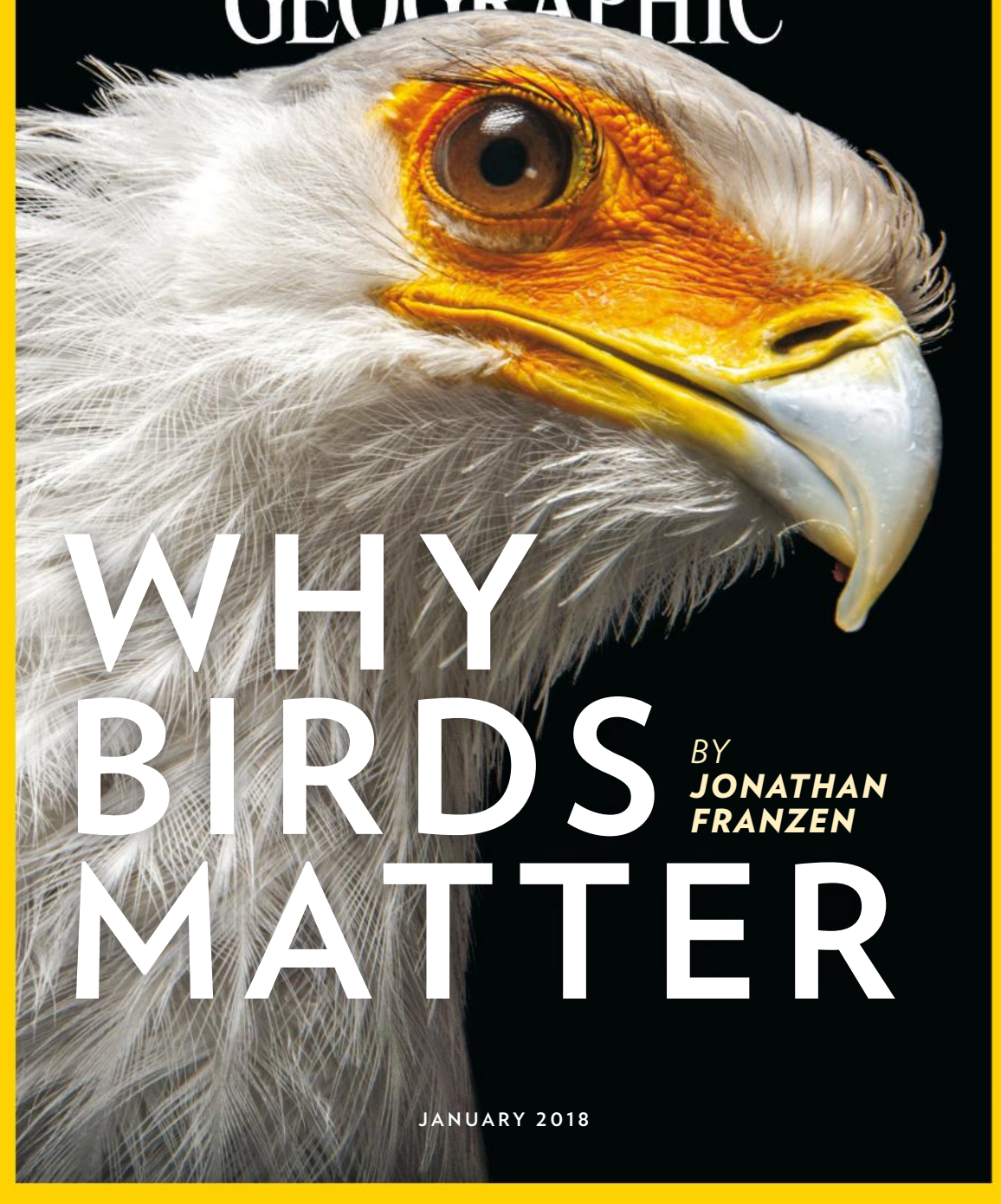
THE ARCTIC'S LAST SEA ICE | SCIENCE OF GOOD & EVIL | THE HEALING OF COLOMBIA

NATIONAL GEOGRAPHIC



WHY BIRDS MATTER

BY JONATHAN FRANZEN

JANUARY 2018

PREPARED FOR A LONGER RETIREMENT?

THE EXPERIMENT THAT GOT COUPLES TALKING.

We're living longer, which is great. But it means we could be underestimating how much money we'll need in retirement. The bigger concern? Most of us aren't talking about it.

So we invited couples to guess how much money they'll need in retirement using our interactive walkway. It turned out that most couples weren't on the same page and fell short of the average length of retirement. They walked away from our experiment with an important new perspective—because we're living longer, we need to start planning for longer. A good place to start? Planning for income that lasts all our years in retirement.

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JANUARY 2018 • VOL. 233 • NO. 1 • OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

FRONT

FEATURES

On the Cover Today one in eight bird species is threatened with global extinction, BirdLife International reports. Vulnerable species include the secretary bird, *Sagittarius serpentarius;* this one lives at the Toronto Zoo. *Photo by Joel Sartore*

Corrections and Clarifications
Go to *natgeo.com/corrections.*

PHOTO: PAUL NICKLEN

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ELSEWHERE

TELEVISION

THE *CHAIN OF COMMAND* IN TERROR FIGHT

The documentary *Chain of Command* offers a penetrating look at the U.S. role in the fight against global extremism. A story told by the people who live it, the eight-part series results from extensive reporting around the globe and extraordinary access to U.S. defense officials. Episodes air Mondays at 9/8c starting January 15, on National Geographic.

NAT GEO WILD

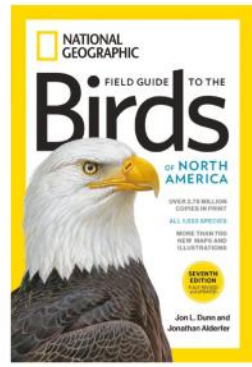
PLANET OF THE BIRDS BECKONS

Besides humans, only one kind of animal can be found on all seven continents: birds, which make their homes from the Antarctic to Africa. Celebrate National Geographic's Year of the Bird by watching these winged marvels in *Planet of the Birds,* airing January 19 on Nat Geo WILD.

BOOKS

KNOW YOUR *BIRDS OF NORTH AMERICA*

Kick off National Geographic's Year of the Bird with *Field Guide to the Birds of North America, Seventh Edition.* Completely revised, it's full of hand-painted illustrations, new and updated maps, essential identification details, and more. Available wherever books are sold and at *shopng.com/books.*



TRAVELER MAGAZINE

EXPLORE THE 'BEST OF THE WORLD 2018'

Discover 21 spectacular places to visit in the year ahead. Find new hues in Oaxaca, Mexico's most colorful state. Go table-hopping on Oahu, the tastiest island in Hawaii. Say "cheers" in Dublin, the world's friendliest city—and more, in the December/January issue of *Traveler* magazine.

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PHOTO: NATIONAL GEOGRAPHIC

Sri Lankan Gray Langur *(Semnopithecus priam thersites)*
Size: Head and body length, 58.4 - 64 cm (23 - 25.2 inches); tail, 66 - 101.6 cm (26 - 40 inches) **Weight:** Males, 11.4 - 13.5 kg (25.1 - 29.8 lb); females, unknown **Habitat:** Dry, deciduous forests in the lowlands of eastern Sri Lanka **Surviving number:** Unknown

Photographed by Will Burrard-Lucas

WILDLIFE AS CANON SEES IT

Revered. Seen as a manifestation of the monkey god Hanuman, the Sri Lankan gray langur is fed and treated as an honored guest when it appears in urban areas and the grounds of temples. When foraging on its own, it favors fruits, flowers and especially leaves, which are fermented and digested in its complex, compartmentalized stomach. But this aggressive monkey's habit of crop raiding often leads to deadly reprisals, and its exalted status is no safeguard against the twin threats of subsistence hunting and habitat loss.

As Canon sees it, images have the power to raise awareness of the threats facing endangered species and the natural environment, helping us make the world a better place.

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'IF YOU TAKE CARE OF THE BIRDS, YOU TAKE CARE OF MOST OF THE BIG PROBLEMS IN THE WORLD.'

That's what Thomas Lovejoy says, and he should know. The famed biologist and conservationist, a National Geographic–funded scientist, helped introduce the term "biological diversity" to the world. And he long predicted that by early in the 21st century, the Earth would start losing a dramatic number of species—a prediction, unfortunately, that is turning out to be spot-on.

We were taken with Lovejoy's quote about birds and decided to use it as a launchpad for what we're calling the Year of the Bird. In this 12-month multiplatform exploration—with our partners from the National Audubon Society, BirdLife International, and the Cornell Lab of Ornithology—we'll examine how our changing environment is leading to dramatic losses among bird species around the globe. And just as important, we'll document what we can do about it.

At *National Geographic* we've been looking at the planet's health from a bird's-eye view for a long time. This magazine has featured birds on its cover more often than it has featured other popular creatures—at least 30 times, compared with 13 times for apes. And the National Geographic Society has awarded hundreds of grants for ornithology research and projects.

In 2018—the centennial of the Migratory Bird Treaty Act, which protects more than 1,025 species—we'll take our coverage of topics affecting birds to a new level. In this issue we launch a year of storytelling with "Why Birds Matter," an essay by best-selling author Jonathan Franzen. It's paired with remarkable avian portraits created by National Geographic photographer Joel Sartore.

Why is National Geographic focusing so much attention on birds? That's just another way of asking, as Franzen does, Why do birds matter? Among his eloquent answers: "They are our last, best connection to a natural world that is otherwise receding."

Thank you for reading *National Geographic* and joining with us in the Year of the Bird.

Susan Goldberg, *Editor in Chief*

The program *Planet of the Birds* airs January 19 on Nat Geo WILD.

Throughout 2018, look for National Geographic's Year of the Bird offerings: digital content, books, *Traveler* magazine stories, travel adventures built around birds – and community and social media experiences.

NATIONAL GEOGRAPHIC
PHOTO ARK
JOEL SARTORE

JOEL SARTORE PHOTOGRAPHED THESE RED LORIES *(EOS BORNEA)* AT THE INDIANAPOLIS ZOO.


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SEEKING A SAFE, GREEN COLOMBIA

Colombian President **Juan Manuel Santos,** 66, won the 2016 Nobel Peace Prize for negotiating an end to his nation's 52-year civil war. He was honored recently by National Geographic for greatly increasing protected land and marine areas in Colombia, one of the world's most biologically diverse countries.

You dramatically expanded, by thousands of square miles, areas protected in parks, wildlife sanctuaries, marine reserves, and elsewhere. Why were you so intent on doing that?
We are one of the richest countries in terms of biodiversity, and we are one of the most vulnerable countries to climate change. That gives us a special responsibility to protect, as soon as possible, the largest amount of territories that are a jewel for Colombians and for humanity. That's why I accelerated the process of protecting the most valuable resources we have.

Colombia faces many challenges in the postwar era: compensating farmers who were ousted from their land, educating some 7,000 demobilized guerrillas, accounting for tens of thousands of people who are missing and presumed dead, and removing land mines buried throughout the countryside. What's most urgent?
All of the above, but there's one priority we need to address, which is demining. Colombia is still the second most mined country in the world, after Afghanistan. If we want to enjoy peace, we need to demine the country. That's priority number one. But of course restitution of land to the peasants, which we are doing, is a priority, along with the sustainable way of developing [areas touched by the war], for people to see change as fast as possible.

You've said that the summer 2017 storms in the Caribbean and Texas reflect the dangers posed by climate change. What do you say to skeptics?
Anybody who doesn't see the impact of climate change is really, I would say, myopic. They don't see the reality. It's so evident that we are destroying Mother Earth. This is not the problem of one country or a few countries; it is the problem of mankind. We need to work together to stop this. Otherwise our future generations will simply disappear.

Healing from war, Colombians struggle to secure a lasting peace (page 66).

PHOTO: MARK THIESSEN, NGM STAFF
THIS INTERVIEW WAS EDITED FOR LENGTH AND CLARITY.


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VISIONS

Taiwan
"Rubber Duck," a 59-foot-tall inflatable sculpture created by Dutch artist Florentijn Hofman, was on display for a month in Kaohsiung. The installation drew large crowds and inspired a tribute, performed by costumed young girls.

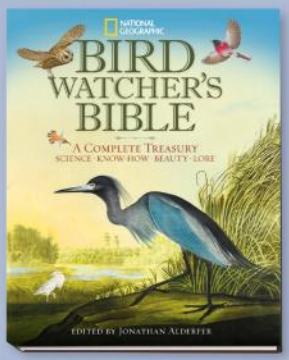
PHOTO: ASHLEY PON, GETTY IMAGES

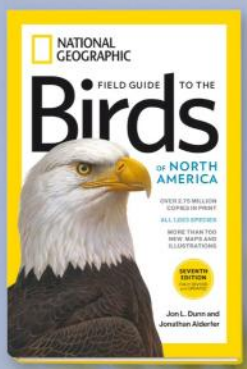
Ronit Singh Bhullar
Mumbai, India

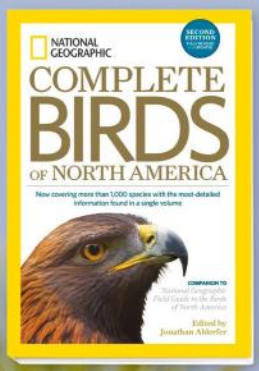
Bhullar had read that birds flocked near one of New Delhi's Yamuna ghats, stairs that lead down to the river. One evening a man in a boat fed the birds, which brought them together in Bhullar's frame. "The sun was about to set, so I was aware of the perfect color the sky would give me," he says.

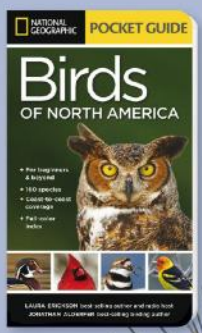
NATIONAL GEOGRAPHIC BIRD BOOKS

FOR BEGINNERS TO EXPERTS, AT HOME, OR IN THE FIELD.









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EXPLORE
BIRDS

A sculpted pigeon peers through its artful disguise – the crocheted plumage of the extinct Guadalupe caracara.

PHOTO: ANDY DIAZ HOPE. ILLUSTRATION BY PETER SCHOUTEN FROM *A GAP IN NATURE: DISCOVERING THE WORLD'S EXTINCT ANIMALS* BY TIM FLANNERY

HOMAGE TO THE EXTINCT

By Eve Conant

The caracaras of Guadalupe only became valuable once they'd nearly vanished. Abundant on the Mexican island in 1876, the raptors were systematically shot and poisoned as pests. By the late 1800s the endemic birds of prey had become extremely rare—and of interest to collectors. People started trapping them, hoping to sell the live birds to the highest bidder. They went extinct anyway—which makes them an appropriately ironic subject for Laurel Roth Hope.

Years ago Hope, a self-taught artist who once worked as a park ranger, found herself observing urban pigeons. "I started thinking about the way we ascribe value to things that are rare and denigrate things that are common, and how that affects the way we see wildlife," she says. "I wanted to put the two together."

Hope began crocheting what she calls "Biodiversity Reclamation Suits for Urban Pigeons." "I wanted to use a little bit of humor, since caring about the environment and extinction can easily be overwhelming," the artist says. The first suits consisted of "the pigeon as an icon of successful adaptation and the dodo as an icon of extinction."

Hope starts by sculpting and casting the pigeons from resin. Then she chooses stitch patterns and colors to make a "3-D sketch in crochet" of an extinct bird's plumage. (She says crochet, with its mathematical underpinnings, is a natural fit for feather patterns.) She samples the suit on her mannequin, as a tailor might.

"The suits act like a cozy," explains Hope, "covering up something we don't want to see—environmental degradation and species extinction—with something arguably more attractive."

SOLVING CRIMES AGAINST BIRDS

By Catherine Zuckerman

"I identify the victims of wildlife crime—if the victim is a bird." That's how forensic ornithologist Pepper Trail (above, at his Ashland, Oregon-based lab) summarizes his job. The position is so rare that he's one of just two people in the United States to hold it.

The work is inherently macabre. First Trail picks through the evidence—bagged bones and feathers, or even whole carcasses, that wildlife law enforcement agents send him from the field. Next he performs an analysis. Sometimes he recognizes the species right away; if he doesn't, he conducts a prolonged examination that involves building a theory from details such as size and plumage pattern. Once Trail has identified the species, his job is usually done. His colleagues—scientists who, like Trail, are U.S. Fish and Wildlife Service staff—will study the victim further if needed, to isolate DNA or determine cause of death.

Often the birds have been shot or snared in traps. Some have perished while being smuggled across the border in the caged-bird trade. Others are killed and made into accessories or talismans; Trail has long been tracking what in Mexico are called *chuparosas,* dried hummingbirds marketed as love charms.

Trail has to be objective in the roughly 100 avian crime cases he handles a year, though sometimes he gets emotional. Knowing an animal has "died horribly" is not easy to accept, he says. "But I get satisfaction when I'm able to draw attention to an issue, like the chuparosas."

Hummingbirds are killed – possibly by slingshot – and sold in some markets as good luck charms for young lovers.

PHOTOS: TOM FOWLKS

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TRASH IN NESTS TELLS A STORY

By Nina Strochlic

The white plastic bags fluttering in the treetops of the Italian Alps intrigued Fabrizio Sergio. The Italian ecologist knew the trash hung from the nests of a certain bird, the black kite. But why?

Many species of birds decorate their nests to attract a mate—but kites already have partners when they build nests. Still, the ornamentation on kite nests suggests "that there's something they want to show off," says Sergio, who works for the Spanish National Research Council.

As he and other scientists study the makeup of birds' nests, they're looking for signs of human influence. Some birds have begun using insulation, foil, and cigarette butts, for example, instead of natural materials, says Luis Sandoval, an ornithology professor at the University of Costa Rica. These adaptations may increase their reproductive success—or indicate that natural building materials have disappeared from the habitat. "Humans are directly affecting birds' nests in a way that we are still trying to understand," Sandoval says.

As part of a six-year study, Sergio and his colleagues set out different-colored pieces of plastic in the wild. Black kites consistently selected white for their nests and ignored the transparent and dark options that didn't contrast as dramatically with the colors in nature.

Sergio's conclusion: that black kites were using style to show their social dominance. Nests with the most plastic belonged to the strongest birds, able to fend off attackers that coveted their decor. Plain nests belonged to younger and older birds, which would be too weak to defend their homes from such raids.

Part of the nest of a Bullock's oriole is woven with plastic. Some birds decorate garishly to draw in females; others, including black kites, use bright or contrasting plastic to deter would-be competition.

PHOTOGRAPHED BY RICHARD BARNES AT WESTERN FOUNDATION OF VERTEBRATE ZOOLOGY


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RECOGNIZE THESE DIRTY BIRDS?

By Laurel Braitman

Last January on Unalaska Island, Suzi Golodoff poured herself a hot cup of coffee, pulled on her boots, and stepped outside. She was immediately assaulted. "I'm pretty sure they were watching me leave the house, saw I had something in my mug, and waited," she said. "I could have lost a finger." But she didn't. She was one of the lucky ones.

Her assailants were bald eagles, *Haliaeetus leucocephalus*—or Dutch Harbor pigeons, as they're known around this fishing port in the Aleutian chain on the edge of the Bering Sea.

Especially during fishing season, hundreds of eagles come to scavenge and nest in the area, which is home to about 4,400 human residents. The birds make their presence known from atop telephone poles and stoplights. They accost people who wander too close during nesting season, sending victims to the medical clinic for scalp stitches. And they swarm every boat that comes into port, festooning the rigging by the dozen like baleful Christmas ornaments.

We're used to seeing America's national bird depicted as a majestic hero plucking wild salmon from pristine streams. But here you can see eagles for what they really are: scrappy, opportunistic feeders. If fresh fish isn't available, the birds will eat seagulls, ducks, squirrels, mice, the occasional raven, bits of rotten meat dug out of the trash—or, in one case, a piece of pepperoni pizza snatched out of a teenager's hand. Like us, eagles are adaptable. We should be proud.

PHOTO: COREY ARNOLD

American bald eagles and ravens feast on food scraps in bundled garbage at the Unalaska City Landfill in the Aleutian Islands, Alaska.

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NORTH & CENTRAL AMERICA · CARIBBEAN · SOUTH AMERICA · EUROPE · AFRICA · ASIA · MIDDLE EAST & CENTRAL ASIA · OCEANIA · ANTARCTICA

Cherry-throated tanager
Nemosia rourei
CURRENT POPULATION:
30-200, Espírito Santo, Brazil

MAIN THREATS
104 BIRD SPECIES
AGRICULTURE

35

Akohekohe
Palmeria dolei
3,800, Maui, Hawaii

67
LOGGING

27

20
POLLUTION

8

Northern bald ibis
Geronticus eremita
200-249, Morocco

59
HUNTING & TRAPPING

Spoon-billed sandpiper
Calidris pygmaea
240-400, northeastern Russia and Southeast Asia

22
RESIDENTIAL & COMMERCIAL DEVELOPMENT

9

68
INVASIVE SPECIES

30

35
CLIMATE CHANGE & SEVERE WEATHER

13

Hooded grebe
Podiceps gallardoi
660-800, Patagonia, Argentina

64
OTHER
Includes human disturbance, mining, fires

23

BIRDS ON THE BRINK

By Eve Conant

Found on all seven continents, birds are a vital gauge of ecosystem health. Yet many species have had it rough since at least 1500, when recordkeeping began. During the rise of global trade in the colonial era, birds in the biodiverse tropics, for example, were hard hit by habitat loss and the introduction of invasive species—threats that persist

DOCUMENTED SINCE 1500

ALREADY EXTINCT

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Each illustrated bird (drawn roughly to scale) is shown over a threat or a driver of its extinction.

Slender-billed grackle
Quiscalus palustris
LAST SEEN:
1910, state of Mexico, Mexico

MAIN DRIVERS
33 BIRD SPECIES

20 AGRICULTURE

27 LOGGING

Kakawahie
Paroreomyza flammea
1963, Molokai, Hawaii

2 POLLUTION

Passenger pigeon
Ectopistes migratorius
1900, Ohio

34 HUNTING & TRAPPING

Carolina parakeet
Conuropsis carolinensis
1910, Florida

3 RESIDENTIAL & COMMERCIAL DEVELOPMENT

Least vermilion flycatcher
Pyrocephalus dubius
1980, Galápagos Islands, Ecuador

81 INVASIVE SPECIES

11 CLIMATE CHANGE & SEVERE WEATHER

Canarian oystercatcher
Haematopus meadewaldoi
1913, Canary Islands, Spain

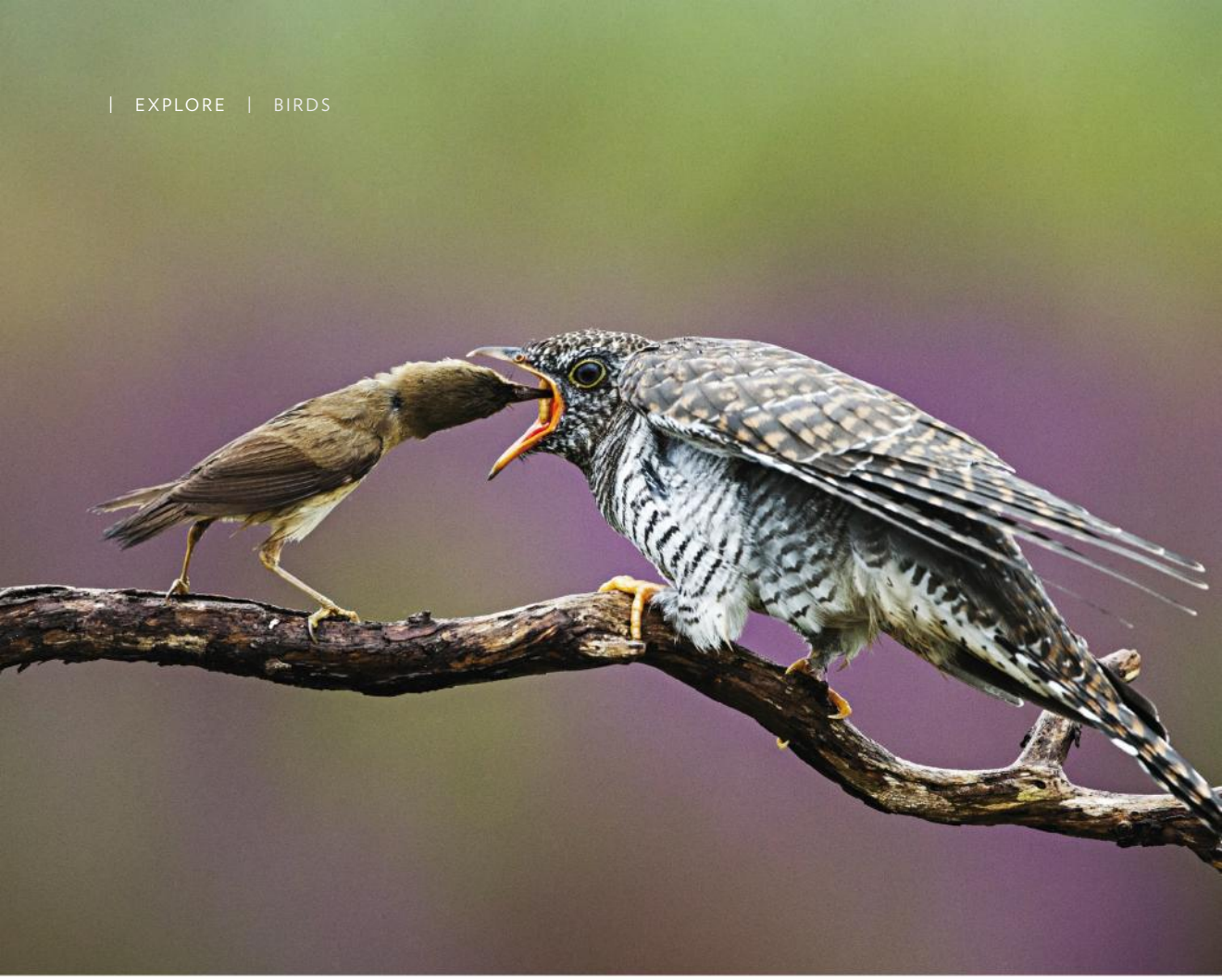
18 OTHER

today. Nearly 200 species are gone forever, according to BirdLife International, the official authority for birds on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Even more species are critically endangered, many clinging to grim odds: Fewer than 50 adults survive in the wild.

SPECIES COUNT

Size indicates the number of species under threat or extinct. Some face multiple threats in multiple regions.

ALBERTO LUCAS LÓPEZ AND RYAN T. WILLIAMS, NGM STAFF. SOURCE: BIRDLIFE INTERNATIONAL
EXTINCT CATEGORY ALSO INCLUDES THOSE SPECIES THAT ARE LIKELY EXTINCT AND THOSE THAT ARE EXTINCT IN THE WILD.



A BIG BIRD BABY THAT'S A BULLY

By Alison Fromme

For the care and feeding of its offspring, the common cuckoo outsources.

When she's ready to lay an egg, a female *Cuculus canorus* swoops to the unattended nest of a smaller species. She then swallows one of the eggs that's been laid there and lays one of her own—a behavior known as brood parasitism.

Sometimes potential victims revolt. The parents that inhabit the nest may mob the cuckoo mom, preventing her from dropping off her egg; they may push out cuckoo eggs before they hatch, or they may even abandon the nest.

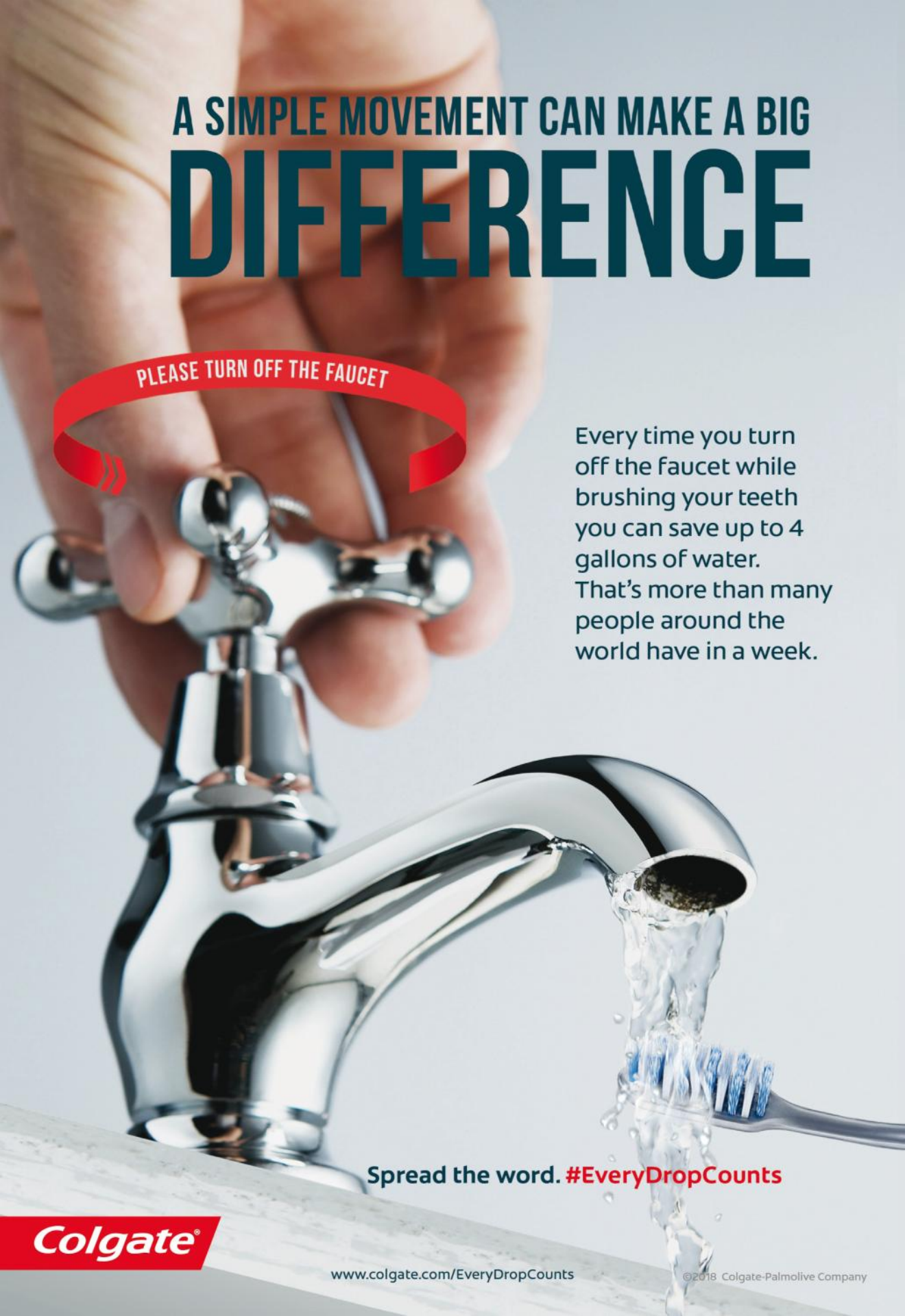
But often the cuckoo mom gets away undetected, leaving her parental duties behind, and the nest's owners return none the wiser. *C. canorus* is known to have passed its eggs on to more than 100 host species, according to the International Union for Conservation of Nature.

When the cuckoo chick hatches, it ejects other eggs or hatchlings to get all the space—and food—for itself. Hungry as a whole brood, the outsize baby devours everything brought by its foster parents—in the photo above, the provider is a reed warbler, a common host.

Franka Slothouber, a retired photo editor who's an avid wildlife photographer, observed the birds' behavior in 2014 in Amsterdam, where she lives. "The poor warbler almost disappears in the wide-opened mouth of its 'adopted' baby," Slothouber says. And yet "the warbler couple is convinced this chick is theirs and treat it accordingly, by feeding it until it can look after itself."

A reed warbler (left) feeds a cuckoo chick. In 30 days cuckoo chicks grow from 0.1 ounce to 3.2 – nearly eight times the warbler's weight.

PHOTO: FRANKA SLOTHOUBER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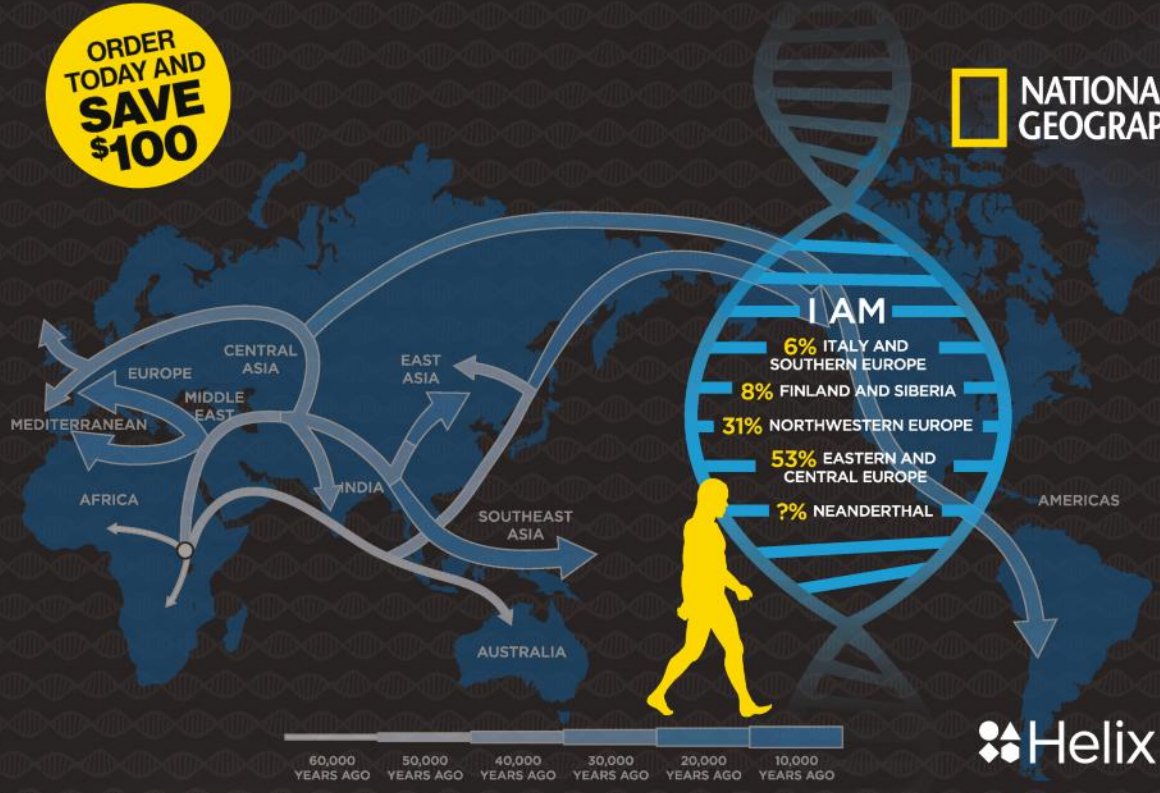

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HATCHING FLIGHT

By Hannah Lang

Birds lay eggs of surprising variety, and scientists have long wondered why. Could it be that certain shapes protect eggs from shattering? Or perhaps allow them to fit snugly in a nest? Or was Aristotle correct when he asserted that long, pointy eggs contained females while rounder eggs held males? (He wasn't.)

To crack the mystery about egg shapes, Princeton University evolutionary biologist Mary Caswell Stoddard and her colleagues examined almost 50,000 eggs from more than 1,400 species. They classified the eggs based on their asymmetry and ellipticity, discovering that the more pointy or oval shaped an egg, the more likely it came from a strong flier. "We were shocked to see that one of the best explanations for egg-shape variation was flight ability," says Stoddard.

Common murres, for instance, have particularly pointy and elliptical eggs (see below)—and are expert divers. Perhaps a streamlined bird needs a streamlined egg; stout flightless birds like ostriches and emus hatch from eggs that are nearly round.

Penguins, however, break the mold: Although the aquatic birds can't take to the air, their eggs are asymmetrical. This discovery initially left the researchers puzzled, but they developed a working hypothesis, says Stoddard: "The same processes that may influence egg shape in good fliers may also be at work in good swimmers, like penguins."

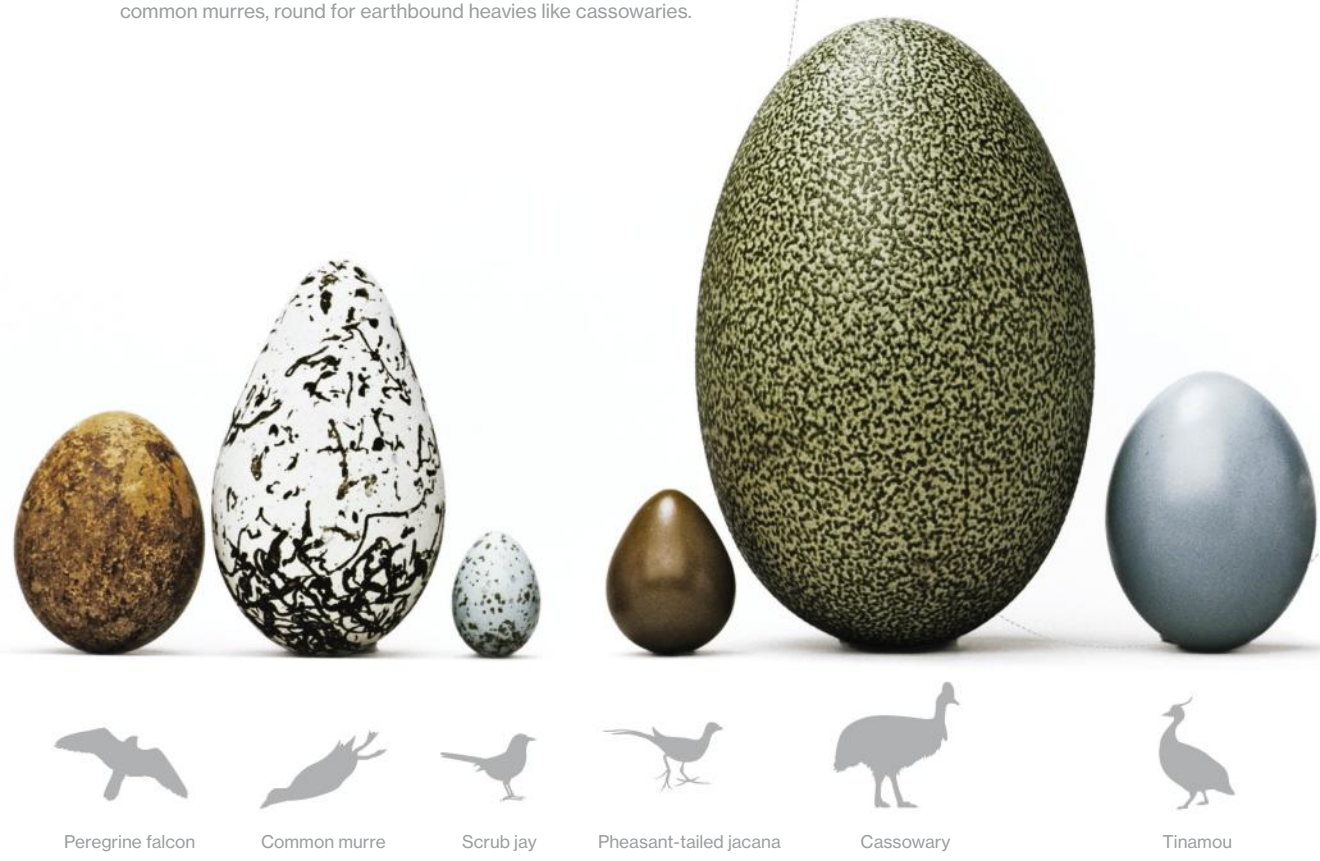
PHOTO: FRANS LANTING

ILLUSTRATIONS: DAISY CHUNG, NGM STAFF

SOURCE: RENÉ CORADO, WESTERN FOUNDATION OF VERTEBRATE ZOOLOGY

5.5 INCHES
ACTUAL HEIGHT OF CASSOWARY EGG

Egg shapes reveal flight abilities – pointed for strong fliers like common murres, round for earthbound heavies like cassowaries.



BIRD DRAWINGS NOT TO SCALE

Superb parrot

Polytelis swainsonii

Native to southeastern Australia, the bright green superb parrot is one of 10,000 bird species enlivening the planet. "If you take care of the birds," says conservationist Thomas Lovejoy, "you take care of most of the big problems in the world."

PHOTOGRAPHED AT PARROTS IN PARADISE, AUSTRALIA

American flamingo

Phoenicopterus ruber

A flamingo comes into the world with white plumage; its striking color derives from organic pigments called carotenoids in its diet of mollusks, crustaceans, and algae. Its bizarre beak makes more sense upside down, as it is when the bird is filter feeding, head inverted.

PHOTOGRAPHED AT LINCOLN CHILDREN'S ZOO, NEBRASKA

THE YEAR OF THE BIRD

WHY BIRDS MATTER

It's not just what they do for the environment—it's what they do for our souls. In 2018 we'll explore the wonder of birds, and why we really can't live without them.

BY JONATHAN FRANZEN
PHOTOGRAPHS BY JOEL SARTORE

Great hornbill

Buceros bicornis

With its massive bill and casque and a wingspan approaching six feet, the great hornbill is king of the jungle skies in Southeast Asia. It adorns its black and white feathers with a yellow-tinted oil secreted from a gland near its tail.

PHOTOGRAPHED AT HOUSTON ZOO

RYAN T. WILLIAMS, NGM STAFF
ART: MATTHEW TWOMBLY

For most of my life, I didn't pay attention to birds. Only in my 40s did I become a person whose heart lifts whenever he hears a grosbeak singing or a towhee calling and who hurries out to see a golden plover that's been reported in the neighborhood, just because it's a beautiful bird, with truly golden plumage, and has flown all the way from Alaska. When someone asks me why birds are so important to me, all I can do is sigh and shake my head, as if I've been asked to explain why I love my brothers. And yet the question is a fair one, worth considering in the centennial year of America's Migratory Bird Treaty Act: Why do birds matter?

My answer might begin with the vast scale of the avian domain. If you could see every bird in the world, you'd see the whole world. Things with feathers can be found in every corner of every ocean and in land habitats so bleak that they're habitats for nothing else. Gray gulls raise their chicks in Chile's Atacama Desert, one of the driest places on Earth.

The Year of the Bird

In 1918 Congress passed the Migratory Bird Treaty Act to protect birds from wanton killing. To celebrate the centennial, National Geographic is partnering with the National Audubon Society, BirdLife International, and the Cornell Lab of Ornithology to declare 2018 the Year of the Bird. Watch for more stories, maps, books, events, and social media content throughout the year.

Get the book

Birds of the Photo Ark, with photos by Joel Sartore and text by Noah Strycker, will be available in April 2018 at *shopng.com/books*.

Western rosella

Platycercus icterotis

The sociable western rosella of southwestern Australia is often seen foraging in pairs or small groups. Damaging to fruit orchards, they used to be shot as vermin. The species is now protected, but its numbers are still declining because of loss of habitat.

PHOTOGRAPHED AT BLANK PARK ZOO, DES MOINES, IOWA

Emperor penguins incubate their eggs in Antarctica in winter. Goshawks nest in the Berlin cemetery where Marlene Dietrich is buried, sparrows in Manhattan traffic lights, swifts in sea caves, vultures on Himalayan cliffs, chaffinches in Chernobyl. The only forms of life more widely distributed than birds are microscopic.

To survive in so many different habitats, the world's 10,000 or so bird species have evolved into a spectacular diversity of forms. They range in size from the ostrich, which can reach nine feet in height and is widespread in Africa, to the aptly named bee hummingbird, found only in Cuba. Their bills can be massive (pelicans, toucans), tiny (weebills), or as long as the rest of their body (sword-billed hummingbirds). Some birds—the painted bunting in Texas, Gould's sunbird in South Asia, the rainbow lorikeet in Australia—are gaudier than any flower. Others come in one of the nearly infinite shades of brown that tax the vocabulary of avian taxonomists: rufous, fulvous, ferruginous, bran-colored, foxy.

Birds are no less diverse behaviorally. Some are highly social, others anti. African queleas and flamingos gather in flocks of millions, and parakeets build whole parakeet cities out of sticks. Dippers walk alone and underwater, on the beds of mountain streams, and a wandering albatross may glide on its 10-foot wingspan 500 miles away from any other albatrosses. I've met friendly birds, like the New Zealand fantail that once followed me down a trail, and I've met mean ones, like the caracara in Chile that swooped down and tried to knock my head off when I stared at it too long. Roadrunners kill rattlesnakes for food by teaming up on them, one bird distracting the snake while another sneaks up behind it. Bee-eaters eat bees. Leaf-tossers toss leaves. Thick-billed murres can dive underwater to a depth of 700 feet, peregrine falcons downward through the air at 240 miles an hour. A wren-like rushbird can spend its entire life beside one half-acre pond, while a cerulean warbler may migrate to Peru and then find its way back to the tree in New Jersey where it nested the year before.

Birds aren't furry and cuddly, but in many respects they're more similar to us than other mammals are. They build intricate homes and raise families in them. They take long winter vacations in warm places. Cockatoos are shrewd thinkers, solving puzzles that would challenge a chimpanzee, and crows like to play. (On days so windy that more practical birds stay grounded, I've seen crows launching themselves off hillsides and doing aerial somersaults, just for the

Ringed teal

Callonetta leucophrys

This pair of chest-bumping ringed teals (the male is at left) is native to South America. Many birds form strong pair bonds during the breeding season, but the notion that most species are sexually monogamous is outdated. We now know from genetic tests that both males and females seek out mates other than their social partners.

PHOTOGRAPHED AT SYLVAN HEIGHTS BIRD PARK, SCOTLAND NECK, NORTH CAROLINA

Society Grant Your National Geographic Society membership helped fund this project.

fun of it, and I keep returning to the YouTube video of a crow in Russia sledding down a snowy roof on a plastic lid, flying back up with the lid in its beak, and sledding down again.) And then there are the songs with which birds, like us, fill the world. Nightingales trill in the suburbs of Europe, thrushes in downtown Quito, hwameis in Chengdu. Chickadees have a complex language for communicating—not only to each other but to every bird in their neighborhood—about how safe or unsafe they feel from predators. Some lyrebirds in eastern Australia sing a tune their ancestors may have learned from a settler's flute nearly a century ago. If you shoot too many pictures of a lyrebird, it will add the sound of your camera to its repertoire.

But birds also do the thing we all wish we could do but can't, except in dreams: They fly. Eagles effortlessly ride thermals; hummingbirds pause in midair; quail burst into flight heart-stoppingly. Taken all together, the flight paths of birds bind the planet together like 100 billion filaments, tree to tree and continent to continent. There was never a time when the world seemed large to them. After breeding, a European swift will stay aloft for nearly a year, flying to sub-Saharan Africa and back, eating and molting and sleeping on the wing, without landing once. Young albatrosses spend as many as 10 years roving the open ocean before they first return to land to breed.

Black-throated magpie-jay

Cyanocorax colliei

The raucous call of the black-throated magpie-jay is a common sound in its native western Mexico. Magpies, crows, jays, and other corvids are highly intelligent birds. Magpies can recognize themselves in mirrors, and crows are adept toolmakers.

PHOTOGRAPHED AT HOUSTON ZOO

A bar-tailed godwit has been tracked flying nonstop from Alaska to New Zealand, 7,264 miles in nine days, while a ruby-throated hummingbird may burn up a third of its tiny body weight to cross the Gulf of Mexico. The red knot, a small shorebird species, makes annual round-trips between Tierra del Fuego and the Canadian Arctic; one long-lived individual, named B95 for the tag on its leg, has flown more miles than separate the Earth and the moon.

There is, however, one critical ability that human beings have and birds do not: mastery of their environment. Birds can't protect wetlands, can't manage a fishery, can't air-condition their nests. They have only the instincts and the physical abilities that evolution has bequeathed to them. These have served them well for a very long time, 150 million years longer than human beings have been around. But now human beings are changing the planet—its surface, its climate, its oceans—too quickly for birds to adapt to by evolving. Crows and gulls may thrive at our garbage dumps, blackbirds and cowbirds at our feedlots, robins and bulbuls in our city parks. But the future of most bird species depends on our commitment to preserving them. Are they valuable enough for us to make the effort?

VALUE, IN THE LATE ANTHROPOCENE, has come almost exclusively to mean economic value, utility to human beings. And certainly many wild birds are usefully edible. Some of them in turn eat noxious insects and rodents. Many others perform vital roles—pollinating plants, spreading seeds, serving as food for mammalian predators—in ecosystems whose continuing wildness has touristic or carbon-sequestering value. You may also hear it argued that bird populations function, like the proverbial coal-mine canary, as important indicators of ecological health. But do we really need the absence of birds to tell us when a marsh is severely polluted, a forest slashed and burned, or a fishery destroyed? The sad fact is that wild birds, in themselves, will never pull their weight in the human economy. They want to eat our blueberries.

What bird populations do usefully indicate is the health of our *ethical* values. One reason that wild birds matter—ought to matter—is that they are our last, best connection to a natural world that is otherwise receding. They're the most vivid and widespread representatives of the Earth as it was before people arrived on it. They share descent with the largest animals ever to walk on land: The house finch outside your window is a tiny and beautifully adapted living dinosaur. A duck on your local pond looks and sounds very much like a duck 20 million years ago, in the Miocene epoch, when birds ruled the planet. In an ever more artificial world, where featherless drones fill the air and Angry Birds can be simulated on our phones, we may see no reasonable need to cherish and support the former rulers of the natural realm. But is economic calculation our highest standard? After Shakespeare's King Lear steps down from the throne, he pleads with his elder two daughters to grant him some

vestige of his former majesty. When the daughters reply that they don't see the need for it, the old king bursts out: "O, reason not the need!" To consign birds to oblivion is to forget what we're the children of.

A person who says, "It's too bad about the birds, but human beings come first" is making one of two implicit claims. The person may mean that human beings are no better than any other animal—that our fundamentally selfish selves, which are motivated by selfish genes, will always do whatever it takes to replicate our genes and maximize our pleasure, the nonhuman world be damned. This is the view of cynical realists, to whom a concern for other species is merely an annoying form of sentimentality. It's a view that can't be disproved, and it's available to anyone who doesn't mind admitting that he or she is hopelessly selfish. But "human beings come first" may also have the opposite meaning: that our species is uniquely worthy of monopolizing the world's resources because we are *not* like other animals,

because we have consciousness and free will, the capacity to remember our pasts and shape our futures. This opposing view can be found among both religious believers and secular humanists, and it too is neither provably true nor provably false. But it does raise the question: If we're incomparably more worthy than other animals, shouldn't our ability to discern right from wrong, and to knowingly sacrifice some small fraction of our convenience for a larger good, make us more susceptible to the claims of nature, rather than less? Doesn't a unique ability carry with it a unique responsibility?

A FEW YEARS AGO in a forest in northeast India, I heard and then began to feel, in my chest, a deep rhythmic whooshing. It sounded meteorological, but it was the wingbeats of a pair of great hornbills flying in to land in a fruiting tree. They had massive yellow bills and hefty white thighs; they looked like a cross between a toucan and a giant panda. As they clambered around in the tree, placidly eating fruit, I found myself crying out with the rarest of all emotions: pure joy. It had nothing to do with what I wanted or what I possessed. It was the sheer gorgeous fact of the great hornbill, which couldn't have cared less about me.

The radical otherness of birds is integral to their beauty and their value. They are always among us but never of us. They're the other world-dominating animals that evolution has produced, and their indifference to us ought to serve as a chastening reminder that we're not the measure of all things. The stories we tell about the past and imagine for the future are mental constructions that birds can do without. Birds live squarely in the present. And at present, although our cats and our windows and our pesticides kill billions of them every year, and although some species, particularly on oceanic islands, have been lost forever, their world is still very much alive. In every corner of the globe, in nests as small as walnuts or as large as haystacks, chicks are pecking through their shells and into the light. □

Northern white-faced owl

Ptilopsis leucotis

The northern white-faced owl occupies a broad band of Africa below the Sahara. Like most owls, it is a superb nocturnal hunter, with highly sensitive hearing and eyesight and special primary feathers that allow it to swoop in silently on unsuspecting prey.

PHOTOGRAPHED AT CINCINNATI ZOO AND BOTANICAL GARDEN

Bird-watcher and novelist **Jonathan Franzen** wrote about the killing of migrating songbirds for the July 2013 issue of *National Geographic.* Photographer **Joel Sartore** is creating studio portraits of the world's animals for National Geographic's Photo Ark project at *natgeophotoark.org.*

THE GIFT OF SONG

Wake up early enough almost anywhere, and you'll likely be treated to some tunes from songbirds, which make up almost half the world's avian species. Unlike instinctual calls, the extravagantly complex pitch, rhythm, and structure of true birdsongs must be learned early in life and can vary locally within a species.

Superb lyrebird

Menura novaehollandiae

Australia's superb lyrebird is a masterful mimic. To attract a mate, a male riffs on the calls of other birds in the forest while shaking its splendid tail feathers overhead. Captive birds have been recorded aping the sounds of chain saws, car alarms, and camera shutters.

PHOTOGRAPHED AT HEALESVILLE SANCTUARY, AUSTRALIA

Kirtland's warbler

Setophaga kirtlandii

Central Michigan's rare Kirtland's warbler depends on natural fires to promote the stands of young jack pines it needs for nesting. Males arrive first at their usual breeding grounds in spring and begin to sing, to establish territories and attract incoming females.

PHOTOGRAPHED IN THE WILD
NEAR MIO, MICHIGAN

Painted bunting

Passerina ciris

Looking as if it has splashed around for a while in a child's watercolor box, the painted bunting is a fairly common songbird in Mexico and the southeastern United States. During mating season, males often sing back and forth at each other in a territorial duet called countersinging.

PHOTOGRAPHED IN THE WILD NEAR CHRISTOVAL, TEXAS

Prothonotary warbler

Protonotaria citrea

In the swamp forests of the southeastern U.S., the persistent *tweet-tweet-tweet-tweet* of the prothonotary warbler can be heard from high in the trees in summer. The species migrates early in spring from Central America and northern South America.

PHOTOGRAPHED AT VIRGINIA AQUARIUM AND MARINE SCIENCE CENTER

TAILORED TO THE TASK

"The shape of a beak tells a poignant story of each bird's evolution and survival, and helps us to understand its place in the world," writes Noah Strycker in *Birds of the Photo Ark*. A sparrow's sturdy triangular beak packs the power to crack seeds, while a hawk's sharp, hooked beak makes short work of prey.

Secretary bird

Sagittarius serpentarius

With its outlandishly long legs and fierce demeanor, the secretary bird of the African savanna looks like a cross between a crane and an eagle. Its hooked beak is all raptor.

PHOTOGRAPHED AT TORONTO ZOO

White-headed duck

Oxyura leucocephala

Endangered, the white-headed duck is native to Spain, North Africa, and Central Asia. The flat beaks of ducks typically have soft edges for sensing food in the water and comblike lamellae inside to sieve out insects, seeds, and other morsels.

PHOTOGRAPHED AT SYLVAN HEIGHTS BIRD PARK, SCOTLAND NECK, NORTH CAROLINA

King penguin

Aptenodytes patagonicus

Perfect for spearing small fish and squid, a king penguin's beak sports orange or yellow patches that reflect ultraviolet light we cannot see, but they can. Males and females share this trait and appear to judge prospective mates in part by the intensity of the UV light beckoning from their beaks.

PHOTOGRAPHED AT INDIANAPOLIS ZOO

Long-billed curlew

Numenius americanus

With a wingspan that can approach three feet, the long-billed curlew is North America's largest shorebird. In winter it employs its eponymous feature to probe for shrimp and crabs in Mexican tidal mudflats, and in summer it uses its bill to seek burrowing worms in pastures of the western United States.

PHOTOGRAPHED AT TRACY AVIARY, SALT LAKE CITY

FROM FINERY TO FLIGHT

Feathers first appeared not on birds but on dinosaurs long before birds evolved; even some early tyrannosaurs sported primitive ones. Dinosaur feathers were likely used for insulation or display. More complex feathers specialized for flight took birds – the sole remaining dinosaur lineage – to new heights.

Malayan peacock pheasant

Polyplectron malacense

Nearly half of a male Malayan peacock pheasant's 20-inch average length is devoted to its tail, which it raises and spreads out in a splendid fan to impress females. Its range and numbers have declined dramatically as its lowland forest habitat has been cleared for cultivation.

PHOTOGRAPHED AT PHEASANT HEAVEN, CLINTON, NORTH CAROLINA

Birds were not the first to evolve head ornamentation – both dinosaurs and even more distant relatives, the pterosaurs, had them. But today's birds display a remarkable variety of crowns and crests, used to attract mates and intimidate rivals. Left to right, from top: red-fan parrot *(Deroptyus accipitrinus),* blue crowned pigeon *(Goura cristata),* Major Mitchell's cockatoo *(Cacatua leadbeateri),* palm cockatoo *(Probosciger aterrimus),* and black crowned crane *(Balearica pavonina).*

PHOTOGRAPHED AT HOUSTON ZOO; OMAHA'S HENRY DOORLY ZOO AND AQUARIUM, NEBRASKA; PARROTS IN PARADISE, AUSTRALIA; JURONG BIRD PARK, SINGAPORE; COLUMBUS ZOO AND AQUARIUM, OHIO

Vermilion cardinal

Cardinalis phoeniceus

Like its North American cousin, the vermilion cardinal of Colombia and Venezuela is an irresistible eye-catcher – only more so. The male's feathers are even redder, and it holds its long, spiky crest aloft nearly all the time. The males sing and flaunt their finery from conspicuous perches in early morning.

PHOTOGRAPHED AT NATIONAL AVIARY OF COLOMBIA

Cape vulture

Gyps coprotheres

Vultures are hardly the most lovable birds – they're big and ugly, and they eat disgusting things in disgusting ways. But without them to clean up carrion, insect populations would soar – and diseases with them. This trio of Cape vultures is native to southern Africa.

PHOTOGRAPHED AT CHEYENNE MOUNTAIN ZOO, COLORADO SPRINGS, COLORADO

FOR THE BENEFIT OF ALL

Beyond the sheer joy they provide, birds play a vital role in the environment, pollinating plants, dispersing seeds, controlling insects, and removing rotting flesh. “The future of birds, and us, are intertwined more than we know,” writes photographer Joel Sartore in *Birds of the Photo Ark*. “We soar, or plummet, together.”

Flight Paths

A photographer captures the invisible patterns that birds make across the sky.

Soaring above the Skógafoss waterfall at their nesting site in Iceland, northern fulmars reveal zipperlike patterns.

By Catherine Zuckerman
Photo Illustrations by Xavi Bou

If birds left tracks in the sky, what would they look like? For years Barcelona-based photographer Xavi Bou has been fascinated by this question. Just as a sinuous impression appears when a snake slides across sand, he imagined, so must a pattern form in the wake of a flying bird. But of course birds in flight leave no trace—at least none visible to the naked eye. Bou, now 38, spent the past five years trying to capture the elusive contours drawn by birds in motion, or, as he says, "to make visible the invisible."

First he had to shed the role of mere observer. "Like a naturalist, I used to travel around the world looking at wildlife," he says. He began exploring photographic techniques that would allow him to express his love of nature and show the beauty of birds in a way not seen before.

Ultimately he chose to work with a video camera, from which he extracts high-resolution photographs. After he films the birds in motion, Bou selects a section of the footage and layers the individual frames into one image. He finds the process similar to developing film: He can't tell in advance what the final result will be. There's one magical second, he says, when the image—chimerical and surreal—begins to emerge.

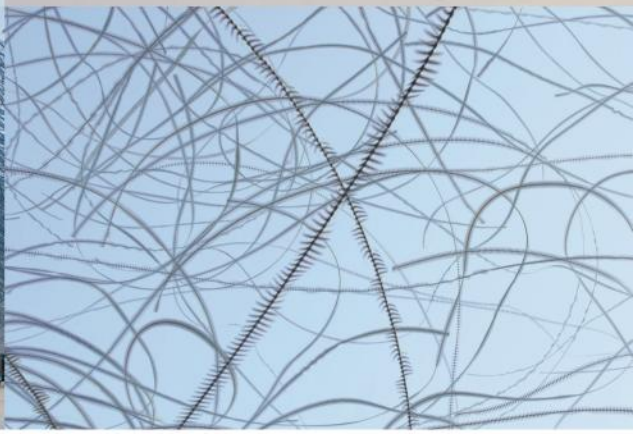
Before Bou began this project, which he calls "Ornitografías," he earned degrees in geology and photography in Barcelona, then worked as a lighting technician in the fashion industry and also co-owned a postproduction studio. This current work, he says, combines his passion and his profession. "It's technical, challenging, artistic, and natural. It's the connection between photography and nature that I was looking for." □

Evoking an airborne serpent, western marsh harriers glide above trees where great cormorants perch. The wildlife-rich wetlands of Estany d'Ivars i Vila-Sana, Spain, were drained around 1950 for agricultural use and restored in 2005.

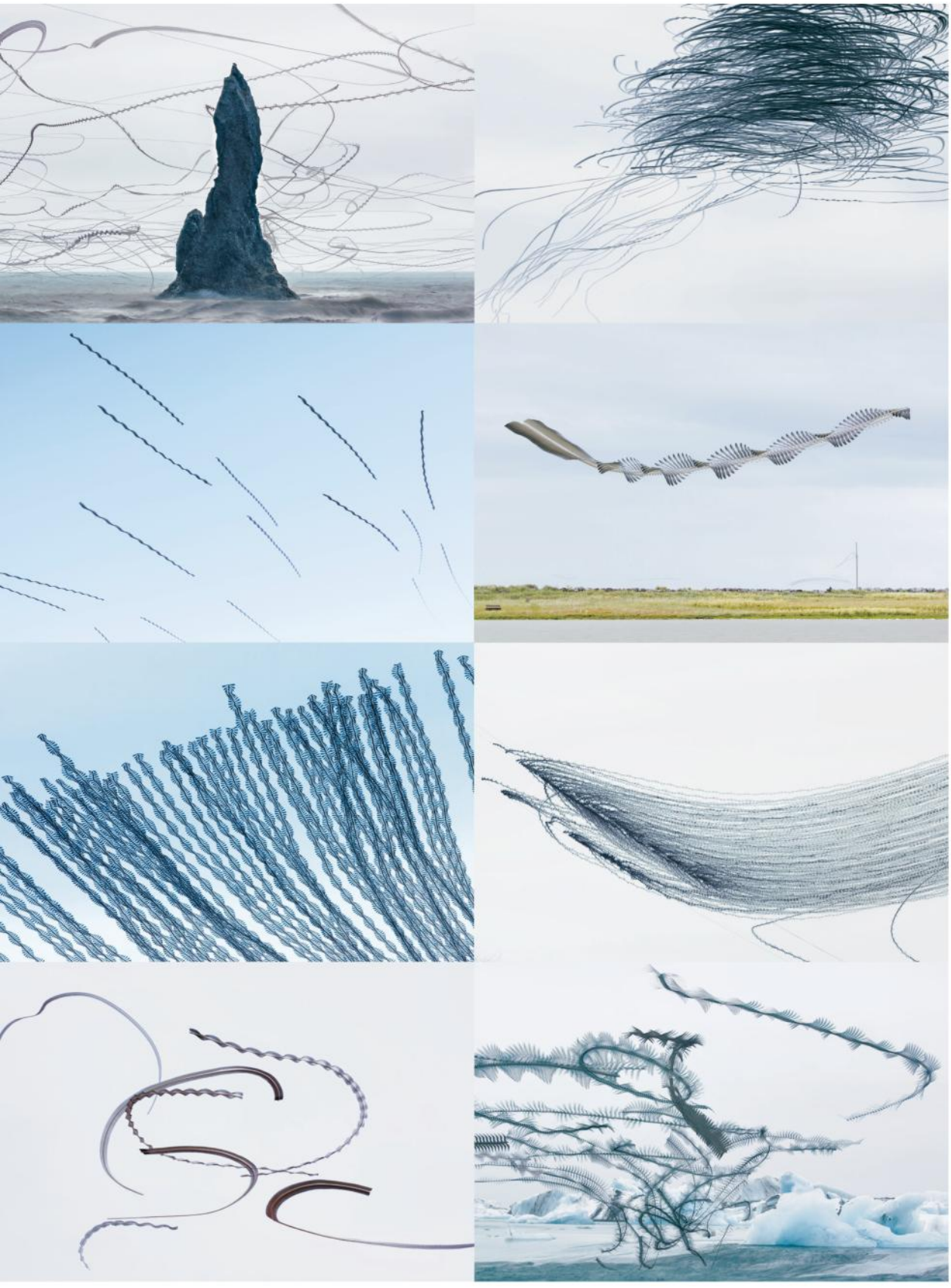






From arctic terns to common swifts, birds in flight become surreal impressions in the hands of photographer Xavi Bou, who uses a high-resolution video camera to create his images. Bou was first captivated by the



BIRDS AND LOCATIONS PICTURED HERE CAN BE FOUND AT *NGM.COM/2018/01.*

natural world when he was a child and would take long walks with his grandfather, who lived on the Llobregat River Delta near Barcelona. As an adult, Bou began to wonder what it might look like if birds left trails in the sky.

Near the fishing village of Roses, Spain, seagulls form a dreamy tableau as they chase a boat for scraps.

The Healing of Colombia

After a 52-year civil war, the battered but hopeful nation seeks a lasting peace and new opportunities across its countryside.

An airplane that drug lord Pablo Escobar used for smuggling cocaine adorns the entrance of Hacienda Nápoles. His once lavish estate is now a theme park with animal exhibits, waterslides, and dinosaur statues.

In southwestern Colombia in February 2009, members of the FARC rebel group killed nine people – two of them pregnant – from the Awá indigenous community. The FARC said they were informants for the Colombian Army. The remains were returned to the Awá in late 2014 for proper burial.


POLICIA

Pedestrians watch a wedding party's arrival at the Church of San Pedro Claver, in the historic district of Cartagena. The resort city's Spanish colonial charms are a boon for tourism, which the government says has risen 250 percent in Colombia since 2006.

By Alma Guillermoprieto
Photographs by Juan Arredondo

‘Run!’

María Magdalena Padilla’s brother yelled to her mother. “This time it’s for real. Get away right now!”

María Magdalena, a 10-year-old known as Mayito, could see the black smoke coming from farther down the hill as the *paramilitares,* criminals with a right-wing ideological bent, advanced on the town of El Salado, setting fire to her neighbors’ houses as they approached. Mayito’s mother emptied all the corn out of a burlap bag so the chickens would have enough to eat, threw some clothing into it, and climbed on the back of the family donkey with Mayito, as her two older brothers walked alongside. For a full week they hid, with little water and almost no food, in the shacks that campesino families keep in their fields here.

“I remember that we children were always quiet during that time,” she says now. “Not even the babies seemed to cry.”

From a distance the terrified family could not have guessed the full extent of what was taking place in El Salado, a prosperous town by rural standards, at the center of territory disputed between left-wing guerrillas and their paramilitary adversaries. The assault produced one of the most horrifying episodes in Colombia’s five decades of brutal ideological warfare.

Villagers who hadn’t had time to flee were rounded up in front of the church, in a field normally used for pickup soccer games. As their relatives were forced to watch, the victims, accused of sympathizing with guerrillas, were taken into the center of the field one by one, tortured, mocked, knifed, and then strangled or shot. The paramilitaries beat those who cried out at the sight. They raped young women before killing them. They raided the community center, and, in this region of northern Colombia where music and dance are a central part of existence, they took the local band’s instruments and celebrated each murder with loud, drunken playing.

The killing in El Salado and nearby towns lasted six days, from February 16 to 21, 2000. By the end of it, 66 people were dead. Returning home with her family, the child Mayito recoiled from the sight of the charred houses and the lingering smell of death. This time no one in her immediate family was among the dead, but the family had already been traumatized: Mayito’s father had been murdered years earlier, accused of being a guerrilla sympathizer. Her mother packed up the family belongings as other survivors gave their relatives a hasty burial in four mass graves. Within a week, all of El Salado’s 4,000 residents had fled, joining more than two million other internally displaced Colombians at that time who were robbed of their families, their homes, their livelihoods, and their peace.

In February 2000, when members of a paramilitary group massacred townspeople in El Salado, one victim was Miguel Ángel Contreras. His father, Jesús Contreras, has not visited El Salado since. Now 86, blind, and deaf, he lives with his daughter in Cartagena.

What makes this story different from other episodes of horror and heartbreak in Colombia is that the people of El Salado came back. In a stubborn return to this most unlikely promised land, the Saladeros took back their town two years after the killings, clearing the tropical vines that had climbed across roads, up walls, and into every empty room, whitewashing the adobe houses, and replanting the tobacco fields that had provided a tolerable income not so long before. There was no school for the children, but Mayito Padilla, by then 12 years old, decided to start one on her own, including literacy drills and the multiplication tables, and a history course in which her 37 students went over their own experiences so as not to forget the terrible events of the recent past.

Today, El Salado and Colombia are transforming their grim heritage. The girl now known as "Miss Mayito" worked her way through a degree in early childhood education and became the head of community relations in her hometown. And after half a century in which the war circled repeatedly in on itself, and after four years of painstaking negotiations, the country's oldest guerrilla group, the Fuerzas Armadas Revolucionarias de Colombia—or FARC, by its Spanish initials—turned over the last of its weapons in June 2017 to a United Nations team. By then the entire country had been reshaped by violence. Now a lasting peace will have to be won, inch by inch. El Salado, with its head start on reconstruction, has given people hope that the country too can heal.

THE REALITY is that in the two centuries since it gained independence from Spain, Colombia has rarely been without violent conflict. Some would argue that the latest cycle of bloodshed began on April 9, 1948, with the assassination

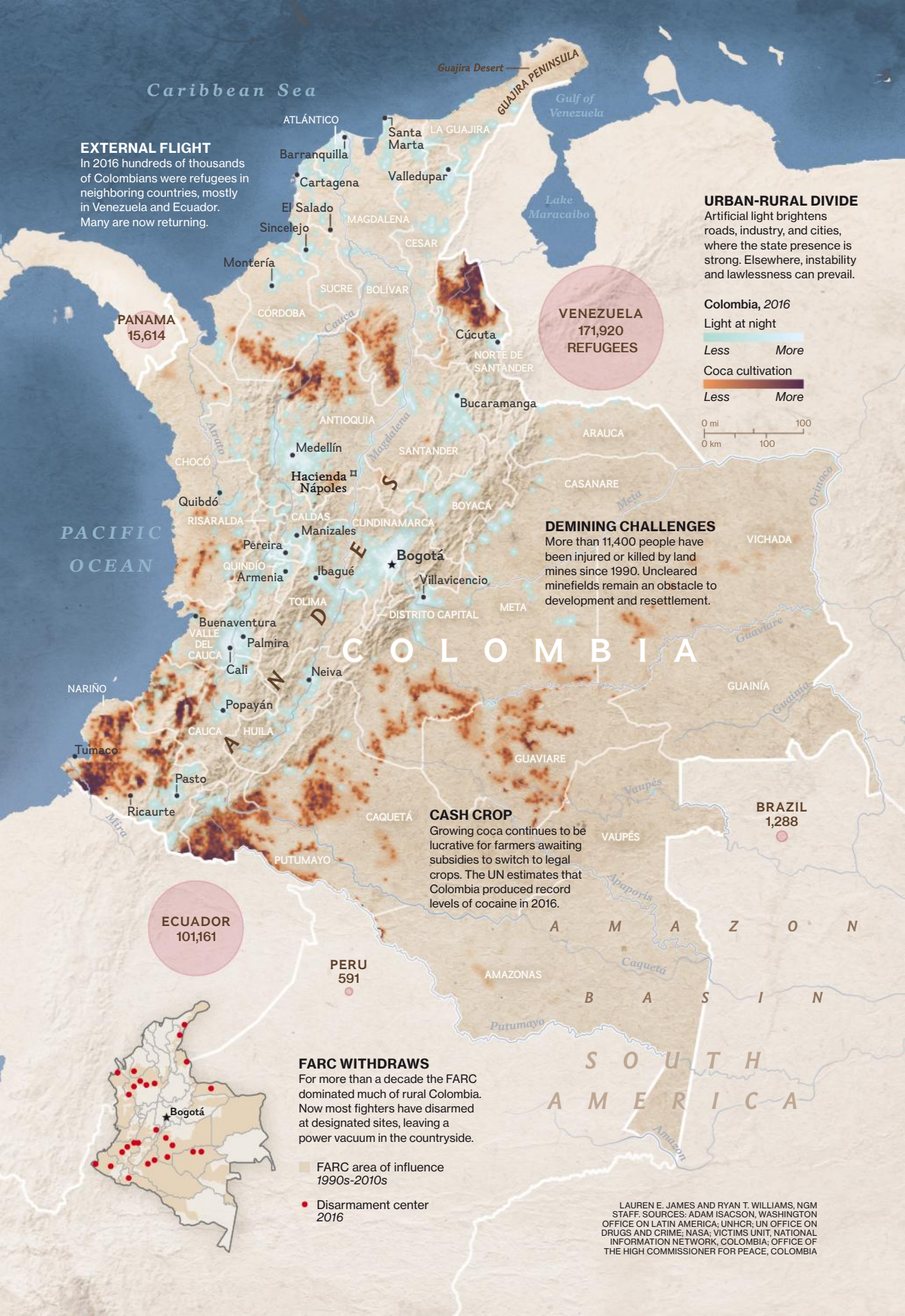
The paramilitaries played music as they carried out the massacres in El Salado. Today students in a band drown out those memories. A teacher visits once a week to instruct the musicians, who range in age from seven to 23 and practice in a local park.

of an overwhelmingly popular leader of the traditional Liberal Party, Jorge Eliécer Gaitán. The murder sparked deadly riots in the capital, Bogotá, and a 10-year wave of partisan killings—La Violencia—in the countryside. But long before that, members of the Conservative Party had been slaughtering Liberals, and often enough, vice versa.

In 1957 an agreement to end the violence by rotating power between both parties led to a decade or so of relative peace, and in the cities not many people took notice of a few dozen Liberal campesino families who'd been radicalized by a forceful communist organizer. Among those who did were the army, the sitting president, and an archconservative senator who accused the campesinos of wanting to create "independent republics" inside Colombia. In 1964 a military operation involving thousands of troops overran the Liberal group's small, precipitous holdings in Colombia's Andean foothills. Further radicalized by being bombed, the campesinos adopted the FARC name and embarked on a guerrilla war against the state that was to last 52 years.

The small band of radical campesinos with no weapons to speak of and no proper military training little by little recruited neighbors and nearby villagers, until their numbers exceeded the most fantastical expectations. Then the FARC grew again, explosively, in the 1980s, thanks to a war on drugs that began in the United States and was largely fought in Mexico and the Andean countries, where coca is grown. Leaves from the shrubby coca bush are medicinal, sacred to the native populations of the Andes. They're also the central ingredient in cocaine, a chemical compound first developed in Germany in the mid-19th century. When growing coca was declared a criminal activity more than a hundred years later, Andean peasants simply moved what was by far their sturdiest cash crop to increasingly remote parts of Colombia's vast hinterland. After all, some bloodthirsty drug mafia or other was always willing to pay top dollar for the otherwise useless plant.

Given the never-ending demand for recreational drugs from New York to Shanghai, the drug war only served to force prices ever upward.



LAUREN E. JAMES AND RYAN T. WILLIAMS, NGM STAFF. SOURCES: ADAM ISACSON, WASHINGTON OFFICE ON LATIN AMERICA; UNHCR; UN OFFICE ON DRUGS AND CRIME; NASA; VICTIMS UNIT, NATIONAL INFORMATION NETWORK, COLOMBIA; OFFICE OF THE HIGH COMMISSIONER FOR PEACE, COLOMBIA

The FARC sensed an opportunity and stepped in. In exchange for protecting the campesinos from ruthless traffickers and ensuring standard prices for the coca leaves they harvested, the FARC levied an export tax for every kilo of processed coca paste that left the territories under its control.

Soon FARC troops had standardized uniforms and boots—and standard-issue combat weaponry too. Their numbers swelled to an estimated 20,000. The guerrillas were awash in money, and the leadership inevitably became corrupt, vicious, and hungry for more. Hardly revolutionary, they extorted, kidnapped, and set off bombs. And because FARC guerrillas attracted the attention of paramilitary groups that sprang up to combat them, they inflicted great suffering on the very campesinos they lived among. It was the FARC that the paramilitary killers in El Salado accused the villagers of sympathizing with, and it was the FARC that, backed into a corner militarily, finally signed a peace accord with the Colombian government on November 24, 2016, and turned over its weapons in June of last year.

At age 17, after Antonio saw paramilitaries displace his family, he joined the FARC. At 22, he and other guerrillas met to talk about turning in their weapons. Within a year a peace pact was signed, leaving the rebels the task of reintegrating into towns they'd once terrorized.

FROM THE PENINSULAR Guajira Desert to the high Andean *páramos,* where it's possible to walk with one's head literally in the clouds; from the tropical plains along the Atlantic to the deep green jungles of the Pacific, this is a breathtaking country, with only 48 million people occupying a territory almost twice the size of France. Colombia has more varieties of hummingbirds, butterflies, orchids, frogs, and whatever other tropical living thing one can imagine than just about anywhere else on Earth.

Many people here are shockingly poor, which is particularly clear if you travel from the modern cities to, say, the Pacific region of Chocó, whose impoverished Indian and Afro-Colombian populations still navigate numerous broad rivers in canoes because there are so few roads. Visitors to the resort city of Cartagena are rarely told about an outlying barrio named after Nelson Mandela, where some 40,000 people, mostly refugees from the violence in places such as Chocó and El Salado, live in shameful conditions. Flying over the emerald-green country, you can see broad, gleaming rivers everywhere; steep valleys covered in a patchwork of coffee farms; lush pastures spreading like velvet cloaks toward the Amazon.

What you can't see are the land mines.

When a round of peace talks in the early 2000s broke down, the tide of the war turned against the FARC, which intensified its use of mines—technically, improvised explosive devices, since they're handmade—to obstruct the army's hot pursuit. They're bitter souvenirs of the guerrillas' fight, and eradicating them is a crucial task faced by the government. Too often a campesino steps on a mine somewhere that was planted long ago, leaving a child blinded by shrapnel or a farmer missing a leg or an arm and no longer able to feed his family. According to the HALO Trust, a worldwide mine-clearing organization, Colombia has consistently ranked behind Afghanistan as the country with the second highest number of mine victims in the

world; mines have killed or wounded more than 11,400 Colombians since 1990.

"Land mines did more damage to campesinos than to the army," Álvaro Jiménez, a mine expert, told me. Jiménez is a former guerrilla himself (the organization he belonged to, the M-19, turned over its weapons to the government in 1990). Eighteen years ago he became the head of the Colombian Campaign Against Mines, which creates and sponsors harm-reduction programs in areas mined by the guerrillas. "Mines generate many fears," he said. "Like the fear of venturing out after dark to look for a doctor if someone is sick, taking children to school. Normally campesinos live in a harmonious relationship with their surroundings. Mines destroyed that."

Jiménez suggested I travel to the department of Nariño, a land of high rolling hills quilted in a patchwork of soft green fields and then a plunge to the untamed tropics of the Pacific coastline. In the remote town of Ricaurte, which like most urban clusters in Colombia is crowded and graceless and roaring with motorbikes, I was introduced to Cristian Marín, a member of the Awá indigenous people who live in a jungle preserve not far away. Slight, cinnamon skinned, and just a little potbellied, Marín is one of the youngest leaders to be elected by the Awá to solve disputes and deal with the outside world.

Marín speaks in a murmur and relies on understatement, so it's hard to get a picture of the damage his community suffered without resorting to rude questioning, and it was only in response to one such interrogation that he told me about an army-guerrilla confrontation near his own family's compound in which, as usual, neither party emerged the winner.

"And as usual," Marín said, "the guerrillas mined as they retreated. So people decided not to leave their homes. They were afraid." Besieged


EL Billar
del GOZO
¡Vá Gozar!

As the peace agreement was being negotiated, the violence and crime in Colombia began to lessen. National police patrols swept communities for drugs and weapons. In the town of Quibdó they confiscated several weapons at this bar, then shut it down.

SEBASTIAN LISTE

by fear, unable to work their fields or travel to market for supplies, they didn't venture beyond their own yards for months, suffering accordingly. Marín didn't mention, until I asked, that he himself had lost four relatives to mines. He seemed to me as incapable of optimism as a tree might be of flight.

We spoke under the shade of a leafy ficus in a public square bordered by nondescript municipal buildings. Marín was working in Ricaurte as an Awá representative, recruited to receive training in human rights. "It's a political thing they want to do," he said, shrugging. "There's a budget for it—the Norwegians are giving money." Nevertheless, he acknowledged, the effort was helping Awá citizens obtain legal documents and file complaints about human rights violations. And as part of the accords signed between the government and the FARC, a joint program with army personnel and demobilized guerrillas is beginning the slow and risky process of mine eradication. The current combat-free era is a great advantage too, he said: It's easier now for Awá children to get at least the substandard schooling available to them. "In my school I was always behind," Marín said, "because I spent so much time hiding under a mattress from the fighting."

A pit full of plastic balls at La Octava bar typifies Medellín's growing nightlife and tourist appeal. It's a dramatic change from the violent days under Escobar's Medellín cartel, which at its height brought in as much as four billion dollars a year in the cocaine trade.

IN THE BOOMING CITIES, with their sophisticated restaurants and art galleries and designer buildings, people could forget that a war was on. Even now that foreign investment is turning from a trickle to a flow and traffic jams are world-class, it's hard to remember that this is a modest economy, with a government that runs on a painfully inadequate budget.

In Bogotá I talked with a prominent Colombian senator, Antonio Navarro Wolff, in a shabby office with a crowded waiting room barely large enough for a hermit and a phone system that looked like it was set up in 1980. Navarro Wolff, once a governor of Nariño, is something of an expert in *posconflicto,* given that he was a leader of the former M-19 guerrilla organization. His group demobilized successfully, and he has kept abreast of the many peace talks that have taken place over the years.

I asked him which post-conflict task the government should take on first, in light of budget and personnel limitations: Land restitution to campesinos evicted from their holdings by paramilitaries? Education and resocialization for some 7,000 demobilized guerrilla troops? Exhumations and identification of Colombia's tens of thousands of "disappeareds"? Mine clearing?

"The principal, most urgent, question is only one," Navarro Wolff answered. "Who is going to occupy the land abandoned by the FARC? The government or the new criminal bands?"

Guerrillas and paramilitaries fought for control of remote territories ideal for growing coca and the kind of poppy used for making heroin. "The guerrillas may go, but the land remains," Navarro Wolff said. And so does the illegal drug trade—and the drug war. "What we need now is police. In the posconflicto the task will no longer be to kill criminals but to make sure that there

are no new criminals. For that we need a security force, but right now we have barely 10,000 police" in rural areas, he explained.

In a great irony of this complicated war, the FARC may turn out to be by far the cheaper of two evils, compared with the cost of controlling the savage new drug-trafficking gangs taking over the territories where guerrillas and paramilitaries once fought for control. The government estimates that 5 percent of the guerrilla forces have refused to lay down their weapons and may eventually find their way into the ranks of the so-called *bacrim* (short for *bandas criminales*). Today these gangs are mostly involved in the drug trade, but they're slowly taking over old guerrilla and paramilitary sidelines as well: extortion, kidnapping, and human trafficking.

And as Marín had told me in the little plaza of Ricaurte, "At least with the guerrillas, they had a central command one could negotiate with," for things such as curfew hours. Not so with the new criminal bands. "They just say '*plata o plomo,*'"—silver or lead, meaning bribes or bullets—Navarro said. "And anyone with any brains at all will say, 'Oh, I'll take silver, because lead is far too heavy.'"

HOW WILL the 23 percent of Colombians who live in the countryside fare now that there's peace? Over the course of half a century, more than seven million people left their homes in the rural areas most afflicted by guerrilla and paramilitary violence. The government's reconstruction and reparations efforts are focusing on these regions. Seventeen years after the massacre that emptied out the town, El Salado is a good place to look for first results.

Set a couple of hours inland from the Caribbean shore, the town still isn't much to look at: A gulch runs through the center, and an unrepaired

After 2011, when orange-roofed escalators were installed in Comuna 13, one of Medellín's poorest and most isolated hillside barrios, life changed. On the escalators, tourists now take in the view, and residents get a break from climbing the equivalent of 28 stories.

In the past, FARC members – about a third of whom were women – gathered in secret to plan their next moves. But with the peace agreement under discussion, hundreds came out of hiding in the jungle to attend a September 2016 conference, which included dances and other public events.

Luis Torres has a dream: A technical school in his hometown of El Salado, one that will train kids who now zip around aimlessly on motorbikes for something better than a dirt-poor life.

aqueduct made water supply problematic when I visited. And yet for a cohort of its residents in exile, nostalgia for their place of birth proved strong enough for them to band together, 2,000 strong, in defiance of death threats and their own dreadful memories, to reclaim it.

Luis Torres led the return campaign 17 years ago, and when the first 130 people agreed to come back to El Salado, he raised the funds to hire the trucks that brought them home. An articulate 71-year-old with a rugged face and a startling liveliness about him, he was employed when I visited as the primary intermediary between the town and the Semana Foundation, which for many years coordinated the effort to resurrect El Salado.

In the beginning Torres had to negotiate permission for the residents to resettle their town with a FARC detachment that then held sway over the region. He subsequently spent three months in prison, charged with "rebellion," and then went into a long exile in the Netherlands, Switzerland, and Spain before he felt it was safe to return. Now he glowed with a sense of accomplishment as he showed me the sights of his hometown: a cell phone tower that at last allows Saladeros to communicate with the outside world, a preschool, a hundred new houses for the community's poorest families, a couple of storefront groceries, an evangelical church, a street lively again with scampering children, neighbors waving hello.

"When people first came back here, their fears were wide awake," Torres remembered. "And they had a stigma chasing them. In the cities they say about us, 'They must have done something if they had to leave their homes.' No one wants to hire a displaced person. And for our part, we have a mistrust and fear that won't go away. It's only recently that people have started leaving their doors open."

Depending on who was taking stock of the improvements—Torres or, say, me—one could see either heroic achievements against all the odds or modest recovery to the tune of millions of donated dollars, without solving many of the town's most basic problems, including water, jobs, and education. And El Salado is just one small town out of thousands in similar straits. It was only two years ago that it acquired its most significant improvement: a 12-mile stretch of paved road that reduced travel to the nearest major town and highway to 30 minutes, down from as much as four hours, depending on the rain. Perhaps the transformation of El Salado has simply allowed it to become one more community without adequate water, sewage, education, health care services—and where all too many campesinos lack title to lands they may have occupied for generations.

Luis Torres has an ultimate dream: He sees himself standing in the crowd and applauding as the ribbon is cut on a technical school in his hometown, one that will train the kids who now zip around so aimlessly on their motorbikes for something better than a dirt-poor life. "Once I see that ribbon being cut, I'll die in peace," he said.

AT THE CENTER of the new Colombia, the former guerrillas who played such a large role in creating the old one have grander dreams. "I want to help create equality not just for ourselves but for all the Colombian people and—why not?—for the world," said a young man whose nom de guerre was Alex. We were sitting on an overlook, taking in an expanse of valley, all green fields and golden light. Behind us was a bare-bones communal kitchen, and around us a new settlement—one of 26 built from scratch in the past six months—designed to accommodate 300 or so demobilized

guerrillas. The settlements are part of the 297-page agreement so laboriously negotiated between guerrilla leaders and the government. They're supposed to contribute to a smooth transition into modern-day consumer society for some 7,000 fighters, now that they have laid down their weapons.

Despite the ramshackle quality of the dormitories—one wallboard room per guerrilla or guerrilla couple, toilet and shower stalls across the way—Alex was truly pleased with his new surroundings. All of 25, painfully shy of strangers and completely innocent of the ways of capitalism, he looked and acted more like a teenager, as if his real life had stopped when he ran away from his family to join the FARC at age 15. "No money, no work, no chance to study—my family was poor," he explained. He said he had never had a moment of regret, but one wonders how much his situation improved: During his 10 years as a guerrilla fighter he never slept under a roof, saw his family, or used money. "Looking back, those were years of suffering and hardship," he said. Sleeping most often in a hammock protected from the rain by a plastic sheet, bedtime was at six every day lest a conversation, a giggle, a lit cigarette give away the group's location. Radios weren't allowed, because an infiltrator might easily place a microchip locator in one. Crisscrossing the country with hundred-pound backpacks, guerrillas relied on rice as their main sustenance. On his first day out of training, Alex said, his group ambushed a military post, and he saw three of his young comrades die.

"One feels the change most in the *tranquilidad,"* he said. And then there are the dormitories: "Now we each have an opportunity to organize our little room as we like. Our bedtimes have changed, because some like to watch their telenovela, others their soccer game." He worried that a monthly government subsidy of about $300 per demobilized fighter would be hard to administer properly, but the money was being deposited into a nearby bank. "Now that we're civilians," he said, "we have to learn to manage ourselves, and we know that out there you need money for everything."

IF THE GOVERNMENT had been bolder, or richer, or less hemmed in by loud opposition to the peace agreement in Congress and among Colombians in general, each former combatant would have received a far larger amount of money—enough to set up a curbside *arepa* stand, or finish school, or in other ways help ensure that a person reentering society from the equivalent of Mars, with only the clothes on his or her back, would find legality more attractive than a job with one of the criminal bands now hiring. The monthly subsidy will end in July of 2019, as will the demobilization territories, where the United Nations verification mission and the national police are ensuring safety and protection. It was almost unfair to ask Alex, still adjusting to the basics of his new life, how he saw the future after this transition period, but clearly it was something he and his mates discussed constantly.

"What I worry most about is security," he said immediately. In the mid-1980s failed negotiations with the FARC included a truce, an amnesty, and the opportunity to create a political party, which was called the Unión Patriótica. Within the decade more than a thousand party militants had been assassinated, mostly in broad daylight and, instructively, in public spaces. Now the FARC is transforming itself into a new party, which is supposed to guide the ex-fighters, win elections, and lead Colombia into the new world Alex thinks his years of struggle have made possible. When he's speaking in what might be considered his heroic voice, Alex muses about a future of collective effort and collective joy, but caught off guard, he dreams aloud about the little farm he hopes FARC leaders will arrange for him and the nursing degree or baking certificate to which others in his group aspire. He'd like to study too, finish elementary school and get his high school diploma. On the farm? He hesitates. Life is complicated and uncertain for everyone these days, but who knows? It might all work out in the end. □

Alma Guillermoprieto, who lives in Bogotá, writes often about Latin America for the magazine. Photographer **Juan Arredondo,** formerly a chemist, is also based in Bogotá. This is his first *National Geographic* story.

Last Ice

Later this century, forecasters say, the sea ice that covers most of the Arctic will be reduced to a strip above Greenland and Canada. It will become a refuge for polar bears and other wild creatures as they fight to survive.

Off the north coast of Canada's Baffin Island, a June sun transforms snow and ice into limpid pools of turquoise. The Arctic's perennial sea ice cover – the ice that survives the summer melt season – has shrunk dramatically.

BRIAN SKERRY

On a nearly ice-free August morning, walruses flop ashore on Devon Island, north of Baffin. Walruses dive as deep as 300 feet to feed on clams and other bottom dwellers. In between dives they rest on sea ice; dry land is a less convenient substitute.

FLORIAN LEDOUX

A pod of beluga whales swims through Lancaster Sound north of Baffin Island. The whitest ones are adults that have already molted: Every summer belugas seek out shallows where they can rub off their old skin against gravel and sand.

PAUL NICKLEN

By Tim Folger

We see evidence of the kill first: a shockingly broad spread of scarlet, probably the blood of a ringed seal, on snow-covered sea ice. Then the polar bear appears. She's big, maybe 500 pounds, trailed by a single cub. They've just jumped into a lead—a long fissure of open water in the frozen sea. In seconds they're out of the water again, running across the ice, spooked by the approach of our helicopter. Prolonged running can harm polar bears: Fat and fur insulate them so well they risk overheating. François Létourneau-Cloutier, our 33-year-old Québécois pilot, takes us higher, and the mother and cub slow to an amble.

After following them for several minutes, Létourneau-Cloutier sets the helicopter gently onto the ice a few hundred feet away and cuts the engine. The mother rises on her hind legs, assessing our 35-foot-long flying machine with the unruffled gaze of the Arctic's top predator; the cub remains on all fours behind her. For a few timeless moments we savor the scene—bears against an otherwise empty immensity of snow and ice, countless shallow pools of meltwater reflecting a high summer sun ringed by faint halos of red and blue. Then, with a frenzied whine, the helicopter's rotor blades break the spell, and we lift off, veering southwest toward our campsite on the northernmost tip of Baffin Island, Canada, about 700 miles north of Hudson Bay.

Within a few decades such vistas are unlikely to exist, at least not here, during summer. As the planet heats up, the summer sea ice and all the superbly adapted life it supports—the bears, the seals, the walruses, the whales, the Arctic cod, the crustaceans, the ice algae—may well vanish around Baffin. As we fly over the vast frozen expanse, it almost strains belief to think that we're witnessing—and with the rest of humanity, helping to cause—its demise. In the 1980s satellite data showed that Arctic sea ice extended on average across nearly three million square miles at the end of summer. Since then more than a million square miles has been lost—an area roughly the

Dripping wet, a polar bear climbs onto an ice floe in northernmost Hudson Bay. Polar bears perch on sea ice to ambush seals – the source of 90 percent of their calories – when the seals surface. National Geographic Explorer-in-Residence Enric Sala is leading an effort to preserve some of the bears' dwindling habitat. "In Russia we found bears stuck on islands eating grass and seabirds," he says.

PAUL SOUDERS

size of Alaska, Texas, and California combined.

Climate models suggest that by the 2050s, less than 200,000 square miles of perennial sea ice will remain. The good news, such as it is: What's left will collect in a compact region, not here but farther north, above Greenland and Canada's Ellesmere Island. That shrunken redoubt will be the last stand for many of the Arctic's wild things.

"The animals that depend on the edge of the sea ice for a living will be congregating there in the summer," says marine ecologist Enric Sala, leader of the National Geographic Society's Pristine Seas project. "It will be like one of those watering holes in Africa where everybody shows up."

Sala has come to Baffin with divers and filmmakers to document the icy world that's doomed here—and to make the case for preserving the "last ice" farther north. Since he started Pristine Seas a decade ago, the project has helped protect more than three million square miles of ocean. But preserving the remnants of Arctic ice, which will require the cooperation of Greenland and Canada, will be its most ambitious undertaking.

It's also the most urgent. "The Arctic is changing faster than anything else," Sala says, and as the ice goes away, shipping, fishing, and oil and gas development may intrude. If sea ice and its denizens are to be protected, it must happen before exploitation of Arctic resources becomes unstoppable. With the last-ice project, Sala says, "we're looking 25 years ahead."

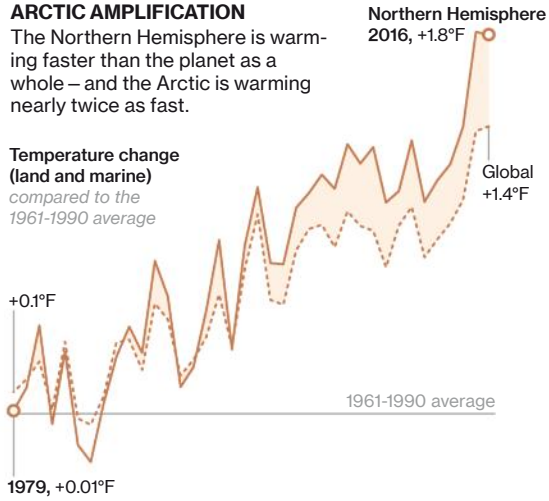
IN SATELLITE PHOTOS, and perhaps in our imaginations, the icescape glazing the top of our world appears static, like a featureless white continent, permanent and immobile. Actually it's a jostling mass of ice floes that, propelled by winds and currents, drift from one side of the Arctic to the other in journeys lasting years.

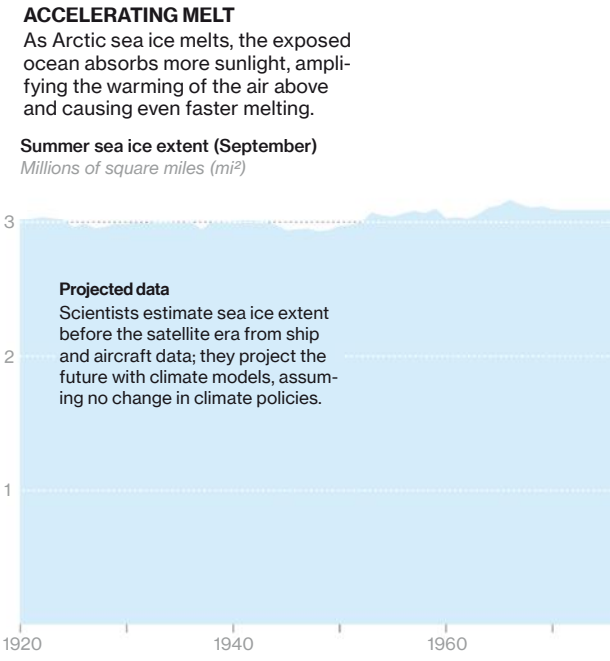
"People don't understand the Arctic," says Stephanie Pfirman, an oceanographer at Barnard College and Columbia University. "They think of it as an ice cap. They think that it's rigid and that when it melts it's just melting back on the edges.

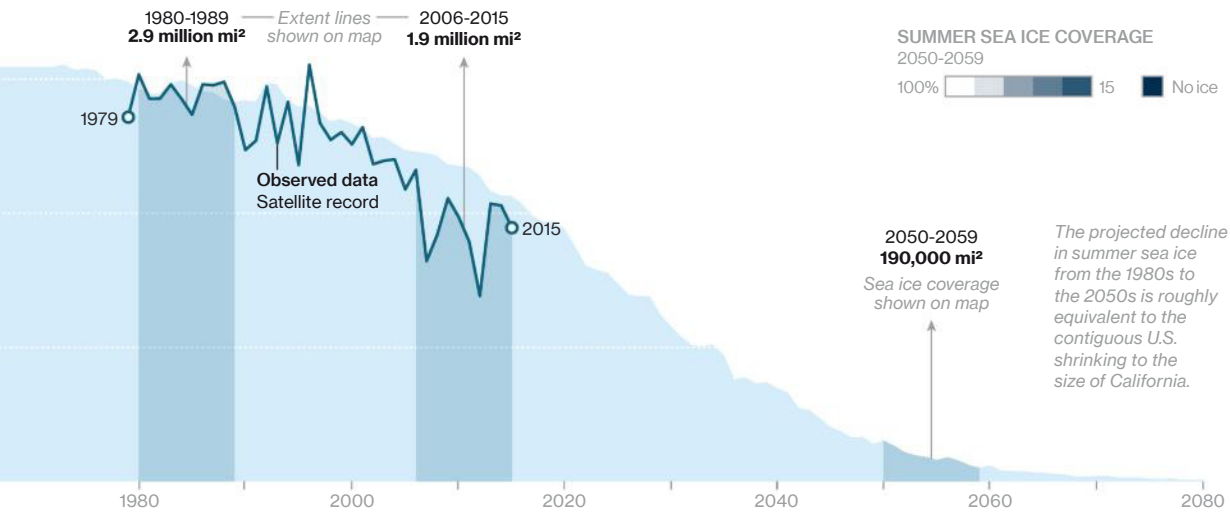
Society Grant Your National Geographic Society membership helped fund this project.

Ice on the Edge

The Arctic's year-round ice is projected to shrink to a narrow strip off the northern edge of Canada and Greenland in the next few decades. Wind and ocean currents will help thicken the ice in this final, frozen refuge.







SUMMER SEA ICE COVERAGE
2050-2059
100% 15 No ice

The projected decline in summer sea ice from the 1980s to the 2050s is roughly equivalent to the contiguous U.S. shrinking to the size of California.

NGM STAFF; LAWSON PARKER. SOURCES: BRUNO TREMBLAY, McGILL UNIVERSITY; PATRICIA DeREPENTIGNY, UNIVERSITY OF COLORADO BOULDER; ROBERT NEWTON, COLUMBIA UNIVERSITY; CLIMATIC RESEARCH UNIT, UNIVERSITY OF EAST ANGLIA

Pants made of polar bear fur identify Naimanngitsoq Kristiansen, an Inuit man from Qaanaaq in northwestern Greenland, as a seasoned hunter. With sea ice thinning every year, his dogsled journeys have grown increasingly hazardous.

PAUL NICKLEN

Narwhals mingle in Lancaster Sound, off Baffin Island. They winter in ice-covered waters, feeding on halibut. The corkscrew tusk, a canine that grows up to nine feet long, may serve to impress females, which rarely have one.

PAUL NICKLEN, NATIONAL GEOGRAPHIC CREATIVE

Walruses dive and court near the Norwegian island of Spitsbergen. Their skin, light gray or brown in frigid water, reddens when the blubbery animals haul out on land and blood flushes through their thick outer layers of skin.

PAUL SOUDERS

They don't think of this dynamic aspect of it."

In 2010 Pfirman was part of a team that identified the most likely location for the Arctic's last summer sea ice, work that has helped guide the Pristine Seas effort. Comparing a variety of computer models and satellite data, she and her colleagues found that winds and currents conspire to funnel drifting sea ice from all over the Arctic onto the northern edges of Greenland and the Canadian Arctic Archipelago—a region of spectacular fjords and more than 36,000 islands, including Ellesmere and Baffin. Year after year, massive ice floes stack up in that relatively calm zone. Some of the ice there is decades old and more than 80 feet thick.

'Some people say it's hopeless; we're on a trajectory where ice is going to be lost. But it has this long tail, which gives us time.'

Stephanie Pfirman, oceanographer

Pfirman and her colleagues realized that by mid-century, this frigid haven would hold the Arctic's only year-round ice. Their discovery was far from obvious. In some earlier climate models, Pfirman says, the Arctic's ice cover simply retreated evenly along its southern flank as the planet warmed, ultimately settling right around the North Pole. "That makes no sense at all, though," she says. "There's no reason for ice to congregate at the North Pole. It's going to keep moving until it hits something."

Despite the steep decline in store over the next several decades, a long, narrow band of perennial ice will persist late into this century. If we can end our reliance on planet-heating fossil fuels, it could survive even longer—into a time when, just maybe, we'll figure out how to remove enough carbon from the atmosphere to cool the planet again. "The ice models don't drop down to zero," Pfirman says. "Some people say it's hopeless, because we're on a trajectory where ice is going to be lost. But if you look at the climate models, it drops down precipitously, and then it has this long tail, which gives us some time to act and potentially mitigate the warming."

The ice that does remain in the Arctic may provide a stable environment, albeit a compact one, for organisms that depend on ice. "For people concerned about habitats, it's not that you will sometimes have the summer ice off the coast of Siberia and sometimes have the ice in the Beaufort Sea," Pfirman says. "Because you couldn't sustain a habitat if that ice was moving all around. It's actually pretty consistently going to be banked up off the coastlines of Greenland and Canada."

"THIS IS A NEWCOMER," says Theo Ikummaq, stooping and pointing to a delicate green shoot on the rocky beach near our campsite. Ikummaq, a 60-year-old native of Igloolik, an island off of Baffin, is a guide and adviser for our expedition. It's a cold and foggy June afternoon; the inlet we're walking along is still frozen. Clouds have covered the sun for days now. Ikummaq carries a rifle over his shoulder in case we need to scare away polar bears. We've already spotted the tracks of one in the sand only a few hundred yards from our camp.

The little green shoot, maybe a couple of inches high, has no name in the Inuit dialect spoken in this part of the Arctic. Ikummaq doesn't recognize it; he knows only that it's another example of how the land and life are changing here. During our walk we've passed what Ikummaq says are new features in the landscape: large circular sinkholes, created by thawing permafrost.

Later that day, in the big tent where we have our meals, Ikummaq tells me the names for a few Arctic animals. An *aarluk*—"kills everything"—is a killer whale; a *tingugliktuq*—"bad liver, don't eat"—is a horned lark. But some animals, such as robins, are so new to the Arctic that Ikummaq, at least, doesn't know names for them.

With global warming, plant and animal species from the south have started to move north. It's a trend that will only accelerate, says Brendan Kelly, a biologist at the University of Alaska in Fairbanks. As the habitat for Arctic wildlife shrinks, the animals that survive are likely to

undergo profound changes. Diverse species will be thrust into closer contact than ever before.

"There's the potential for a massive scrambling of genes in the whole Arctic Ocean," Kelly says. "We did a survey of marine mammals and came up with 34 species that are capable of hybridizing." For reasons that scientists don't yet understand, marine mammals have tended to retain the same number of chromosomes—a key requirement for hybridization—as they diverged into different species and even genera.

"So you end up with things that you would otherwise say are different genera, but are in fact able to produce fertile hybrid offspring," says Kelly. "An example would be harp seals and hooded seals, which we classify as different genera—but we've seen them hybridize in the wild. There is some evidence of a hybrid between belugas and narwhals." Pizzlies—crosses of grizzlies and polar bears—already roam the Arctic. Genetic studies show that polar bears began diverging from grizzly bears within the past 500,000 years. Global warming threatens to reunite the two species.

"We could lose polar bears," Kelly says. "They might be reabsorbed into the grizzly bear genome out of which they came. We're not just talking about ecological change. We're talking about evolutionary change—really sped up."

The end result, says Kelly, is likely to be a tremendous, irreversible loss of genetic diversity. But even if that weren't the case, the Arctic's wildlife would still be in trouble. "We're changing the habitat so fast that even if they have the genetic diversity to respond, they may not have the time." For some of the world's iconic species, the last-ice region could make the difference between survival and extinction.

"PEACEFUL, ISN'T IT?" Enric Sala is smiling as he joins me on the beach in front of our camp's double row of two dozen orange tents. We're looking east across the frozen reaches of Navy Board Inlet toward Bylot Island, several miles away. Covered with mountains and glaciers, a refuge for denning polar bears and hundreds of thousands of nesting birds, it's larger than the big island of Hawaii. The sun is out, the weather has finally lifted, and there's barely any wind. After more than a week of waiting, Sala and his team of divers are eager to explore some open water around a couple of small islands off Bylot's western shore. In a few weeks, algae will be in full bloom, the water will cloud, and underwater filming opportunities will vanish. But now, the sea here is just beginning to blaze with life.

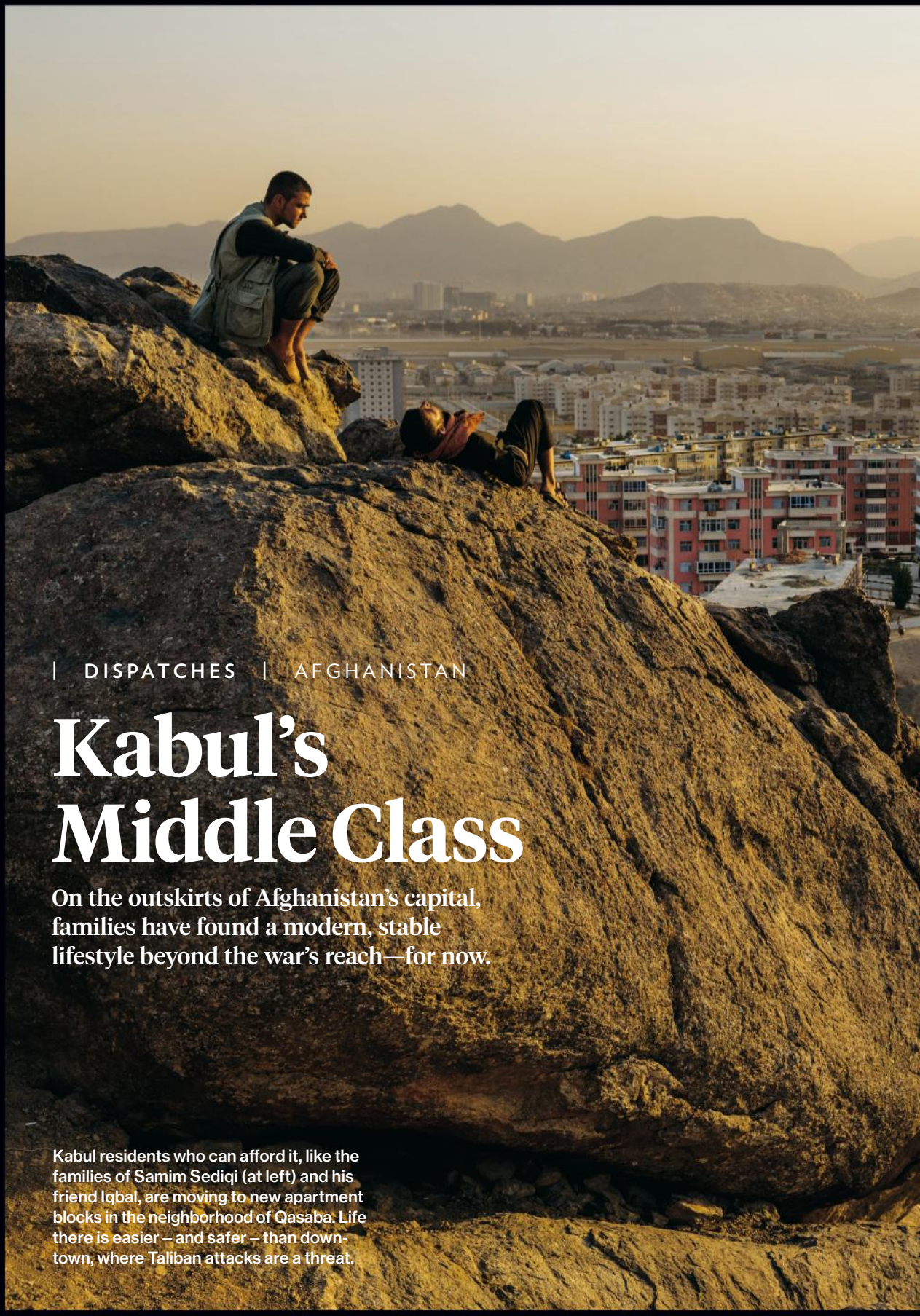
"Sunlight is like a lighter for this ecosystem; it's why we're here now," says Manu San Félix, a diver and photographer who has joined us on the beach, wearing his dry suit. Over the next few days, if the weather holds, he, Sala, and other expedition members will record the beauty of what will be lost if we fail to protect the Arctic's last ice.

The harder work, more arduous even than diving in freezing water, will take years: persuading governments to cooperate to save a region that extends across borders. Preserving the last-ice region itself won't be enough; because ice migrates long distances, its sources eventually will have to be protected as well. Right now, for example, Siberian ice contaminated with nickel and lead from the Russian industrial city of Norilsk—one of the world's most polluted places—sometimes drifts into the Canadian Arctic. There it poisons the food web as it melts.

"It's a good sign that we are seeing narwhals, belugas, and polar bears," says San Félix. It means the food chain here is still healthy. We talk about a pod of bowhead whales that were spotted during a helicopter flight the other day and about how their huge heads enable them to smash through two feet of ice. Bowheads can live 200 years or more. (One way their age has been determined is by carbon-dating old harpoon points embedded in their bodies.) The oldest of them now, says San Félix, might have been born when Napoleon was still alive. "Imagine!" he says. "That calf we filmed might be here in 2215!"

If we're lucky, that is, and foresighted enough. Says Sala: "This is not a simple, linear story where we know how it ends." □

Tim Folger has written many features for *National Geographic*, including two on how climate change is affecting Greenland. He lives in Gallup, New Mexico.



| DISPATCHES | AFGHANISTAN

Kabul's Middle Class

On the outskirts of Afghanistan's capital, families have found a modern, stable lifestyle beyond the war's reach—for now.

Kabul residents who can afford it, like the families of Samim Sediqi (at left) and his friend Iqbal, are moving to new apartment blocks in the neighborhood of Qasaba. Life there is easier – and safer – than downtown, where Taliban attacks are a threat.

BY **SUNE ENGEL RASMUSSEN**
PHOTOGRAPHS BY **ANDREW QUILTY**

On Fridays residents of the Khwaja Rawash apartment complex on the outskirts of Kabul climb to their rooftops to fly kites. But on one recent afternoon they stood watching a more ominous sight: white smoke curling skyward after Taliban mortar shells launched from the mountains to the north hit the airport nearby.

Khwaja Rawash, in a neighborhood called Qasaba, opened in 2017. It's home to some 9,000 tenants from an Afghan middle class that has been bolstered since 2001 by foreign aid and military contracts. For many residents the appeal is safety: With the departure of foreign troops, downtown Kabul is under growing threat from Taliban insurgents. These new apartments have running water and central heating, unlike the city's ubiquitous slum dwellings with their polluting woodstoves. Outside in Qasaba, women walk freely in the fresh air, socializing over ice cream, a sign of liberalism and security.

Abdul Kabir Ziarkash greets me at the door to his apartment. At 71, the former communist who spent four decades as a government meteorologist before retiring is lean and has the hoarse voice of a lifelong smoker. He wears an embroidered white robe and keeps his mustache neatly trimmed and his white widow's peak slicked back.

Two other generations live here with Ziarkash and his wife, Parwin: their youngest son, Aimal, 34, and daughter-in-law, Khalida, also 34, and their two sons. Aimal and Khalida met at college while studying computer science. Unlike most men of his generation here, Aimal allows Khalida to work, as a teacher at a girls vocational school. She's been the family's breadwinner since American funding dried up for Aimal's construction job. Khalida also cooks, cleans, washes dishes, and takes the sons to the playground. "I don't have a lot of free time," she says with a smile. Aimal, who has given up looking for a job, spends much of his day playing video games with the boys.

Lounging in his parents' bedroom, Arshid, 10, plays a game on his dad's smartphone. Three generations share this fifth-floor apartment, which has running water and central heating, luxuries in a city where at least 70 percent of residents have minimal services.

Black-and-silver faux-leather sofas dominate the living room, where Ziarkash drags on slim Dunhills while watching an Indian crime comedy on TV. He reminisces about the 1960s and '70s—periods of relative stability and democratic reform in Afghanistan. "It was nothing less than Paris," he says. "Our country is broken," Parwin chimes in. "But we try our best to make a good atmosphere inside the house." In the children's bedroom Arshid, 10, and Rashid, 8, sleep on Mickey Mouse bedsheets. Marvel stickers decorate the walls, and a cage with two canaries takes up most of the bedside table.

Khwaja Rawash is the latest addition to a city whose architecture tells of its history. From its chaotic old town, Kabul expands into webs of dusty streets between rectangular, walled compounds. Slums creep up hillsides to hold a

NGM MAPS

population that tripled to more than 4.5 million between 2001 and 2015. The city center—crowded with heavily guarded embassy compounds, military headquarters, and government ministries—has become practically "uninhabitable," says Jolyon Leslie, an architect who has worked in Afghanistan since 1989. That's "except for the über-elite whose feet don't touch the ground because the streets have been cleared for them."

Decades of conflict and changing methods of warfare have molded Kabul. Neighborhoods are no longer only pummeled from the outside by rockets. Instead the war has become increasingly "vehicular borne," Leslie says—be it with armored NATO vehicles muscling through downtown or cars with suicide bombers whose explosives seem to get bigger as foreigners retreat farther behind blast walls. Kabul's diplomatic quarter lies within a secure "green zone" that is being more than doubled in area to include all embassies, as well as the NATO and U.S. military headquarters. A new blue zone, with traffic restrictions, will encompass much of the rest of the city center and the airport. Downtown landmarks such as the presidential palace are largely inaccessible to ordinary Afghans. "I would like for everyone to see the palace, to know it's part of their culture," Ziarkash says.

An escalation in the war between the Taliban and the Western-backed government could threaten Qasaba's calm. Mikrorayons, building projects similar to Khwaja Rawash that embody a bygone era of Soviet support for the communist regime, became a target of armed factions in the civil war during the 1990s. Qasaba is "pretty vulnerable," Leslie says. □

Above: Suliman (at top left in gray pants) and his siblings, with their caged pet partridge, spend time outside their apartment block. Kidnappings are a growing problem in central Kabul, but Qasaba is safe enough that parents let their children roam more freely. Below: Young girls from a nearby village buy soft-serve ice cream for 10 afghanis (15 cents), using money they earned selling plastic bottles for recycling.

Above: Arshid is first in place in the dining room as his father, Aimal, and grandmother, Parwin, lay out a lavish lunch. On Fridays and holidays Afghan families gather over big meals, such as this feast of dumplings, meatballs, and stews of okra and eggplant. Below: Boys and girls assemble outside one of the two schools that service the approximately 9,000 residents at the Khwaja Rawash complex.

October 1, 2017 | Las Vegas, Nevada | **58 killed, 546 injured**

Firing from the 32nd floor of a hotel, a man armed with semiautomatic rifles, modified to fire faster, rained more than a thousand rounds on a music festival. Public mass shootings have become much more frequent since 2011.

THE SCIENCE OF

Good and Evil

What makes people especially giving or cruel? Researchers say the way our brains are wired can affect how much empathy we feel for others.

December 14, 2012 | Sandy Hook Elementary School | **27 killed, 2 injured**

Six staff members and 20 children died in the Newtown, Connecticut, shooting. The assailant also killed his mother. The school was torn down and replaced. Nothing was saved from the old school, not even the flagpole.

June 12, 2016 | Pulse nightclub, Orlando, Florida | **49 killed, 53 injured**

In one of the deadliest terrorist attacks in the U.S. since September 11, 2001, a gunman pledging allegiance to ISIS targeted a bar popular with the gay community. On the first anniversary, mourners returned to the scene.

June 7, 1998 | Huff Creek Road, Jasper, Texas | **1 killed**

White supremacists murdered James Byrd, Jr., an African American, by chaining him to a pickup truck and dragging him along this road. Evidence circles mark where pieces of Byrd's body were found.

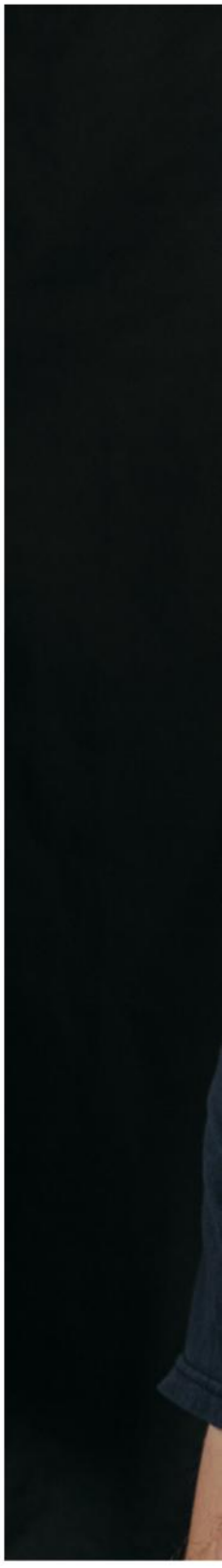
By Yudhijit Bhattacharjee
Photographs by Lynn Johnson

From the kitchen window of her mobile home in Auburn, Illinois, Ashley Aldridge had a clear view of the railroad crossing about a hundred yards away.

When the 19-year-old mother first saw the man in the wheelchair, she had just finished feeding lunch to her two children, ages one and three, and had moved on to washing dishes—one more in an endless string of chores. Looking up, Aldridge noticed that the wheelchair wasn't moving. It was stuck between the tracks. The man was yelling for help as a motorcycle and two cars went by without stopping.

Aldridge hurried out to ask a neighbor to watch her kids so she could go help. Then she heard the train horn and the clanging of the crossing gate as it came down, signaling that a train was on its way. She ran, barefoot, over a gravel path along the tracks. When she got to the man, the train was less than half a mile away, bearing down at about 80 miles an hour. Failing to dislodge the wheelchair, she wrapped her arms around the man's chest from behind and tried to lift him, but couldn't. As the train barreled toward them, she pulled with a mighty heave. She fell backward, yanking him out of the chair. Within seconds, the train smashed the wheelchair, carrying fragments of steel and plastic half a mile up the track.

The man Aldridge saved that afternoon in September 2015 was a complete stranger. Her unflinching determination to save him despite the threat to her own life sets her apart from many.



Micah Fletcher

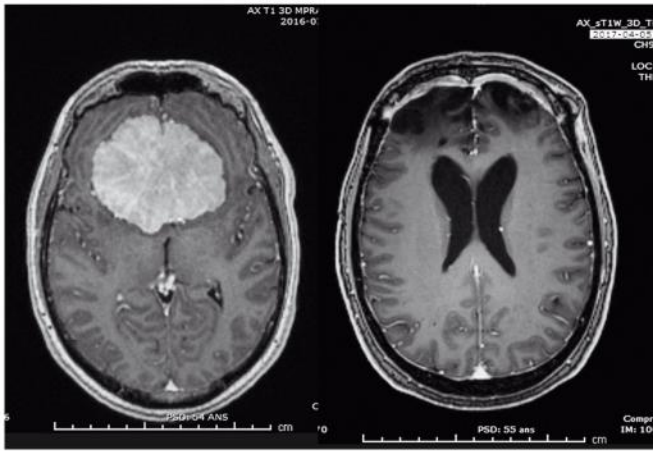
INTERVENING TO HELP STRANGERS

Fletcher and two other men defended two women – one wearing a hijab – from a man spewing anti-Muslim abuse on a Portland commuter train. The assailant stabbed all three men. Two died, and Fletcher suffered a deep neck wound. He said he instinctively stepped in to help the women. Diagnosed as being on the autism spectrum as a child, he was bullied and beaten. "If you are truly a community, then everybody should be expected to stand up for one another," he says.

Aldridge's heroic rescue is an example of what scientists call extreme altruism—selfless acts to help those unrelated to oneself at the risk of grave personal harm. Not surprisingly, many of these heroes—such as Roi Klein, an Israeli army major who jumped on a live grenade to save his men—work in professions in which endangering one's life to protect others is part of the job. But others are ordinary men and women—like Rick Best, Taliesin Namkai-Meche, and Micah Fletcher, who intervened to defend two young women, one wearing a hijab, from a man spewing anti-Muslim abuse at them on a commuter train in Portland, Oregon. All three were stabbed; only Fletcher survived.

Contrast these noble acts with the horrors that humans commit: murder, rape, kidnapping, torture. Consider the carnage perpetrated by the man who sprayed bullets from the 32nd floor of the Mandalay Bay hotel in Las Vegas, Nevada, in October at a country music festival. Three weeks later, officials put the casualty toll at 58 dead and 546 wounded. Or think about the chilling ruthlessness of a serial killer like Todd Kohlhepp, a real estate agent in South Carolina, who appears to have left clues about his murderous habit in bizarre online reviews for products, including a folding shovel: "Keep in car for when you have to hide the bodies." In spite of how aberrant these horrors are, they occur often enough to remind us of a dark truth: Humans are capable of unspeakable cruelty.

Extreme altruists and psychopaths exemplify our best and worst instincts. On one end of the moral spectrum, sacrifice, generosity, and other ennobling traits that we recognize as good; on the other end, selfishness, violence, and destructive impulses that we see as evil. At the root of both types of behaviors, researchers say, is our evolutionary past. They hypothesize that humans—and many other species, to a lesser degree—evolved the desire to help one another because cooperation within large social groups was essential to survival. But because groups had to compete for resources, the willingness to maim and possibly kill opponents was also crucial. "We are the most social species on Earth, and we are also the most violent species on Earth," says Jean Decety, a social neurologist at the University of Chicago. "We have two faces because these two faces were important to survival."



Phineas Gage and the frontal lobe

LEARNING HOW THE BRAIN WORKS

A railroad construction foreman, Gage (left) survived an explosion in 1848 that drove an iron rod through his left frontal lobe. When he recovered, he was no longer friendly and respectful; he was uncaring and indifferent. A patient in Canada underwent a similar change when a benign tumor grew in his frontal lobe. After it was removed in 2016, his wife told the Sherbrooke University medical team, "Thank you for giving me back my husband." His MRI scans (above) show before and after surgery. Cases like these help explain how brain structures guide social and moral behavior.

For centuries the question of how good and evil originate and manifest in us was a matter of philosophical or religious debate. But in recent decades researchers have made significant advances toward understanding the science of what drives good and evil. Both seem to be linked to a key emotional trait: empathy, which is an intrinsic ability of the brain to experience how another person is feeling. Researchers have found that empathy is the kindling that fires compassion in our hearts, impelling us to help others in distress. Studies also have traced violent, psychopathic, and antisocial behaviors to a lack of empathy, which appears to

PHINEAS GAGE, FROM GAGE FAMILY ARCHIVES;
MRI SCANS COURTESY DAVID FORTIN, SHERBROOKE UNIVERSITY

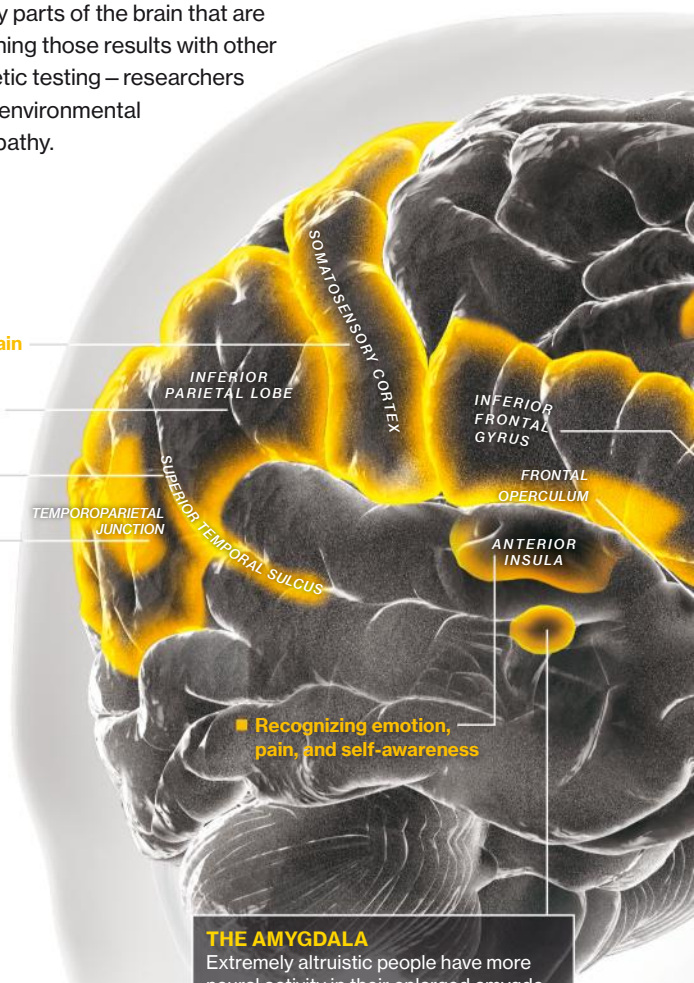
Anatomy of Empathy

Using scanning technology, scientists can identify parts of the brain that are active when we empathize with others. By combining those results with other findings – from psychological evaluations to genetic testing – researchers are beginning to determine which biological and environmental factors reinforce or corrode our capacity for empathy.

The Empathy Circuit

Highlighted areas have distinct roles in how the brain responds to others.

- **Viscerally reacting to others' physical pain**
- **Mirroring people's actions and emotions**
- **Reading the eye expressions and movements of others**
- **Imagining thoughts of others** *(right side only)*



THE AMYGDALA
Extremely altruistic people have more neural activity in their enlarged amygdalas – a part of the brain associated with learned emotional responses and the processing of distressing stimuli.

How the circuit is activated

Biological
Genetic variations enable some people to recognize facial expressions better or produce more of an enzyme related to lower aggressiveness.

Psychological
A nurturing childhood can potentially transform someone who is genetically predisposed to lack empathy into a social, nonviolent citizen.

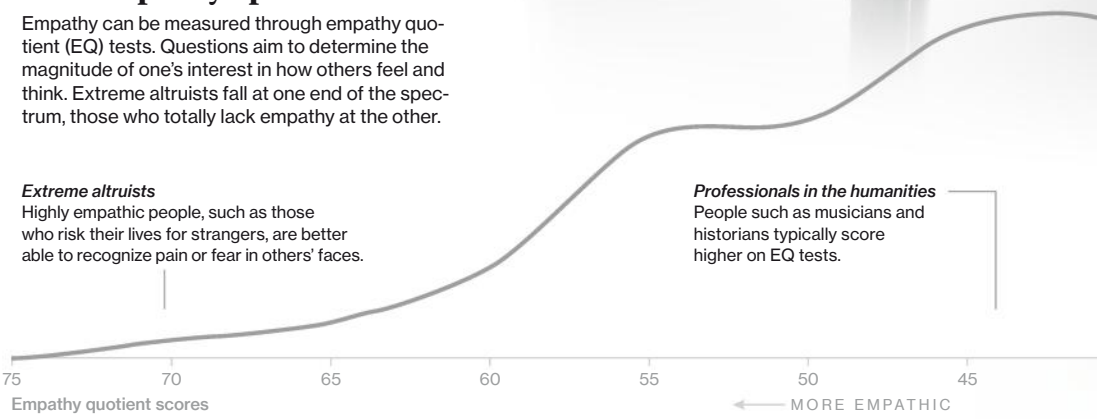
Social
Watching a friend cry or hearing a dog whimper, for example, can evoke empathy and a desire to end what is perceived as shared suffering.

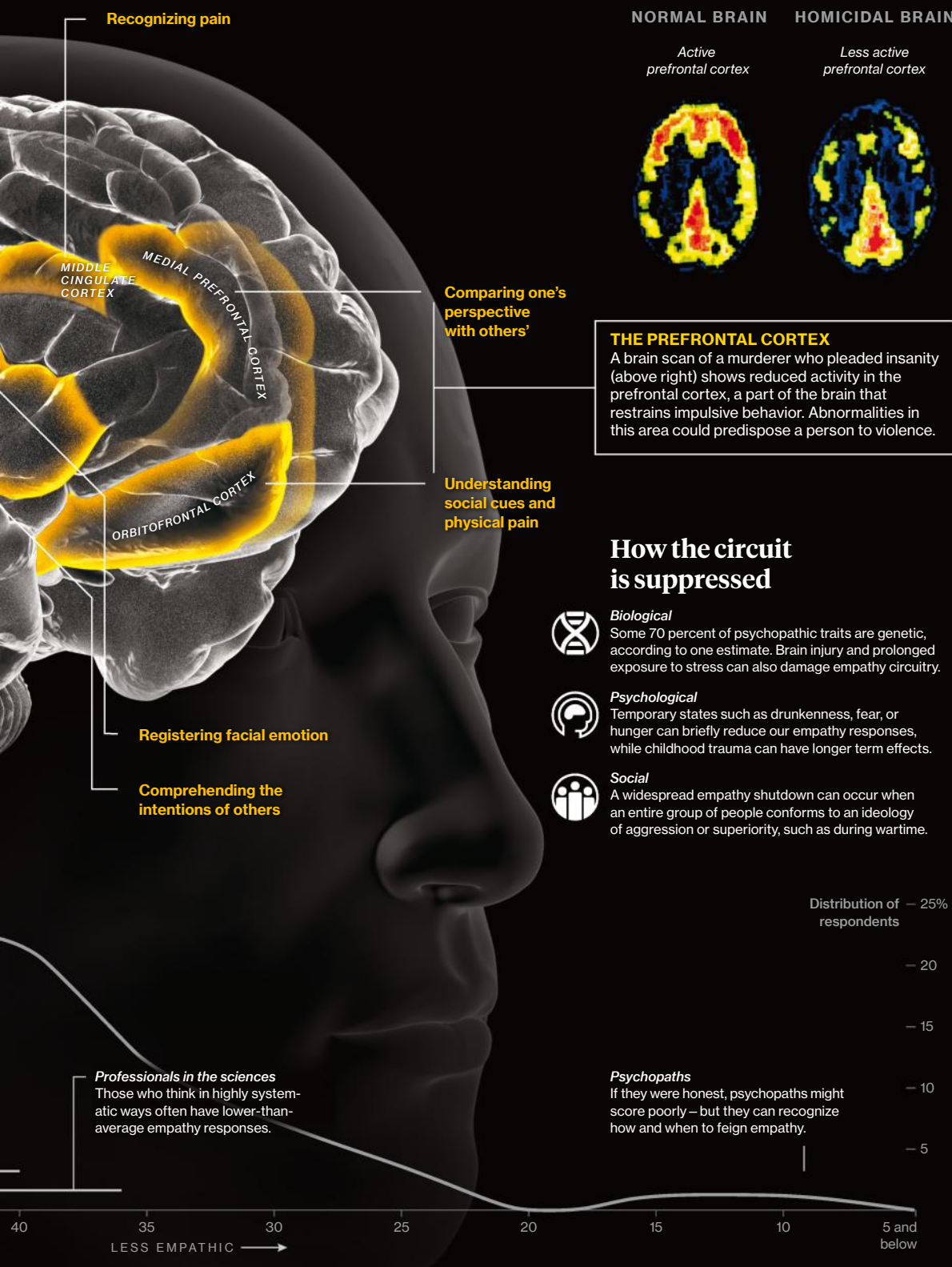
The Empathy Spectrum

Empathy can be measured through empathy quotient (EQ) tests. Questions aim to determine the magnitude of one's interest in how others feel and think. Extreme altruists fall at one end of the spectrum, those who totally lack empathy at the other.

Extreme altruists
Highly empathic people, such as those who risk their lives for strangers, are better able to recognize pain or fear in others' faces.

Professionals in the humanities
People such as musicians and historians typically score higher on EQ tests.





JASON TREAT AND RYAN T. WILLIAMS, NGM STAFF. ART: BRYAN CHRISTIE
SOURCES: SIMON BARON-COHEN, DAVID M. GREENBERG, UNIVERSITY OF CAMBRIDGE; BRAIN PET SCANS COURTESY ADRIAN RAINE, UNIVERSITY OF PENNSYLVANIA

Researchers have found that empathy is the kindling that fires compassion, impelling us to help others.

stem from impaired neural circuits. These new insights are laying the foundation for training regimens and treatment programs that aim to enhance the brain's empathic response.

RESEARCHERS ONCE THOUGHT young children had no concern for the well-being of others—a logical conclusion if you've seen a toddler's tantrums. But recent findings show that babies feel empathy long before their first birthday. Maayan Davidov, a psychologist at Hebrew University of Jerusalem, and her colleagues have conducted some of these studies, analyzing the behavior of children as they witness somebody in distress—a crying child, an experimenter, or their own mother pretending to be hurt. Even before six months of age, many infants respond to such stimuli with facial expressions reflecting concern; some also exhibit caring gestures such as leaning forward and trying to communicate with the one in distress. In their first year, infants also show signs of trying to understand the suffering they're seeing. Eighteen-month-olds often translate their empathy into such positive social behavior as giving a hug or a toy to comfort a hurt child.

That's not true of all children, however. In a small minority, starting in the second year of life, researchers see what they call an "active disregard" of others. "When someone reported that someone had hurt themselves," says Carolyn Zahn-Waxler, a researcher at the University of Wisconsin–Madison, "these children would kind of laugh at them or even kind of swipe at them and say, 'You're not hurt,' or 'You should be more careful'—saying it in a tone of voice that was judgmental." Following these toddlers into adolescence, Zahn-Waxler and her colleague Soo Hyun Rhee, a psychologist at the University of Colorado Boulder, found they had a high likelihood of developing antisocial tendencies and getting into trouble.

Other studies have measured callousness and lack of emotional expression in adolescents using questions such as whether the subject feels remorseful upon doing something wrong. Those with high scores for "callous-unemotional" traits tend to have frequent and severe behavioral problems—showing extreme aggression in fights, for instance, or vandalizing property. Researchers have also found that some of these adolescents end up committing major crimes such as murder, rape, and violent robbery. Some are prone to becoming full-blown psychopaths as adults—individuals with cold, calculating hearts who wouldn't flinch while perpetrating the most horrific acts imaginable. (Most psychopaths are men.)

If the empathy deficit at the core of psychopathic behaviors can be traced all the way back to toddlerhood, does evil reside in the genes, coiled up like a serpent in the DNA, waiting to strike? The answer isn't a categorical yes or no. As it is with many illnesses, both nature and nurture have a hand. Studies of twins have established that callous-unemotional traits displayed by some young children and adolescents arise to a substantial degree from genes they inherit. Yet in a study of 561 children born to mothers with a history of antisocial behaviors, researchers found that those living with adoptive families that provided a warm and nurturing environment were far less likely to exhibit callous-unemotional traits than those with adoptive families that were not as nurturing.

Children born with genes making it more likely that they will have difficulty empathizing are often unable to get a break. "You can imagine that if you have a child who doesn't show affection in the same way as a typically developing child, doesn't show empathy, that child will evoke very different reactions in the people around them—the parents, the teachers, the peers—than a child who's more amenable, more empathetic," says Essi Viding, a research psychologist at University College London. "And many of these children, of course, reside within their biological families, so they often

have this double whammy of having parents who are perhaps less well equipped for many of the parenting tasks, are less good at empathizing, less good at regulating their own emotions."

THE FIREFIGHTERS TRIED desperately to save the six Philpott children from their burning house in Derby, England, in the early hours of May 11, 2012. But the heat and smoke were so intense that only one of the kids was alive when rescuers finally made their way upstairs where they had been sleeping. That boy, too, perished two days later in the hospital. The police suspected arson, based on evidence that the fire had been started by pouring gasoline through the door's mail slot.

Derby residents raised money to help the children's parents—Mick and Mairead Philpott—pay for a funeral. At a news conference to thank the community, Philpott was sobbing and dabbing his eyes with a tissue that remained curiously dry. Leaving the event, he collapsed, but Derbyshire's assistant chief constable, walking behind, was struck by the unnaturalness of the behavior. Eighteen days later, the police arrested Philpott and his wife. Investigators determined that they had set fire to the house with an accomplice to frame Mick's mistress. A court found all three guilty of manslaughter.

Philpott's faking of grief and his lack of remorse are among the characteristics that define psychopaths, a category of individuals who have come to embody evil in the popular imagination. Psychopaths have utter disregard for the feelings of others, although they seem to learn to mimic emotions. "They really just have a complete inability to appreciate anything like empathy or guilt or remorse," says Kent Kiehl, a neuroscientist at the Mind Research Network and the University of New Mexico who was drawn to studying psychopathy in part because he grew up in a neighborhood that was once home to the serial killer Ted Bundy. These are people who are "just extremely different than the rest of us."

Kiehl has spent the past two decades exploring this difference by scanning the brains of prison inmates. (Nearly one in every five adult males in prison in the U.S. and Canada scores high in psychopathy, measured using a checklist of 20 criteria such as impulsivity and lack of remorse, compared with one out of every 150 in the general male population.)

Using an MRI scanner installed inside a tractor trailer, Kiehl and his colleagues have imaged more than 4,000 prison inmates since 2007, measuring the activity in their brains as well as the size of different brain regions.

Psychopathic criminals show reduced activity in their brain's amygdala, a primary site of emotional processing, compared with non-psychopathic inmates when recalling emotionally charged words they were shown moments earlier, such as "misery" and "frown." In a task designed to test moral decision-making, researchers ask inmates to rate the offensiveness of pictures flashed on a screen, such as a cross burning by the Ku Klux Klan or a face bloodied by a beating. Although the ratings by psychopathic offenders aren't that different from those by non-psychopaths—they both recognize the moral violation in the pictures—psychopaths tend to show weaker activation in brain regions instrumental in moral reasoning.

Based on these and other, similar findings, Kiehl is convinced that psychopaths have impairments in a system of interconnected brain structures—including the amygdala and the orbitofrontal cortex—that help process emotions, make decisions, control impulses, and set goals. There is "basically about 5 to 7 percent less gray matter in those structures in individuals with high psychopathic traits compared to other inmates," Kiehl says. The psychopath appears to compensate for this deficiency by using other parts of the brain to cognitively simulate what really belongs in the realm of emotion. "That is, the psychopath must *think* about right and wrong while the rest of us *feel* it," Kiehl wrote in a paper he co-authored in 2011.

WHEN ABIGAIL MARSH, a psychologist at Georgetown University, was 19, her car skidded on a bridge after she swerved to avoid hitting a dog. The vehicle spun out of control and finally came to a stop in the fast lane, facing oncoming traffic.

Kent Kiehl

SCANNING TO UNDERSTAND PSYCHOPATHS

A neuroscientist at the University of New Mexico, Kiehl has found striking abnormalities in the brains of psychopaths. He has scanned more than 4,000 inmates, measuring the activity in their brains as well as the size of different brain regions. He says psychopaths have impairments in the interconnected brain structures that help process emotions, make decisions, control impulses, and set goals.

Mendota Juvenile Treatment Center

TRYING TO MOLD THE MIND TO DO RIGHT

At this facility in Wisconsin for violent teen offenders, a program is helping to keep many from hardening into lifelong criminals. Based on their behavior each day, youths can earn or lose privileges for the next day, such as being allowed to play video games. This approach allows them to redeem themselves every 24 hours. Here a boy holds a graph of his average weekly points for a year.

Our social brain is plastic, even in adulthood, and we can be trained to be more kind and generous.

Marsh couldn't get the engine to start and was too afraid to get out, with cars and trucks rushing past the vehicle. A man pulled over, ran across the highway, and helped start the car. "He took an enormous risk running across the freeway. There's no possible explanation for it other than he just wanted to help," Marsh says. "How can anybody be moved to do something like that?"

Marsh kept turning that question over in her head. Not long after she began working at Georgetown, she wondered if the altruism shown by the driver on the bridge wasn't in some ways the polar opposite of psychopathy. She began looking for a group of exceptionally kind individuals to study and decided that altruistic kidney donors would make ideal subjects. These are people who've chosen to donate a kidney to a stranger, sometimes even incurring financial costs, yet receive no compensation in return.

Marsh and her colleagues brought 19 donors in from around the country for the study. The researchers showed each one a series of black-and-white photographs of facial expressions, some fearful, some angry, and others neutral, while their brains were scanned using an MRI machine to map both activity and structure.

When looking at fearful faces, donors showed a greater response in their right amygdala than a control group. Separately, the researchers found that their right amygdalas were, on average, 8 percent larger than those of the control group. Similar studies done previously on psychopathic subjects had found the opposite: The amygdalas in psychopathic brains are smaller and activated less than those in controls while reacting to frightened faces.

"Fearful expressions elicit concern and caring. If you're not responsive to that expression, you're unlikely to experience concern for other people," Marsh explains. "And altruistic kidney donors just seem to be very sensitive to other people's distress, with fear being the most acute kind of distress—maybe in part because their amygdalas are larger than average."

THE MAJORITY OF PEOPLE in the world are neither extreme altruists nor psychopaths, and most individuals in any society do not ordinarily commit violent acts against one another. And yet, there are genocides—organized mass killings that require the complicity and passivity of large numbers of people. Time and again, social groups organized along ethnic, national, racial, and religious lines have savaged other groups. Nazi Germany's gas chambers extinguished millions of Jews, the Communist Khmer Rouge slaughtered fellow Cambodians in the killing fields, Hutu extremists in Rwanda wielding machetes slaughtered several hundred thousand Tutsis and moderate Hutus, and Islamic State terrorists massacred Iraq's Yazidis—virtually every part of the world appears to have suffered through a genocide. Events such as these provide ghastly evidence that evil can hold entire communities in its grip.

How the voice of conscience is rendered inconsequential to foot soldiers of a genocide can be partly understood through the prism of the well-known experiments conducted in the 1960s by the psychologist Stanley Milgram at Yale University. In those studies, subjects were asked to deliver electric shocks to a person in another room for failing to answer questions correctly, increasing the voltage with every wrong answer. At the prodding of a person in a lab coat who played the role of an experimenter, the subjects often dialed up the shocks to dangerously high voltage levels. The shocks weren't real and the cries of pain heard by the subjects were prerecorded, but the subjects only found that out afterward. The studies demonstrated what Milgram described as "the extreme willingness of adults to go to almost any lengths on the command of an authority."

Gregory Stanton, a former U.S. State Department official and founder of Genocide Watch, a nonprofit that works to prevent mass murder, has identified the stages that can cause otherwise decent people to commit murder. It starts when demagogic leaders define a target group as "the other" and claim it is a threat to the interests of supporters. Discrimination follows, and soon the leaders characterize their targets as subhuman, eroding the in-group's empathy for "the other."

Next, society becomes polarized. "Those planning the genocide say, 'You are either with us or against us,'" says Stanton. This is followed by a phase of preparation, with the architects of the genocide drawing up death lists, stocking weapons, and planning how the rank and file are to execute the killings. Members of the out-group are sometimes forced to move into ghettos or concentration camps. Then the massacres begin.

Many of the perpetrators remain untouched by remorse, not because they are incapable of feeling it—as is the case with psychopathic killers—but because they find ways to rationalize the killings. James Waller, a genocide scholar at Keene State College in New Hampshire, says he got a glimpse of this "incredible capacity of the human mind to make sense of and to justify the worst of actions" when he interviewed dozens of Hutu men convicted or accused of committing atrocities during the Rwandan genocide. Some of them had hacked children, even those they personally knew, to death. Their rationale, according to Waller, was: "If I didn't do this, those children would have grown up to come back to kill me. This was something that was a necessity for my people to be safe, for my people to survive."

OUR CAPACITY TO EMPATHIZE and channel that into compassion may be innate, but it is not immutable. Neither is the tendency to develop psychopathic and antisocial personalities so fixed in childhood as to be unchangeable. In recent years researchers have shown the feasibility of nipping evil in the bud as well as strengthening our positive social instincts.

The possibility of preventing violent teenage boys from hardening into lifelong criminals has been put to the test at the Mendota Juvenile Treatment Center in Wisconsin, a facility that houses serious offenders but is run more as a psychiatric unit than as a prison. The adolescents referred to the center come in with already long criminal histories—teenagers who are a threat to others. "These are folks who essentially have dropped out of the human race—they don't have any connection to anyone, and they are in a real antagonistic posture with everybody," says Michael Caldwell, a senior staff psychologist.

The center attempts to build a connection with the kids despite their aggressive and antisocial behaviors. Even when an inmate hurls feces or sprays urine at staff members—a common occurrence at many correctional institutions—the staff members keep treating the offender humanely. The kids are scored on a set of behavior rating scales every day. If they do well, they earn certain privileges the following day, such as a chance to play video games. If they score badly, say, by getting into a fight, they lose privileges. The focus is not on punishing bad behavior but on rewarding good conduct. That's different from most correctional institutions. Over time the kids start to behave better, says Greg Van Rybroek, the center's director. Their callous-unemotional traits diminish. Their improved ability to manage their emotions and control their violent impulses seems to endure beyond the walls of Mendota. Adolescents treated in the program have committed far fewer and less violent offenses between two and six years after release than those treated elsewhere, the center's studies have found. "We don't have any magic," Van Rybroek says, "but we've actually created a system that considers the world from the youth's point of view and tries to break it down in a fair and consistent manner."

During the past decade researchers have discovered that our social brain is plastic, even in adulthood, and that we can be trained to be more kind and generous. Tania Singer, a social neuroscientist at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany, has pioneered studies demonstrating this.

Empathy and compassion use different networks in the brain, Singer and her colleagues

Missy Ewing

OFFERING A GIFT OF ASTONISHING GENEROSITY

Like her husband, Ewing donated a kidney to a stranger. Her only reward was the good feeling that she got from making the donation. She says her gift was a response to the overflow of love she has received in her life. Researchers have found that altruistic kidney donors such as Ewing have larger and more responsive right amygdalas, making them more sensitive to the emotions of others.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Anthony Chavez

GUIDING OTHERS TO SAFETY

When Chavez saw a woman next to him covered in blood at a Las Vegas music festival, he realized he and his girlfriend, Deianara Torres (far left), were under fire. He helped her escape to safety over a crowd barrier near the stage, then saw another concertgoer they'd met earlier. "We locked eyes, and it was complete fear," he says. "I knew I had to stay there and help her." He aided her and several others paralyzed by shock, boosting them over the fence.

William Ramirez

GETTING IN HARM'S WAY

On his way to his job washing boats, Ramirez (left) rescued a Miami police officer from a barrage of bullets fired by a man with an assault rifle. He drove his van in between the officer and the shooter, opened a door so the officer could jump in, and sped away to safety. "I could not just go by, go to work without doing anything. The police risk their lives for people all the time," he told the *Sun Sentinel* newspaper.

Samer Attar

HEALING WAR'S VICTIMS

Attar, an orthopedic surgeon from Chicago, has volunteered in Iraq, Jordan, and Syria to treat patients from conflict zones. Like other extreme altruists, he pays little heed to the risks to his life in trying to save others. When Aleppo was under siege in 2016, he was the last U.S. doctor to depart, anguished that he was leaving behind a few brave doctors. "I am not a hero," he wrote, "but I was surrounded by them."

Ashley Aldridge

FACING DOWN FEAR TO HELP

A young mother of two, Aldridge ran barefoot to a railroad crossing to rescue a man whose wheelchair was stuck on the tracks. She yanked him free just before a train would have hit them. "I don't really think of myself as a hero, but my kids tell me all the time that I am," she says. "I was just helping somebody, I guess is how I see it, because if that was my grandpa, I would hope somebody would help him too."


The Avielle Foundation

Jeremy Richman

SEEKING WAYS TO PREVENT VIOLENCE

"To prevent other people from suffering this horrible heartbreak," Richman started a foundation named after his six-year-old daughter Avielle, who was killed in the Sandy Hook School shooting. The foundation supports brain research with the aim of treating violence as a disease. It is located on the grounds of the closed Fairfield Hills Hospital (above), which once housed some dangerous psychiatric patients.

found. Both can lead to positive social behavior, but the brain's empathic response to seeing another person suffer can sometimes lead to empathic distress—a negative reaction that makes the onlooker want to turn away from the sufferer to preserve his or her own sense of well-being.

To enhance compassion, which combines awareness of another's distress with the desire to alleviate it, Singer and her colleagues have tested the effects of various training exercises. A prominent exercise, derived from Buddhist traditions, involves having subjects meditate on a loved one—a parent or a child, for example—directing warmth and kindness toward that individual and gradually extending those same feelings toward acquaintances, strangers, and even enemies, in an ever widening circle of love. Singer's group has shown that subjects who trained in this form of loving-kindness meditation even for a few days had a more compassionate response—as measured by the activation of certain brain circuits—than untrained subjects, when watching short film clips of people suffering emotional distress.

In another study, Singer and her colleagues tested the effects of compassion training on helpfulness by using a computer game in which subjects guide a virtual character on a computer screen through a maze to a treasure chest, opening gates along the way. They can also choose to open gates for another character wandering about, looking for treasure. The researchers found that subjects who underwent compassion training were more helpful than those in a control group toward the other character—the equivalent of a stranger.

That we might be able to mold our brains to be more altruistic is an ennobling prospect for society. One way to bring that future closer, Singer believes, would be to include compassion training in schools. The result could be a more benevolent world, populated by people like Ashley Aldridge, in which reflexive kindness loses its extraordinariness and becomes a defining trait of humanity. ▯

Yudhijit Bhattacharjee is a contributing writer for *National Geographic*. **Lynn Johnson** regularly photographs features for the magazine.

Sue Klebold and Coni Sanders

SHARING SORROW

Klebold (at left) is the mother of Dylan Klebold, one of two teenagers who carried out the 1999 shooting at Colorado's Columbine High School. Klebold wrote about her experience in *A Mother's Reckoning* and donates any profits to mental health charities. She has become a mother figure to Sanders (at right), whose father was killed in the massacre. For years Sanders was angry with Klebold for raising a son who became a killer. But her struggle to raise her own teenagers helped her understand Klebold. "If anyone's pain is greater than my own, it's hers," she says. The women, here at a memorial for the victims in Olinger Chapel Hill cemetery, now share a strong bond.


Kelly Fleming
Isaiah Sweets
Lauren Townsend

FURTHER

A GLIMPSE OF WHAT'S NEW AND NEXT

The SmartBird, an ornithopter created by the company Festo, flies so well because it twists its wings as it flaps them, just like real birds do.

PHOTO: MAX PINCKERS

BOTS ON THE WING

By Brendan Borrell

Remote-controlled drones have become an invaluable tool for government agencies, researchers, filmmakers—anyone trying to get a bird's-eye perspective on the world. Today's most common drone, the quadcopter, excels at vertical takeoffs and stationary hovering. But it's noisy and is a literal drag when it comes to forward flight. Its whirring motors burn about four times the amount of power as a plane-like drone with rigid wings.

So-called ornithopters, which have flapping wings, offer the best of both worlds. The one seen here, named SmartBird, has a 6.5-foot wingspan and was modeled after a herring gull. It can cross the sky silently and efficiently and can take off and land in tight quarters.

The next advance, dronebuilders say, will be to emulate the way birds change the shape of their wings by overlapping their feathers, as when a peregrine falcon performs a dive at more than 200 miles an hour. "I don't know any aerial robot that can do that," says David Lentink, a Stanford University mechanical engineer who studies biological flight.


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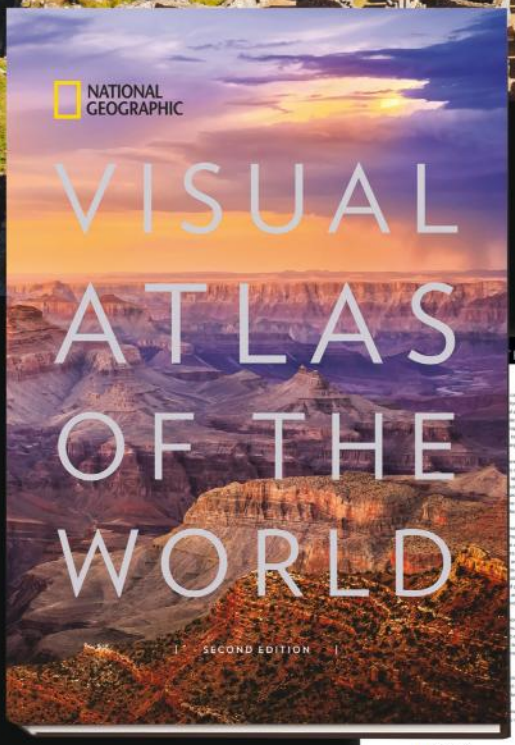

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