKS WOGAN



BEST OF THE WORLD

Our annual list highlights travel destinations that educate, illuminate, and spark connections and wonder.

BY GEORGE W. STONE

AFTER THE FRENETIC REVIVAL of travel last summer—you might recall a few delays and a few million mishandled bags—many are asking how to enjoy the rush of exploration without the crush of crowds. Tourism's expected return to pre-pandemic levels by the end of 2023 could translate to more prosperity and increased stability for places that rely on visitors. But a lasting recovery depends on channeling the revenues of tourism into conservation models that support communities, ecosystems, and environmentally responsible infrastructure. This is

more likely to happen when travelers thoughtfully choose when, where, and how to go. To help with that, *National Geographic's* global editors have picked 25 awe-inspiring destinations for the year ahead. Framed by five categories (adventure, culture, nature, family, and community), these are places of wonder that are working to leverage the potential of tourism to benefit locals, preserve natural environments, and sustain cultural spaces—all of which attract travelers in the first place. Here are four starting points to launch your own itinerary.





See the full list
at [natgeo.com/
BestOfTheWorld](https://natgeo.com/BestOfTheWorld).

COMMUNITY

Dodecanese Islands, Greece

These Greek islands have endured waves of conquerors—Romans, Ottomans, Italians—who over the centuries left their fingerprints on everything from the architecture to the food. Today's invaders come not for fortune

but for selfies at better-known Dodecanese isles such as Kos or Patmos. Now less trafficked parts of the archipelago, like Karpathos, hope to balance the economic need for tourism with the environmental stresses

caused by it. Karpathos's whitewashed churches (pictured, a chapel on Mount Profitis Ilias) and ancient traditions are tourist draws, but the island has a scarcity of drinking water and a limited capacity for recycling.



NATURE

TULI BLOCK, BOTSWANA



Botswana continues to confront a series of threats, such as poaching, to its expansive, wildlife-rich national parks and game reserves. But new anti-poaching efforts, voluntourism, and community-based outreach may help alleviate some of the pressure. In the Tuli Block, a wilderness on the country's eastern border that holds leopards, brown and spotted hyenas, and a large elephant population (below), rangers are installing advanced technology in the 270-square-mile Central Tuli Game Reserve. Dutch organization Smart Parks has developed low-power sensors that transmit radio data back to a central station, alerting rangers to poachers and their vehicles, or even tracking the movements of animals themselves.

Botswana is also responding to a new generation of visitors. "Since COVID, our millennial travelers have become more interested in meaningful human connection," says National Geographic Explorer Koketso "Koki" Mookodi. "Expect to see more craft-based tours and village homestays." Mookodi, the managing director of the Wild Bird Trust in Botswana, is establishing an education program in 10 remote villages in the Okavango Delta, in the country's north. Called Educators Expeditions, her program takes village teachers on safaris into the delta and shows them how to weave the environment and local culture into their lessons. "This is an opportunity to use nature as a blackboard," she says.



CULTURE

Louang- phabang, Laos



The pandemic closed the borders of many tourism-dependent countries like Laos. But the Southeast Asian nation hopes the December 2021 inauguration of a Chinese-constructed bullet train will boost domestic travel. Its 260-mile route within Laos starts at the border town of Boten, traverses more than 70 tunnels and 160 bridges, runs through Louangphabang (right, New Year celebrations at the ancient city's Wat Xiengthong), and terminates in the capital, Vientiane. Although the train's promise is to expand tourism among the Lao themselves, the cost of tickets and the country's increasing indebtedness to China are sources of controversy.





ADVENTURE

CHOQUEQUIRAO, PERU

One of the most remote Inca sites in the Peruvian Andes, the ruins of Choquequirao are reserved for the hardy few who put in the effort to reach their 10,000-foot elevation. “Many myths exist around Choquequirao,” says archaeologist Gori-Tumi Echevarría. Its numerous temples, terraces, and plazas are yet to be fully excavated. But new infrastructure plans are expected

to boost visitation to Machu Picchu’s sister city. The government has pledged to spend \$260 million to build a cable car spanning three miles between the town of Kiuñalla and the site. Development may create more economic opportunity for locals at the expense of Choquequirao’s serenity. For now, the ruins remain a place of seclusion that calls out to any traveler’s imagination.





While fasting, Chris Hemsworth plays underwater hockey—one of the extreme activities filmed for the *Limitless* series.

LIVING TO THE LIMITS

FOR A NEW SERIES ON LONGEVITY, ACTOR CHRIS HEMSWORTH TESTS BOTH ACCEPTED AND EXTREME STRATEGIES FOR ENHANCING HEALTH.

BY JACQUELINE CUTLER

Chris Hemsworth plunged into Arctic waters, dangled high above a canyon while climbing a rope, fasted for four days, and prepared for his own eventual death—all in the pursuit of living longer.

In *Limitless With Chris Hemsworth*, a six-part National Geographic documentary streaming on Disney+, the actor doesn't just rely on a physique honed during a decade of playing Thor in movies. He challenges mind as well as body in a quest to develop habits that might extend life. His, and ours.

Experts guide him. Some of their tips sound familiar—eat less, exercise more—but others, not so much: Accept reality. Harness stress.

Before this project, Hemsworth had “always trained specifically for a movie,” where the goal might have been “to have abs this summer or whatever. And it was more superficial. I always felt better, but doing a deep dive into the science-backed evidence of why I felt better was a completely new experience,” the actor tells me from his Byron Bay, Australia, home.

Limitless—which took more than two years to complete, given pandemic shutdowns and breaks for Hemsworth's movies—stems from a 2006 film that executive producers Darren Aronofsky and Ari Handel had written: *The Fountain*, about a man searching for everlasting youth. Handel recalls a quote that

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Watch *Limitless With Chris Hemsworth*, a six-part National Geographic series streaming on Disney+.

resonates today: “Death is a disease; it’s like any other. And there’s a cure. A cure—and I will find it.”

Nearly two decades ago, they worried the idea was implausible for audiences. Now, with an aging population and high-tech companies “trying to beat death and reaching for immortality in a lot of different ways,” Aronofsky says, it doesn’t seem as far-fetched.

With production company Nutopia, the team set out to craft a series about longevity that was informative yet entertaining. Hemsworth undertakes complicated stunts, but there are takeaways for viewers at home. Nutopia executive producer Jane Root says it’s less a sci-fi vision of extending life and more about improving chances for a long life “that is fulfilled and happy and active.”

How active? In Norway, to study extreme temperature’s effects on the body, *Limitless* had Hemsworth swim and surf in a fjord’s 36-degree water. Aronofsky—who managed a numbing dip himself—said it was “an amazing experience to... see Chris really pushing himself to the edge.”

To push that hard takes exceptional drive, says Ross Edgley, who coached Hemsworth for his fjord feat. A sports scientist and the only person to swim around Great Britain (some 1,790 miles), Edgley also helped him train for the movie *Thor: Love and Thunder*. “People know Chris as the actor, but not a lot of people know him as the athlete,” he says. Hemsworth had been a hurdler in his school days and still surfs.

In *Limitless*, Hemsworth plays underwater hockey during a four-day fast, part of a test to measure

fasting’s potential benefits. The actor tends to keep the mood light, joking about being hungry. But there’s a dark moment when Peter Attia, a preventative care physician, tells Hemsworth, then 37, that blood tests reveal he has 10 times the average risk of developing Alzheimer’s disease because of genetic traits. Daily exercise, good sleep, and stress reduction might help lower that vulnerability, Attia adds.

“It was initially pretty scary,” Hemsworth says. “But now, because of this information, there’s an opportunity to live an even better life.”

Hemsworth’s extreme exploits in the series include walking on a two-foot-wide construction beam 900 feet above Sydney Harbor. And yet it’s simple scenes in the finale—an episode about accepting reality and death—that crystallize why we yearn to live longer.

For a few moments at a time, Hemsworth experiences aspects of old age. He wears an MIT-designed suit that adds weight and restricts movement, hearing, and vision, mimicking how he might feel in his late 80s. He listens to people who are close to death and reflects on what matters. He’s then led toward an apparently older woman, sitting with her back to him—and the second he touches her shoulder he recognizes his wife, Elsa Pataky, under extensive aging makeup. She turns to him, and they embrace.

The show’s team hadn’t warned Hemsworth about this encounter; it wanted his purely natural reaction. Suddenly, he’s trying to reckon with being near the end of his days, and it’s evident why he’ll sweat, freeze, and starve. Does it all come down to love?

“Absolutely,” Hemsworth says, a smile creasing his face. “One of the first questions I had from Peter Attia was, What does your life look like in 20 years... in 30? What does your death look like?”

Hemsworth pauses. Then he says, “A good death for me would be having lived a good life.” □

Journalist **Jacqueline Cutler** regularly covers television. She previously wrote about the Nat Geo series *Welcome to Earth*.



Hemsworth completes a test of the body’s reactions to fear: He climbed up a hundred-foot-long rope suspended from a cable car, high above a canyon floor in Australia’s Blue Mountains.

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FEMALE SKATEBOARDERS IN BOLIVIA ARE CHALLENGING MALE DOMINANCE IN THE SPORT—AND HONORING THE TRADITIONAL ATTIRE OF INDIGENOUS WOMEN.

SCIENTISTS USING THE LATEST CUTTING-EDGE TECHNOLOGIES ARE REVEALING THE

LIVING

LONGER

By FRAN SMITH

INTRICACIES OF HUMAN AGING AND SEEKING DRUGS TO SLOW IT, OR EVEN REVERSE IT.



Photographs by JASPER DOEST, DAVID GUTTENFELDER, NICHOLE SOBECKI, and MELANIE WENGER

ER

AND BETTER

HOW FAR CAN SCIENTISTS STRETCH OUR LIFE SPAN? AND HOW FAR SHOULD THEY GO?

To understand aging, researchers look for clues in animals, such as those studied by the 51-year-old Amboseli Baboon Research Project in Kenya. As part of that work, Benard Oyath and Jackson Warutere prepare to take blood and other samples from Olduvai, who was tranquilized and then released back to the wild. The project's scientists have found that baboons with strong social connections in adulthood can recover from harmful health effects of a stressful childhood.

NICHOLE SOBECKI

PREVIOUS PHOTO

Seconds after his birth, Tommaso Citti has his vital signs checked at Beauregard Hospital in Aosta, Italy. Children born today in prosperous countries are very likely to live into their 90s. As the world grows significantly older, research into slowing or reversing aging becomes more and more important.

MELANIE WENGER





Mirsada Mehinagić, 65, swings her two-year-old granddaughter, Selma, while her husband, Mirsad, 66, watches bemused on the terrace of their home in Sarajevo, Bosnia and Herzegovina. "With the children around, I have to sing and jump a lot," she says. "It keeps us young." Humans evolved to be active, so a sedentary senior lifestyle is risky, but even modest exercise can improve physical and mental health.

JASPER DOEST





OUR BIOLOGY,
IT SEEMS,
CAN BE
OPTIMIZED
FOR GREATER
LONGEVITY.
UNIMAGINABLE
RICHES AWAIT
WHOEVER
CRACKS
THE CODE.

Matt Kaeberlein, 51, a pathology professor at the University of Washington, deadlifts 305 pounds in his North Bend, Washington, garage. He believes exercise is the most important way to prevent disease and disability in old age, but like other scientists, he hopes to find medications to help. Kaeberlein is investigating whether rapamycin, a drug used to prevent organ rejection, can increase the life span of dogs and decrease their incidence of age-related disease. One reason he chose to study pets is because they live with people, sharing the same environment.

DAVID GUTTENFELDER





SCIENTISTS ARE GREAT AT MAKING MICE LIVE LONGER.

Rapamycin, widely prescribed to prevent organ rejection after a transplant, increases the life expectancy of middle-age mice by as much as 60 percent. Drugs called senolytics help geriatric mice stay sprightly long after their peers have died. The diabetes drugs metformin and acarbose, extreme calorie restriction, and, by one biotech investor's count, about 90 other interventions keep mice skittering around lab cages well past their usual expiration date. The newest scheme is to hack the aging process itself



Veterinary cardiologist Ryan Baumwart performs an echocardiogram on a dog named Joe Pup at Washington State University in Pullman as part of Kaeberlein's study of whether rapamycin has antiaging potential.

DAVID GUTTENFELDER

LIMITLESS WITH CHRIS HEMSWORTH

Watch this series on human potential and combating aging by National Geographic, streaming now.





by reprogramming old cells to a younger state.

“If you’re a mouse, you’re a lucky creature because there are a lot of ways to extend your life span,” says Cynthia Kenyon, a molecular biologist whose breakthrough work decades ago catalyzed what is now a research frenzy. “And long-lived mice seem very happy.”

What about us? How far can scientists stretch our life span? And how far should they go? Between 1900 and 2020, human life expectancy more than doubled, to 73.4 years. But that remarkable gain has come at a cost: a staggering rise in chronic and degenerative illnesses. Aging remains the biggest risk factor for cancer, heart disease, Alzheimer’s, type 2 diabetes, arthritis, lung disease, and just about every other major

illness. It’s hard to imagine anyone wants to live much longer if it means more years of debility and dependence.

But if those mouse experiments lead to drugs that clean up the molecular and biochemical wreckage at the root of so many health problems in old age, or to therapies that slow—or, better yet, prevent—that messy buildup, then many more of us would reach our mid-80s or 90s without the aches and ailments that can make those years a mixed blessing. And more might reach what is believed to be the natural maximum human life span, 120 to 125 years. Few people get anywhere close. In industrialized nations, about one in 6,000 reaches the century mark and one in five million makes it past 110. The record

RIGHT

Rochelle Buffenstein, a research professor at the University of Illinois, Chicago, examines a naked mole rat. She has spent decades studying the long-lived mammal, looking for ways to adapt its unique traits to prevent some of the adverse effects of aging in humans.

DAVID GUTTENFELDER

BELOW

A yellow-winged bat rests in a biologist's hand in Uganda. Eighteen of the 19 mammals that live proportionally longer than humans based on body size are bats. (The naked mole rat is the other.) Bats fascinate scientists because they carry deadly viruses but are not affected by them.

NICHOLE SOBECKI





holder, Jeanne Calment in France, died in 1997 at 122 years, 164 days.

Human biology, it seems, can be optimized for greater longevity. Unimaginable riches await whoever cracks the code. No wonder investors are pouring billions into trying. Google led the spending spree with the 2013 launch of Calico Life Sciences, where Kenyon is the vice president of aging research. Over the past few years, investment in the industry has come from tech tycoons, overnight crypto millionaires, and most recently Saudi royals. It seems everyone with cash to burn is placing a bet on aging's next—or really, its first—big thing.

This work is powered by artificial intelligence, big data, cellular reprogramming, and an increasingly exquisite understanding of the zillions of molecules that keep our bodies humming. Some researchers even talk about “curing” aging.

Humans have chased dreams of eternal youth for centuries. But the study of aging and longevity was such a scientific backwater as recently as 30 years ago that Cynthia Kenyon had trouble

recruiting young researchers to assist her in the experiments that would break the field open. Working then at the University of California, San Francisco, she altered one gene in tiny roundworms known as *C. elegans* and doubled their life span. The mutants acted younger, too, slithering friskily under the microscope while their unaltered peers lay about like lumps.

Kenyon's startling discovery showed that aging was malleable—controlled by genes, cellular pathways, and biochemical signals. “The whole thing shifted from being out there in the nebulous world to familiar science that everyone understood,” she says. “And everyone could do it. So people just moved in.”

Delaying death in worms and mice, however, doesn't mean it will work in humans. For a hot minute, senolytics, which kill damaging cells that accumulate with age, appeared poised to become the first antiaging therapy to make it through the regulatory gauntlet. But one of the first clinical trials, a highly anticipated study of an osteoarthritis treatment, found that it didn't reduce swelling or joint pain any better than a placebo. Researchers and biotech companies are now testing senolytics to treat early onset Alzheimer's, long COVID, chronic kidney disease, frailty in cancer survivors, and a complication of diabetes that can cause blindness. Clinical trials of other antiaging compounds are also under way. But so far, none of the experimental drugs that have had such dazzling effects in mice have made it to the market.

“There are lots of different approaches,” Kenyon says. “We don't know if any of them will work. But maybe they'll all work! Maybe combinations will be fabulous. The good news now is that people have literally accepted this kind of science as being real. They're excited about the possibilities. We just have to try a lot of things. And that's what people are doing.”

WALLET

Crompton, a retired biomedical engineer in Silicon Valley, is 69 years old. He has ample white hair, a white goatee, and a dark vision of growing older. “I'm at the age where I'm swirling around faster and faster at the bottom of the toilet,” he says. “You look around, more and





WE HAVE CHASED DREAMS OF ETERNAL YOUTH FOR CENTURIES. BUT THE STUDY OF AGING AND LONGEVITY WAS A SCIENTIFIC BACKWATER AS RECENTLY AS 30 YEARS AGO.

“Don’t eat too much,” says Grazia Cosmano, 102, and stick to fruits and vegetables. “Keep it as simple as possible.” That’s how Cosmano became one of an unusual concentration of centenarians in Italy’s Calabria region, says biochemist Valter Longo of the University of Southern California. Longo, whose parents are from Cosmano’s hometown of Molochio, has known her since childhood. When she turned 100, he added her to his study of Calabria’s centenarians and their diet.

JASPER DOEST

more of your peers are dying, getting horrible diseases. You have little aches and pains, all of a sudden your knee hurts when you run, and blah, blah, blah. If it's not one thing, it's another."

With a mindset like that, it's no surprise Crompton became obsessed with aging and life-extension research. He read the mouse studies. He helped out at a longevity lab. He attended conferences where scientists spoke of the "hallmarks" of aging, the interconnected ways that biology goes awry over time.

Protective caps on chromosomes, called telomeres, shorten. The genome becomes unstable and cancer-causing DNA mutations increase. Changes occur in the epigenome—compounds that latch onto DNA and regulate the activity of genes. Some cells become senescent, meaning they stop functioning normally, but like zombies, they don't die, and they secrete chemicals that cause inflammation. Disruptions occur in pathways that respond to nutrients, lipids, and cholesterol, throwing metabolism out of whack. And the list goes on. There's no consensus on how these changes influence one another, or which is the most important to address.

At a conference, Crompton heard a scientist named Gregory Fahy explain his theory that immunological aging could be reversed by treating the thymus, a small gland in the chest that stimulates the development of disease-fighting T cells. Fahy was seeking volunteers to test his idea that injections of recombinant human growth hormone, a drug used for decades to treat children with short stature, could rejuvenate the thymus and the body's waning defenses against disease. Fahy had injected himself with the stuff on and off for eight years, and with his thick dark brown hair and youthful enthusiasm, he appeared in enviable shape for a guy of Social Security age. Crompton signed up.

Fahy, the chief scientific officer of Intervene Immune, a California-based company, is well known as a cryobiologist who developed a technique to preserve kidneys by infusing them with ethylene glycol and storing them at minus 135°C (-211°F) until they can be transplanted. He created a stir by rewarming a rabbit brain in near-perfect condition, raising hopes a way will be found to allow mammalian brains, ours included, to survive cryopreservation. But Fahy has been fascinated by the thymus for decades, since he read a study by scientists who refreshed the immune systems of rats by implanting cells



that make growth hormone. He believes most drugs that extend mice lives will disappoint us, because they "don't do anything about keeping your immune system from going south."

Recombinant human growth hormone is off patent, so repurposing it for antiaging won't yield the financial bonanza of a new drug; it's also associated with an elevated risk of some cancers. Fahy tried to get other scientists interested in doing a clinical trial and failed. "I took matters into my own hands and started regenerating my own thymus based on what I could glean from the rat study," he says.

Because the drug can raise the risk of type 2 diabetes, he added two pills: metformin and dehydroepiandrosterone, or DHEA, a hormone that improves blood-sugar regulation. Both are also thought to mitigate the effects of aging, and they're commonly used for that purpose. Metformin, which is taken for diabetes by 150 million people worldwide, may reduce the incidence of neurodegenerative diseases and cancer. U.S. researchers are planning a study to see if it

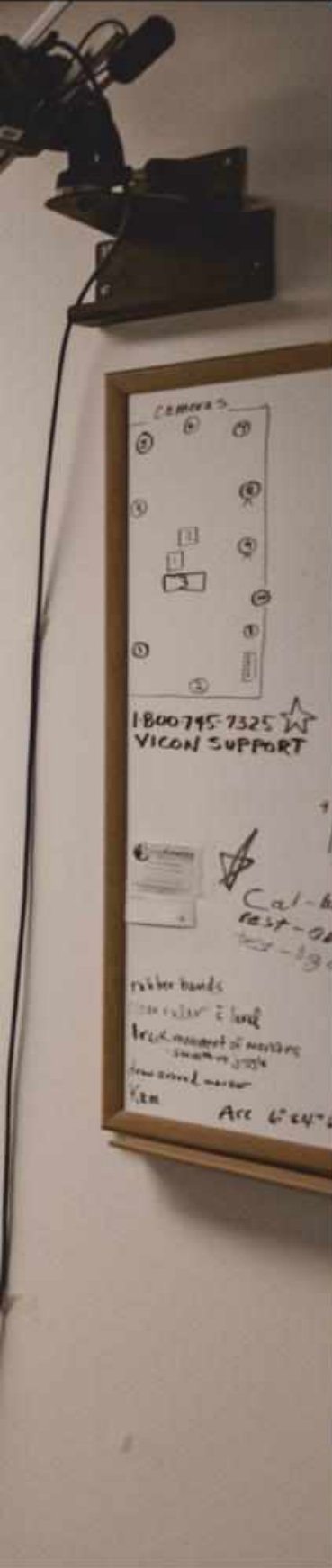


Fasting may help explain why Calabria has so many centenarians. Longo says in lean times they ate little, perhaps just pasta (below) with olive oil and legumes. To test if a diet mimicking a fast can reset the body's metabolism, Longo is enlisting 500 people from the region with health problems, such as obesity. For five days every three months, some of them will eat only enough to stave off hunger: a combination of nut-based or chocolate-crisp bars, spearmint or hibiscus tea, an algal oil capsule, vegetable soup, a multivitamin and mineral supplement, almond-and-kale crackers, olives, and a glycerol drink. "We are hoping to demonstrate that this changes the health of most people," Longo says.

JASPER DOEST (BOTH)







SCIENTISTS STUDY HEALTHY ELDERS AND TRACK CENTENARIANS TO FIGURE OUT HOW THEY MANAGE TO DEFY THE ACTUARIAL TABLES.

Joan Valentine, 90, tests her gait at Harbor Hospital as part of the Baltimore Longitudinal Study of Aging. Since her first visit in 2012, she has returned eight times. Launched in 1958, it's one of the longest such studies in the world. The researchers have followed more than 3,200 people, some of them for more than 50 years. They collected blood and urine samples, measured strength and agility, assessed cognitive function, and performed physical exams. The data have been used in thousands of scientific papers.

DAVID GUTTENFELDER

CAUSES OF DAMAGE
 These four hallmarks are considered the primary ways cells are harmed. While the other five mechanisms can sometimes be beneficial, all of these have unequivocally negative effects on the body. Each can set off a cascade of cumulative consequences.

HOW OUR

Over the past three decades, biomedical researchers have identified a number of mechanisms, or “hallmarks,” of aging to explain the cellular and molecular processes that damage cells. Grouped here into three categories, nine of these are at the core of cutting-edge efforts to slow aging—the leading risk factor for many major diseases, including cancer.

ANATOMY OF A CELL

Chromosomes, found in the nucleus, contain the cell's genetic code.

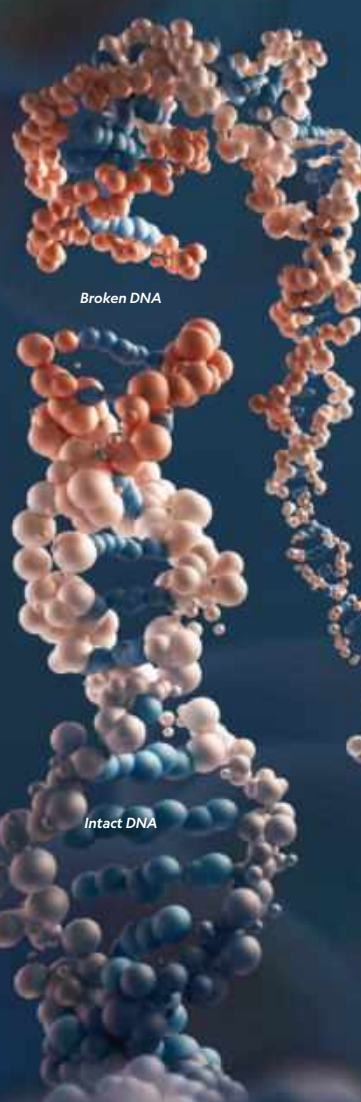
Mitochondria in the cytoplasm convert nutrients into cellular energy.

NUCLEUS
 CYTOPLASM
 CELLULAR MEMBRANE

INSIDE THE NUCLEUS



The nucleus is the heart of the cell. Because it contains DNA, the blueprint for all cellular activity, any damage inside the nucleus is serious and can be transmitted to the entire cell, causing a torrent of negative effects.



CAUSE OF DAMAGE

Unrepaired DNA

Myriad hazards, such as pollution, are a constant threat to DNA. Our genomes encode processes that address assaults, but the repair isn't always successful and flaws can accumulate, leading to cancer and other diseases.

CAUSE OF DAMAGE

Defects in DNA regulation

DNA strands are wound around spools of proteins called histones. Genes are turned on and off depending on where methyl groups attach to DNA and histones. When those attachments malfunction, precise coordination of gene activity can be compromised.

CAUSE OF DAMAGE

Harmed chromosome caps

DNA has special protective end caps, much as shoelaces do. Called telomeres, these caps shorten with age and degrade. Chromosomes then begin to fall apart, causing the death of cells in vital organs.



CELLULAR INTERACTIONS



Cells need to be able to communicate with one another for our body's organs to function in an optimal way. When DNA or cells become damaged, as shown here in the intestinal wall, cells can't receive the proper signals.

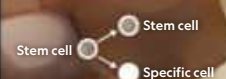


PROGRESSIVE DECLINE

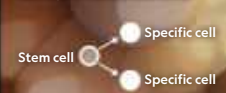
Loss of stem cell function

Our body's ability to repair tissues and organs depends on healthy stem cells—the main source of new cells. But stem cells replicate only on demand, an ability that declines with age.

Stem cells are multipotent, meaning they are capable of forming several specific cell types.



As we age, our stem cells stop replicating, reducing our ability to replace damaged tissues and cells.



Stem cells



REACTION TO DAMAGE

Formation of zombie cells

Defective cells can enter a permanent nondividing state called senescence. Sometimes called zombie cells, they can play important roles at times, such as in wound healing. But they accumulate with age and never die. These rogues also secrete molecules that harm neighboring cells.

PROGRESSIVE DECLINE

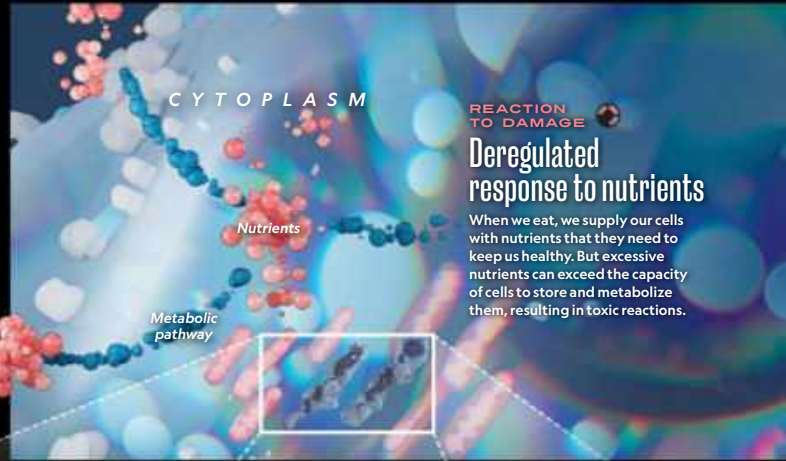
Intercellular miscommunication

Precise communication between cells, mostly mediated by hormones, keeps the body functioning. Disruption of signals (perhaps because of zombie cells or other unknown factors) can, for example, turn an appropriate response to a temporary injury into constant low-level inflammation.

INSIDE THE CELL



Cells are like factories with many critical, interacting parts. Damage to any of them, including the mitochondria that turn food into energy, will compromise the cell's function. This degradation can eventually affect the cell's nucleus and lead to disease.



CYTOPLASM

REACTION TO DAMAGE

Deregulated response to nutrients

When we eat, we supply our cells with nutrients that they need to keep us healthy. But excessive nutrients can exceed the capacity of cells to store and metabolize them, resulting in toxic reactions.



REACTION TO DAMAGE

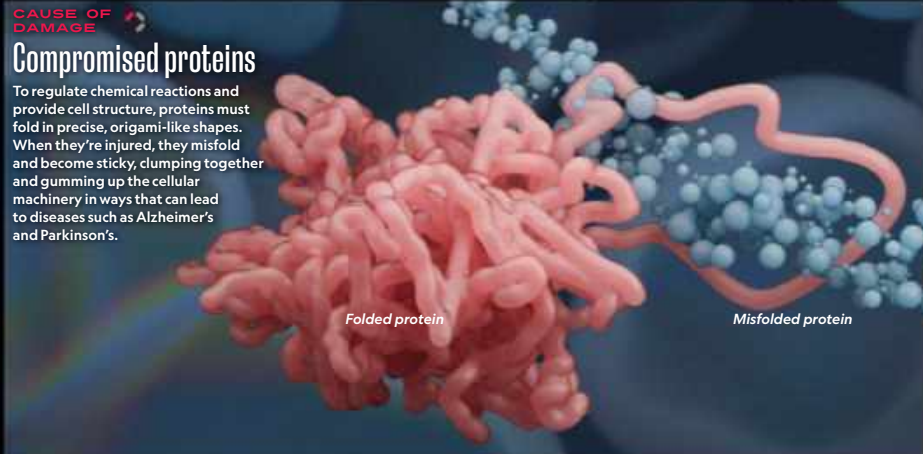
Mitochondrial dysfunction

Mitochondria produce more than 90 percent of a cell's energy and almost all of its free radicals, also called reactive oxygen species. In low amounts these unstable molecules can be useful for signaling stress and triggering maintenance and repair, but too many can be toxic.

CAUSE OF DAMAGE

Compromised proteins

To regulate chemical reactions and provide cell structure, proteins must fold in precise, origami-like shapes. When they're injured, they misfold and become sticky, clumping together and gumming up the cellular machinery in ways that can lead to diseases such as Alzheimer's and Parkinson's.



Folded protein

Misfolded protein

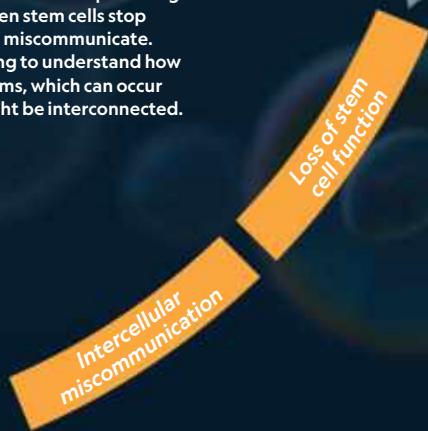
CELLS AGE

REACTIONS TO DAMAGE

These processes are beneficial when they occur in response to sporadic injury or nutrient scarcity but not when they're accelerated by the first four hallmarks. When these three mechanisms experience constant or intense assaults, they become harmful, undermining their original purpose.

PROGRESSIVE DECLINE

The last two hallmarks reflect accumulated damage from the previous seven. Organs and tissues can experience compounding negative effects when stem cells stop replicating and cells miscommunicate. Scientists are working to understand how these two mechanisms, which can occur simultaneously, might be interconnected.



JASON TREAT AND EVE CONANT, NGM STAFF; KELSEY NOWAKOWSKI
ART: MARKOS KAY

SOURCES: STEVEN AUSTAD, UNIVERSITY OF ALABAMA AT BIRMINGHAM; MANUEL SERRANO, INSTITUTE FOR RESEARCH IN BIOMEDICINE, BARCELONA

FACING THE FACTS

Age is written on our faces. As we grow older, our mouths elongate, our noses widen, our eyelids droop. And, of course, there are wrinkles and sags. Jing-Dong Jackie Han, a researcher at the Chinese Academy of Sciences, wondered whether our faces reveal our physiological age, which can differ from chronological age by as much as six years. She and her colleagues merged images of Chinese faces to create averages. Using a 3D camera system and artificial intelligence to compare faces with the averages, the scientists found, is a more accurate method to detect aging than a physical exam or a blood test. The method also offers a noninvasive way to help doctors decide whether to check for high cholesterol, hypertension, or other age-related diseases.

JING-DONG JACKIE HAN, MAX PLANCK PARTNER INSTITUTE FOR COMPUTATIONAL BIOLOGY, CHINESE ACADEMY OF SCIENCES; REUSED WITH PERMISSION FROM SPRINGER NATURE



AGE: 17-29
Female average



AGE: 17-29
Male average

prevents or delays major age-related illnesses. But some longevity scientists aren't waiting: They pop metformin daily.

Crompton says he immediately felt the effects of Fahy's regimen. "It seemed like I could leap tall buildings in a single bound." He shed unwanted pounds without dieting. Another participant, Hank Pellissier, 70, tells me his hair, previously white, began growing in brown.

Tests showed that T cell production increased with the treatment, thymus fat disappeared, and kidney and prostate health improved. Most striking, the men lost an average of two and a half years of biological age, as measured by what's known as an epigenetic clock. It uses blood to measure chemical changes to DNA that alter

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Fahy's st

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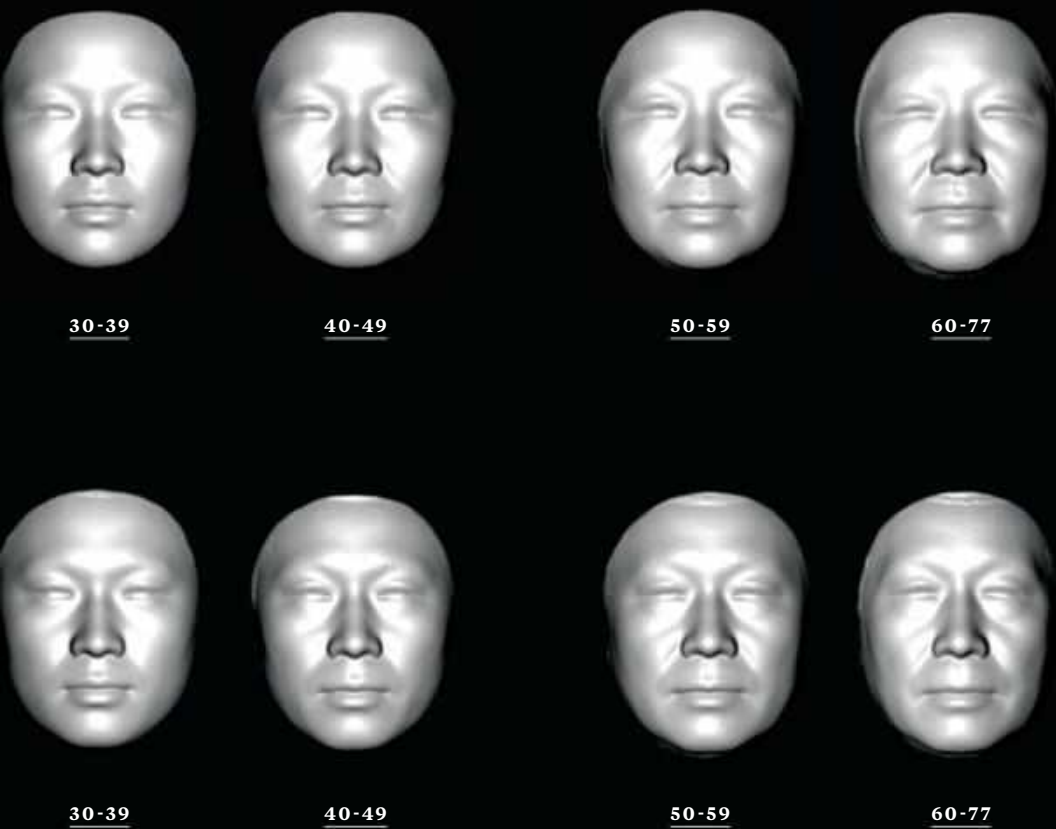
Fahy, wh

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getting up

clock is tick

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...sion and mark the passage of time. ... study, published in 2019 in the journal ... was too small to prove anything, and ... placebo controlled. Nevertheless, the ... at provided the tantalizing sugges- ... medical intervention might lower ... biological age. Steve Horvath, who ... the epigenetic clock that's now a go-to ... geivity research, was impressed. The ... geneticist and biostatistician is now a ... in the larger trial Fahy is conducting. ... no is 72, enrolled as his own guinea ... sumed his hormone injections. "I'm ... there, unfortunately," he says. "The ... king. I have to do my work fast to save ... everybody else but myself as well."

A I

98, my mother, Dorothy, has outlived my father, her two younger sisters, and a late-life boyfriend. Her short gray bob is always salon perfect. She is thin and walks slowly, with a cane, but she stands straight. On most weekdays she goes to her neighborhood senior center, where she takes exercise classes, dances, and eats lunch with friends. She never forgets a birthday or a bill due.

Not much about her lifestyle would have predicted such healthy longevity. She escaped Nazi Germany as an adolescent, suffering more than her share of trauma, though I've never heard

her use that word. She smoked cigarettes for decades. My father was a butcher, and we lived on red meat. On the plus side, she has always been physically active. She ran competitive track as a child, walked a few miles back and forth to work, and swam several times a week for years after she retired.

Scientists study healthy elders like my mother and track centenarians to figure out how they manage to defy the actuarial tables. Kristen Fortney, a 40-year-old biotech executive with a Ph.D. in medical biophysics, is putting big data and computational wizardry to the task. Most drug development for aging aims to fix something that goes wrong; Fortney is trying to understand what goes right.

"I've always approached it from the perspective of what's going to have the greatest impact and what's the low-hanging fruit," Fortney says. "I've always believed that's to copy what already works. There are already all these human examples of successful aging... individuals out there who are making it to a hundred and beyond, and their muscles still work, their brains still work, so we know it can be done."

Fortney's company, BioAge Labs in Richmond, California, analyzes blood and tissue stored in biobanks from Hawaii to Estonia. The specimens are linked to electronic medical records, so Fortney and her colleagues know the health outcomes of the people behind every vial of blood, and they search for biomarkers that distinguish those who've aged well. Machines measure each sample for up to tens of thousands of variables, including 7,000 proteins. (A decade ago, the best technology could pick out only a few hundred.) Using artificial intelligence, the scientists then identify possible targets for medication and search the reject piles of pharmaceutical companies for drugs that were developed for other purposes and shown to be safe but never released.

Fortney's team has tested several dozen drug candidates in mice, and has two in clinical trials. One targets the immune system, and the other addresses muscle mass and strength. Because the U.S. Food and Drug Administration approves drugs only if they prevent or treat a disease, and the agency doesn't consider aging a disease, trials such as Fortney's investigate a drug's effect on an age-related condition. But the researchers almost always have grander ambitions.

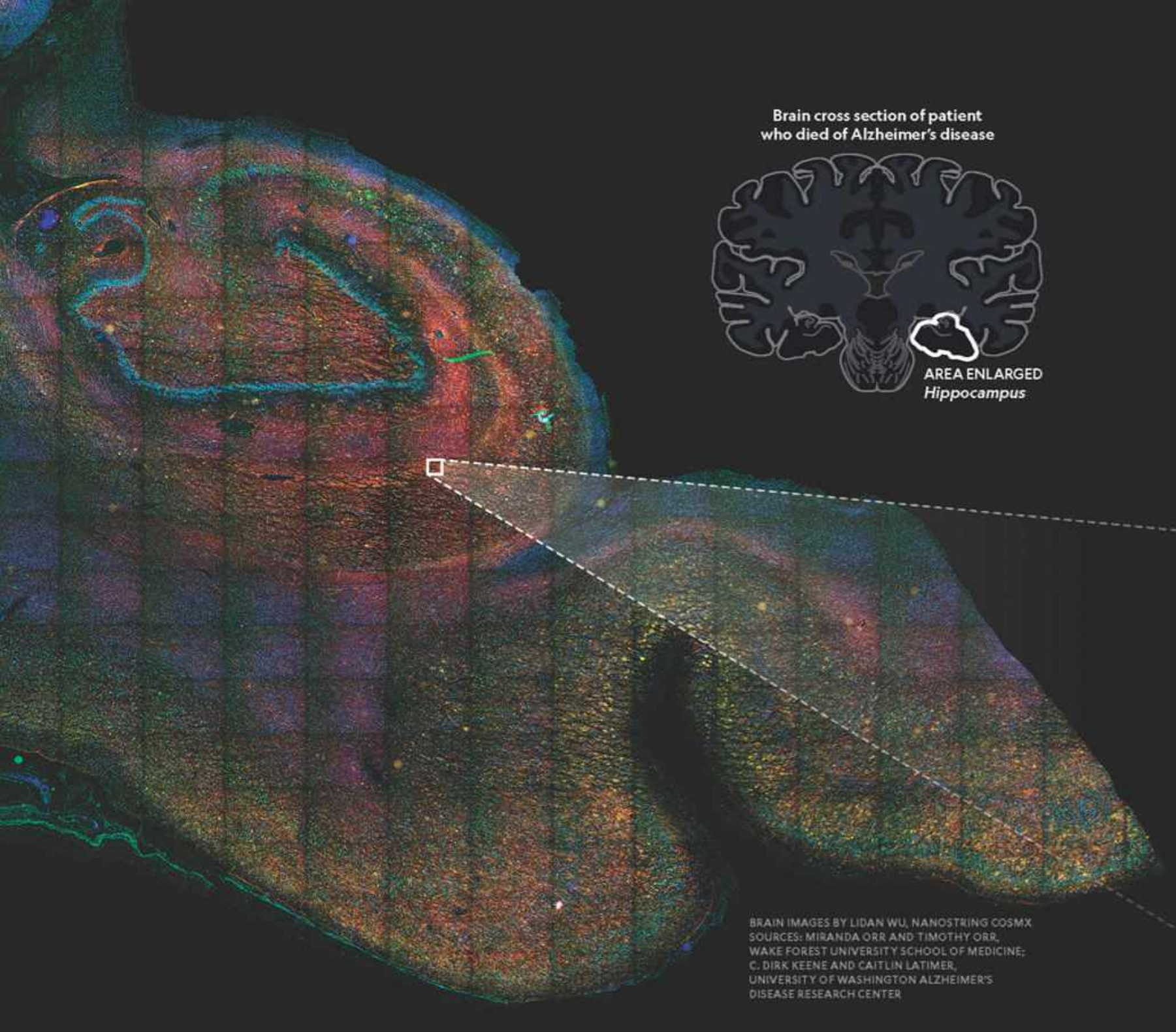
For example, Fortney is evaluating a compound, code-named BGE-117, for age-related





To slow Don Lueck's dementia, his doctors suggested he learn a new skill. He took up art in 2019 and has made more than 17,000 paintings. The hobby helped the gregarious 77-year-old endure pandemic-imposed isolation in his Madison, Wisconsin, home. "Painting every day during this time saved our lives, because his brain was actively engaged in a creative process he loves," says his wife, Jenny Villwock. "He often includes faces or creatures in his painting—someone with whom he could socialize."

DAVID GUTTENFELDER (LEFT)



muscle dysfunction because it acts on a pathway involved in tissue regeneration, remodeling blood vessels, and other critical processes. But the hope, the company explains, is to target “multiple diseases of aging with large unmet needs, high prevalence, and huge markets.”



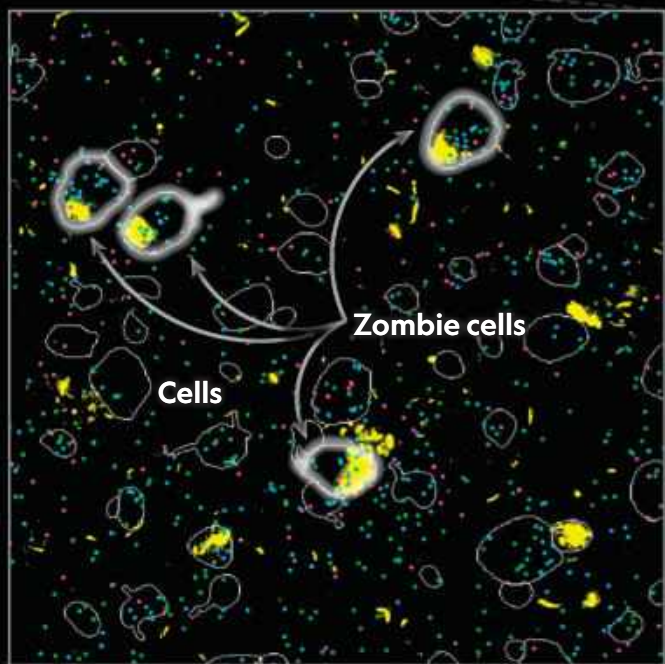
was feeding time when I visited Vera Gorbunova’s super-agers: 300 naked mole rats, give or take—a litter had been born four days earlier, and one pregnant female looked ready to burst.

The refrigerator held bountiful options, including five pounds of apples, 18 ears of corn, two pounds of celery, three bags of romaine lettuce, purple grapes, bananas, white potatoes, sweet potatoes, and carrots, all of it organic.

Naked mole rats can live more than 40 years in captivity, 10 times longer than typical for a rodent their size. I couldn’t help thinking we’d all live longer if we just ate what these small, wrinkled, bucktoothed creatures do. Gorbunova and Andrei Seluanov, who are married and both biologists at the University of Rochester, study naked mole rats in hopes of stealing their longevity adaptations for us. “In every long-lived animal we find something new. Crazy things!” Gorbunova tells me.

SLAYING ZOMBIES

Miranda Orr, who researches brain aging at the Wake Forest University School of Medicine, and her team discovered senescent cells, or zombie cells, in regions crucial for memory, such as the hippocampus. These cells don't die naturally, and they release toxic substances. Orr and her colleagues are studying whether drugs can kill these deadly cells and restore memory. The close-up image below shows the effects of Alzheimer's disease. **Yellow shows tau tangles**, the snarls of tau proteins that are a hallmark of degenerative brain diseases. **Blue marks molecules that indicate stress**, **magenta is a sign of damage beyond repair**, and **green shows inflammation**, a result of senescence. When blue, magenta, and green all appear in a cell, especially a large cell, that's evidence it's a zombie.



The mystery of the phenomenal longevity of some animals has propelled studies around the globe. Researchers have endured Arctic storms and seasickness to catch, study, tag, and release Greenland sharks, which live at least 250 years and maybe even a few centuries more. Scientists dredging ocean quahog clams from the seabed north of Iceland hauled up a 507-year-old. University of Birmingham biologist João Pedro de Magalhães, seeking clues in DNA, sequenced the genome of the bowhead whale, a 120,000-pound behemoth thought to be the longevity champion of the mammalian world but endangered by pollution and other threats. He also worked with Gorbunova and Seluanov to investigate the naked mole rat genome.

The rodent habitat in Rochester, New York, is 90 degrees, dark, and humid, like a burrow. Each colony—a queen, her consorts, and many generations of her minions— inhabits its own plexiglass dwelling. It has wide tubes connecting three large canisters, ostensibly for sleeping, eating, and excreting. If naked mole rats don't like a meal, says Nancy Corson, who manages the colonies, “they'll put it in the toilet.”

They look adorably social as they somersault over one another and huddle in piles like laundry, but they're belligerently territorial. Researcher Rochelle Buffenstein, who once had more than 7,500 and now has 2,000 in her lab at the University of Illinois, Chicago, has found the old don't die any more often than the young. “Many of them die because they fight,” Gorbunova says. “That is not age dependent.”

Gorbunova showed me the other residents in her lab: Damaraland mole rats; Chilean rodents called degus, a model for studying Alzheimer's; and African spiny mice, which have almost mythical powers to regenerate skin and cartilage. A large freezer is packed with tissue from squirrels, rabbits, porcupines, beavers, wild mice, bats, and two dozen other species. She gets these specimens from exterminators, hunters, animal-control officers, state conservation employees. She also traps some. And Wolfy, the family German shepherd whose framed portrait is displayed in her office, deposits the occasional carcass on her doorstep. I winced at that. “They served science,” she assures me.

Bowhead whales have more than a thousand times the cells we do, which should dramatically increase their risk of a cancer-causing mutation. But they don't get cancer. Studies have shown they are astonishingly efficient and accurate at repairing DNA and keeping cells healthy. Gorbunova has found that other long-lived animals, including naked mole rats, share this superpower.

Bats control inflammation so masterfully they can harbor viruses without getting sick, a feat that drew global attention after they were suspected as the source of the pandemic's coronavirus. “We were interested in bats even before COVID,” Gorbunova says. Scientists estimate that chronic inflammation, which often progresses as we age, is a major factor in more than half of all deaths worldwide.

And naked mole rats? One of their anti-aging marvels is hyaluronan, a gooey sugar secreted by connective tissue. We make the

substance, too, and it's a staple of "age defying" skin creams. But Gorbunova and Seluanov discovered that the naked-mole-rat version has a different, heavier, molecular structure from ours, it's much more abundant, and it doesn't degrade as much as ours does. (And she told me, to my disappointment, that it's produced differently from the pricey products I slather on my face.) Hyaluronan in naked mole rats not only makes their skin supple enough to squeeze through cramped tunnels but also suppresses tumors, the biologists found.

Studying longevity inevitably makes scientists contemplate their own. Once they pass a certain age, many do something—or a lot of things—to stave off molecular damage. Gorbunova, who is 51, tells me she eats seaweed because it activates a protein, sirtuin 6, which aids DNA repair and genomic stability. It struck me as on-brand that a biologist whose ringtone is a barking dog, and who says she chose her specialty because "I like animals and everything you can learn from them," would try to enhance her own longevity by consuming fish food.

Gorbunova doesn't study humans, though we're considered long-lived animals too. We outlive all other primates, and not only because they're more likely to be eaten by lions. Within a generation, Gorbunova believes, we'll have treatments that extend the human life span by a decade or two. To push beyond that would require fundamentally changing the human operating system, and that may not be as wild as it sounds. "I think it's possible," she says.



2006, Shinya Yamanaka, a stem cell researcher in Japan, figured out how to reprogram adult cells and return them to an embryonic-like state. The discovery revolutionized cell biology and the search for ways to treat human diseases, winning Yamanaka a Nobel Prize. Now researchers are determined to use the technique, called cellular reprogramming or epigenetic reprogramming, to reverse aging and eradicate the illnesses that come with it.

"The implications could be bigger than CRISPR," says biologist David Sinclair, referring to the transformative gene-editing technology.

"I'm going to get destroyed for saying that! It's certainly the biggest thing since CRISPR in terms of the amount of money and people getting into it."

A group of high-profile tech entrepreneurs, including Jeff Bezos, shook the tight-knit world of aging research in early 2022 with the launch of a three-billion-dollar reprogramming venture, Altos Labs. Yamanaka signed on as an adviser, and other superstar scientists were lured from prestigious academic posts. Depending on your point of view, the massive investment in a technology that is itself embryonic either epitomizes Silicon Valley hubris or marks a shrewd bet on the future of medicine. "People will not invest serious money unless the science is believable," says Steve Horvath, who retired recently from the University of California, Los Angeles to join Altos. "So the question is, will you and I benefit?"

Yamanaka used four proteins known as transcription factors, which initiate and regulate gene expression, to erase the identity of mature cells—essentially rewinding them to their original state. The leap to apply it to aging came from Juan Carlos Izpisua Belmonte, a biologist studying organ regeneration. He wanted to use the Yamanaka factors to turn back time only partway, restoring the youthful resilience of cells while maintaining their identity and function.

He and his team at the Salk Institute for Biological Studies in La Jolla, California, experimented with mice for several frustrating years until they hit upon a protocol that rejuvenated the animals instead of killing them. They used partial reprogramming to extend the lives of prematurely aged mice and to accelerate healing in normally aged old mice with muscle injuries. At the time, Izpisua Belmonte said the experiments demonstrated that aging "may not have to proceed in one single direction."

Now, as a scientific director at Altos, he no longer talks publicly about turning aging into a two-way street. The company insists it is not in the business of reversing aging but of reversing disease. Maybe the backers want to distance themselves from the long, dubious history of antiaging snake oil, or they have their sights on what the FDA will approve: treatments for diseases, not for aging. But I was not the only one to puzzle over their distinction.

"What's the difference?" Sinclair says, rolling his eyes.

Sinclair, a professor of genetics and co-director of the Paul F. Glenn Center for Biology of Aging Research at Harvard Medical School, makes no secret of his mission to thwart aging, including his own. He has founded and invested in more than a dozen companies to commercialize longevity technologies and molecules. At 53, he takes metformin and sprinkles resveratrol on his breakfast. “I try things once, at

colleague who is an ophthalmology researcher bet him it wouldn’t work.

“And guess what?” Sinclair says. “It did.”

Since publishing the results in *Nature* in December 2020, Sinclair has continued the studies and says the benefits appear long-lasting. Meanwhile, he and the researchers in his lab are doing mind-bending back-to-the-future experiments in which they speed up aging in mice,

FIVE HABITS MAY INCREASE LIFE EXPECTANCY BY 14 YEARS IN WOMEN AND 12 YEARS IN MEN: GOOD DIET, REGULAR EXERCISE, HEALTHY WEIGHT, NOT SMOKING, AND NOT DRINKING TOO MUCH.

least, that people are talking about,” he says. “I’m curious. I like to be an experimenter.” He lifts weights to keep his hormone levels up—he posted on Instagram that his testosterone is high. He recently adopted a vegan diet. “It’s not as boring as I thought it would be,” he tells me. He closely monitors his biological age through InsideTracker, a company he advises that analyzes 43 biomarkers.

When I visited his office, he offered to show me his results. We looked at the graphs on a computer screen. First up: C-reactive protein, an indicator of inflammation. “I’m way below what a 20-year-old would have,” he says. He scrolled through more data, concluding, “I’m way off the chart for youth.”

Sinclair modified the Yamanaka formula, eliminating one transcription factor that has been implicated in cancer, and then used partial reprogramming in mice to regrow crushed optic nerves. “That was great,” he says, “but I thought if this is really age reversal, we should be able to reverse age-related disease.” So he tried it in mice with a glaucoma-like condition, and their vision returned. But they weren’t very old, so Sinclair decided to reprogram cells of geriatric mice experiencing age-related vision loss. A

turning them wizened and sluggish, or accelerate aging in just one organ or in all of them. By switching aging on, they hope to learn how to shut it off.

Sinclair targeted the optic nerve because it’s one of the first places affected by aging. Shortly after birth, we lose the ability to regenerate cells there. He believes his studies offer a game-changing model for treating spinal cord injuries and disorders of the central nervous system. If turning back cellular age can recapture lost vision, he says, why not also the ability to walk or remember?

NOBODY

knows when, or whether, a moon-shot technology like cellular reprogramming will do for humans what it accomplishes so marvelously in mice. But in the meantime, we can do plenty to take on aging. Researchers at the Harvard T.H. Chan School of Public Health looked at decades of data from 123,219 adults in the U.S. and found that five habits may increase life expectancy by





Teun Toebes (center) chats with residents of a nursing home for adults with dementia in Utrecht in the Netherlands. The 23-year-old stayed there for more than two years, living for free in exchange for interacting with the residents. "I believe that everyone has the right to a beautiful, equal, and inclusive society," he says.

JASPER DOEST

14 years in women and 12 years in men: good diet, regular exercise, healthy weight, not smoking, and not drinking too much.

“I think the one that gives you the most bang for your buck, if you’re only going to do one—which I don’t recommend—is exercise,” said Matt Kaeberlein, a professor of laboratory medicine and pathology and the director of the Healthy Aging and Longevity Research Institute at the University of Washington.

He’s a hard-core scientist, not a fitness guru. His lab developed a robotics platform called WormBot, which collects data simultaneously from hundreds of parallel experiments to tease out the factors that influence the life span of the roundworm *C. elegans*. He’s also testing rapamycin in dogs. But no matter how busy he gets, three days a week Kaeberlein, 51, heads to the make-shift gym in his garage and cycles through bench presses, squats, dead lifts, and shoulder lifts to maintain muscle mass. “For most people over 50, loss of muscle mass due to a sedentary lifestyle usually is one of the most important predictors of poor health outcomes later on,” he says.

Fitness experts argue endlessly about which exercise regimen best maximizes health and strength late in life. Similarly, nutrition experts disagree about the optimal diet—time-restricted eating, intermittent fasting, keto, vegan, Mediterranean, you name it.

Animal studies provide compelling evidence that severe calorie restriction increases life span. Whether that’s true for people has been notoriously difficult to determine. The National Institute on Aging initiated a large study two decades ago to measure the effects of a diet that cut calories by 25 percent. But even though participants received counseling, software to track what they ate, and meals for a while, they shaved calories by only 12 percent. I was reminded of the doctor who told me the best healthy diet is the one you’ll follow.

Becca Levy, a professor of epidemiology and psychology at Yale University, points to another important, controllable influence on healthy longevity: our beliefs about aging. In one study, which has been replicated around the world, Levy found that people in their 30s and 40s who had positive expectations for old age—they equated it with wisdom, for example, instead of decrepitude—were more likely to be in good health decades later. In another study, she showed that older people who have



Arnold Camfferman free-falls about 7,000 feet above Ameland, an island off the coast of the Netherlands. As a skydiving instructor who’s still teaching, the 69-year-old has jumped out of airplanes more than 20,800 times. “I don’t want to stop anytime soon,” he says. His advice for a long and healthy life? “Never ever stop playing.”

JASPER DOEST
(WITH AARON MOLLOY)

positive views of aging are much more likely to recover fully from a disabling injury. And in yet another, she found that positive views of old age were associated with a lower risk of Alzheimer’s. Levy has found that people with the brightest beliefs about aging live an average of seven and a half years longer than those with the gloomiest.

Reading research by scientists trying to unravel the mysteries of aging can make it hard to feel good about growing older. The idea of “curing” aging casts it as pathology. Published studies start, relentlessly, with bad news. “Aging is a degenerative process that leads to tissue dysfunction and death,” begins a typical paper. As I learned more about the science, I grew excited about the possibilities



for breakthroughs but distressed about my own prospects as I approached 68.

Steve Horvath offered to run an epigenetic clock on me, a test with the anxiety-producing name of GrimAge. I sent him two vials of my blood. A while later I opened the report: My biological age was 3.3 years lower than my chronological age. The report offered a cheerful “congrats” and said, “You are already beating the clock!” But I felt let down. I certainly wasn’t in league with David Sinclair in bucking the tempest of time.

Then I thought about my mother, still enjoying life in her late 90s. Becca Levy’s research convinced me that my mom’s outlook at least partly explains her vitality. I’ve never heard her grumble about her birthday or say she can’t do

something because she’s too old, a complaint I’m starting to hear from friends my age.

“No,” she says, when I point this out. “I’m not too old. I might do it slower, and I might do less of it. But I’m not too old to dance or walk or do anything I like to do.”

She pauses. “Well, I wouldn’t swim anymore.”

“Because you haven’t done it in a long time?”

“Because I don’t like the way I look in a bathing suit.” □

Fran Smith, a regular contributor to the magazine, lives near New York City and specializes in stories about health. Four National Geographic Society Explorers photographed this story: **Jasper Doest** from Rotterdam, Netherlands; **David Gutenfelder** from Minneapolis; **Nichole Sobecki** from Nairobi, Kenya; and **Melanie Wenger** from Paris.



BY **GENA STEFFENS**

PHOTOGRAPHS BY **JASON GULLEY AND ERIKA LARSEN**



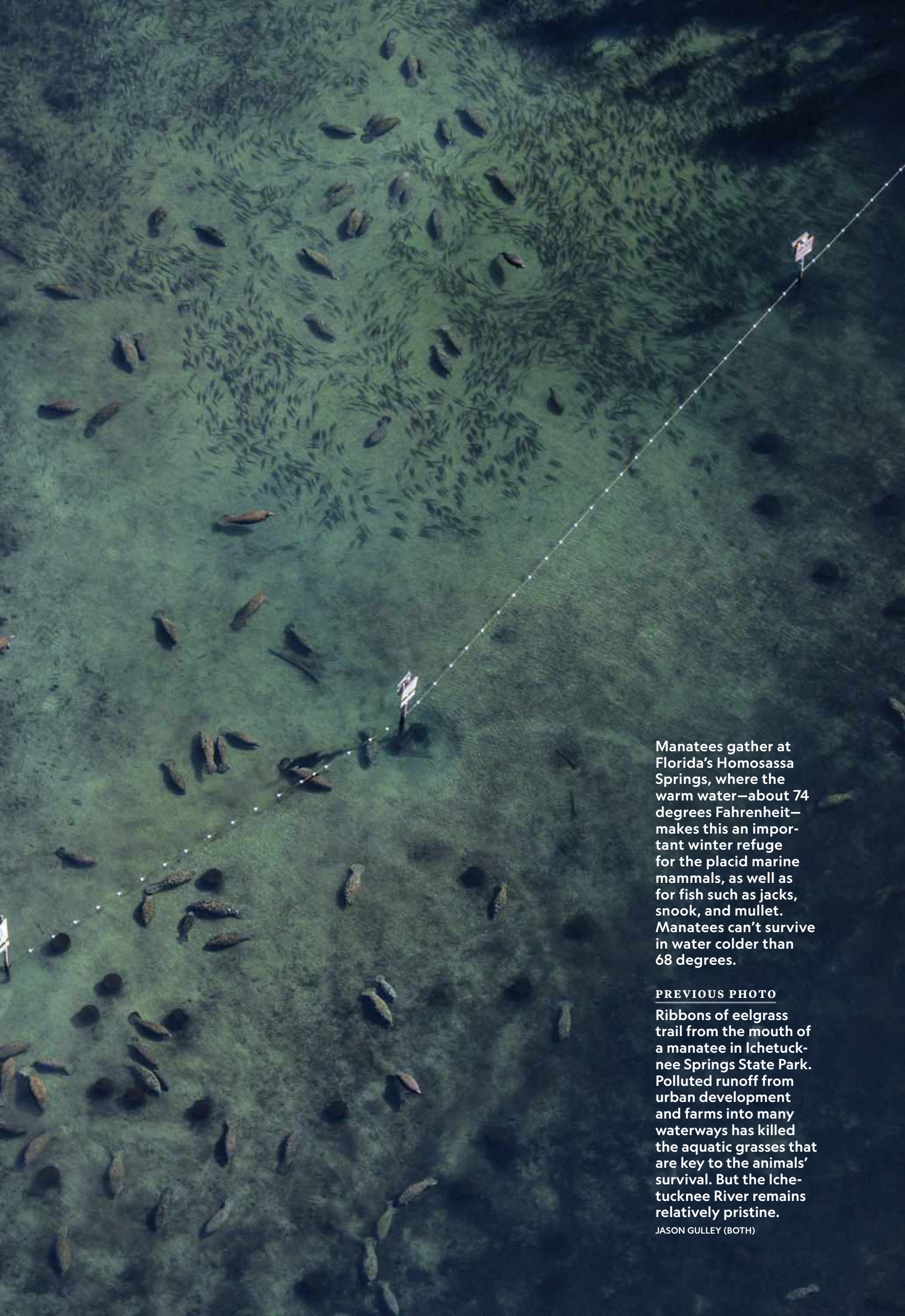
FOR
LOVE

OF

MANATEES

EXTINCTION LOOMED FOR THESE
GENTLE MARINE MAMMALS IN FLORIDA JUST
DECADES AGO. PEOPLE RALLIED,
AND **MANATEE** NUMBERS ROSE. BUT RECENT
DIE-OFFS ARE **WORRYING**.





Manatees gather at Florida's Homosassa Springs, where the warm water—about 74 degrees Fahrenheit—makes this an important winter refuge for the placid marine mammals, as well as for fish such as jacks, snook, and mullet. Manatees can't survive in water colder than 68 degrees.

PREVIOUS PHOTO

Ribbons of eelgrass trail from the mouth of a manatee in Ichetucknee Springs State Park. Polluted runoff from urban development and farms into many waterways has killed the aquatic grasses that are key to the animals' survival. But the Ichetucknee River remains relatively pristine.

JASON GULLEY (BOTH)

Clean, warm water in the discharge canal at Tampa Electric Company—and at other power plants in the state—provides manatees an unexpected haven for resting in winter, when the ocean becomes too cold for them.

JASON GULLEY





I WASN'T EXPECTING

to invite a stranger into my great-grandmother's house that afternoon. I'd hoped to interview National Geographic Explorer Buddy Powell on the water in Crystal River, a small town in Florida north of Tampa, where the manatee's modern-day story begins. But our boat broke down, and it was too hot to hang around the pier to talk. So there we were, sitting across from each other on matching orange sofas in Hazel Gaines's 1970s-themed living room.

My great-grandmother moved to Crystal River more than 60 years ago; she died in 1993. We've kept those sofas because they remind us of her and of our childhood spent exploring the river outside. Buddy Powell is slightly older than the sofas but in far better shape, with youthful posture and alert eyes that kept wandering out toward the water. "It's a subconscious thing," he said. "I've spent most of my life searching for manatees, and now it's like my brain is permanently wired with their search image."

When Powell was growing up here in the 1960s, manatees had all but vanished from Florida. "To find one was very exciting," he said. One of the world's foremost experts on these herbivorous marine mammals, he signs his email messages as "James Powell, Ph.D., President and Executive Director of Clearwater Marine Aquarium." But he always goes by Buddy.



Critical care veterinary staff at ZooTampa at Lowry Park take x-rays of Bellissima, brought in after a hiker spotted her on land. Animal care supervisor Jaime Vaccaro says Bellissima might have been stranded while foraging during an abnormally high tide.

ERIKA LARSEN




MANATEES—OFTEN CALLED sea cows—are an anomaly in the animal kingdom. Neither predator nor prey, these peaceable creatures, which can grow to 13 feet and weigh more than 2,000 pounds, are evolutionarily devoid of aggression. They also fall into the class of “charismatic” wild animals that hold humans in their thrall. Their presence in Florida is a reminder of the good humans can do: People have helped them rebound there from under a thousand in the 1960s to more than 7,500 six years ago, based on estimates from aerial surveys, by protecting and restoring manatee habitat, introducing rules to prevent boat collisions, and spreading awareness about these magnificent animals. Crystal



The National Geographic Society, committed to illuminating and protecting the wonder of our world, has supported Explorers Gena Steffens, Jason Gulley, and Erika Larsen in their storytelling about our relationship with the environment.

ILLUSTRATION BY JOE MCKENDRY



An aerial photograph showing a group of manatees in clear, turquoise water. In the foreground, several people are standing on a boat, looking down at the animals. Some are holding up their phones to take pictures. The manatees are scattered across the water, with some appearing to be resting or sheltering. The water is a vibrant greenish-blue color, and the boat's deck and railing are visible at the bottom of the frame.

Visitors watch manatees sheltering in the warm outflow of Florida Power & Light Company's Riviera Beach Next Generation Clean Energy Center, in Palm Beach County. Scientists and government wildlife managers often stop here and at other warm-water refuges to assess manatee populations.

ERIKA LARSEN

River—“Manatee Capital of the World”—is the epicenter of their recovery.

Yet despite the gains, manatees still face grave threats. Three-quarters of Florida’s 22 million people live along the coast, many in prime manatee habitat, where the strain of human presence has degraded the state’s enchanted springs, waterways, and wetlands. In Indian River Lagoon, for example, an important manatee habitat along Florida’s densely populated east coast, decades of human waste, sediment from real estate development, and fertilizers from lawns and farms have clouded the water. That has killed seagrass, manatees’ main food source there. More than a thousand manatees have died in the lagoon during the past two years. As the death toll has risen, facilities that rescue ailing manatees with the hope of returning them to the wild—including ZooTampa at Lowry Park and SeaWorld, in Orlando—have been overwhelmed by an influx of new patients.

Media have framed the manatee die-off as an environmental wake-up call, but Powell puts it this way: “People keep talking about manatees being the canary in the coal mine. But by the time this canary dies, all the miners are already long gone.” In other words, manatee deaths aren’t a signal of forthcoming disaster; their losses *are* the disaster—the result of warnings long ignored.

THE ADOPTION of charismatic animals—such as elephants (manatees’ closest living relative on land), pandas, and dolphins—as conservation symbols can create powerful activism for their protection. In 1978, the Florida Manatee Sanctuary Act designated the state as a “refuge and sanctuary” for manatees, limiting boat speeds in warm-water winter refuges, including Crystal River. The measure bolstered the Marine Mammal Protection Act and the Endangered Species Act, which had become law earlier in the decade.

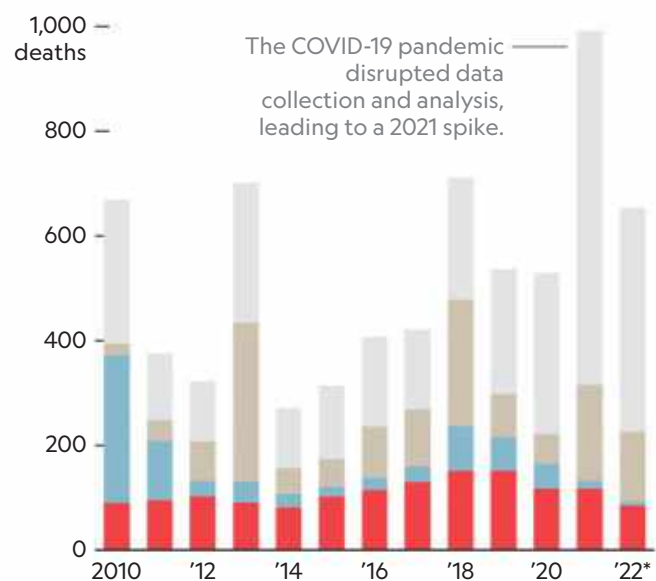
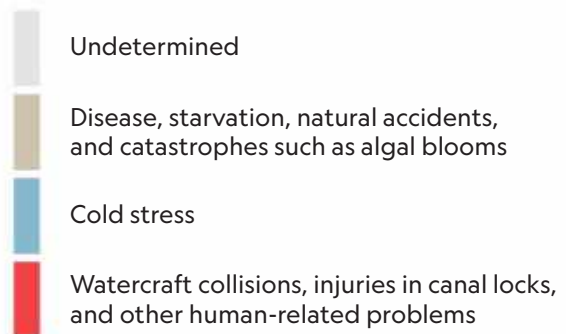
“Everyone is obsessed with them,” says Lisa Smith, a caretaker at ZooTampa’s David A. Straz, Jr. Manatee Critical Care Center. Gift shops in the Sunshine State offer everything from manatee back scratchers and dog leashes to five-foot-tall manatee mailboxes. Members of manatee-themed Facebook groups swap memes and show off manatee arts and crafts. One post offers a rendition of Leonardo da Vinci’s “Last Supper”—but instead of Jesus and his Apostles, it’s manatees seated around the table.



MANATEES ON THE MOVE

Florida’s manatees face an uncertain future as warming seas, agricultural runoff, and septic tank seepage jeopardize their main food source—seagrass. But human activity, in some cases, is helping. Water discharged by power plants, for example, provides an unlikely winter refuge.

Causes of adult manatee deaths in Florida



*2022 data are as of October 14.

CHRISTINE FELLEENZ, NGM STAFF. SOURCES: JAMES POWELL, CLEARWATER MARINE AQUARIUM RESEARCH INSTITUTE; FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION; FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION



Warm wanderings
Tranquil swimmers, manatees are often spotted as far away as Mississippi and North Carolina in mild months before returning to Florida for the winter.

Abundant west
Florida's Gulf Coast provides more extensive seagrass meadows than the Atlantic side, and rivers feeding into bays hold freshwater food sources.

Manatee gathering locations

- Power plant, warm discharge waters
- Natural springs, heated to about 73°F
- Thermal basin, heat retained as surrounding waters cool

Built-up area

Range of Florida manatee
Trichechus manatus latirostris
(subspecies of West Indian manatee)

Migratory area

State manatee protected area

Seagrass habitat

Critical habitat
Manatees move freely in saline or brackish water but only gather for extended periods where they find ample food, warm freshwater, and calm conditions.

25 mi
25 km

But charismatic animals also can be flash-points, and manatees have been an intense polarizer: Fervent advocates on one side, and on the other, coastal developers, business interests, and recreational boaters who want unfettered use of Florida's waters. The divide came to be known as the manatee wars.

What do people find so compelling about an animal that looks like a misshapen blimp and spends its time eating, sleeping, and breaking wind? An answer can be found in the Manatee Tunnel at ZooTampa's manatee critical care center, a working hospital that can rehabilitate more than 20 of Florida's signature creatures at once.

It's dark inside the tunnel, womblike. Whimsical music plays softly in the background. Beyond thick panes of glass, manatees appear to somersault through space like astronauts. Fragments of lettuce catch the light, shimmering like stars. Manatees' flippers move like a human's lower arm and are rimmed with fingernails—a 50 million-year-old reminder that their ancestors once walked on land. Wiry hairs on slate gray skin are tactile antennae, giving them an exquisite sense of touch to aid navigation by detecting water movement.

Some spectators, hypnotized by manatees' incomprehensible, meditative grace, stand in silence. Others murmur about how cute they are. "Is that a walrus?" a man whispers. "No," his partner replies. "It looks like a giant baked potato."

Everyone giggles as a manatee swims by and does a barrel roll, releasing a stream of bubbles from her rear end before gliding off with a swoop of the big, paddle-shaped tail. Sea cows, like land cows, are voracious vegetarians and very

**'THE BEST
CONSERVATIONISTS ARE
THE ONES WITH THE MOST
PRECIOUS CHILDHOOD
MEMORIES.'**

BUDDY POWELL
Clearwater Marine Aquarium



gassy. The manatee is not as pretty and certainly is "less Hollywood" than the sleek and playful dolphin, wrote Cuban author Manuel Pereira. But, he continued, "all the maternal instinct of the universe is concentrated in this animal."

Is obsession with manatees enough to ensure their survival in Florida? Only if it goes beyond the gift shop.

"What people don't understand," Smith says, "is the need to help support them in waterways." Above all, that means restoring seagrass beds and freshwater aquatic vegetation, the basis of their existence and of the overall health of Florida's waters. Seagrass sequesters carbon—"blue carbon"—35 times as fast as tropical rainforests and stores twice as much per acre.



Employees from the Florida Fish and Wildlife Conservation Commission dispose of a dead manatee at the Pinellas County Solid Waste Disposal Complex. The manatee was recovered from an area affected by red tide—algae toxic to marine mammals, fish, birds, and humans. Although not every manatee receives a full necropsy, reports of carcasses are investigated, and the probable causes of death are logged into a mortality database.

JASON GULLEY

FED BY UNDERGROUND SPRINGS, Crystal River mostly lives up to its name. Its electric blue waters are laced with swamps and islands thick with trees festooned by Spanish moss. The air vibrates with the sound of cicadas and carries the sweet scent of marsh mud and salt.

In one of my most vivid childhood memories, from about 1997, I'm standing waist-deep in the water with a snorkel and mask on. My dad has lowered me from the seawall by my wrists and is standing above me, encouraging me to put my face in the water. A creature the size of a small car grazes peacefully a few feet away in the cloudy water. I'm terrified, but I submerge my face anyway. I hear her teeth grinding and

feel her enormous presence right beside me.

"The best conservationists are the ones with the most precious childhood memories," says Powell, who also grew up exploring Crystal River, often in a little rowboat with his father. Only occasionally, he'd catch a glimpse of a large shadow gliding beneath the surface. Not many people understood—or cared—that these ghostly swimmers were among the last surviving manatees in Florida.

Powell's lifetime fixation seems fated. In 1967, at age 13, he had the chance to assist a graduate student named Daniel Hartman, who was doing the first in-depth study of manatee natural history. Their work, described in the September 1969 issue of *National Geographic*, introduced

SPECIES AT RISK

Apart from cetaceans, manatees and related dugongs are the only fully aquatic mammals. All are listed as vulnerable by the IUCN.



GENTLE GRAZERS

Manatees evolved adaptations for harvesting and digesting aquatic plants after their land-dwelling ancestors took to water 50 million years ago. But degradation of their watery habitats puts these "sea cows" at risk.



Manatees are solitary, except for two years of mother-and-calf bonding.

TRICHECHIDAE (round-tailed)



AVER. 9 ft
1,000 lbs
Two subspecies: the Florida (shown below) and the Antillean



They rise for air every three to five minutes when active, and every 10 to 15 when at rest.

Worn teeth fall out



Sensory hairs supplement poor eyesight by detecting currents, freshwater, and warm water.

A CHANGING MENU

Algal blooms in 2011 killed half the seagrass in Florida's Indian River Lagoon. This forced manatees to eat more seaweed, with as yet unknown effects on them.

SEAGRASS



SEAWEED



MURKY WATERS

Sensitive to temperature and salinity levels, seagrass remains hardy if it has enough light. But human-driven runoff fuels light-blocking algal blooms.

FERNANDO G. BAPTISTA, LUCAS PETRIN, EVE CONANT, CHRISTINE FELLEHZ, HGM STAFF, LAWSON PARKER

SOURCES: MARTINE DE WIT, FLORIDA FISH AND WILDLIFE MANAGEMENT DISTRICT, AARIN CONRAD ALLEN AND C



DUGONGIDAE
(fork-tailed)

B Amazonian manatee 8 ft
Trichechus inunguis 800 lb

C African manatee 8.2 ft
Trichechus senegalensis 880 lb

D Dugong 9 ft
Dugong dugon 660 lb

E Steller's sea cow 26 ft
Hydrodamalis gigas 13,800 lb Extinct by 1768

DAILY DIET: 100 pounds of food

Manatees consume roughly 10 percent of their body weight each day in vegetation, ripped up with a trunklike upper lip and sent on a weeklong journey through the body.

DIGESTION: 120-foot-long intestines

Bacteria in the intestines help digest the cellulose in plant matter. The large digestive system—roughly a fifth of body mass—produces internal warmth and copious gas.

BUOYANCY: 3-foot-long lungs

Air sucked into long, narrow lungs keeps manatees buoyant and level. Heavy skin and bones are counterweights to gas; a muscular diaphragm adjusts for roll and pitch.

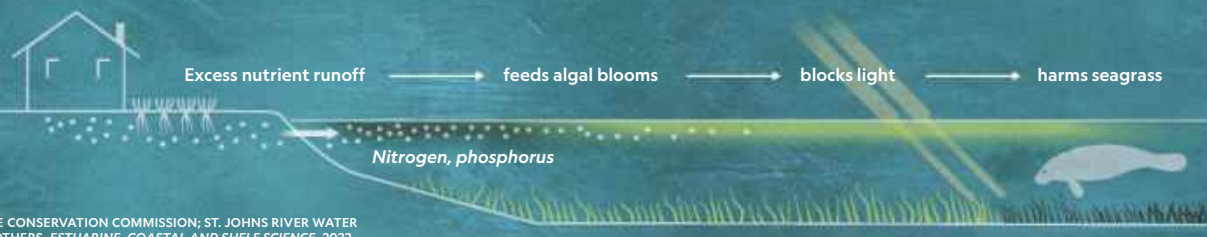
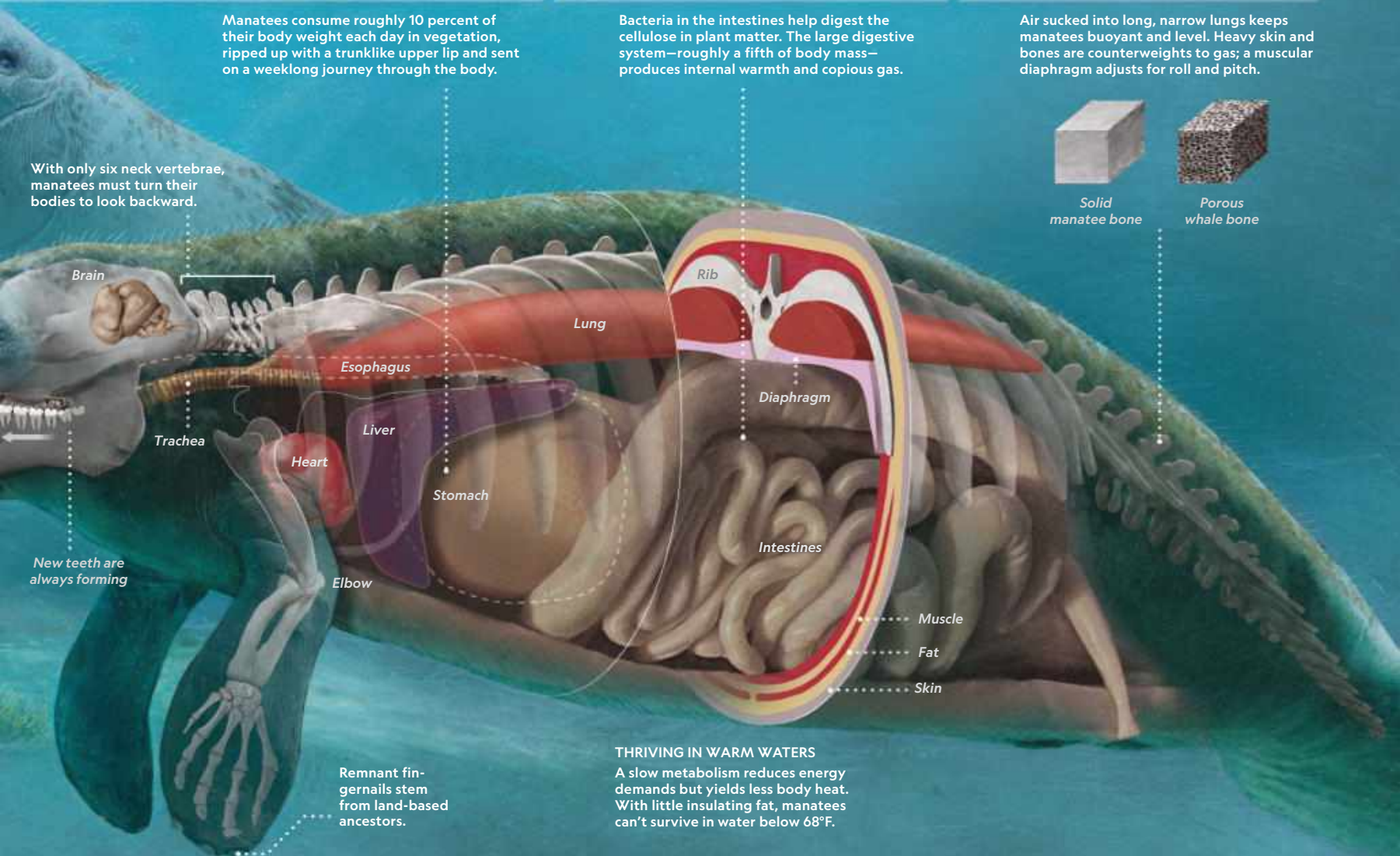
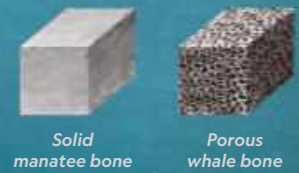
With only six neck vertebrae, manatees must turn their bodies to look backward.

New teeth are always forming

Remnant fin-gernails stem from land-based ancestors.

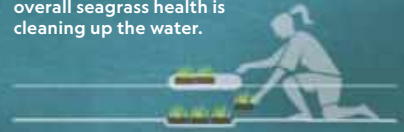
THRIVING IN WARM WATERS

A slow metabolism reduces energy demands but yields less body heat. With little insulating fat, manatees can't survive in water below 68°F.



SEAGRASS SOLUTIONS

Planting seagrass is a labor-intensive way to restore what's been lost. The best hope for overall seagrass health is cleaning up the water.



U.S. FISH AND WILDLIFE SERVICE; ST. JOHNS RIVER WATER QUALITY MONITORING PROGRAM; OTHERS, ESTUARINE, COASTAL AND SHELF SCIENCE, 2022





Manatees gather on the sandy bottom near Homosassa Springs, where the water is warm in winter. It's estimated that there may be as many as 7,500 manatees in Florida today, up from under a thousand 50 years ago.

JASON GULLEY



LEFT, FROM TOP

Torie Arrison shows off her face painting at Crystal River's Florida Manatee Festival.

This mailbox is one of the ubiquitous manatee curiosities in Crystal River.

The Cotton family stops at Blue Spring State Park, in Orange City, to see manatees.

RIGHT, FROM TOP

Ezrah Johnson and his little brother, Nathaniel, gaze at a manatee at Zoo-Tampa's Manatee Tunnel in the rehabilitation facility.

Festivalgoers stand in front of Hope, the Save the Manatee Club's inflatable figure.

Manatee signs and symbols help create Crystal River's identity.



manatees to the world. Hartman's story cautioned readers about the dangers manatees would face as Florida's population grew. "Pollution has already destroyed the manatee's food resources in several rivers," he wrote. "Their future rests entirely in our hands."

By the time he was 20, Powell had come to know more about the enigmatic manatee than almost anyone else, and the United States Fish and Wildlife Service (FWS) offered him a job with its new manatee research program. He spent the next nine years painting a picture of manatees' increasingly imperiled existence, not just in Florida but across their range in the southeastern United States. "We traveled from Alabama around to South Carolina interviewing fishermen along the entire coastline," he says. The research team bought a small plane and hired a pilot, flying over every waterway, searching for manatees. "We would land on remote country highways to pump fuel from the back of a pickup truck before taking off again."

The information Powell and his team gleaned became the basis of the Florida manatee conservation movement. The Save the Manatee Club led the way, using the manatee's benign countenance to build an engaged fan base. Groups litigated both for increased regulations that aim to protect the animals and their habitat, and against those who oppose such measures as boating speed limits, restrictions on waterfront development, and the setting aside of areas for manatees.

In 2011, the FWS unveiled a plan to set aside Kings Bay—the roughly 600-acre headwaters area of Crystal River—as a manatee refuge, with

a year-round slow-speed rule for boaters. This prompted Steve Lamb, a prominent businessman and philanthropist, and others to form Save Crystal River—to fight back against the “manatee folks.”

“When there’s an endangered species involved, the government can make up rules, and there’s not a damn thing you can do about it,” Lamb says. “They were taking little bites at a time out of our rights.”

The manatee wars culminated in 2012, when the Pacific Legal Foundation petitioned FWS on behalf of Save Crystal River to downlist the animals from endangered to threatened, arguing that their numbers had rebounded. (In 2011, the Florida Fish and Wildlife Conservation Commission had counted 4,834 manatees in the state.) After further review, in 2017 FWS made the controversial decision to downlist manatees. It didn’t change existing protections, but manatee advocates worry that it indicates reduced urgency for a species still very much in need of concerted conservation efforts.

“The decision to downlist the manatee was based on criteria that suggested habitat protections and boat-speed rules had seemed to be effective, allowing manatee populations to rebound,” Powell says. But “we knew there were all these environmental changes beginning to occur—red tide, increasing development in Florida and its impact on waterways, climate change. It’s these bigger environmental and landscape issues that are much more difficult to control,” he says. “They were warned.”

O N A CHILLY JANUARY MORNING, Will Wolfson noses our boat into Mosquito Lagoon, part of the Indian River Lagoon system. Wolfson, a fishing guide with 10 years’ experience on these waters, knows them as if they were an extension of his body. “This whole place is a wasteland,” he says as we skim past a trailer park and into a labyrinth of mangroves. “It’s pretty from above, but below it’s wrecked.”

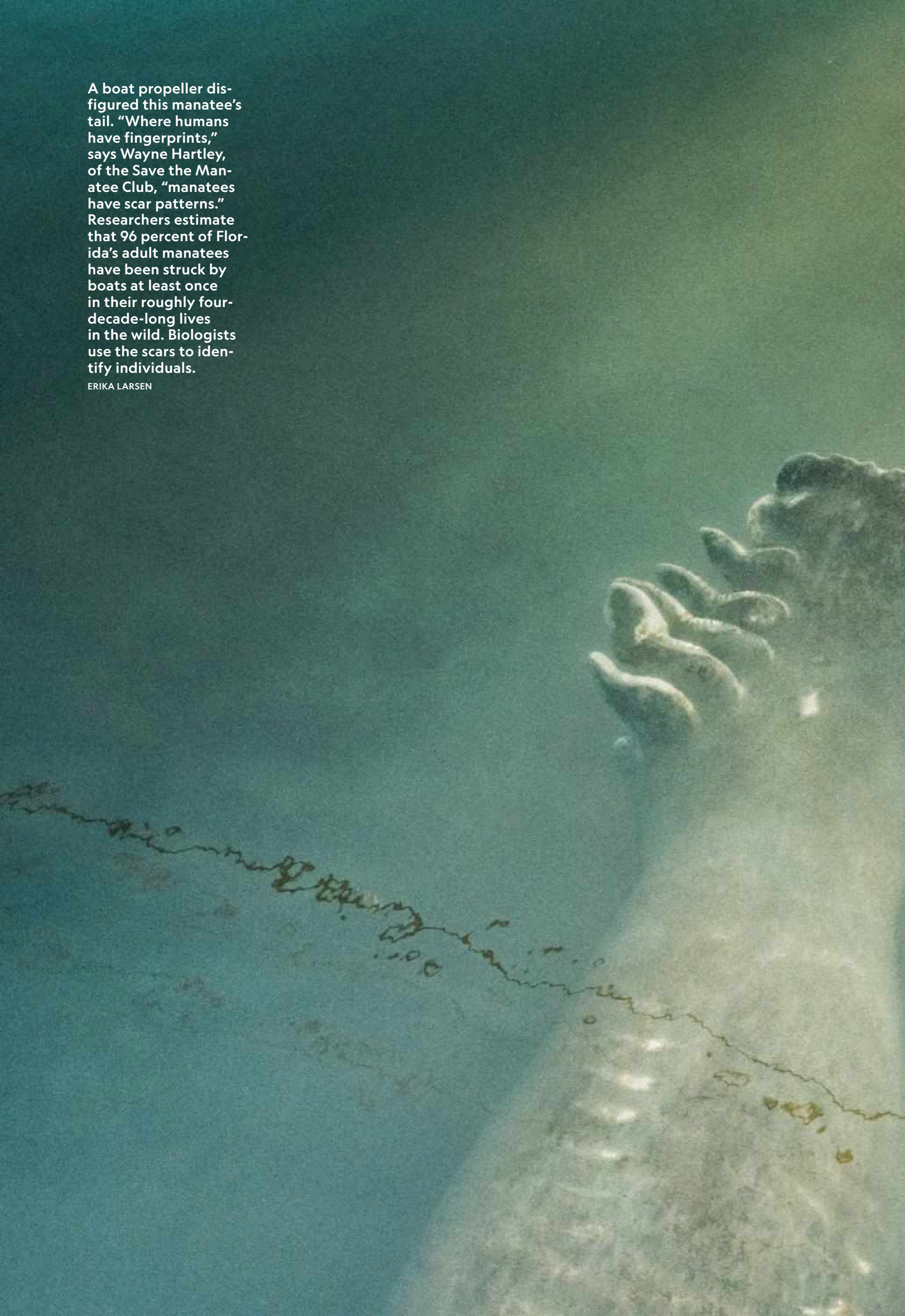
Indian River Lagoon’s abundant seagrass and sheltered waters have long made it an important habitat for manatees and fish alike. But between 2011 and 2019, more than half the seagrass disappeared. In some places, greater than 90 percent was gone. “Seagrass can no longer grow here,” Wolfson says. “The water’s too murky.”

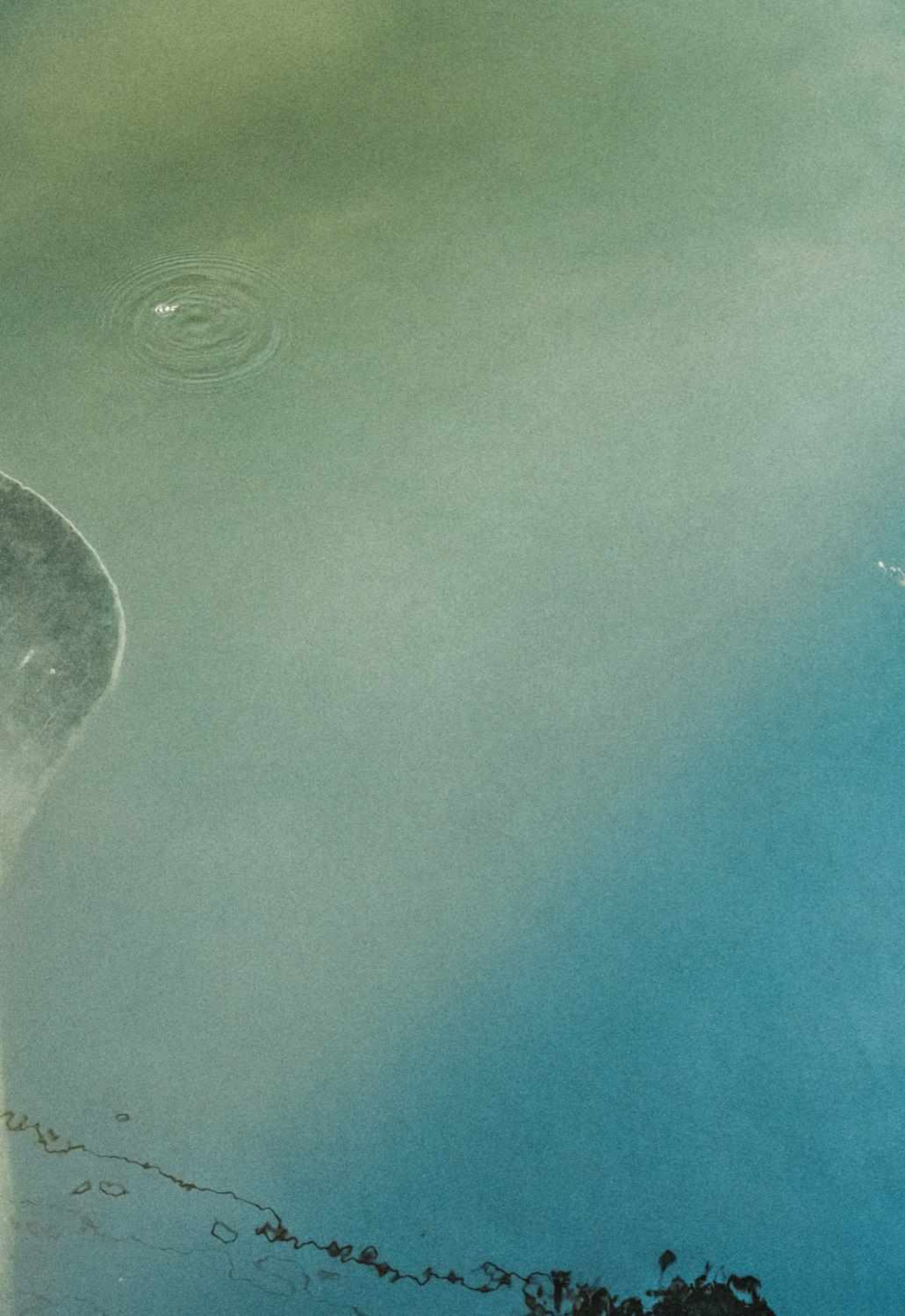
In 2010, an unusually cold winter killed hundreds of manatees. In the following years, as



A boat propeller disfigured this manatee's tail. "Where humans have fingerprints," says Wayne Hartley, of the Save the Manatee Club, "manatees have scar patterns." Researchers estimate that 96 percent of Florida's adult manatees have been struck by boats at least once in their roughly four-decade-long lives in the wild. Biologists use the scars to identify individuals.

ERIKA LARSEN





temperatures warmed and sediment, sewage, and fertilizer runoff continued to flow into the lagoon, algae bloomed out of control, blocking sunlight from reaching plant life. This place used to be thick with seagrass, Wolfson says. “Now I’m on my hands and knees looking for a single blade of grass.”

As seagrass disappeared, Wolfson and other fishermen began educating the public and pressuring state and federal representatives to take action. But seagrass isn’t charismatic. “No one seemed to care until last year, when things hit critical mass, and all these manatees started floating up,” he says. “No one does anything until they hear the m-word,” he adds. “People hear ‘manatee,’ and they start getting jazzed about environmental plight.”

The seagrass calamity in Indian River Lagoon isn’t unique: In the early 2000s, when I was a teenager spending summers at my great-grandmother’s house, algae blooms had transformed this manatee oasis into a festering wasteland. Algae grew into thick, stringy mats that would tangle boat propellers, clog up the vents of underground springs, and block sunlight, which killed any remaining aquatic vegetation. “We were worried about manatees having enough to eat,” Powell recalls.

T HIS HORROR benefited no one. Kayakers and powerboaters missed the clear water. Anglers missed catching fish. Manatee tour guides and hotel owners worried about how to make a living. Grandparents worried about their grandchildren, who wouldn’t grow up, as they had, exploring the primordial beauty of the place.

Steps to reverse the damage started small. Neighbors gathered with rakes, scooping up algae by hand. Ironically, it was Save Crystal River—the group environmentalists had opposed during their fight over the manatee’s endangered status—that spearheaded the restoration of aquatic vegetation. In confronting the collapse of the place he loved, Steve Lamb shifted his attention toward figuring out how to fix the problem. In 2015, with funding from the state legislature, Save Crystal River hired Sea & Shoreline, an aquatic restoration firm, to remove the muck and replant the river bottom with eelgrass, which grows long, ribbonlike leaves.

The prospect of replanting the entire river was daunting. “People thought we were crazy,” says Lisa Moore, president of Save Crystal River. But



after vacuuming more than 300 million pounds of detritus and planting some 350,000 individual eelgrass pods by hand, the groups have flipped the river back to an ecosystem no longer dominated by algae.

“For years and years, there was no food for the manatees,” Lamb says. “Now we have an abundance of this wonderful eelgrass and clean water. They’re having a heyday, and God bless them. This is awesome.”

Instead of spending the few short winter months in Crystal River before heading back out into the Gulf of Mexico to graze, some manatees now linger here year-round, enjoying fat times and boosting the town’s tourism economy. Aerial surveys from January 2022 revealed the highest number of manatees ever recorded in these waters—more than a thousand in Kings Bay alone. The newly restored vegetation also has allowed more animals—fish, blue crabs, snails, and others—to make their way back into Crystal River.

The Environmental Protection Agency calculates it will cost five billion dollars and



LEFT

News crews jostle for position in December 2021 to film ranger Jackie Gordon emptying baskets of eelgrass from Crystal River into the water to feed hungry manatees being rehabilitated at Ellie Schiller Homosassa Springs Wildlife State Park. A manatee eats about a hundred pounds of aquatic vegetation each day.

BELOW

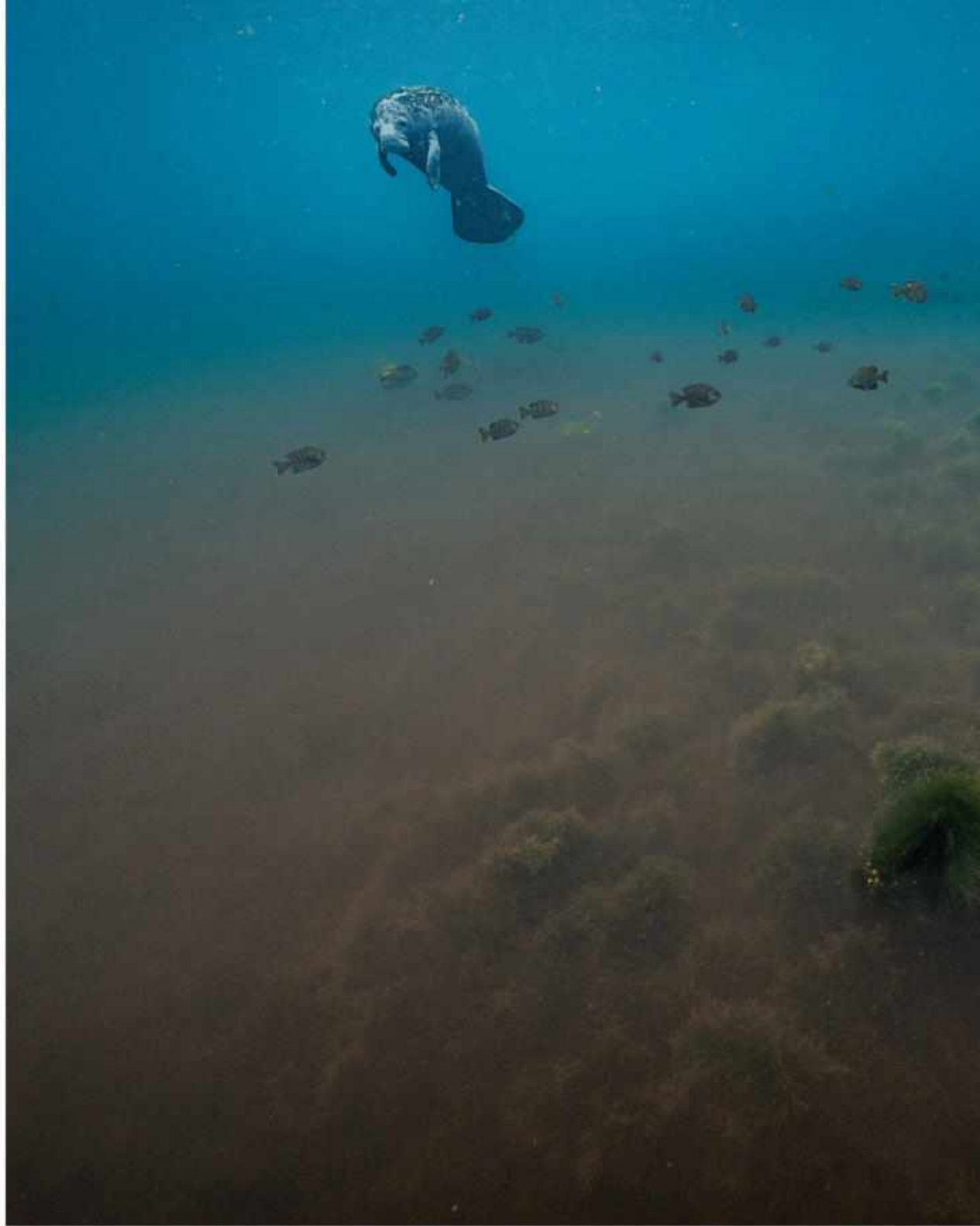
Manatees at the same park chew on eelgrass collected from neighboring Crystal River by the aquatic restoration firm Sea & Shoreline. Lettuce, sometimes fed to manatees under expert human care, is a good option for providing food in the absence of the plants manatees eat in the wild.

ERIKA LARSEN (BOTH)



In Fanning Springs, a manatee hovers with beguiling grace in a layer of warm, clear groundwater above colder tannic water from the flooded Suwannee River. Manatees look chubby because they have massive digestive tracts to process the plant matter they must eat to survive.

JASON GULLEY



take 20 to 30 years to reverse Indian River Lagoon's ecological collapse. The lagoon lies mostly within Republican-majority Brevard County, whose residents voted in 2016 to adopt a voluntary sales tax that will provide nearly \$500 million over 10 years for wastewater infrastructure projects and aquatic restoration. "Anytime you get a Florida county to tax themselves purposely—and that's a red county too—that's a win for the environment," says Carter Henne, lead biologist and president of Sea & Shoreline. Meanwhile, bipartisan legislation is fast-tracking state funding for manatee rescue and rehabilitation, as well as for projects to address the problems that have killed seagrass.

Homeowners in some counties are supplementing money from grants with their own cash to convert leaky septic tanks to mainline sewer systems. In other counties, communities are pushing to restore seagrass and dredge rivers to remove loads of nitrogen and phosphorus trapped on the bottom.

William Bunch—a Crystal River restaurant owner, community leader, and family friend—met my great-grandmother in the 1960s when he was a teenager running a landscaping business. "I remember back then, your great-grandmother refused to let us put fertilizer on her lawn," he says with a laugh. "Your grandmother was the same. They didn't want any of that stuff washing out into the river."



NEITHER PREDATOR NOR PREY, THESE PEACEABLE CREATURES ARE EVOLUTIONARILY DEVOID OF AGGRESSION.

a leading pollutant, by 59 percent—more than twice what was required by law. Adopting nutrient-stewardship techniques saves farmers money, Hopkins says. But most important, it’s “the right thing to do. If we don’t maintain the viability of our land, we’re just putting ourselves out of business.”

BETTY OSCEOLA—an educator, conservationist, and clean-water advocate who grew up in Florida’s Everglades—is a member of the Miccosukee Tribe. She says her mother and grandmother would tell stories about seeing manatees deep within the heart of the “river of grass.”


Now, roads and levees block them from swimming so far inland. “There has to be a mind shift,” Osceola says. “If you think about healing the water body, about healing the land, you’ll see much more improvement versus managing, eradicating.”

Part of the shift, she says, is for more people to understand that we’re within a living system where manatees, plant life, and all of us are interconnected. “I can’t speak for other Indigenous people, but from my upbringing, we’re always taught to look at everything around you as your relative,” she says. “You’re a part of that. We all have our place and our purpose, and we all have to help foster life for each other.”


As calves, manatees learn survival skills from their mothers. Humans aren’t so different. When I was growing up, my parents took us to Crystal River to spend time with our grandparents, who taught us about the world we were inheriting. After dinner, we’d sit outside, watching the heat lightning flicker in the distance and listening to the music of frogs and insects drift across the water. Sometimes another sound would jolt us to attention: *Pffff!*—a manatee coming up for air. □

Today homeowners and businesses are embracing Florida-Friendly Landscaping guidelines, part of an extension program to reduce water and fertilizer use. And increasingly, sugarcane, vegetable, and rice farmers—among the major contributors of nutrients that fuel algae blooms—are adopting voluntary, science-based “nutrient stewardship programs” to reduce their industry’s impact on water quality.

“We’re not the bad guys,” says Eric Hopkins, a third-generation vegetable and sugarcane grower in Palm Beach County, about 25 miles from Indian River Lagoon. “Everybody plays a part in messing things up, and everyone can play a part in fixing things.” In 2021, Hopkins says, farmers in his area reduced phosphorus,

A photograph of a Buddhist stupa in a barren highland landscape. The stupa is a multi-tiered, cylindrical structure with a conical top, situated on a rocky, sandy slope. The background features a dark, starry night sky with wispy clouds and a large, dark mountain range. The overall scene is desolate and atmospheric.


Deep in the barren highlands of northern Nepal, a Buddhist shrine reminds travelers of the possibility of enlightenment. As a new road brings the outside world to the former kingdom of Mustang, its unofficial leader worries his people could lose their way of life.



**ONCE OFF-
LIMITS
TO OUTSIDERS,
THE HIMALAYAN
KINGDOM
OF MUSTANG
IS NOW OPENING
TO THE WORLD ...**

BY MARK SYNNOTT

PHOTOGRAPHS BY CORY RICHARDS

A photograph of the interior of a Tibetan monastery. In the foreground and middle ground, several monks are seated on a raised wooden platform, facing away from the camera. They are wearing traditional maroon robes. The room is supported by large, dark wooden pillars. In the background, there are colorful murals of Buddhist figures on the walls. A bright light source in the upper center creates a starburst effect. The overall atmosphere is quiet and traditional.

**BUT WILL ITS
UNIQUE
CULTURE,
AND PRICELESS
TROVE OF TIBETAN
ANTIQUITIES,
SURVIVE
WHAT'S COMING?**



Monks chant morning prayers in Thubchen Lhakhang, a temple in Lo Manthang, the fabled, historic capital of Mustang. For centuries the monastic system has been a bedrock of Tibetan Buddhism and education, but fewer young men are now joining the monastery.

THE KING OF MUSTANG WILL SEE YOU NOW

DRESSED IN WELL-WORN JEANS and a green fleece jacket, the king stood in the center of a low-ceilinged room in his centuries-old palace. He was reciting a Buddhist chant and methodically fingering a string of prayer beads. Around him, the walls and wooden pillars holding up the sagging roof were decorated with intricate paintings of Buddhist deities. Some wore gold robes and reclined blissfully. Others, bearing swords and surrounded by flames, howled with rage.

It was mid-October, and tucked away in this barren range of foothills on the northern edge of the Himalaya, the cold, earthen walls of the drafty palace hinted at the onset of winter.

A window offered a view over the 600-year-old walled city of Lo Manthang, the historic capital of Nepal's fabled Mustang region, situated just 10 miles from the Chinese border. Tight rows of whitewashed mud-brick and rammed-earth buildings extended below. Smoke curled from the rooftops, and groves of Himalayan poplars, their luminous golden leaves near their peak, shimmered in the afternoon breeze. To the southeast, braids of the Kali Gandaki River



Wearing a *chuba*, a traditional Tibetan coat, Jigme Singhi Palbar Bista holds the prayer beads of his father, the last official king of Mustang. The Nepali government dissolved the monarchy in 2008, yet the people still look to Jigme for guidance and leadership.



 **The National Geographic Society,** committed to illuminating and protecting the wonder of our world, has funded Explorer Mark Synnott's expeditions since 1999 and Explorer Cory Richards's photography since 2014.

ILLUSTRATION BY JOE MCKENDRY

spread out like a fan across the valley, flowing toward an imposing wall of snowcapped peaks that gleamed against the deep-blue sky.

Such a view was once off-limits to foreigners like me. For much of the 20th century, access to Mustang was tightly controlled by the Nepali government. But now, the king had brought me to his deteriorating palace to show me one of the many challenges his kingdom faces in the modern age.

The king's full name is Jigme Singhi Palbar Bista, but he'd introduced himself to me simply as Jigme. He is slender, with thinning gray hair, and possesses an energy that belies his six decades. He'd nimbly led me on a dimly lit obstacle course through the palace, which his family had been forced to leave after it was severely damaged during an earthquake in 2015. We'd climbed trembling wooden staircases, navigated gaping holes in the floor, and skirted crumbling walls decorated with mud-streaked murals.

Despite the palace's decrepitude, the room where we now stood seemed to be extremely well preserved. Jigme noticed me looking at a portrait of a man and a woman wearing traditional Tibetan robes. "My parents," he said. "This was my father's prayer room. He was the last king of Mustang, the 25th in our lineage. I am the 26th."

To my left, a sandalwood cabinet, covered in gold leaf, stretched from floor to ceiling. Inside, a jumble of bronze figurines depicting Buddhist deities gazed out through glass doors. A cluster of votive lamps burning yak butter filled the room with the distinctive smoky, sour scent that imbues Buddhist temples across the Himalaya.

Jigme explained that the figurines were more than just works of art—they were living spirits that have watched over his family since antiquity. Before placing each statue on the altar, he said, a high monk would perform a ritual to animate it with an enlightened body, speech, and mind.

Now it is Jigme who watches over these deities, at least in their physical form. In the secular world, a black-market antiquities dealer could sell this small collection for a sizable fortune. For centuries, the idea of someone taking them was of little worry here in this isolated, devoutly Buddhist city. But the outside world finally had ascended to Mustang's doorstep, and art theft was just one of many new things that the king now had to worry about.

As Jigme and I shared this quiet moment in his prayer room, I could just make out the low rumble of earthmoving equipment improving

Protected only by a rope and Mustang's remote location, centuries-old artifacts belonging to the royal family gather dust in a storeroom. Priceless religious relics, long considered safe in the region's devoutly Buddhist community, increasingly may be vulnerable to theft by outsiders.



the road that approaches the city from the south. The nearly 300-mile journey from Nepal's capital, Kathmandu, which once required weeks either on foot or on the back of a horse or yak, can now be completed—albeit not by the faint of heart—in just three days of driving. Vehicles, preferably with four-wheel drive, traverse a dizzying series of switchbacks on a rough, narrow track carved along the cliffs lining the Kali Gandaki Gorge. During my journey, I was delayed by landslides that blocked the route for hours, leaving a winding line of cars stranded across the cliff face. Nevertheless, the road is a



paradigm-shifting improvement for the people of Mustang, allowing for the flow of cheap goods and easier access to modern medical facilities, among many other conveniences.

This stream of goods and people may soon become a surging river of commerce. To the north, the Chinese have anticipated a lucrative new trade route and are waiting with a freshly paved road that connects their side of the border with highways that lead all the way to Beijing. What remains is to join the roads, and a new era of trade can begin in this legendary corner of the roof of the world. The question for Jigme and the

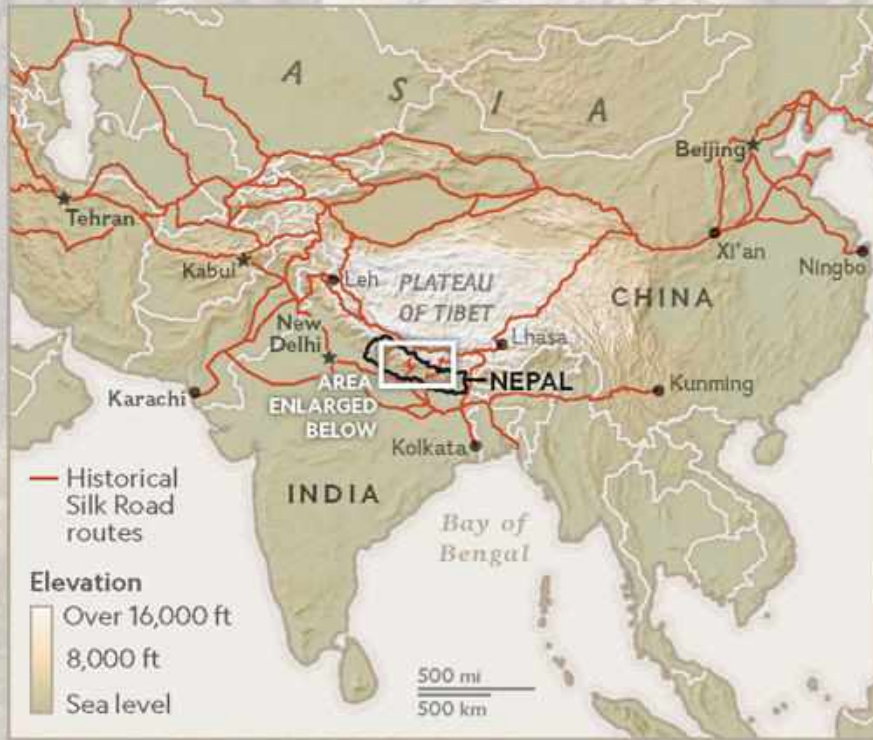
people of Mustang is whether they can preserve the parts of this tiny kingdom that for centuries have made it special.

Around us, the painted deities smiled and snarled. Jigme sat down on a bench and lowered his eyes. I thought he might be meditating or praying, but then, with a quick motion, he pulled out his iPhone and checked his messages.

IT WOULD BE fitting for Mustang to become once again a hub for trade. The palace Jigme had shown me was a relic of the city's golden age, dating back to the 15th century. At that time,

ANCIENT GATEWAY

Once a pivotal link in the Silk Road network, Nepal's Mustang district also served as a crossroads for Buddhist scholars, dating back to the 11th century. Following one of the few routes through the Himalaya, merchants traversing Mustang traded Tibetan salt and wool for spices and grains from the Indian subcontinent until the 1950s, when China's annexation of Tibet closed the corridor.



Enriched by trade
In the 15th and 16th centuries, the independent Kingdom of Lo grew wealthy by controlling the upper part of Mustang. Taxes on the trade route funded religious artwork and the construction of Buddhist temples.



Tibetan Connection

The Lo-pa people of Mustang are culturally Tibetan but cut off from Chinese-controlled Tibet. They mainly practice Buddhism, unlike the rest of Nepal, which is predominantly Hindu.

the upper portion of the region was known as the Kingdom of Lo. Its people, the Lo-pa, ethnic cousins of Tibetans, had amassed great wealth by controlling trade through the Kali Gandaki Valley. Flanked on the west by the world's seventh highest peak, Dhaulagiri I (26,795 feet), and on the east by the 10th highest, Annapurna I (26,545 feet), the gorge offered one of the most direct trading routes between the rich salt deposits of the Tibetan Plateau and the markets of India. Here, the Lo-pa taxed the yak caravans, which, in

addition to salt, carried barley, turquoise, and the glands of musk deer (used for medicine and perfume). The name Mustang derives from a Tibetan word meaning "plain of desire," a reference to the potential riches to be gleaned there.

But even before Mustang had evolved into a vibrant trading hub, it had been an important crossroads for Buddhist scholars and pilgrims moving between India and China. Eventually, Buddhist teachings were fused with the region's animistic practices, and Tibetan Buddhism was



born. Over time, the kingdom embraced this new faith and built ornate temples and monasteries. According to local legend, the first Tibetan Buddhist temple in the kingdom was constructed a few miles south of Lo Manthang by an Indian mystic who destroyed a demoness there. Today this temple, known as Lo Gekar, sits among a stand of twisted willow trees at the end of an isolated canyon, where locals believe it still pins down the heart of the slain demoness.

By the 18th century, with powerful states

rising on Mustang's borders, the king of Lo traveled to meet the king of the newly united Nepal. Jigme described how his predecessor brought offerings of milk, mustard seeds, and soil to demonstrate that Mustang had land and wealth to share. Impressed by the gesture, the Nepali king offered Mustang protection in exchange for nominal taxes and an annual tribute.

Two centuries later, this affiliation would save Mustang from the ravages of China's control of Tibet, which began shortly after Mao Zedong

invaded in 1950. Over the next decade, as thousands of Buddhist sites in Tibet were closed, Mustang's treasures remained untouched.

But the kingdom's isolation wouldn't prevent it from getting pulled headlong into the Cold War. In the early 1960s, a secret army of CIA-trained Tibetan guerrillas trekked into Mustang. Supported by U.S. airdrops of arms, supplies, and trained radio operators, they planned to launch cross-border raids on the Chinese army and then set up bases in Tibet. Despite capturing some important intelligence documents, they achieved little and were disarmed by the Nepali government in 1974. The political fallout led the Nepali government to seal the region more tightly than ever before.

This was the world in which Jigme was raised, a forbidden kingdom isolated among some of the planet's most forbidding terrain. As king, his father kept an eye on the border, but his primary job was to keep the peace. He traveled constantly between villages, settling local quarrels and disputes over property. "He rarely spent even two days at home," Jigme told me. "He would hear of a problem or a fight, jump on his horse, and go there. His word was the final say in the kingdom."

When he wasn't settling disputes, the king oversaw religious ceremonies. One of the most important is a lavish three-day festival known as Tiji, where dozens of monks, hidden under ferocious masks, dance before the king in the square just outside the palace in Lo Manthang, to celebrate the triumph of good over evil.

When he was 21 years old, Jigme left Mustang to attend college in Kathmandu. Each winter his father would visit, making the three-week journey across the mountains as his ancestors had done to honor the treaty with the Nepali king. "He'd bring local products for the king—wool carpets, blankets, and horses," Jigme said. "And while he was there, he would reconcile accounts for how government funds were spent and ask for money for new projects."

Things began to change in 2008. After a decade of civil war, Nepal adopted a new constitution, reinventing itself as a federal republic. All monarchies were abolished, and Jigme's father was stripped of his official position. Suddenly, the role for which Jigme had been preparing was eliminated, at least officially.

"It didn't upset me," Jigme said. "I recognized that times were changing and had my own life to focus on. We were never proud of our position,



and we didn't receive any compensation for it. So we accepted it."

After his father passed away in 2016, Jigme was thrust into an awkward position. Most of the Lo-pa regarded him as the rightful king but one with no official power. Yet they still depended on him to lead religious rituals and occasionally to adjudicate local disputes. And the people's veneration of him is plain. Earlier in the day, as we walked through the narrow alleyways of Lo Manthang, everyone we passed reverently removed their hats and bowed their heads to him. Jigme, smiling and jovial, greeted each person by name.

SO HOW DOES A KING—who has no real power or authority—preserve his kingdom's cultural heritage? Jigme's decaying palace is just one example of the challenges he faces. Said to



LEFT

A Chinese truck spews exhaust as it barrels north toward the border, leaving behind Nepal's snowcapped Annapurna massif. When this road is connected to its completed counterpart in China, it will offer one of the most direct overland routes between Beijing and New Delhi.

BELOW

In the fall of 2019, Nepali traders huddle against the wind as they await permission to cross the tightly guarded border into China, later closed because of the COVID-19 pandemic. New construction on the Chinese side of the barbed wire obscures the view of a newly paved road into China.



have been built in 1441 by the son of Ama-Pal, the legendary first king of Mustang, it's listed by UNESCO as a potential World Heritage site, but due to damage from the earthquake and an increasingly wet climate, it needs extensive funds just to prevent further decay. Meanwhile, beyond the walls of Lo Manthang, the kingdom's numerous valleys and canyons hold many more ancient palaces and temples, each inhabited by its own deities and filled with its own treasures.

I'd heard about one site in particular—an abandoned Buddhist nunnery called Gompa Gang, which sits on a bluff above the Kali Gandaki River, midway up the valley. The next morning before sunrise, Jigme's cousin, Tsewang Jonden Bista, and I set off to see it.

With the landscape coming alive in the early light, we drove along the Kali Gandaki as it flowed lazily across a wide plain, and passed foothills stratified into a layer cake of grays, browns, yellows, and reds. Herds of shaggy pashmina goats trotted alongside the road, tended by dust-covered teenage boys and girls. Terraced fields lined the fertile land along the river. It was harvest time, and whole families—children included—were headed into green fields of buckwheat and orchards brimming with apples.

We parked at the base of a towering mud cliff. High above, its face was pitted with dozens of dark, windowlike openings. Tsewang, who runs a trekking company, switched to tour guide mode and explained that Mustang is famous for these mysterious “sky caves.” Thousands of them are bored into cliffs across the region. Carbon dating suggests that some were excavated more than a millennium ago. In 2008 a *National Geographic* team managed to access a cave 700 feet above the ground. Inside, they found a large room containing thousands of manuscripts with Buddhist and pre-Buddhist writing and imagery. Other caves held skeletons, but no one knows exactly who dug them or why they went to such lengths to create these caches.

We made our way up a trail to a ridge overlooking the river. There, a thick grove of willows surrounded a whitewashed earthen structure. We pushed open an iron gate and walked into the courtyard. A weathered prayer flag was mounted on a wooden pole driven into a pile of stones and bleached yak horns. The flag snapped in the wind as Tsewang explained how, during the nunnery's zenith in the 1700s, pilgrims traveled to this site from all over India, Nepal, and Tibet to pray

A young Lo-pa girl waits outside while her family unloads Chinese goods at their shop near Lo Manthang. Motorcycles have largely replaced horses in Mustang, once known as the Kingdom of Lo, where horsemanship and horse culture were long revered.



and receive blessings. As Mustang's prosperity waned, the nunnery slowly fell into disrepair.

We stepped through a low door into the main hall, where a colossal, two-story statue of the Maitreya Buddha dominated the room. Its head extended through an opening in the ceiling into a second-floor chamber, where rays of sunlight illuminated its face. Tsewang explained that this incarnation of the Buddha represents a future teacher who will spread wisdom across the world after a long period of famine and war.

Tsewang shined a flashlight onto the wall, and I saw the room was covered in murals. One



depicted a Buddha who sat cross-legged atop a cloud beside a bare-breasted woman holding a conch shell in one hand and offering a silver bowl in the other. There were endless figures set in complex and colorful, if faded, scenes. As we worked our way through the darkness, Tsewang pointed his light to images representing the cosmos, the wheel of life, and hundreds of deities. “There is Guru Rinpoche,” he said, illuminating a figure in blue and red robes, the principal founder of Tibetan Buddhism, who is believed to have traveled through Mustang in the eighth century.

Upon closer inspection, I noticed that many

of the paintings were disintegrating. One was riddled with pockmarks. Another was furrowed with cracks, and in places the plaster bulged like a blister. For centuries, this region near the Tibetan Plateau got little rain, but the climate here is changing rapidly, and the rammed-earth structure is facing moisture levels it was never designed to handle.

“In the past, the rain and melting snow would only soak through one layer of brick,” Tsewang said. “Now the storms are fewer but bigger. Sometimes we’ll get a winter’s worth of snow in one big spring storm. When it melts all at

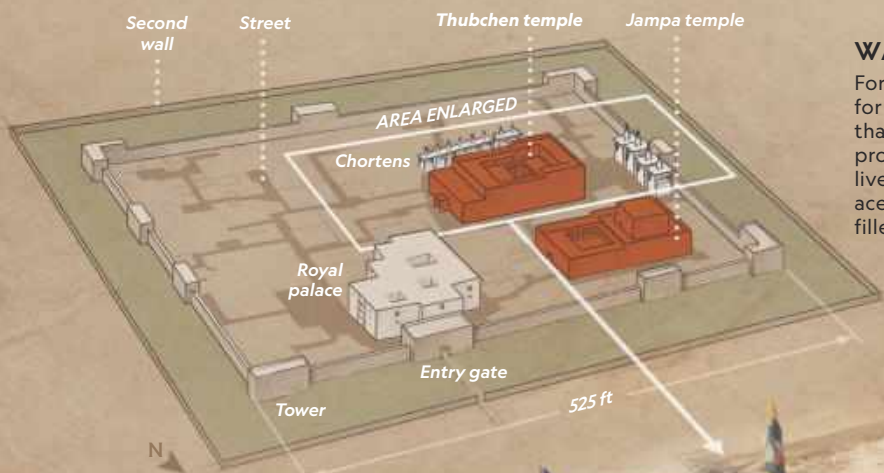
15TH-CENTURY MASTERPIECE

In its heyday, Lo Manthang, the Kingdom of Lo's capital, was a center of Tibetan Buddhist art and architecture, including Thubchen Lhakhang, a temple reconstructed here in its original glory. Today, after centuries of isolation, the region is opening up, threatening the Lo-pa people's cultural heritage.



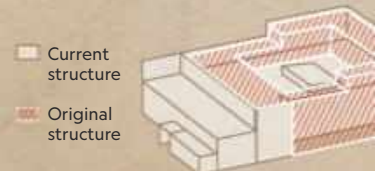
TIMELESS TEMPLE

One of the best surviving examples of traditional Tibetan Buddhist architecture, Thubchen Lhakhang has survived centuries of use, earthquakes, and the elements.



WALLED CITY

Fortified cities were typical for the period. Lo Manthang's thick, earthen walls protected inhabitants and livestock, as well as its palace and sacred buildings filled with treasures.



MUSTANG HOME

A livestock shelter lies below the family's living quarters that are accessed by ladder. Cooking and heating stoves are fueled with animal dung.



ENTERING THE

Large guardia vestibule rep cardinal direc rooms are a p tion to the or

FERNANDO G. BAPTISTA, PATRICIA HEALY, EVE CONANT, RILEY D. CHAMPINE, NGM STAFF

SOURCES: BEN AYE ARCHITECTURE, CH

PROTECTIVE CARVINGS

Three dozen wooden lion heads guard an opening in the ceiling that provides light for the prayer hall below.



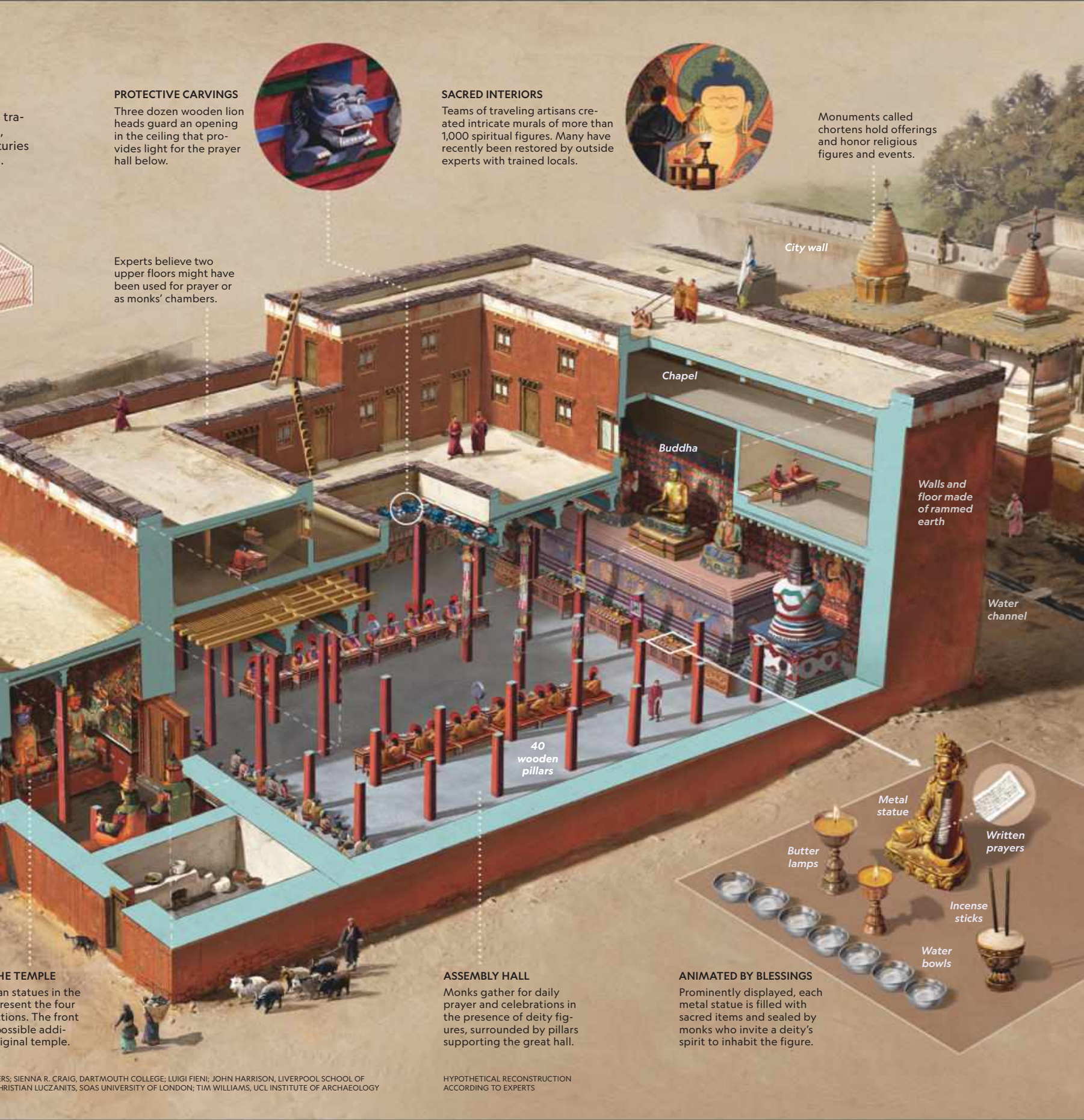
SACRED INTERIORS

Teams of traveling artisans created intricate murals of more than 1,000 spiritual figures. Many have recently been restored by outside experts with trained locals.



Monuments called chortens hold offerings and honor religious figures and events.

Experts believe two upper floors might have been used for prayer or as monks' chambers.



City wall

Chapel

Buddha

Walls and floor made of rammed earth

Water channel

40 wooden pillars

Metal statue

Written prayers

Butter lamps

Incense sticks

Water bowls

THE TEMPLE

Four statues in the front represent the four directions. The front is the most possible additional temple.

ASSEMBLY HALL

Monks gather for daily prayer and celebrations in the presence of deity figures, surrounded by pillars supporting the great hall.

ANIMATED BY BLESSINGS

Prominently displayed, each metal statue is filled with sacred items and sealed by monks who invite a deity's spirit to inhabit the figure.

ILLUSTRATIONS BY SIENNA R. CRAIG, DARTMOUTH COLLEGE; LUIGI FIENI, JOHN HARRISON, LIVERPOOL SCHOOL OF ARCHITECTURE; CHRISTIAN LUCZANITS, SOAS UNIVERSITY OF LONDON; TIM WILLIAMS, UCL INSTITUTE OF ARCHAEOLOGY

HYPOTHETICAL RECONSTRUCTION ACCORDING TO EXPERTS

Found in a pile of discarded artifacts in one of the royal family's disused palace complexes, this clay effigy of the Buddha may date back to the 14th century, when such figures were often found in homes and temples.





Sacred monastic texts lie stacked beneath depictions of many forms of the Buddha in a fortified *gumpa*, or monastery, where the texts are used in religious ceremonies. Each loose-leaf book, or *pecha*, contains hand-inked pages—many illuminated with paintings—and hand-carved wooden covers wrapped in cloth.



A crumbling palace in the village of Tsarang perches on a hilltop overlooking the Kali Gandaki Gorge, with peaks of the Annapurna massif rising in the distance. A severe earthquake in 2015 damaged this and other structures in Mustang.



RIGHT

Novice monk Ngwang Phinjo holds a fading treasure from Mustang's past. The canvas painting, called a *thangka*, depicts a deity holding the moon, which contains an image of a rabbit. Possibly used for personal meditation or monastic instruction, such paintings risk deterioration from time and exposure to the elements.

BELOW

Clubs and swords hang in a chapel along with a mummified hand and masks of protector deities that counter ignorance, intruders, and evil. According to one story, the hand belonged to an enemy who attacked the kingdom.





once, this is what happens.”

Moisture seeps deep into the earthen walls and penetrates the dry interior. When the water evaporates, salt crystals form behind the paint, causing the murals to peel. This process is occurring at sites across the Himalaya and is virtually impossible to stop once started. “Even the weather is conspiring against us,” Tsewang said.

In a passage behind the towering Buddha, Tsewang pointed to a spot on its hip where the statue was crudely patched with mud. “About 20 years ago,” he said, “thieves broke in here and stole the *gsung*”—the treasures that consecrate and animate the statue.

Traditionally, ritual sculptures, regardless of size, have a hollow center. During the consecration process, they are filled with written prayers and valuable objects like agate beads, bronze

figurines, gold, and precious stones. The treasure helps animate the statue, but the valuables also can be used to rebuild the monastery should it ever be damaged or destroyed.

According to Charles Ramble, a scholar who researched the theft, and local leaders, a Tibetan lama arrived at Gompa Gang around 2000 and offered to reestablish a community of nuns. Thrilled by the offer, local representatives let him see the *karchak*, a book that includes key facts about the building, including the location of the *gsung*. Afterward, the visiting lama departed, promising to return soon. A short while later, a caretaker discovered the hole in the Buddha’s hip. There was no record of what had been hidden inside the statue, but whatever treasures had been animating this deity for centuries were gone. The lama was never heard from again. Ever since, Gompa Gang has been considered powerless. Tsewang told me hardly anyone goes to pray there anymore.

“DID YOU SEE THE BUS?” Jigme asked, as we sat drinking tea one afternoon. Earlier that day we’d watched an Indian-made bus grind and sway up the dusty switchbacks leading into Lo Manthang. The bus had left the town of Jomsom, a 60-mile drive south of Lo Manthang, before dawn, and every seat was packed with locals mixed in with a few Nepali tourists. A large banner decorated with Nepali script was strung loosely across the flat nose of the vehicle, announcing it as the first public bus ever to make the journey. “As a child, I never imagined that one day we could *drive* here from Kathmandu,” Jigme said.

But for years that perception had been changing. As China’s economy boomed and other parts of Nepal developed, Jigme, and everyone else in Mustang, could see that a road was inevitable. In fact, we were sitting in the most tangible example of that knowledge: the Royal Mustang Resort. Jigme had built this 22-room hotel just outside the city walls of Lo Manthang on land that had been passed down to him by his father. It resembles a whitewashed citadel, with miniature watchtowers on each of its four corners, and its broad rooftop terrace offers a postcard-worthy view of Kali Gandaki Valley. We sat in plush leather chairs in the reception area, sipping our tea in front of a woodstove stoked with a crackling fire of dried willow branches.

Tourists were finally allowed to visit Mustang in 1992, but relatively few permits have

A prayer group of elderly Lo-pa women meets in a hall outside Jampa Lhakhang, a temple in Lo Manthang, to eat porridge and recite mantras. Having lived through a time of great change, their generation may include some of the last permanent residents of Mustang.





been issued each year. The pace has remained slow until now, but Jigme is confident that will soon change. And while Nepal is famous for Mount Everest expeditions, much of the country's half-billion-dollar tourism sector is driven by trekkers and religious pilgrims—for whom Mustang has a special appeal. Mustang, Jigme noted, offers spectacular landscapes but also a window into Tibetan culture that has largely evaporated elsewhere.

Despite Jigme's optimistic outlook, it seemed that the return on this sizable investment was still a long way off. At that moment, Tsewang and I were the hotel's only guests. And Jigme isn't the only one banking on tourism. At the time of my visit, there were dozens of hotels in Lo Manthang, a town with only 1,300 official residents. And Mustang's harsh climate makes visiting feasible for only about six months each year. Winter temperatures regularly drop far below zero, freezing pipes and making hotel toilets inoperable. During summer, landslides triggered by monsoons often block the road for weeks.

While Jigme hopes the road will bring people to Lo Manthang, it makes it easier for the town's dwindling population to leave. Over the past several years, young adults have been departing in droves to seek their fortunes in Kathmandu, Japan, Korea, and the United States. The valley's economy has long relied on the large herds of goats and yaks, but now that brutal work is rapidly losing its appeal. (By one count, more than 2,000 Lo-pa live in New York City, which is more than the entire population of Lo Manthang.) If this trend continues, Jigme predicts, the region will lose 80 percent of its population over the next 20 years.

The picture has been further muddled as the promise of tourism has spurred rampant land speculation. "There was once an unwritten rule that Lo-pa could not sell property to outsiders," Jigme explained. But as values skyrocket, this taboo has been ignored. Jigme told me that a single acre of rock-strewn pasture, not far from where we sat, had recently sold for \$700,000. "Can you blame a farmer who only makes \$700 a year for selling out and moving to Kathmandu or New York City?" he asked.

I HAD MENTIONED to Jigme that I wanted to visit the Chinese border, so one morning he sent Tsewang and me off in a four-by-four. We traveled along a smooth gravel road that led us northward

toward a range of brown hills, their crests dusted with snow. After an hour we rolled up to a Nepali Army checkpoint. A young soldier saw me in the back seat, frowned, and said something in Nepali. "He says that foreigners aren't allowed to visit the border," Tsewang said. "This is new since the last time I was here."

We turned around, and a few miles back down the road we stopped for noodles at a small restaurant. The proprietor, when he heard the story, said that there was an alternate path to the border. "I can show you," he said. Soon he and I were speeding along a dusty trail on the man's motorbike, me on the back, my arms wrapped tightly around his leather jacket. Heading north, we ascended rutted switchbacks that led us up and over the Kora La, at 15,290 feet. A couple of miles beyond the pass, the road abruptly ended at a barbed wire fence stretching across the barren land as far as we could see.

The wind howled. Broken beer bottles and plastic wrappers littered the ground. A sign in English read: "No Parking in the No Man's Land" and "No Photography." Some Nepali tourists, who'd also arrived by motorbike, ignored the sign and took selfies around a squat concrete pillar that marked the Nepal-China border. A few hundred feet behind the fence, on the Chinese side, three monolithic buildings, each roughly the size of a Walmart and clad in what appeared to be white marble, completely blocked our view to the north. Numerous video cameras mounted on metal poles pointed in our direction.

Later, I found satellite images that revealed what lay beyond the giant marble buildings—structures that locals said were military barracks and a long black ribbon of pavement heading north across the Tibetan Plateau.

It's no coincidence that Nepal's roadbuilding boom is occurring concurrently with Chinese president Xi Jinping's Belt and Road Initiative, a massive infrastructure campaign designed to expand China's economic and political influence from East Asia all the way to Europe. When complete, it will include multiple roads across the Himalaya, but perhaps none will offer a more direct route to India than the one I had just followed from Kathmandu to this spot on the border.

Also, weighing in the background is the 2014 discovery of a large deposit of uranium in Mustang. China is rapidly building nuclear plants to meet its growing energy needs and carbon-reduction pledges. Though no mines have

opened yet, it seems logical that at some point uranium will become another of Mustang's coveted treasures.

That evening Jigme invited me to dinner at the Royal Mustang Resort. Next to our table, a propane heater warded off the chill in the dining room decorated with Tibetan paintings and sepia-toned photographs of the royal family.

As we ate, Jigme predicted that within a few years the Chinese would build a business park on the Kora La with Western-style hotels, casinos, and maybe an airport. "Tourism will grow massively," he said. And a boom in tourism and industry might be exactly what Mustang needs. But, he acknowledged, it could also bring a tsunami of outside influences that might subsume what it means to be Lo-pa, yet it was a risk every Lo-pa I spoke with felt they had to accept. "In order to save our culture, we need tourism," Jigme said. "And in order to have tourism, we need the road."

ON MY LAST MORNING in Mustang, I met Jigme for breakfast at his hotel. Over coffee and eggs he told me that he had something special to show me. Like many people in Mustang, Jigme was reluctant to share information about his own artifacts. To date, he told me, he hadn't allowed anyone to see the treasures passed down to him from his family's royal dynasty.

He took me to a location I promised not to reveal. We opened a creaky wooden door in the floor leading to a crude stairway. We clicked on headlamps, and I carefully followed Jigme down to a windowless room. We had to crouch to avoid hitting our heads on the hand-hewn beams. The air was stale and heavy with dust. Jigme lit a single yak butter lamp, and out of the darkness a row of almost-life-size bronze statues appeared—a pantheon of deities, decorated with gold, silver, turquoise, and coral. They glowed in the yellow light. In the shadows beyond, I could see the rest of the room was filled with dusty wooden boxes, like cargo stacked in the hold of a ship.

"I've inherited all this," said Jigme, with a sweep of his hand, "and I have to do something great with it. I'm showing you because my dream is to create a living museum where I can display these items and keep them alive. Then, someday, I can hand it all over to my children. But that takes a lot of money, which I don't have." Laughing, he added, "What I really need is a dollar machine."

For the moment, there was nothing for Jigme to do but pray and hope that he can somehow

'IN ORDER TO
SAVE OUR CULTURE,
**WE NEED
TOURISM,**
JIGME, THE KING, SAID.
'AND IN ORDER
TO HAVE TOURISM,
**WE NEED
THE ROAD.'**

find a way to protect what he has. Maybe the road will eventually bring enough tourists to fill his hotel, and it can become the dollar machine he needs to preserve his family's treasures.

None of this seemed to weigh too heavily on Jigme as he approached the statues and bowed his head to light a second lamp. As he prayed softly in Tibetan, I wondered if he felt the body, speech, and mind of these ancient deities flowing into him, like they once might have done into the Mustang kings before him. As the wick crackled and the flame cast dark forms on the crumbling walls around us, I thought about this kingdom—not just its historical treasures but also the mesmerizing grandeur of its wild landscape and soul-calming stillness. There's so much here to preserve. And even more to lose. □

Mark Synnott's April 2022 story was about a climbing expedition in Guyana to study life atop an Amazonian tepui. **Cory Richards** photographed "A Line in the Mountains" for the March 2021 issue.

BOLIVIAN SKATEBOARDERS ARE REVIVING INDIGENOUS

Ramping Up Tradition

BY PAULA RAMÓN

PHOTOGRAPHS BY LUISA DÖRR



FASHIONS TO MAKE A STATEMENT.



Huara Medina, 25, who rides with a women's skateboarding group that uses performances to promote Indigenous identity, poses with her braids aloft. The hairstyle stands for pride and empowerment in a country where almost half the population has Indigenous roots.

Members of the women's group, ImillaSkate, practice their moves on a ramp near the city of Cochabamba. The word *imilla* means "young girl" in Aymara and Quechua, the most widely spoken Native languages. Their skirts, known as polleras, celebrate ties to their Indigenous ancestry.





COLORFUL POLLERAS

ARE SYMBOLS

OF CULTURAL
IDENTITY

IN BOLIVIA'S

COUNTRYSIDE.

The history of the voluminous, traditional skirts worn by Indigenous Aymara and Quechua women is complex: Dating to the Spanish conquest in the 16th century, polleras were imposed by colonial rulers to reflect a style worn in Spain.

The skirts eventually were adopted as part of Andean attire, most commonly associated with *cholitas*—Indigenous women from the highlands. Polleras inspire cultural pride, but they're also a reminder of rural oppression.

Now a group of women athletes in Bolivia has brought pollera fashion to the city, donning the skirts during skateboarding exhibitions to celebrate the heritage of *cholitas* and put a modern face on the ancestral garments.

"The pollera is associated with the countryside, with ignorant people without resources," says Daniela Santiv  nez, a co-founder of Imilla-Skate, a skateboarding troupe that has made the skirts a centerpiece of its performances. "We want people to understand that there is nothing wrong with wearing a pollera—we have them in our roots. If anything, we need to feel proud."



ABOVE

Lucía Rosmery Tinta Quispe helps her daughter, Joselin Brenda Mamani Tinta, with earrings at their home on the outskirts of Cochabamba. Brenda says skateboarding “makes me feel capable, because I can break my own limits,” and the clothing represents where she comes from.

RIGHT

Belén Fajardo Fernández, one of ImillaSkate’s nine skaters, tries on a hat during a visit to La Cancha market in Cochabamba. The traditional hat worn by Indigenous women, she says, “is the ornament that projects the beauty of the pollera women. It gives a touch of elegance and therefore creates a cultural identity.”



NGM MAPS

Just as their ancestors gave the skirts their own identity by mixing them with patterned blouses, local jewelry, and hats, the skateboarders modify their polleras.

“The polleras are very valuable to me,” says Deysi Tacuri López, 28, another member of the skating group, which was founded in 2019 in the city of Cochabamba. “I wear them with pride.”

Tacuri sees the polleras as not only a cultural expression but also a form of empowerment. In the Americas, according to the Economic Commission for Latin America and the Caribbean, Bolivia has one of the highest proportions of Indigenous people. Nearly half of Bolivia’s population is of Indigenous descent.

Tacuri and fellow members of ImillaSkate are among those with Indigenous ancestors. Some of their relatives still wear polleras.

“They are my mother’s and my aunts’ clothing, and I see them as strong women. Here in Bolivia, many women in polleras are the head of their families,” Tacuri says. “For me, women

in polleras can do anything.”

Tacuri and her teammates spend hours practicing moves at Ollantay Park, one of two places in Cochabamba with ramps and other structures designed for the sport.

The polleras billow and twirl with every turn, jump, and occasional tumble. Riding—and performing complex tricks—in the heavy layers was not easy at first, Tacuri admits. But it’s unique.

Santiváñez, 26, one of the original ImillaSkate members, learned to ride as a child from her brother. At the time, it was “rare to see girls on skateboards.”

In Bolivia, skateboarding has been popular for about two decades. But without women role models to follow in the sport in Cochabamba—and having grown tired of listening to her mom’s complaints about her bruises from falls—Santiváñez stopped riding when she was a teenager. She took it up again after college, where she earned a degree in graphic design. By then, she’d discovered she was not the only



Surrounded by flowers, 25-year-old Elinor Buitrago Méndez floats while wearing customary Indigenous dress. The fashion's origin in Bolivia dates back to the 16th-century Spanish conquest.





woman with a passion for the sport.

“One day I was having a conversation with the girls about why all the boys get together to skate—why don’t girls do that?” recalls Santiváñez, who now is studying commercial engineering at the Domingo Savio Private University. After finishing this degree, she hopes to launch an audiovisual production company.

The group’s name captured its aspirations: *Imilla* means “young girl” in Aymara and Quechua, the two most widely spoken Native languages in Bolivia. The founders began practicing together, and that attracted more members.

During the past three years, ImillaSkate has grown to nine skaters. Being an active member means weekly practice and shared respect for diversity and tradition.

The group is based in Cochabamba, but through social media it has garnered an audience well beyond Bolivia. ImillaSkate has more than 24,000 followers on Instagram, 8,000-plus followers on Facebook, and a YouTube channel where some of its videos get thousands of views. It also has a presence on TikTok, with about 4,500 followers.

Santiváñez notes that members wear polleras only for performances: “We do it as a demonstration, as a cry for inclusion.”

Skateboarding “brings all kinds of people together,” she says. “It’s a community, and we’ve taken advantage of this to make the world a kinder place.”

Tacuri says ImillaSkate has also helped its members embrace their own roots.

“We ourselves have decided to get to know our culture and our identity. We have decided to revalue our clothing and encourage new generations,” says Tacuri, who took a leave from her carpentry job to devote herself full-time to training for a national skateboard competition that took place in November 2021 in Tarija, in southern Bolivia.

Once the skaters decided to use polleras to show the pride they feel for their rural heritage, they faced a challenge: getting more acquainted with the elaborate skirts themselves.

They didn’t know where to find the polleras, so they turned to their grandmothers for help. The young women then went on a hunt for stores in the city that sold them, as well as hats to wear and ribbons to put in their braided hair. When



'They are my mother's and my aunts'
clothing, and I see them as strong women ...
For me, women in polleras can do anything.'

DEYSI TACURI LÓPEZ

ABOVE

Deysi Tacuri López, 28, wants to help popularize skateboarding and create more opportunities for young Bolivians to learn about their roots. "The polleras are very valuable to me," she says. "I wear them with pride."

RIGHT

ImillaSkate members shop for traditional outfits at the bustling La Cancha market.

they showed up at the Mercado de Punata, a market for food and used clothing in Cochabamba, “everyone was surprised that we were going for this kind of clothing. We are young and from the city. People didn’t understand why we wanted to dress like this,” says Santiváñez.

“We try to explain that this helps us understand our mothers, our aunts, and grandmothers,” Tacuri adds. For her, the stigma attached to polleras changed somewhat with the election of former president Evo Morales in 2006. Under Morales, Bolivia’s first Indigenous president, voters approved a new constitution that formally recognized 36 Indigenous languages and also empowered the nation’s Indigenous people with rights such as communal ownership of land. Morales stepped down in 2019 amid protests and accusations of attempts to undermine democracy to extend his nearly 14-year rule.

Tacuri feels the group could push for more cultural recognition of Indigenous people.

“The polleras are worn at events and cultural exhibitions. Women are becoming more

empowered, but it is a work in progress,” she says.

For now, the imillas see a shift in their city.

“When I was a little girl, it didn’t cross my mind that girls would skate,” Tacuri says. “In fact, that’s why I stopped for a few years. Now, with ImillaSkate, we have achieved a network. It’s not so rare anymore to see a girl skateboarding.”

Seven members of the group even embarked on a trip to the interior of Bolivia to record a short documentary. In the six-minute trailer posted on YouTube, they wear their colorful skirts as they skate in industrial zones, rural areas, parks, and other spots.

“Our goal is to promote and encourage the practice of skateboarding, to expand the sport and at the same time open new spaces to practice,” says Tacuri. “But we also want to send out a message: Let’s not forget our roots.” □

Paula Ramón wrote in the October issue about Brazilian descendants of people who escaped slavery. Brazilian photographer **Luisa Dörr** works on stories about women and cultural traditions.





INSTAGRAM

MATTHIEU PALEY

FROM OUR PHOTOGRAPHERS

WHO

A National Geographic Explorer drawn to human cultures and experiences

WHERE

Baluchistan Desert, Pakistan

WHAT

Fujifilm GFX 50 with a 35mm lens

Paley is fascinated by pilgrimages and particularly how these strenuous journeys can affect the mind and body. During the spring, in Muslim-majority Pakistan, he joined Hindu devotees on a multiday trek to Hinglaj temple. The walk was joyful, Paley recalls, with chanting and loud music. When they reached this volcano summit, a key stop, many pilgrims applied mud to their faces, and one man reached out to an image of the god Shiva.

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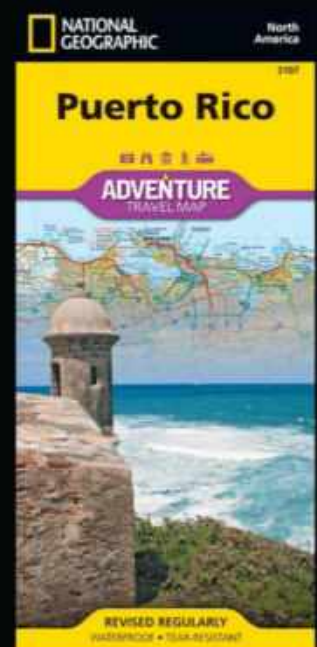
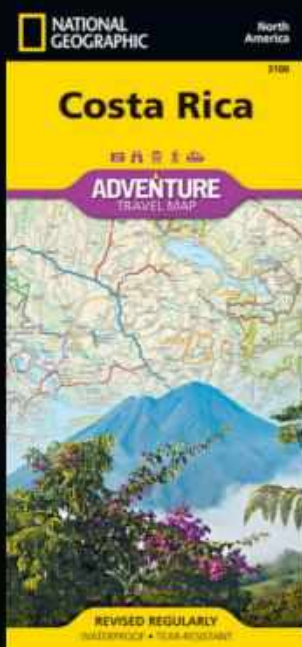
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