

NOVEMBER 2010

NATIONAL INTERACTIVE EDITION GEOGRAPHIC

MYSTERIES OF

Great Migrations

What Guides Them
Into the Unknown?



**WORLD'S
AMAZING
MIGRATIONS**

Interactive
Exclusive



**LITTLE IDEAS THAT CAN
CHANGE THE WORLD**

Dreams of Southern Sudan

Where's the Aztec Emperor?

NATIONAL GEOGRAPHIC

VOL. 218 • NO. 5

November 2010

Cover Story

Great Migrations

Birds, butterflies, and beasts take off. Humans interfere.

Sudan's Lost Herds

They survived civil war yet still need protection.

E-EXTRA: **Hi-Res Exclusive Graphic**

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November 2010 | Features

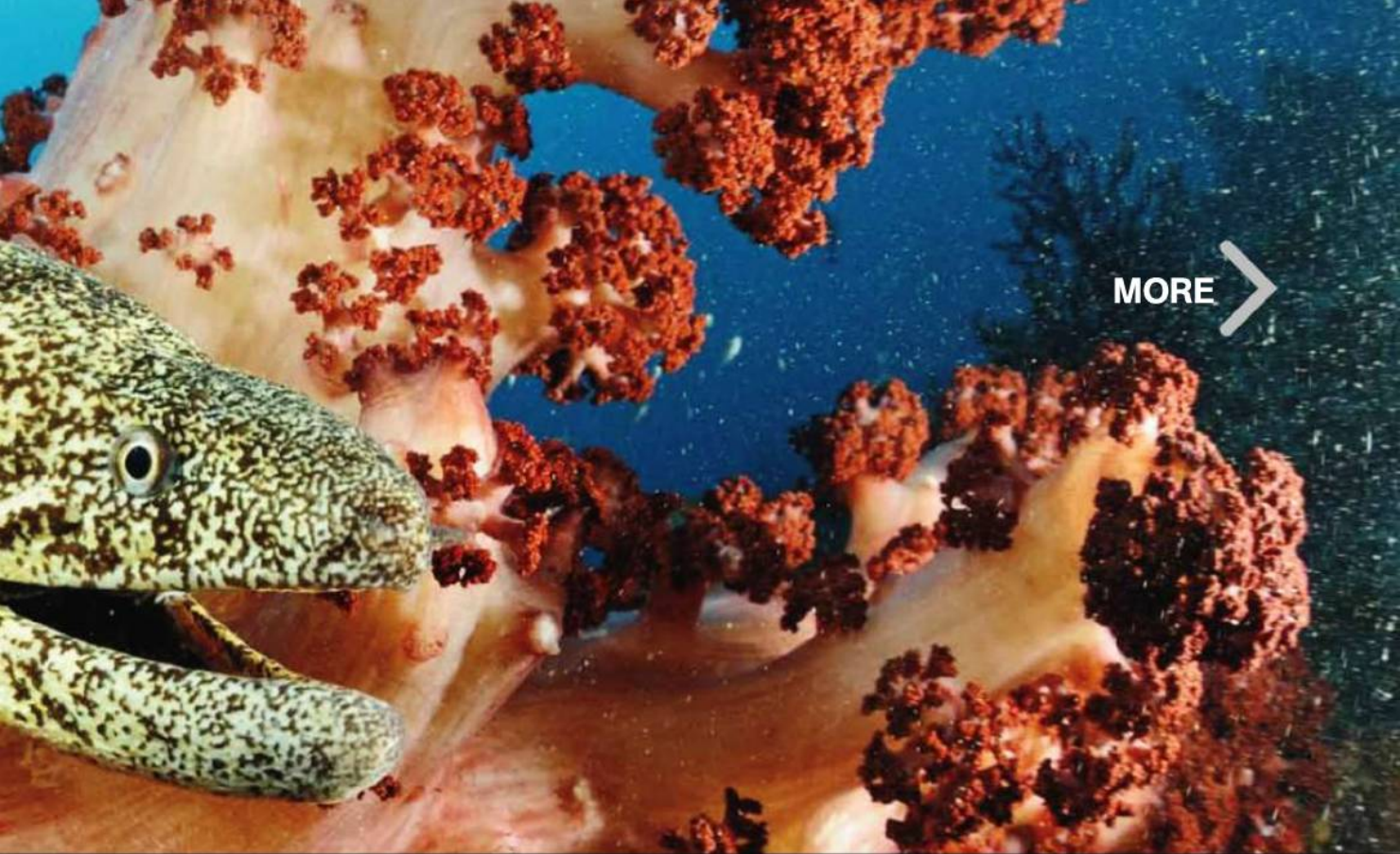
Southern Sudan's Shaky Peace

The scars and hopes of a boy named Logocho mirror his land.

Japan's

E-EXTRA: VIDEO





MORE



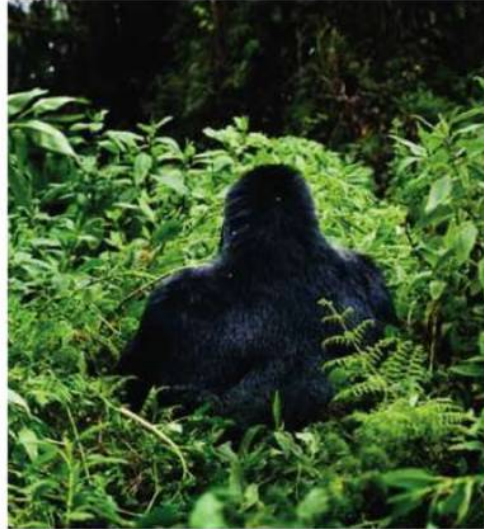
Seas

o Swim with their fanciful fish.

Unburying the Aztec

Diggers find eagles, knives, but no tomb.





Editor's Note

VIDEO

Letters

Your Shot

SLIDE SHOW

Photo Journal

E-EXTRA: VIDEO

Visions of Earth

Inside Geographic

Flashback

On the Cover

Wildebeests kick up dust as they barrel across Liuwa Plain National Park in Zambia at sunset.

Photo by Chris Johns



CONSERVATION

Tracking Gorillas

Humans make them nervous. So census takers use clues like dung, nests, and trails.

OCEANS

Underwater Exploration

Milestones include the only manned trip to the deepest point on Earth, the Sealab II habitat, and the discovery of the *Titanic*.

GEOGRAPHY

Children at Work

Across the globe, 215 million youngsters make pots, sell trinkets, toil in agriculture.



HEALTH

Medical Marijuana

It's legal in a dozen-plus states; a poll shows support for such laws in the rest of the U.S.

THE BIG IDEA

Little Packages

Do a Lot of Good

Designers devise a low-cost infant warmer, a purifying straw, a paper asthma device, and more.



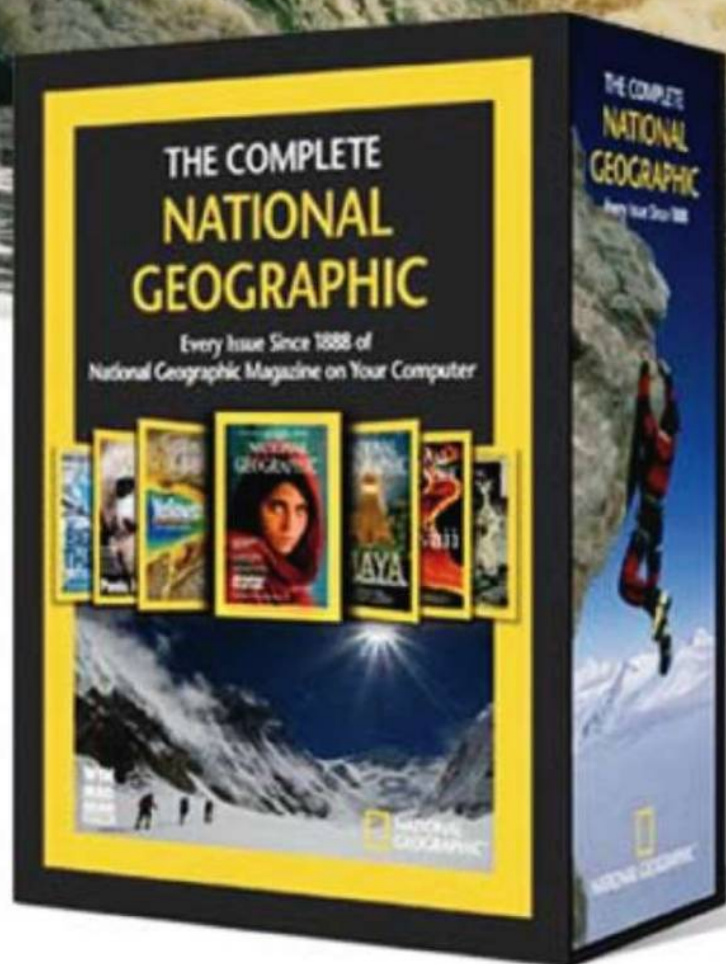
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**“There will not be a day
for the rest of my life that
I do not think of this place.
I finally found here
what I had been looking
for my whole life.”**

- Michael Fay

*Megatransect 1,200 miles of
untamed Africa surveyed on foot*

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EDITOR'S NOTE



Cape buffalo on the move in Botswana's Okavango Delta play a vital role in the region's ecosystem.

PHOTO: CHRIS JOHNS

I awoke at sunrise to a day on the Serengeti Plain that scarcely resembled the peaceful night before. The landscape that had been so quiet and empty was filled with thousands of wildebeests. They had followed the rain in search of grass, but this hardly seemed like an organized migration. It was anarchy in motion; wildebeests bucked and staggered in tight circles. They are comical-looking animals. African folklore says they were made from spare parts left from the creation of other beasts, but their role in sustaining the Serengeti is serious. Their migratory patterns are critical.

Bison once played a similar role on the North American prairie. In 1806 William Clark wrote: "I ascended to the high Country and from an eminence I had a view of...a greater number of buffalow than I had ever seen before at one time. I must have seen near 20,000 of those animals feeding on this plain." When Clark journeyed west with Meriwether Lewis, tens of millions of bison lived on the grasslands, shaping vegetation, dispersing seeds, coexisting with burrowing owls and prairie dogs. By the late 1800s bison had been hunted nearly to extinction.

Fortunately, many other migratory spectacles survive. This month the world of migrations comes to life on the pages of our magazine, on the National Geographic Channel, and at *nationalgeographic.com*. Our photographers and writers spent two years on the project. They were astonished and inspired by the determination and grace of these animals. I am sure you will be too.

A handwritten signature in black ink, appearing to read "Chris Johns". The signature is fluid and cursive, with a long horizontal line extending from the end of the name.



On the Move This month the National Geographic Channel presents *Great Migrations*, a seven-part, global television event with unprecedented footage of millions of animals making their instinctive treks in the name of survival. Three years in the making, this program takes viewers across the globe, intimately capturing the often harrowing migrations of wildebeests, walruses, red crabs (above), and more. Then it takes us behind the scenes to see the advanced technology required to capture this spectacular, high-definition show of wildlife. Catch the first episode on November 7 at 8 p.m. ET; 7 p.m. PT.

Learn more about these and other Great Migrations projects at natgeotv.com/migrations.

NAT GEO CHANNEL

Great Migrations, a seven-part series, begins November 7 at 8 p.m. ET.

NG BOOKS

Great Migrations: Epic Animal Journeys is in bookstores now. Prints of images from the book are available at printsngs.com.

PROGRAMS

National Geographic Live events include "The Making of Great Migrations," a screening and panel discussion, at Grosvenor Auditorium in Washington, D.C., on November 1.

Photographer Joel Sartore will speak and show images of "Great American

Migrations" in Mesa, Arizona, on December 8, and in Chicago, Illinois, on December 14.

The National Geographic Museum in Washington, D.C., will feature "Great Migrations" photographs and video along the 17th Street portico beginning October 15.



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Evolutionary Road

The title on the July 2010 cover reading “4-Million-Year-Old Woman” was a bit sensational and even misleading. A less interesting but more accurate title would have been “4-Million-Year-Old Female Hominid.” The term “woman” refers to our own species and not to females of other species.

BRIAN RITTER

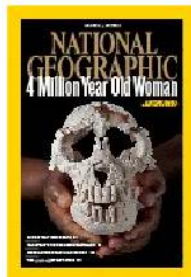
Huntington Beach, California

This article is the best description of human evolution that I have ever read. Besides being understandable to a layperson (me), it illustrates the diligent work and dedication of the many archaeologists, paleontologists, and geologists who have devoted their lives and talents to this study. This article should elicit many responses from the creationists. Please publish some of these letters.

RICHARD D. STACY

Montrose, Colorado

I thought you might find it interesting to see that your printer has messed up the July issue. Imagine my surprise when I cracked it open only to find the inside has articles from *Evolution Today* magazine. I was crestfallen as I discovered that my joyful romp through wonderful lands to learn about other people and places had been replaced by a scientific treatise. I can only hope that next month the printer (*Touch Text button to read more.*)



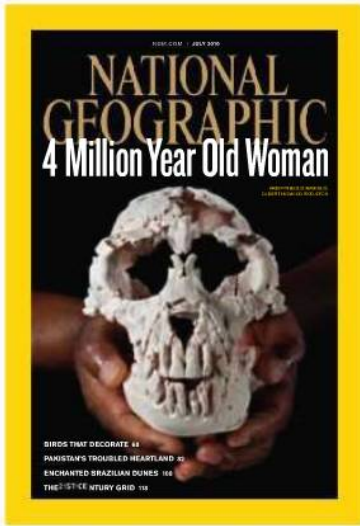
July 2010

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EDITORS' CHOICE **Paul Cotter** Charlotte, North Carolina
As his mother's health declined, Cotter, 52, thought "of all her small acts of kindness—like the tomato soup she made for me when I was a little boy." This shot was his way to say "farewell and to thank her for warming my heart."



Selections from our editors





Selections from our editors





Rattlesnake Roundup

Do you know what they grow a lot of on the fields and ranchland outside Mangum, Oklahoma? Rattlesnakes.

They don't do it on purpose. Agricultural communities in the region have suffered population losses for years. When farms fell into decline, their fallow fields happened to provide a great habitat for rattlers, and they increased dramatically.

That's why, since 1966, a group of folks known as the Shortgrass Rattlesnake Association—one of them goes by the title “Fangmaster”—has thrown a kind of three-day annual party called the Mangum Rattlesnake Derby. Thousands of people come from all over to hunt, touch, eat, and have their pictures taken with rattlesnakes. These visitors also bring a lot of much needed revenue into this little prairie town.

But still photos don't really do Mangum justice. That's why I shot 70,000 frames with my still camera at this year's derby and then spent ten days splicing them into this video.

I hope you don't get too rattled.



Watch 70,000 still frames come to life (2:20).



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VISIONS OF EARTH

Scotland Peering through glass, visitors at the Edinburgh Zoo regard—and are regarded by—Tibor, a captive-born Sumatran tiger. About 400 of this subspecies, the world's smallest tiger, live in the wild.

PHOTO: DAVID CHESKIN, PRESS ASSOCIATION/AP IMAGES



Through glass, visitors at the Edinburgh Zoo regard—and are regarded by—Tibor, a Sumatran tiger. About 400 of this subspecies, the world's smallest tiger, live in the wild.

PHOTO: DAVID CHESKIN, PRESS ASSOCIATION/AP IMAGES



Kenya Aimed skyward from photos atop a train, the eyes of women pierce a rooftop landscape in Nairobi's Kibera slum. The display, part of a global art project, paid tribute to women from Africa, Brazil, India, and Cambodia.

PHOTO: JR/AGENCE VU/AURORA PHOTOS



rooftop landscape in Nairobi's Kibera
frica, Brazil, India, and Cambodia.

PHOTO: JR/AGENCE VU/AURORA PHOTOS



United States A 14-week-old male fawn gazes out a window at the Sarvey Wildlife Care Center. The Arlington, Washington, facility rehabs regional animals, including up to 30 orphaned or injured young deer each spring.

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PHOTO: ANNIE MARIE MUSSELMAN



Wildlife Care Center. The Arlington,
injured young deer each spring.

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PHOTO: ANNIE MARIE MUSSELMAN



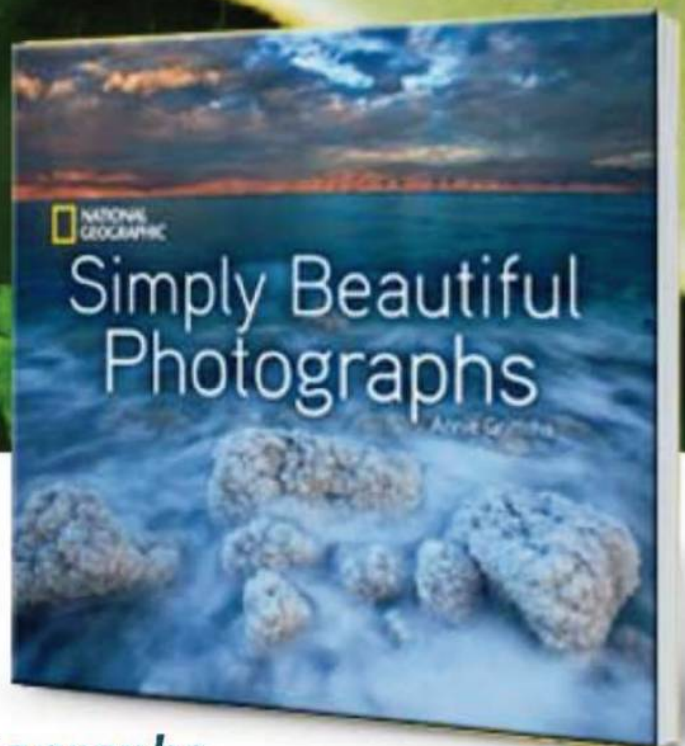


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C O N S E R V A T I O N



In Rwanda's Volcanoes National Park, a young silverback gorilla sits in solitude.

PHOTO: MATTIAS KLUM. NGM MAPS

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Tracking Gorillas When counting mountain gorillas, try to avoid the animals themselves. That's the tack primatologist Martha Robbins and 71 others took while conducting their latest census of the endangered species. "We don't want to encounter unhabituated gorillas," she explains, "because it is stressful for them." Rather than seeking out individuals, the team followed clues such as dung, nests, and trails to estimate gorilla numbers in the volcanic Virunga Mountains of equatorial Africa—one of only two places where the great apes live.

At last count, in 2006, some 680 were estimated to remain in that area and Uganda's Bwindi Impenetrable National Park. The 2010 Virunga census, followed by a Bwindi survey next year, will tell how the gorillas are faring now, after years of poaching, deforestation, and political unrest. Also expected, thanks to fecal-sample analysis: fresh insights into the elusive creatures' genetic diversity and overall health. —*Catherine Barker*



The Virunga range is home to one of just two mountain gorilla populations that remain today.

G E O G R A P H Y

No Minor Issue Across the globe, kids can be seen hawking trinkets and swabbing down tea shops. But these are only the most visible of the world's 215 million child laborers. A new report by the United Nations' International Labour Organization (ILO) says that 60 percent of them toil unseen in the agricultural sector, often for little or no pay. And the isolation of those in domestic work, says Human Rights Watch, can increase the odds of their exploitation.

Between 2004 and 2008 the number of child laborers decreased by seven million; Asia and Latin America, particularly Brazil, led the way, thanks to government initiatives. Yet South Asia remains home to the most in the world; one in four sub-Saharan kids is still classified as a child laborer; and the economic crisis could stall progress by feeding demand for cheap labor.

Going forward, the ILO urges a global commitment to compulsory education—by abolishing school fees, for instance—and government pacts with organized workers. It estimates that spending \$140 billion in sub-Saharan Africa over 20 years could produce up to \$724 billion in benefits, including massive health-care savings as children cease doing hazardous work. “The world can afford this,” the report concludes. Call it a minor investment with a major payoff. —*Noy Thrupkaew*

Child laborers include those under 12 doing any jobs other than household chores. Long hours, underground work, and heavy-machinery use are termed hazardous.

*EXCLUDES AUSTRALIA, NEW ZEALAND, JAPAN, AND PARTS OF CENTRAL ASIA. PHOTO: G. M. B. AKASH, PANOS PICTURES. GRAPHIC: MINA LIU. SOURCE: INTERNATIONAL LABOUR ORGANIZATION

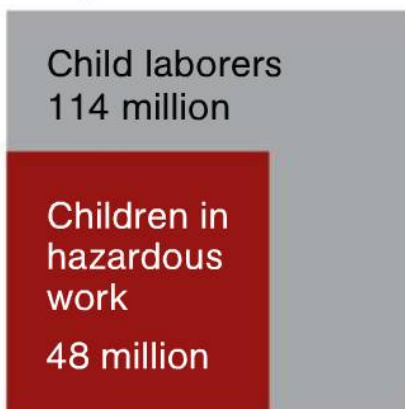




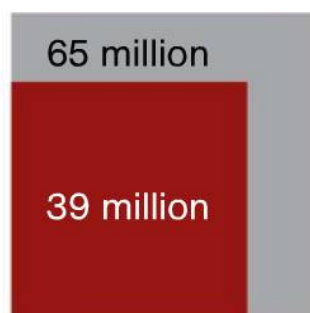
Liyakot Ali, 13, makes cooking pots in a Bangladesh factory.

Child labor estimates by region 2008

Asia; the Pacific*



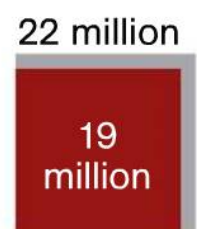
Sub-Saharan Africa



Latin America; the Caribbean



Other



1913

Sea surface

5,000 ft

10,000

15,000

20,000

25,000

30,000

35,000

A Century Beneath the Sea In 1960 a bathyscaphe took two men to the deepest point on Earth. In 2010 that manned descent to the Mariana Trench—still unmatched—won co-pilot Don Walsh the Hubbard Medal, National Geographic’s top honor for research and discovery. Yet it remains just a single, vital drop in an age of ocean exploration.

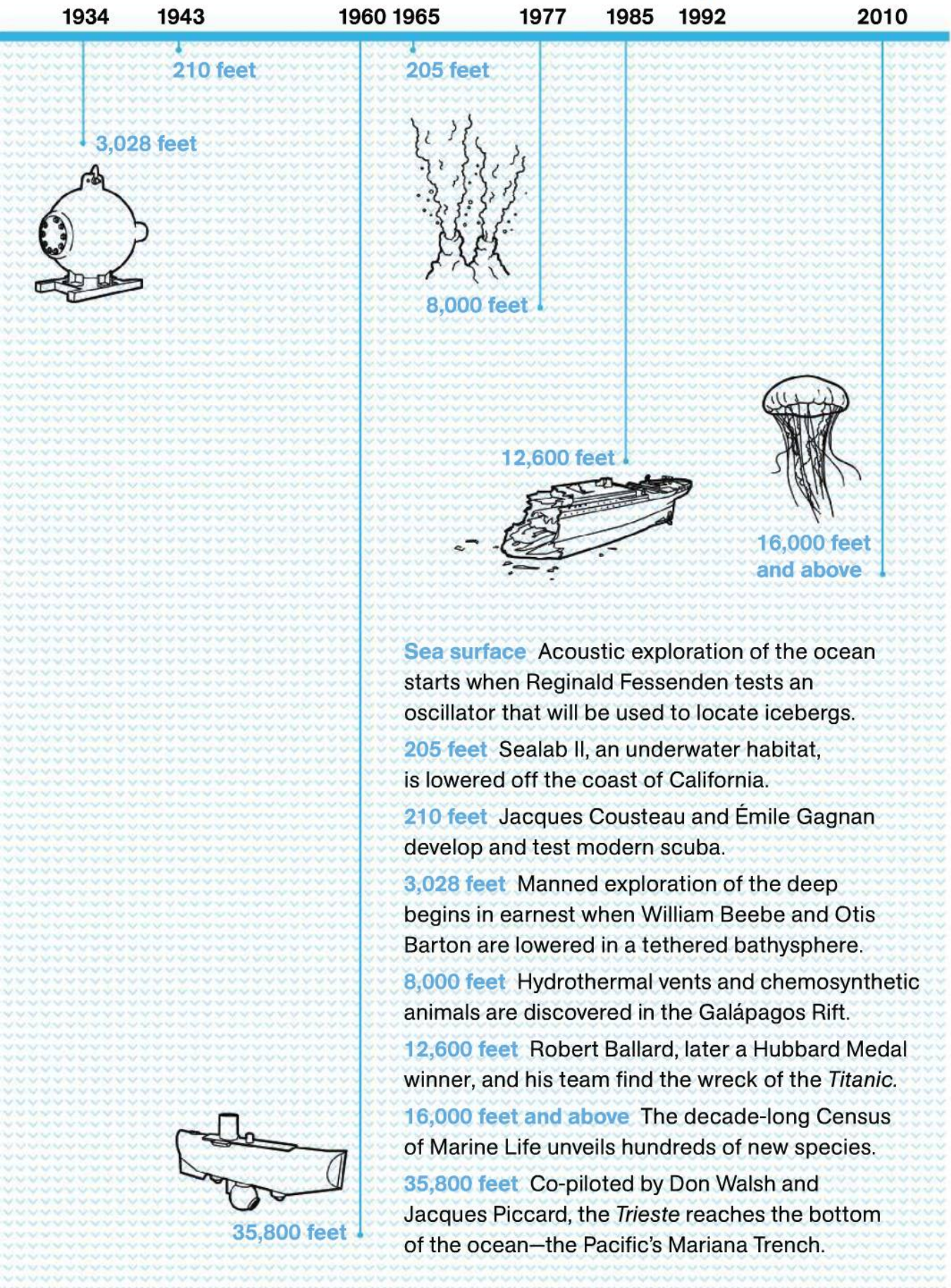
The secrets of the deep have emerged from research done far below the waves—and from far above them. Oceanographer Walter Munk deems the satellite TOPEX/Poseidon’s 13-year mapping of the sea surface, showing how currents affect climate, “the most successful ocean experiment of all times.”

What will the next century of marine science reveal? Maritime historian Helen Rozwadowski says that although most scientists think robotics are the way forward, some idealists still call for a Sealab-style colonization of the sea. Either way, she says, environmental concerns will likely influence all future ocean exploration—“unless somehow the dreamers get our attention again.” —*Jeremy Berlin*

830 miles above Earth

The TOPEX/Poseidon satellite begins mapping the surface of the sea.

IN OCEAN EXPLORATION



Sea surface Acoustic exploration of the ocean starts when Reginald Fessenden tests an oscillator that will be used to locate icebergs.

205 feet Sealab II, an underwater habitat, is lowered off the coast of California.

210 feet Jacques Cousteau and Émile Gagnan develop and test modern scuba.

3,028 feet Manned exploration of the deep begins in earnest when William Beebe and Otis Barton are lowered in a tethered bathysphere.

8,000 feet Hydrothermal vents and chemosynthetic animals are discovered in the Galápagos Rift.

12,600 feet Robert Ballard, later a Hubbard Medal winner, and his team find the wreck of the *Titanic*.

16,000 feet and above The decade-long Census of Marine Life unveils hundreds of new species.

35,800 feet Co-piloted by Don Walsh and Jacques Piccard, the *Trieste* reaches the bottom of the ocean—the Pacific's Mariana Trench.

Reefer Referral Here's a sign that the times are a-changin': Nearly three out of four Americans say they favor legalizing medical marijuana in their state, according to a 2010 Pew Research Center survey. And 41 percent think all marijuana should be legal, up from 35 percent in 2008 and 12 percent in a 1969 Gallup poll. Pot has become political in recent years. This summer Congress let the District of Columbia join a dozen-plus states with medical-marijuana laws on the books. Proponents say legalization will create tax revenues and save money on enforcement. And the American College of Physicians and the American Medical Association have endorsed research on the plant's makeup. Issued for glaucoma and to help cancer patients deal with chemotherapy, cannabinoids like THC are also being probed for anticancer properties.

All of which means aging hippies aren't alone. The Pew poll found backing for medical marijuana across the political spectrum and all age groups—a clear sign that tolerance is growing. —Alex Dominguez





Medical marijuana like this is federally supplied to only a handful of patients.

Approval in the U.S. for medical marijuana 2010

- In favor
- Opposed
- Don't know

A minimum of 61% of all groups are in favor.

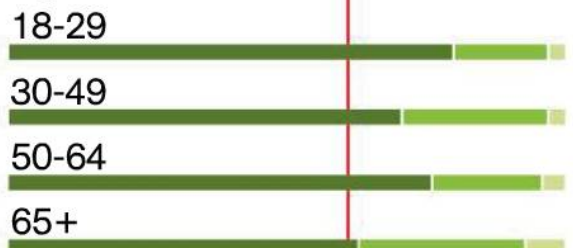
Gender



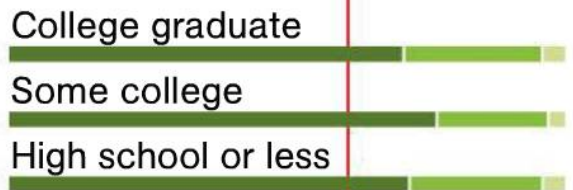
Ethnicity



Age



Education



Political affiliation

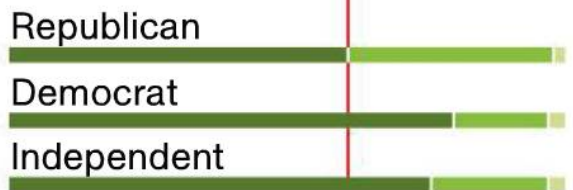


PHOTO: PAUL WELLMAN. CHART: LAWSON PARKER, NGM STAFF
SOURCE: PEW RESEARCH CENTER FOR THE PEOPLE & THE PRESS

Big Ideas

Little Packages

Designers are creating innovative, affordable products as solutions to problems all over the world.

SOME OF THE OBJECTS ON THESE PAGES ARE COURTESY OF THE EXHIBIT "DESIGN FOR THE OTHER 90%" BY THE SMITHSONIAN COOPER-HEWITT, NATIONAL DESIGN MUSEUM.

PHOTO: REBECCA HALE, NGM STAFF

NATIONAL GEOGRAPHIC NOVEMBER 2010



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Infant Warmer

Around 19 million low-birth-weight babies are born every year in developing countries. Unable to regulate their body temperatures, many die. The Embrace helps to warm vulnerable infants (a special pouch slips into the back of the bag to provide hours of safe heat) while allowing for nursing and cuddling.

Developed by Jane Chen, Linus Liang, Naganand Murty, Rahul Panicker

Website embraceglobal.org

Launch country India

CAN GOOD DESIGN SAVE THE WORLD? It just might, one novel idea at a time. Designers have always dreamed up innovative goods for those who could afford such things: New offerings include solar roof tiles, electric motorcycles, and more. Now, sparked by programs such as the Entrepreneurial Design for Extreme Affordability course at Stanford University's Institute of Design (source for several items in this article), some are taking a look at the concerns of people in developing countries as well. Keeping local culture in mind, designers are creating products to meet communities' particular needs. It turns out that even the most pressing problems, from health care to potable water, can have affordable—and beautifully designed—solutions. —Margaret G. Zackowitz

Water Container

In impoverished rural areas, clean water is often miles away from the people who need it, leaving them susceptible to waterborne diseases. The sturdy Q Drum holds 13 gallons in a rolling container that eases the burden of transporting safe, potable water—a task that falls mostly to women and children.

Developed by P. J. and J. P. S. Hendrikse

Website qdrum.co.za

Launch country South Africa



MORE >

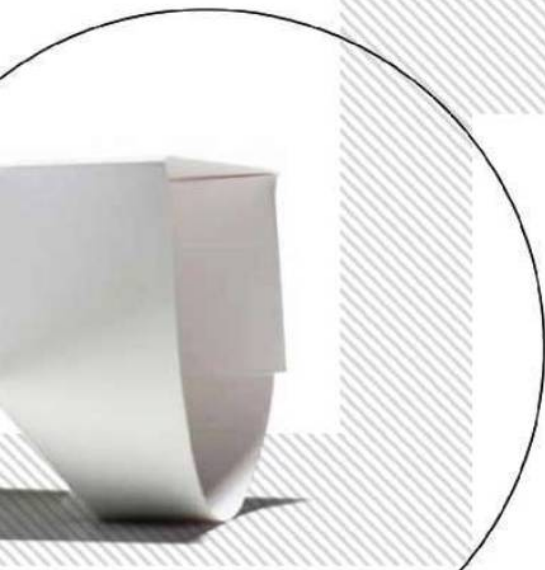
Purifying Straw

Some 900 million people lack access to safe drinking water. Sipping through the LifeStraw filters surface water on-site, reducing the transmission of bacteria and viruses. Thousands of ten-inch LifeStraws were donated to Haiti after this year's earthquake. Each filters about 160 gallons; a new, shorter model, nearly 265.

Developed by Vestergaard Frandsen

Website lifestraw.com

Launch country Kenya



Asthma Device

Young asthmatics often can't coordinate breathing with the aerosol puff dispensed by inhalers. The folded-paper Respira "spacer" traps medication around the mouth so that it can be inhaled. Conventional spacers can run \$20 or more—a prohibitive cost in the developing world, where asthma rates are rising. Respira costs about a dollar.

Developed by Eric Green, Santiago Ocejo, Barry Wohl

Website respiradesign.org

Launch country Mexico

PHOTOS: RENEE COMET (LIFESTRAW, Q DRUM);
MARK THIESSEN, NGM STAFF (INHALER)

Portable Clay Refrigerator

Building upon an ancient food-storage technique, the pot-in-pot system uses evaporation from a layer of wet sand between two nesting pots to help extend the life of farmers' goods. Tomatoes can last weeks instead of just days, meaning more fresh produce at the market and more income for farmers.

Developed by Mohammed Bah Abba

Website none available

Launch country Nigeria





MORE >

Sugarcane Charcoal

Burning wood and dung, the main fuel sources for many in the developing world, has contributed to deforestation and respiratory ailments. Not only do briquettes made from crushed sugarcane stalks make use of an abundant local resource, they burn more cleanly and allow residents to start a charcoal business for less than \$50.

Developed by MIT D-Lab

Contact d-lab.mit.edu/resources

Launch country Haiti

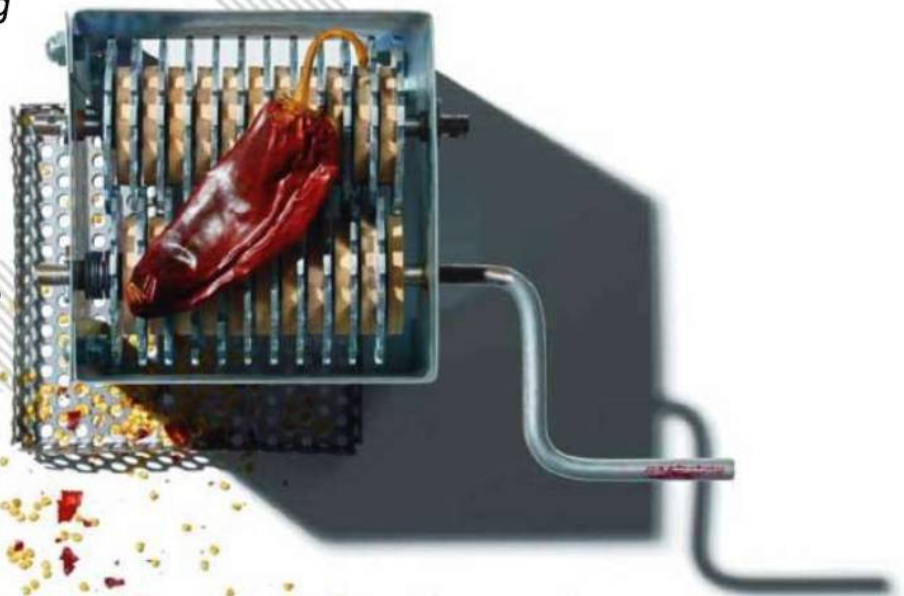
Chili Grinder

Ethiopian women have for centuries crushed chili peppers by hand—a time-consuming, painful way to add value to a staple spice. The Pepper Eater mills chilies four times faster, creating uniform flakes and sparing hands from chili-oil burns.

Developed by Samuel Hamner, Scott Sadlon

Website thepeppereater.org

Launch country Ethiopia



PHOTOS: MARK THIESSEN, NGM STAFF (GRINDER);
RENEE COMET (CHARCOAL, COOLER)



Solar Roof Tiles

Solé Power Tiles may look like blue versions of the clay roof tiles traditionally used in sunny climates, but they're made of a durable polymer—and they're actually curved photovoltaic solar panels, creating enough energy daily to cut a typical American home's electric bill by 70 percent or more.

Developed by SRS Energy

Website srsenergy.com

Launch country U.S.

Solar Light

Hazardous kerosene lamps are the only source of lighting for millions of people all over the world. The solar-powered MightyLight is safer, cleaner, and more versatile: It can be hung on a wall, placed on a tabletop, or carried. It also lasts longer—its LED technology is good for up to 30 years of use.

Developed by Amit Chugh,
Matthew Scott

Website cosmosignite.com

Launch country India



MORE >

Electric Motorcycle

Made mostly from recycled materials, the Enertia “refuels” at either 110-volt or 220-volt electrical sockets. It travels at up to 60 miles an hour, emits no exhaust, and goes more than 40 miles between charges. The faster Empulse, with longer battery life, is due out in 2011.

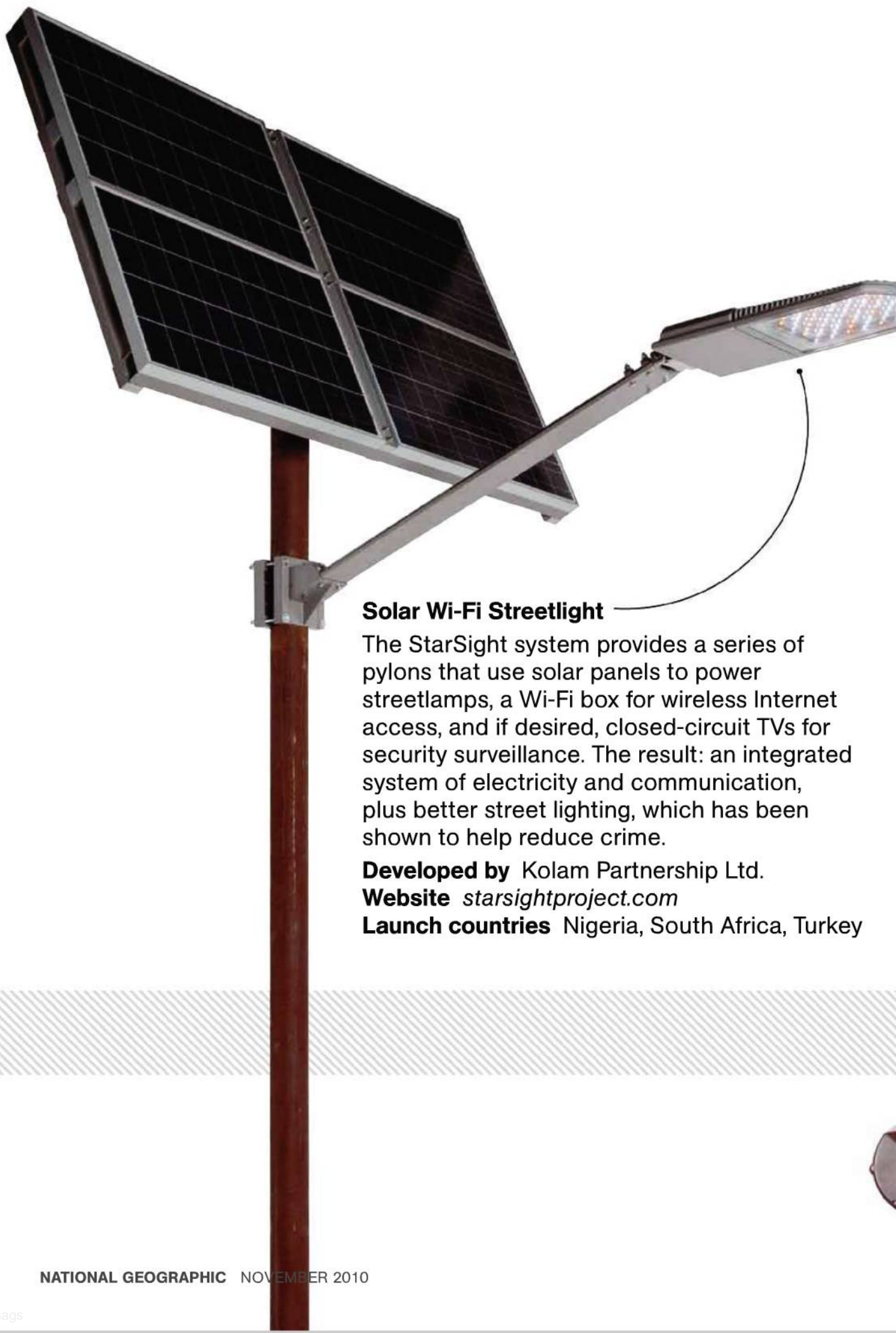
Developed by Brian Wismann

Website *brammo.com*

Launch country U.S.



PHOTOS: MARK THIESSEN, NGM STAFF (TILE, LIGHT);
PAUL WELLMAN (MOTORCYCLE)



Solar Wi-Fi Streetlight

The StarSight system provides a series of pylons that use solar panels to power streetlamps, a Wi-Fi box for wireless Internet access, and if desired, closed-circuit TVs for security surveillance. The result: an integrated system of electricity and communication, plus better street lighting, which has been shown to help reduce crime.

Developed by Kolam Partnership Ltd.

Website starsightproject.com

Launch countries Nigeria, South Africa, Turkey

Affordable Laptops

The One Laptop per Child project aims to educate children in remote parts of the world. Governments purchase the computers, each equipped with Wi-Fi “rabbit ears” and e-book mode, for schools. Uruguay has already distributed some 400,000 laptops, with another 90,000 on order. A tablet version is due in 2012.

Developed by Nicholas Negroponte,
Rodrigo Arbroleda Halaby

Website laptop.org

Launch country Brazil



Hearing-Aid Recharger

The high cost of imported batteries can render hearing aids unaffordable for people in developing nations. This solar recharger accepts specially fitted hearing aids and standard rechargeable batteries, making hearing help less costly. More than 6,000 units are already in use in Africa, South and Central America, and Asia.

Developed by Godisa Technologies Trust

Website none available

Launch country Botswana



Great M



In the summer bull trout forge 50 miles upstream from Lake Koochanusa to spawn in the Wigwam River drainage in British Columbia.

migrations



WHAT IS IT THAT MAKES ANIMAL
MIGRATION SUCH A MAGNIFICENT
SPECTACLE FOR THE EYE AND THE MIND?

Is it the sheer abundance of wildlife in motion? Is it
the steep odds to be overcome? Is it the amazing feats
of precise navigation? The answer is all of the above.

But there's another reason why the long-distance
journeys of wildebeests, sandhill cranes, monarch
butterflies, sea turtles, and so many other species
inspire our awe. One biologist has noted the

“undistractibility” of migrating animals. A non-
scientist, risking anthropomorphism, might say:

Yes, they have a sense of larger purpose.

Half a million sandhill cranes pause on the Platte River in Nebraska to fatten up on corn waste, worms, and other food in nearby fields. The break occurs on their spring flight from Mexico and the southern U.S. to breeding grounds in the far north.







Tens of millions of bison once rumbled across the Great Plains on a quest for grazing. By the late 1800s nearly all had been slaughtered. Today most of the half million remaining bison are in captivity, like these on the Triple U ranch in South Dakota.



Millions of monarch butterflies travel to ancestral winter roosts in Mexico's shrinking mountain fir forests. Surfing winds from southern Canada and the northern U.S., they travel thousands of miles, taking directional cues from the sun.





BY DAVID QUAMMEN
PHOTOGRAPHS BY JOEL SARTORE

Animal migration is a phenomenon far grander and more patterned than animal movement. It represents collective travel with long-deferred rewards.

It suggests premeditation and epic willfulness, codified as inherited instinct. A biologist named Hugh Dingle, striving to understand the essence, has identified five characteristics that apply, in varying degrees and combinations, to all migrations. They are prolonged movements that carry animals outside familiar habitats; they tend to be linear, not zigzaggy; they involve special behaviors of preparation (such as overfeeding) and arrival; they demand special allocations of energy. And one more: Migrating animals maintain a fervid attentiveness to the greater mission, which keeps them undistracted by temptations and *(Touch Text button to read more.)*



Worn like a backpack, a tiny plastic geolocator helps map bobolinks on their 12,000-mile flight from the grasslands and rice fields of Bolivia and Argentina to North America, including a stopover along the Platte River in Nebraska (above). If a male bobolink hears another male calling in his territory, he'll chase the intruder away. So researchers who want to tag males with geolocators catch them by playing a recording of a male's call, which to human ears sounds like the chirps of R2-D2, the robot of *Star Wars* fame.

Contributing Writer David Quammen is the author of 11 books, including The Reluctant Mr. Darwin. Nebraska-based Joel Sartore specializes in covering biodiversity. This is his 30th story for the magazine.

Text



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Mountain goats in Montana's Glacier National Park may travel thousands of feet a day—vertically. This one descended a sheer rock wall to lick salt and other exposed minerals. Nutrients that aren't as available during the long winter may trigger the hankering.







Incredible Journeys



Migration routes

- ↔ Sandhill crane
- ↔ Pronghorn
- ↔ Monarch butterfly
- ↔ Mexican free-tailed bat

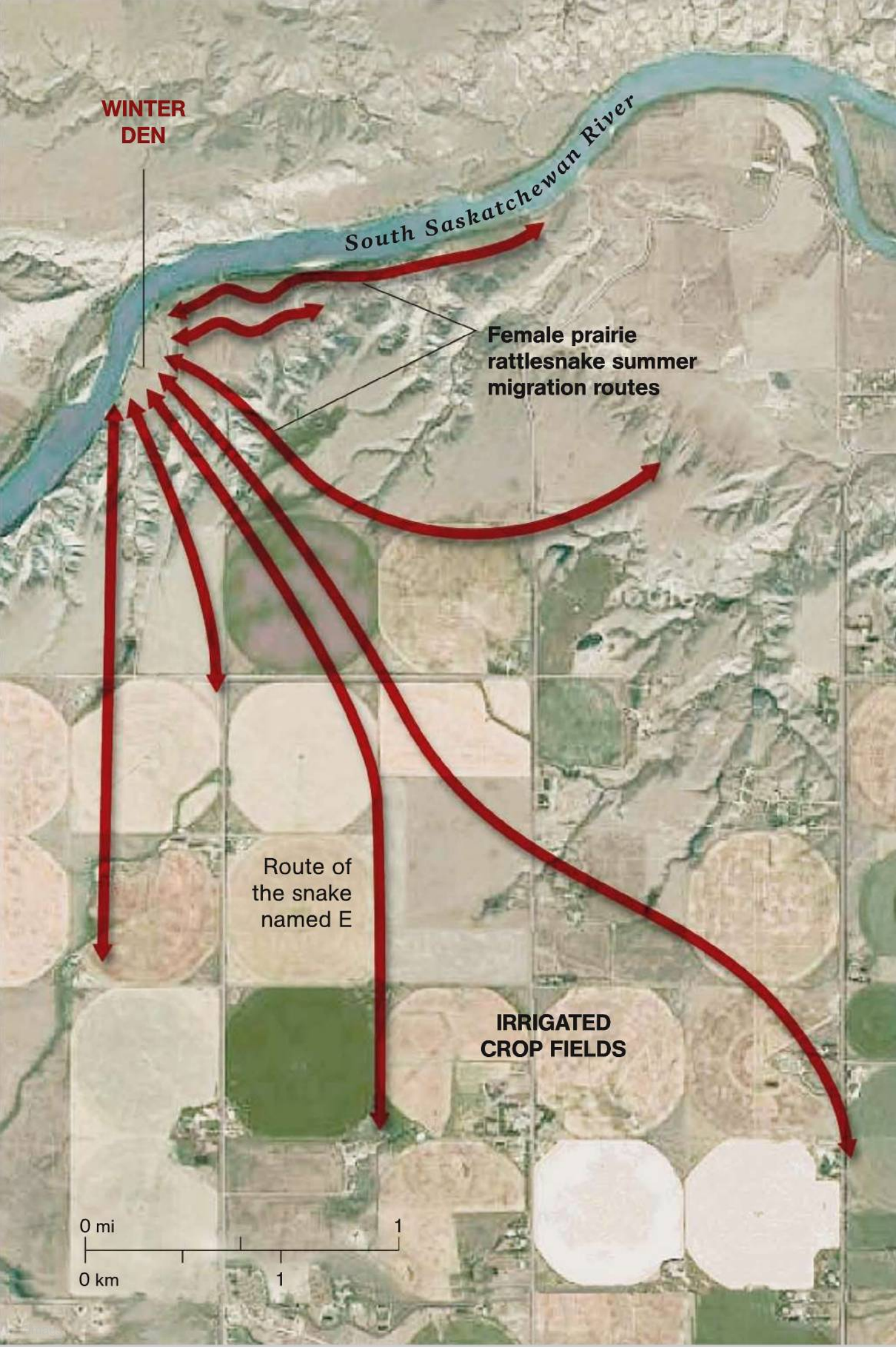
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WILLIAM E. MCNULTY AND LISA R. RITTER,
NGM STAFF. SOURCES: ROWE SANCTUARY,
NATIONAL AUDUBON SOCIETY (CRANE);
MICHAEL SUITOR, UNIVERSITY OF CALGARY
(PRONGHORN); MONARCH BUTTERFLY
FUND AND MONARCH WATCH (BUTTERFLY);
GARY MCCRACKEN, UNIVERSITY OF
TENNESSEE (BAT)



Out of hibernation—and hungry—many species of snakes follow the same scent trails year after year, no matter the obstacles (see map, following spread). A western cottonmouth didn't survive the trip across a levee road in Illinois.







Rattlesnakes on spring feeding forays from underground winter dens near Medicine Hat, Alberta, encounter a landscape altered by human activity.

NGM MAPS. SOURCE: DENNIS JØRGENSEN, WWF.
SATELLITE IMAGE: GEOEYE



JOEL SARTORE WITH COLE SARTORE



Mexican free-tailed bats spiral out of Eckert James River Bat Cave Preserve in Texas at dusk. The bats are hungry for pests like corn earworm moths—nutrition to keep milk flowing for their pups. Every spring millions of free-tails return to this cave.



These 32 bats and four songbirds represent an average yearly toll for each of the 23 turbines at a Pennsylvania wind farm. Raptors like the red-tailed hawk (left) are rare victims.



Horse Hollow wind farm near Abilene, Texas, one of the world's largest, has more than 400 turbines. The turbines' spinning blades cause a drop in air pressure, which can kill bats.

JOEL SARTORE WITH PETER COLTMAN







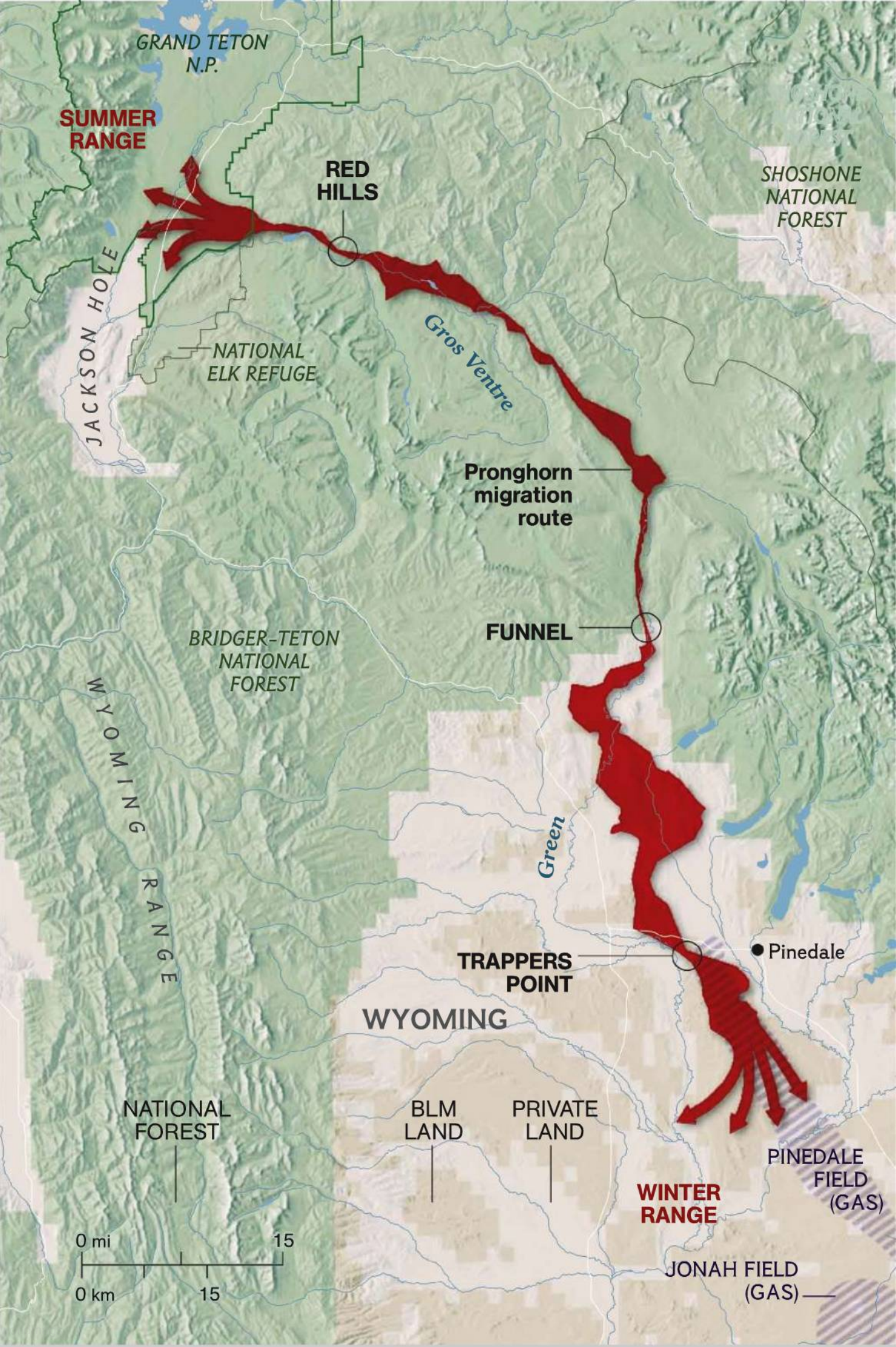
Pronghorn run fast—upwards of 60 miles an hour—but they rarely jump fences. Some ranchers plan to raise the lowest fence strands so pronghorn, like these near Medicine Hat, Alberta, can more easily slip under during their winter migration.





Gas drilling projects, such as Jonah Field, impede pronghorn migration, and new homes restrict corridors to no more than a few hundred yards wide in places.





GRAND TETON N.P.

SUMMER RANGE

RED HILLS

SHOSHONE NATIONAL FOREST

JACKSON HOLE

NATIONAL ELK REFUGE

Gros Ventre

Pronghorn migration route

FUNNEL

BRIDGER-TETON NATIONAL FOREST

WYOMING RANGE

Green

TRAPPERS POINT

● Pinedale

WYOMING

NATIONAL FOREST

BLM LAND

PRIVATE LAND

WINTER RANGE

PINEDALE FIELD (GAS)

JONAH FIELD (GAS)





Pronghorn migrating between summer and winter ranges in north-western Wyoming negotiate steep valleys, forested mountainsides, and a gantlet of man-made intrusions.

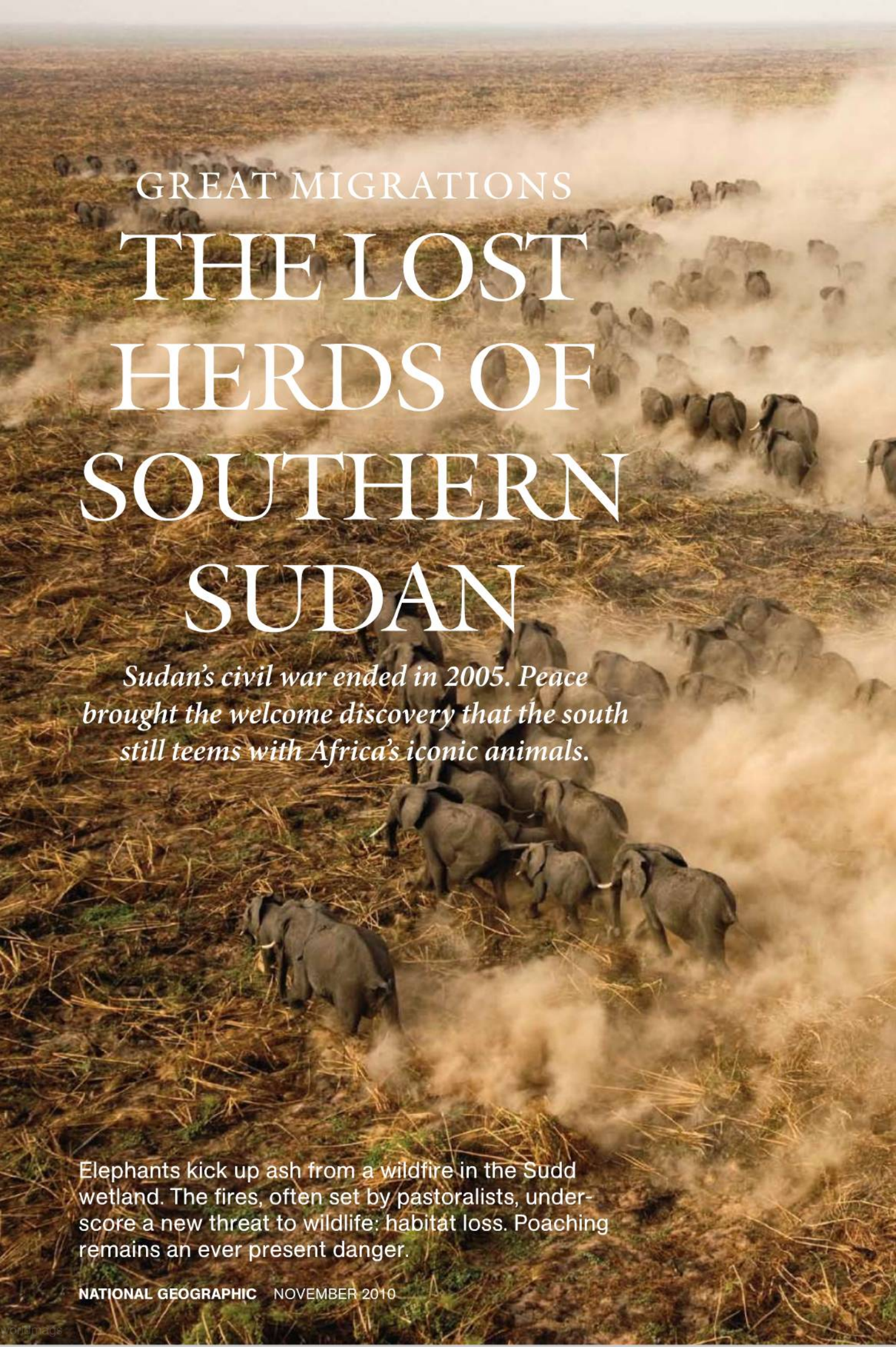
NGM MAPS. SOURCE: ANDRA TOIVOLA, WILDLIFE CONSERVATION SOCIETY

A border wall along the lower Rio Grande in Texas divides nations as well as habitats, hindering essential daily movements of animals in the area. Bobcats would normally cross the border to find mates or catch dinner—this one caught a rat. The wall also blocks the daily rounds of ocelots, another member of the cat family.

JOEL SARTORE, WITH MITCH STERNBERG, JENNIFER LOWRY, AND NAGHMA MALIK, ALL U.S. FISH AND WILDLIFE SERVICE







GREAT MIGRATIONS
THE LOST
HERDS OF
SOUTHERN
SUDAN

Sudan's civil war ended in 2005. Peace brought the welcome discovery that the south still teems with Africa's iconic animals.

Elephants kick up ash from a wildfire in the Sudd wetland. The fires, often set by pastoralists, underscore a new threat to wildlife: habitat loss. Poaching remains an ever present danger.







Thousands of white-eared kob race in the shadow of a Wildlife Conservation Society survey plane in a park east of Bor. The seasonal migration of animals in southern Sudan is a spectacle to rival the flow of animals across Tanzania's Serengeti Plain.

BY MATTHEW TEAGUE

PHOTOGRAPHS BY GEORGE STEINMETZ

Not long ago in Juba, in an old colonial building with cracked walls and fitful electricity, two former military men—Lt. Gen. Fraser Tong and Maj. Gen. Philip Chol Majak—were explaining the situation.

“Organized gangs, maybe 50 men, are coming in on horseback,” Tong said. “They’re targeting elephants and the bigger ungulates. They dry the meat and keep the ivory and transport it on camelback.”

Tong is the undersecretary for wildlife in semi-autonomous southern Sudan, based in Juba, the capital. Majak is a senior staffer, a wildlife field commander whose army unit was famous for shooting down MiG jets with shoulder-fired missiles during Sudan’s latest civil war, which began in 1983. A cease-fire ended that conflict five years ago, but now Majak is fighting a new war. “We have to protect these animals,” he said.

There’s urgency *(Touch Text button to read more.)*

Matthew Teague wrote about the Uyghurs of China’s Xinjiang region last December. George Steinmetz began his photographic career in Africa 30 years ago.



Wildlife experts struggle to place a GPS satellite collar on a tranquilized bull elephant in Boma National Park. A Wildlife Conservation Society project aims to track elephant migration to and from Ethiopia.

Text



Wildlife experts struggle to place a GPS satellite collar on a tranquilized bull elephant in Boma National Park. A Wildlife Conservation Society project aims to track elephant migration to and from Ethiopia.

Abundant Animals, High Risk

Migration routes

Tiang, white-eared kob

Mongalla gazelle, reedbuck

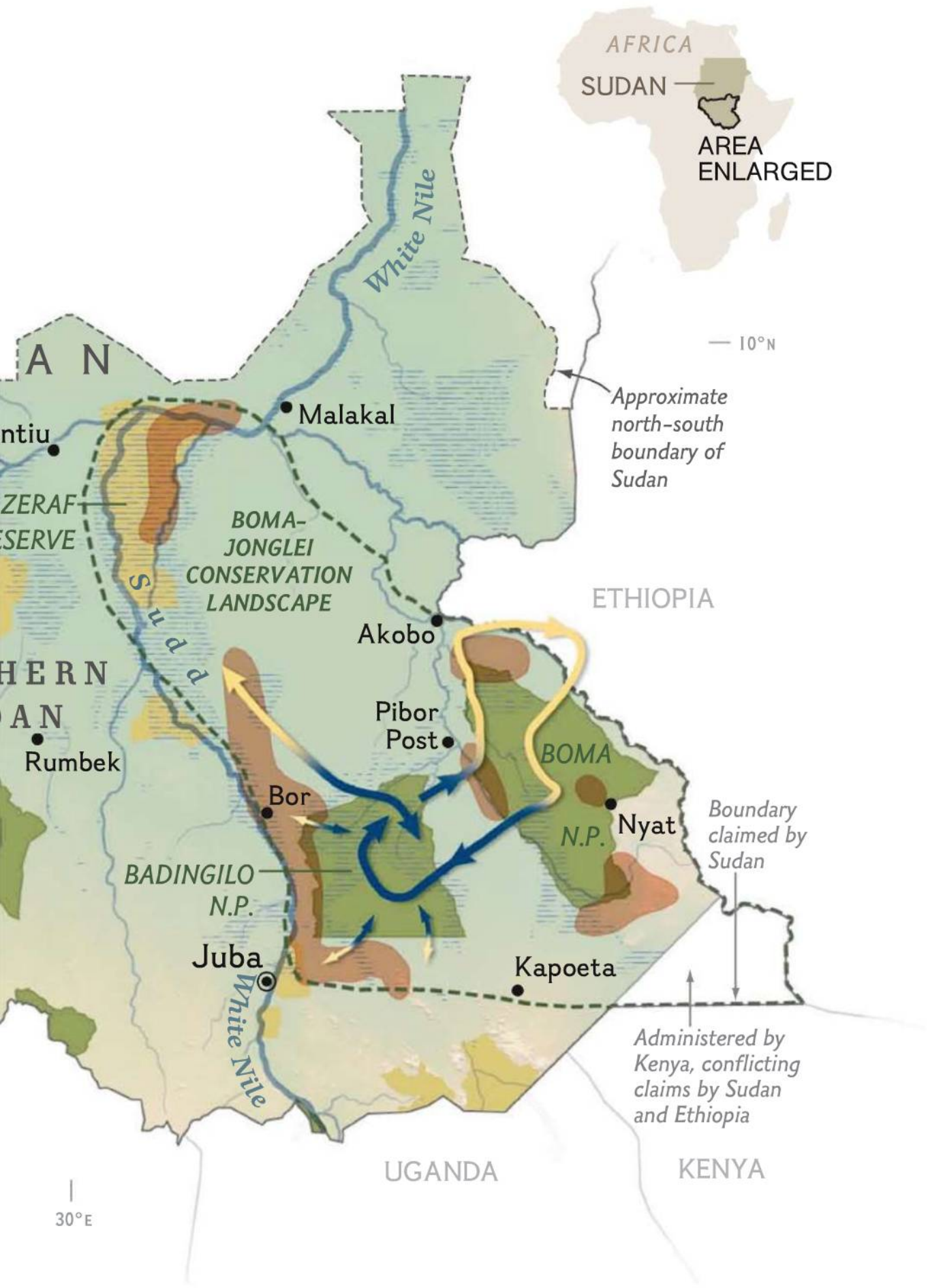


Dry season
Nov. to Apr.

Wet
May to Oct.



NGM MAPS: INTERNATIONAL MAPPING
SOURCE: WILDLIFE CONSERVATION SOCIETY



AFRICA
SUDAN
AREA ENLARGED

10°N

Approximate north-south boundary of Sudan

ETHIOPIA

Boundary claimed by Sudan

Administered by Kenya, conflicting claims by Sudan and Ethiopia

UGANDA

KENYA

30°E





A floating fishing camp drifts in the Sudd, one of Africa's largest wetlands—more than 20,000 square miles in the rainy season. The scale of this place makes it difficult for wildlife authorities to patrol and enforce hunting and fishing laws.





As dry season peaks, people at a Dinka fishing camp hunt anything they can find, like this Nile lechwe laid out on a hippo skin. The meat is dried on wooden racks. Authorities tend to overlook subsistence hunting. To evade capture, commercial poachers hide in vast stretches of wilderness.



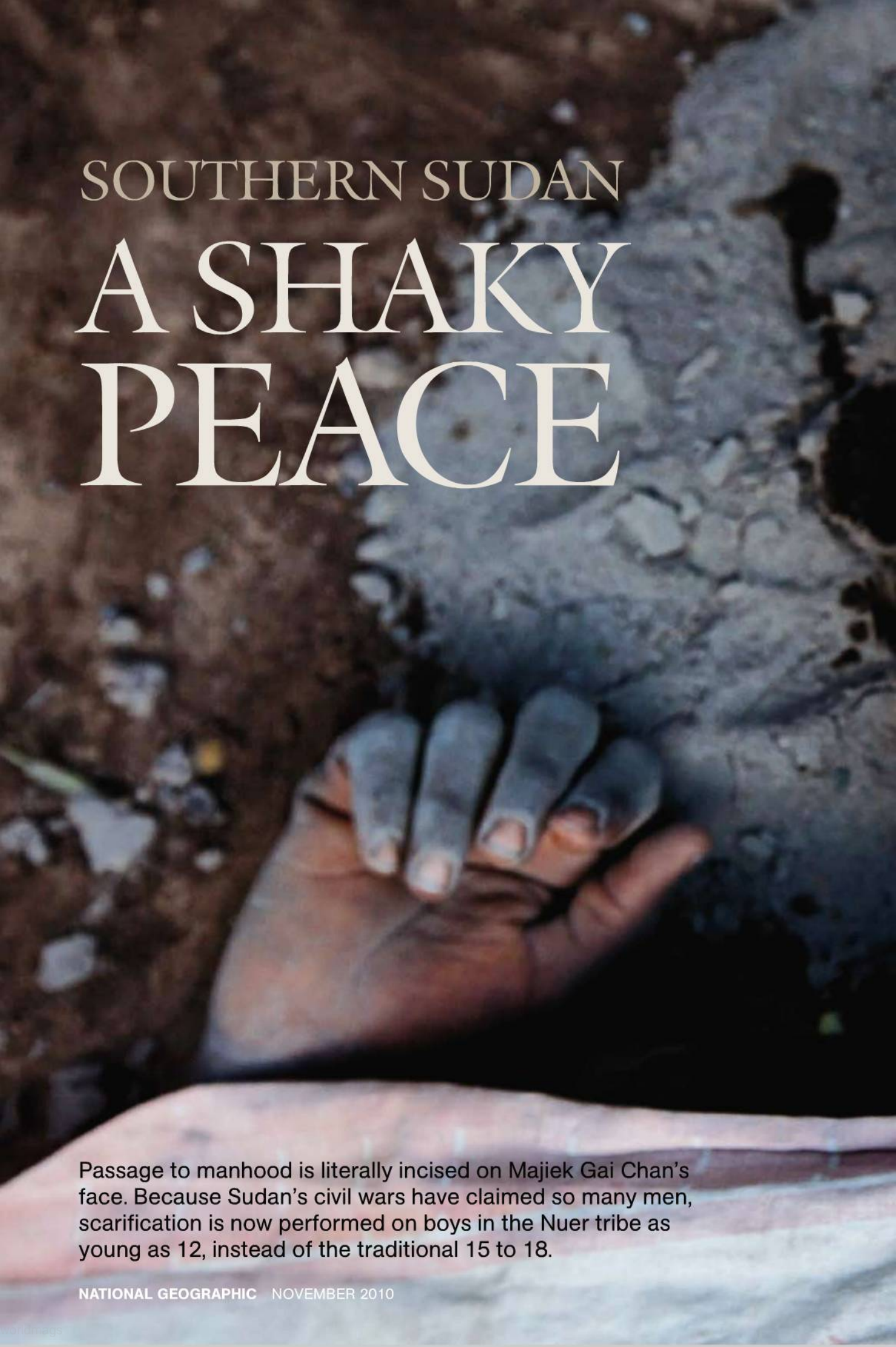


A herd of buffalo navigates grasslands in the Sudd, which contains about 10,000 of the animals. Before 1983, when Sudan descended again into civil war, 60,000 buffalo roamed Southern National Park, some 200 miles from here. Today, WCS aerial surveys of the park have sighted none.





Masses of vegetation float like giant lily pads on the ever changing surface of the Sudd. Southern Sudan's virtually impenetrable wetlands provided sanctuary for wildlife during 25 years of civil war.



SOUTHERN SUDAN A SHAKY PEACE

Passage to manhood is literally incised on Majiek Gai Chan's face. Because Sudan's civil wars have claimed so many men, scarification is now performed on boys in the Nuer tribe as young as 12, instead of the traditional 15 to 18.







In September 2009 Nuer tribesmen attacked the Dinka village of Duk Padiet. The death toll of at least 167 included civilians as well as soldiers, adding to the lives lost in regional violence despite a 2005 treaty ending Sudan's most recent civil war. A UN helicopter evacuated the wounded.





Cattle—foundation of the Dinka economy—speckle a floodplain in a camp near a branch of the Nile during the dry season. The animals are corralled at night to defend them against cattle raiders, then taken out to graze during the day.





Villagers abandoned Nyiek during the civil war. Years later, after the peace treaty, they returned to find oil drillers had moved in—so they moved up the road. Little of the oil revenue trickles down: The village lacks both electricity and running water.

BY MATTHEW TEAGUE

PHOTOGRAPHS BY GEORGE STEINMETZ

One day some years ago, before the latest civil war began in earnest, a Sudanese boy named Logocho peeked into the entry of his family's grass hut. His father sprang out and grabbed him, and then, with an older boy, pinned him in the dirt.

A strange boy, Logocho. Above him, his father's shoulders and chest rippled with welted tribal scars. A Morse code of dots and dashes crossed the father's face and forehead, signaling to any potential cattle raiders—the Dinka, the Nuer—that he, as a Murle, would defend his stock with spear, knife, fists, and teeth.

But his son showed no interest in the old ways. When other children, including his own brother, underwent an early Murle rite of passage, he ran and hid in the grass. Now his body, smooth as a calf's, trembled and arched in the dust. Nothing marked him as Murle.

More alarming, the nine-year-old boy showed no interest in cattle. Like his brother, Logocho crouched to suckle the udders *(Touch Text button to read more.)*



The trademark hat worn by Salva Kiir, president of semiautonomous southern Sudan, was a gift from President George W. Bush during a summit. A former battlefield commander who has led the south since 2005, Kiir will guide his country through a referendum next year, when a vote for full independence is expected.

Text





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Oil Divide

Under the 2005 Comprehensive Peace Agreement between the south and the north, the south was to receive 50 percent of the profits from oil produced there. The treaty also gave southerners the right to hold a referendum on independence in 2011. If they vote to secede, will Khartoum let them—and the oil—go?

Oil infrastructure




-  Refinery
All of Sudan's oil refineries are in the north.
-  Oil fields
The south produces 65 percent of Sudan's oil.

Oil blocks

-  Blocks producing oil
-  Blocks not producing oil

Multinational consortiums buy extraction rights in oil blocks. Discrepancies in reported production (below) feed the south's concern that the north does not share oil revenue as agreed under the peace treaty.

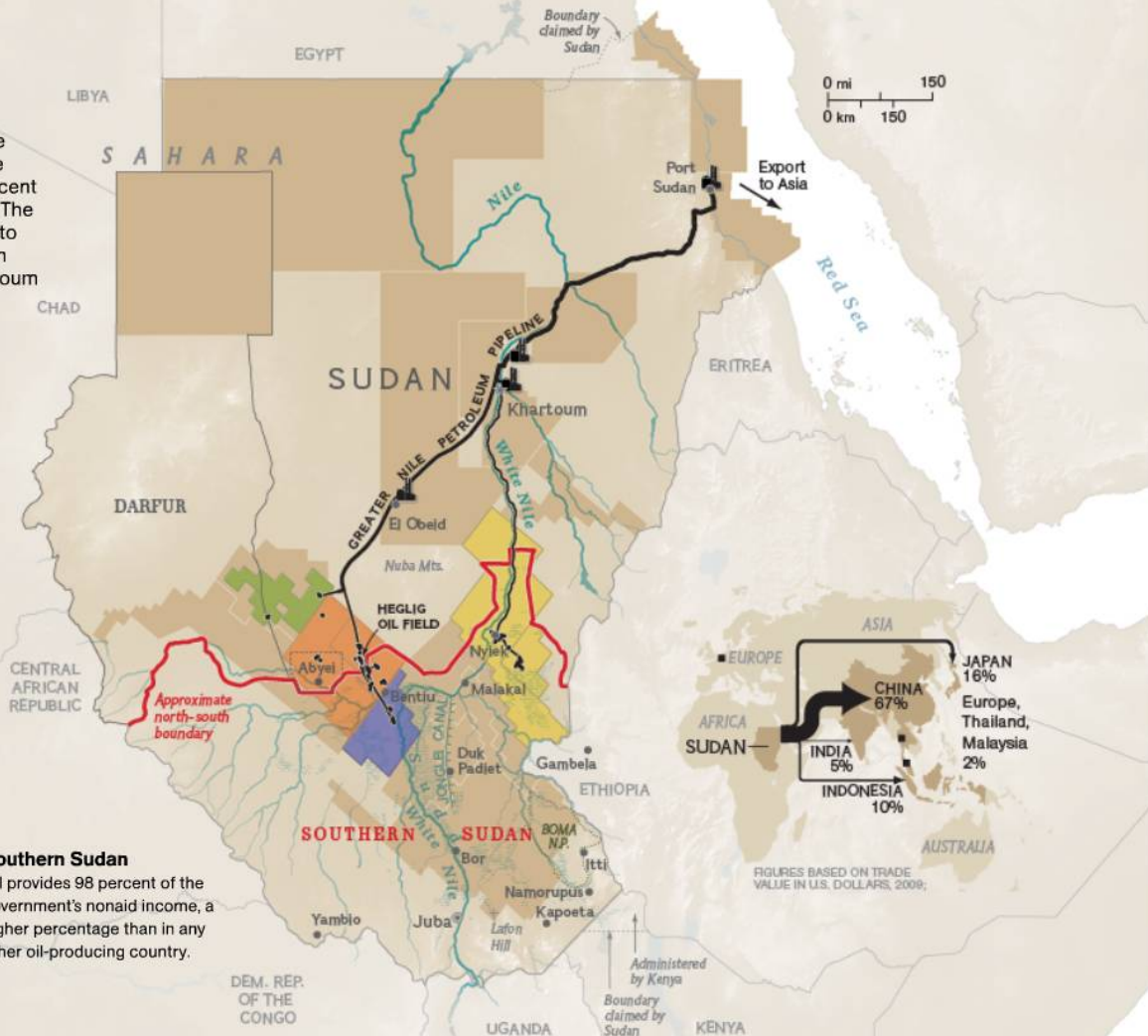
Oil production by block

-  Reported by government
-  By oil company
-  Oil company not reporting

0 100 200 300
THOUSANDS OF BARRELS A DAY, 2007

Southern Sudan

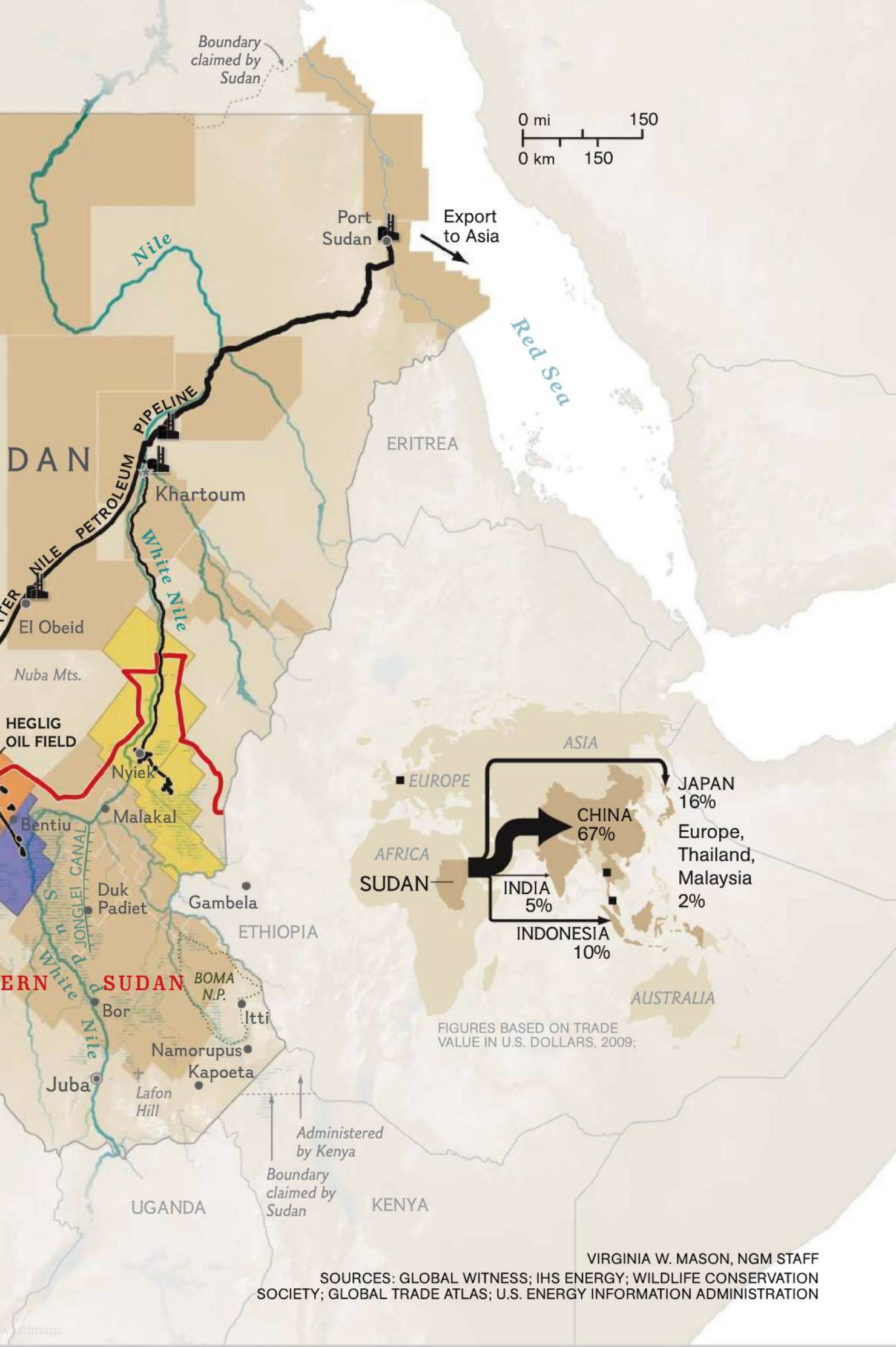
Oil provides 98 percent of the government's nonaid income, a higher percentage than in any other oil-producing country.



FIGURES BASED ON TRADE VALUE IN U.S. DOLLARS, 2009

SOURCES: GLOBAL WITNESS; IHS ENERGY; WILDLIFE CONSERVATION SOCIETY; GLOBAL TRADE ATLAS; U.S. ENERGY INFORMATION ADMINISTRATION

VIRGINIA W. MASON, NGM STAFF



Boundary claimed by Sudan



Export to Asia

Nile

Red Sea

White Nile

ERITREA

SUDAN

El Obeid

Nuba Mts.

HEGLIG OIL FIELD

Bentiu

JONGLEI CANAL

EASTERN SUDAN

Juba

Lafon Hill

UGANDA

Namorupus

Kapoeta

Malakal

Duk Padiet

Bor

Itti

Namorupus

Kapoeta

Lafon Hill

Namorupus

Kapoeta

ETHIOPIA

BOMA N.P.

Itti

Namorupus

Kapoeta

Lafon Hill

Namorupus

Kapoeta

Administered by Kenya

Boundary claimed by Sudan

KENYA

EUROPE

AFRICA

SUDAN

ASIA

CHINA

JAPAN

16%

Europe, Thailand, Malaysia

2%

INDIA

5%

INDONESIA

10%

AUSTRALIA

FIGURES BASED ON TRADE VALUE IN U.S. DOLLARS, 2009;

VIRGINIA W. MASON, NGM STAFF

SOURCES: GLOBAL WITNESS; IHS ENERGY; WILDLIFE CONSERVATION SOCIETY; GLOBAL TRADE ATLAS; U.S. ENERGY INFORMATION ADMINISTRATION





Women's work in the Toposa village of Namorupus includes making a granary roof from natural materials like grass. Farming falls mainly to women, while caring for and herding cattle to seasonal grazing grounds falls to men.



The newly welded framework for a shop takes to the road in Bentiu. The town sits amid the oil fields of Unity State, governed by the south since the end of the civil war. Without a pipeline of its own, the south must send its oil through a northern pipeline to a port on the Red Sea.



Sudan finds itself wobbling between the possibility of lasting peace and the threat of fresh violence. In 2011 the people of southern Sudan will vote on whether to secede.





With a constant stream of hucksters and workers lured by the promise of jobs and peace, Juba winks at all comers like a gold rush town. Having grown threefold since 2005, the unruly capital of southern Sudan can barely provide basic city services for its residents.





Under a southern Sudanese civilian-disarmament program, soldiers from the Sudan People's Liberation Army found 762 rifles and one 60-millimeter mortar in and around the village of Kuda. Since last November, 35,000 weapons have been collected in the south.





As rain greens the land in Burgilo County, men from the Pari tribe will bring their cows home from seasonal grazing camps eight miles away. Until soldiers razed it during the civil war, their village lay at the foot of Lafon Hill (at top right).



The chaos and carnage of Sudan's history make it impossible to predict whether the 2005 peace pact will hold through the 2011 vote on independence.



Members of southern Sudan's security service bury two colleagues after the brutal intertribal assault on Duk Padiet. Last year conflicts in the south took 2,500 lives and displaced 350,000. Southerners accused the Khartoum government of stirring up violence to destabilize the region.





At the Royal Junior School in Bor, students teach until their regular teacher arrives. As basic as this private school is, it offers a better alternative than many of southern Sudan's public schools.





Arms raised like cattle horns, Jacob Mawich celebrates his victory in the election for leader of a Nuer youth association in Juba. Constituents rejected formal paper ballots and voted in the traditional way by lining up behind their man.



For countless generations men lived alongside their cows. They named them, decorated them, slept beside them. Sang of them. Danced in their honor. Loved them.



The connection between a Dinka man and his cow is profound; it is part of his personal identity. The matter of a southern Sudanese national identity is on the table as leaders prepare for next year's referendum on independence, when they hope to persuade Dinka, Nuer, and other feuding tribes to unify.

3 Degrees of Japan's Seas

The waters off the coast vary
from frigid to temperate to tropical.

The marine life is
uniformly extraordinary.

Hunting for morsels of plankton, a school of spadefish hovers near the surface off Japan's subtropical Bonin Islands. The turquoise color permeates the water late in the afternoon, as the red rays of the setting sun spread out and grow weak.





Seventy miles southwest of Tokyo, a moray eel slithers through the branches of a soft coral in the cool waters of Suruga Bay. Deep and narrow, the bay plunges more than 8,000 feet.





The photographer's assistant hangs on to part of an ice canopy that can reach a thickness of 25 feet in winter, blanketing Shiretoko Peninsula waters. A decade ago these seas were icebound an average of 90 days a year. Today the span is about 65 days.



Sunlight streams between cracks in the ice. Thicker chunks glow emerald green, bejeweled by algae. The characters of this frosty realm begin to appear: a translucent, blue swimming snail, a pink fish with a tail like a geisha's fan, a bright orange lumpsucker that looks as if it leaped out of a Pokémon cartoon.

This is the underwater world that awaits photographer Brian Skerry, who is lumbering across the beach near a fishing town called Rausu, in Japan's northeastern corner. Wearing a hooded dry suit and carrying an air tank, hoses, regulator, and 32 pounds of weights, he pulls on his fins and slowly submerges his face to get used to the 29°F water. His lips go numb. And then, camera in hand, Skerry dives between the ice floes into the waters of the Sea of Okhotsk, bordering the Shiretoko Peninsula.

Most people think of Japan as a compact collection of large islands, but a map of the country shows otherwise. Japan stretches over 1,500 miles and includes more than 5,000 islands. As land mingles with sea over these vast distances, it embraces *(Touch Text button to read more.)*

A contributor to the magazine since 1998, photojournalist and veteran diver Brian Skerry is the author of Face to Face With Manatees.



On a coral reef in the Bonin Islands, an abandoned wormhole is home to a hermit crab. Unlike its mobile cousins that forage the reef for food, this crab stays put and fishes for floating plankton with its feathery antennae.

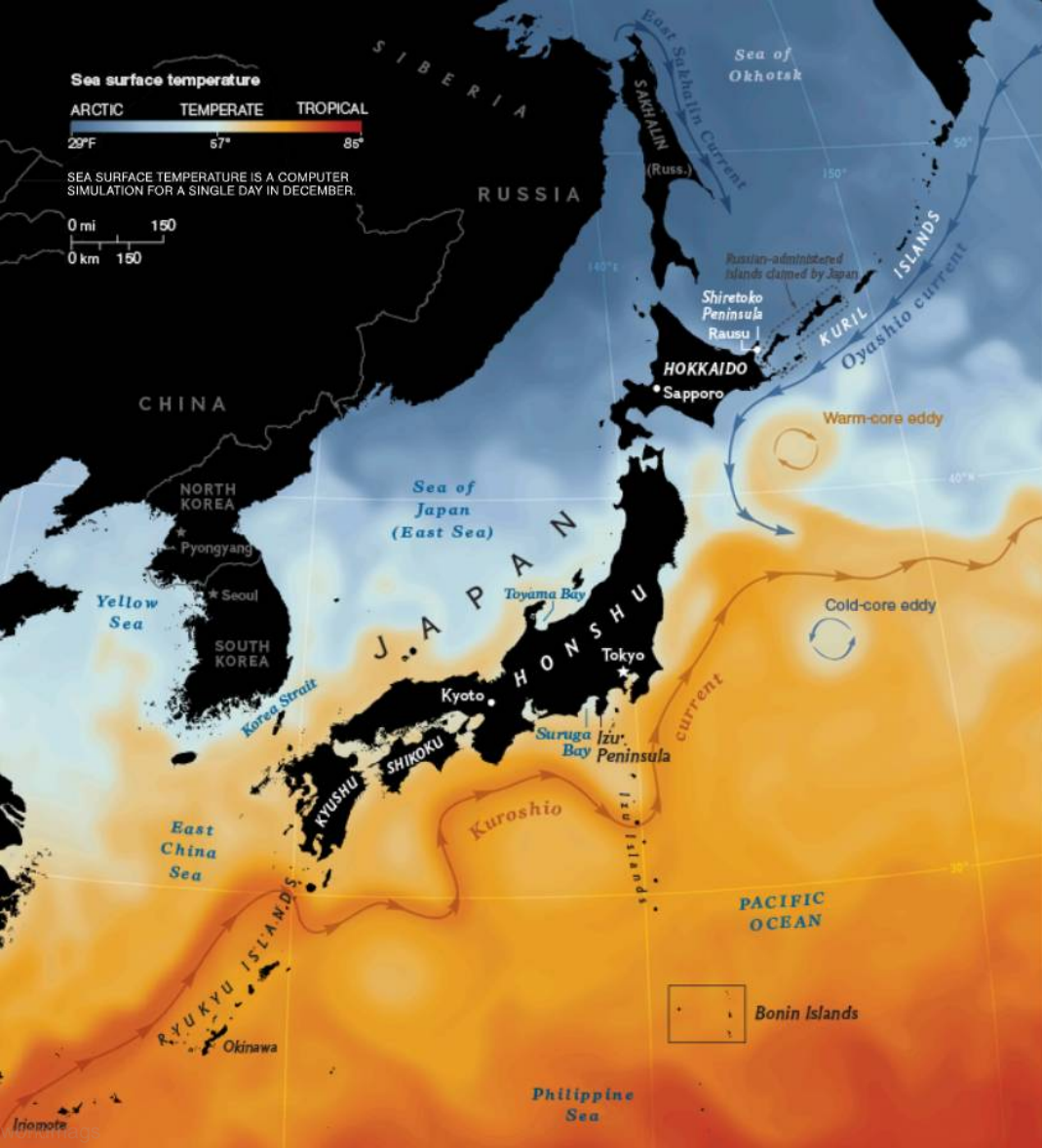


Dive with Brian Skerry to find out his secrets of underwater photography. (1:53)



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Dive with Brian Skerry to find out his secrets of underwater photography. (1:53)



Japan's Swirling Seas

Warm and cold ocean currents collide off the coast of Japan, creating a wide range of temperatures. The result is a series of strikingly different marine communities, swept in by the currents.

East Sakhalin and Oyashio currents

These currents pull cold water from northern latitudes toward Japan.

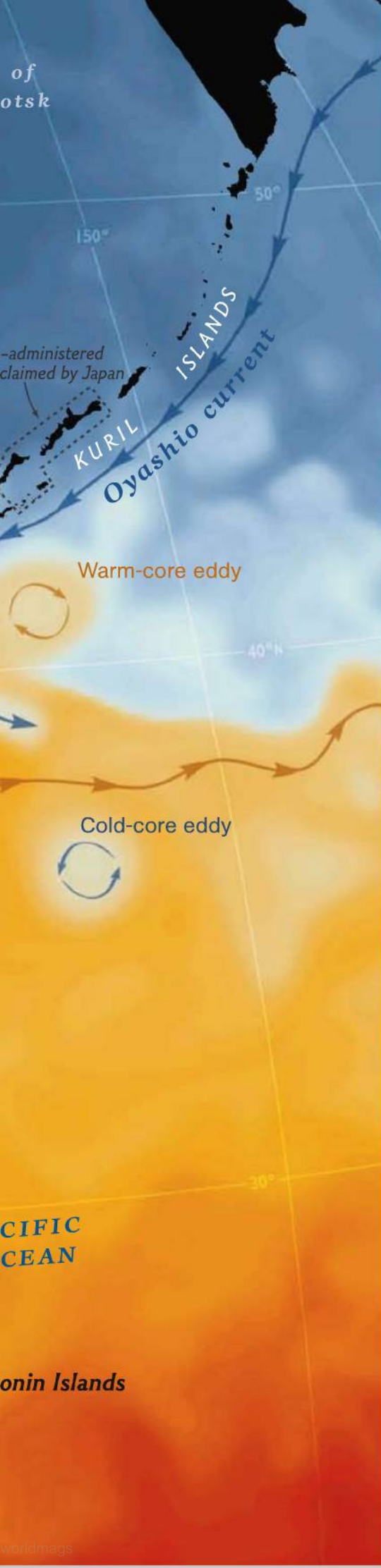
Eddies

Where currents collide, nutrients from cold water feed warm-water phyto-plankton. The result is a spinning buffet for fish.

Kuroshio current

Reaching five miles an hour or more, this deep, powerful current ferries warm waters northward along Japan's coast.

VIRGINIA W. MASON, NGM STAFF
SOURCE: GEOPHYSICAL FLUID DYNAMICS
LABORATORY, NOAA



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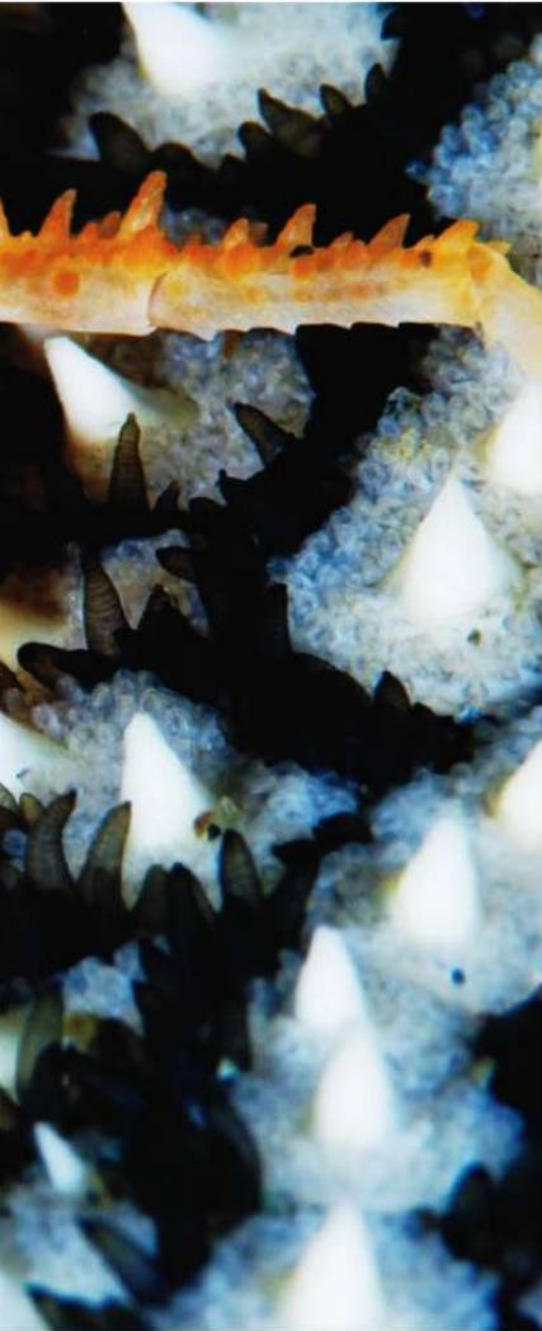
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VIRGINIA W. MASON, NGM STAFF
SOURCE: GEOPHYSICAL FLUID DYNAMICS
LABORATORY, NOAA





Spikes meet spikes as an Alaska king crab the size of a nickel crawls over a knobby sea star off the Shiretoko Peninsula. After a dozen years, the crustacean will grow to the size of a tractor tire.

NorthCentralSouth



NorthCentralSouth



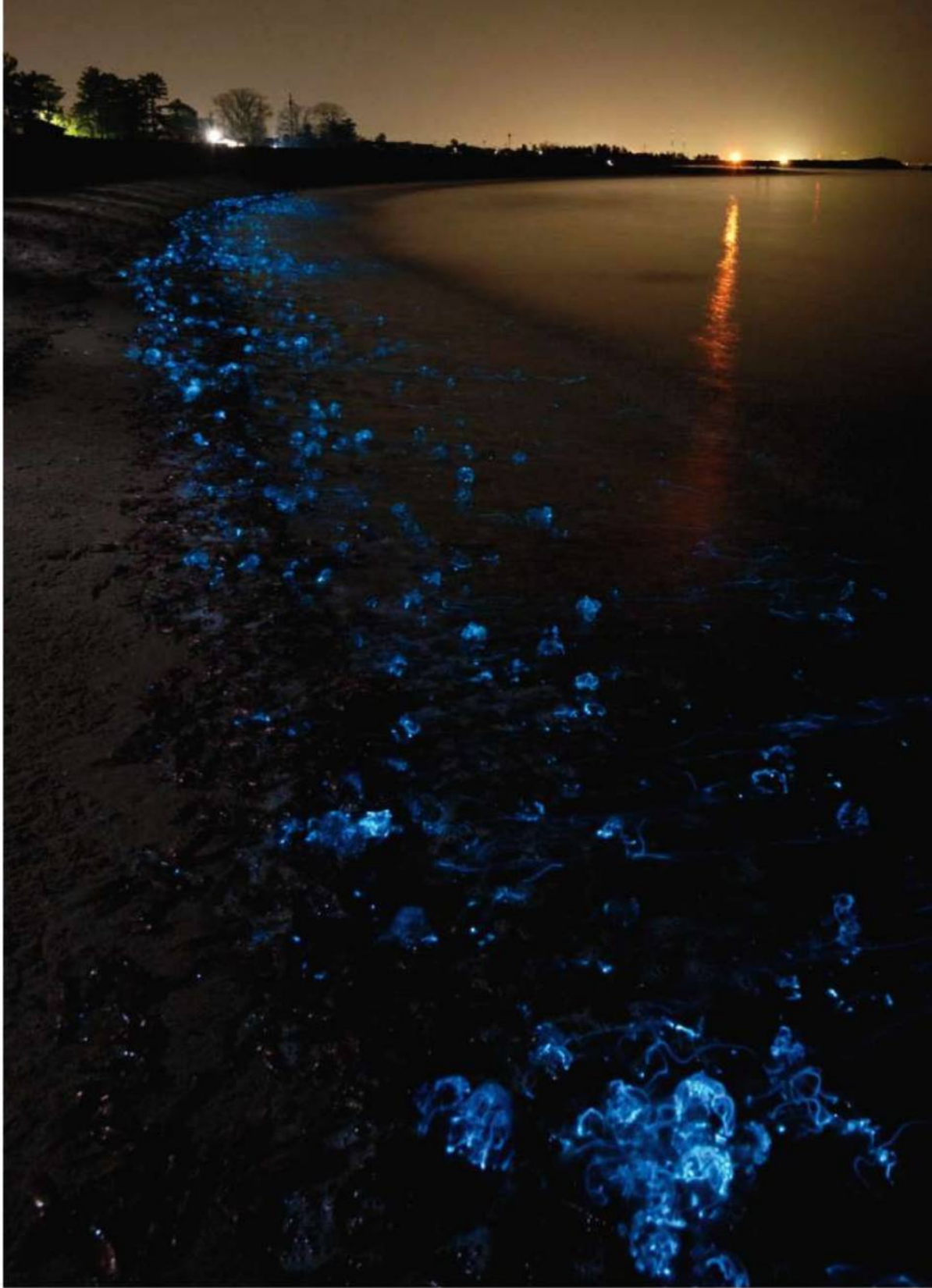
The keen eyes of a Steller's sea-eagle seek the flash of herring between ice floes off the Shiretoko Peninsula.



NorthCentralSouth



In the shallow waters off Hokkaido, a barbed poacher crawls across glistening volcanic sand on spiny pectoral fins. Only the females of this cold-water fish sport a distinctive Pinocchio-like snout.





A volcanic beach off Toyama Bay glows electric blue. The light comes from female firefly squid, which spawn in spring, then die and wash ashore, their tentacles lit like millions of aquamarine LEDs.

NorthCentralSouth



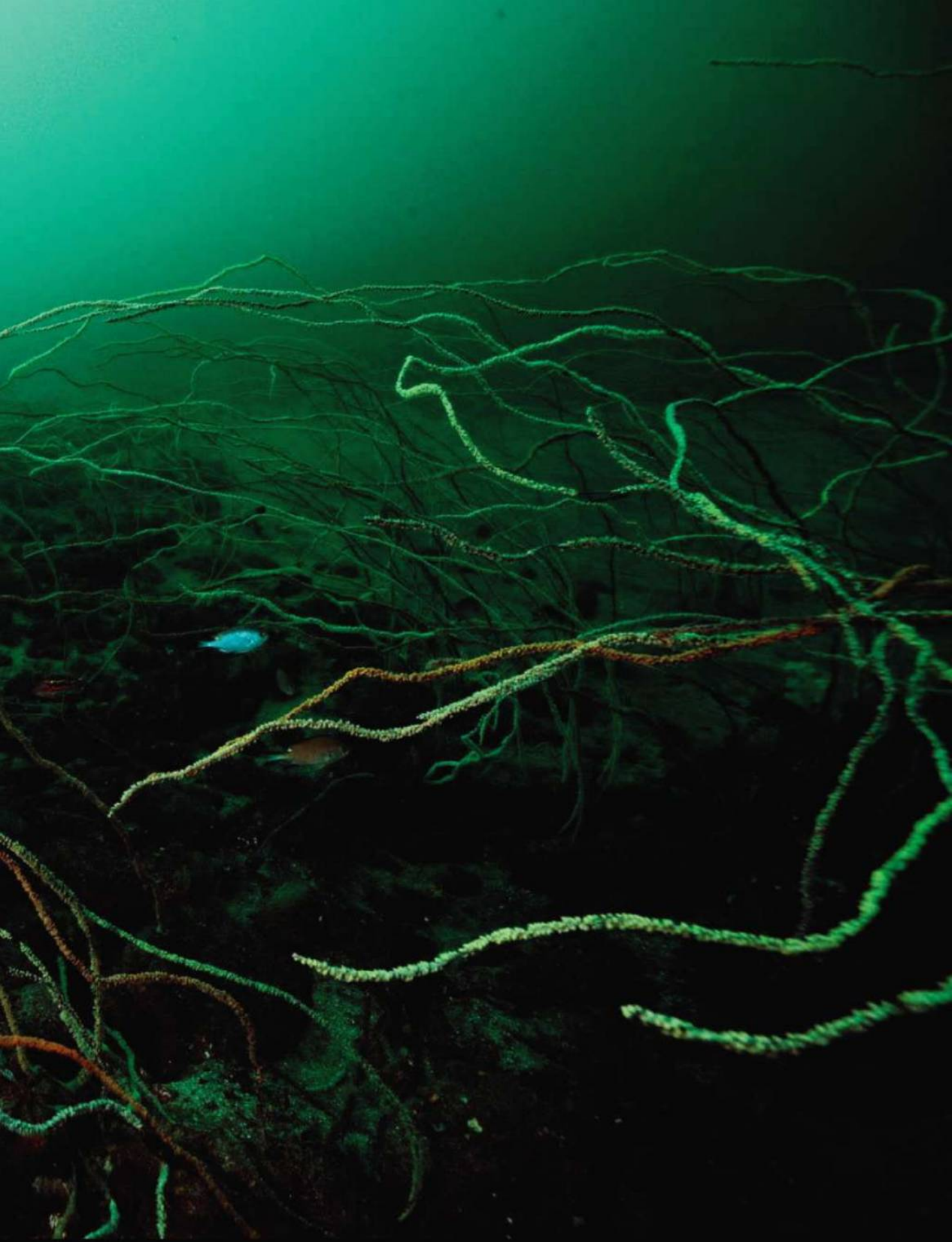
NorthCentralSouth



Off the Izu Peninsula, a yellow goby peers through the window of its corroded soda-can home, evidence of the 127 million people just above the water's surface.



NorthCentralSouth



What looks like a tangle of gnarled cables is in fact a forest of deepwater whip coral in Suruga Bay. Each strand is studded with feeding polyps that reach tiny tentacles into the currents to grab floating food.





Off the Bonin Islands, a wrasse cleans the skin of a wrought iron butterflyfish, whose black-and-white motif evokes the patterns of a samurai kimono.

NorthCentralSouth



NorthCentralSouth



Purple tunicates filter the water for food. They have no scientific name and live behind a single rock in a cave off Chichi-shima island.



NorthCentralSouth



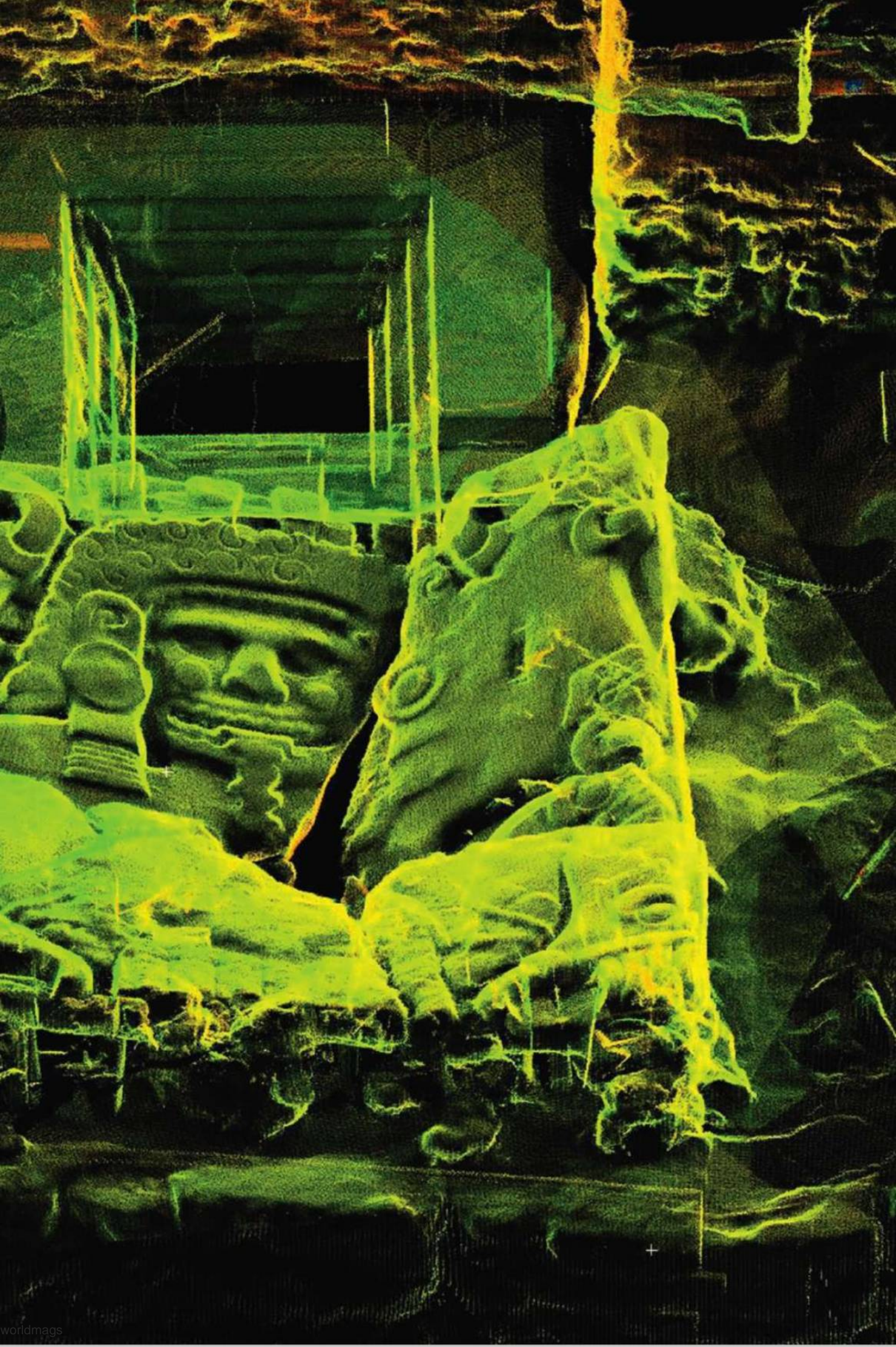
A sand tiger shark off the Bonin Islands will soon give birth. During the nine-month pregnancy, the largest two pups will have eaten their siblings for sustenance, a kind of cannibalism unique to this species.

UNBURYING THE AZTEC

THE EXCAVATION OF
A SACRED PYRAMID IS
TURNING UP CLUES TO
THE EMPIRE'S BLOODY
RITUALS—BUT SO FAR,
NO SIGN OF ITS MOST
FEARED EMPEROR.

+

GUIDO GALVANI AND MARÍA SÁNCHEZ VEGA, COURTESY TEMPLO MAYOR
PROJECT, NATIONAL INSTITUTE OF ANTHROPOLOGY AND HISTORY, MEXICO



In May a team of 30 technicians and two cranes took 15 hours to move a 12-ton stone of the earth goddess Tlaltecuhтли, broken into four pieces, about 500 feet from the excavation site to a new home in Mexico City's Templo Mayor Museum. A two-and-a-half-year restoration process has revealed traces of the andesite stone's original ocher, red, blue, white, and black pigments.

While the fractured stone was still in situ, archaeologists used laser-driven pulses of light to produce a green 3-D image of it (see previous spread). In an adjacent shaft lay six offerings of artifacts.





BY ROBERT DRAPER
PHOTOGRAPHS BY KENNETH GARRETT
AND JESÚS LÓPEZ



ON THE EDGE OF MEXICO CITY'S FAMED ZÓCALO PLAZA, next to the ruins of the Aztec sacred pyramid known as the Templo Mayor, the remains of an animal—perhaps a dog or a wolf—were discovered. It had been dead for 500 years and lay in a stone-lined shaft eight feet deep. It is likely the animal had no name, nor an owner. Yet the anonymous canine had evidently meant something to someone. It wore a collar made of jade beads and turquoise plugs in its ears. From its ankles dangled bracelets with little bells of pure gold.

The archaeological team, led by Leonardo López Lu-ján, unearthed the *(Touch Text button to read more.)*

Robert Draper is a contributing writer for National Geographic. Kenneth Garrett frequently photographs archaeology stories for the magazine. Photographer Jesús López lives in Mexico City.

JESÚS LÓPEZ (ABOVE); KENNETH GARRETT (RIGHT)



Text

Its skeleton reassembled for museum display, the animal known as the Aristo-Canine wore a seashell belt and gold bells (left) on its hind legs.



Its skeleton reassembled for museum display, the animal known as the Aristo-Canine wore a seashell belt and gold bells (left) on its hind legs.





Archaeologists, including Ángel González (left), have already recovered tens of thousands of artifacts that will help scholars decode the Aztec view of the universe. The search for a royal tomb has moved to a new tunnel within the Templo Mayor excavation site, part of the remnants of ancient Tenochtitlan in the heart of Mexico City.



PETER ESSICK

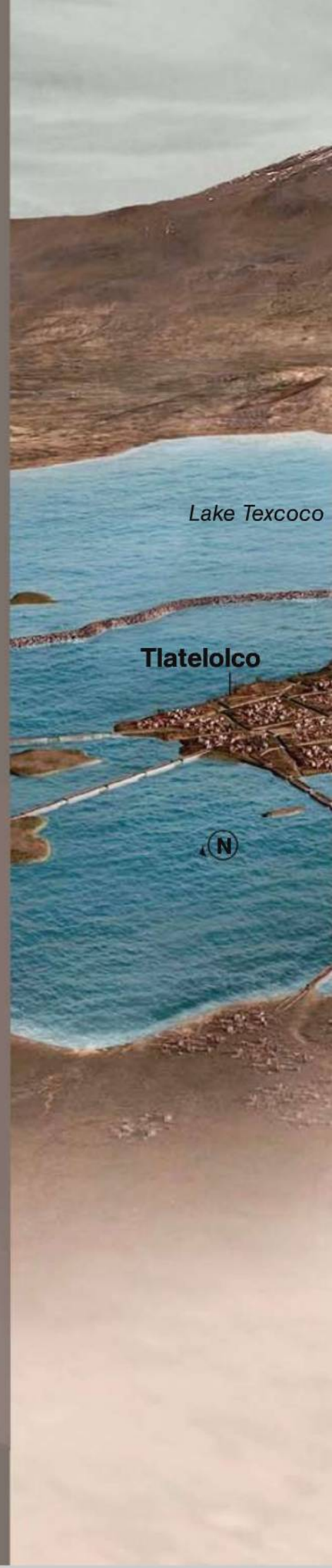
NATIONAL GEOGRAPHIC NOVEMBER 2010



Red, white, and green lights illuminate the ruins of the Templo Mayor for nighttime visitors. Digs have revealed 13 phases of construction from 1375 to 1519, including the pyramid's double staircases.

AN AZTEC ISLAND HOME

Aztec rulers built a powerful city-state on an island in Lake Texcoco in the Basin of Mexico. Called Tenochtitlan, it was divided by long avenues, crisscrossed by canals, and connected to the mainland by causeways. At its heart was the Sacred Precinct, the empire's religious center, anchored by the Templo Mayor, which was built to unite sky, earth, and worlds below.



Triple Alliance

Texcoco
Tenochtitlan
(Present-day
Mexico City)
Tlacopan

AREA
ENLARGED

NORTH
AMERICA

SOUTH
AMERICA

0 mi 100
0 km 100

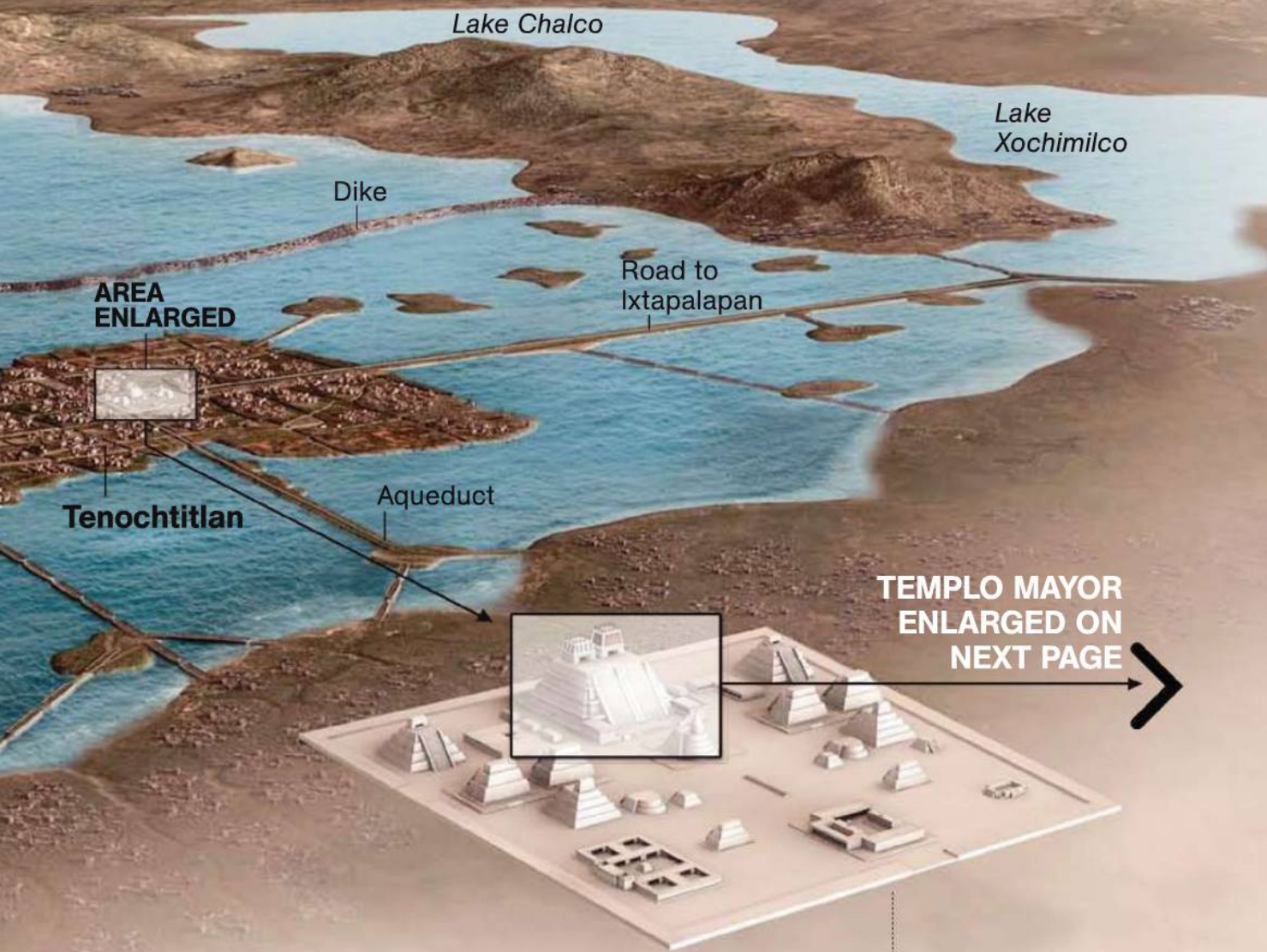
- Extent of Ahuitzotl's Aztec Empire
- Enemy state

Iztaccíhuatl

Popocatepétl

Reflection of the Cosmos

The Aztec imagined the universe as a plot of land surrounded by water, with a vertical axis linking 13 heavens and 9 levels of the underworld. Tenochtitlan's grid may have been modeled on that cosmic order.



Tenochtitlan

TEMPLO MAYOR
ENLARGED ON
NEXT PAGE

Sacred Precinct

Religious rituals and civic life in the city of 200,000 converged on a 30-acre plaza. Inside its walls, shrines and racks of enemy skulls stood in the shadow of the Templo Mayor. The plaza also contained smaller pyramids, schools for nobles, and a ball court.

TEMPLO MAYOR

A ceremonial theater, the stepped pyramid was topped by two small temples to honor rain god Tlaloc and Huitzilopochtli, god of sun and war. The pyramid towered 150 feet tall.

Scene depicted circa 1500.

Serpent Sculptures

The base of the pyramid was ornamented with sculptures of snakes, linking it to mythical Coatepec—"hill of serpents," a sacred place.



Ritual Sacrifice

Spilling human blood, priests frequently reenacted the death of goddess Coyolxauhqui at the hands of her brother, Huitzilopochtli—a mythic battle between night and day, female and male.



Shrine to Huitzilopochtli

Shrine to Tlaloc

SACRED PRECINCT

Coyolxauhqui

DETAIL ON
NEXT PAGE

Tlaltecuhтли Stone

Found at the foot of the pyramid, the monolith of the earth goddess was carved of pink andesite quarried six miles away and transported by 200 to 500 men with ropes, poles, and perhaps a balsa raft.

OFFERINGS TO THE GODS

Beneath the Tlaltecuhтли monolith and in a deep shaft beside it, archaeologists unearthed many offerings, filled with animals, plants, and objects of gold, jade, copper, turquoise, and flint, brought to the temple from all realms of the empire. The Aztec buried objects to worship the gods—a symbolic ritual archaeologists are still decoding.

Earth, Sun, Moon

The largest Aztec monolith yet discovered, the 12-ton earth goddess stone is shown with original red, ocher, blue, white, and black pigments.

Almost seven feet below the monolith itself was offering 126, the largest cache of artifacts found to date and a fitting tribute to Tlaltecuhтли's fertile, feminine nature.

**Tlaltecuhтли Stone
(Earth Goddess)**
Found 2006



13.7 x 11.9 ft

Sun Stone
1790



11.7 ft

**Disk of Coyolxauhqui
(Moon Goddess)**
1978



10.6 x 10.1 ft



Offering 121



**DETAIL OF
OFFERING 125
ON NEXT PAGE**



Offering 127

Offering 128

Offering 129

Offering 131

The offerings in the shaft seem to mark a gateway to Earth's center, rather than to a burial spot, as first thought. The search for royal tombs continues.

BURIED MEANING

The spatial arrangement of the complex contents of offering box 125 provides clues to a mystery: Were the artifacts layered to represent a soul's journey to Mictlan, the underworld?

LEVEL 1

The top layer contained gold bells, a spider monkey pelt, jade and gold ornaments, and golden eagles wearing copper.

The eagles faced west, toward the setting sun. Nocturnal power was signified by eight knives "dressed" as lunar deities.

LEVEL 2

A layer of 62 marine species from the Atlantic and Pacific included crabs, clams, snails, sea urchins, and corals.

The abundant sea life may represent dangerous waters the dead must cross, trekking through nine levels of obstacles.

LEVEL 3

In the last layer, an aged female dog or wolf wore a jade necklace, olive shell belt, and turquoise earplugs.

Perhaps the jewelry signified a royal pet assigned to guide and protect its master on the dark odyssey.



Spider monkey pelt



Golden eagles



Gold and jade ornaments

Dressed knife




Marine shells and animals



Canine

19.7 in

33.5 in

 Offering orientation

AZTEC RULERS

Tenochtitlan was founded in 1325. Over the centuries only 11 men ruled as *tlaotoni*, each with a unique name glyph.



ACAMAPICHTLI
(Handful of Arrows)
is the first tlaotoni,
hereditary ruler of
the Aztec city-state.



HUITZILIHUITL
(Hummingbird Feather)
marries into two rival
royal families, cement-
ing alliances.

1325

1337 The market town of Tlatelolco grows north of Tenochtitlan.

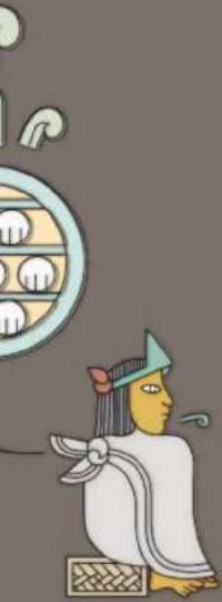
1375

1350 Causeways and canals link Tenochtitlan's neighborhoods.

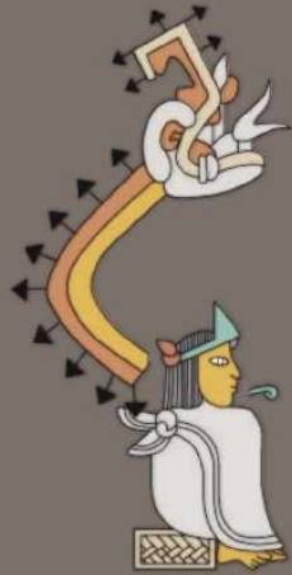
1395

1396 Huitzilihuitl makes alliances and expands the capital.

MORE >



CHIMALPOPOCA (Smoking Shield) survives ten years before he is murdered by a rival.



ITZCOATL (Obsidian Snake) joins leaders of Tlacopan and Texcoco in mobilizing a new empire.



MOCTEZUMA ILHUICAMINA (Angry Lord, He Shoots the Sky) expands the empire using elite warriors, including “eagle lords.”

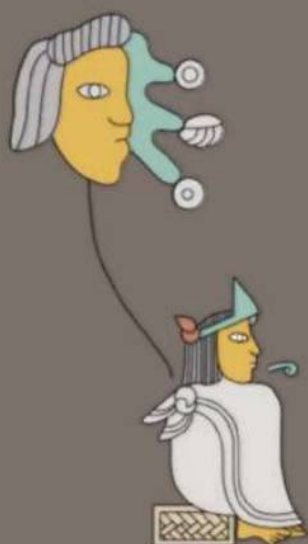
1417

1427

1440

1427-1430 An alliance led by Tenochtitlan wins control of central Mexico.

1450-54 Floods, then severe drought and famine, plague the Basin of Mexico.



AXAYACATL (Water Face) attacks the Tarascan people but loses the war and 20,000 men.

1469



TIZOC (Chalk Leg), brother to Axayacatl and Ahuitzotl, rules weakly and is assassinated.

1481



AHUITZOTL (Water Beast) conquers new lands and is called *huey tlatoani*, or great speaker.

1486

1473 Tenochtitlan subjugates Tlaxcala and rises to dominant city-state.

1487 Templo Mayor is rededicated with the blood of thousands.



MOCTEZUMA XOCOYOTZIN
(Angry Lord, the Younger)
aggressively moves to consolidate his empire, largest in Mesoamerica's history.



CUITLAHUAC
(Excrement)
rules only 80 days before succumbing to smallpox.



CUAUHTEMOC
(Descending Eagle)—
the last emperor—is captured, tortured, and hanged by Cortés.

1502

1500 Heavy rains in poorly built aqueduct flood Tenochtitlan.

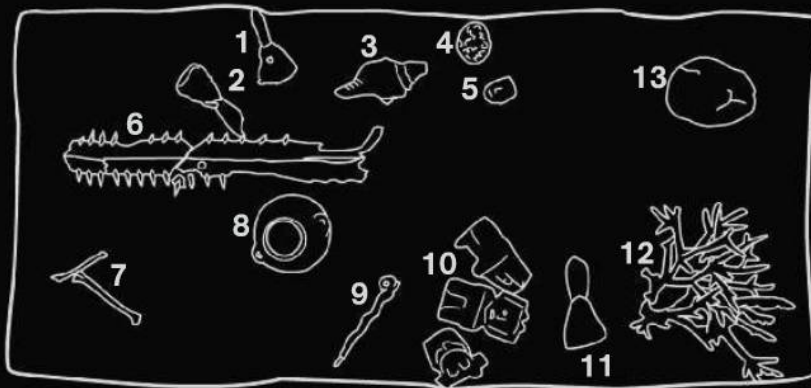
1520

1490-1506 Drought and famine plague the Basin of Mexico.

1519 Cortés enlists native city-states to destroy the empire.

1521 Smallpox begins to ravage the basin's million inhabitants.

ALEJANDRO TUMAS; SHELLEY SPERRY. ART: HERNÁN CAÑELLAS. MAP: MAGGIE SMITH
SOURCES: LEONARDO LÓPEZ LUJÁN, TEMPLO MAYOR PROJECT, INAH; FRANCES F. BERDAN, CALIFORNIA STATE UNIVERSITY, SAN BERNARDINO; JULIANA NOVIC AND MICHAEL E. SMITH, ARIZONA STATE UNIVERSITY; EMILY UMBERGER, UNIVERSITY OF ARIZONA



Directly under Tlaltecuhтли, the largest offering yet unearthed (box 126, right, and drawing above) held shells and corals (3, 4, 12, 13), tiny pine masks (5), a sawfish bill (6), 8,500 animal bones (7), a jar of grain (8), a scepter (9), fire god sculptures (10), and flint and copal knives similar to one shown above (1, 2, 11).



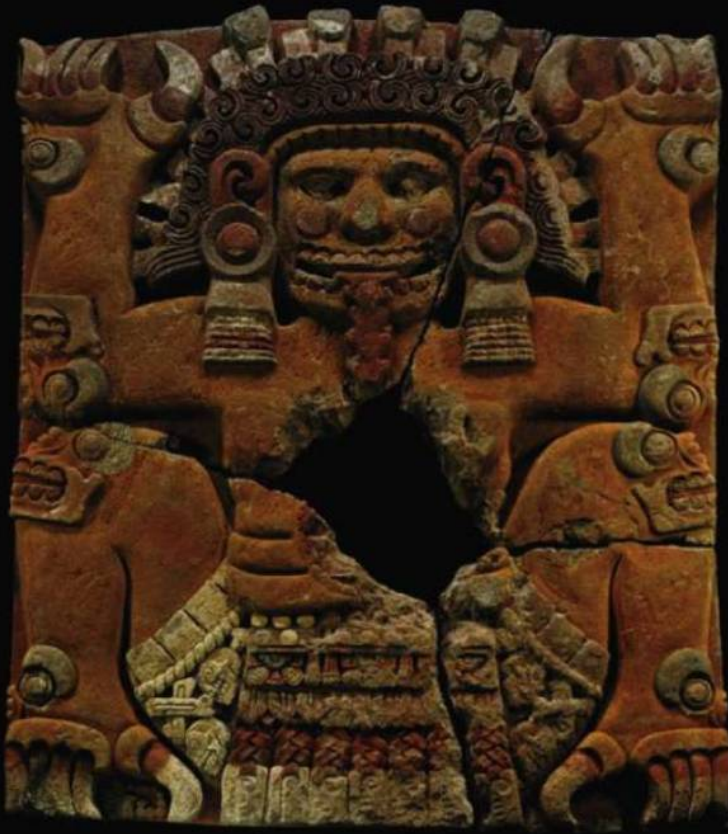






Inside the shaft beside the monolith, archaeologists found offering box 125, depicting what project leader López Luján calls a “miniature image of the universe.” Among the treasures offered to the gods were a gold ornament (above, top) and a greenstone necklace (above). Opposite is one of the tiny pine masks found in box 126.





The missing piece at the center of the monolith of the earth goddess was never found. Right: Art depicts Ahuizotl's funerary bundle, in turquoise diadem and mask, being carried to his pyre.

KENNETH GARRETT (ABOVE); JUSTIN SWEET (RIGHT)



SPECIAL ISSUE

Sacred Journeys What is it about a place that compels us to travel there for spiritual sustenance? From Mecca to Vatican City, destinations the world over draw throngs of people seeking religious fulfillment. Yet for many others a hike to Mount Fuji or a walk in the woods also offers a powerful experience—and a holiness of its own. Explore some of Earth's most fascinating and important spiritual sites in *Sacred Journeys*, featuring a map of major pilgrimages and places and an essay by *National Geographic's* senior editor Don Belt. This new National Geographic special issue is available in bookstores November 2 or at ngm.com/sacred-journeys (\$10.99).

NG BOOKS

Brilliantly illustrated with more than 250 color photographs, *Great Migrations* is the essential companion to the television series of the same name. This book will captivate animal lovers and environmentalists alike with its in-depth coverage of the never-before-seen wildlife behavior and stories showcased in the groundbreaking documentary. Other highlights include archival images and unforgettable film stills. Look for *Great Migrations* in bookstores in mid-October (\$35).

Pilgrimage Sites From Stonehenge to Galilee

FREE
MAP
WORLD
FAITHS

SPECIAL EDITION

NATIONAL GEOGRAPHIC

ESSAY:
SEARCHING FOR
MIRACLES

Earth's
Holiest
Places

SACRED JOURNEYS

OUR LADY OF FÁTIMA,
PORTUGAL

NATIONAL
GEOGRAPHIC

FLASHBACK

Modern Mermaids A Japanese ama goes overboard in search of shellfish in the 1930s. For centuries these female free divers worked the country's coasts without much clothing, but that changed: "Except for a few older women, the ama of Hekura no longer dive semi-naked," wrote Luis Marden after visiting one group of divers. His July 1971 *Geographic* story, "Ama, Sea Nymphs of Japan," goes on to say, "The girls wore black leotards. Most others wore all-enveloping suits of black neoprene, the diver's wetsuit."

There aren't many ama left in Japan. Most who remain are middle-aged or older; divers sometimes work into their 80s. Today few young women care to take the plunge. —Margaret G. Zackowitz

PHOTO: EUROPEAN PICTURE SERVICE/NATIONAL GEOGRAPHIC STOCK

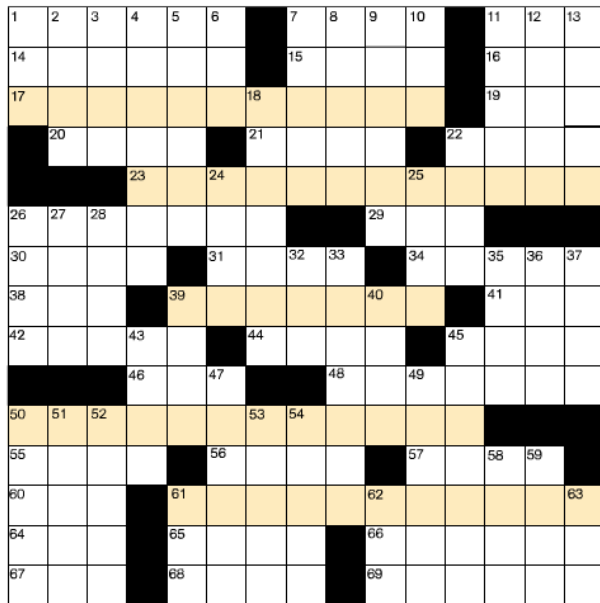
NATIONAL GEOGRAPHIC NOVEMBER 2010





GEOPUZZLE

Click here for the answers.



ACROSS

- 1 Marine animal that's no square
 7 Little lumps
 11 Mount Rushmore prez
 14 Rescuer
 15 Oaxacan "other"
 16 Roman goddess of peace
 17 Choice an arctic term might face when offered a mid-migration herring
 19 Terre Haute sch.
- 20 Make out, in Liverpool
 21 Hydrodynamic duo
 22 Inn need
 23 With 50 Across, prairie rattlers' migration scheme?
 26 Language of Manila
 29 Schmooze
 30 Prefix with lateral
 31 Smooth-talking
 34 Passerine's perch
 38 Not talking

- 39 Chinook salmon's migration to its birthplace for egg laying?
 41 Long March leader
 42 Capellini or cannelloni
 44 Brazil nut, botanically
 45 Chief
 46 Enemy in this year's Gulf "war"?
 48 Feminine
 50 See 23 Across
 55 Cape of Chile
 56 Spiritual adviser
 57 Its hips may be in tea
 60 It's behind hubris
 61 Overwhelm like monarch butterflies during their migration?
 64 Abacus calculation
 65 Suit to __
 66 Grammy winner Twain
 67 Salmon's first migration destination
 68 Place for a modesty panel
 69 Swans vis-à-vis swallows
- 11 Like some drones
 12 Rudimentary
 13 Radiate, as confidence
 18 Does some back-and-forth switching
 22 Shark type
 24 Bagged launch
 25 Infield protector
 26 One working in a sub way
 27 Blue hue
 28 Checkout-aisle assortment
 32 Suffix akin to "-ian"
 33 Where suds are made and served
 35 Mideast sultanate
 36 It gets reefed
 37 Award for *Bye Bye Birdie*
 39 Skinniness exemplar
 40 Superstar
 43 __ crier
 45 Thoroughbred grandfather of Seabiscuit
 47 Surgically tie
 49 Actress Mason in *The Goodbye Girl*
 50 Mating game
 51 Scamp
 52 Bakery lure
 53 Subject of SALT I and II
 54 Like nu
 58 Did a round
 59 Sandusky's lake
 61 Wee bit
 62 Fashion designer's monogram
 63 Deface

DOWN

- 1 Former fast flier to JFK
 2 Goals on greens
 3 Tandoor, e.g.
 4 Russian form of the saint aka Santa
 5 Ten to the hundredth power
 6 Mix metaphors, say
 7 Org. that "tracks" Santa
 8 Prenatal "nurseries"
 9 Loud and overbearing
 10 He's hardly a teetotaler

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PUZZLE BY CATHY ALLIS



A herder serenades his goats near Jerusalem.

PHOTO: GREG GIRARD

December 2010

Veiled Rebellion

Afghan women are starting to fight for a just life.

A Serenade to Swans

The whooper swan is a bird to inspire flights of fancy.

David and Solomon

Archaeologists dig up controversy as they dig into the kings.

Heart of the Milky Way

The black hole at the galaxy's center is giving up its secrets.

Alaska's Choice

In Bristol Bay, the debate is on: gold mine versus salmon runs.

Bat Crash

A fungus has killed at least a million U.S. bats.