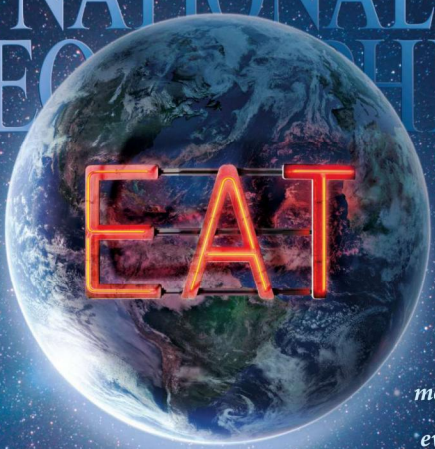
UTAH DINOSAUR HUNTERS | THE SOUL OF **PARIS**

MAY 2014

NATIONAL GEOGRAPHIC



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They say that tradition is what makes a luxury sedan, but is that truly the case? Or can luxury simply be defined by the way something looks? The way it feels? The way it makes you feel? Perhaps it's the way it makes others feel about you? While some will cling to the notion that heritage is what makes a luxury sedan, the open-minded will form an opinion of their own.

2015 K900 V8 expected Spring 2014. Initially only available in select markets with limited availability. 2015 K900 V8 prototype shown with optional features. Not all features are available on all trim levels. THE MATRIX, THE MATRIX RELOADED, THE MATRIX REVOLUTIONS: TM & © Warner Bros. Entertainment Inc. (s14)

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VOL. 225 • NO. 5

NATIONAL GEOGRAPHIC

"Move away! We're cutting this section. Do you want to die?"
page 88

May 2014

A surprising variety of dinosaurs lived on the landmass Laramidia, including this clawed carnivore from the dromaeosaurid family.
CORY RICHARDS

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

FOOD

THE FUTURE OF FOOD

Our new series will offer daily updates at *natgeofood.com*.

Food Hub
Tasty features, food news, a blogging chef, and more.

Food Fact of the Day
Find out how many peanuts are in a 12-ounce jar of peanut butter and much more.

On the Cover
Illustration by Nick Kaloterakis

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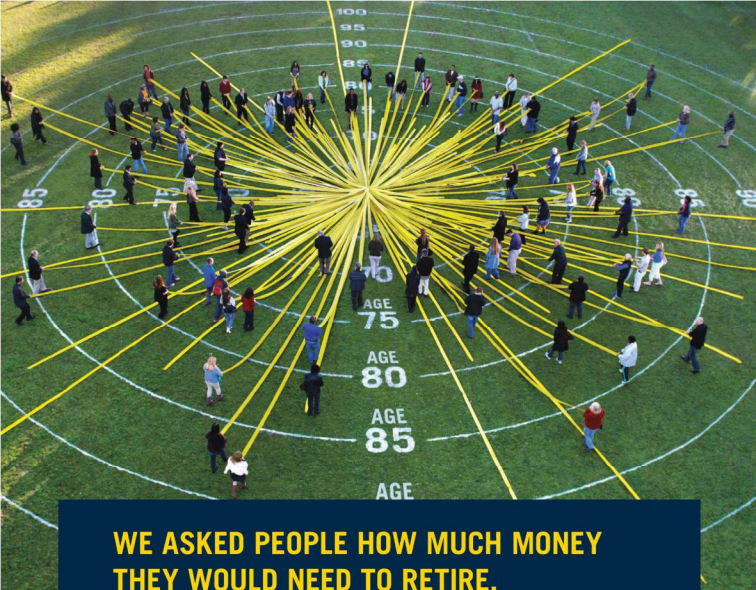

WE ASKED PEOPLE HOW MUCH MONEY THEY WOULD NEED TO RETIRE.

THEN SHOWED HOW LONG IT MIGHT LAST.

Recently we conducted an intriguing experiment. We asked 200 people to think about how much money they'll need in retirement, then had them stretch out a length of ribbon representing that amount to see how long it might last. What we learned is that most of us significantly underestimate how much we'll need. The fact is, with people living longer, retirement could last up to 30 years or more. How can you make sure the money is there for you, year after year? Talk to your financial professional about our guaranteed retirement income solutions that can help provide annual income for each year of retirement from Day One.

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Tom Giessel harvests wheat on his farm near Larned, Kansas.

Food for Thought

Food, like water and air, is life. Starting this month and continuing through the end of the year, we will focus on food and the challenge of feeding the global population of nine billion projected by 2050.

We would do well to pay attention to how our food is produced and whether that is done in a sustainable, efficient, and safe manner. Nearly 40 percent of the world's ice-free land is given over to agriculture. Farming has an impact on our water supply, which can be polluted by pesticides and fertilizer runoff. It affects climate, releasing, by some measures, more greenhouse gases than all the cars, trucks, and planes in the world. Dams rearrange and disrupt rivers to provide water for crops. Landscapes are stripped of trees to create cultivable land.

To tell the story, we'll go to savannas in Africa, meat-processing plants in Brazil, and fields in the American Midwest. To show how food sustains us spiritually, we'll sit down at dinner tables in Mexico, the Philippines, Belarus, and Pakistan. We'll look at the farming frontier of the ocean along with the pluses and minuses of aquaculture.

As with all resources necessary for life—water, air, energy—need must be balanced with sustainability. In meeting our obligation to humanity, we must not neglect our responsibility to the Earth.

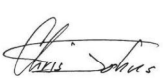


PHOTO: JIM RICHARDSON

Izu Thrush *(Turdus celaenops)*
Size: Body length, approx. 23 cm (9.1 inches) **Weight:** 70 - 80 g (2.5 - 2.8 oz)
Habitat: Mature deciduous woodlands with little underbrush, as well as secondary deciduous forest **Surviving number:** Estimated at 3,000 - 15,000

Photographed by Hirozo Maki

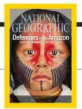
WILDLIFE AS CANON SEES IT

Danger to the left, danger to the right. As it goes about its daily business of searching for fruit, seeds and invertebrates, the Izu thrush is surrounded by threats. Crows swoop in to prey on vulnerable nesting young. Even weasels, introduced to control booming rat populations, have ended up depredating nests. To top it all off, a volcanic eruption on the island of Miyake-jima in 2000 is still affecting the ecosystem. The Izu thrush has been declared a Japanese Natural Monument, but will that be enough to protect it from a multitude of dangers?

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.

EOS System

Canon



Kayapo Courage

As I consider climate change, species disappearing, violence among humans, the population explosion—the whole global crisis—one thing strikes me. Who will adapt? Who will survive? Who will thrive? Certainly, indigenous people such as the Kayapo have the best chance. I was very struck with your phrase, the Kayapo's "conception of the continuum between humans and the natural world [is] intact."

ANNETTE CLARK
Reeseville, Wisconsin

How I loved seeing the observation "they know who they are" mirrored in the eyes of the Kayapo elders. It was an arresting feeling to look into those eyes through the almost human-size photographic portraits.

LORENE LAMBERT
Cross Plains, Tennessee

I am disappointed that your article on the Kayapo did not represent both genders of activists in this tribe. Why not showcase youth movement Mebengôkre founder—and female—Mayalu Txucarramãe? The photos in this article were mostly of men. It is time to be more inclusive and present a female view of life, culture, activism, and the world in general.

LIZ O'SULLIVAN
Bishop, California

I wouldn't want to wear boxer shorts made out of black feathers and sticks, but let us leave them to manipulate their culture their own way without us babysitting and tinkering with their traditions. It is not a matter of brute force and war. We should learn not to meddle with cultures that are not ours.

EDWARD PARK
Cypress, California

I understand that they prefer to be called Mebengôkre, not Kayapo, which means "monkey-like." It is the term by which their enemies refer to them.

GEORGE WAGG
Cambridge, England

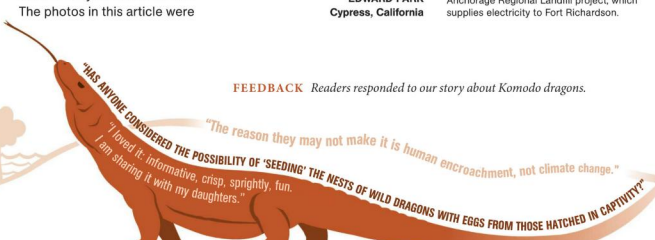
Kayapo translates to "those who look like monkeys," which likely derives from a ritual during which Kayapo men wear monkey masks. This is the name by which the tribe is most commonly known, though the tribespeople refer to themselves as Mebengôkre, "the men from the water place."

Chip Brown's article was filled with ironies, none more poignant than the fact that he carried tobacco and beads as gifts to his hosts. Where have we heard that story before?

DAVID KAMM
Decorah, Iowa

Corrections

JANUARY 2014, NEXT: THE AFTERLIFE OF A LANDFILL We neglected to include Alaska's Anchorage Regional Landfill project, which supplies electricity to Fort Richardson.



FEEDBACK *Readers responded to our story about Komodo dragons.*

EMAIL comments to ngsforum@ngm.com; for subscription help, ngsline@customersvc.com. **TWITTER** @NatGeoMag
WRITE National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199. Letters may be edited for clarity and length.

ART: JUAN VELASCO, NGM STAFF

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Who should use Humalog?

Humalog is used to treat people with diabetes for the control of high blood sugar.

IMPORTANT SAFETY INFORMATION FOR HUMALOG

What is the most important information I should know about Humalog?

- Do not change the insulin you use without talking to your healthcare provider. Doses of oral antidiabetic medicines may also need to change if your insulin is changed.
- Test your blood sugar levels as your healthcare provider instructs.
- When used in a pump, do not mix Humalog with any other insulin or liquid.

Who should not take Humalog?

- Do not take Humalog if your blood sugar is too low (hypoglycemia) or if you are allergic to insulin lispro or any of the ingredients in Humalog.

Before using Humalog, what should I tell my healthcare providers?

Tell your healthcare providers:

- About all of your medical conditions, including liver, kidney, or heart problems.
- If you are pregnant or breastfeeding.
- About all the medicines you take, including prescription (especially ones commonly called TZDs [thiazolidinediones]) and non-prescription medicines, vitamins, and herbal supplements.

How should I use Humalog?

- Humalog is a rapid-acting insulin. Take Humalog within fifteen minutes before eating or right after eating a meal.
- Always make sure you receive the correct type of Humalog from the pharmacy.
- Do not use Humalog if it is cloudy, colored, or has solid particles or clumps in it.
- Do not mix Humalog with insulin other than NPH when using a syringe. Do not mix or dilute Humalog when used in a pump.
- Inject Humalog under your skin (subcutaneously). Never inject into a vein or muscle. Change (rotate) your injection site with each dose. Make sure you inject the correct insulin and dose.
- Depending on the type of diabetes you have, you may need to take Humalog with a longer-acting insulin or with oral antidiabetic medicines.
- If you forget to take your dose of Humalog, your blood sugar may go too high (hyperglycemia), which can lead to serious problems like loss of consciousness (passing out), coma, or even death.
- Your insulin dose may need to change because of illness, stress, other medicines you take, change in diet, or change in physical activity or exercise.

What are the possible side effects of Humalog?

- Low blood sugar is the most common side effect. There are many causes of low blood sugar, including taking too much Humalog. It is important to treat it quickly. You can treat mild to moderate low blood sugar by drinking or eating a quick source of sugar right away. If severe, low blood sugar can cause unconsciousness (passing out), seizures, and death. Symptoms may be different for each person. Be sure to talk to your healthcare provider about low blood sugar symptoms and treatment.
- Severe life-threatening allergic reactions (whole-body reactions) can happen. Get medical help right away if you develop a rash over your whole body, have trouble breathing, have a fast heartbeat, or are sweating.
- Reactions at the injection site (local allergic reaction) such as redness, swelling, and itching can happen. If you keep having skin reactions or they are serious, talk to your healthcare provider. Do not inject insulin into a skin area that is red, swollen, or itchy.
- Skin may thicken or pit at the injection site (lipodystrophy). Do not inject insulin into skin with these types of changes.
- Other side effects include low potassium in your blood (hypokalemia) and weight gain.
- Serious side effects can include:
  - swelling of your hands and feet
  - heart failure when taking certain pills called thiazolidinediones or "TZDs" with Humalog. This may occur in some people even if they have not had heart problems before. Tell your healthcare provider if you have shortness of breath, swelling of your ankles or feet, or sudden weight gain, which may be symptoms of heart failure. Your healthcare provider may need to adjust or stop your treatment with TZDs or Humalog.
- These are not all of the possible side effects. Ask your healthcare providers for more information or for medical advice about side effects.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

How should I store Humalog?

- Unopened Humalog should be stored in a refrigerator and can be used until the expiration date on the carton or label.
- Humalog should be stored away from light and heat. Do not use insulin if it has been frozen.
- Opened vials should be kept at room temperature or in a refrigerator. Opened cartridges or prefilled pens should be kept at room temperature.
- Once opened, Humalog vials, prefilled pens, and cartridges should be thrown away after 28 days.

Humalog is available by prescription only.

For additional information, talk to your healthcare providers and please see Brief Summary on the following page. Please see Instructions for Use that accompany your pen.

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Partnership for Prescription Assistance

If you need assistance with prescription costs, help may be available. Visit www.pparx.org or call 1-888-4PPA-NOW.

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100 units/mL

HI851956 12/2013

Lilly

Information for Patients about Humalog®
(insulin lispro injection, USP [rDNA origin])

Read the "Patient Information" that comes with Humalog (HU-ma-log) before you start using it and each time you get a refill. There may be new information. This leaflet does not take the place of talking with your healthcare provider about your diabetes or treatment. If you have questions about Humalog or diabetes, talk with your healthcare provider.

What is Humalog?

Humalog is an injectable, rapid-acting, man-made insulin. It is used to treat people with diabetes for the control of high blood sugar. You should take Humalog within fifteen minutes before eating or right after eating a meal.

What is the most important information I should know about Humalog?

- Do not change the insulin you use without talking to your healthcare provider. Doses of oral diabetes medicines may also need to change if your insulin is changed.
- You must test your blood sugar levels as your healthcare provider instructs.
- If you forget to take your dose of Humalog, your blood sugar may go too high (hyperglycemia). If high blood sugar is not treated it can lead to serious problems like loss of consciousness (passing out), coma, or even death.
- Always make sure you receive the correct type of Humalog from the pharmacy. Do not use Humalog if it is cloudy, colored, or has solid particles or clumps in it.
- Do not mix Humalog with insulin other than NPH when using a syringe.
- Inject Humalog under your skin (subcutaneously). Never inject into a vein or muscle. Change (rotate) your injection site with each dose. Make sure you inject the correct insulin and dose.
- When used in a pump, do not mix Humalog with any other insulin or liquid. The infusion set should be changed at least every 3 days. The Humalog in the pump reservoir should be changed at least every 7 days even if you have not used all of the Humalog.
- Taking other medicines known as TZDs (thiazolidinediones) with Humalog may cause heart failure. Tell your healthcare provider if you have any new or worse symptoms of heart failure, such as shortness of breath, swelling of your ankles or feet, or sudden weight gain.

Who should NOT take Humalog?

Do not take Humalog:

- if your blood sugar is too low (hypoglycemia).
- before checking with your healthcare provider regarding any allergies you may have to its ingredients.

What are the possible side effects of Humalog?

- Low blood sugar (hypoglycemia). There are many causes of low blood sugar, including taking too much Humalog. It is important to treat it quickly. You can treat mild to moderate low blood sugar by drinking or eating a quick source of sugar right away. Low blood sugar may affect your ability to drive or operate machinery. Severe low blood sugar can cause unconsciousness (passing out), seizures, and death. Symptoms may be different for each person. Be sure to talk to your healthcare provider about low blood sugar symptoms and treatment.
- Severe life-threatening allergic reactions. Get medical help right away if you develop a rash over your whole body, have trouble breathing, have a fast heartbeat, or are sweating.
- Reactions at the injection site such as redness, swelling, and itching. If you keep having skin reactions or they are serious, talk to your healthcare provider. Do not inject insulin into a skin area that is red, swollen, or itchy.
- Skin may thicken or pit at the injection site (lipodystrophy). Do not inject insulin into this type of skin.
- Other side effects include swelling of your hands and feet, low potassium in your blood (hypokalemia), and weight gain.
- Taking other medicines known as TZDs (thiazolidinediones) with Humalog may cause heart failure in some people.
- These are not all of the possible side effects. Ask your healthcare providers for more information.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

What should I tell my doctor before using Humalog?

- About all of your medical conditions, including liver, kidney, or heart problems.
- About all the medicines you take, including prescription (especially ones commonly called TZDs [thiazolidinediones]) and non-prescription medicines, vitamins, and herbal supplements.
- If you are pregnant or breastfeeding.

How should I store HUMALOG?

- Unopened Humalog should be stored in a refrigerator and can be used until the expiration date.
- Humalog should be stored away from heat and light. Do not use insulin if it has been frozen.
- Opened vials should be kept at room temperature or in a refrigerator. Opened cartridges or prefilled pens should be kept at room temperature.
- Once opened, Humalog vials, prefilled pens, and cartridges should be thrown away after 28 days.

Available by prescription only.

Lilly

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Additional information can be found at www.Humalog.com

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Humalog® (insulin lispro injection, USP [rDNA origin])

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Putin's Party

The most stunning of author Brett Forrest's reasons against Sochi's selection is the alleged genocide of Circassians about 150 years ago. If this logic is to be applied consistently, then the U.S. should have never been granted rights to hold any Olympics, since its genocide against Native Americans was far more significant in scale.

INNA KOUZMINA
Corning, New York

Not sure if you can label the Kuban Cossacks vagabond warriors. The Cossacks traditionally settled themselves along rivers and established towns and settlements. The Kuban Cossacks originally emigrated from Ukraine, moving east and away from 18th-century Russian rule. The tsar's government eventually co-opted the various independent-minded Cossacks, using them to stake out imperial territory along the frontiers.

JAMES BRANNICK
Elmira, New York

Once Upon a Dragon

While working at Zoo Atlanta, I was informed that the Komodo dragon has no venom but instead a large assortment of bacteria in its mouth that can be deadly. These bacteria, along with backward-facing serrated teeth, make the mouth of the Komodo dragon dangerous.

TAYLOR CUNEFARE
Atlanta, Georgia

According to venom expert Bryan Fry, it is a misconception that Komodo dragons have dangerous bacteria in their mouths. Research shows that they store venom in multichambered ducts between their teeth. Rather than injecting venom directly via a forceful bite, they use a bite-and-pull motion to ooze the toxin into wounds during an attack.

LETTERS

Far From Home

When I was in Djibouti in 2010, I asked a colleague about the men that I saw walking across the sands of the lake bed of the Grand Bara. They carried few possessions. My colleague replied that they were likely Ethiopians traveling to Yemen to find work. Two years later, this time in Ethiopia, I was surprised to find the airport full of attractive young women. I asked an attendant what was going on, and she said that they were contracted to work in the countries of the Arabian Peninsula. I responded that I hoped that they'd be all right. The lady lowered her head and quietly said, "I don't think so."

GILLES STOCKTON
Grass Range, Montana

Ease of travel and communication fuels demand for cheap foreign workers. Western countries satisfy the demand by extending visas, neglecting immigration laws, and campaigning for a path to citizenship for immigrants. Oil-rich Gulf states don't fret over citizenship: Foreign workers get second- and third-tier temporary status. Which model for supplying cheap labor will be sustainable?

TOM SHUFORD
Lenoir, North Carolina

NEXT: Sand Story

What if archaeologists of the future uncovered the *Star Wars* set for Tatooine? Their form of carbon dating would tell them the find is only a thousand years old, but the site would depict something different. How would they decipher the data?

MARK MOLYNEUX
Lakewood, Colorado

Inspiring people to care about the planet

NATIONAL GEOGRAPHIC

The National Geographic Society is chartered in Washington, D.C., as a nonprofit scientific and educational organization "for the increase and diffusion of geographic knowledge."

VISIONS

United States
A hundred miles off the southern California coast, near the Cortes Bank, a curious harbor seal peers through a kelp forest. The kelp is a rich habitat for many marine species. The swaying stalks offer seals a fish buffet—and safety from predators.

PHOTO: KYLE MCBURNIE

Vietnam
On the Huong River in Hue, young women in traditional garb float paper-flower candles—lights for lost souls pardoned every July 15. The Buddhist holiday began in medieval China. Today it's celebrated throughout Asia.

PHOTO: PHAM TY

Brazil
Dozens of bioluminescent mushrooms sprout on a dead log, green stems glowing in the light of a full moon. This species—*Mycena lucentipes*—grows on the wood of flowering trees in the rain forests of Brazil and Puerto Rico. Its edibility is unknown.

PHOTO: TAYLOR F. LOCKWOOD

Assignment: Foodscapes

For this month's Your Shot, we asked for your best photos of food. Entries showed how edibles are a tool for expression around the world. Here are the favorites, chosen by our editors. Find future assignments at *yourshot.nationalgeographic.com/assignments-stories*.

Janguo Zha Hangzhou, China

Zha traveled with friends to the Chinese city of Lishui for a fall festival. One afternoon they came across a woman carrying pumpkins to a nearby market. "Small villages always bring us pleasant surprises of beautiful color and strong local flavor," says Zha, an engineer.

For people with a higher risk of stroke due to Atrial Fibrillation (AFib) not caused by a heart valve problem

I focused on finding something better than warfarin.

NOW I TAKE ELIQUIS® (apixaban) FOR 3 GOOD REASONS:

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2. ELIQUIS had less major bleeding than warfarin.
3. Unlike warfarin, there's no routine blood testing.

ELIQUIS and other blood thinners increase the risk of bleeding which can be serious, and rarely may lead to death.

Ask your doctor if ELIQUIS is right for you.

ELIQUIS is a prescription medicine used to reduce the risk of stroke and blood clots in people who have atrial fibrillation, a type of irregular heartbeat, not caused by a heart valve problem.

IMPORTANT SAFETY INFORMATION:

- **Do not stop taking ELIQUIS without talking to the doctor who prescribed it for you. Stopping ELIQUIS increases your risk of having a stroke.** ELIQUIS may need to be stopped, prior to surgery or a medical or dental procedure. Your doctor will tell you when you should stop taking ELIQUIS and when you may start taking it again. If you have to stop taking ELIQUIS, your doctor may prescribe another medicine to help prevent a blood clot from forming.
- **ELIQUIS can cause bleeding which can be serious,** and rarely may lead to death.
- **You may have a higher risk of bleeding if you take ELIQUIS and** take other medicines that increase your risk of bleeding, such as aspirin, NSAIDs, warfarin (COUMADIN®), heparin, SSRIs or SNRIs, and other blood thinners. **Tell your doctor about all medicines, vitamins and supplements you take.** While taking ELIQUIS, you may bruise more easily and it may take longer than usual for any bleeding to stop.
- Get medical help right away if you have any of these signs or symptoms of bleeding:
  - unexpected bleeding, or bleeding that lasts a long time, such as unusual bleeding from the gums; nosebleeds that happen often, or menstrual or vaginal bleeding that is heavier than normal
  - bleeding that is severe or you cannot control
  - red, pink, or brown urine; red or black stools (looks like tar)
  - coughing up or vomiting blood or vomit that looks like coffee grounds
  - unexpected pain, swelling, or joint pain; headaches, feeling dizzy or weak
- **ELIQUIS is not for patients with artificial heart valves.**
- **Before you take ELIQUIS,** tell your doctor if you have: kidney or liver problems, any other medical condition, or ever had bleeding problems. Tell your doctor if you are pregnant or breastfeeding, or plan to become pregnant or breastfeed.
- **Do not take ELIQUIS if you** currently have certain types of abnormal bleeding or have had a serious allergic reaction to ELIQUIS. A reaction to ELIQUIS can cause hives, rash, itching, and possibly trouble breathing. Get medical help right away if you have sudden chest pain or chest tightness, have sudden swelling of your face or tongue, have trouble breathing, wheezing, or feeling dizzy or faint.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

Please see additional Important Product Information on the adjacent page.

Individual results may vary.

Visit ELIQUIS.COM or call 1-855-ELIQUIS

Eliquis®
(apixaban) tablets 5mg

IMPORTANT FACTS

Eliquis® (apixaban) tablets | Rx ONLY

The information below does not take the place of talking with your healthcare professional. Only your healthcare professional knows the specifics of your condition and how ELIQUIS® may fit into your overall therapy. Talk to your healthcare professional if you have any questions about ELIQUIS (pronounced ELL eh kwiss).

What is the most important information I should know about ELIQUIS (apixaban)?

Do not stop taking ELIQUIS without talking to the doctor who prescribed it for you. Stopping ELIQUIS increases your risk of having a stroke. ELIQUIS may need to be stopped, prior to surgery or a medical or dental procedure. Your doctor will tell you when you should stop taking ELIQUIS and when you may start taking it again. If you have to stop taking ELIQUIS, your doctor may prescribe another medicine to help prevent a blood clot from forming.

ELIQUIS can cause bleeding which can be serious, and rarely may lead to death. This is because ELIQUIS is a blood thinner medicine that reduces blood clotting.

You may have a higher risk of bleeding if you take ELIQUIS and take other medicines that increase your risk of bleeding, such as aspirin, nonsteroidal anti-inflammatory drugs (called NSAIDs), warfarin (COUMADIN®), heparin, selective serotonin reuptake inhibitors (SSRIs) or serotonin norepinephrine reuptake inhibitors (SNRIs), and other medicines to help prevent or treat blood clots.

Tell your doctor if you take any of these medicines. Ask your doctor or pharmacist if you are not sure if your medicine is one listed above.

While taking ELIQUIS:

- you may bruise more easily
- it may take longer than usual for any bleeding to stop

Call your doctor or get medical help right away if you have any of these signs or symptoms of bleeding when taking ELIQUIS:

- unexpected bleeding, or bleeding that lasts a long time, such as:
  - unusual bleeding from the gums
  - nosebleeds that happen often
  - menstrual bleeding or vaginal bleeding that is heavier than normal
- bleeding that is severe or you cannot control
- red, pink, or brown urine
- red or black stools (looks like tar)
- cough up blood or blood clots
- vomit blood or your vomit looks like coffee grounds
- unexpected pain, swelling, or joint pain
- headaches, feeling dizzy or weak

ELIQUIS (apixaban) is not for patients with artificial heart valves.

What is ELIQUIS?

ELIQUIS is a prescription medicine used to reduce the risk of stroke and blood clots in people who have atrial fibrillation.

It is not known if ELIQUIS is safe and effective in children.

Who should not take ELIQUIS?

Do not take ELIQUIS if you:

- currently have certain types of abnormal bleeding
- have had a serious allergic reaction to ELIQUIS. Ask your doctor if you are not sure

What should I tell my doctor before taking ELIQUIS?

Before you take ELIQUIS, tell your doctor if you:

- have kidney or liver problems
- have any other medical condition
- have ever had bleeding problems
- are pregnant or plan to become pregnant. It is not known if ELIQUIS will harm your unborn baby
- are breastfeeding or plan to breastfeed. It is not known if ELIQUIS passes into your breast milk. You and your doctor should decide if you will take ELIQUIS or breastfeed. You should not do both

Tell all of your doctors and dentists that you are taking ELIQUIS. They should talk to the doctor who prescribed ELIQUIS for you, before you have **any** surgery, medical or dental procedure.

Tell your doctor about all the medicines you take, including prescription and over-the-counter medicines, vitamins, and herbal supplements. Some of your other medicines may affect the way ELIQUIS works. Certain medicines may increase your risk of bleeding or stroke when taken with ELIQUIS.

How should I take ELIQUIS (apixaban)?

Take ELIQUIS exactly as prescribed by your doctor. Take ELIQUIS twice every day with or without food, and do not change your dose or stop taking it unless your doctor tells you to. If you miss a dose of ELIQUIS, take it as soon as you remember, and do not take more than one dose at the same time. **Do not run out of ELIQUIS. Refill your prescription before you run out. Stopping ELIQUIS may increase your risk of having a stroke.**

What are the possible side effects of ELIQUIS?

- See **"What is the most important information I should know about ELIQUIS?"**
- ELIQUIS can cause a skin rash or severe allergic reaction. Call your doctor or get medical help right away if you have any of the following symptoms:
  - chest pain or tightness
  - swelling of your face or tongue
  - trouble breathing or wheezing
  - feeling dizzy or faint

Tell your doctor if you have any side effect that bothers you or that does not go away.

These are not all of the possible side effects of ELIQUIS. For more information, ask your doctor or pharmacist.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

This is a brief summary of the most important information about ELIQUIS. For more information, talk with your doctor or pharmacist, call 1-855-ELIQUIS (1-855-354-7847), or go to www.ELIQUIS.com.

Manufactured by:
Bristol-Myers Squibb Company
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Marketed by:
Bristol-Myers Squibb Company
Princeton, New Jersey 08543 USA
and
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New York, New York 10017 USA

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This independent, non-profit organization provides assistance to qualifying patients with financial hardship who generally have no prescription insurance. Contact 1-800-736-0003 or visit www.bmspaf.org for more information.

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December 2012
432US13CB503604

Rare African Emerald Find Shocks Colombian Cartel

U.S. jeweler seizes more than 10,000 carats and makes history by releasing the One-Carat Pride of Zambia Emerald Ring for UNDER $100!

LUSAKA, ZAMBIA - A recent find of high quality emeralds in this African republic has thrown the luxury gem world into tumult. For hundreds of years, Colombians have controlled the high-end emerald market and sent prices soaring to over $15,000 per carat for top graded stones. But the history-making discovery of Zambian emeralds has revealed a green gemstone with mesmerizing clarity that simply changes everything.

This important find led Stauer, a major gem dealer and importer, to bid on over 10,000 carats. Stauer designed a classic 1-ctw ring for people who love the gem but don't love outrageously priced luxury. Because of their timely buy, Stauer is releasing this exclusive, natural emerald ring—aka ***"The Pride of Zambia"***—to the public for under $100!

Discover a Different Kind of Emerald

"For the price, these natural gemstones were the most magnificent emeralds that I've seen in 30 years," said Michael Bisceglia at Stauer. "The value of Colombian stones can't compare."

Industry experts back him up. Lab tests prove that Zambian emeralds are less porous and brittle than their Colombian brothers. And gem cutters have found Zambians so brilliant that they lend themselves more to high-luster cuts than traditional emerald designs.

Unfortunately, the window on this exciting emerald opportunity is closing fast. Not long after Stauer acquired their cache, a recent auction saw Zambian emerald prices hit a new record high. The time to act on this great gem value is now, before it's too late. Please call our U.S.-based client service team at 1-888-277-8375 or visit us online at www.stauer.com.

Emerald Is THE Gem of 2014

The rise of emeralds is more than just a passing trend. An article in the *Financial Times of London* from June of this year pointed to the reason. In "Emeralds: Shades of Green Start to Outshine Diamonds," the newspaper reported that emerald demand is soaring worldwide even as diamond demand softens. Rarity is key as fine emeralds are much rarer than diamonds.

"With wealthy Russian and Chinese demand for emeralds way up, we expect prices to continue to rise quickly," Bisceglia said. "That's why we're so happy to have found these beautiful stones at this price."

Your Satisfaction is 100% Guaranteed

Call today and wear the ***Pride of Zambia*** RISK-FREE (less s&p) for 30 days. If you're not dazzled by this precious gemstone, simply send it back for a full refund of your purchase price.

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Hugo Martinez Santa Barbara, California

For his master's thesis Martinez wanted to photograph a dead chicken that was still fully intact. He found one, unexpectedly, at his local supermarket, sitting on ice. He brought it back to his garage and took this portrait.

Limor Sidi
Savyon, Israel

As part of a photography course, Sidi and her classmates were asked to bring in raw foods. She experimented with a cracked egg, salt, and black pepper flakes—first against a white background, then (here) in front of black, which made the colors more vibrant.

Chicago Doctor Invents

Affordable Hearing Aid

Superb Performance From Affordable Digital Hearing Aid

Board-certified physician Dr. Cherukuri has done it once again with his newest invention of a medical grade ALL DIGITAL affordable hearing aid.

Dr. Cherukuri knew that untreated hearing loss could lead to depression, social isolation, anxiety, and symptoms consistent with Dementia and Alzheimer's disease. In his practice he knew that many of his patients would benefit from new digital hearing aids, but many couldn't afford the expense, which is not generally covered by Medicare and most private health insurance.

Same Digital Technology as $3,000 Hearing Aids

He evaluated all the high priced digital hearing aids on the market and then created his own affordable version — called **MD**HearingAid® ***AIR*** for its virtually invisible, lightweight appearance. This sleek doctor- designed digital hearing aid delivers crisp, clear sound all day long and the soft flexible ear domes are so comfortable you won't realize you are wearing them.

This new digital hearing aid is packed with the features of $3,000 competitors at a mere fraction of the cost. Now most people with hearing loss are able to enjoy crystal clear, natural sound — in a crowd, on the phone, in the wind — without "whistling" and annoying background noise.

Try it at Home with Our 45-Day Risk-Free Trial

Of course hearing is believing, and we invite you to try it for yourself with our RISK-FREE 45-Day home trial. If you are not completely satisfied simply return it within that time period for a full refund of your purchase price.

- **Mini Behind-the-Ear Digital hearing aid**
- **Sleek, nearly invisible**
- **Doctor-Recommended, Audiologist-Tested**
- **FDA-Registered**
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- **100% Money Back Guarantee!**

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"...my mother hasn't heard this well in years, even with her $2,000 Digital! It was so great to see the joy on her face." —Al P., Minnesota

"I would definitely recommend them to my patients with hearing loss"
—Amy S., Audiologist, Indiana

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Natia Tsuleiskiri
Tbilisi, Georgia

After reading about this month's food-themed assignment, Tsuleiskiri got to work building a winter scene out of a broccoli stalk and branches from a pine tree, with flour to resemble snow. She started at 11 p.m. one night. Five hours later she had her favorite shot.

Srdjan Stepanovic Loznica, Serbia

Stepanovic and his girlfriend took a morning walk through Thailand's famous Amphawa Floating Market, outside of Bangkok. One vendor was arranging small magnets of Thai dishes on a wall. "It was a great opportunity to capture all of my favorite Thai foods in one shot," he says.


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Let's Go Places
Prototype shown with options. Production model may vary. ©2014 Toyota Motor Sales, U.S.A., Inc. Muppets ©2014 Disney

Evelyn Müller São Paulo, Brazil

Müller was visiting Istanbul, Turkey, with her family. One evening, while crossing the city's Galata Bridge, she saw a street vendor selling *tulumba*, a Turkish fried dough covered in syrup. Müller was hypnotized, she says, by the lighting and the background.

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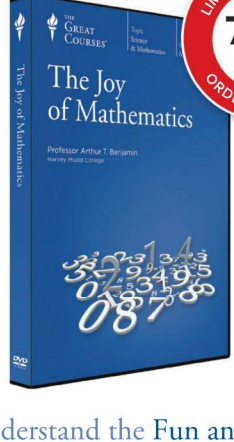

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6. The Joy of Algebra
7. The Joy of Higher Algebra
8. The Joy of Algebra Made Visual
9. The Joy of 9
10. The Joy of Proofs
11. The Joy of Geometry
12. The Joy of Pi
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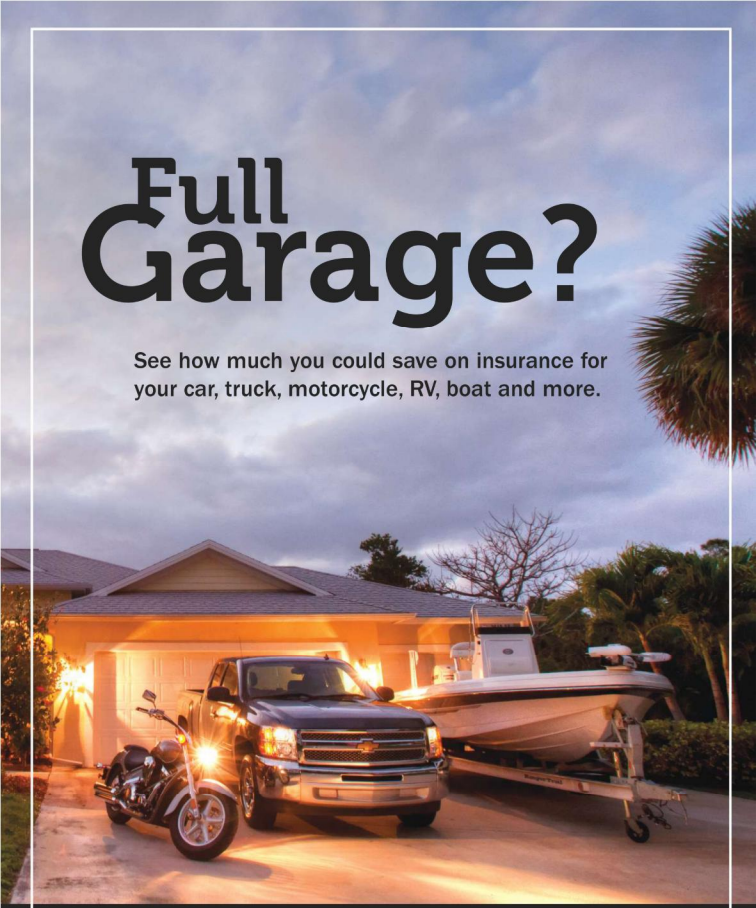

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Degrees of Separation

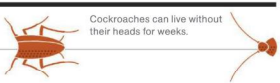
The old saying "cold hands, warm heart" may have some truth to it. University of Utah researchers found that though women's core body temperature can run 0.4°F higher than men's, women's hands run 2.8°F colder—87.2°F on average, compared with 90°F for men.

Blood vessels in the body's extremities are the first to constrict when temperatures drop. The gender differences in such cold responses are still not completely understood, says Johns Hopkins University's Fredrick Wigley, but hormone levels and muscle mass could play a role. Women are also up to five times as likely to have Raynaud's, a disorder in which cold temperatures or even emotional stress can make blood vessels temporarily collapse. Fingers can turn white, blue, or red in even mildly cold situations, such as when opening a refrigerator. *–Eve Conant*

A thermal photo shows a woman's hand (top) cooler than a man's hand (bottom).

72.4°F 86.3°F

PHOTO: TYRONE TURNER



Cockroaches can live without their heads for weeks.

Monkey See

One monkey looks at another and imitates the expression on its face. That's what primatologist Elisabetta Palagi saw in a zoo in Rheine, Germany, where she was studying geladas, a species that has roamed Ethiopia's high grasslands for some three million years. For her, it was a eureka moment. Humans instinctively engage in what's called rapid facial mimicry, but this was evidence of its ancient origins. The geladas, which weigh in at 30 to 45 pounds, are the only surviving species of grazing primates.

"It is not a behavior that can be learned," says Palagi, who works at the University of Pisa. "If you don't have a brain adapted to express the behavior, you can't do it." The copying is believed to be a form of emotional connection. *—Catherine Zuckerman*

Martian Time

Mars research can come with jet lag. For the first few months of missions, Earth-based scientists driving rovers prolong their days and nights to match the red planet's slightly slower rotation. To help, NASA facilities usually include nap rooms. *—Daniel Stone*

PHOTOS: PIER FRANCESCO FERRARI (TOP); NASA/JPL/TEXAS A&M/CORNELL. ART: ÁLVARO VALIÑO (TOP)
GRAPHIC: JASON TREAT, NGM STAFF. SOURCE: LAURA K. BARGER, HARVARD MEDICAL SCHOOL

The Great Energy Challenge

ENERGY.
WATER.
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The world's energy, water, and food systems are tightly linked. Water is needed to extract energy and generate power; energy is needed to treat and transport water; and both water and energy are needed to grow food. Understanding the interconnection between these resources is critical as we approach a world of 9 billion people by mid-century. Visit The Great Energy Challenge, a National Geographic initiative in partnership with Shell, to learn more and do more.

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NATIONAL GEOGRAPHIC

A NATIONAL GEOGRAPHIC INITIATIVE IN PARTNERSHIP WITH SHELL

Men are nearly six times as likely to be killed by lightning strikes in the United States as women.

An elongated snout helps the seahorse sneak up on its prey.

Head Hunter

Seahorses bob about clumsily in the water, they have no teeth, and their main food source—a tiny crustacean called a copepod—is highly elusive. So how does this upright-swimming fish manage to capture 90 percent of the prey it pursues? It's all in its head, says marine biologist Brad Gemmell. Using a high-speed, hologram-generating optical system, he found that the seahorse's snout allows it to come in for the kill without creating much disturbance in the water. This is key, since copepods are blind and rely on current fluctuations as their signal to flee. "People see seahorses as slow and passive," says Gemmell, "but in reality they're very effective predators, able to feed on one of the ocean's greatest escape artists." *—Catherine Zuckerman*

Digging Up the Past

The original peanut of the American South—brought over on slave ships from West Africa—is back. Called the Carolina African, it vanished 90 years ago, supplanted by the less sweet but more popular Virginia variety. Now Clemson University scientist Brian K. Ward and University of South Carolina food historian David Shields are reviving the lost legume, growing seeds from the 1930s found frozen in a seed bank. Ward harvested the first crop (right) last November. In two years, he says, locals will get to taste what they've been missing. *—CZ*

PHOTOS: DAVID LIITTSCHWAGER (TOP); MATT EICH. NGM ART. SOURCE: CDC

We found our most important watch in a soldier's pocket

It's the summer of 1944 and a weathered U.S. sergeant is walking in Rome only days after the Allied Liberation. There is a joyous mood in the streets and this tough soldier wants to remember this day. He's only weeks away from returning home. He finds an interesting timepiece in a store just off the Via Veneto and he decides to splurge a little on this memento. He loved the way it felt in his hand, and the complex movement inside the case intrigued him. He really liked the hunter's back that opened to a secret compartment. He thought that he could squeeze a picture of his wife and new daughter in the case back. He wrote home that now he could count the hours until he returned to the States. This watch went on to survive some harrowing flights in a B-24 bomber and somehow made it back to the U.S. Besides the Purple Heart and the Bronze Star, my father cherished this watch because it was a reminder of the best part of the war for any soldier—the homecoming.

He nicknamed the watch *Ritorno* for homecoming, and the rare heirloom is now valued at $42,000 according to *The Complete Guide to Watches*. But to our family, it is just a reminder that nothing is more beautiful than the smile of a healthy returning GI.

The Hunter's Back

The Ritorno watch back opens to reveal a special compartment for a keepsake picture or can be engraved.

We wanted to bring this little piece of personal history back to life in a faithful reproduction of the original design. We've used a 27-jeweled movement reminiscent of the best watches of the 1940s and we built this watch with $26 million worth of Swiss built precision machinery. We then test it for 15 days on Swiss made calibrators to insure accuracy to only seconds a day. The movement displays the day and date on the antique satin finished face and the sweep second hand lets any watch expert know that it has a fine automatic movement, not a mass-produced quartz movement. If you enjoy the rare, the classic, and the museum quality, we have a limited number of *Ritornos* available. We hope that it will remind you to take time to remember what is truly valuable. If you are not completely satisfied, simply return it within 30 days for a full refund of the purchase price.

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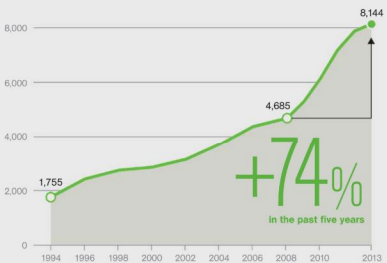
Food for the City

The local-food movement is blossoming, with farmers markets springing up all over the United States. Demand for fresh produce and a desire to invest in local economies are driving this growth. Consumers show increased interest in "food transparency"—what the USDA's Arthur Neal defines as the "full story behind how our food is produced." Improved marketing, he says, using tools like social media and electronic forms of payment, is also contributing to the boom. *—Kelsey Nowakowski*

THE FARMERS MARKET BOOM

FARMERS MARKETS IN THE U.S.

The number of markets has skyrocketed in ten years, with the fastest growth rates seen in the western United States. Winter farmers markets are up by nearly 60 percent since 2010.



FARMERS IN THE U.S.

PERCENTAGE OF THE U.S. WORKFORCE WHO ARE FARMERS

Mechanization has improved farm efficiency, allowing more people to pursue nonfarm occupations.

TWELVE STATES ACCOUNT FOR HALF OF ALL MARKETS.

California is number one, with 759 markets.

66%

Percentage of surveyed farmers markets located in urban counties in 2009

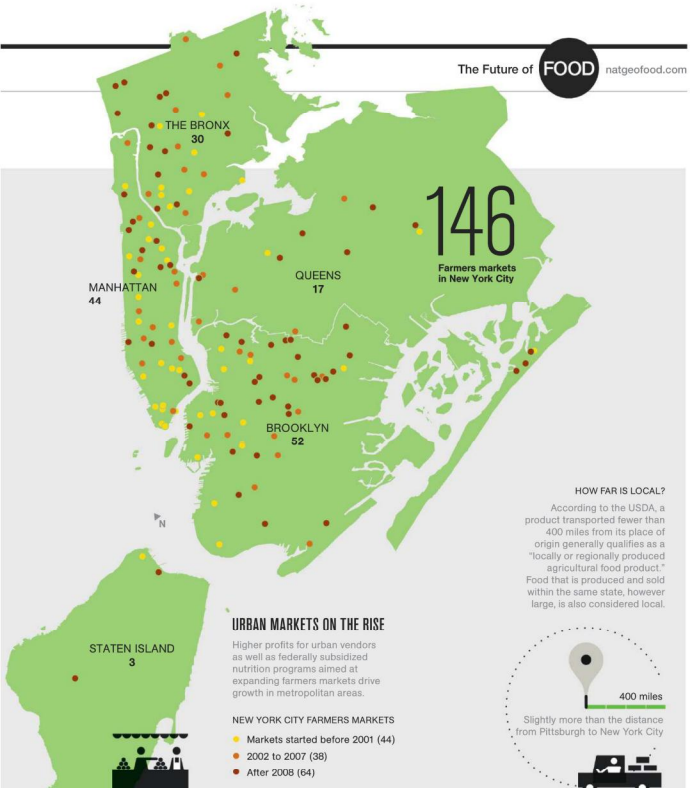
AVERAGE AGE

58

Of the 2.1 million farmers, 120,000 are younger than 35.

AGE IN AGRICULTURE

For every farmer under 35, the U.S. has seven farmers over 65. Experts say the local-food movement is inspiring more young people to farm.



146

Farmers markets in New York City

URBAN MARKETS ON THE RISE

Higher profits for urban vendors as well as federally subsidized nutrition programs aimed at expanding farmers markets drive growth in metropolitan areas.

NEW YORK CITY FARMERS MARKETS

- Markets started before 2001 (44)
- 2002 to 2007 (38)
- After 2008 (64)

HOW FAR IS LOCAL?

According to the USDA, a product transported fewer than 400 miles from its place of origin generally qualifies as a "locally or regionally produced agricultural food product." Food that is produced and sold within the same state, however large, is also considered local.

Slightly more than the distance from Pittsburgh to New York City

FARM ECONOMICS

CUTTING OUT THE MIDDLEMAN

Purchasing food from farmers markets helps shorten long price chains, leaving more money for farmers.

SMALL AND MEDIUM FARMS WITH LOCAL FOOD SALES

($0-249,999 in sales)

are **95%** of the total number of farms ...

but provide only **30%** of the total local-food sales.

GRAPHICS: ÁLVARO VALIÑO. SOURCES: USDA; ROBERT A. LEWIS & ASSOCIATES, REGIONAL FOOD SYSTEMS PLANNING

There are 16 people per elephant in Botswana.

These human hairs—not yet fully mature—were generated from donor follicles.

New Hope for Hair

A better treatment for baldness could be coming soon. Researchers from Durham and Columbia Universities discovered that cells from human hair follicles could produce new hair in donor tissue, but only when grown in a spherical environment instead of a traditional petri dish. After gravity helped the human hair cells clump together, the cells were transplanted into the dermis and epidermis of human skin that was grafted to lab mice. In five of seven rodents, the human hair that sprouted several weeks later was fine, like "peach fuzz," says lead researcher and geneticist Angela Christiano.

This method could be especially useful for people who don't have thick enough patches of hair for traditional hair-transplant surgery. Christiano says the next step is to try to grow thicker hair that has better color. Then, she says, she'll pluck it to see if it grows back. "That's a true test of a bona fide useful therapy." *–Eve Conant*

THE LIST

Tooth Tellers

We surveyed some editors of *National Geographic*'s international editions to find out how their countries celebrate lost baby teeth. Chew on this: Sometimes the tooth fairy doesn't make it all the way around the world.

Brazil, Greece, Japan

Children toss teeth on or over the roof. In Japan bottom teeth go on the roof and upper teeth are stashed under the floor to encourage the new teeth to grow in straight.

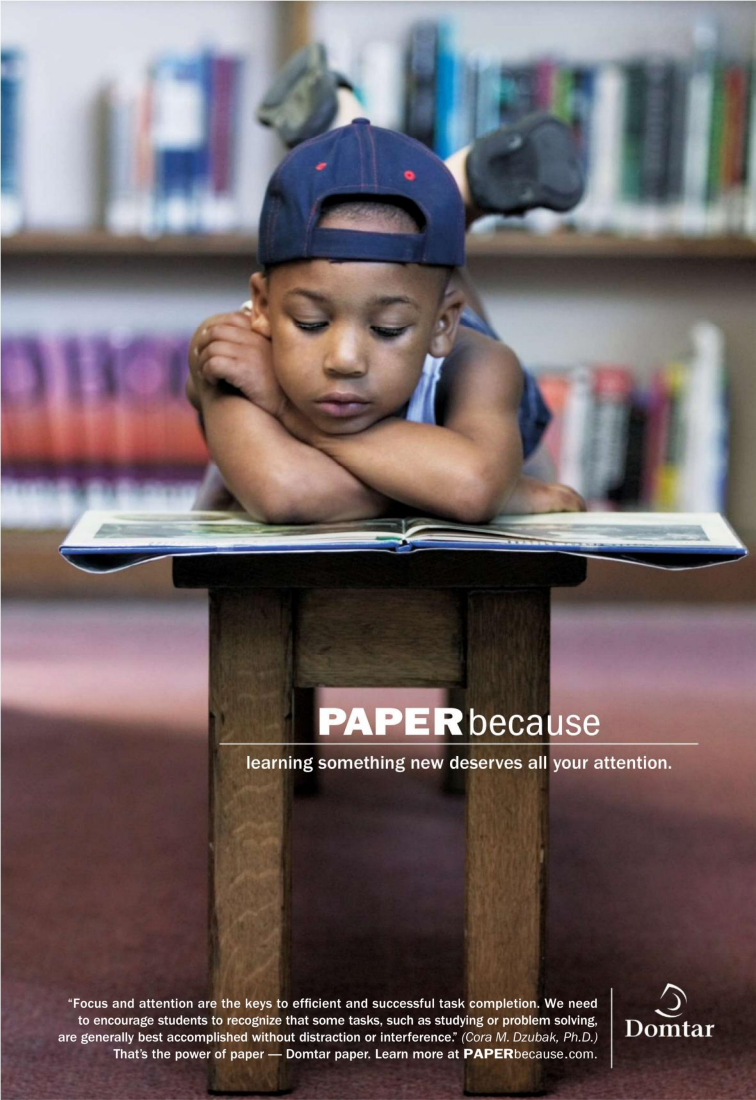
Mexico, Italy, Spain, Turkey, Scandinavia

Children place teeth under pillows at bedtime. The "fairy" who comes in the night is as quiet as a mouse—because for some it *is* a mouse (*ratón de los dientes* in Mexico) that leaves a gift in the tooth's place.

Mongolia

The tooth is wrapped in a piece of cattle fat; then the child gives it to a dog to eat and says, "Please take my tooth and give me a better one."

PHOTO: MARK THIESSEN, NGM STAFF. GRAPHIC (TOP): ÁLVARO VALIÑO. NGM ART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Hungry for information? Make a selection from our menu of food facts—and taste more at *natgeofood.com*.

EVERYTHING BUT THE SQUEAL

A 250-pound pig yields about 144 pounds of meat cuts for retail sale.

8lb 4oz

POTATO RECORD

The weight of the largest potato ever grown, according to *Guinness World Records*

35%

GO ASK YOUR MOM

More than a third of American adults still call their mothers for cooking advice.

BEST OF BOTH WORLDS

Melons can be considered both a fruit and a vegetable.

HERE'S A TIP

Half of all American adults have worked in a restaurant at some point in their lives.

DRIVE-THROUGH MENU

In 2013 the state of Montana legalized salvaging roadkill.

$1.8 BILLION/DAY

EATING OUT

Amount U.S. restaurant sales are projected to reach in 2014

BERRY BANANA

A banana is technically a berry, but a strawberry is not.

CHOCOLATE STATE

The Swiss eat more chocolate than any other nationality: 26 pounds per year per capita.

PHOTO: REBECCA HALE, NGM STAFF. ART: ÁLVARO VALIÑO
CHOCOLATE COURTESY DICK TAYLOR CHOCOLATE

If Your Toilet Has a Connector Made by Watts,

You Could Claim Benefits from a Class Action Settlement

There is a settlement with Watts Water Technologies, Inc. and Watts Regulator Co. ("Watts") about toilet connectors that could fail and cause water damage. Watts denies that it has done anything wrong.

The settlement covers the purchase and possession of a Watts toilet connector and payments for repairs for property damage caused by failure.

Who's Included?

You are included if you own or owned (or lease or leased) a residence or other structure in the United States containing a toilet connector with coupling nuts made with acetal plastic designed, manufactured, and/or distributed by Watts between 1999 and July 2009. Acetal is a type of plastic material. Images of included toilet connectors are available at www.ToiletConnector.com.

What does the Settlement provide?

The settlement agreement provides for the payment of $23 million into a settlement fund to: (1) pay Class Members for replacement of toilet connectors and/or property damage due to failure of acetal coupling nuts; (2) cover notice and settlement administration expenses; (3) pay attorneys' fees as ordered by the Court of up to 25% of the settlement fund (or $5.75 million), plus up to $650,000 in expenses; and (4) pay a total incentive award of up to $32,500 to the Class Representatives.

What can I get?

Class Members filing a claim for replacement of toilet connectors can get up to $20. Class Members filing a claim for property damages can recover up to 25% of their documented repair costs.

Your Options

If you do nothing, you will remain in the settlement and your rights will be affected. If you do not want to be included, you must exclude yourself by **June 29, 2014**. If you exclude yourself you will keep your right to sue Watts about the claims in this lawsuit. If you remain in the Settlement, you can object to it by **June 29, 2014**.

The Court will hold a hearing on **July 16, 2014** to consider any objections, whether to approve the settlement, award attorneys' fees, and incentive award. You can appear at the hearing, but you don't have to. You can hire your own attorney, at your own expense, to appear or speak for you at the hearing.

For more information: 1-877-819-9632 www.ToiletConnector.com

YOUR FREE PEARLS ARE HERE

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We owe you an apology. This exclusive deal is guaranteed to ruin every jewelry purchase you make from now on. Once you realize that it's possible to own a genuine cultured pearl necklace for **FREE**, other luxury brands are bound to disappoint. They can't handle **FREE** jewelry. They can't even afford to try. But you can. And that's all that matters to us.

We're offering our ***Mitsuko Organic Cultured Pearl Necklace*** online for $299. But if you'd like it for near **NOTHING** (you pay only the $19.95 shipping & processing–*see details below*) all you need to do is call 1-800-859-1542.

It's okay to be skeptical. You have every right to be. Why would any company give away a pearl necklace? Good question. We believe that once you try us, you'll be back for more. But maybe a better question is why other luxury jewelers don't think twice about offering cultured pearls for hundreds—even thousands—more. I'm sure they have their reasons. But you don't have to fall for them. Not anymore. Call today for your **FREE** ***Mitsuko Organic Cultured Pearl Necklace*** and you'll realize that luxury doesn't have to cost a fortune.

By implanting a nucleus inside the oyster, farmers stimulate the natural creation of a pearl. Each Mitsuko cultured pearl is harvested, polished and strung by hand.

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This exclusive FREE offer can't last forever. Unfortunately, we are only able to make a limited number of these necklaces available to the public for free. Don't let this incredible opportunity pass you by! To ensure that you receive your ***FREE Mitsuko Organic Cultured Pearl Necklace***, please call today. Your idea of luxury will never be the same!

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Boning Up

Bison Bob (above) is a 36,000-year-old Ice Age steppe bison. The Idaho Museum of Natural History wants to bring his bones—and its complete collections—to the masses. Bob is part of an online repository of archaeological and fossil scans including everything from ancient *Helicoprion* sharks to bows and arrows. The 360° scans of these objects can be rolled, flipped, and zoomed, at better resolution than the naked eye can see. The museum's director, Herb Maschner, calls it a move to democratize science and preserve fragile specimens. More than 15,000 bones and artifacts have already been scanned. See Bison Bob at *ivl.imnh.isu.edu* along with the other items. —*Johnna Rizzo*

Take a 360° spin around these animal bones in our digital editions.

Short-beaked common dolphin

Muskox

Walrus

ET CETERA

China—the world's biggest market for illegal ivory—held a public ceremony to crush more than six tons of **CONFISCATED IVORY** to discourage trade. • A **SHORTAGE OF ONIONS** in India, where they are a culinary staple, led to a 248 percent price increase for the vegetable in 2013. • Archaeologists discovered that the citizens of **POMPEII** dined on giraffe in restaurants. • Astronomers announced the detection of a possible **THORNE-ŻYTKOW OBJECT**—a neutron star inside a red supergiant.

PHOTOS (CLOCKWISE FROM TOP): UNIVERSITY OF ALASKA MUSEUM, UAMES 29458 (BISON) AND UAM 14793 (WALRUS); BURKE MUSEUM OF NATURAL HISTORY AND CULTURE, MAMMAL COLLECTION, UWBM 39478; NATIONAL MUSEUM OF NATURAL HISTORY, DEPARTMENT OF VERTEBRATE ZOOLOGY, DIVISION OF MAMMALS, USNM 550201

The Future of FOOD natgeofood.com

By 2050 we'll need to feed two billion more people. This special eight-month series explores how we can do that—without overwhelming the planet.

Where will we find enough food for 9 billion?

It doesn't have to be industrial farms versus small, organic ones. There's another way.

A Five-Step Plan to Feed the World

By *Jonathan Foley*

Photographs by *George Steinmetz* and *Jim Richardson*

On the Vulgamore farm near Scott City, Kansas, each combine can harvest up to 25 acres of wheat an hour—as well as real-time data on crop yields. Most of the food Americans eat is now produced on such large-scale, mechanized farms, which grow row after row of a single crop, allowing farmers to cover more ground with less labor.

GEORGE STEINMETZ

At Granja Mantiqueira in Brazil eight million hens lay 5.4 million eggs a day. Conveyor belts whisk the eggs to a packaging facility. Demand for meat has tripled in the developing world in four decades, while egg consumption has increased sevenfold, driving a huge expansion of large-scale animal operations.

GEORGE STEINMETZ

A bumper crop of corn piles up outside full silos in Brazil's Mato Grosso state, which sends much of its grain to China and South Korea to feed their pigs and chickens. The demand for more crops to feed livestock is one reason experts say we'll need to double crop production by 2050.

GEORGE STEINMETZ

FOOD

When we think about threats to the environment, we tend to picture cars and smokestacks, not dinner. But the truth is, our need for food poses one of the biggest dangers to the planet.

Agriculture is among the greatest contributors to global warming, emitting more greenhouse gases than all our cars, trucks, trains, and airplanes combined—largely from methane released by cattle and rice farms, nitrous oxide from fertilized fields, and carbon dioxide from the cutting of rain forests to grow crops or raise livestock. Farming is the thirstiest user of our precious water supplies and a major polluter, as runoff from fertilizers and manure disrupts fragile lakes, rivers, and coastal ecosystems across the globe. Agriculture also accelerates the loss of biodiversity. As we've cleared areas of grassland and forest for farms, we've lost crucial habitat, making agriculture a major driver of wildlife extinction.

The environmental challenges posed by agriculture are huge, and they'll only become more pressing as we try to meet the growing need for food worldwide. We'll likely have two billion more mouths to feed by mid-century—more than nine billion people. But sheer population growth isn't the only reason we'll need more food. The spread of prosperity across the world, especially in China and India, is driving an increased demand for meat, eggs, and dairy, boosting pressure to grow more corn and soybeans to feed more cattle, pigs, and chickens. If these trends continue, the double whammy of population growth and richer diets will require us to roughly double the amount of crops we grow by 2050.

Unfortunately the debate over how to address the global food challenge has become polarized, pitting conventional agriculture and global commerce against local food systems and organic farms. The arguments can be fierce, and like our politics, we seem to be getting more divided rather than finding common ground. Those who favor conventional agriculture talk about how

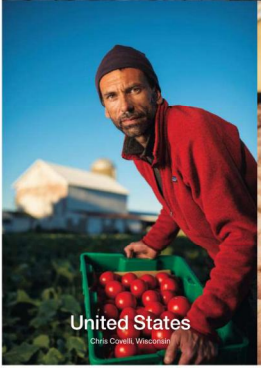
High in the Peruvian Andes, Estela Cóndor grows five different varieties of potatoes to sell in the market, along with a yellow tuber called *mashua* that she cooks for her family. Small farmers like Cóndor grow much of the food for people in the developing world.

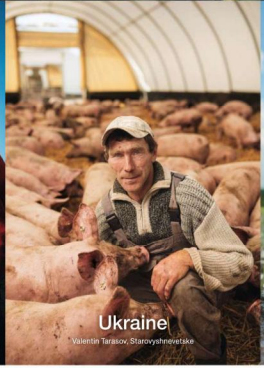
JIM RICHARDSON


Mali
Bassama Camara, Siby


Ukraine
Olexandra Salo, Hlynske


Bangladesh
Anwara Begum, Sajiali


United States
Chris Covelli, Wisconsin


Ukraine
Valentin Tarasov, Starovyshnevetske


Indonesia
Pak Kompiang, Bali

JIM RICHARDSON (ALL)

Industrial-size farms achieve high yields using fertilizer and pesticides to grow huge fields of one crop.

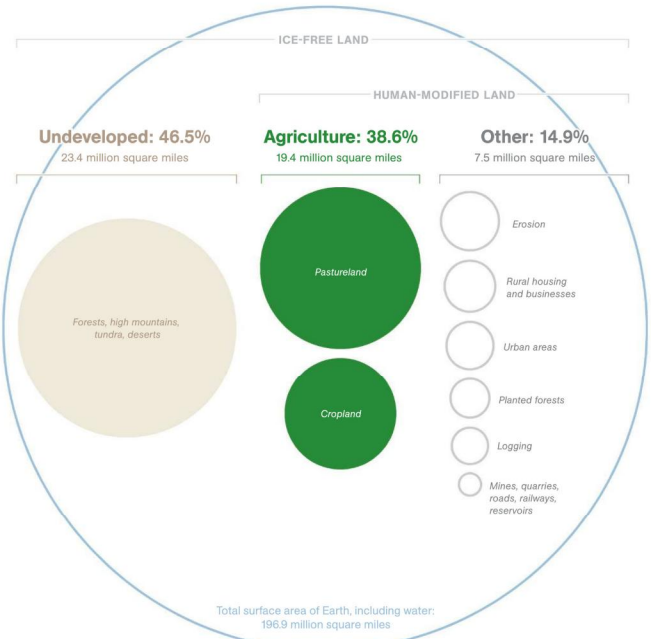
Though small farms tend to lag behin they often deliver more food that actu

d industrial farms in yields,
ally ends up feeding people.

JIM RICHARDSON (BOTH)

Agriculture's Footprint

Farming of both livestock and crops is the largest human endeavor on Earth, using more than 38 percent of ice-free land. Our next largest impact: erosion caused by agriculture, building, logging, and mining.



ALL GRAPHICS AND MAP BY VIRGINIA W. MASON AND JASON TREAT, NGM STAFF. SOURCE: ROGER LEB. HOOKE, UNIVERSITY OF MAINE

modern mechanization, irrigation, fertilizers, and improved genetics can increase yields to help meet demand. And they're right. Meanwhile proponents of local and organic farms counter that the world's small farmers could increase yields plenty—and help themselves out of poverty—by adopting techniques that improve fertility without synthetic fertilizers and pesticides. They're right too.

But it needn't be an either-or proposition. Both approaches offer badly needed solutions; neither one alone gets us there. We would be wise to explore all of the good ideas, whether from organic and local farms or high-tech and conventional farms, and blend the best of both.

I was fortunate to lead a team of scientists who confronted this simple question: How can the world double the availability of food while simultaneously cutting the environmental harm caused by agriculture? After analyzing reams of data on agriculture and the environment, we proposed five steps that could solve the world's food dilemma.

STEP ONE *Freeze agriculture's footprint*

For most of history, whenever we've needed to produce more food, we've simply cut down forests or plowed grasslands to make more farms. We've already cleared an area roughly the size of South America to grow crops. To raise livestock, we've taken over even more land, an area roughly the size of Africa. Agriculture's footprint has caused the loss of whole ecosystems around the globe, including the prairies of North America and the Atlantic forest of Brazil, and tropical forests continue to be cleared at alarming rates. But we can no longer afford to increase food production through agricultural expansion. Trading tropical forest for farmland is one of the most destructive things we do to the environment, and it is rarely done to benefit the 850 million people in the world who are still hungry. Most of the land cleared for agriculture in the tropics does not contribute much to the world's food security but is instead used to produce cattle, soybeans for livestock, timber, and palm oil. Avoiding further deforestation must be a top priority.

STEP TWO *Grow more on farms we've got*

Starting in the 1960s, the green revolution increased yields in Asia and Latin America using better crop varieties and more fertilizer, irrigation, and machines—but with major environmental costs. The world can now turn its attention to increasing yields on less productive farmlands—especially in Africa, Latin America, and eastern Europe—where there are "yield gaps" between current production levels and those possible with improved farming practices. Using high-tech, precision farming systems, as well as approaches borrowed from organic farming, we could boost yields in these places several times over.

STEP THREE *Use resources more efficiently*

We already have ways to achieve high yields while also dramatically reducing the environmental impacts of conventional farming. The green revolution relied on the intensive—and unsustainable—use of water and fossil-fuel-based chemicals. But commercial farming has started to make huge strides, finding innovative ways to better target the application of fertilizers and pesticides by using computerized tractors equipped with advanced sensors and GPS. Many growers apply customized blends of fertilizer tailored to their exact soil conditions, which helps minimize the runoff of chemicals into nearby waterways.

Organic farming can also greatly reduce the use of water and chemicals—by incorporating cover crops, mulches, and compost to improve soil quality, conserve water, and build up nutrients. Many farmers have also gotten smarter about water, replacing inefficient irrigation systems with more precise methods, like subsurface drip irrigation. Advances in both conventional

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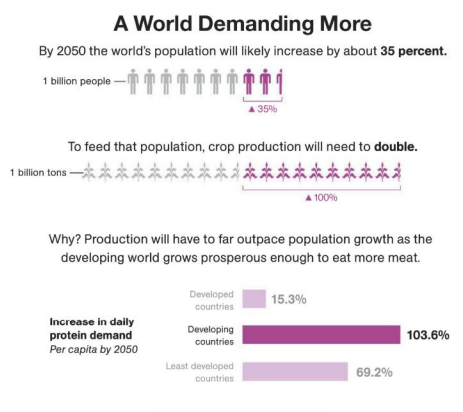
Jonathan Foley directs the Institute on the Environment at the University of Minnesota. Jim Richardson's portraits of farmers are the latest in his body of work documenting agriculture. George Steinmetz's big-picture approach reveals the landscapes of industrial food.



and organic farming can give us more "crop per drop" from our water and nutrients.

STEP FOUR *Shift diets*

It would be far easier to feed nine billion people by 2050 if more of the crops we grew ended up in human stomachs. Today only 55 percent of the world's crop calories feed people directly; the rest are fed to livestock (about 36 percent) or turned into biofuels and industrial products (roughly 9 percent). Though many of us consume meat, dairy, and eggs from animals raised on feedlots, only a fraction of the calories in feed given to livestock make their way into the meat and milk that we consume. For every 100 calories of grain we feed animals, we get only about 40 new calories of milk, 22 calories of eggs, 12 of chicken, 10 of pork, or 3 of beef. Finding more efficient ways to grow meat and shifting to less meat-intensive diets—even just switching from grain-fed beef to meats like chicken, pork, or pasture-raised beef—could free up substantial amounts of food across the world. Because people in developing countries are unlikely to eat less meat in the near future, given their newfound prosperity, we can first focus on countries that already have meat-rich diets. Curtailing the use of food crops for biofuels could also go a long way toward enhancing food availability.

STEP FIVE *Reduce waste*

An estimated 25 percent of the world's food calories and up to 50 percent of total food weight are lost or wasted before they can be consumed. In rich countries most of that waste occurs in homes, restaurants, or supermarkets. In poor

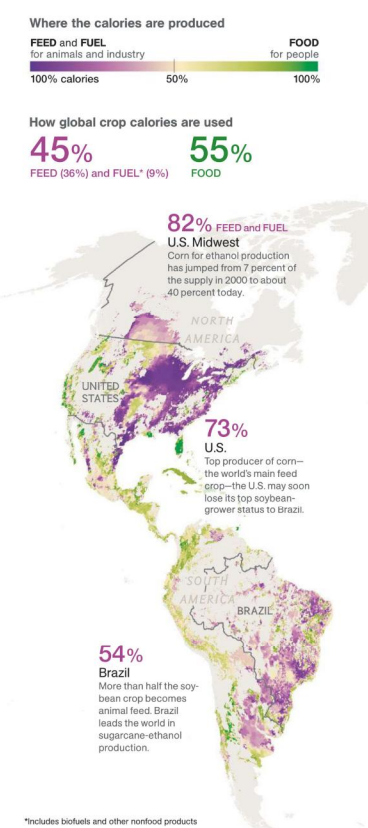
Mariam Kéita harvests peanuts on a farm in Siby, Mali. The green revolution's mix of hybrid seeds, fertilizers, and irrigation never took off in Africa. But sub-Saharan countries now offer a key opportunity to boost global food production, because their yields can be vastly improved.

JIM RICHARDSON

countries food is often lost between the farmer and the market, due to unreliable storage and transportation. Consumers in the developed world could reduce waste by taking such simple steps as serving smaller portions, eating leftovers, and encouraging cafeterias, restaurants, and supermarkets to develop waste-reducing measures. Of all of the options for boosting food availability, tackling waste would be one of the most effective.

TAKEN TOGETHER, these five steps could more than double the world's food supplies and dramatically cut the environmental impact of agriculture worldwide. But it won't be easy. These solutions require a big shift in thinking. For most of our history we have been blinded by the overzealous imperative of more, more, more in agriculture—clearing more land, growing more crops, using more resources. We need to find a balance between producing more food and sustaining the planet for future generations.

This is a pivotal moment when we face unprecedented challenges to food security and the preservation of our global environment. The good news is that we already know what we have to do; we just need to figure out how to do it. Addressing our global food challenges demands that all of us become more thoughtful about the food we put on our plates. We need to make connections between our food and the farmers who grow it, and between our food and the land, watersheds, and climate that sustain us. As we steer our grocery carts down the aisles of our supermarkets, the choices we make will help decide the future. □



The Future of Food

COMING IN JUNE

We already eat more farmed fish than beef…

Can the "blue revolution" solve the world's food puzzle?

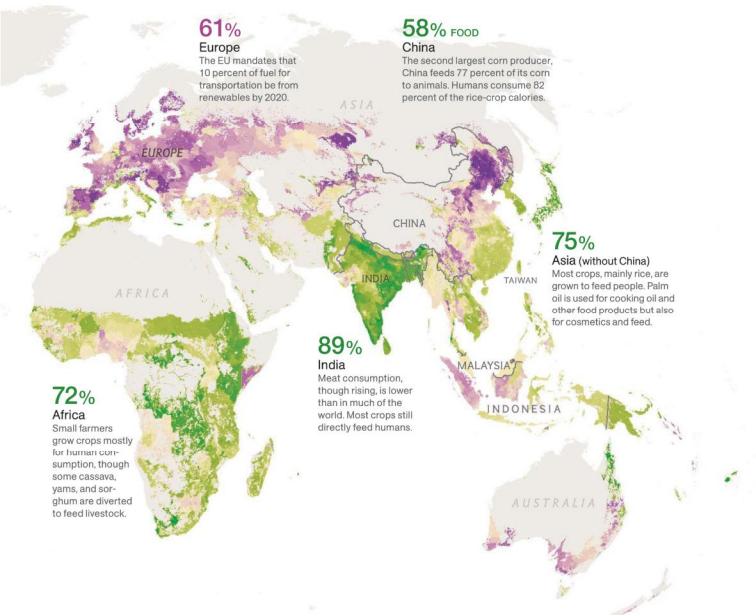
ON THE WEB

Join the conversation at *natgeofood.com* and get daily food news, videos, informed blogs, interactive graphics, bonus photos, and food facts of the day.

The magazine thanks The Rockefeller Foundation and members of the National Geographic Society for their generous support of this series of articles.

Food Versus Feed and Fuel

Percentages on the map show whether most of the calories in a region's crops go directly to human consumption (green) or go to animal feed and biofuels (purple). Only 55 percent of the world's food-crop calories directly nourish people. We get another 4 percent indirectly by eating meat, dairy, or eggs from animals raised on feed.



Only the Brazil nut trees—protected by national law—were left standing after farmers cleared this parcel of Amazon rain forest to grow corn. Despite progress in slowing deforestation, this northern state of Pará saw a worrying 37 percent spike over the past year.

GEORGE STEINMETZ

At the Nutribras pig farm in Brazil sows are confined to sectioned crates that allow a mother to suckle her piglets without accidentally crushing them. Hog farms can be big polluters—the average 200-pound pig produces 13 pounds of manure a day—but Nutribras recycles waste as fertilizer and methane power.

GEORGE STEINMETZ

On the Bassetti farm near Greenfield, California, workers harvest celery to be shipped to retail outlets in the U.S. and Asia. Dubbed "America's salad bowl," the Salinas Valley relies on groundwater for irrigation, which could be at risk if the current drought continues.

GEORGE STEINMETZ

Each month some 4.5 million chickens are killed, plucked, cut, trimmed, and packaged at this plant near Sidrolândia, Brazil. Their parts will travel the globe: Wings and feet go mostly to China, legs to Japan, and breasts to Europe. The global appetite for chicken means that production of poultry is growing much faster than that of either pork or beef.

GEORGE STEINMETZ


SEARA

At Monsanto's North Carolina lab, corn plants emerge from an automated photo booth that documents their growth. The company is trying to develop strains of corn and soybeans that need less water and fertilizer—a goal that's eluded biotech thus far. Reducing the use of such resources is key to feeding the world in the coming decades.

GEORGE STEINMETZ

Beyond Delicious

You might say the apple fell from grace in the 1920s and '30s with the advent of refrigerated long-distance shipping. Thanks to supermarket Darwinism, thousands of heirloom varieties, like many of those at right, went commercially extinct. Produce bins featured Delicious, Jonathan, and Rome—selected for durability and beauty, but boring in taste. "People switched off their tastebuds," says Diane Miller, an apple geneticist at Ohio State University. Apple consciousness-raising, says Miller, came with the release of the aptly named Honeycrisp hybrid in 1991. Now breeders create dozens of flavorful new hybrids a year and heirlooms are back in style.

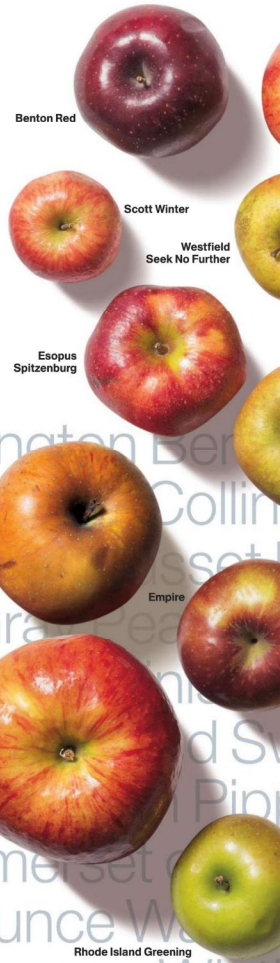
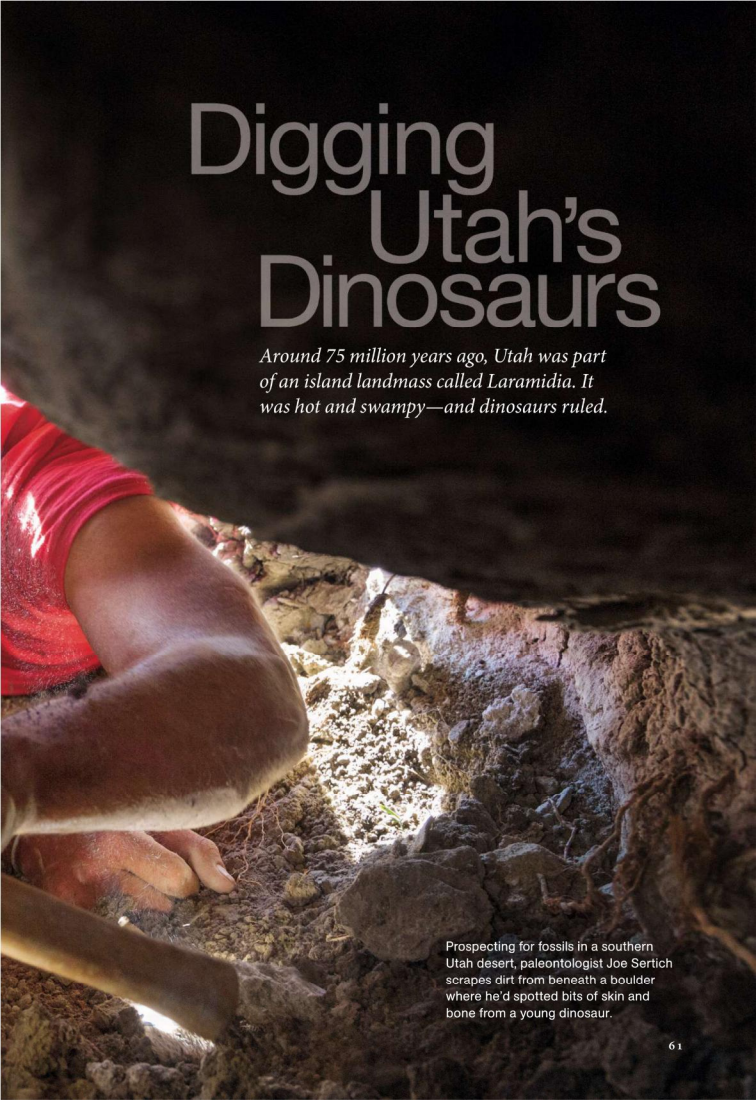


PHOTO ILLUSTRATION: REBECCA HALE, NGM STAFF

Digging Utah's Dinosaurs

Around 75 million years ago, Utah was part of an island landmass called Laramidia. It was hot and swampy—and dinosaurs ruled.



Prospecting for fossils in a southern Utah desert, paleontologist Joe Sertich scrapes dirt from beneath a boulder where he'd spotted bits of skin and bone from a young dinosaur.

On a cold May evening Sertich and volunteer Billy Doran walk a ridgeline—often the only way to get from here to there in the fossil-rich badlands of southern Utah.

Kosmoceratops richardsoni, a rhino-size plant-eater that lived on Laramidia, had five horns around its face and ten on the rear of the fanlike frill. Potential mates may have been impressed.

NATURAL HISTORY MUSEUM OF UTAH

By Peter Miller
Photographs by Cory Richards

The Miller brothers looked more like prospectors than paleobotanists. Their beards were caked with dirt; goggles kept their eyes from being sandblasted by the desert winds. Both were big men, more than six feet three, and on a knife-edged ridge in southern Utah they moved with the quiet confidence of outdoorsmen. As Ian swung a pickax into the mudstone, Dane attempted to roll a cigarette between gusts. Loose tobacco flew from the paper. "Doggone it," he said, and tried again.

Along with Scott Sampson, chief curator at the Denver Museum of Nature & Science, and Joe Sertich, the museum's dinosaur paleontologist, the brothers were prospecting for fossils last spring in the Grand Staircase–Escalante National Monument. Within that largely roadless wilderness they were exploring a particularly remote area, a maze of steep bluffs and gullies north of Horse Mountain. While the rest of their team was a few miles away, working fossil quarries discovered in previous years, Sampson, Sertich, and the Millers were looking for new ones. After months of office duty at the museum Sampson could barely contain his joy at being "where no paleontologist has ever been before"—with the prospect of discovering new treasure from the "lost continent" of Laramidia.

The layer of mudstone the Millers were hacking into had been deposited on the east coast of that slender landmass, which once stretched 4,000 miles from the Arctic Ocean to the Gulf of Mexico. Laramidia was created 90 million years ago, during the late Cretaceous period, when rising seas flooded the middle of North America and split it in two. Today Laramidia is buried under the western states; it can be accessed only in eroded badlands like these, where wind and rain have brought its fossil-rich deposits within reach of picks and shovels.

Since 2000 Sampson had helped lead expeditions into the wilds of Laramidia. The researchers and the impetus came from the Natural History Museum of Utah and the U.S. Bureau of Land Management as well as the Denver Museum. Working mainly in the Kaiparowits formation, a 2,600-foot-thick deposit dating from 77 million to 75 million years ago, they'd unearthed fossils of thousands of plants and animals,

Peter Miller is a contributing writer. Cory Richards has shot several adventure stories for the magazine, but this is his first foray into paleontology.

Hot, swampy, and teeming with dinosaurs

Horned and duck-billed herbivores meet at a river 77 million years ago in what is now southern Utah desert. A carnivore called *Talos*, a birdlike theropod, watches from a tree. The landscape that supported such a dense concentration of species on Laramidia may have resembled the subtropical wetlands of northern Louisiana.

Parasaurolophus

Utahceratops

Talos

Kosmoceratops

ART: RAÚL MARTÍN
SOURCE: SCOTT SAMPSON, DENVER MUSEUM OF NATURE & SCIENCE

An adult and a juvenile *Teratophoneus* get a dusting from Geoffrey Leonard at the Natural History Museum of Utah. Like *Tyrannosaurus rex*, their larger relative, they likely were fierce predators.

NATURAL HISTORY MUSEUM OF UTAH


Labrador Seaway
Hudson Seaway
Western Interior Seaway
LARAMIDIA
APPALACHIA
Dinosaur Park
Two Medicine
Judith River
Kaiparowits
Fruitland
Present-day shoreline
North America, about 77 million years ago
Dinosaur fossil site
0 mi 300
0 km 300
RYAN MORRIS, NGM STAFF
SOURCE: RON BLAKEY, COLORADO PLATEAU GEOSYSTEMS

from conifer cones to crocodiles, turtles, and dinosaurs—especially dinosaurs. During the 20 million years or so that it existed, Laramidia seems to have been a runaway dinosaur factory, cranking out large and small dinosaurs in a surprising diversity of species. Figuring out how and why that happened, the researchers said, could tell us something fundamental about the interplay between ecology and evolution.

"This place is littered with bones," Sampson said, as his boots crunched up a slope not far from where the Miller brothers were working. "I've got pieces of a turtle going up this hill, but I have no idea where the rest of this thing is." He picked up a small beige object and licked it to see if it was porous bone or boring rock. "If it's bone, it will stick to your tongue," he said. "If it's rock, it won't." This one stuck.

FOSSIL HUNTING has always been stubbornly low-tech. When it comes to fieldwork, not much has changed since the great "bone rush" of the 19th century, when discoveries in the Wild West sparked a furious campaign to get fossils out of the ground and into the great halls of East Coast museums. While the U.S. Army was chasing Sitting Bull across the northern plains, teams of scholars, wranglers, and ruffians were pulling giant leg bones from the badlands, wielding the same picks, shovels, and plaster employed by paleontologists today.

"We use the same techniques because they work," said Ian Miller, who heads the department of earth sciences at the Denver Museum. His preferred tool: a six-pound pickax with a hickory handle. "A good one is hard to get these days," he said. "But they don't break."

One of the first big discoveries in the Kaiparowits came in 2002, when a field volunteer named Duncan Everhart spotted a jawbone in the ground. As researchers later found out, it was attached to the hefty upside-down skull of a 30-foot-long hadrosaur, or duck-billed dinosaur. Its jaws were packed with as many as 800 teeth, making it the "Cuisinart of the Cretaceous," according to Sampson. The snout had a pronounced crest that placed the animal in the genus *Gryposaurus* (hooked-nose lizard), first described a century ago from specimens at what is now Dinosaur Provincial Park in Alberta. This Utah giant, though, was clearly different from its Canadian cousins. It looked "pumped up," Sampson said, switching metaphors, "like the Arnold Schwarzenegger of duck-billed dinosaurs." He and Terry Gates, then a University of Utah graduate student, named the new species *G. monumentensis,* after the site where it had been found.

That same year Mike Getty, now the chief preparator at the Denver Museum, discovered another novel creature here, a seven-foot-tall dinosaur. This meat-eating, two-footed, and possibly feathered beast became *Hagryphus giganteus,* or giant birdlike god of the western desert.

More species followed: dome-headed dinosaurs, armored dinosaurs, a cousin of *Tyrannosaurus rex,* sickle-clawed relatives of *Velociraptor* (the speedy predator made famous by the movie *Jurassic Park*), and several new horned dinosaurs, each more extravagant looking than the last. Consider the brute that Sampson and colleagues named *Kosmoceratops richardsoni* in 2010: A rhino-size relative of *Triceratops,* it had a record-breaking 15 horns on its head.

Specimens related to most of these animals had been found at late Cretaceous sites in Alberta, Montana, and Wyoming, places that at that time had also been along Laramidia's east coast. But the Utah dinosaurs were different.

"Almost every animal was a new species," Sampson said. And it wasn't just the dinosaurs,

FORGOTTEN WORLD

A shallow sea divided North America about 77 million years ago, during the late Cretaceous period, when Earth was much warmer than it is today. Recently discovered fossils from Laramidia, as the western landmass is called, suggest that evolution was in high gear there: New species of dinosaurs and other animals were emerging in the south that were distinct from those up north.

Exposed by wind and rain, a two-foot-long segment of a duck-billed dinosaur tail (above) remains embedded in sandstone in the Kaiparowits formation. Duckbills, or hadrosaurs, are so common in this deposit that "we didn't even collect this one," Joe Sertich said. Another hadrosaur tail (below) remains in the plaster jacket used to transport it to the museum in Salt Lake City. A fossil branch (right) came from an extinct species of conifer, similar to living sequoia trees, that once may have towered above Laramidian forests.

NATURAL HISTORY MUSEUM OF UTAH

DENVER MUSEUM OF NATURE & SCIENCE

but also the mammals, fishes, lizards, turtles, and crocodiles. "The whole fauna, it seemed, was new to science."

Something had isolated the dinosaurs of southern Laramidia from their relatives up north, the researchers figured. Left to itself, each community of animals had evolved differently, just as Darwin's famous finches had done in the Galápagos, where they'd become new species after populating different islands. But Sampson and his colleagues were skeptical of the idea that a physical barrier, such as a mountain range or a large river, had kept the animals apart. Mountains may block the path of some animals, he said, but others are known to walk right over them: "They do it all the time." As for rivers, "it's hard to imagine that a river could last for tens of thousands or hundreds of thousands of years," Sampson said. "Sooner or later there will be periods of drought when rivers dry up."

THAT NIGHT, sitting beside our campfire near a dry creek bed, Sampson laid out an alternative explanation for the "provinciality" of Laramidian dinosaurs. As he talked, Ian Miller's dog, Wilson, which was curled up next to him, cocked his ears at a sound in the darkness. Earlier we'd seen mountain lion tracks. But the Australian shepherd wasn't concerned enough to get up.

The theory Sampson favored took off from work done in the 1980s by Thomas Lehman, a paleontologist at Texas Tech University. What if variations in environmental conditions had segregated the animals on Laramidia, Lehman wondered? That made sense to Sampson: Once a dinosaur species had spread over a large enough range, the populations at opposite ends of it would find themselves adapting through natural selection to different climate zones and vegetation. Over time members of the two populations might evolve so disparately that even if they were to meet, they would no longer recognize each other as potential mates—and at that point the two populations would have become two species.

What's more, Sampson and his colleagues

At the Grand Staircase–Escalante National Monument, Carol Lucking of the Denver Museum of Nature & Science cuts through a slab of sandstone with a diamond-bladed rock saw. Her object: bones from a young duckbill.

reasoned, the divergence might have been encouraged not only by natural selection but also by another evolutionary force: sexual selection. The bizarre-looking traits that differentiated these southern animals from those up north, especially among the herbivorous dinosaurs, looked like prime examples of sexual selection. Whereas natural selection acts preferentially on features that are essential to the struggle for survival, such as limbs and teeth, sexual selection is concerned with features key to the competition for mates, such as peacock tails or moose antlers. The elaborate horns, spikes, and frills of the Utah herbivores wouldn't have been much use against predators. The horns of ceratopsians, for example, were better suited for contests against other animals of the same species to establish dominance. And their frills, which were too thin to withstand combat, were probably used to impress the opposite sex, Sampson said. "They were more about showing off."

But what about the jumbo size of these dinosaurs? How could so many different giants—more


CAPACITY
16,000 LBS

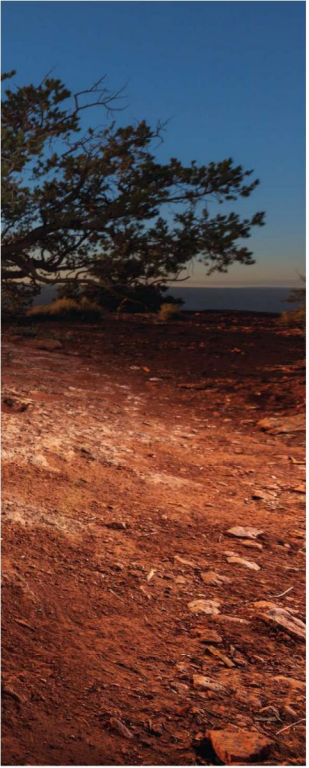
A carnivore from the dromaeosaurid family shares the freight elevator at the Natural History Museum of Utah with exhibit designer Tim Lee. A cousin of *Velociraptor,* it may have had feathers—and it definitely had slashing talons.

NATURAL HISTORY MUSEUM OF UTAH

than there have ever been on the African savanna—have survived in Laramidia? Wouldn't they have needed room to spread out? Making the thousand-mile journey between Utah and Alberta shouldn't have been a challenge for, say, 30-foot-long dinosaurs. Shouldn't there have been more mingling going on?

THAT'S WHERE THE PLANTS came in, said Ian Miller the next morning at the new leaf quarry he'd found on the ridge. Sitting on a ledge, looking out over an arid, jagged, and mostly unvegetated landscape, Miller tapped a cantaloupe-size rock with his hammer, splitting it neatly in two. On either side of the interior were mirror-image impressions of a leaf—intact, with all the detail of a specimen that had fallen into a pond the day before.

"This wasn't a desert 75 million years ago," Miller said. "We've found more vines in this formation than in any other I've ever seen. The forest here was more like a jungle, with vines



These theropod tracks, up to 17 inches long, cross Flag Point near Kanab. They're relics of an era 100 million years before Laramidia became an island—and evidence that, in the American West, dinosaurs ruled for a very long time.

twining up the trees. We've also found lily pads and water lettuce, so we know there were ponds here with floating vegetation. And big rivers. Think of the Amazon, where you have the main channel of the river but also side channels and lakes that are so filled with tannin they turn black. That's probably what the little pond looked like that this leaf fell into."

The vegetation could have been so thick and lush in this part of Laramidia that there was no need for animals to wander very far, Miller speculated. Perhaps even the largest duck-billed dinosaur was able to get its fill within a relatively small range. That's what you see today in tropical rain forests, he said: many species sharing the same small spaces. The whole continent could have been organized as a series of ecological zones at different latitudes, each defined by varying amounts of precipitation or sunlight and each supporting its own set of dinosaurs. You wouldn't need a physical barrier to explain the explosion of new species.

"We haven't done enough work yet," Miller said. "In many respects it's still a hunch. But if we're right, and there were these small provincial populations that weren't moving around, not interacting with other populations, you could have sexual selection happening very rapidly."

The lush landscape that would have made this possible was more like the swamplands of Louisiana than what you see here today, Sampson said. But any such comparison is necessarily flawed, he added, because the Earth was so different 75 million years ago. "We're still really in the dark when it comes to understanding the ecological dynamics."

That's why he and his team return season after season to the Utah badlands, where every trek into the desert sheds new light on Laramidia's story. "Every rock you crack open, you're saying, Oh my God, I've never seen that before," Miller said. "It's brand-new. Unknown to science." □

Society Grant The research of the team of scientists in this story was funded in part by your National Geographic Society membership.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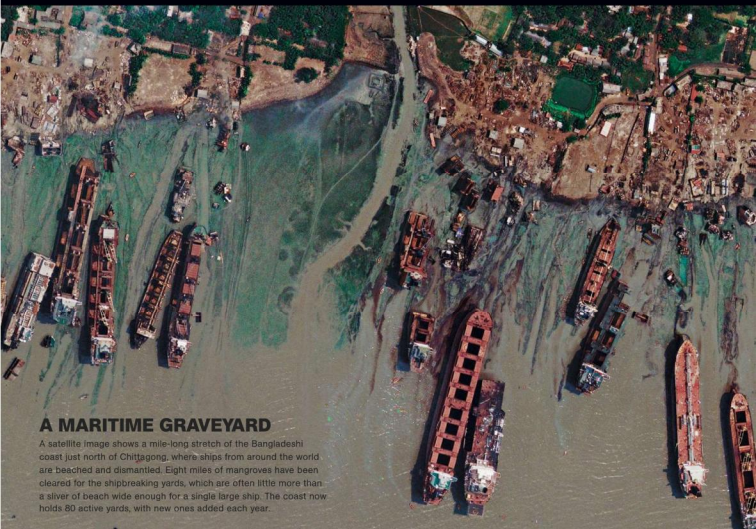
In Bangladesh men desperate for work perform one of the world's most dangerous jobs.

THE SHIP EAKERS

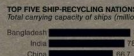
At low tide ship-breakers haul a 10,000-pound cable to a beached ship to winch pieces ashore as they dismantle it.



A MARITIME GRAVEYARD

A satellite image shows a mile-long stretch of the Bangladeshi coast just north of Chittagong, where ships from around the world are beached and dismantled. Eight miles of mangroves have been cleared for the shipbreaking yards, which are often little more than a sliver of beach wide enough for a single large ship. The coast now holds 80 active yards, with new ones added each year.

TOP FIVE SHIP-RECYCLING NATIONS (2003-2013)
Total carrying capacity of ships (millions of metric tons)



Over the past decade India recycled more ships, but Bangladesh led in deadweight tonnage, meaning the biggest vessels generally ended up on its beaches. China and Turkey enforce more safety measures than the others and take steps to reduce the environmental impact.


SATELLITE IMAGE ©DIGITALGLOBE

These ship-breakers claim to be 14, the minimum legal age to work in the yards. Managers favor young workers because they are cheap and know less about the dangers, and their small bodies enable them to access a ship's tightest corners.

BY PETER GWIN
PHOTOGRAPHS BY MIKE HETTWER

I had been warned that it would be difficult to get into Bangladesh's shipbreaking yards. "It used to be a tourist attraction," a local man told me. "People would come watch men tear apart ships with their bare hands. But they don't let in outsiders anymore." I walked a few miles along the road that parallels the Bay of Bengal, just north of the city of Chittagong, where 80 active shipbreaking yards line an eight-mile stretch of the coast. Each yard was secured behind high fences topped with razor wire. Guards were posted, and signs warned against photography. Outsiders had become especially unwelcome in recent years after an explosion killed several workers, prompting critics to say the owners put profits above safety. "But they can't block the sea," the local said.

So late one afternoon I hired a fisherman to take me on a water tour of the yards. At high tide the sea engulfed the rows of beached oil tankers and containerships, and we slipped in and out of the deep shadows cast by their towering smokestacks and superstructures. Some vessels remained intact, as if they had just arrived. Others had been reduced to skeletons, the steel skin cut away to reveal their cavernous black holds.

We drifted alongside barnacle-encrusted hulls and beneath the blades of massive propellers. I read off names and flags painted on the sterns: *Front Breaker* (Comoros), *V Europe* (Marshall Islands), *Glory B* (Panama). I wondered about cargoes they had carried, ports where they had called, and crews that had sailed them.

The life span of such ships is roughly 25 to 30 years, so most of these likely had been launched during the 1980s. But the rising cost to insure and maintain aging vessels makes them unprofitable to operate. Now their value was contained mostly in their steel bodies.

Nearly all the demolition crews had left work for the day, and the ships stood silent, except for the gurgling in their bowels and the occasional echo of metal clanking. The air hung heavy with the odor of brine and diesel fuel. Making our way around one hull, we heard laughter and came upon a group of naked boys who had swum out to a half-submerged piece of wreckage and were using it as a diving platform. Just beyond the line of ships, fishermen were casting their nets for schools of tiny ricefish, a local delicacy.

Suddenly a shower of sparks rained down from the stern several stories above us. A head appeared over the side, then arms waving vigorously. "Move away! We're cutting this section," a man yelled down at us. "Do you want to die?"

Oceangoing vessels are not meant to be taken apart. They're designed to withstand extreme forces in some of the planet's most difficult environments, and they're often constructed with toxic materials, such as asbestos and lead. When ships are scrapped in the developed world, the process is more strictly regulated and expensive, so the bulk of the world's shipbreaking is done in Bangladesh, India, and Pakistan, where labor is cheap and oversight is minimal.

Industry reforms have come in fits and starts. India now requires more protections for workers and the environment. But in Bangladesh, where 194 ships were dismantled in 2013, the industry remains extremely dirty and dangerous.

It also remains highly lucrative. Activists in Chittagong told me that in three to four months the average ship in Bangladeshi yards returns roughly a one-million-dollar profit on an investment of five million, compared with less than

Peter Gwin wrote about the psychology of risk taking in June 2013. Mike Hettwer photographed a Stone Age cemetery for the September 2008 issue.

Steel from ship hulls is harvested in plates. Each can weigh a thousand pounds or more. Using brute strength and improvised rollers, teams of carriers (above) move the plates to trucks, which transport them to mills where they are converted into steel rods for construction. Carriers spend their days slathered in mud (top) contaminated with heavy metals and toxic paint particles that leach from the ships into the tidal flats.

"Cuttermen" armed with acetylene torches and trailed by their assistants first strip a ship of its fittings and then methodically carve through the layers of decks. Demolition takes three to six months, depending on the ship's size.

After workers spent several days cutting through the decks of the *Leona I*, a large section suddenly crashes, sending shards of steel flying toward the yard managers. Built in Split, Croatia, the cargo vessel was at sea for 30 years, about the average ship's life span.

Oblivious to the risk of lung cancer, workers fend off the nighttime chill by burning a pipe gasket likely containing asbestos (top). Some 300 people in Dhunot, a village in the Himalayan foothills, attend the funeral of Rana Babu (above), a 22-year-old ship-breaker who was killed when a torch sparked a gas pocket and set off an explosion. “He was just a boy,” said one mourner. “Why does this keep happening?”

$200,000 profit in Pakistan. I called Jafar Alam, former head of the Bangladesh Ship Breakers Association. He denied that profit margins were that high. "It varies by ship and depends on many factors, such as the current price of steel," he said.

Whatever the actual profits, they are realized by doggedly recycling more than 90 percent of each ship. The process begins after a ship-breaker acquires a vessel from an international broker who deals in outdated ships. A captain who specializes in beaching large craft is hired to deliver it to the breaker's yard, generally a sliver of beach barely a hundred yards wide.

Once the ship is mired in the mud, its liquids are siphoned out, including any remaining diesel fuel, engine oil, and firefighting chemicals, which are resold. Then the machinery and fittings are stripped. Everything is removed and sold to salvage dealers—from enormous engines, batteries, generators, and miles of copper wiring to the crew bunks, portholes, lifeboats, and electronic dials on the bridge.

After the ship has been reduced to a steel hulk, swarms of laborers from the poorest parts of Bangladesh use acetylene torches to slice the carcass into pieces. These are hauled off the beach by teams of loaders, then melted down and rolled into rebar for use in construction.

"It sounds like a good business until you consider the poison that is soaking into our land," says Muhammed Ali Shahin, an activist with the NGO Shipbreaking Platform. "Until you've met the widows of young men who were crushed by falling pieces of steel or suffocated inside a ship." At 37 Shahin has been working for more than 11 years to raise awareness about the plight of the men who toil in these yards. The industry, he says, is controlled by a few powerful Chittagong families who also hold stakes in the ancillary businesses, including the steel rerolling mills.

Shahin insists he's not blind to his country's desperate need for the jobs shipbreaking creates. "I do not say shipbreaking must stop entirely," he says. "But it must be done cleaner and safer with better treatment for the workers."

His criticism isn't reserved just for Bangladeshi ship-breakers. "In the West you don't let people pollute your countries by breaking up ships on your beaches. Why is it OK for poor workers to risk their lives to dispose of your unwanted ships here?"

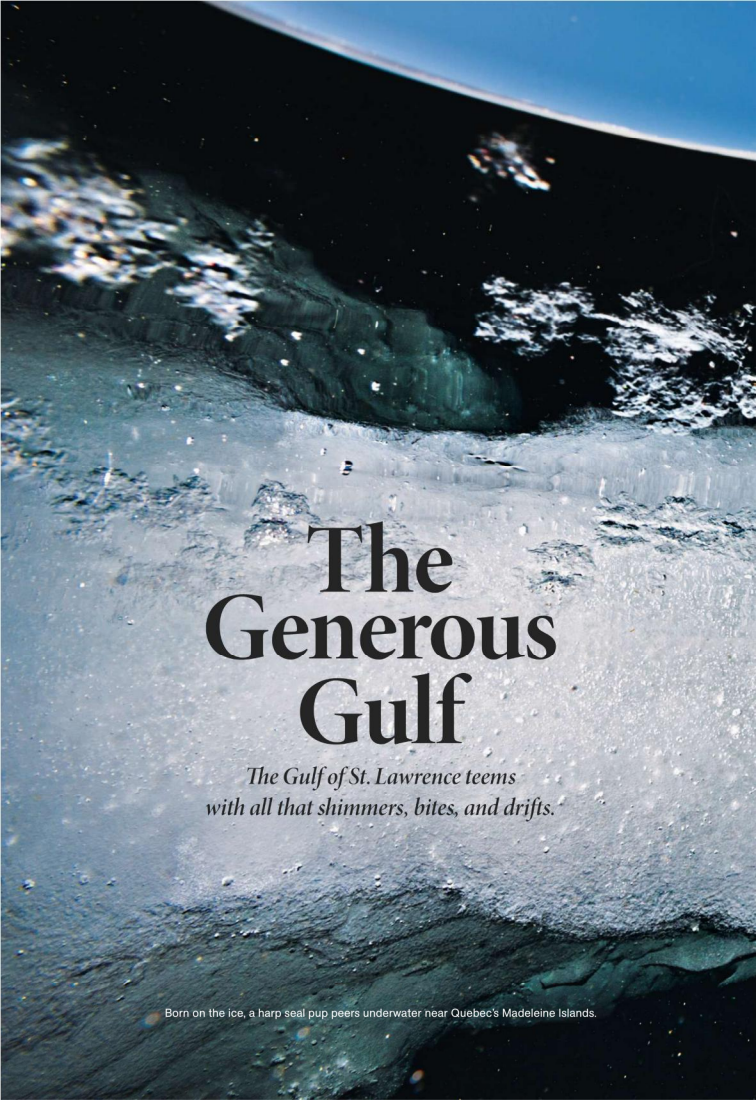
In the sprawling shantytowns that have grown up around the yards, I met dozens of the workers about whom Shahin is most concerned: the men who cut the steel and haul it off the beaches. Many had deep, jagged scars. "Chittagong tattoos," one man called them. Some men were missing fingers. A few were blind in one eye.

In one home I meet a family whose four sons worked in the yards. The oldest, Mahabub, 40, spent two weeks as a cutter's helper before witnessing a man burn to death when his torch sparked a pocket of gas belowdecks. "I didn't even collect my pay for fear they wouldn't let me leave," he says, explaining that bosses often intimidate workers to keep silent about accidents.

He points to a photo in a small glass cabinet. "This is Jahangir, my second oldest brother," Mahabub says. Jahangir went to work at 15, after their father died. "He was a cutter in the Ziri Subedar yard and was fatally injured there in 2008." He and his fellow workers had been cutting a large section for three days, but it wouldn't fall. During a rainstorm they took shelter beneath the piece, and it suddenly gave way.

The third brother, Alamgir, 22, is not home. He had been assisting a cutter when he fell through a hatch on a tanker, plunging about 90 feet into the hold. Miraculously, enough water had seeped into the bottom to break his fall. One of his friends risked his own life to shinny down a rope and pull him out. Alamgir quit the next day. Now he serves tea to the managers in the yard's office.

The youngest brother, Amir, 18, still works as a cutter's helper. He is a wiry boy with smooth, unscarred skin and a nervous smile. I ask if he's scared by his brothers' experiences. "Yes," he says, smiling shyly as if unsure what to say next. As we talk, a thunderclap shakes the tin roof. Another boom follows. I look outside, expecting to see the onset of one of Bangladesh's famously violent monsoons, but the sun is shining. "It's a large piece falling from a ship," says the boy. "We hear this every day." □



The Generous Gulf

The Gulf of St. Lawrence teems with all that shimmers, bites, and drifts.

Born on the ice, a harp seal pup peers underwater near Quebec's Madeleine Islands.

Cunners zero in on a sunlit kelp patch to prey on everything from shrimp to jellyfish in nutrient-rich Bonne Bay, off the west coast of Newfoundland.

A pair of Atlantic wolffish—named for their fangs—cozy up in a den in Bonne Bay. The female departs after laying eggs, leaving their care to the male.

By Rob Dunn
Photographs by David Doubilet and Jennifer Hayes

THE GULF OF ST. LAWRENCE IS the sum total of everything that rolls downhill. It gathers from rivers whose finger streams begin hundreds of miles away—in cities like Montreal and in old-growth forests in New York State. It sweeps up sediment, runoff, and the litter of leaves. It churns and roils in a constant state of metamorphosis. Underwater, bacteria and plankton mix sediment with light and animate the inanimate. The accounting adds up to a density of shimmering, biting, drifting life as rich as anywhere else on Earth.

Geologically speaking, the gulf is new to the world. Nineteen thousand years ago, the entire gulf was under ice more than a mile thick. The ice pressed down the land to such an extent that when it finally melted, the earth sprang back up in what one can describe only as relief. As the land rose and the ice melted, the gulf filled with water and life. Freshwater fish migrated down the St. Lawrence River; saltwater fish, sea urchins, sea stars, plankton, and whales arrived from the Atlantic.

The thumb of land known as Cape Breton Island separates the southern edge of the Gulf of St. Lawrence from the sea. On the cape's east the waters are cold and can be terrifying. On its west the waters are, if not warm, warmer, and if not calm, calmer. The first gatherers on Cape Breton were the ancestors of the Mi'kmaq (pronounced MIG-maw), one of the indigenous peoples of Canada's Maritime Provinces. They arrived at the gulf at least 9,000 years ago, spreading through what is now Nova Scotia and Newfoundland and gathering the bounty according to their preferences and needs: seals, seabird eggs, salmon, sturgeons, shad, and even whales.

Beginning in the 1500s French, Basque, and Portuguese fishermen came and traded with the local people. Those who came later settled around the native people, for they too were dependent on the gulf's life and subject to its cycles. Cod appeared, and boats would appear over them. Walruses appeared, and hunters would soon follow.

For Europeans used to the overfished waters of their homeland, where many species had already become scarce and large mammals even more so,

Rob Dunn's latest book is The Wild Life of Our Bodies. *David Doubilet and Jennifer Hayes live beside the St. Lawrence River in New York State.*

John Taylor, second from right, and crew haul in a trap pulsing with herring in the Strait of Belle Isle. "I'm the last of my breed," says Taylor, whose children aren't interested in the rigors of fishing life.

life in the gulf seemed large. And it was. But the discovery of this life triggered a wave of exploitation, the first industrial-scale gathering in the New World. Thousands of fish were harvested, then tens of thousands, and soon millions. By the 17th century tons of cod, whales, and other creatures had been harvested from the gulf and shipped to Europe, exceeding the value of gold and silver shipped from the Gulf of Mexico. Under such pressure, populations began to give way. What seemed infinite was finite, after all.

Just how badly the species of the gulf were affected by the Europeans' (and, with time, North Americans') harvest depended on the size of the catch and on the tempo of those species' lives. Whales with their ponderous babies, walruses with their bulbous accumulation of body mass, and sturgeons all grow slowly, mate rarely, and die old. They were affected first. Recently, some whale populations have begun to recover, but slowly. Walruses remain missing from the gulf, except for the odd straggler from Arctic waters. The sturgeons persist as they have for tens of millions of years, by hanging on.

Many fish mature faster, breed more often, and recover faster than the big mammals, but even they are vulnerable. They multiply, from two to many, but not quickly enough to feed the multitudes who came to depend on them. The cod are now rare, on the verge, in some places, of

Billion-year-old Precambrian rocks form the walls—and loom on the bottom—of Western Brook Pond, a see-through lake in Gros Morne National Park.

For now the gulf is still wild with life, with trillions of

extinction. Every so often a fisherman puts out a line to check for them, but the line comes back empty, water hanging like hope on the hook.

Although numbers of cod and other predatory fish have plunged, lobsters are surging. Other species, many of them bottom-feeders, are fished too, but lobsters are now the fate to which the most lives here are tied, and the weather that draws out the boats or sends them home. The lobsters are not infinitely abundant either, but for now, at least, the crustaceans are thriving.

The gulf has changed and will continue to change. Even if fishing were to stop tomorrow, populations would wax and wane with climate change, which threatens to make the gulf warmer and less salty. So far we have chosen to make the gulf and its life-forms a little less useful to humans with each generation, and a little less lovely. Case in point: We eat the big cod, and so the remaining cod mature at an earlier age and a smaller size, so they can breed before getting big enough to be dinner worthy.

For thousands of years the gulf has been a place to gather from the generous waters, but times have changed. Gatherers are no longer just men and women in boats; they now include petroleum executives for whom fortune does not leap out of the water like a fish.

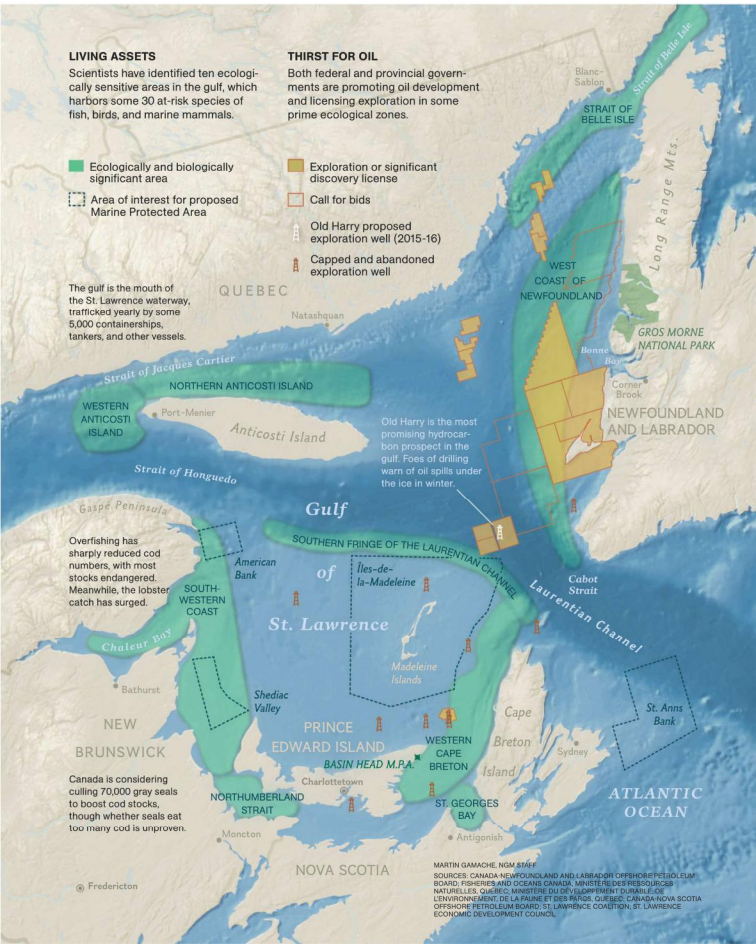
Plans are under way to drill the first big oil well in the gulf, in an area known as Old Harry. Environmentalists see the oil as a tragedy that's different from the old tragedies of the gulf. Maybe. You could also see it as just one more story of our choices about what we gather. We gathered the cod, as food and for oil, which fueled the lamps of industry. We gathered the whale for the same. If we gather Old Harry's oil, it will run out faster than whale or cod, but it will fuel our daily actions, our commutes and our enterprise, just the same. Of course, if it ever spills, it will also fuel oil-eating bacteria and other species that grow at our expense rather than to our benefit.

The good news is we get to choose—algal weeds or whales, oil-eating bacteria or seals. We get to choose because for now the gulf is still wild with life, with trillions of individual organisms, and a great many hopes and dreams. □

Fertile waters

The bounty of the St. Lawrence Gulf and its estuary comes from nutrient-rich currents from the Atlantic Ocean that mix with fresh water from the interior. Jurisdiction is split between Canada's federal government and five provinces, complicating management. Years of overfishing, warming waters, and possible offshore drilling cause concern for the ecosystem's health.

organisms and a great many hopes and dreams.



MARTIN GAMACHE, NGM STAFF

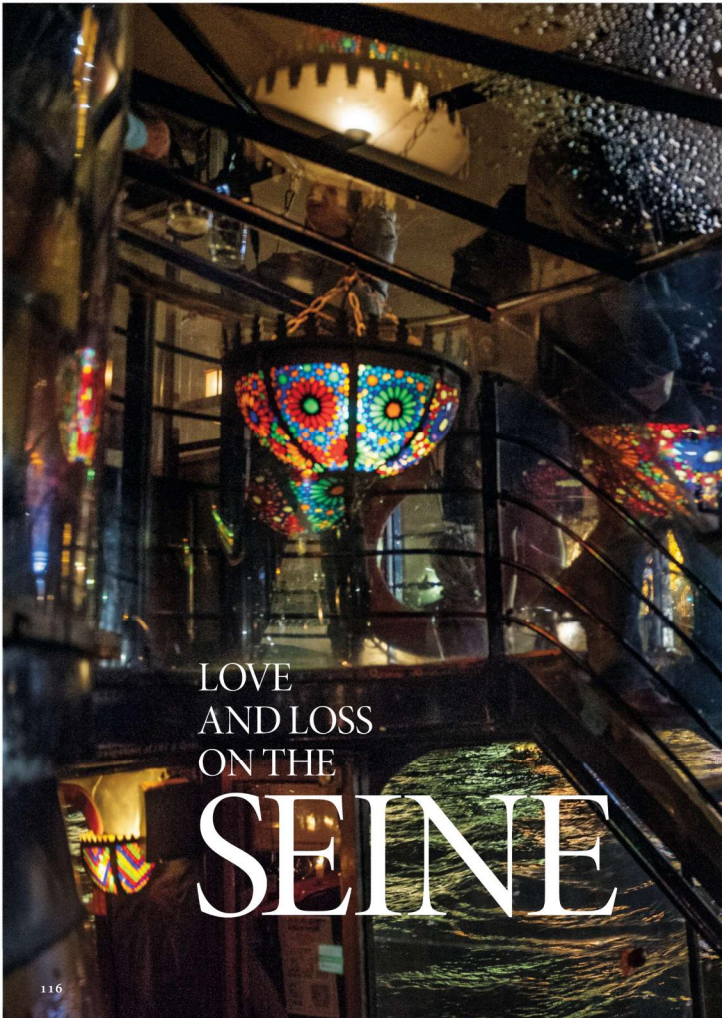
SOURCES: CANADA-NEWFOUNDLAND AND LABRADOR OFFSHORE PETROLEUM BOARD; FISHERIES AND OCEANS CANADA; MINISTÈRE DES RESSOURCES NATURELLES, QUÉBEC; MINISTÈRE DU DÉVELOPPEMENT DURABLE, DE L'ENVIRONNEMENT, DE LA FAUNE ET DES PARCS, QUEBEC; CANADA-NOVA SCOTIA OFFSHORE PETROLEUM BOARD; ST. LAWRENCE COALITION; ST. LAWRENCE ECONOMIC DEVELOPMENT COUNCIL

A blizzard of snow geese fills the sky above the St. Francis River in Quebec. Migrating in fall from the Arctic, the birds pause here on the Atlantic flyway to feed and rest.

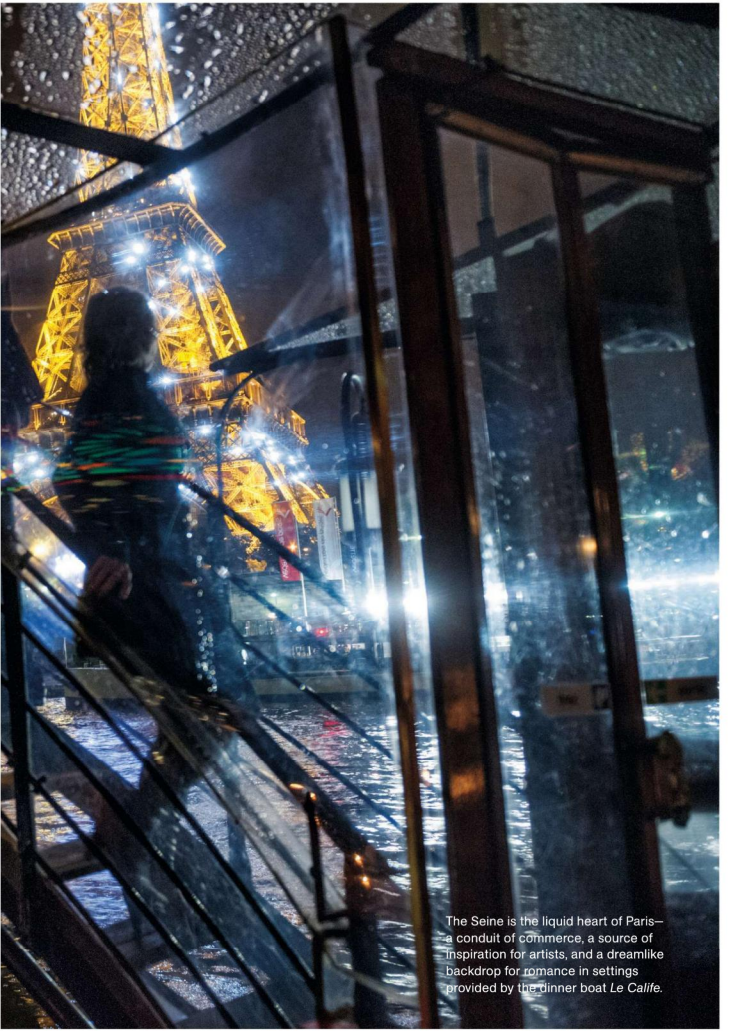
With a mother's touch, a female harp seal (top left) coaxes her white-furred pup off the ice to swim near Prince Edward Island. In a time of warming waters and diminished ice cover in the gulf, two weeks of maternal care is no guarantee a newborn will survive. After the mother leaves, pups sometimes drown when thinning or unstable ice collapses. The greatest threats to a beluga (bottom left) aren't scrapes with fellow males, which left tooth scars on this juvenile, but the industrial contaminants and shipping collisions in its habitat. A lion's mane jellyfish (above) drifts in Bonne Bay. The species can grow to eight feet across.

A shorthorn sculpin hides amid fish scales beneath a pier in Blanc-Sablon, Quebec. A voracious feeder, it is cursed by anglers who hook the spiny fish.

A lone harp seal hugs thinning ice near the Madeleine Islands. Pups spend their first month on an ice floe, a precarious nursery as ice shrinks in the gulf.



LOVE AND LOSS ON THE SEINE



The Seine is the liquid heart of Paris—a conduit of commerce, a source of inspiration for artists, and a dreamlike backdrop for romance in settings provided by the dinner boat *Le Califé*.

BY CATHY NEWMAN

PHOTOGRAPHS BY WILLIAM ALBERT ALLARD

Most every morning at nine, the emergency responders assigned to the Seine pull on their wet suits and swim around the Île de la Cité. In the course of their circuit around this teardrop-shaped island in the middle of the river in the middle of Paris, the firemen-divers scour the bottom, retrieving bikes, cutlery (which they clean and use in the

nearby houseboat where they live), cell phones, old coins, crucifixes, guns, and once, a museum-grade Roman clasp.

By the Pont des Arts, where lovers affix brass locks inscribed with their names (*"Steve + Linda Pour la Vie"),* they retrieve keys tossed in the water by couples hoping to affirm the eternal nature of their padlocked love. One bridge upriver, at the Pont Neuf, near the Palace of Justice law courts where divorces are decreed, they find wedding bands, discarded when eternal love turns out to be ephemeral.

As the central artery of Paris, the Seine naturally accrues the detritus of human civilization and relationships. Through centuries it has served as highway, moat, water tap, sewer, and washtub. Its scimitar arc slices the city, dividing it into Left and Right Banks. Historically, Left was bohemian, Right, aristocratic, but distinctions have blurred over time.

Cathy Newman dreams of owning a pied-à-terre on the Left Bank. This story marks William Albert Allard's 50th year as a contributor to the magazine.

On the Île de la Cité itself, in front of the Gothic tracery of stone that is the Cathedral of Notre Dame, is a bronze compass rose set into paving stones. From here—*point zéro*—all distances from Paris are measured. The Seine centers Paris; it is its liquid heart. "For Parisians the Seine is a compass, a way to know where you are," says Marina Ferretti, an art historian and curator.

It is also, as the French say, *fluide,* a word with philosophical implications. Surrender to impermanence and flux, it whispers. Nothing stays the same. No use commanding the Seine to sit still. A river stilled is no longer a river. It changes with the time of day and season. Its currents carry the jetsam and flotsam of life and death—lost plastic toys, escaped balloons, cigarette butts (Gauloises, naturally), empty wine bottles, sometimes even a corpse—as they swirl, churn, flood, and flow past the monumental architecture of Paris. You cannot step into the same river twice, Heracleitus tells us. *C'est fluide.*

The Impressionists distilled its light into quicksilver. Claude Monet kept a floating studio

The river slips past 37 bridges on its way west through Paris. This view is from the Eiffel Tower.

on the river near Argenteuil. Henri Matisse, a post-Impressionist, had a studio on the Quai Saint-Michel. The flat, gray ribbon of water painted by earlier artists danced with opalescence through the lens of the Impressionists. Their art reflected the flow of not just the Seine but the world as well.

"The Impressionists watched the world change and painted in a way corresponding to that new world," says Ferretti, curator at the Giverny Museum of Impressionisms. The industrial revolution had arrived. Electricity hung pearls of light against the black night. Construction of the Paris Métro was imminent. The rhythm of the world was accelerating. "It was rapid and fluid," she explains. And so was the brushwork of the Impressionists.

With a nod to them, let us sketch the river that flows in and around the lives of Parisians and serves as a stage for dramas of love and loss. There is the occasional gentle jest, as well, in the guise of vendors who sell cheap, made-in-China copies of the Eiffel Tower. Sometimes the buyer is a Chinese tourist who brings the trinket home, completing an unwitting circuit. The Seine is witness to irony, as well as joy and sorrow.

J'AIME MON BATEAU

A coup de foudre is to fall in love suddenly, fiercely. So it is with men and their boats.

One day 34 years ago Claude Tharreau, a young market researcher, was walking along the Seine near the Quai de Conti, when he saw the *Cathare,* a 70-foot-long Dutch barge built in 1902, for sale.

"I had been actually looking for an apartment," he says. It was Sunday. On Wednesday he signed the contract.

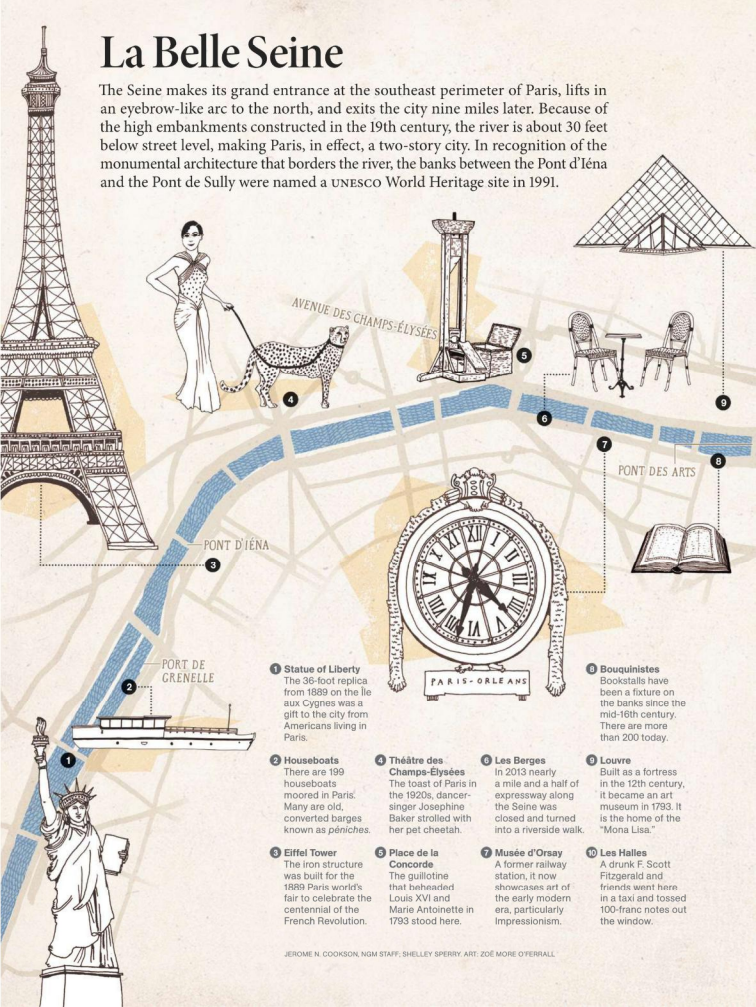
"It was only afterward I noticed it was a boat with no electricity or water."

There are 199 houseboats moored in Paris and, undoubtedly, 199 stories of infatuation. In the 1970s, when the economics of transport favored trains and trucks over barges, a boat could be bought cheaply. The lifestyle was inexpensive

In Paris even the eating of an ice-cream cone is carried out with panache. For a month in summer parts of the riverbank are transformed into palm-tree-studded beaches, an event known as Paris Plages.

La Belle Seine

The Seine makes its grand entrance at the southeast perimeter of Paris, lifts in an eyebrow-like arc to the north, and exits the city nine miles later. Because of the high embankments constructed in the 19th century, the river is about 30 feet below street level, making Paris, in effect, a two-story city. In recognition of the monumental architecture that borders the river, the banks between the Pont d'Iéna and the Pont de Sully were named a UNESCO World Heritage site in 1991.



1 Statue of Liberty
The 36-foot replica from 1889 on the Île aux Cygnes was a gift to the city from Americans living in Paris.

2 Houseboats
There are 199 houseboats moored in Paris. Many are old, converted barges known as *péniches*.

3 Eiffel Tower
The iron structure was built for the 1889 Paris world's fair to celebrate the centennial of the French Revolution.

4 Théâtre des Champs-Élysées
The toast of Paris in the 1920s, dancer-singer Josephine Baker strolled with her pet cheetah.

5 Place de la Concorde
The guillotine that beheaded Louis XVI and Marie Antoinette in 1793 stood here.

6 Les Berges
In 2013 nearly a mile and a half of expressway along the Seine was closed and turned into a riverside walk.

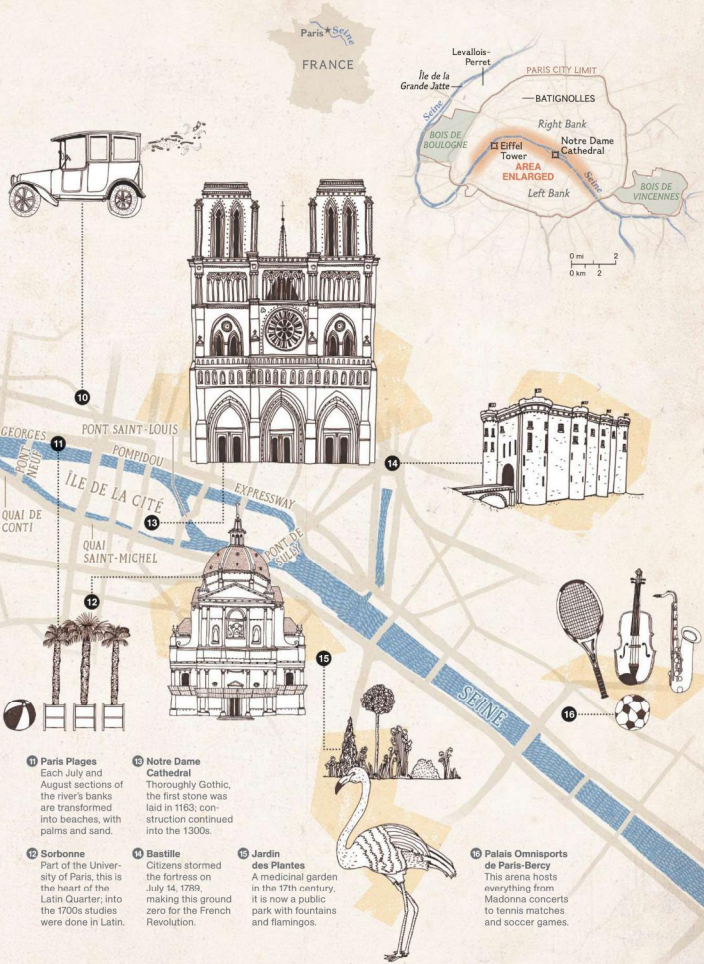
7 Musée d'Orsay
A former railway station, it now showcases art of the early modern era, particularly Impressionism.

8 Bouquinistes
Bookstalls have been a fixture on the banks since the mid-16th century. There are more than 200 today.

9 Louvre
Built as a fortress in the 12th century, it became an art museum in 1793. It is the home of the "Mona Lisa."

10 Les Halles
A drunk F. Scott Fitzgerald and friends went here in a taxi and tossed 100-franc notes out the window.

JEROME N. COOKSON, NGM STAFF; SHELLEY SPERRY, ART; ZOË MORE O'FERRALL



11 Paris Plages
Each July and August sections of the river's banks are transformed into beaches, with palms and sand.

12 Sorbonne
Part of the University of Paris, this is the heart of the Latin Quarter; into the 1700s studies were done in Latin.

13 Notre Dame Cathedral
Thoroughly Gothic, the first stone was laid in 1163; construction continued into the 1300s.

14 Bastille
Citizens stormed the fortress on July 14, 1789, making this ground zero for the French Revolution.

15 Jardin des Plantes
A medicinal garden in the 17th century, it is now a public park with fountains and flamingos.

16 Palais Omnisports de Paris-Bercy
This arena hosts everything from Madonna concerts to tennis matches and soccer games.

and unregulated until 1994, when the city instituted a housing tax, a mooring fee, and rules requiring a contract of occupation.

Frédéric Chaslin, a conductor and composer, has a Steinway grand piano in the living room of his boat, *Caracalla*, and in the kitchen, a trio of espresso machines that whistle the same note in unison when brewing.

"I loved it," he says of the first boat he bought. "My wife did not. I thought, wife, boat, wife…

"…Boat," he finishes.

"It is something out of the ordinary to buy a boat," says Eric Piel, a retired psychiatrist and the owner of *Orion,* a barge moored opposite the Eiffel Tower. "It is not the same as buying an apartment. There's an element of risk. But…to own a place and have mobility too! It is the best of all possible worlds."

Piel, who has a wiry frame and a face flushed with tiny riverine capillaries, framed by graying curls, continues. "An apartment is a shoe box, and so you spend your whole life working so you can live in a shoe box? Do you think that is a sign of good health?

"At least I am not trapped in a shoe box," he muses. "There are other traps, though."

INSTANT BEACH (JUST ADD WATER)

At 10:58 p.m. on July 19 a flatbed truck with 36 palm trees, escorted by four policemen on motorcycles and a squad car, inched its way down the Champs-Élysées from the Bois de Boulogne, where the trees had spent the winter, and pulled up at the Pont Neuf, which despite its name is the oldest bridge in Paris.

Twenty-six minutes later a crane lifted the first 25-foot-high tree and set it down onto the beach that had materialized in three days on the banks of the Seine in front of City Hall. The palms *(Trachycarpus fortunei)* are the crowning touch of Paris Plages—an annual tour de force that takes place in summer when three full-blown beaches are installed along the river.

The sandbox-on-the-Seine was initiated 12 years ago by Paris Mayor Bertrand Delanoë. To accommodate the beach, the Georges Pompidou Expressway flanking the Right Bank of the river is blocked off for four weeks. It is as if the mayor of New York blocked off FDR Drive on Manhattan's East Side to allow New Yorkers to unfold beach towels in the shadow of the United Nations.

"It's not rocket science," says project manager Damien Masset. He ticks off the ingredients for an instant beach: 5,500 tons of sand, 250 blue umbrellas, 350 deck chairs, 800 chairs, 250 chaise longues, 40 hammocks, 200 tables, four ice-cream stands, eight cafés, 875 yards of wooden fencing; 250 people to put it up, 450 to run it.

For one summer month in Paris the Seine becomes an urban Riviera, an ebb and flow of beach-volleyball players; sand-castle engineers; samba, tango, and break dancers; rock, jazz, soul musicians; and sunbathers—who demonstrate the infinite variety of the human form.

WHAT COLOR IS THE SEINE?

"When you have clouds, for a few minutes it is white as salt," says Jean Esselinck, a retired diplomat who lives on the barge *Soleil.* "But then it turns black. Look at the river, for now it's green."

"Transparent," says Marie-Jeanne Fournier, mayor of Source Seine, a village in Burgundy 180 miles from Paris, near where the river originates. Despite the distance, the Seine can be said to begin in Paris, because the fir copse where it bubbles up and starts its 482-mile journey to the sea became the property of Paris in 1864 by order of Napoleon III. Here, in its infancy, the Seine *is* transparent: clear as eau-de-vie and located in Paris. Technically.

Monet's river in "Banks of the Seine, Island of the Grande Jatte" is pink, white, and blue; Matisse's Seine in "Pont Saint-Michel" has red in it, but, cautions Doris Alb, an artist who lives on the *Sun Day,* by the Pont des Arts, you must take care when referring to colors in French. "In German red is red. But in French red could be…well, perhaps it is red…but with a bit of yellow…or

Grace notes from classically trained violinist David Vinitzki embellish the ambience of the Pont Saint-Louis.

verging on pink…or perhaps only the illusion of red." Alb is a sturdy woman who stands on sturdy shoes, with yellow hair that flies around as if painted by Botticelli. Her eyes are forced into a squint by the sun. She will not wear sunglasses. "It would dull the colors of the world."

What color is the Seine?

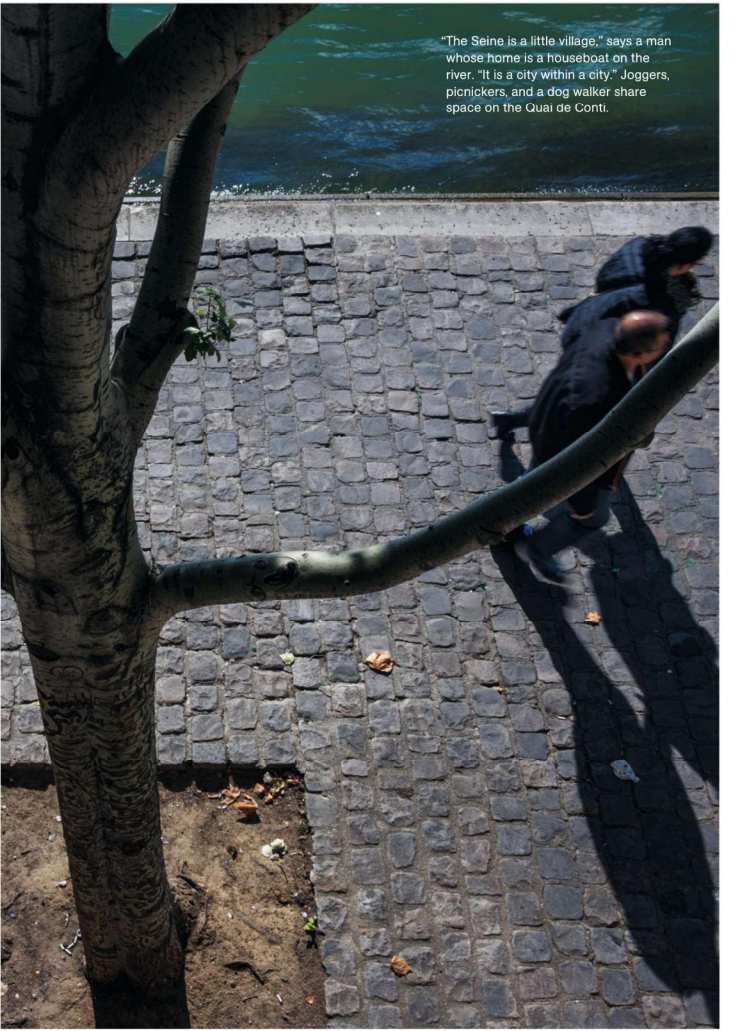
"*C'est compliqué.* The Seine reflects life and everything around. So its colors are infinite."

RECLAIMING THE RIVER

In the 1960s Prime Minister Georges Pompidou delivered the coup de grâce to Paris's relationship with the Seine. He built expressways on both sides of the river. "Paris must adapt to the car," he said with "let them eat cake" ease. In truth the disconnect dates back to the 18th century. Until then the riverfront was a vibrant commercial and social space, historian Isabelle Backouche explains. After 1750 the royal administration and the city began to clear out markets, laundry boats, and workshops from the banks to make the Seine more hospitable to navigation. The high embankments engineered in the 19th century cemented the estrangement. "The river was abandoned as a lively space and transformed into a museum unconnected to the everyday life of Parisians," Backouche says.

Fast-forward to 2013. Enter Socialist Mayor Delanoë, initiator of Paris Plages, city bicycle and electric car share systems, and a pilot program employing four "lawn mower" sheep to clip grass at the city archives. Last June, after years of political bickering, Delanoë closed nearly a mile and a half of expressway on the Left Bank and opened Les Berges—a riverside walk with floating gardens, restaurants, and playgrounds. "The road's stale air is being blown away, creating an open-air environment where everyone can…enjoy themselves," he announced happily.

Not everyone was as happy. "I opposed it," says Rachida Dati, mayor of the affluent 7th arrondissement. Dati, daughter of a Moroccan bricklayer, is a maverick on the political right. She looks defiant behind her desk in the



"The Seine is a little village," says a man whose home is a houseboat on the river. "It is a city within a city." Joggers, picnickers, and a dog walker share space on the Quai de Conti.

17th-century town hall where she presides, dressed in skinny jeans, a short black jacket, and impossibly high heels.

"The Berges cost 40 million euros [$55 million]," she argues. "Perhaps instead we could have taken care of the 27,000 children unable to attend a crèche or developed public transport. Three-quarters of Parisians ride the Métro, but there's been no investment in its infrastructure in years."

Doesn't the new space make life in Paris more pleasant?

"Paris is not about pleasure. We need to work."

On the transformed riverbank in front of the Musée d'Orsay, many seem happy to indulge in its pleasures.

"We are Parisians but don't feel like we're in Paris," enthuses Bertine Pakap, a beautician who lives in Batignolles, in an outlying arrondissement. She has come for a family reunion. Her daughter Elohina raptly watches two mimes perform, while her mother sits at a picnic table. "Normally we wouldn't come to a chic neighborhood like this," she says. "It's almost inaccessible for us. Now it's more democratic. Also free—we don't need money to have a good time."

PASSENGERS

By 6:20 p.m. three men have lined up in front of the gangway leading to the *Fleuron St. Jean,* a light green barge moored on the city's outskirts. The men are about to embark on a one-night voyage that will not entail travel—simply a warm meal and comfortable bed.

"We call them passengers out of respect," says Adrien Casseron, manager of the floating homeless shelter funded by the Order of Malta in France and 30 Million Friends Foundation, an animal welfare organization (the men are allowed to bring their dogs). The voyage is an interlude in a life that has stalled in the vise of unemployment and poverty.

"In a village if you lose your job, your neighbors help. In a big city you are alone. You lose your job, your family, and you find yourself in the street.

"Don't imagine the boat holds just the French," he adds. "If there is a conflict in Mali or Afghanistan, we see it here."

The men, some with backpacks, some with only the clothes they wear, are greeted with a handshake and shown their bunks. At 7:45 they sit down for dinner. The day's menu: green beans, fish, cheese, yogurt, and fruit, served "as you would in your own home," Casseron says.

"I came from Martinique," says René, who is 58 and wears a gray T-shirt and jeans. In a voice full of wistful sadness, he explains how he lost his most recent job building cabinets for electronics. "They outsourced my work. I lived in my sister's flat for two months. She threw me out.

"Family stories can be complicated," he adds ruefully. He will not elaborate.

There is little conversation at the dining table. The men eat hurriedly, reaching eagerly for a second, third, and fourth piece of bread. After dinner three men settle down to a game of Scrabble. Others play cards. René fills his pipe. "During the day I go to exhibitions or the library. But I never give up. You have to be strong. It's easy to let go. Two beers, a joint. That's it. You sink."

Patrick Declerck, anthropologist and author of *Les Naufragés (The Castaways),* estimated the number of homeless in Paris to be between 10,000 and 15,000 in 2001. According to the National Institute of Statistics, the number has increased by 50 percent since then. No one keeps exact statistics; the total could be much higher.

Casseron goes to greet a late arrival. "There are never enough places for everyone," he says. "The work is rewarding, but I always ask myself if I am doing enough.

"This"—he means the shelter the boat provides—"is a drop of water. Pure. Unpolluted. But just a drop of water in the river that is the Seine."

THOU SHALT NOT WATER-SKI

On one of those wilting summer days when heat rises from the asphalt in visible waves, the river outside the office of the chief of the police who patrol

Île de la Grande Jatte, site of the 19th-century painting by Georges Seurat, offers a breath of green now as then.

the Seine looks inviting and cool.

Can you swim in the Seine? I ask Sandrine Berjot, the crisp, no-nonsense police commandant who heads the Brigade Fluviale.

Non, she says flatly. "Thirty-eight euros." The fine for violation.

What about wading? Dangling your feet?

"Not so much as a toe."

Other infractions: Waterskiing in certain zones. Tying your boat around a tree with a rope. Protesting or putting up banners. ("That is for the street," Berjot says.)

More serious is failure to aid someone in distress. The penalty: up to 75,000 euros ($103,000) and five years in jail.

"If someone is drowning, you don't have to jump in. You do have to call the police," Berjot explains. Just as well—the lifesaving rings formerly mounted on every bridge are gone. Collectors snitched many. Now the deployment of the Gallic sense of *fraternité* is enabled by a sign displaying a number to call in an emergency. In France, to be a Good Samaritan is a moral imperative.

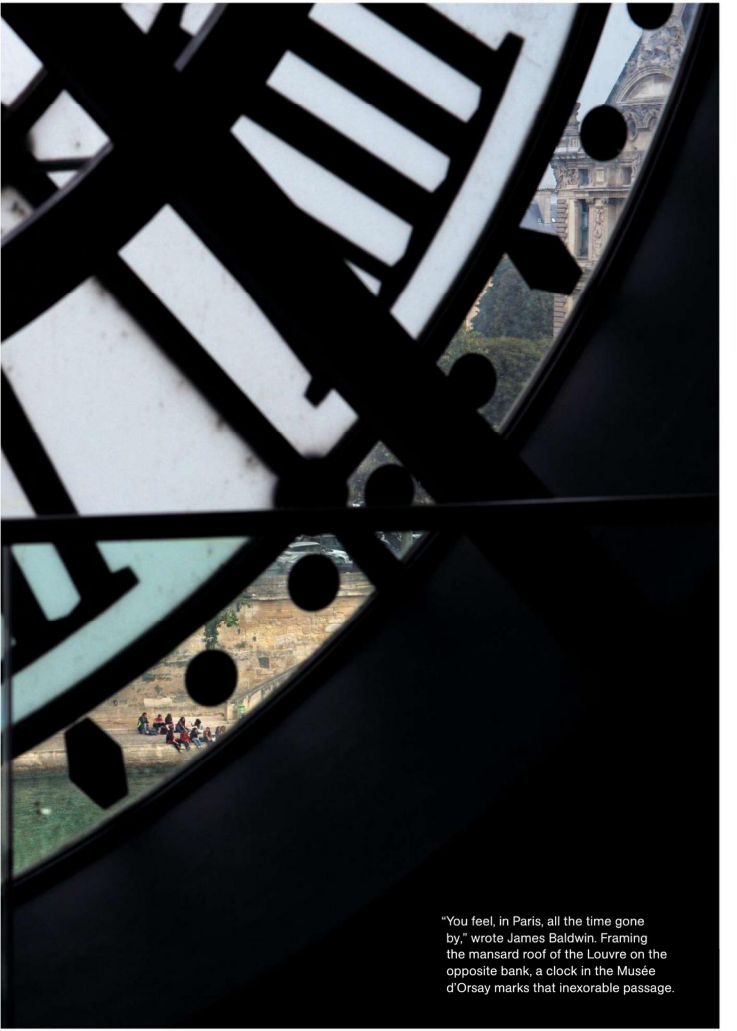
"Naturally," a Paris lawyer once told me, "that doesn't obligate us to simpler civilities, like giving you the time of day."

BIG FISH STORY

Street fishing—casting a lure in the shadow of the Eiffel Tower or Louvre—

has become a popular sport. A festival last year attracted 100 fishermen, but, says Damien Bouchon of the Maison de la Pêche et de la Nature, a nature center at Levallois-Perret, "fishing the Seine is difficult because the embankments are so high. The fish are educated. They've seen lots of lures."

In postwar decades, pollution reduced the species count to five, but French water regulations starting in the 1960s revived the tally to 32, including perch, pike, and the *silure*—a Quasimodo of a beast (a seven-footer is the record) with a vacuum cleaner mouth, mud-colored skin the texture of rubber, and small, beady eyes. The silure is an opportunist; it eats fish, ducks, and pigeons that have the misfortune



"You feel, in Paris, all the time gone by," wrote James Baldwin. Framing the mansard roof of the Louvre on the opposite bank, a clock in the Musée d'Orsay marks that inexorable passage.

to alight for a drink near its lurking jaws.

"But they are exciting sport," Bouchon hurries to add, lest I think unkindly of them. "To catch one is a moment of adrenaline."

INTERLUDE

At three in the morning the Seine is quiet and dark as India ink. A resolute line of barges files past the Quai de Conti. The blue umbrellas on the Paris Plage in front of City Hall are furled like morning glories awaiting the sun.

The traffic light on the Right Bank by the Pont Neuf turns red, though there are no cars to heed its warning. The hazard buoy off the tip of the Île de la Cité flashes a Morse code of emerald green. Houseboats rock gently on the wake of the barges; mooring lines creak in protest.

A light winks in a window on the top floor of the Louvre above the Quai du Louvre. A guard checking to see that the Old Masters are safely tucked into their frames, perhaps?

There is no one to ask.

AN ANCIENT MARINER

Like the motto of Paris—"*Fluctuat nec mergitur,* tossed by waves but unsinkable"—there are those tossed by waves who remain tenaciously unyielding. René Ballinger, 87, lives on the *Siam* by the Port de Grenelle with his wife, Nenette, 86. His grandfather built the boat. He was born on it; so was his son, Marc. During its working life, the barge crossed Belgium, Holland, Germany, and Switzerland, carrying grain, coal, and steel.

Nenette, who wears gold-rimmed glasses and has skin like parchment and short, feathery, white hair, was not born into a mariner family. "I worked as a secretary in northern France," she says, seated at her dining table. "I lived beside the water. One day he arrived on a boat."

"I saw her," René interjects. His glance said the rest. They married in 1947. She calls him "old scamp." He says she is his best friend. Their daughter says they argue too much.

"We argue," Nenette told her, "because we are still alive. When we are dead, we will be quiet.

"He was a mariner. I was of the land. When I married, I asked myself, What kind of tribe have I joined?"

She learned a mariner's life. She helped paint the boat, pilot it; she tolerated stowaway mice and living in less than 100 square feet of space. The adventure of an unfixed, fluid existence compensated for lack of comfort. Every day brought new towns, landscapes, and a freedom unknown to those shackled to an office chair. "We worked as if we were on a holiday," she says.

Twenty-seven years ago they retired.

"We could have moved to land. He refused," Nenette says.

"I'd feel trapped," he replies.

Their son and daughter have their own lives and children. The *Siam* is not in their plans.

What, then, will become of the boat when they are gone?

"Perhaps when we die, our children won't be able to do anything with it. The navigation authority will say, You cannot leave it here. It must go," René says.

He means it will be taken to a shipyard in Conflans, 20 miles northwest of Paris, and scrapped. The word he uses is *déchirer.* To tear apart.

Can you describe how that is done? I say.

"I cannot. I will not," he answers. Tears well.

"To imagine destroying my boat is like pulling my heart out. There are too many memories. My whole life is in that boat.

"Suppose we decide to buy an apartment? We clear everything out. The suitcases are on the embankment. The mariner sees his boat and knows it's all over. Like death."

He wipes his eyes.

A recent illness has left him with a limp. His wife has health issues too. Their daughter worries they are too old to manage.

"You are 87," I say. "How much longer can you stay?"

A hard stare.

"They will have to take us out feet first."

French kiss: Romance and the river converge on the Île de la Cité. The Pont des Arts is in the background.

BOAT OVER TROUBLED WATERS

"The Seine is the most beautiful avenue in Paris," says Eric Piel, the retired head of psychiatry for the hospitals of central Paris, who lives on the *Orion*. "I thought, Why shouldn't others experience it, especially the mentally ill, who are the most excluded in everyday life?" He envisioned a floating psychiatric clinic: open yet protected. Doctors, nurses, and patients collaborated with an architect, and four years ago the *Adamant*—a structure with walls of glass—was launched. Patients come for coffee, a snack, to confer with the medical staff, create art, or simply enjoy the view.

From the first day aggression evaporated. Why? No one can explain, clinic director Jean-Paul Hazan says.

"Perhaps," suggests Jacqueline Simonnet, the head nurse, "it's the rocking of the boat."

"Traditionally the psychiatric hospital was hidden away," Hazan says. "You disappear behind locked doors. Here instead of closed, all is open. These are very sick patients, but there has been no violence." He pauses. "I think it has changed us too, but I can't say how."

Four mulberry trees on the quay mark the seasons. Yellow in fall, bare in winter, pale green in spring, dark green in summer. A cormorant swims by, hinting of nature's grace. The river's reflected light dapples the interior. The layout is open. The space, Simonnet says, is *fluide*. Glass erases the divide between inside and out.

It also, metaphorically at least, blurs the boundary between *them* and *us*—between the marginalized mentally ill and the presumably normal. "We are all in the same boat," Gérard Ronzatti, the architect who designed it, told me.

Space, like water, is mutable, changing with the flow of time and events. "After the revolution, many monasteries were used as jails," he said quietly. "In the same space you can have freedom. Or confinement." A building, a room, can confine or release, allowing the spirit to expand into the space provided and beyond. In designing the floating clinic, Ronzatti opted for the latter. The *Adamant* is as beautiful and fluid as the river it floats on. □

NG CONNECT

Every month this page features our staff picks of National Geographic Society products and events. For more go to *nglive.org*.

NATIONAL GEOGRAPHIC ON TV

Showdown of the Unbeatables

This month the National Geographic Channel stages one-on-one battles between some of the world's most powerful inventions. The goal? To find out which is stronger. See for yourself whether a 5000°F torch can ignite a fireproof superfabric (left) and whether a giant rock breaker is tough enough to smash through a heavy-duty safe.

EXHIBIT

PERUVIAN GOLD See jewelry and other artifacts, like this headdress (right), crafted by early Andean civilizations, at the National Geographic Museum in Washington, D.C. For more information visit *ngmuseum.org*.

SPECIAL EDITION

GREAT WOMEN Remarkable women who have shaped human history come alive in the latest edition of *National Geographic*'s *Exploring History*. Cleopatra, Catherine the Great, and Sacagawea share the stage with Elizabeth I, Harriet Tubman, and others. Find the issue on newsstands or at *shopng.com/specialeditions*.

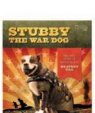
TRIP

POLAR REALMS Voyage to the ends of the Earth aboard a National Geographic ship. Itineraries for Antarctica, Arctic Norway, Iceland (right), and Greenland are at *ngexpeditions.com/polar*.

LECTURE

EXTREME PLANET Ever photograph inside an active volcano? It's all in a day's work for Carsten Peter. Check *nglive.org* for his speaking dates.

Book of the Month



Stubby the War Dog Ann Bausum

Meet Sergeant Stubby, a canine hero of World War I. Adopted by a soldier, he earned military honors for his bravery in the trenches. Ann Bausum tells his story in two books: one for adults ($24) and one for kids (left, $17.99). Both are on sale now. Read our cover story on America's heroic war dogs in the June issue of *National Geographic*, out May 15.

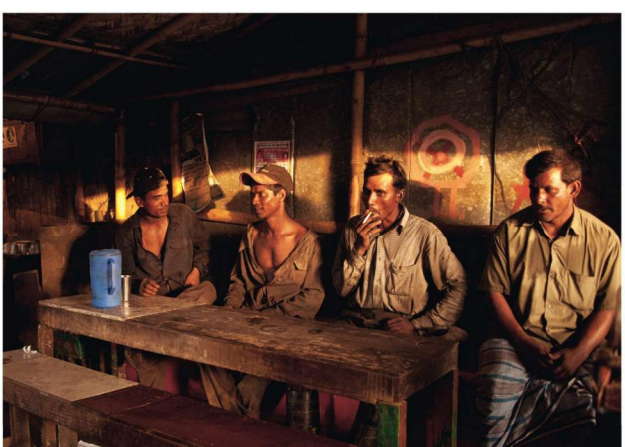
PHOTOS (FROM TOP): SEQUOIA ENTERTAINMENT, INC.; JOAQUIN RUBIO, MUSEO LARCO, LIMA, PERU; RALPH LEE HOPKINS

Tea Breakers

Each afternoon, with the sun slipping toward the horizon, photographer Mike Hettwer would hurry from Bangladesh's shipbreaking yards to a teahouse where workers gathered for their evening break. "I noticed this golden light that would gradually descend the wall for just a few minutes," he says. The men seemed to bask in it, lingering over the last of their sweet tea before returning to the job at hand: dismantling derelict ships, using little more than acetylene torches and their bare hands.

"When I started photographing in the yards, I was impressed by the spectacle of massive ships being demolished," says Hettwer. "But I soon realized the heart of this story is these men who risk their lives for little more than a couple dollars a day." During several trips over six years, he followed them into the oil-slick bowels of tankers and through the pitch-black passages of cargo ships. But his most intense experience was feeling the shock wave when a ship exploded nearby and rushing to the scene. "The owners had sealed off the yards, but from a distance I could see workers frantically carrying the bodies of their friends out of the smoking wreckage." *—Peter Gwin*

Listen to an interview with Mike Hettwer on our digital editions.



PHOTOS: MIKE HETTWER

The Handmade Dam "Sheer muscle power lifts the structure inch by inch," notes the caption for this photo—published in the May 1963 *Geographic*—of the Nagarjuna Sagar Dam on India's Krishna River. "Some 125,000 workers pour out their strength in building dam and irrigation canals," the caption continues. "Two-man teams haul 300-pound rocks up the bamboo ramps; women in ceaseless streams carry up pans of mortar on their heads. By using hand labor, India saves the hard currency needed to buy machinery abroad." The project was begun in 1955 and put into full use in 1972. Measuring 407 feet high and more than half a mile long, the Nagarjuna Sagar is the largest masonry dam in operation in the world. *—Margaret G. Zackowitz*

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