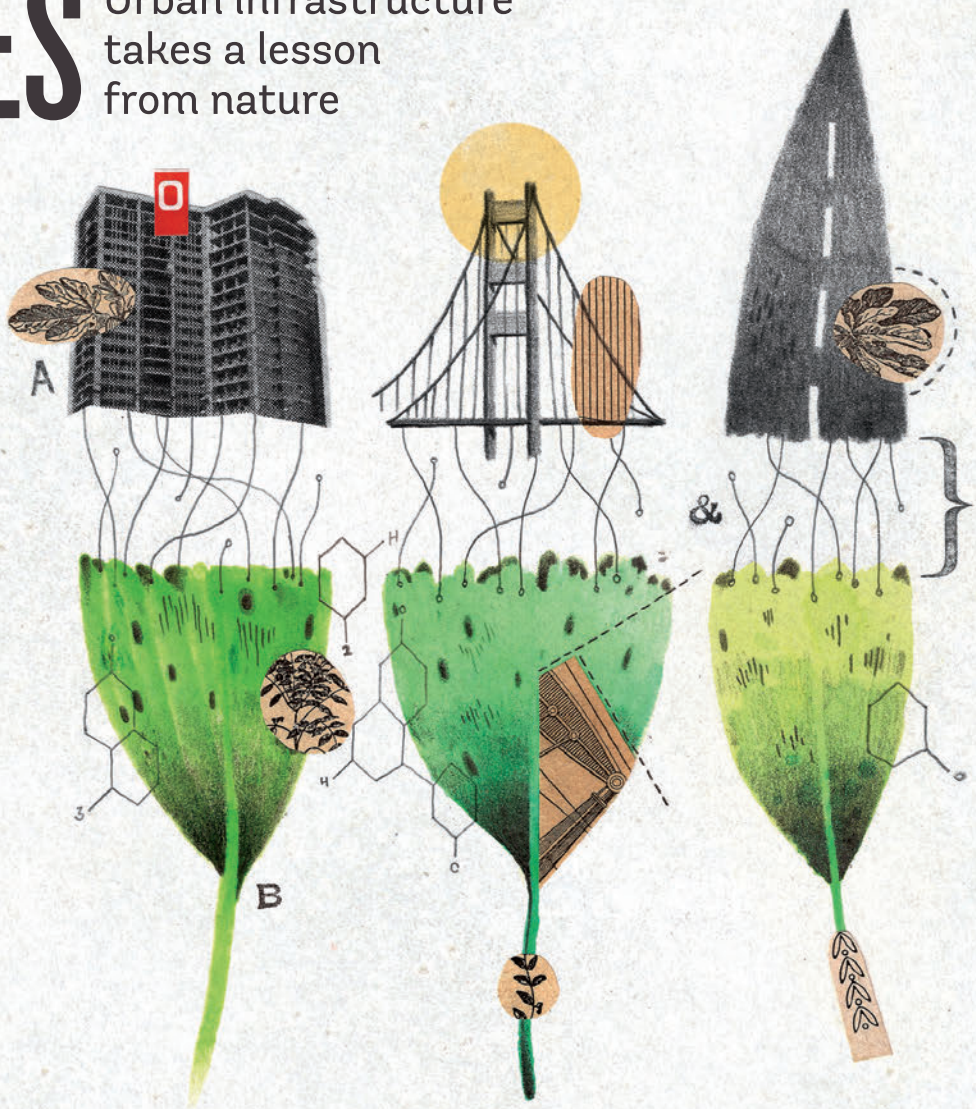
ensia

SPRING 2013 | ENVIRONMENTAL SOLUTIONS IN ACTION

PREMIERE ISSUE
FORMERLY momentum

SLICKER CITIES

Urban infrastructure takes a lesson from nature



PLUS:

GAMING OUR WAY to sustainability, **CARPETS** *to* **CAR PARTS**, *ocean acidification, low-carbon cement & more*

REINVENTING THE WORLD

LET'S FACE IT: Too many of our systems are broken, and we seem unable to fix them.

Whether the issue is tackling climate change, building enduring food and water security, eliminating deforestation, or preserving the world's remaining biodiversity, the environmental challenges we face as a society seem to be getting worse. And, unfortunately, our current political and economic systems seem utterly incapable of addressing them.

Even more troubling, we seem interminably stuck, going around in circles, getting nowhere closer to a real solution. We fiddle and the planet burns.

I think we've gotten stuck because we expect old solutions are going to solve our new problems. We try the same things, again and again, and they just don't seem to work. So we try them again, hoping that *this* time they will. But we should all remember the old definition of insanity: doing the same thing over and over, expecting a different result.

It doesn't need to be this way. Instead of repeatedly playing, and losing, the same old game, maybe it's time to change the rules. Maybe it's time to try some new approaches to solve our greatest environment problems.

I'm convinced that many of those solutions are staring us in the face right now; we just have to look for them.

For example, we can see perfectly functioning, amazingly complex, truly sustainable systems operating in nature every day. In fact, the rest of the planet works perfectly well with zero waste, running at ambient temperatures, driven purely by renewable energy from the sun. Life is a system that takes inert matter, and with a few photons and hydrogen bonds, creates marvelous replicating patterns that have been evolving on this planet for billions of years.

Let's admit it: Nature is a hell of a better engineer than we are. It works because it knows how to close the Earth's material loops, without depleting key resources or creating untenable pollution, and shapes the most magnificent systems in the universe. Nature also knows how to use easily available, renewable forms of energy, from the sun or from other organisms, to power the workings of the entire biosphere. Maybe there's a lesson or two for us here?

In this issue, we introduce some of the world's most creative environmental thinkers, and explore some of the world's leading innovations in environmental solutions, from improving urban infrastructure to saving endangered species. A common thread in these stories is one of *reinvention:* looking at an old problem and reimagining it with new approaches to find a new solution.

Here at the Institute on the Environment, we're also in the process of reinvention. Momentum has become Ensia, a new print and online magazine and event series that's out to change the world. Reaching across sectors, disciplines, political persuasions and continents, Ensia will provide people who have the power to shape new solutions to environmental grand challenges with the innovative ideas, information and inspiration they need to do so.

Made possible in large part by a generous grant from the Gordon and Betty Moore Foundation, Ensia will still offer the quality reporting and exceptionally designed print magazine you have told us you appreciate and value. Extending far beyond the limits of conventional magazines, Ensia online will provide daily updates that include fresh looks at well-known challenges, solution-focused alerts to emerging issues, new perspectives from leading thinkers around the world and much more. And over the course of the next two years, Ensia Live will evolve into a world-class event that provides the spark we need to ignite solution-focused action around key global issues.

We welcome you as one of the inaugural members of the Ensia community, and we encourage you to share this remarkable resource with others. Working together, we can escape the "over and over" rut and begin, finally, to traverse the path of truly transformative change.

PHOTO BY JOSH KOHANEK

Momentum has become Ensia, *a new print and online magazine and event series that's out to change the world.*

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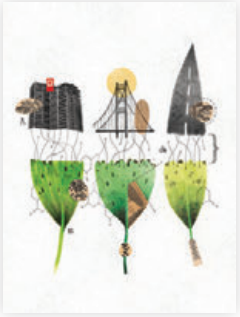
IonE is committed to sustainability. This magazine is printed on environmentally friendly paper with an average of 100% recycled fiber and 60% postconsumer waste.



ON THE COVER

Colombian illustrator **Samuel Castaño** specializes in collage work and hand lettering for clients, including Rosetta Stone and *El Tesoro*. His work also appeared in *Momentum*, Ensia's predecessor, for a story about mass migration. View his portfolio at samuelcastano.com.

DEPARTMENTS

FEATURES

WELCOME TO ENSIA—a magazine and event series showcasing environmental solutions in action. We connect people who can change the world with the ideas and inspiration they need to do so. Learn more and share your thoughts at **ensia.com**.

BUILDING A HEALTHY HOME

Peter Williams was living an architect's dream, designing intellectually stimulating and creative projects in the U.S., the United Arab Emirates and Asia, when a life-altering trip to South Africa combined with an experience from childhood made him change direction and look at building in a new way. Seeing how central homes are to people's health around the world, in 2006 he founded Architecture for Health in Vulnerable Environments, an international charity with the mission to use one basic need—housing—to deliver one basic right—health. Since then, ARCHIVE has worked toward that mission in Haiti, the U.K., Cameroon, Ethiopia, Nepal and elsewhere.

INTERVIEW BY DAVID DOODY | PHOTO BY MICHAEL WESCHLER

Williams at a glance...

HOME BASE:
New York; London

WEARS THE HATS OF:
Architect and humanitarian

GOOD TO KNOW:
Founded ARCHIVE Global

HOPE FOR THE FUTURE:
That housing will be prioritized as a strategy to promote health

HOW AND WHY DID YOU START LOOKING AT THE CONNECTION BETWEEN HOUSING AND HEALTH? Pretty much from the age of 8 I was determined to be an architect. I grew up in Jamaica where I would always see people making basic changes to their houses, like adding rooms or renovating. I saw a guy mixing concrete on the road once and I remember saying to my dad, "I would like to do that." He said, "No, son, you want to be an architect. You don't want to be a construction laborer."

In terms of the health addition, my dad ultimately developed a disease, which was attributable to poor housing conditions. He became paralyzed and bedridden. I saw the way in which something simple like a donation of a wheelchair from the local church was rendered inoperable because we simply could not move the chair between rooms—the doorways weren't wide enough. It wasn't until years later, when I was a design student, that I was able to put those things together. On one hand, I saw that housing was directly responsible for my dad's illness and on the other, housing was also incapable of meeting his cure needs.

Upon completing graduate school I received a fellowship to examine the link between AIDS and architecture by going to South Africa, the epicenter for the pandemic at that time. I saw firsthand that the context in which people lived presented itself as a risk factor associated with disease transmission. That really allowed me, over time, to reflect on the nexus between health and housing.

WHY DID YOU START ARCHIVE? When I took a sabbatical to conduct the research in South Africa, I was working for the second largest design firm in the world. Having those two experiences side by side—designing Apple stores in New York to

being transplanted to a country like South Africa—that's a life-changing experience. It was very difficult to reconcile those two worlds. There was no organization dealing with the health-housing issue globally. So I felt like if it isn't being done, and I believe it should be done, then simply put, I needed to do it.

WHAT DOES ARCHIVE DO? Our interest is 360-degree medium- and long-term development. We make a clear distinction between humanitarian work and the kind of medium- and long-term development work to which we're particularly committed. We split our time between the pragmatics (delivering projects on the ground, improving lives directly), helping to change and direct policy (where possible at the government level) and working to generate and communicate new knowledge through research. We're interested in low-cost, low-tech integrated strategies, which have often been sidelined in global health and housing efforts.

WHICH COMPONENTS OF HOUSING HAVE YOU FOUND HAVE THE BIGGEST IMPACT ON HEALTH? For us it's about understanding how the components are interrelated. Far too often the model is to focus on one specific area and do it really well. Around the world … diarrhea kills about 2 million people every year. There is a direct correlation between the lack of suitable sanitation and contracting diarrhea-related illnesses. Yet, it's not just about having toilets—it's really about whether toilets are present *and* whether there's access to clean water. We are in fact talking about the relationship between two infrastructure components.

In Nepal, work that we are about to get started is based on findings that paving floors can improve the cognitive development of a child by as much as 96 percent, reduce the risk of anemia by as much as 80 percent and reduce that risk of parasitic and diarrhea-related illnesses by as much as 50 percent. This is the exciting way that housing can be a *major* vehicle for curbing the risk of contracting diseases and therefore the mortality for some of the poorest people on our planet. But the extent to which we can render this effective is the extent to which we can, I would argue, move away from this notion of looking at the issues in silos.

WHY DO YOU THINK HOUSING HAS NOT RECEIVED MUCH ATTENTION AS A WAY TO ENCOURAGE HEALTH? It's simply not sexy—that's what we've been told. We all know the major headline development issues not just because of the burden they cause, but because of the way in which they've been communicated. If you're in a developed country, your perception of a home is very different from the perception of a home for someone living on less than a dollar a day. So when you try to make the argument that it's important to develop a healthy home, the typical person in North America will think of a three-bedroom environment. It's not reductionist enough. We've found that sometimes it's about getting people to think differently about what a home means for families around the world.

IN TODAY'S UNPREDICTABLE ENVIRONMENT, WHAT HAPPENS IF YOU BUILD A HOUSE AND THINGS AROUND IT CHANGE SO MUCH THAT NEW PROBLEMS ARISE? CAN A HOUSE BE ADAPTABLE ENOUGH TO MEET CHANGING NEEDS? We don't adopt a top-down approach. Several months prior to any project getting started are spent learning, listening and understanding how people build, at what cost, over what period of time. It's really about respecting and appreciating the value in that, because for many, these traditions have been handed down. Many of the most vulnerable on our planet build incrementally. So the idea of the house being a static entity is not, for many, a reality. People are quite sophisticated at times in terms of the adaptability and resilience with which they've applied their designs. The people who live on less than a dollar a day have been able to borrow from their neighbors or their ancestors to refashion and continually improve their homes.

ARCHIVE looks for the nuances in the way that people have already developed a level of resilience. We build on that with lessons we have learned from other environments.

IN 10 YEARS, WHAT WOULD YOU LIKE TO SEE CHANGE AS A RESULT OF ARCHIVE? On a large scale, I'd like to see governments and large institutions changing for themselves the paradigm where living conditions of vulnerable people on the planet and health risks are dealt with separately. We are urbanizing more than ever, with multiple issues related to having 9 billion people living on our planet in the next 40 years. A cost-effective approach to this means deploying a strategy which invests in improving two key areas of development: housing/living conditions and health. We think that success for us, and really success for humanity, is about a shift in that paradigm. It already is more cost-effective to address these issues as a paired approach. As the need to house people and to treat people becomes more urgent and more dire in a world of 9 billion with finite resources, we'll begin to think creatively and more cost-effectively. So we are optimistic that we will change. Unfortunately, you need political will and you need leadership, like any scenario, to usher it through. Until that happens, sadly, we will remain in our present paradigm.

It's about understanding how the components are interrelated. *Far too often the model is to focus on one specific area and do it really well.*

+ MORE PETER WILLIAMS:
READ THE FULL INTERVIEW AT **ENSIA.US/WILLIAMS** AND VISIT **ENSIA.COM/LIVE** FOR INFO ON APRIL 11 ENSIA LIVE TALK IN MINNEAPOLIS

PHOTO ARK

More than two decades of photographing wildlife around the world left National Geographic photographer Joel Sartore desperate to help slow the downward spiral of global biodiversity. And so began his Photo Ark project: creating studio portraits of vanishing animals as a testament to what we are losing. To date, Sartore has captured compelling images of some 2,300 species.

"They say people will only save what they love—and they can't love something if they don't know it exists," he says. "That's where these photos come in."

+ SEE MORE IMAGES AND READ SARTORE'S STORY:
ENSIA.US/PHOTOARK

THE NEW NORMAL

Super storms, melting ice, dying forests … What does the "New Normal" look like and how might we best prepare for the challenges and opportunities it brings? William Chameides, David J. Hayes, David Orr and Kevin Trenberth shared their intriguing answers to those questions at the Aspen Environment Forum. Catch their lively conversation at **ensia.us/newnormal**

4.4 POUNDS OF TRASH generated per day on average by Americans in 2010
—*Christian Science Monitor*

TAPPED OUT

Tap water, crop irrigation and other human uses around the world are using groundwater at 3.5 times the sustainable rate. In some cases, water is being sucked from aquifers (underground water-bearing formations) faster than new water can filter in. In others, "fossil aquifers"—formations that no longer replenish—are being used up. Solutions being explored include improving the efficiency of water use by agriculture and encouraging conservation in homes and businesses. Learn more at **ensia.us/tapped**

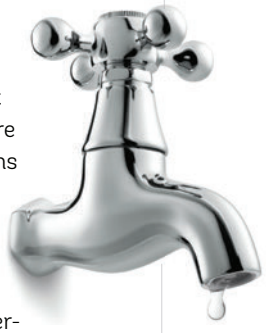


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PHOTO BY THOMAS SHAHAN

STAND UP FOR THE SPINELESS

Everybody loves a polar bear. But what about spiders? Eight of every 10 known species on this planet are invertebrates, yet invertebrates tend to get the short shrift when it comes to conservation. Learn more about why and how to protect the species that really run the show at **ensia.us/invertebrates**

LOOKING LONG

When you plan for the future, how far do you look? For the folks at The Long Now Foundation, the operative time frame is millennia, not decades. Check out videos and podcasts of what pundits like Mark Lynas and E.O. Wilson see when they take a really long look at the future at **ensia.us/longnow**

1 BILLION+ number of invertebrates in a single hectare of rain forest —*E.O. Wilson*

CONSERVATION: THE SEQUEL

Does conservation need a new narrative that accounts for human economy, engages local ownership, values ecosystem services and motivates private and public partnership for investment in natural infrastructure? That's the question nearly three dozen conservation leaders tackled most recently as part of the Dialogue on Conservation in the 21st Century convened by the Aspen Institute's Energy and Environment Program. Download a summary of the dialogue's report, *Nature as Foundation of Economy: Investing in Natural Infrastructure for Conservation Supporting Human Development*, at **ensia.us/foundation**

750

NUMBER OF TREE SPECIES typically found in 4 square miles of rain forest

—*The Nature Conservancy*

NEW LIFE FOR OLD TEXBOOKS

At last, a good use for that chemistry book you last cracked in 2001. Green Textbooks finds new homes for textbooks, software, study guides and related educational materials up to 20 years old, saving them from landfills and providing a valuable source of knowledge to individuals who lack other options. Every book donated to the organization is either reused or recycled into new paper products. Check it out at **ensia.us/textbooks**

THINK ON THESE THINGS

It's easy to identify the obvious challenges to biodiversity: climate change, invasive species, habitat loss. Less obvious are the things we're not thinking of but should. Led by Cambridge University conservation biologist William Sutherland, scientists from around the world recently completed an elaborate "horizon scanning" exercise to identify 15 relatively obscure global events and trends that stand to have huge impact on biodiversity conservation. Among them: growth of concentrated solar power, the increase in demand for coconut water and the use of antimicrobials in health care and food industries. Learn more at **ensia.us/horizon**

VIBE INSPIRATION

Most wind generators go around and around. This one just waves. Inspired by the rustling of leaves in the breeze, Cornell University faculty Frank Moon and Kevin Pratt are working on capturing wind energy through panels that oscillate rather than blades that spin. The approach could find application in restricted spaces such as urban areas unsuitable for conventional turbines. Learn more at **ensia.us/windvibe**

PAINT JOB

Each year millions of gallons of household paint end up in landfills—creating a huge waste of raw materials and processing, and a potential pollution problem down the road. A better solution? If you do end up with leftovers, share with a neighbor or nonprofit organization, or check out **ensia.us/paint** for a recycling/safe disposal option in your area.

64 MILLION

gallons of paint Americans buy but don't use each year

—*Product Stewardship Institute*

PHOTO BY KATE MELTON

POWER WALK

The average American takes somewhere around 5,000 steps per day. And what do we have to show for it? The folks at Energy Harvesters have invented a device that can enhance shoes so they not only get you places, but make electricity doing it. Learn more at **ensia.us/energyharvesters**

FOR MORE NOTABLES, VISIT ENSIA.COM


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Inspired INFRASTRUCTURE

From roads to municipal water to buildings to waste management systems, aging **urban infrastructure** is in growing need of replacement. What if, instead of spending trillions on more of the same, we turned to **nature for design advice**?

BY **NATE BERG** | ILLUSTRATIONS BY **SAMUEL CASTAÑO**

We humans are problem solvers. We're doers. We encounter challenges and complicated situations and we find ways to surmount them—crafting tools, erecting bridges, programming computers. We've innovated and designed our way out of countless predicaments and, dammit, we will forevermore.

We are also hopelessly arrogant.

See, we humans sometimes forget that we are not the only innovators and designers out there. We're not the only ones able to creatively adapt our way through tricky or threatening conditions. We forget about nature.

Long before we showed up on the scene, there were wetlands that made dirty water clean, prairies that grew sustainable food crops and termites that built living spaces capable of maintaining a nearly steady internal temperature year round. These and other natural systems, developed over thousands or millions of years, are amazingly adept at dealing with the sort of logistical concerns humans face every day—whereas many of the workarounds we've found for the problems of our lives are inefficient or overly expensive or carry on the oh-so-human tradition of causing more problems than they solve.

Luckily, we've also managed to learn that sometimes the best way to solve a problem is to borrow somebody else's good idea.

Enter biomimicry—the idea of emulating strategies nature has perfected. By looking closely at natural processes and organisms, we can identify and learn from some of the ways nature solves the problems that challenge us. And the closer we look, the more of these solutions we find. Many of these nature-inspired solutions have implications for that most human of habitats: the city. From stronger building materials to more intuitive water systems, biomimicry has applications in urban infrastructure that can dramatically improve the way we live.

Cities as Ecosystems

In her landmark 1997 book *Biomimicry: Innovation Inspired by Nature,* biologist Janine Benyus presents elegant examples of ways in which the natural world offers very clear hints about how to improve elements of our human world, such as how spider silk can inform the engineering of super-strong materials and how plants can teach us better ways to harvest energy from the sun. That book is now required reading for engineers, environmental scientists, industrial designers and practitioners of countless other disciplines.

To spread these ideas into the real world, Benyus created a consulting firm called Biomimicry 3.8—as in 3.8 billion years of research and design done for us already by nature. Biomimicry 3.8 biologists and designers work with groups and companies all over the world to try to inject some of the lessons of nature into their products and services. They've helped major apparel companies, airplane makers, hospitals and furniture designers.

The lessons of nature, Benyus says, apply widely across the spectrum. Even to entire cities.

"Actually, architects and city planners were the first audience to really embrace the book," Benyus says.

That might seem surprising at first. But in many ways, urban areas are like ecosystems. They have interconnected components such as buildings, streets and sewer systems that are themselves complex—like birds, orchids and insects all living within the framework of a tree. This sort of systems thinking is crucial for cities. Running cities that are efficient and equitable requires being able to see, for example, how water systems react to population growth or how the extent of a transportation network determines energy use and development patterns. Like nature, all these elements are connected.

"INSPIRED" LEAF DESIGNED BY TAK IMOTO/THE NOUN PROJECT

by the NUMBERS

by Lauren Werner-Foley

A growing population, urbanization and age are calling for a massive overhaul of urban infrastructure around the world. In the U.S., for example, large shares of the water, power and transportation systems are between 50 and 100 years old. Global industry counts on such infrastructure to share materials, goods, services and information—and the need is growing.

60 MILLION
increase in the number of Americans who will rely on domestic infrastructure in 2030

2.5 BILLION
number of people who lack access to basic sanitation today

428,600
average number of people being added to the world's cities each day

600,000
approximate miles of sewer line in the U.S.

7 BILLION
gallons of water wasted each day in the U.S. due to leakage from municipal supply systems

2/3
proportion of people worldwide who lack Internet access

100%
the amount global infrastructure will need to increase by 2050 to meet future demand

One thing is certain
Whether for growth, repair or development, demand for change is everywhere.

"You don't design a set of roads in isolation but in relation to buildings, but also to the sewer system below or to the cabling," says Ilaria Mazzoleni, an architect and professor at the Southern California Institute of Architecture who's been teaching and working with the concept of biomimicry in architecture for nearly 10 years. "There are a lot of invisible elements that go into it. And nature is really a master example of making different things work one to the other and eliminating things that don't fit with the picture."

Mazzoleni says this type of thinking is becoming more prevalent. True biomimicry, she argues, considers an object or building or infrastructure as part of a much larger system. Cities, therefore, are the perfect arena for biomimetic design. And given the vast amounts of aging and crumbling infrastructure in urban areas around the world, there's plenty of work to be done.

More and more, biomimicry is being thought of as a way to reconsider the ways we build and operate cities. Today, these lessons are being actively applied in the realm of urban infrastructure and design in an effort to make places that are more sustainable, more livable, more intuitively designed and—at their core—more natural.

Lessons From Lavasa

About 60 miles (as the crow flies) southeast of Mumbai, India, the city of Lavasa is rising from the hills. With the guidance of Benyus and Biomimicry 3.8, Lavasa is being designed as a set of five small villages with populations between 30,000 and 50,000 people that will climb up the area's steep slopes and mimic its dense forest. Benyus and her team have partnered with the architecture and planning firm HOK on the master plan for the second of the five villages, Mugaon. The plan and architecture are intended to create a sustainable framework for urban development in India, where the supply of housing is struggling to keep pace with the country's swift urbanization.

Located in one of India's monsoon hot spots, the hillside that will host Lavasa is subject to a short but intense rainy season that can see nearly 30 feet of rainfall in just three months, followed by months of drought. Despite all this water falling on steep hills, the area experiences almost no erosion and is able to use those water resources all year round.

To understand how the hills stay intact, biologists from Biomimicry 3.8 studied the area's ecosystem. Then they developed a set of "Genius of Place" design recommendations and ecological performance standards the city's developers can use to ensure that whatever gets built performs at the same level as the natural environment. That means roofs that help re-release some of the monsoonal water back into the air as water vapor, pavement that allows water to permeate into the ground and building foundations that grip the hillsides like the roots of trees. To design roads, for example, the team looked to local anthills that are able to remain structurally sound during the region's heavy rains. The key, Benyus explains, is the anthills' sinuosity, which channels and slows water as it runs over them. Lavasa's roads are planned to mimic that characteristic.

That means roofs that help re-release some of the monsoonal water back into the air as water vapor, pavement that allows water to permeate into the ground and ***building foundations that grip the hillsides like the roots of trees.***

Benyus and her team identified six "ecosystem services" provided by the area's moist deciduous forest: water collection, solar gain, carbon sequestration, water filtration, evapotranspiration and the cycling of nitrogen and phosphorus. Then they handed those to the planners and designers at HOK as guides for what their design would need to accomplish.

"They said in an ideal design solution, your new built environment would perform as if it were a moist deciduous forest," says Mary Ann Lazarus, HOK's director of sustainable design.

All Scales

Development in Lavasa has slowed recently due to some controversy over how the land was procured and how loans for construction were acquired, but Benyus says the model is sound. Biomimicry 3.8 is at work on similar projects in other places—especially China, where large-scale city building is occurring at an unprecedented rate. Biomimicry 3.8 and HOK, for example, drafted a master plan for Langfang, a city of about 4 million that's part of the North China Plain's Beijing-Tianjin mega-region. The plan seeks to


1/2

counteract the drought and subsidence the city has suffered due to unsustainable agriculture by implementing a wetland mimicry scenario.

Lazarus says HOK has integrated biomimetic thinking into its design work at all scales around the world. Some of the firm's designers have even completed Biomimicry 3.8's intense certification program on biomimicry thinking. In addition, they've developed a system of natural strategies based on each of 18 "biome regions" to guide projects when they can't pull in the formal Biomimicry 3.8 team.

Even at the building scale, HOK is using the principles of biomimicry to improve design. One pro bono design, an orphanage in earthquake-ravaged Port-au-Prince, Haiti, used lessons from the local kapok tree to provide passive cooling, collect rainwater and mimic the tree's protective bark for shielding the building from excessive heat. With no water, sewage or electrical connections, the building's design is heavily reliant on these sort of natural systems. "It wasn't like an aspirational goal," Lazarus says. "It was like we have to have a closed-loop solution."

Lazarus says that applying the lessons of nature to urban design and architecture has such obvious benefits that there's no reason not to.

"In a way, I don't consider it an urban issue or not an urban issue," she says. "It works at all scales."

Cleansing Power

Most often, infrastructural biomimicry happens at the smaller scale and with a focus on water. One of the most prominent examples is the Eco-Machine, a trademarked water treatment technique created by John Todd and his firm John Todd Ecological Design. Based on ideas that have evolved over the last three decades, the Eco-Machine is a type of constructed wetland that mimics the cleansing power of a marshland or estuary by combining plant life, aquatic tanks and various forms of living organisms to clean wastewater through a cycle of passive processes that doesn't require any hazardous chemicals. By traveling into and out of a series of specialized tanks filled with specific plants, fish, zooplankton and bacteria, water is refined from polluted to clean. Eco-Machines have been used at a variety of scales to process water, from the sewage of office buildings to the groundwater of contaminated sites.

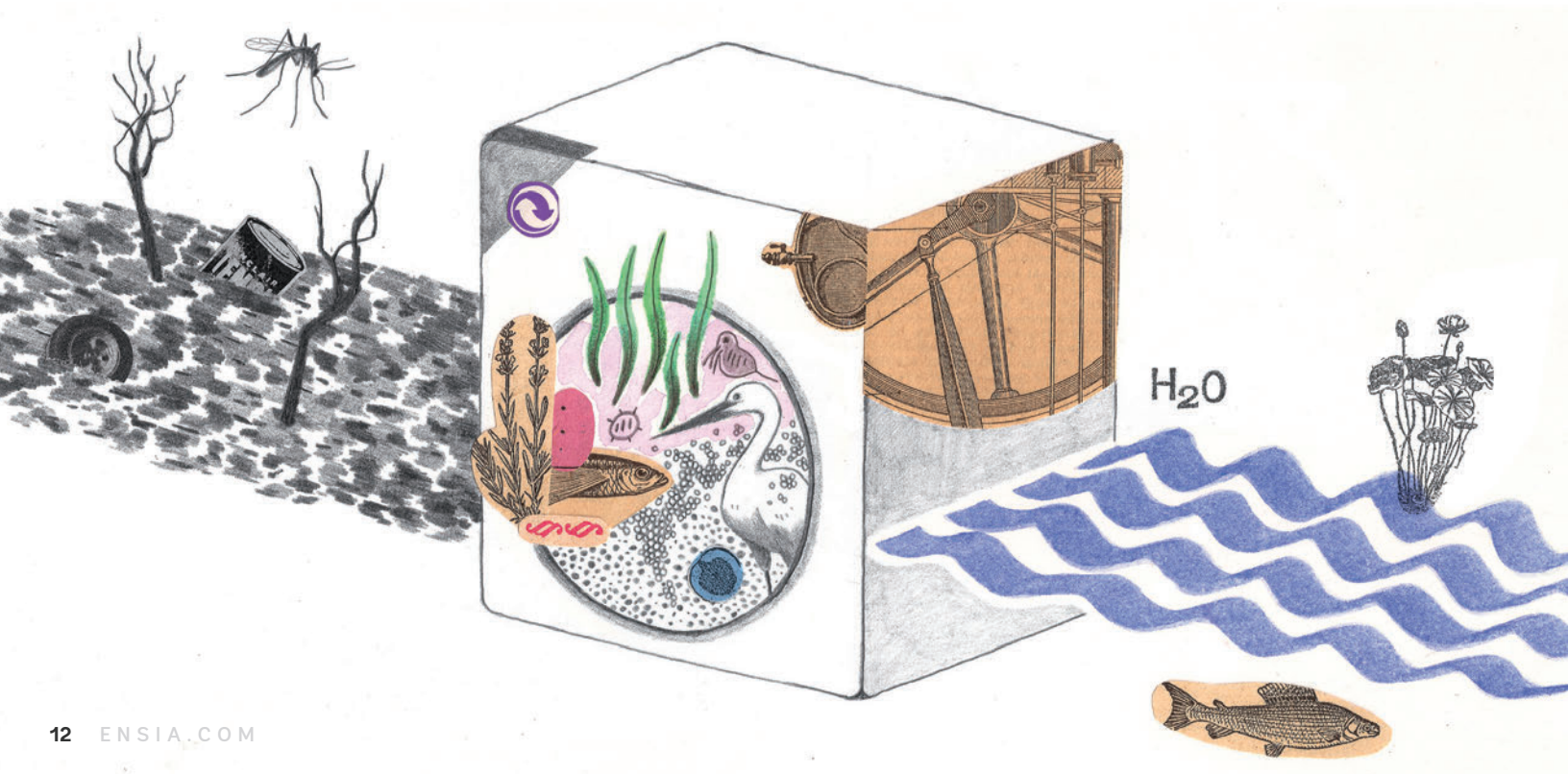
One of Todd Ecological's latest applications of the Eco-Machine technique takes on an intimidating problem. In Grafton, Mass., the firm is working with the site of a former mill on the Blackstone River. The mill burned down in the 1990s, and a new owner is hoping to turn the site into a small village. But along with the remnants of the mill are a series of buried storage tanks that have degraded over time, leaking a heavy oil known as Bunker C into a canal leading to the nearby river.

Removing the tanks and the contaminated soil would be far too expensive for the site's owner or probably any single person. So, with a grant from the U.S. Environmental Protection Agency, Todd Ecological was contracted to install an advanced version of its Eco-Machine that combines a floating system of plants and a biofilter within the canal to clean and draw water up to the system of tanks on the shore. The water cycles through the various tanks, and also a series of closed cells containing special fungi that perform even more intense cleansing before returning the water to the canal.

> "When **Category 5 hurricanes** start coming up the **East Coast** every couple of years, that's an **indication that we need to get creative**."

The system began operations in June 2012. Since then, the water has shown significant improvements. "Our results are showing over a 90 percent reduction of petroleum hydrocarbons within the system," says Camron Adibi, a project manager at the firm.

"It cost the EPA $1 million to remove oil-contaminated sediment and took six months to dredge 300 feet of the canal," Adibi says. "The Eco-Machine cost less than half this amount."



Heal Thyself

Though water treatment is one of the most important functions of urban infrastructure, perhaps the most visible and ubiquitous example of urban infrastructure is concrete. From sidewalks to buildings to highway dividers to bridges, concrete is what our cities are made of.

Though typically thought of as a blunt tool with a limited lifespan, concrete is actually becoming better and smarter. Researchers at the University of Michigan have been developing a new type of concrete that's modeled on the self-healing properties of biological systems. Like human skin or the bark of a tree, this new concrete is able to fill in tiny surface fractures—essentially healing itself as it degrades. By absorbing moisture from the air, microfibers in the concrete slowly expand and harden, filling cracks in the material.

Far from being just a fancy trick, the nature-inspired ability to adjust to circumstances could save your life. Nearly 70,000 bridges across the U.S. are classified by the Federal Highway Administration as "structurally deficient"—two words it's hard not to think about when you're driving across a span of concrete over a 100-foot drop. While these bridges aren't exactly crumbling beneath our tires, they are getting old and threatening to fail us in the most devastating of ways. Could nature inspire a better design next time? Researchers at the Swiss Federal Institute of Technology think so. They're developing bio-inspired bridge designs that have the built-in ability to adapt to potential problems.

Using the structural principle of tensional integrity, or tensegrity, this bridge design is made up of two sets of components that are in either perfect tension or perfect compression. It's a lightweight combination of struts and cables that is both strong and efficient.

With the addition of sensors and actuators, tensegrity bridges can adapt their shape to account for the varying structural stresses of changing environments, such as wind or heat or particularly heavy loads, mimicking how nature stabilizes molecules, cells and even entire organisms. The result is a bridge that knows when its structure is being compromised and slightly rearranges its components to compensate—and stay standing.

Return on Investment

For Benyus and Biomimicry 3.8, applying the principles of biomimicry or even bio-inspiration to infrastructure and city problems is the future of design. More than half the world's population now lives in urban areas; as that proportion grows, finding better ways to keep urban systems functioning will be even more important than it is today.

Some people worry that transitioning to biomimetic infrastructure like engineered wetlands for water treatment is too cost-prohibitive to really work in urban areas. But Benyus rejects that concern outright.

"That's a hackneyed excuse. It's old. It no longer applies," she says, arguing that there's a clear return on these investments in terms of energy expenditures, water savings and the productivity of people.

Continuing along the conventional path, she says, may be contributing to greater problems in the future. We need to look only as far back as the latest natural disaster to see how things can go wrong.

"When Category 5 hurricanes start coming up the East Coast every couple of years, that's an indication that we need to get creative," Benyus says.

And getting creative is one of those things we humans do so well. But we don't have to do it all alone. Nature has already field-tested many of the solutions we need for the problems we face. If we only look, they're not hard to find.

Nate Berg is a writer who focuses on cities, science and design. His work has appeared in various publications, including the *New York Times, Wired,* National Public Radio, *The Atlantic Cities* and *Domus.* He lives in Los Angeles.

ISLANDS with a MISSION

by Lisa Palmer

Keeping lakes and rivers healthy is a challenge for cities around the world as runoff adds nutrients, development eats up habitat, landfills pollute and wastewater stagnates. Wetlands and marshlands along waterways cleanse water, protect biodiversity and reduce erosion. But wetlands and marshes take a long time to develop naturally. So how can humans help? Inventors are finding solutions by looking to the natural world.

Anne and Bruce Kania of Montana-based Floating Island International are working to bring a concentrated wetland effect to any body of water through biomimicry. Their water management work is inspired by the kind of floating peat bogs found in waters across northern latitudes.

Municipalities, the U.S. Army Corps of Engineers, private organizations and many others from California to New Zealand have commissioned the floating islands for lakes and waterways because the islands clean polluted water, provide nutrients for fish, contribute to species habitat and sequester carbon. More than 5,000 islands have been built from a non-woven mat of filter material made of recycled plastic (think loofah sponge made from recycled soda bottles) that is seeded with native plants. In the company's early days, it created mostly small, backyard-pond-sized swaths. More recently, though, FII has focused on larger islands, like one in Lake Rotorua, New Zealand, which spans roughly 55,000 square feet.

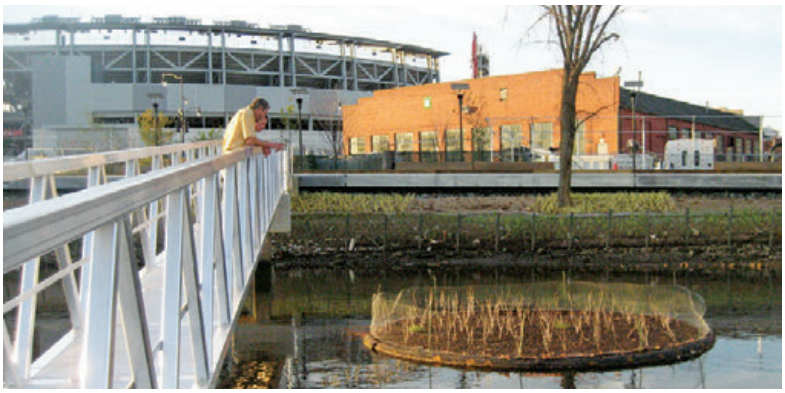


PHOTO COURTESY OF FLOATING ISLAND INTERNATIONAL

PHOTO BY PHOTO EPHEMERA

OCEANS away

Scientists take a closer look at the impact of CO_2 on marine ecosystems.

BY ELIZABETH GROSSMAN

The sky is low and dusky, and the rain comes in blustery gusts as we make our way out onto a spill of rocks that juts seaward from the shore just north of Boiler Bay on the Oregon coast. Low tide is just beginning; at times it looks as if we'll be swamped by waves. It's October 30 and in the late afternoon gloaming, my eyes take a few minutes to adjust so I can begin to differentiate mussels from rock and to spot the clutch of seals watching our progress.

To the scientists who make up the Ocean Margin Ecosystem Group for Acidification Studies, this spot is known as the Fogarty Creek Intertidal Long-Term Ecological Research Site. The obvious drama of this place comes from the waves and wind and charismatic whiskered marine mammals. But I'm here to witness a different kind of drama with Oregon State University graduate student Jeremy Rose, who specializes in marine ecology and is part of a team of scientists investigating the effects of ocean acidification on the small organisms that inhabit the rocky tide-pool landscape beneath our feet.

While it can't be seen in a glance, what's happening to the marine environment on the Pacific Northwest coast as a result of the growing concentration of carbon dioxide in Earth's atmosphere is indeed dramatic. Since the mid-18th century, human activity—mainly fossil fuel burning—has increased the atmospheric concentration of CO_2 by about 40 percent. Because oceans absorb about a quarter of the CO_2 released into the atmosphere each year, as more CO_2 enters the atmosphere, more ends up in the ocean. "Think of carbon as a global pollutant that affects the ocean everywhere it touches the sky," explains Stanford University marine science professor and Hopkins Marine Station director Steve Palumbi.

As CO_2 dissolves in seawater, chemical reactions produce an acid. Over the past 250 or so years, the acidity of the world's oceans has increased 30 percent. Scientists believe oceans have not experienced the current level of acidity in about 2 million years. Not only that, but according to National Oceanic and Atmospheric Administration senior scientist Richard Feely, conditions are changing faster than anything seen in geologic history. If today's global CO_2 emission trends continue, scientists estimate that by the end of this century, oceans will be more acidic than they have been for more than 20 million years.

And that's a problem. The rise in dissolved CO_2 and concurrent drop in pH (lower pH indicates higher acidity), changes ocean chemistry in a way that robs marine organisms, such as mollusks and corals, of the carbonate ions they need to build shells and skeletons. At the same time, the increasing acidity can erode at the structures they've already built, and appears capable of disrupting their bodies in other ways that make it hard for them to thrive. This is bad news not only for the organisms themselves, but also for people who rely on them for food and jobs, and perhaps even more profoundly, for the stability of the ecosystems with which they—and we—are intertwined.

INVESTIGATING IMPACTS

The chemistry behind ocean acidification is well understood. What scientists are working on now is trying to understand what is happening within marine organisms and their coastal communities as the ocean's pH drops at the same time marine environments experience other stressors such as warming temperatures, pollution and overfishing.

Among their big questions: Can marine species adapt to this rapid change, and if so, how? Or as Morgan Kelly, a postdoctoral researcher studying ocean acidification impacts at the University of California, Santa Barbara, puts it, "Will evolution come to the rescue?"

> Over the past 250 or so years, the acidity of the world's oceans has increased **30%**.

To begin to answer this question, scientists are exploring how—down to the subcellular level—marine species are responding biologically to acidification. They are also examining how individual species' responses may affect marine ecosystems. An adverse impact to one species, or conditions that overwhelmingly favor another, can create imbalances in the marine food web and lead to survival problems for a whole suite of species. And on an even larger scale, scientists are investigating what such changes may mean for fisheries and the people who depend on them, and how marine policy and conservation might respond.

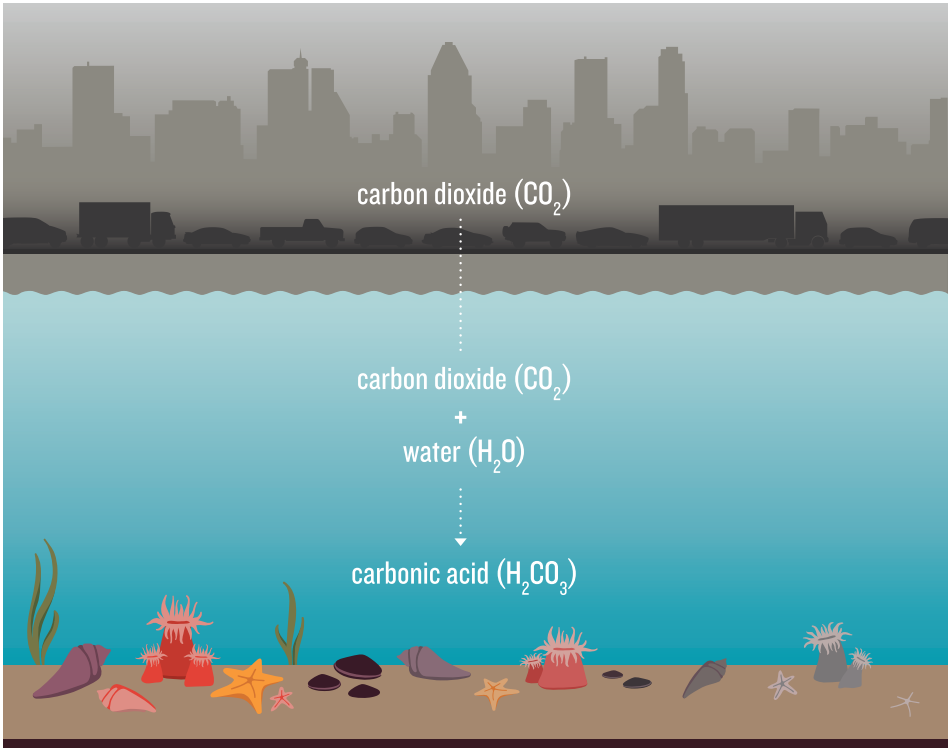
Laboratory experiments are part of the picture. But because ocean conditions are so complex and difficult to replicate, scientists are also conducting research in places like Fogarty Creek. The OMEGAS project, which includes study sites along the northern California and Oregon coast, is tracking ocean pH with offshore sensors while monitoring what's happening biologically at these sites to intertidal species as seawater becomes more acidic. As UC Santa Barbara professor Gretchen Hofmann

explained at the 2012 Ocean in a High CO_2 World meeting held in Monterey, Calif., in September, scientists are investigating the "fine tuning of populations to their local environment" in locations now experiencing the most dramatically lowered pH.

PURPLE URCHIN

As Rose and I walk out on the rocks, at first I see only boulders and water. But as I crouch to get a better look, an intricate world comes into focus. Yards of pearly black mussels are punctuated by patches of pale whorled pointy shells of gooseneck barnacles. Beneath the surface of the water, trapped in small pools as the tide recedes, are clusters of anemones that look like upside-down branchless coral. I spot a few fat pink sea stars and several distinct types of algae. Among these are long, bright-green rubbery streamers, short dull olive bristly algae and delicate lacy salmon-colored coralline algae, named for the calcareous skeleton that looks like bones of an exceptionally tiny bird. Deeper underwater, nestled among the anemones, are the creatures we have come to see: *Strongylocentrotus purpuratus,* the purple sea urchin.

Purple sea urchins are of interest to marine biologists studying ocean acidification for numerous reasons. These creatures live up and down the Pacific Coast where pH is changing markedly. Their habitat is one that naturally varies greatly with the ebb and flow of tides. It is also a highly structured community of species in which the sea urchins play an important role as a food source for sea otters, in controlling algae and as a component of a healthy ecosystem. They're also a well-studied species—so well studied that their entire genome has been sequenced, enabling scientists to investigate genetic impacts of ocean acidification. This information is essential to understanding the species' future and how their fate may affect other ecological community members.



Carbon dioxide given off by vehicles, power plants and other human sources spells trouble for many marine organisms. The gas combines with seawater to form carbonic acid, which reduces availability of the carbonate ions they need to build shells and other structures. Acidification also appears to disrupt physiological processes.

Because the pH recorded on the Oregon coast is much lower than that in California (thanks to ocean circulation, seasonal winds and upwelling), how the northerly purple sea urchins are responding to ocean acidification will help scientists understand what may happen to this whole community of species as ocean pH drops further, explains Kelly. It appears that seawater pH affects how hard the urchins must work to maintain the biochemical balance within their cells. That some seem to be "doing okay" under lower pH doesn't mean that all is well, says Kelly. It means they're doing something to compensate.

Tyler Evans, Kelly's colleague at UC Santa Barbara, is an environmental physiologist and postdoctoral fellow investigating how higher dissolved CO_2 and lower pH affect sea urchins' genes. By looking at the individual genes, he hopes to see exactly which are being altered by the changes in seawater chemistry and how ocean acidification is affecting the genes' ability to make proteins—among the most basic building blocks of life. Thus far, Evans explains, they've identified important changes in how sea urchins' cells transport calcium and sodium. A balance of these is vital to urchins, both for maintaining healthy cell function and for shell building. If sea urchins have to work harder to maintain this balance, it could affect their development or ability to reproduce. If urchins fail to thrive, it would likely have an adverse effect on their entire community of mussels, sea stars, anemones, fish and marine mammals.

"The behavioral and energy changes needed to maintain yourself as a species are really complicated," explains National Center for Atmospheric Research scientist Joanie Kleypas, a pioneering ocean acidification researcher. Not only that, notes Stanford's Palumbi, the costs of coping with changes such ocean acidification may take more than one generation to become apparent.

Similar effects have been observed for species other than the purple sea urchin. In lab experiments, green sea urchin larvae exposed to low pH have grown more slowly and developed physiological abnormalities. Mussels

exposed experimentally to low pH appeared to have increased metabolic rates, reduced reproduction and some immune system suppression—all clear indications that acidified conditions are adversely affecting these animals' physiological functions.

NATURAL LABORATORIES

To investigate the ecological impacts of acidification over the long term, scientists are also studying what are effectively natural laboratories for high CO_2—places where the gas bubbles up through vents in the ocean floor. One such site is in the Mediterranean, where UC Davis Bodega Marine Lab postdoctoral researcher Kristy Kroeker and colleagues are studying how these conditions affect the ecology of the local reef community.

Reef communities are typically very biologically diverse, with numerous species that each play important roles in the community's physical structure and food web, explains Kroeker. But under high CO_2 conditions, certain algae begin to dominate while the coralline algae that depend on calcium carbonate fare less well, changing what the community provides in the way of food and shelter. Kroeker and her colleagues are investigating how seemingly small changes in these food and structure roles will play out on an ecosystem scale and how this compares to acidification-related changes at sites like Fogarty Creek.

As Kleypas explains, such studies will help us understand if "a community is going to change a lot or not" under ocean acidification and how any changes that do occur might affect the community's ecological resilience. Changes to a community's anchor or keystone species—one that plays a crucial role in an ecosystem's function—she explains, are the most likely to affect the whole food web.

By learning which species are most vulnerable to acidification and which are better able to adapt, scientists can target conservation measures aimed at protecting those species, explains Kelly. This could involve curtailing other pollutants or development that's adversely impacting vulnerable species and habitat, including by identifying potential reserves. Such actions can't remove excess CO_2 already in the system, but they can help build resilience. This could be particularly helpful where important fisheries may be affected, says Kelly. But, cautions Evans, "we really don't know yet what it takes to survive in a low pH ocean, and we need that information to set conservation priorities."

> If urchins fail to thrive, it would likely have an adverse effect on their entire community of mussels, sea stars, anemones, fish and marine animals.

GET A GRIP

Yet these are but short-term strategies as the world tries to get a grip on the carbon emissions that are ultimately responsible for ocean acidification.

"First and foremost," says NOAA outgoing administrator Jane Lubchenco, "we need to demand that our elected representatives take seriously the need to reduce carbon emissions, and that's true at a national level but also at the local level."

The process of ocean acidification, like the other manifestations of climate change prompted by excessive atmospheric CO_2, now cannot be reversed entirely. But with swift and dramatic action, the rate of change might be slowed. And to help lessen acidification's impacts, scientists suggest addressing not only carbon emissions but other environmental stressors that can exacerbate these effects as well. We "also need to reduce other sources of pollution," including excess nutrients from both urban and rural sources, Lubchenco says.

This is exactly the strategy Washington state's Blue Ribbon Panel on Ocean Acidification recommended in a report released in November. The report formed the basis of an executive order signed by Washington governor Chris Gregoire the same day. The first such policy aimed at tackling ocean acidification, both the report and the executive order (designed to implement the report's recommendations) combine strategies to reduce CO_2 emissions and other pollution that exacerbates acidification, along with $3.3 million in funding for research and implementation. The recommendations are also part of legislation Washington state senator and blue ribbon panel member Kevin Ranker recently introduced—and that he says he hopes will be copied by other coastal states.

"We have a lot of work to do," says Lubchenco, noting that most people in the U.S. have not yet heard of ocean acidification. "But," she says, "if they like eating oysters or salmon or enjoy watching whales or scuba diving in coral reefs, they should be paying attention—because it's a serious threat."

"The basic policy message," says Palumbi, is that carbon emissions are "a global pollutant, and we have to fix this problem." While a shellfish hatchery may be able to control the chemistry of water in its tanks or choose a different species to farm, the same can't be done in the world's wild oceans.

In the meantime, as effects of ocean acidification play out, scientists and policy makers continue the quest to understand how individual species and marine communities will fare and how this information can be used to protect them before even more dramatic changes occur. "When it comes to ocean acidification," says Lubchenco, "we're all still explorers."

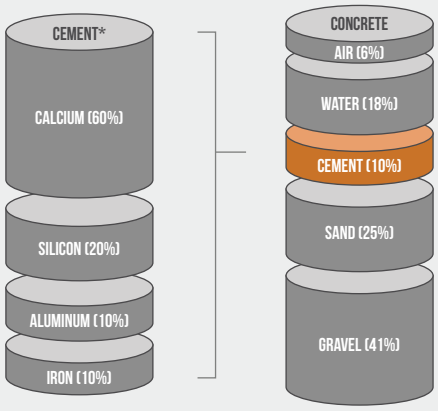
Elizabeth Grossman is the author of *Chasing Molecules: Poisonous Products, Human Health, and the Promise of Green Chemistry; High Tech Trash: Digital Devices, Hidden Toxics, and Human Health*; and other books. Her work has appeared in a variety of publications including *Environmental Health Perspectives, Yale e360, Scientific American,* TheAtlantic.com, *Salon, the Washington Post, The Nation and The Pump Handle.*

BUILDING BLOCKS

Roads, bridges, buildings, runways, homes, dams, canals and more are all built with concrete. The coarse, gray building material has been so ubiquitous throughout history that even the nearly 2,000-year-old Roman Colosseum was constructed with an ancient concoction of concrete. Despite all its benefits of strength and durability, there is a downside. Production of cement, a primary ingredient in concrete, is responsible for a whopping 5 percent of human-generated carbon dioxide emissions. The good news: Some industry newcomers are creating cleaner versions of the versatile building material.

RESEARCH AND TEXT BY BEN LAUER WITH LAYOUT AND DESIGN BY TODD REUBOLD | SOURCES: U.S. DEPARTMENT OF ENERGY, U.S. GEOLOGICAL SURVEY, U.S. ENERGY INFORMATION ADMINISTRATION | PHOTO: © SHUTTERSTOCK.COM/IBAJARS

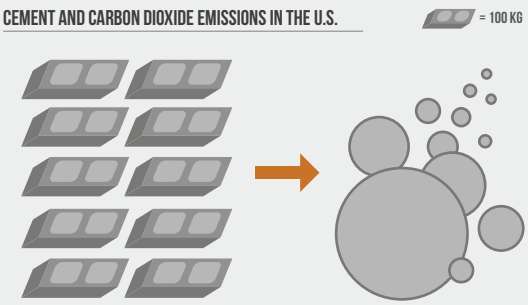
FROM CEMENT TO READY-MIXED CONCRETE (BY PERCENTAGE WEIGHT)



*Plus trace amounts of other materials and chemicals

5 PERCENT OF GLOBAL CO_2 EMISSIONS ATTRIBUTED TO CEMENT PRODUCTION

CEMENT AND CARBON DIOXIDE EMISSIONS IN THE U.S.

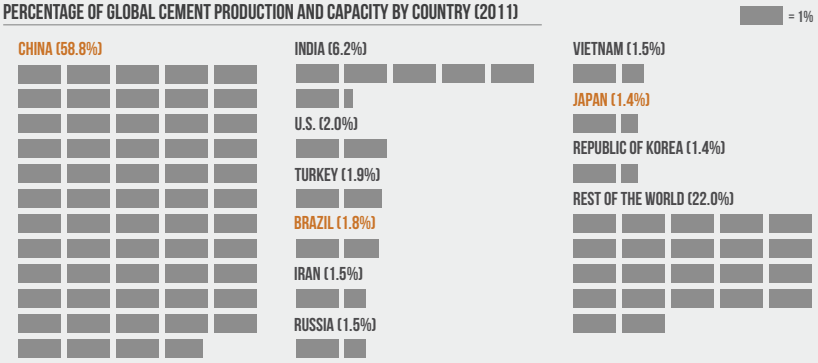


Cement, which typically originates from limestone, is made by heating a mixture of raw materials to over **1,450 C**.

67,800,000
METRIC TONS OF CEMENT PRODUCED IN THE U.S. (2011)

3.4 TO 4.4B METRIC TONS
PROJECTED GLOBAL GROWTH OF CEMENT PRODUCTION BETWEEN 2010 AND 2050—AN INCREASE OF 30%

PERCENTAGE OF GLOBAL CEMENT PRODUCTION AND CAPACITY BY COUNTRY (2011)



In 2010, **CHINA** (6.4%) and **BRAZIL** (5.9%) experienced the greatest proportional increase in cement production and capacity. **JAPAN** (-8.7%) experienced the biggest decline.

THE FUTURE OF LOW-CARBON CEMENT

NOVACEM: This London-based company reduces the CO_2 burden of cement by using lower temperatures early in the production process, different feedstocks and a CO_2-absorbing composition. The process reduces CO_2 production to 420 kg/ton or less and removes up to another 100 kg from the atmosphere.

LOUISIANA TECH: Louisiana Tech University researchers are exploring the use of substitutes for cement's binding function in concrete production. Geopolymer concrete, composed of the industry by-product fly ash, uses strong silica and aluminum binders that avoid large CO_2 outputs.

CALERA CORPORATION: This California-based start-up hopes to incorporate carbon sequestration into its cement production process. Carbon from power plant emissions will be transformed into solid minerals that can be used to make a range of building materials.


FOOD INDUSTRIES (4.1%)
MACHINERY PRODUCTION (4.1%)
PULP & PAPER (4.5%)
ALUMINUM PRODUCTION (4.9%)
IRON & STEEL (16.4%)
CHEMICALS & PETROCHEMICALS (16.8%)
CEMENT PRODUCTION (20.5%)
OTHER IDUSTRIAL MANUFACTURING (28.7%)
PERCENTAGE OF CARBON DIOXIDE EMISSIONS WITHIN THE GLOBAL MANUFACTURING SECTOR
Cement production accounts for nearly 21% of the global manufacturing sector's carbon dioxide emissions.

A woman in Kenya irons clothes for the following day's work using a portable solar lantern. PHOTO BY ANDRES BIFANI/LIGHTING AFRICA

DEVELOPING SOLAR

Tiny lamps and clever financing may finally bring solar to the developing world.

BY JESSICA MARSHALL

The people of Bangalore, India, face eight or more half-hour blackouts each day. Anurag Mehndiratta, a telecommunications engineer there, wanted something more reliable, so he bought a solar water heater and solar photovoltaic system for his home to provide power and comfort when the rest of the city went dark. "Energy is not super expensive in this country, but it's very unpredictable," he says. He had lived in the U.S. and upon returning to India, he wanted "at a minimum, seamless power for my home."

Mehndiratta is one of a billion people around the world who live where electrical grid service is unreliable. At least 1.3 billion more live completely out of range of the grid, and usually these people cannot afford solar setups like the one Mehndiratta had installed. Yet it is easy to see why people would want what solar promises. For starters, it offers an alternative to firewood and kerosene, both of which pollute indoor air. Harvesting firewood can also cause deforestation, and kerosene is a leading cause of poisoning and burns in children—and an expensive, poor quality light source to boot. Meanwhile, solar water heaters quickly pay for themselves with the money saved by not having to heat water with electricity, people in remote locations could use solar power to charge cell phones and, well, who doesn't want a color TV?

Of course, people forever have used the sun to dry foods, fish, clothes, hides and more, and situated their homes with its rays in mind. Today, low-tech solar options have been installed in the developing world, such as plastic bottles filled with water and bleach stuck through metal roofs to disperse daytime light throughout homes—a simple innovation for capturing sunlight. But higher-tech solutions have struggled to make good on their promise of providing clean, sustainable energy to all.

That might be changing in developing countries, as entrepreneurs test possible solutions to a number of the obstacles solar energy has faced over the years—some technical but many social, economic and political.

PANEL POWER

One need look no further than mobile phones for a case study of how a small, portable technology brought its services to people far ahead of the advance of large-scale infrastructure. Solar-powered devices are following a similar trend—bringing electricity and its benefits to people well beyond the grid's reach. The hottest market is for the smallest devices: from little lanterns for illuminating tasks like studying at a desk, making baskets or checking on livestock to tiny "plug and play" systems that can combine, say, a light or two with a cell phone charger using small batteries and book-sized solar panels.

Ned Tozun, president and co-founder of d.light, a company that pioneered this market and claims to have reached 10 million people, sees his products not as an extra expense but as a safer replacement for a dirty alternative on which people already spend plenty of money. "Kerosene is our competition," he says. According to Sameer Hajee of Cape Town, South Africa–based Nuru Energy (which sells a lamp that can be charged by the sun or by the company's patented pedal power generator), Africans alone spend $17 billion per year on kerosene for lighting. These and other companies are looking to redirect that expense to safer, cleaner lights.

"Prior to just a couple of years ago, these technologies had not reached anything like [the current] level of scale," Tozun says. D.light's lowest-priced product—a puck-shaped device with a solar panel on one side and a light on the other, attached to a wire handle that can be hung from a wall or used as a lampstand—costs about $10. Customers save for the lights as they would for a mobile phone, Tozun says. Keeping it cheap allows the company to sell to consumers without relying on financing the products.

While solar panel fabrication has come down in cost, a key driver of the expansion of these small solar devices has been the development of cheaper, more efficient LED lights. The amount of light delivered per watt has nearly tripled in the last several years, says Arne Jacobson, director of the Schatz Energy Research Center at Humboldt State University in Arcata, Calif. "You have a huge decline in price for the same level of performance."

Beyond small lanterns, larger household photovoltaic systems can power a range of items: more lights, ceiling fans or a television. At an even larger scale, mini-grids—some fueled by solar, but others by biomass or wind—are emerging

A mother and son charge their solar lanterns in the Kenyan sun so they are ready to use at night. PHOTO BY ANDRES BIFANI/LIGHTING AFRICA

as new nodes of power to serve areas of 10 or fewer kilometers across that are off the main grid or that have spotty service. And a few locations, such as Burkina Faso and Ghana, are installing large-scale solar systems linked to the grid, says Stephen Gitonga, energy policy advisor to the United Nations Development Programme.

DIRECT USE

Of course, photovoltaics aren't the only way to capture the sun's energy. The sun can be put to direct use as well to replace conventional energy sources that have downsides for human health and the environment.

Solar cooking, for example, reduces smoky indoor fires and the need to gather firewood for cooking, which can contribute to deforestation and put women and children in dangerous situations. However, solar cookers have found only limited use in developing areas.

"Solar cookers are unlikely to be more than a bit player because they require significant changes in cooking habits," Jacobson says. Users have to cook outside the house and during daylight hours, for example. For these reasons, they may work better for institutions, such as schools or temples, rather than in homes, some experts say.

> There are 1.3 billion people without electricity as we speak. This figure has remained like this for the last 50 years. If we don't do anything, it will remain like this until 2030.

Still, Patricia McArdle, a long-term member and former board member of Solar Cookers International, thinks more needs to be done to expand the use of solar cooking. "What's different now is the population is on its way to 9 billion," she says. "A tree takes 30 years to grow. It takes less than a month to burn in a cooking fire."

While solar cookers have faced roadblocks, solar water heaters—often arrays of water-filled tubes that heat water directly by soaking up the sun's rays—are highly efficient and particularly common in cities. Kathmandu, Nepal, for

example, has them on nearly every roof, Gitonga notes, while Bangalore, India, has a law requiring that all new construction above a certain size have solar water heating.

"In the case of water heating, it's just really a straight economic payback where people are using diesel," says Damian Miller, CEO of Orb Energy, an India-based solar company. Their fast payback has made solar water heaters Orb's best-selling product.

OVERCOMING CHALLENGES

The expansion of solar in developing countries has faced challenges at all levels, including governmental, where import tariffs and kerosene subsidies can work against it, and cultural, where technologies sometimes don't mesh with the way people actually live. Still, many start-up companies, looking to capitalize on an enormous potential market while improving lives, are trying to address these and other challenges—especially distribution, reliability and financing.

One of the key challenges is the "uphill battle of small firms making good products against massive 'bottom-feeding' manufacturers dumping shoddy products into the market by the container-load," says Evan Mills, an energy expert at the Lawrence Berkeley National Laboratory in Berkeley, Calif. D.light's Tozun agrees: "We go into markets all the time where people … have had a bad experience [with solar]. We are being fanatical about making our products extremely rugged and affordable."

Lighting Africa and its newer sister organization, Lighting Asia, programs led by the International Finance Corporation, offer product testing and a set of criteria to ensure quality in small devices such as portable lamps. These include making sure a lamp actually delivers the amount of light and battery life claimed on the package and testing whether a product can survive being dropped. They also require a minimum of a six-month warranty. Jacobson, who is the technical lead for the program, says it is beginning to have an effect. Lighting Africa–certified products—40 so far—are gaining market share, with annual sales growing threefold in the past four years.

While reliability is important to encouraging use of any product, so is affordability.

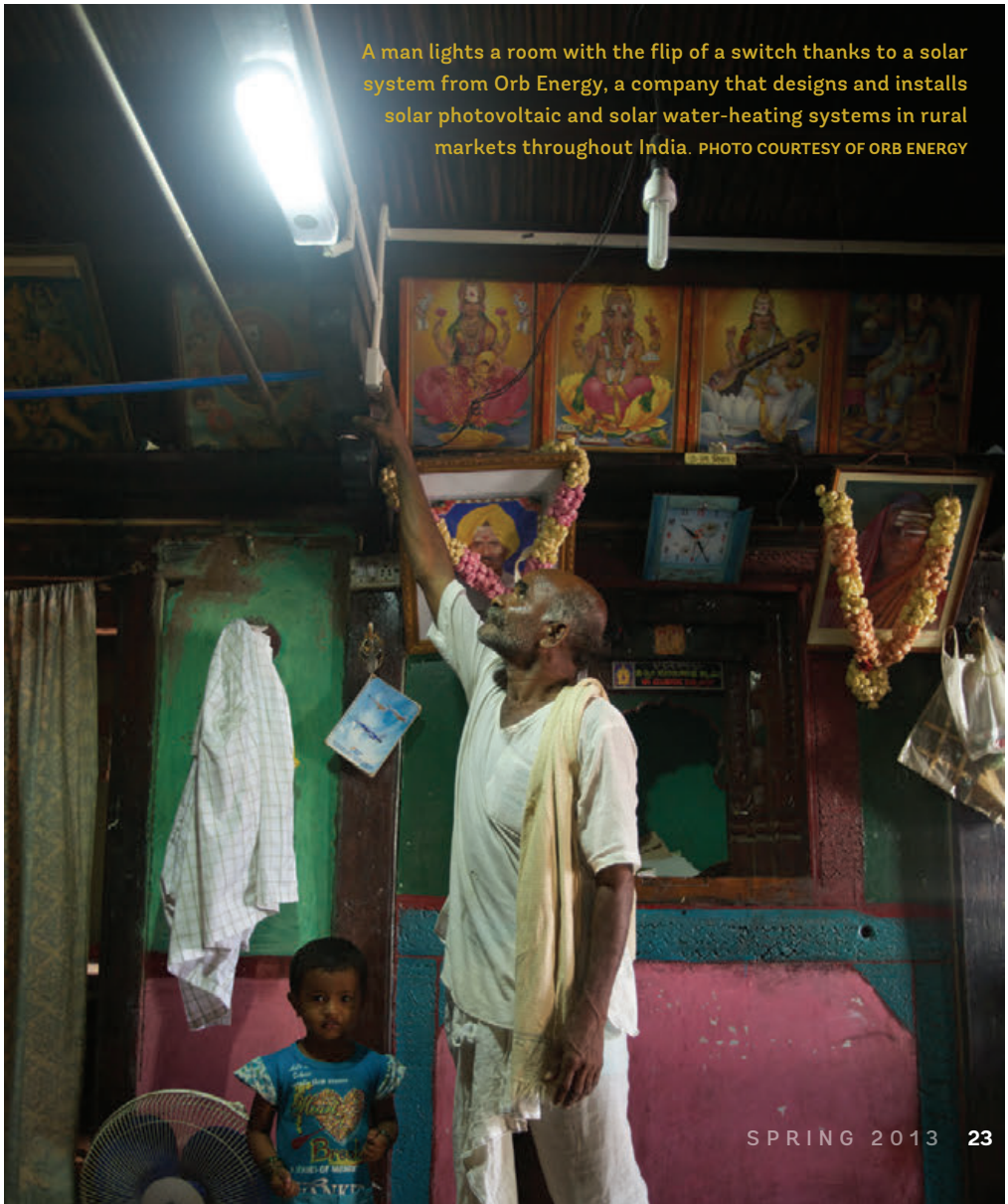
"Mobile banking and microfinancing—those two things combined are making for some interesting possibilities that weren't really there just four years ago," Jacobson says.

Microfinancing gives small loans to households or businesses, which is a good option for some consumers. But lenders can still be slow and risk averse, and many potential buyers have irregular income streams that make a loan with regular repayment, however small, an intractable option. Paul Needham, founder and president of Simpa Networks, which sells energy technology in India using a "progressive purchase" model, draws an analogy once again to cell phones. While cost declines made it easier for people to afford phones, he says, "the biggest innovation is the prepaid, pay-as-you-go pricing. That allowed companies to serve people who don't have credit histories."

Simpa Networks and Kenyan solar energy company M-KOPA are bringing pay-as-you-go models to solar photovoltaics while also capitalizing on innovations in mobile banking. In Simpa's system, customers make payments—via mobile phone if they have access to mobile banking—for a particular amount of energy, and the company unlocks the customers' equipment until they use what they've paid for. When a customer has paid in full for the equipment, it unlocks permanently. Needham believes that this financing approach will allow investment in larger systems by those who would otherwise have been able only to afford a small light.

While many of these ideas are still unproven at the large scale, UNDP's Gitonga says the sun will play a growing role in providing energy to the developing world. "Solar energy will remain a big piece of energy expansion, especially in decentralized remote areas," he says. "There are 1.3 billion people without electricity as we speak. This figure has remained like this for the last 50 years. If we don't do anything, it will remain like this until 2030."

Jessica Marshall is an award-winning science, environmental and health journalist. Her work has appeared in *Discovery News*, *New Scientist*, *Nature*, TheAtlantic.com and Science News for Kids, among other outlets. She has a Ph.D. in chemical engineering and has taught science journalism at the University of Minnesota. She lives in St. Paul, Minn.



A man lights a room with the flip of a switch thanks to a solar system from Orb Energy, a company that designs and installs solar photovoltaic and solar water-heating systems in rural markets throughout India. PHOTO COURTESY OF ORB ENERGY

"Persuading people through technology is the next social revolution."

game on!

BUSINESSES HAVE USED **BEHAVIORAL SCIENCE** TO **INFLUENCE CONSUMERS** FOR DECADES. CAN IT BE USED TO **SAVE THE PLANET?**

BY WENDEE NICOLE | ILLUSTRATION BY KATE WORUM

When Susan Stevens' young son went into anaphylactic shock in 2006, she rushed him to the emergency room as her thoughts raced: Was it something he ate? Something he touched? Turns out a cashew caused the severe reaction, but she learned he had other severe allergies, leading her to completely reevaluate her family's lifestyle choices. Stevens became adept at reading labels and selecting chemical-free cleaning products, and adopted other practices, such as removing shoes at the door to improve indoor air quality. She began blogging about her eco-friendly lifestyle, had her home renovated green and started night school for sustainable design. What started as a personal epiphany was becoming a passion to encourage sustainable behaviors in others. But how could she make a bigger difference?

In 2010, Stevens launched Practically Green, a business that uses game techniques to encourage people to complete simple actions as a path to collective environmental change. She was at the forefront of the emerging strategy called "gamification," rooted in decades of social psychology research. Gamification uses games and social media to motivate behavioral change by tapping people's instincts to follow social norms and to compete.

In fact, marketing and business executives have used tools from social psychology to influence behavior for decades. In the 1990s, BJ Fogg pioneered the study of how technology can be used to influence behavior. His once-controversial research now garners millions of dollars for companies. "Persuading people through technology is the next social revolution," Fogg, now director of the Persuasive Technology Lab at Stanford University, said in *Fortune* magazine.

But can it be used to save the planet? Stevens thinks so.

Before she started her business, Stevens had noticed how much time people spent on social media and on games like FarmVille and wondered, "What if people were doing things that matter?" But it wasn't until she took a class on the U.S. Green Building Council's LEED program, where buildings receive one of four levels of certification by earning points for various actions, that her pondering solidified into something concrete. "I kept thinking, 'Why isn't there something like this for people?'" Stevens recalls. So she developed a point-based program modeled after LEED, but for daily life. Players compete for points and earn badges by completing suggested environmentally friendly actions in four categories: energy, water, health and "stuff." Every action includes links to additional information, such as a database that contains details about various cosmetic products.

Stevens launched Practically Green at the inaugural SXSW Eco conference in Texas in October 2011. Just a year later, her clients included Seventh Generation, which uses the program to encourage employee sustainability, and NBC Universal, whose Practically Green–based app, "One Small Act," is available from iTunes. Anyone can play Practically Green online at no cost—and tens of thousands do.

KEEPING UP WITH THE JONESES

Although people often insist they are not influenced by others' behavior, social scientists know better. In a well-known 2008 study, Arizona State University professor emeritus of psychology

SIX UNIVERSAL PRINCIPLES OF INFLUENCE

SOCIAL PROOF Not only do people tend to follow social norms generally, their likelihood of following the crowd increases when they are uncertain about a choice. People also tend to follow people similar to themselves.

RECIPROCITY Doing something for someone has a tremendous influence on whether they will do something for you. In one study, when a man gave study subjects a Coke, they bought more raffle tickets from him than did subjects not given a Coke. Likewise, companies know that giving away free samples greatly increases product sales.

AUTHORITY People tend to follow authority, even when it goes against their personal objections. Cialdini credits this social behavior influence for the My Lai Massacre in 1968, when American soldiers slaughtered hundreds of unarmed women, children and elderly in Vietnam because of a military order. This concept extends to people with expertise, not just people in authority, such as police, military officers or bosses.

COMMITMENT When people have previously committed to a behavior they are more likely to follow through, even when it seems counterintuitive. In one example, people's reluctance to place gigantic neighborhood watch signs in their front lawn decreased a few weeks after they agreed to place an unobtrusive sticker in their window.

SCARCITY People tend to want something more when availability is limited.

LIKING People we like motivate our behavior more than people we do not like. People are more likable when they compliment us, when they are similar to us or when they are physically attractive.

Robert Cialdini found hotel visitors were most likely to reuse towels when a placard stated that most of the occupants of a guest's room reused their towels—even though each guest in a room has nothing in common with previous or future guests of that room. Messages listing the hotel average for towel reuse or appealing to a sense of environmental stewardship worked less well in promoting towel reuse. Cialdini's principle of influence, called "social proof"—what some think of as peer pressure or following norms—is central to gamification.

"People tend to change over sustainability when the social norms change," Stevens said at the "Why Should I?" panel discussion at the 2012 SXSW Eco conference. "When two, three, four, 10 people start to do [something], it starts to get all the people around them to do it, and then it goes over the tipping point and becomes the norm." For people to act in a particular way—to recycle or carry a water bottle—the norm does not have to be across society, but can be within a company, neighborhood, school or group of friends. It can even involve a "granfalloon"-type group, such as residents of the same hotel room.

Although people often insist they are not influenced by others' behavior, social scientists know better.

In gamification, behavior is driven not only by social proof but also by competition. Several companies using Practically Green have employee teams that compete. "It's hysterical," Stevens said. "Every week when the ranking comes out, you see a massive flood of people in the group on the bottom that's coming in to start to make more points. So it works." She adds that the team aspect boosts participation in folks who might not otherwise want to play because they would feel they let down the others if they didn't join in.

Since Stevens launched Practically Green, similar companies have emerged. Badgeville uses games, analytics and social networking to influence customer and employee behavior for more than 200 companies, from Dell to Panera Bread to Mother Nature Network, though only a small portion of their clients address social responsibility. Grant Williard launched an updated version of his JouleBug app, which encourages sustainable living activities such as water and energy conservation, recycling and other actions, at the 2012 SXSW Eco conference. Williard says he envisioned the app after using an online carbon footprint calculator that measured the impact of his lifestyle on the environment and getting an "awful score." That led him to research how to reduce his carbon footprint. "I got a laundry list of tips, but they weren't applicable," he says. "It was winter and they were air conditioning tips." He decided to create something bite-size.

"The only way to get people motivated is competition. So that's when we came up with the idea of making it social, mobile and gameful," Williard says. "When you're on the subway on your way to work or you are standing in line, pulling out something like this that's made to take 30 to 45 seconds of your time, that's how we feel people will engage with sustainability."

JouleBug provides reminders at particular times of day for appropriate actions—such as turning down your thermostat right before you leave for work (and the app can sync with a player's utility company). Williard recently launched a business side to his consumer app, which sells universities, businesses, cities and other communities the right to use the app to encourage collective changes.

GETTING TO "WANT TO"

One of the groundbreaking aspects of gamification is that it bridges the gap between knowing and doing. Among the biggest misconceptions about promoting environmentally responsible behavior is that if people just knew about issues, that knowledge would compel them to change. This "deficit model" of communication—which says that giving people more information will change their view—has been widely discredited in recent years.

"If educating people about an issue would solve the problem, we would have no obesity and no smokers in our country," said Lee Ann Head, vice president of research from Shelton Group, at the conference. Shelton, a marketing firm specializing in sustainability, found a conflict

between values and actions in its annual Eco Pulse survey of American consumers.

"Two-thirds of American consumers say that conserving water is important to them and that they are concerned about the freshwater supply in the U.S.," said Stevens. "When we ask about their activities … less than one-third have done anything in terms of changing their water habits—gardening or lawn practices or buying a water-efficient fixture for their home."

So what changes behavior? "The first thing we think you need to do is wake someone up to their unconscious behavior," Head stressed. "You have to make them feel a little uncomfortable about it, especially if they have an attitudinal belief that what they're doing is wrong." Using this line of thinking, Shelton Group developed a series of Wasting Water is Weird public service announcements featuring Rip the Drip, who shows up just in time to embarrass a person unconsciously wasting water. The PSAs aired about 24,000 times on 290 TV stations in more than 120 markets and received more than 150,000 views on YouTube, according to Penny Kemp, vice president of account management at Shelton. Through its Eco Pulse survey, the company also found that nearly one-third of people who saw the PSAs were moved to change their water-use habits. This subtle shame—revealing to people that they are not following the accepted norm—is inherent in Cialdini's social proof principle.

"It's not about telling [people] that they're wrong, as that never works. They are just not thinking about what they're doing," said Head. "You have to do it in a lighthearted and fun way so that you make a problem visual. And then you have to give them some prescriptive things to do. It's got to be simple and it's got to be easy."

Robin Krieglstein, senior producer of Badgeville, agreed. "We don't realize over the course of a week or a month we even do some of these behaviors," he said at the panel. "If you actually begin to track how many times people are doing a behavior, then you can set clear goals, like trying to turn off the water while brushing." Games offering congratulation messages, badges and scores encourage people to continue their efforts, and Krieglstein said research shows that a "congratulations" in a game provides a similar effect in the brain as if it were spoken aloud by a person.

One of the groundbreaking aspects of gamification is that it bridges the gap between knowing and doing.

BUT DOES IT WORK?

Head says it's not necessary to make people believe in climate change or be concerned about other environmental issues in order to make them take action. "I don't care about their motivation, I don't care that they do it for the right reason," she said at the panel. "I want to figure out what their motivation is, tap into that and get them to act. What matters is the end result." If the motivation is simply competitiveness, then so be it.

But does it work? Preliminary results suggest yes. Above and beyond behaviors users already engaged in, in just two years Practically Green online has encouraged 1.7 million environmental actions and saved 1.5 million gallons of fuel, 57 million gallons of water and 269 million pounds of carbon dioxide, according to Stevens.

"People want to take steps and actions when it's smart for them, when it's practical and helpful," said Stevens. She says gamification works by using the best behavioral science has to offer to motivate people to become sustainable—and it only takes a few minutes per day. "Not a single client says a few minutes a day focusing on sustainability is time wasted."

Wendee Nicole writes about science, conservation, ecotravel and environmental health for varied publications, including *Nature, National Wildlife, Scientific American* and *Environmental Health Perspectives.* She has traveled the globe, from the Peruvian Amazon to Australia's Coral Sea, in search of great story ideas.

ACTION ALERT

Practically Green users have hundreds of activities to choose from as they work to rack up points. For example:

DRINK WITH A REUSABLE STRAW
+ 10 points

SAVE ENERGY: SKIP THE IRONING
+ 10 points

RECYCLE BATTERIES
+ 15 points

SWITCH TO A GREEN DRY CLEANER
+ 20 points

TURN DOWN THE HOT WATER HEATER
+ 20 points

INFLATE YOUR TIRES TO SAVE FUEL
+ 20 points

WASH LAUNDRY IN COLD WATER
+ 50 points

USE NO-VOC PAINTS
+ 50 points

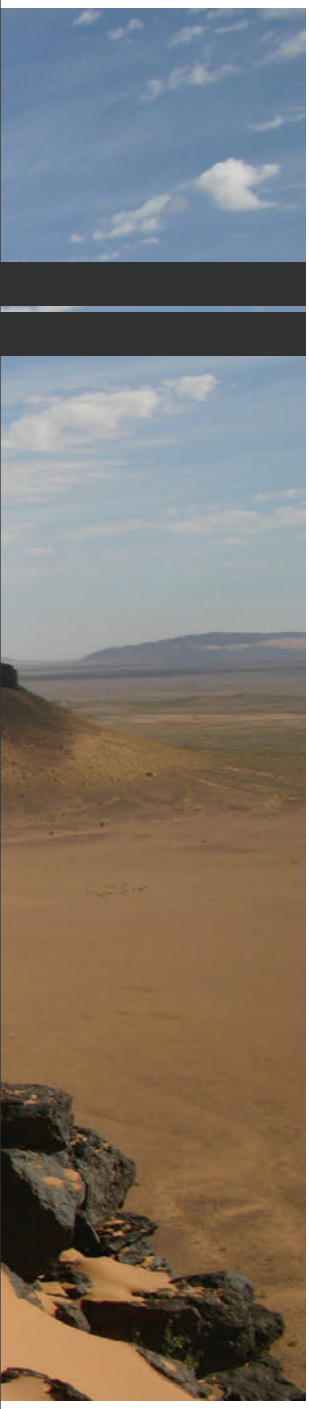
MASS APPEAL

National Geographic Emerging Explorer **Iain Couzin** looks for answers to how and why animals flock, swarm and move in unison.

BY MARY HOFF

*"A bird flock turning as one entity—**the beauty of that I find captivating.**"*

Though much of Iain Couzin's quest to understand how and why animals flock, school and swarm is done through computer simulation, field studies are important—and sometimes hazardous. This trek to Mauritania left Couzin with painful sores on his hands from toxins released by locusts he was studying. PHOTO COURTESY OF IAIN COUZIN



WHEN YOU HEAR "National Geographic Emerging Explorer," scenes of lions and tigers and bears, the tops of mountains and the depths of the sea, likely flash before your eyes.

In the case of Iain Couzin, the appropriate mental image would be something like a soaring flock of starlings so thick they look like smoke against the sky. Or a tide of flightless locust nymphs flowing across desert dunes. You might picture minnows swimming in schools. Or even commuters flowing through a subway station—undulating ribbons of humanity.

You see, when Couzin, a member of the ecology and evolutionary biology faculty at Princeton University who was named a National Geographic Emerging Explorer in 2012, goes exploring, it's to delve into the mysteries of collective behavior—flocking, swarming and other examples of living things moving in unison. His fascination with movement in turn is moving the science of animal behavior to explore whole new realms, which include uncovering insights that might help keep people and nature compatible in an increasingly crowded world.

Ironically, it was blind ants that led Couzin into this line of research. As a biology major at the University of St. Andrews in the U.K., he saw a documentary on BBC-TV about behavioral biologist Nigel Franks' studies of how army ants, which can't see, are able to follow each other in long, cohesive columns through the rain forest. Couzin contacted Franks and ended up pursuing a Ph.D. with him. Soon, under the guidance of another graduate student, Guy Blanchard, his focus shifted from insects into collective behavior more generally.

"I've always been interested in art, painting, drawing, so I was naturally drawn to patterns formed by animal groups," Couzin says. "A bird flock turning as one entity—the beauty of that I find captivating." As a graduate student, Couzin says he incorrectly assumed there would already be a lot of research on how animals formed these coordinated patterns. "It astounded me there was nearly no research—it was a blank canvas."

Among the things that intrigue Couzin about collective behavior is the 1+1=3 nature of it—meaning that the movement of animals in crowds cannot be predicted from the movement of individual animals. Instead, that movement is what biologists call an "emergent property"—something that is a characteristic of the interaction itself, rather than of the organisms involved. Using algorithms, computer programs, mathematical equations and more, Couzin observes, models, simulates and draws conclusions about those emergent properties from the many and varied ways living things move in unison.

Implications for the environment and sustainability are abundant. Computational models of the evolution of animal migration, for instance, have offered two profound insights into this large-scale collective behavior, which is threatened around the world by human encroachment on natural lands. First, encouragingly, migrations can be surprisingly robust. Animals may be able to maintain migration patterns even when they have to adjust to highways and other obstacles. Second, and far less encouraging, once a migration is disrupted to the point that it disappears, it's gone forever—upsetting the balance of nature all along its path. Even if the animal species and the habitat that once supported its migrations recover, Couzin says, because it's an emergent property, "you don't recover the behavior."

Couzin's discoveries related to the emergent properties of collective behavior point to the need for additional research as well. In the 1800s, he notes, passenger pigeons blackened the sky by the billions. By 1915 the birds were extinct.

"Collapse can be absolutely sudden," Couzin says. "Why is that? We don't know." He hopes to find the answer with the help of mathematics-based models of flocks and swarms—and in the process provide valuable insights for efforts to save other species faced with habitat loss, pollutants and other assaults.

Though he prefers studying nonhuman animals, Couzin acknowledges people are a big part of the picture as well. One project he started in 2012 looks at two linked collective-behavior systems—ocean fish and fishermen. Bringing together social scientists, anthropologists, fisheries scientists and animal behavior experts, he's painting a better picture of what it will take to keep both systems healthy.

What's next? Couzin says he doesn't have specific plans for future directions for his work. Instead, he seems to be taking a lesson from his study subjects and staying open to the influence of others as he sets his course.

"I'm excited that I don't know where things are going," he says. "I'm just really enjoying every day."

MAGIC CARPET RIDE

Ford is teaming up with manufacturers to turn old carpets into plastic parts.

BY JOE HART

IT'S A STANDARD AMERICAN refresh for the home or office: Rip out the old, stained carpet and replace it with sparkling, soft wall-to-wall.

But gracing our spaces in this way exacts an ugly environmental toll. In 2011, more than 3.8 billion pounds of used carpet was discarded in the United States (down from nearly 5 billion pounds before the housing market collapsed), according to the Carpet America Recovery Effort, an industry-supported nonprofit organization.

Most of that waste ends up in landfills. Some of those old carpets, however, are ending up in an unexpected new home: the engines of Ford vehicles.

Wellman Engineering Resins, a Johnsonville, S.C., plastics company, has developed a technique to harvest the plastic resins from old carpets. Ford, in turn, is using these recycled plastics, sold under the brand name EcoLon, to manufacture parts, including cylinder head covers used in the Ford Fusion, Escape, Mustang and F-150 trucks.

Carpet is heavy, and since construction "tipping fees" for dumping at landfills typically run by the pound, contractors are happy to unload their carpet debris at one of several collection points Wellman has set up along the East Coast. What Wellman then does to transform the carpet to its raw components is a closely guarded trade secret—but quality coordinator Alton Boyd says it involves a mechanical separation, not a chemical process. "We grind it, and it goes through several processes to clean it," says Boyd. "In the end, we extrude it into a chip that we use to make the resin that's a component in the plastic parts." A second manufacturer uses the EcoLon to build the auto parts for Ford.

Though such technology has been around since the mid-1990s, according to Don Wingard, the recycling technology director at Wellman, it's taken the intervening decades for the process to make economic sense. "It's good to recycle," says Wingard, "but it has to be cost effective." Collecting, transporting and processing old carpets is "very energy and labor intensive," he explains.

As purer forms of plastic have become scarcer, however, demand for recycled alternatives has grown. "Finding alternative sources for materials is becoming imperative as petroleum prices continue to rise and traditional, less sustainable materials become more expensive," explains John Viera, Ford's global director of sustainability and vehicle environmental matters.

Carpet-to-car-part recycling is only one of many efforts to divert used carpeting from landfills. According to CARE's annual report, recycling has grown from 55 million pounds in 2002 to 251 million pounds in 2011. According to Ford press materials, EcoLon accounted for just over 4 million pounds of recycled carpet in 2010.

Still, while the growth in carpet recycling is impressive, less than 10 percent of the nation's used carpets are recycled, and CARE projects that percentage to grow slowly, reaching just 12 percent by 2016. "The amount we're using is nowhere near what's getting thrown out," says Boyd. "It's not a question of supply, but of logistics—of getting it where we can use it."

These logistics are daunting. Yet the effort makes environmental sense, according to Allen Hershkowitz, senior scientist at the Natural Resources Defense Council. "Just for context, in this country we produce between 14 and 16 billion tons of waste every year," he says. "There is no one single undertaking we could carry out that's going to address that ecological issue. It's going to be addressed by millions of businesses and people."

After 35 years of researching and implementing solutions to our solid waste problems, Hershkowitz believes recycled products like EcoLon are vital.

"It makes no sense to take virgin oil from ecologically irreplaceable regions, make it into plastic and throw it away, when it can instead be recycled over and over again," he says. "It makes no sense to put highly refined materials into the landfill when they can be recycled and avoid the upstream ecological costs of refining crude oil and manufacturing plastics."

In light of these factors—and in a world of increasing oil scarcity—recycling efforts like those being made by Wellman and Ford will become ever more important, and sweeping the vital role of plastic reclamation under the carpet will become increasingly difficult.

Joe Hart is a freelance writer, editor and musician based in rural Wisconsin where he lives with his three children. Hart's magazine features have been widely published in the Midwest, and he is a former contributing editor for *Utne Reader*.

4 MILLION POUNDS amount of carpeting diverted from landfills through Ford's use of EcoLon in 2010

The EcoLon material from Wellman Engineering Resins offers an eco-friendly alternative to typical cylinder head covers. The cylinder head cover can be found on the 5.0-liter engine, which powers several Ford models. **PHOTO COURTESY OF FORD MOTOR COMPANY**

SHOULD WE TRY TO KEEP NATURE NATURAL?

In the age of the Anthropocene, when humans have their fingerprints on everything, even altering the climate, does it make sense for ecologists and conservation biologists to talk about pristine nature? As it becomes apparent that humans have been tampering with ecosystems for millennia, is the pre-Columbian world a useful benchmark for restoration? We invited **Emma Marris,** author of *Rambunctious Garden,* and **Sean Gerrity,** president of American Prairie Reserve, to continue a conversation on this topic that began last summer at the Aspen Environment Forum.

BY GREG BREINING

"**THE MORE WE LEARN** about humanity's effects on North American ecosystems before the arrival of Europeans, from day-to-day management with fire and agriculture to potentially anthropogenic extinctions of large animals, the clearer it becomes that using 1491 as a baseline only makes sense in human, cultural terms. In the long view of ecology, 1492 was just a historical moment marking a divide between different kinds of human management of the landscape, not some sort of mystical veil before which the continent was somehow 'pristine.' I think the word *pristine* is nonsensical and unhelpful as applied to ecosystems.

Now, that doesn't mean that 1491 should be forbidden as a restoration goal. It may be that we decide we like the way people back then were managing the land better than we like our current management practices. A restoration in this spirit would bring back not only the plants, animals and ecological relationships of an earlier time, but also the management tools, including rule-bound hunting, fire and perhaps even planting.

This is subtly different than a more traditional goal of reassembling an ecosystem and then letting it go out of our control. I think 'unmanaged-ness' or wildness is a worthy goal, too, though a piece of land that we have chosen to let run wild will very likely not look anything like it did in 1491. Even if we started with a piece of land populated only by native species, we would soon have exotics moving in and competing for space and resources with the natives. And as the climate changes, species would move in and out, and change in abundance. The result, according to emerging research on novel ecosystems, might well be as diverse or more diverse than the native system. But it would be unfamiliar.

This is the paradox of modern conservation. If you want historical ecosystems, you have to manage them intensively, wrestling them to your benchmark against their propensity to change in a changing world. If you want wild or unmanaged ecosystems, they won't be historical."

EMMA MARRIS
AUTHOR, *RAMBUNCTIOUS GARDEN: SAVING NATURE IN A POST-WILD WORLD*

"**EVEN IN THESE TIMES,** I believe it is important to set aside big, fully functioning ecosystems. While we are not likely to wholly understand their scientific value for another few hundred years, by then it would be too late.

In one historically important area of the Great Plains, American Prairie Reserve is working to do just that by building a wildlife park of more than 3 million acres for the public's enjoyment. An abundance of animal, insect and bird species thrived here for thousands of years. Archaeologists have carbon-dated bones of bison, pronghorn antelope, elk, bears and other grassland animals found around the fire pits of early hunters as far back as 9000 BC. Written accounts of the abundant wildlife started in the late 1700s with Hudson Bay fur trappers, continued through the journals of explorers Meriwether Lewis and William Clark in the early 1800s, and were later corroborated in paintings by artists like George Catlin. This diversity, however, was largely wiped out by pastoral newcomers in an astonishingly short period between 1860 and 1900.

With agricultural pursuits and their associated human populations now in decline here due to harsh weather and poor soils, at APR we are betting that it is entirely possible to return wildlife populations to Serengeti-like numbers, especially since the mixed-grass prairie habitat is still mostly intact even if the wildlife abundance and many natural processes are currently missing. By looking to the past to understand the full suite of species that coexisted with humans for thousands of years, I believe that eventually it will be possible to restore species to numbers that will enable fully functioning ecosystems, yet this time surrounded by modern commerce. I believe it is a matter of scale, so at APR we are working to assemble enough habitat to support plant and wildlife diversity, migrations and ecosystem processes, even in times of drought or disease.

In such a future scenario, humans will be integrated into the system, hunting ungulates and torching the prairie as they have done for nearly 11,000 years. Proactive human manipulation of the system existed on this landscape for thousands of years and will continue to do so."

SEAN GERRITY
PRESIDENT, AMERICAN PRAIRIE RESERVE

Greg Breining writes about science, nature and travel for the *New York Times, Audubon* and other publications. He has written more than a dozen books and is a principal of Breeze Communication Arts, a writing and design firm.

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with Ribnic Circus aerialists

Energy Expert **PEGGY LIU**
with Twin Cities Women's Choir

Global Architect **PETER WILLIAMS**
with artist Gregory Euclide and musician S. Carey

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