# terra

DISCOVERY | CREATIVITY | INNOVATION · Fall 2014

## UP IN THE AIR

Oregon's birds face a multitude of threats

### BLUE CARBON

Mangroves as carbon supersinks

### RUNNING WITH ROBOTS

Sci-fi comes home

### REWRITING THE SCRIPT

Discovering unsung Irish playwrights

Oregon State UNIVERSITY

# terra

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Oregon's leading public research university

## FEATURES

## DEPARTMENTS



*The Zumwalt Prairie in northeastern Oregon hosts an abundance of hawks, eagles and songbirds alongside grazing cattle. For two decades, OSU researcher Pat Kennedy has been unraveling the region's ecology. See "Avian Nations," Page 6. (Photo: Lynn Ketchum)*

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Oregon State is Oregon's leading public research university with more than $285 million in research funding in FY2014. Classified by the Carnegie Foundation for the Advancement of Teaching in its top category (very high research activity), OSU is one of only two American universities to hold the Land-, Sea-, Sun- and Space-Grant designations. OSU comprises 11 academic colleges with strengths in Earth systems, health, entrepreneurship and the arts and sciences.

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**On the cover:**
This adult American condor hatched at the Los Angeles Zoo in 1991 and now flies in the wild near Pinnacles National Monument. (Photo: Susan Haig)

# For Our Ancestors

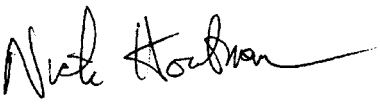
My aunt, the keeper of the family tree, now lives in a skilled nursing facility. Since her room has little space for personal belongings, the archive of correspondence, photos and family ancestry charts has come to my house. I've heard family stories since I could sit at the dinner table, but as I sift through the collection, I'm learning more about my people. Going back as far as the 16th century, they include a shoemaker, lace worker, artist, stockbroker, sugar importer, clergyman and even a shipping line owner. Alas, no journalists or magazine editors.

For the most part, personal ancestors play little if any role in research. But if you dig below the surface, such shadows may appear. For example, Oregon State theater professor Charlotte Headrick turned an interest in the Irish side of her family into a scholarly exploration of Irish women playwrights ("Rewriting the Script," Page 26). In addition to producing some of their plays at OSU, she co-edited a new anthology of works that have been kept largely behind the scenes of Irish drama.

Ancestral relationships also show up in the work of people who study wildlife ("Survivors from the Depths of Time," *Terra*, winter 2014) and those who delve into languages ("A Place of Belonging," *Terra*, winter 2013).

My aunt has lived most of her life in the United States and, like Charlotte Headrick, taught theater. She returned time and again to the dramatic works of her Dutch homeland. The journey is deeply personal as well as professional. She and Headrick embody T.S. Eliot's famous words in his poem *Little Gidding*:

*We shall not cease from exploration*
*And the end of all our exploring*
*Will be to arrive where we started*
*And know the place for the first time.*



Editor

## OSU Launches Terra Newsletter Online

Three times annually, the Terra newsletter provides short articles, news headlines, recent grants and more. Subscribe to this free email service by sending your name and address (both email and postal) to **TerraNewsletter@oregonstate.edu**.

Oregon State UNIVERSITY

## Aspen Recovery in Yellowstone Spurred by Wildlife Shifts

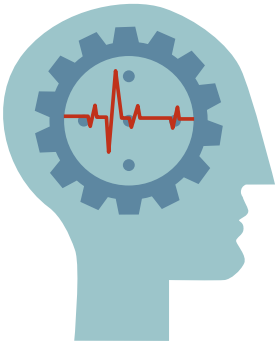
Wildlife in Yellowstone National Park is undergoing dramatic shifts with consequences that are beginning to return the landscape to conditions not seen in nearly a century. In the park's northeast section, fewer elk browse in their historic winter range in the Lamar Valley. They are now more numerous outside the park.

Aspen recovery is widespread in much of the northern range, but where elk are still numerous, aspen stands are heavily browsed and stunted.

"Without wolves this would not have happened," says Luke Painter, an instructor at Oregon State University and lead author of three recent papers that describe the results of his fieldwork monitoring vegetation growth patterns in the park. "Wolves caused a fundamental change, but certainly they are interacting with other factors such as bears, climate, fire and human activity."

Painter teaches in the Department of Fisheries and Wildlife. He conducted his Ph.D. research with William Ripple in the OSU College of Forestry. (For more on carnivore ecology, see "High Alert," *Terra*, spring 2007.)

*Bison browse on aspen and have increased fourfold in the Lamar Valley since the late 1990s. Since bison can't reach as high as elk, more aspen grow to maturity. (Photo: Luke Painter)*



## Small Stressors May Reduce Longevity for Men

Older men who lead high-stress lives, either from chronic everyday hassles or because of a series of significant life events, are likely to die earlier than the average for their peers.

"We're looking at long-term patterns of stress — if your stress level is chronically high, it could impact your mortality, or if you have a series of stressful life events, that could affect your mortality," says Carolyn Aldwin, director of the Center for Healthy Aging Research in the College of Public Health and Human Sciences at OSU.

Her study looked at two types of stress: the everyday hassles of such things as commuting, job stress or arguments with family and friends; and significant life events, such as job loss or the death of a spouse. (For more on the health effects of stress, see "The Stress Paradox," *Terra*, winter 2010.)

## University of Alaska Joins Wave Energy Partnership

Wave-energy researchers will focus on the tidal inlets and coastal waves of Alaska as a result of a $4 million grant from the U.S. Department of Energy. Until now, the Northwest National Marine Renewable Energy Center has been a partnership of Oregon State University and the University of Washington.

"Alaska has an enormous energy resource, both in its coastal waves, tidal currents and powerful rivers," says Belinda Batten, professor in OSU's College of Engineering and head of the energy center. "Partnering with Alaska Fairbanks will allow us to expand the scope of our energy research and tap into additional expertise, to more quickly move wave, tidal and river energy closer to commercial use." (For more on wave-energy research, see "Taking Stock of Wave Energy," *Terra*, winter 2012.)

*OSU researchers deploy one of the nation's first wave-energy testing devices, the Ocean Sentinel, off the Oregon coast. (Photo: Pat Kight, Oregon Sea Grant)*

*Editor's note: Oregon voters will decide this fall whether to require labeling of foods made with genetically engineered ingredients. Below, two OSU scientists offer opinions on the pros and cons of this technology.*

# Arrested Development

## Intellectual property and regulations hinder research

BY JIM MYERS, PROFESSOR OF HORTICULTURE

HOLDER OF THE BAGGETT-FRAZIER VEGETABLE BREEDING ENDOWED PROFESSORSHIP

Genetic engineering has become a valuable scientific tool. It has enabled us to gain tremendous insight into the mechanisms of plant reproduction, disease resistance and other useful traits. However, commercial use of this technology has not lived up to expectations and has created serious hurdles for plant breeders. That, in turn, hampers genetic progress and innovation.

In fact, conventional plant breeding can achieve results efficiently and for much lower cost.

Take the case of the Indigo Rose tomato, which has a purple skin and contains high levels of antioxidant compounds known as anthocyanins. Produced with standard plant-breeding techniques, the variety developed by my program became commercially available in 2011. It has been successful beyond my wildest imagination. Already sold for three seasons in the United States, seeds will soon be available in Japan, Canada and Europe. It has been featured in numerous articles and blogs and was recently highlighted in the premier epicure's magazine, *Bon Appétit*.

Last year, there were a half-dozen new Indigo varieties, some developed by breeders who had easy access to our seeds. Next year, there will be more than 20 new varieties of Indigo tomatoes, three of them from my program and the rest from researchers who crossed our varieties with other types of tomatoes.

Researchers in the United Kingdom have also developed a high-anthocyanin tomato through genetic engineering (GE). While the mechanism that amplifies anthocyanin production in fruit is similar in conventional and GE tomatoes, there are differences in appearance. Anthocyanins in Indigo Rose are light-induced and produced in the skin, whereas the GE tomato genes are expressed in all fruit tissues at all times, resulting in higher concentrations.

While the research on both types of tomatoes began at about the same time, the GE tomato is not commercially available. It has yet to clear the regulatory hurdles in any country. Since European countries tend to restrict GMOs, it may actually be sold in United States and Canadian markets before being commercialized in Europe. I estimate that the development cost for Indigo Rose was less than $100,000. Estimates for development and commercialization of a GE crop run from millions to hundreds of millions of dollars.

As a vegetable breeder, I have an interest in distributing the results of my work as quickly as possible. With genetic engineering, that doesn't happen. Companies that maintain patents on GE crops lock up the seeds and don't allow them to be used by others for breeding. Or if they do, contracts allowing one to use the seeds have many limitations, and license fees to deploy new varieties can be prohibitively expensive.

Plant breeders used to share their seeds quite readily, a practice that led to steady genetic improvement in our crops. Now, intellectual property control that was first implemented for genetic engineering is widely applied to conventionally bred crops. As a result, there is reduced sharing among breeders. The Green Revolution was built on open collaboration, but without such cooperation, similar rates of advance are unlikely.

# The GMO Conundrum

## We could lose a useful crop-improvement tool to politics and fear

BY STEVE STRAUSS

DISTINGUISHED PROFESSOR OF FOREST BIOTECHNOLOGY AND LEOPOLD FELLOW

Oregonians will go to the polls on November 4 to decide whether or not to require prominent labels on food containing ingredients made from genetically modified organisms, or GMOs. The issue of labeling has been around for years, and — déjà vu! — Oregonians have even voted on it before. But the rhetoric has heated up to where its passage has a far better chance this year than it did in 2002.

GMOs are developed by direct modification of DNA. In contrast, conventional breeding modifies DNA indirectly. Humans have selected DNA mutations for millennia. If genetic changes had not occurred, corn would still be a small, inedible and inconsequential grass in Mexico. Potatoes would never have expanded from a small and toxic wild tuber in the Andes to become the world's fourth-largest crop.

Scientists use GMO technology to target and modify specific genes responsible for desirable characteristics, but it is not a silver bullet that is somehow immune from the age-old problems of agriculture. Nevertheless, GMO crops have been adopted on a momentous scale and with great speed around the globe in countries that have permitted them. Most farmers like what they deliver.

GMOs are regulated far more intensively than the products of conventional breeding. For example, some types of GMO crops have new proteins in them. When we insert a gene that makes a protein that was not in our food supply, or when it provides a new means of pest control, we need to make sure it is as safe as what we eat now and as other pest-control methods. Unfortunately, this increased scrutiny has often led to increased worry rather than to increased comfort — in spite of the safety assurances of all of the prominent science and health organizations around the world.

Despite its excellent safety record, GMO technology faces political and economic hurdles for a number of reasons:

- The major GMO crops have mainly benefited farmers while only indirectly benefiting consumers. Why should consumers take any risk without a benefit?
- Some of these crops have not been managed well to date, exacerbating long-standing problems with weed control.
- Organizations and companies that benefit from anti-GMO sentiment are spending huge amounts of money to foster negative perspectives and scare stories.

New GMO products in the pipeline are likely to have much wider public appeal. These include drought-tolerant corn, Golden Rice and Golden Banana (fortified with vitamin A to fight widespread nutrient deficiencies among the world's poor), and a safer potato (when fried, it produces less of a toxic compound called acrylamide). Soon to be commercially available is a modified soy oil that has a composition similar to that of olive oil, producing high levels of heart- and brain-healthy omega-3 fatty acids.

These and many other products could have momentous benefits, if they are not stigmatized out of existence. The demand for affordable, nutritious and sustainable food systems to feed the coming population of 9 billion — amidst a volatile and changing climate — requires that we make judicious use of every available tool.

# AVIAN NATIONS

## Across Oregon's ecoregions, birds struggle to survive

BY LEE SHERMAN

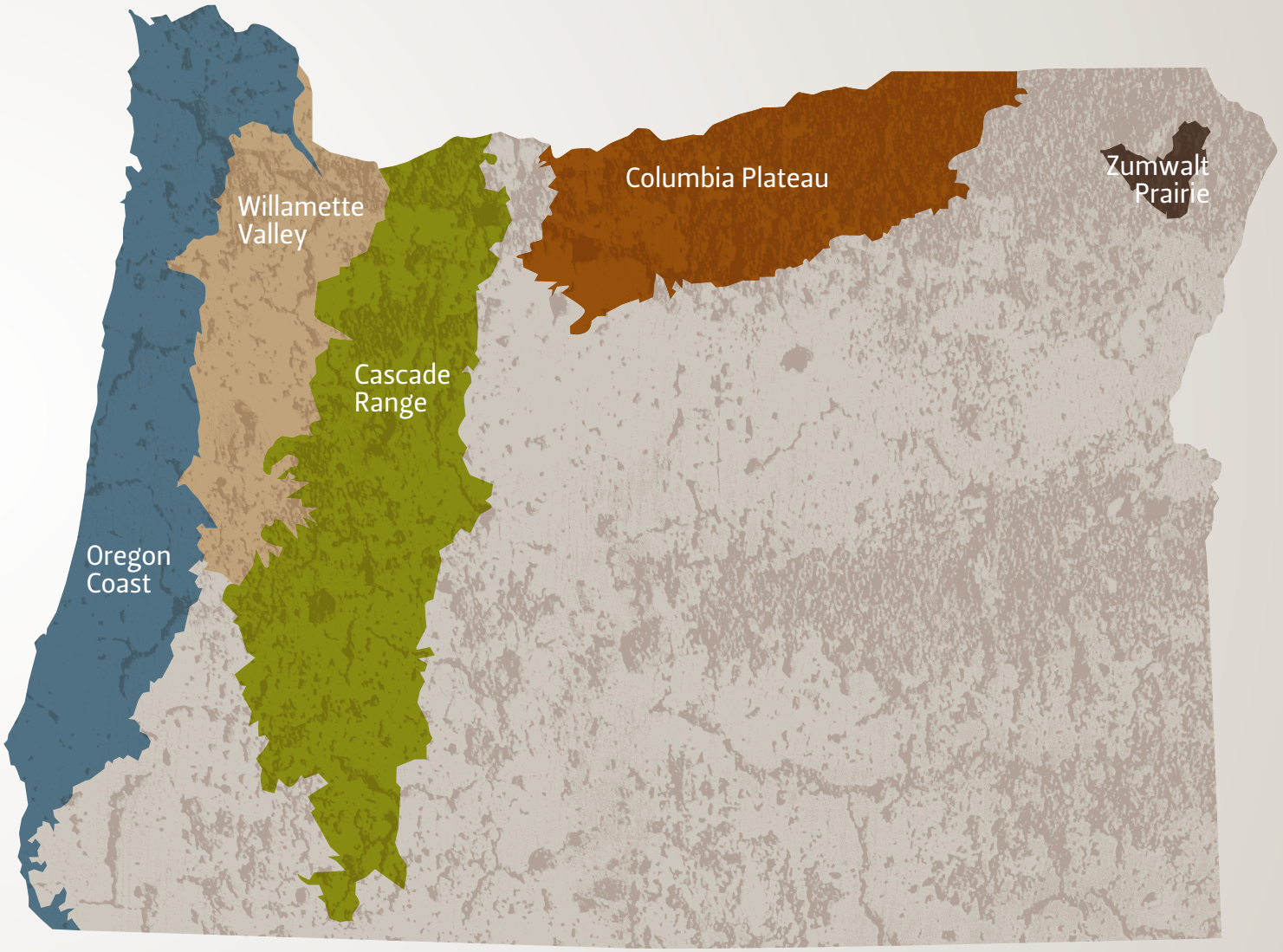
*"(Animals) are not brethren, they are not underlings; they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendour and travail of the earth."*

*– Henry Beston*
The Outermost House

Birdlife in Oregon is as diverse as its landscape. Species range from tiny and whimsical (such as the Rufous hummingbird hovering on 2-inch wings to eat nectar from wildflowers) to huge and pterodactyl-like (such as the soon-to-be-reintroduced California condor, which once soared on wings 9 feet wide, searching for carcasses to scavenge). Penguin-like common murres dive for fish and nest by the thousands on rocky outcroppings. Caspian terns breed on islands of dredged-up sand. Western meadowlarks raise their chicks on grasslands shared by cows. And arguably Oregon's most famous bird, the spotted owl, creeps ever closer to extinction as its barred cousin encroaches on old growth.

A cadre of widely published ornithologists at Oregon State University is studying these Northwest species, as well as dozens of avian species all over the globe. As the world warms up and wildlands shrink, bird populations are on a steep decline. These, OSU's scientists call "indicator species" — the collective canaries in the coal mine we call Planet Earth.

In the pages that follow, you will meet six of more than a dozen OSU ornithologists and learn about findings from the Oregon coast, the Willamette Valley, the Columbia Plateau, the Zumwalt Prairie and the Cascade Range.


Willamette Valley
Columbia Plateau
Zumwalt Prairie
Cascade Range
Oregon Coast

# A Moveable Feast

## Getting fish-eaters to switch from salmon to sardines to carp takes scientific cunning

**WHEN DAN ROBY FLOATED** the idea of relocating 18,000 seabirds in 1999, there was a lot of eye-rolling among wildlife experts in Oregon. "No one believed it would work," says Roby, an ornithologist at Oregon State University specializing in marine species.

But everyone agreed that something had to be done. With suitable seabird habitat shrinking all over the West Coast, Caspian terns (*Hydroprogne caspia*) had begun nesting on a man-made island of sand dredged from the Columbia River and deposited in the estuary in the 1960s. By the turn of the millennium, the mound — dubbed Rice Island — was home to the world's largest breeding colony of Caspian terns.

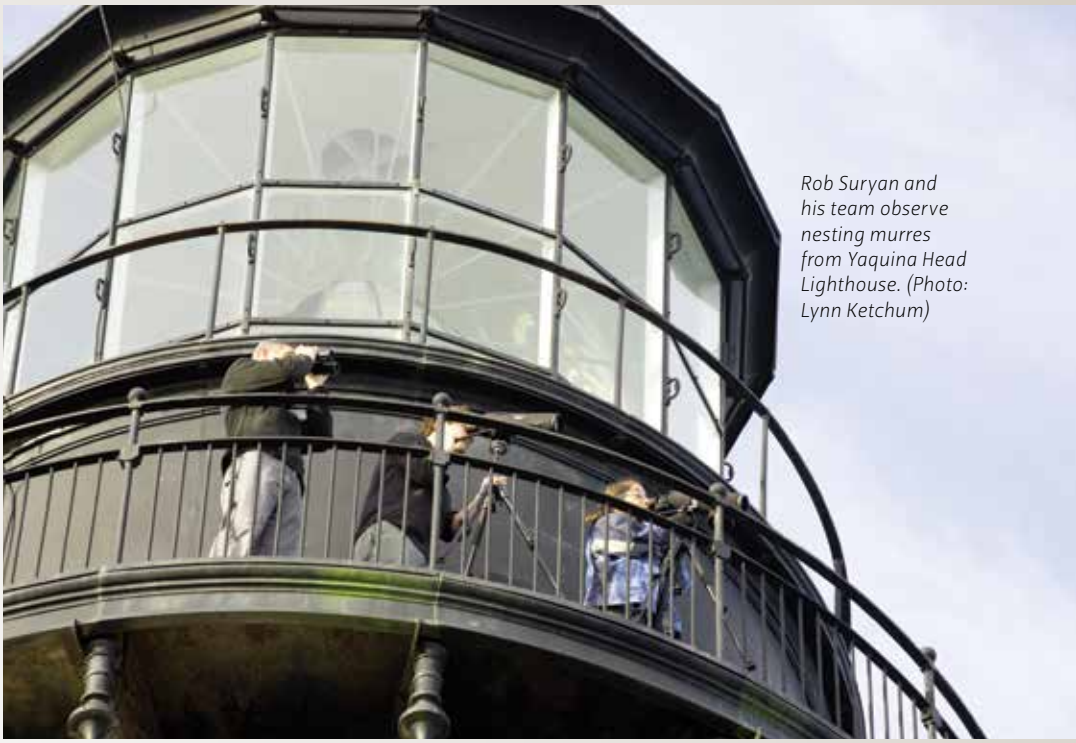
For fisheries managers, the colony posed a problem. The birds were gobbling up millions of young salmon and steelhead as they made their way to the ocean. "This must stop," was the stern message from the National Oceanic and Atmospheric Administration (NOAA), the agency charged with protecting endangered migrating salmon stocks throughout the Pacific Northwest.

So Roby turned to his former professor at Antioch College, Steve Kress, for guidance. Kress, who by then was directing seabird restoration for the National Audubon Society, had successfully restored colonies of Arctic, roseate and common terns in the Gulf of Maine. He agreed to help and flew to Oregon. The massive bird transfer began.

The biologists assembled an eclectic team from both U.S. coasts — an offbeat collective of artisans, entrepreneurs, scientists and engineers. There were craftsmen from Vermont (Mad River Decoy) and Oregon's own Willamette Valley (Dave Smith Decoys) who created hundreds of tern look-alikes from plastic. There were digital-sound specialists from Fairbanks, Alaska (Alaska's Spirit Speaks), and Bristol, Maine (Murremaid Music Boxes), who built audio systems to record and play back the sounds of nesting terns ("Caspian terns' greatest hits," Roby jokes). There were engineers from the Army Corps, who bulldozed tons of dredge soil to prepare the terns' new colony site, East Sand Island, about 15 miles closer to the ocean than Rice Island. There were consulting scientists from the state and federal fish and wildlife agencies. And there were grad students to do fieldwork, which included creating barriers on Rice Island to deter nesting terns.

The basic idea: fool the terns with "social attraction" — audio and visual bird impersonations to draw them to the new site. Much to the surprise of the skeptics, it worked. Within two years, the colony had re-established on the new island. As

*Dan Roby fools Caspian terns into nesting on artificial islands. (Photo: Dan Roby)*



*Rob Suryan and his team observe nesting murres from Yaquina Head Lighthouse. (Photo: Lynn Ketchum)*

hoped, the birds were eating far fewer salmon, choosing anchovies, sardines and other marine forage fish instead. Caspian terns, it seems, are food "generalists" — pragmatic eaters who'll grab the easiest meal at the closest fast-food joint.

But NOAA wasn't entirely content. The terns were still eating lots of salmon. If Roby could move terns 15 miles, maybe he could move them 400 miles — for instance, to Malheur National Wildlife Refuge on Oregon's eastern flank. Malheur, once the "jewel in the crown" of the refuge system, is now awash in invasive carp. What if Caspian terns could be enticed to nest at the lake and, along with the thousands of resident white pelicans, eat up the invaders?

Sure enough, the artificial island built in Malheur Lake three years ago has drawn many Caspian tern nesting pairs with its "social attraction" strategy of decoys and birdcalls. It's too soon to tell, Roby says, whether the island will become a regular haunt for the terns, but so far, the results are encouraging.

# A Rocky Outlook

## Seabirds suffer huge losses to opportunistic predators

**A LIGHT WIND** froths across the headland, kicking up the churn below. Just off Yaquina Head, atop a sea stack named Colony Rock, more than 60,000 seabirds huddle in a wing-to-wing crush. Audible from shore is a raucous din, the collective cry of nesting females incubating eggs and raising chicks while their mates fly in and out delivering herring and other small, silvery fishes foraged at sea.

"Hey, look at the penguins!" a tourist exclaims, pointing seaward from a viewing deck at Yaquina Lighthouse, Oregon's tallest.

The "penguins" aren't penguins at all, but common murres (*Uria aalge*) — roundish, upright birds whose black-and-white plumage makes them easily mistaken for the tuxedoed species of the Southern Hemisphere. Like penguins, murres dive into the inky depths to feed, going as deep as 500 feet. Each summer breeding season for nearly a decade, murre and cormorant colonies at Yaquina Head, Cape Perpetua and other Pacific headlands have been under observation by Oregon State University researchers. From the lighthouse, ornithologist Rob Suryan and his team from OSU's Hatfield Marine Science Center focus their "digiscopes" (high-powered telescopes with digital cameras attached) on the colony for three to six hours a day, documenting feeding and rearing behaviors — behaviors that can shed light on local ocean conditions as well as larger-scale oceanographic trends.

"Seabirds are a perfect study organism for learning how animals interact in a marine environment," says Suryan, who

At Yaquina Head, 60,000 common murres nest in summer. (Photo: Rob Suryan)

leads OSU's Seabird Oceanography Lab. "Unlike fish, which live underwater and out of sight, the life history of birds is visible to scientists. There's enormous information you can gather from birds about ocean conditions — climate change, prey fields, dead zones, wind-driven upwelling — and how those conditions cascade through the food web."

On this choppy morning in July, the scientists watch as a dark form slips from the sky on 6-foot wings. As its shadow passes over the colony, panicked murres plunge by the hundreds from the 50-foot rock, awkwardly flapping their flipper-like wings to slow their descent into the surf. Not all escape. The raptor — one of several bald eagles that have been harrowing the colony daily — skims low, silent as a drone, over those still sitting on their nests. Then, with a swift back-sweep of its yellow talons, the eagle locks onto a murre and retreats while ravens, vultures and gulls raid the unprotected eggs.

"Look how bare it is on the north side of the rock," says Suryan. "That's because of bald eagle disturbances. You can see turkey vultures and other scavengers wandering around eating eggs. We call them secondary predators."

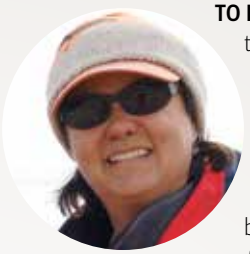
By late July thousands of murres, hectored by eagles and even a few brown pelicans, had abandoned their nests. "Unfortunately, this has been one of the least successful breeding seasons for the common murres at Yaquina Head," Suryan reported in an online update.

Still, some of the chicks survived to fledge. As young as 15 days old and not yet able to fly, each baby murre took a harrowing, nighttime leap off the cliff and (with luck) splashed into the dark surf to join its male parent swimming below, loudly beckoning its offspring. Together, adults and juveniles headed out to sea where they will forage until it's time, once again, to rejoin the colony for another breeding season.

A bald eagle captures an adult murre. (Photo: Rob Suryan)

# Of Spots and Stripes

Two related owl species compete for the last stands of old-growth forest



**TO HEAR KATIE DUGGER** tell it, you'd think catching a baby northern spotted owl (*Strix occidentalis caurina*) for scientific banding was as easy as taking a Tootsie Roll from a toddler.

"They're so mellow and laid-back," the ornithologist says. "If the owl is sitting low enough in a tree, as is often the case, you can just reach up with a tool called a noose pole and peel them off the branch." Other traits she ascribes to the big-eyed raptors, which she has studied for 13 years, are "gentleness" and even "charm."

But the docility that endears these endangered owls to researchers like Dugger and the crew that banded nearly 60 fledglings at Oregon's H.J. Andrews Experimental Forest this summer is part of what's threatening their very existence in a landscape of shrinking habitat and intensifying competition for what's left.

These days, their biggest competitor is the barred owl (*Strix varia*), a species that's as aggressive as the spotted owl is placid. A lot less picky about where it lives and what it eats, the barred bird occupies a much wider niche than its narrowly adapted spotted counterpart. Infiltrating territory that spotted owls haven't had to defend for millennia, they're finding little resistance.

"Barred owls are generalists, while spotted owls are habitat specialists," explains Dugger, who is leading studies at six sites across the West as a wildlife biologist with the U.S. Geological Survey and an associate professor at Oregon State University. Spotted owls live only in old-growth forests and eat mostly small rodents, she says. Their bigger barred cousins, on the other hand, willingly feed and breed in a wide range of forest types, including the old-growth ecosystems once dominated by the smaller spotted owl. The diet of these adaptable raptors spans the food web, from insects to amphibians and fish, even crayfish.

"For every spotted owl territory, you can have anywhere from four to eight barred owl territories overlapping the spotted owl territory," says Dugger, who "inherited" a number of long-term datasets from the late courtesy professor Bob Anthony and co-investigator Eric Forsman of the U.S. Forest Service.

Barred owls are winning — so much so that some researchers are experimenting with "removing" (shooting) barred owls from certain forests where spotted owls once reigned. It's a bitter irony for wildlife biologists like Dugger. When the spotted owl became the poster species for Oregon's old-growth wars in the 1980s — pitting timber companies and rural residents against environmentalists and urban naturalists — loggers were locked out of millions of acres of federal forestlands. Finally, things seemed to be moving in the spotted owl's direction. But before the environmentalists could even heave a sigh of relief, the barred-owl invasion began. It was a body blow to the owl's hard-won protection under the federal recovery plan.

The bird's future is uncertain. "Habitat loss has declined on federal areas," says Dugger. "Now, federal lands are little islands of good habitat." But the wider landscape is a matrix, a patchwork of ownership, regulation and wildfire risk that's hard to assess and even harder to measure. "What I can tell you is," she adds, "spotted owls are still not doing well."

*Katie Dugger studies competition for territory among barred and spotted owls. (Photo: Katie Dugger)*

# Small-Scale Science

Pint-sized humans study tiny birds facing big problems

*OSU researchers in Costa Rica banded and are about to release this green hermit hummingbird. Ava Betts, 8-year-old daughter of ornithologist Matt Betts, looks on. (Photo: Matt Betts)*

**LITTLE KIDS HAVE** a lot in common with hummingbirds. Both are small in size, quick in motion and fond of sugar. Plus, kids think hummingbirds are cool.

So pairing Oregon schoolchildren with the feisty, orange-throated hummers that share their Willamette Valley habitat seemed like a scientific and educational slam-dunk to ornithologist Matt Betts, a researcher in forest ecology at Oregon State University. A few years ago, he spearheaded a project with the Oregon Natural Resources Education program in OSU Extension to bring hummingbird science and fieldwork to classrooms. The project got even richer when he and OSU science educator Kari O'Connell looped in students and teachers from a satellite study site in Costa Rica.

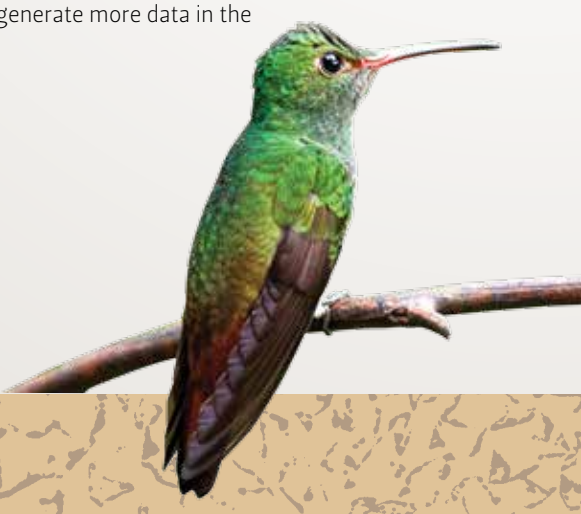
"Schoolchildren in both countries are collecting data on hummingbird abundance, diversity and nectar use to find out whether landscape fragmentation alters hummingbird distribution patterns," explains the OSU Teacher Research Experience Blog site, where three Oregon teachers posted messages about field studies they conducted last winter with their Costa Rican counterparts.

*This rufous-tailed hummingbird (*Amazalia tzacatl*) is one of the species that Matt Betts studies at the Las Cruces Biological Station in Costa Rica. (Photo: Wikimedia Commons)*

Unlike humans, whose numbers are climbing steadily in the Northwest, hummingbirds — particularly the once-ubiquitous rufous (*Selasphorus rufus*), a key pollinator of trees and shrubs — are quickly declining. Seeking reasons for the tiny birds' precipitous 4 percent annual drop (a rate of decline even faster than the endangered spotted owl's), the Betts Lab is collecting data and running experiments on the impact of forest composition, forestry practices and fragmentation (the patchy remnants of woodlands after logging, wildfire or construction). A landmark Betts study in 2010 suggests, for instance, that declines in rufous hummingbirds, as well as orange-crowned warblers and purple finches, are linked to reductions in "early-seral" broadleaf habitats — the first successional growth of trees and shrubs after a disturbance. The hummingbirds tend to decline further (along with certain songbird species like the Wilson's warbler) when herbicides are used heavily to suppress weeds in places where seedlings have been planted, Betts and his colleagues reported recently in the journal *Forest Ecology and Management*.

Human development drives a lot of habitat fragmentation. That's where fourth- and fifth-graders in Albany, Corvallis, Philomath and Woodburn are helping to shed light on hummingbird abundance. In partnership with their Costa Rican peers near the Las Cruces Biological Station, where the Betts Forest Landscape Ecology Lab is doing pollination studies with the green hermit hummingbird, the Willamette Valley students and their teachers have been engaging in active wildlife ecology. After hanging birdfeeders filled with sugar-water (simulating the sweet nectar hummingbirds sip from flowers) at their schools and homes, the students monitor food consumption, record hummingbird visits, identify species (the Anna's hummingbird inhabits the Willamette Valley along with the rufous), and trade insights internationally via the post office and the Internet.

The student datasets have been plotted on maps and graphs. So far, those data indicate that hummingbirds prefer forested areas to developed areas for feeding. And the little kid-little bird partnership will generate more data in the years to come.



# A Delicate Balance

Songbirds, cows, bugs and Buteos live in precarious harmony on the prairie

**NOTHING LOOKS MORE VULNERABLE** than a meadowlark hatchling: a scrap of fluff, a fraction of an ounce, blind, immobile except for its gaping mouth. As if that's not enough fragility, the baby bird's bowl-shaped nest sits on the ground — the same ground where herds of 800-pound cattle may graze.

But the threat implied by this scenario isn't as dire as it seems. So says Pat Kennedy, an Oregon State University ornithologist who studies western meadowlarks (*Sturnella neglecta*) and other ground-nesting songbirds on the Zumwalt Prairie in Oregon's northeast corner, where The Nature Conservancy is partnering with OSU to research the effects of cattle management on grasslands. While grassland birds across North America have declined steeply in recent years, the hooves of cows are not the only, or even the main, culprit, according to Kennedy.

"These birds have evolved along with things that walk around — elk, deer, bison — for millennia," says Kennedy. "They hide their nests in thick vegetation or low-traffic spots. If their eggs get mushed, they double-clutch. Trampling is not the biggest problem for grassland birds."

Bigger problems than crushed nests, she says, are predation and starvation. When cattle tromp and chomp on vegetation, nests may become more visible to badgers, bobcats and several species of hawks in the genus Buteo (red-tailed, ferruginous and Swainson's) that Kennedy studies along with songbirds, including the horned lark, savannah sparrow, vesper sparrow and grasshopper sparrow. Also, insects may be scarcer where cattle graze heavily. "Songbirds are insectivores," Kennedy says. "They like bugs, especially bugs that live in tall grass. Cattle reduce those bugs." Fewer bees, spiders and butterflies mean fewer meals for a chick's gaping mouth.

*Pat Kennedy studies grazing impacts on ground-nesting birds, such as the western meadowlark. (Photo: Lynn Ketchum)*

But these kinds of cattle-related problems crop up mainly at heavy stocking rates — that is, where per-acre cow density is high and the animals graze for long periods on the same pasture. In one recent study, Kennedy reports, "High stocking rates had significant effects on all food web components." On the other hand, low to moderate rates showed far fewer negative effects.

Teasing out the tangled variables in prairie ecosystems — not just the hooved browsers and the winged nesters but the native pollinators and leafhoppers, the bunchgrasses and riparian plants, the raptors and invasive weeds — has dominated the career of Kennedy and several colleagues for a couple of decades. "Grazing can be compatible with birds, just as logging can be sustainable," she concludes. "It's all about finding where the thresholds occur and then managing around them."

# Back from Prehistory

When condors soar again in Oregon, lead ammunition could undo their recovery

*Susan Haig is working to release captive-bred California condors into Oregon skies. (Photo: USFWS)*

**THE "BUTIFULL BUZZARD OF THE COLUMBIA"** was Captain William Clark's descriptor in 1805 for the prehistoric vultures he observed riding thermals on 9-foot wings in the Columbia River Gorge. Yet just 100 years later, the giant condors were all but gone in Oregon.

Now, ornithologist Susan Haig is helping to bring them back. At a "super-secret" location somewhere in Oregon ("If I told you where it is, I'd have to kill you," she jokes), the U.S. Geological Survey scientist has joined ranks with the Oregon Zoo and others to reinstate the California condor (*Gymnogyps californianus*) to its original range along the Pacific coast.

"North America's largest avian scavenger … once soared the skies of the Pacific Northwest and (is) deeply woven into the fabric of many Native American cultures in the region," writes Haig, a courtesy professor of wildlife ecology at Oregon State University, in her 2013 book, *California Condors in the Pacific Northwest*, co-authored with Ph.D. student Jesse D'Elia. "Soon after 1900, however, the condor disappeared from its northern haunts."

Mainly, the condors died from eating the carcasses of wolves and other predators poisoned by farmers and trappers. As the condors' range shrank to a small pocket in Southern California, they succumbed further to shell-thinning pesticides and "secondary poisoning" from scavenging the guts of dead animals killed with lead-laced bullets and shotgun pellets. Haig was a student in raptor ecology at the University of Wisconsin in 1981 when condor researcher Mike Wallace (then a UW grad student) "took the last condor chick out of the wild" for captive breeding to save the species.

But it wasn't until a couple of years ago that Haig really clicked with condors. That's when the American Ornithologists' Union (AOU) invited her to serve on a national condor review panel. After visiting every captive-breeding facility in the country, she came home bursting with superlatives about

*Radio tags help researchers track the giant birds. (Photo: USFWS)*

condor braininess. "For me, there wasn't anything especially magnetic about them until I really spent some time with them," she says. "It almost freaks you out how intelligent they are."

Her personal passion is fieldwork — "sitting and watching the amazing social systems of birds," natural phenomena she describes as "so damned cool that you just can't stand it." But as the planet warms, forests burn, wetlands shrink and icecaps melt, Haig worries about the fate of threatened and endangered birds — not just condors, but piping plovers, oystercatchers, red cockaded woodpeckers, Micronesian kingfishers and other species teetering in a wobbly world.

So for now, she has hung up her binoculars to focus on the big picture: untangling the Gordian knot of clues — biological, physical, chemical — wherein deeper avian insights lie. To that end, she leads integrative studies spanning fields as diverse as genetics, landscape ecology and climate science. She teaches in distant places, like Namibia, Kenya, Mexico and Brazil. She enables hemispheric-wide data sharing through her development of the Migratory Connectivity Project with Smithsonian partner Peter Marra. She presides over the illustrious AOU. And she pushes for bird-friendly policies.

Take lead ammo, for instance. Next year, the Yurok tribe will release condors onto its reservation along the California-Oregon border — condors that will soar into Oregon, unaware of the risks their northward travels entail. That's because while California is phasing out lead ammunition for hunters under a 2014 law, Oregon is just beginning to consider the issue. Haig has been churning out papers and sitting on committees, calling attention to the dangers of lead ammo on both animals and humans. "Oregon lawmakers," she says, "are beginning to take notice." terra

## Oregon Birders and Citizen Scientists Join eBird Project

A team of ornithologists, birders and citizen scientists is collecting data on Oregon birds through a project called Oregon 2020.

"Oregon has a few species of birds we know very well — like the spotted owl, the sage grouse and the meadowlark," says W. Douglas Robinson, the Mace Professor of Watchable Wildlife at OSU and director of the project. "However, the state has more than 500 species of birds, and we know very little about many of them. One of our goals is to establish a baseline for the abundance and distribution of these birds so that we can evaluate impacts on them from disease, wildfire, climate change, or other emerging issues."

Volunteers in each county are gathering data with help from online tutorials and guidance on collecting and logging the data, which will be part of the national eBird database run by Cornell University. The eBird site receives more than 1 million submissions a month, but few from Oregon. Periodic "bird blitzes" are held in Oregon counties, where scientists join volunteers to canvas all types of terrain.

Interested? Log onto the Oregon 2020 website.

# BLUE CARBON

## TROPICAL MANGROVES ARE SUPERSINKS FOR GREENHOUSE GASSES

BY LEE SHERMAN

Looking through J. Boone Kauffman's photo collection is like thumbing a tropical bestiary. There's a proboscis monkey from Borneo, its long, lumpy nose resembling an over-ripe mango. A gibbon and an orangutan from Kalimantan. A green python coiled around a tree. A herd of bristle-nosed pigs. A 15-foot saltwater crocodile whose jaw could crush a cow's skull. A fruit bat wrapped in paper-thin wings, translucent and webbed. A mudskipper (a fish that uses its pectoral fins to walk on land, like some evolutionary trailblazer from the primordial ooze). Then there's the Bengal tiger — its footprint, anyway. Kauffman, an ecosystem ecologist at Oregon State University, found the five-inch diameter print smack-dab on top of the boot print he had left in the Bangladeshi mud just hours before.

Welcome to the mangroves rimming the tropical oceans of the world. The Indonesian archipelago boasts fully a third of the world's mangroves — swampy forests of saltwater-tolerant vegetation where the land meets the sea. But they exist all over the tropics and subtropics. Recognizable by their tangled "pneumatophores" (spidery "stilt roots" that protrude from the soil and support a thick, green canopy overhead) mangroves occur in Liberia, Senegal, Gabon, Mexico, Cambodia, Thailand, Brazil and some 120 other countries, including the United States.

It's in these places where Kauffman plies his science — places rife with rare and predatory animals, parasites and venomous insects, mud "up to your thighs," foliage so dense you have to "squirm your way through," humidity that wraps around you like a steamy towel and tides that never relent. He and his team measure the mangroves' stored carbon. They also guide local people toward studying and conserving these uniquely rich ecosystems for their own livelihoods, as well as for biodiversity and greenhouse gas mitigation.

"Mangroves are among the most carbon-dense forests in the tropics," says Kauffman, who discovered the remarkable carbon-holding power of mangroves and other tropical wetlands while he was studying typhoon damage in Micro-

*Planet Earth's steamy, tangled mangroves — which thrive where seawater meets shorelines in tropical latitudes — host a multitude of exotic species, such as the roseate spoonbill, the* jaiba azul *crab and the capuchin monkey pictured above. (Photos: J. Boone Kaufmann)*

*A little girl in a Liberian village holds a fruit bat she killed with a slingshot for her family's dinner. (Photo: J. Boone Kaufmann)*

nesia more than a decade ago. In fact, he says, mangroves are the penultimate "carbon sinks" (places that absorb more carbon and other greenhouse gasses than they release), in some cases holding onto five times as much carbon as upland forests long known to be important carbon storehouses. In 2011, Kauffman and post-doctoral researcher Dan Donato were among the first scientists to document the phenomenon in a *Nature Geoscience* paper titled, "Mangroves among the Most Carbon-Rich Forests in the Tropics."

The reason for mangroves' massive capacity for carbon can be summed up in two words: perpetual wetness.

"When you have a completely saturated environment of high tides twice a day, the soils are always wet and, in the tropics, always warm," he says, "so they're slowly accumulating carbon all the time." The soil carbon comes from organic matter — the roots, trunks and leaves of plants and trees that constantly add to the rich organic matter stored in the saturated soils. In contrast to upland forests, which have carbon-rich soils only a few inches deep, mangrove soils typically hold huge quantities of carbon up to 10 feet deep or even greater.

Because of the endless wetness associated with these "marine" forests, this form of sequestered greenhouse gasses has been dubbed "blue carbon" — blue for oceanic waters, for tides that surge through the mangroves, for rivers that flood these wetlands during the rainy season. In recognition of this watery carbon trove, the Intergovernmental Panel on Climate Change (IPCC) has added blue carbon to its short list of critical ecosystems for keeping greenhouse gasses in check. Kauffman, in fact, serves on an IPCC committee contributing the latest science on mangroves, saltmarshes and sea grasses as well as inland wetlands. Last year, he was a co-author on an IPCC report on the measuring, monitoring and reporting of wetland carbon stocks.

"For so long, wetlands were poorly represented in the IPCC," says Kauffman. "Now there's a growing recognition of the value of blue-carbon ecosystems, not only the mangroves in the tropics but also the saltmarshes and sea grass meadows that are important right here in Oregon."

Peat swamp forests, another tropical wetland ecosystem, are the freshwater equivalent of mangroves, fed not by tides but by floods from nearby rivers. Like their saline counterparts, they're carbon supersinks. "The peat swamp forests of Indonesia are the very largest carbon stocks of any ecosystem on Earth today," says Kauffman. "Some of our OSU graduate students have measured peat soils that are more than 30 feet over there."

## Dodging Ebola by Days

Exotic fauna aren't the only subjects framed in Kauffman's camera lens. He also photographs villagers who live in the 25 countries whose mangroves he has studied firsthand. In one of those photos, eight Liberian men, their trousers soaked to the thigh despite thick rubber boots, perch on the protruding roots of a giant mangrove tree. The men are giving peace signs and fist pumps, alongside a grinning Boone Kauffman, who has been working with them on mangrove conservation measures. Their faces convey optimism, even joy.

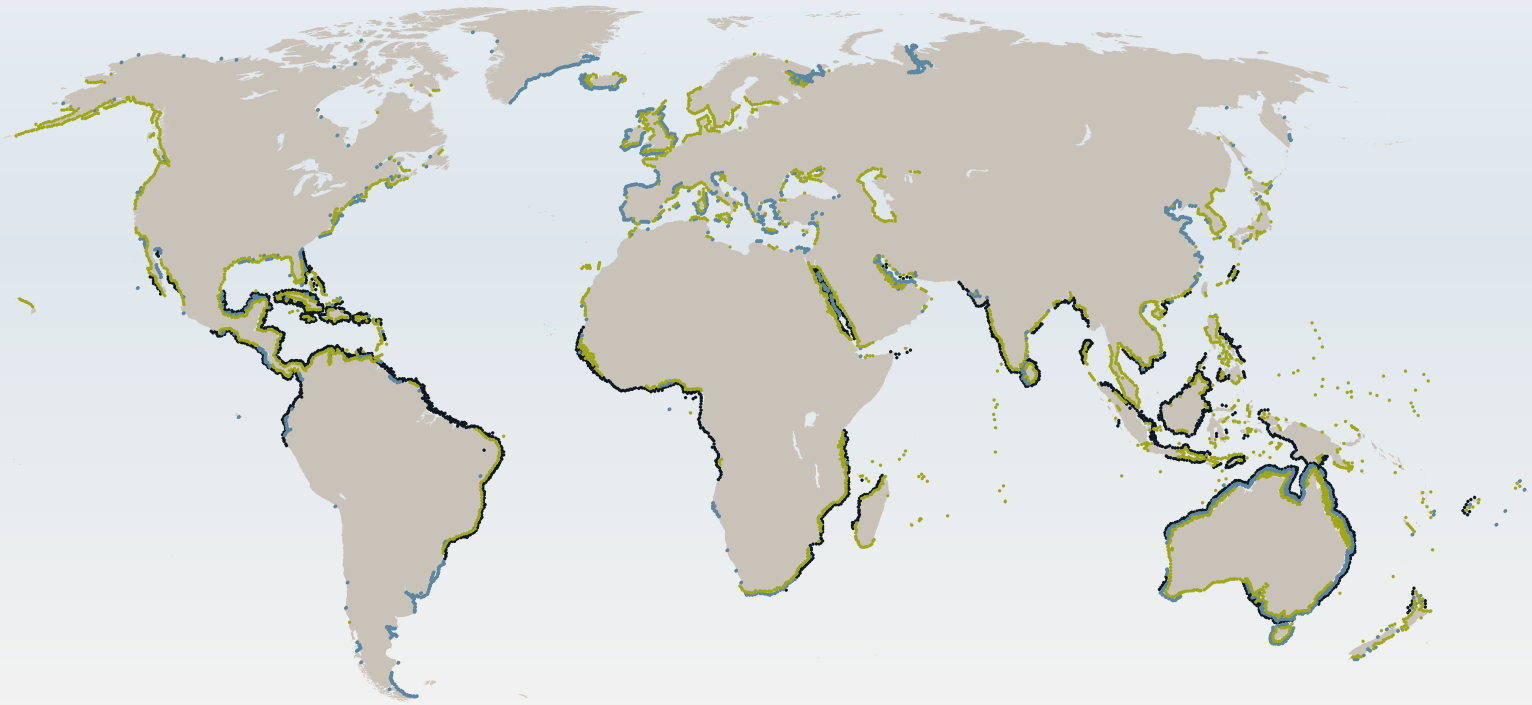
But there's another photo from the same Liberian village that haunts Kauffman: two little girls with solemn expressions, each holding a light-brown fruit bat by its wingtips. The pointy-eared bats, which the girls had killed that morning with slingshots, were destined for the kettle in this poor community where bush meat is a staple.

The photo was taken in late February, just days before Ebola broke in Liberia.

"Fruit bats are carriers of the Ebola virus," says Kauffman as he looks at the girls' serious faces glowing on his monitor at the OSU Department of Fisheries and Wildlife. He slumps slightly in his chair as he wonders aloud about the fate of the little girls — "the daughters I never had."

As the world's wetlands succumb to the chainsaw and the plow, villagers are seeing traditional sources of sustenance wither away. Commercial shrimp farms, rice paddies and palm oil plantations are displacing millions of acres of carbon-rich wetlands in Indonesia, Southeast Asia, Africa and South America every year. The shrimp farms often are abandoned after a few years,

## Global Distribution of Blue-Carbon Ecosystems



Mangroves  Salt Marsh  Sea Grass

*Data source: United Nations Environmental Program – World Conservation Monitoring Centre, Cambridge, UK*

leaving nothing but scarred earth. Palm trees for oil — an ingredient in hundreds of consumer products from Ritz Crackers to Johnson's Bodywash — are overtaking vast landscapes of centuries-old tropical swamp forests. A few commercial farmers and corporations profit from the converted lands. Meanwhile, orangutans and tigers slouch toward extinction. Villagers confront a dying way of life.

"Mangroves have been used for centuries by indigenous peoples for fish and shellfish," says Kauffman. "They are keystone habitats for many marine fishes. When you convert a mangrove to a shrimp farm, you sever the link between the mangrove and the fisherman, whether he's fishing for his family

*J. Boone Kauffman's research takes him to mangroves throughout the world to study their carbon-storage capacity. (Photo courtesy of J. Boone Kaufmann)*

*Shrimp farms that displace mangroves often are abandoned after a few years. (Photo: J. Boone Kaufmann)*

## Carbon Storage in Forests and Mangroves


Data on mean carbon storage by forest type were derived from the Intergovernmental Panel on Climate Change.

or for the marketplace. You lose the mangroves, you lose the fish.

"These farm-raised shrimp are exported to the United States, to Europe, to Japan," he continues. "Literally, we're taking food out of the mouths of local people when we import these products. There are fishing villages in Southeast Asia that were sustained for centuries but are no longer viable because of the loss of the mangroves. Whole villages have been abandoned."

## SWAMP Funds

It's a "double-whammy," Kauffman says, when mangroves and other wetlands are destroyed. That's because they serve a twofold purpose in mitigating global warming: short-term, they take carbon out of the atmosphere every day; long-term, they hold onto it for centuries. So when you hack it down, you not only free up stored carbon into an already carbon-loaded atmosphere, but you also kill the vegetation that has been absorbing Earth's excess carbon since the Industrial Age began pumping out fossil fuel emissions in ever-faster fashion.

Doing science in the mangroves is "like being a child in a jungle gym," Kauffman says. "You have to crawl up and over and through stilt roots and pneumatophores — these large aerial roots — and sometimes you're in mud up to your thighs. You wear old sneakers that you tie on your feet really tight so you don't lose them in the mud." Once inside the mangrove, he and his team establish plots where they measure above-ground biomass (live trees and woody debris) and then, using "allometric" equations (which help scientists predict biomass from characteristics like height or diameter), they estimate carbon content. To sample soils, the team uses a peat auger, a pipe-like device that brings

up slender cores of mud that are then dried and analyzed for their carbon concentration.

But there's so much more to mangroves than the gasses they sequester. They buffer shores against storms. They support coral reefs with nutrients and energy. They filter pollutants. They burst with a unique biodiversity found nowhere else on the planet. They feed and shelter human communities.

Empowering local people to steward their wetlands is one of Kauffman's prime missions. With funding from the Sustainable Wetlands Adaptation and Mitigation Project (SWAMP) of the U.S. Agency for International Development and the Kalimantan Wetlands and Climate Study (KWACS), he mentors villagers in the science and politics of wetland conservation. He, Donato and their Indonesian colleagues at the Center for International Forestry Research (CIFOR) have developed and published protocols for measuring, monitoring and reporting on mangrove forests, not only for other scientists but also for the people who depend on their biological bounty.

"The people we work with in the field, the people in small villages, recognize the value of their mangroves," he says. "So do the land managers. And particularly the climate change negotiators who participate in the United Nations Framework Convention on Climate Change get it. No matter where we've gone in the world, we've been very warmly welcomed. It's been a great collaboration between us and all the places on the planet where we've worked."

*Kauffman works with and trains local scientists, land managers and students such as these in Gamba, Gabon, Africa, enabling them to further conserve, restore and sustainably manage their mangroves. (Photo: David Korte)*

Blue carbon is a planetary lifeline, argues Kauffman, who along with his CIFOR colleagues, is setting up a global network and database for sharing mangrove science.

"When you look at all the greenhouse gasses that are emitted into the atmosphere, about 50 percent stay in the atmosphere, about 25 percent are sequestered by forests, and about 25 percent are absorbed in the oceans," he notes. "The oceans and the forests are doing us a great service by slowing down rates of climate change by sequestering so much of the anthropogenic greenhouse gasses that largely come from burning fossil fuels.

"Without the world's oceans, without the world's forests, we'd be in terrible shape." terra

## The Most Dangerous Thing – "It's not the large carnivores"

BY J. BOONE KAUFFMAN

"You asked me what's the most dangerous thing I encounter in my work. It's not the large carnivores such as crocodiles or tigers or poisonous snakes. It's the little things. In the last few years, I have had two students come down with Dengue fever. This is a huge concern of ours. In our years of tropical research, we not only have contracted Dengue but also malaria, leishmaniasis, dysentery and countless internal and external parasites. This includes leeches in Asia, botflies in the Amazon and ticks in Mexico. We commonly had 20 to 40 leeches on us after a day's work in Borneo. My wife once had over 120 ticks attached to her after one day's work in a Mexican wetland. It's all part of working in this environment."

# RUNNING WITH ROBOTS

## To understand animal locomotion, engineers look to birds

BY NICK HOUTMAN

Hollywood has come a long way since R2-D2 rolled about in *Star Wars* (1977) with the turn-on-a-dime sophistication of a self-propelled lawn mower. Its companion C-3PO wasn't much more advanced. It moved with a mechanical grace reminiscent of the Tin Man in *The Wizard of Oz*.

Fast forward to the Isaac Asimov inspired sci-fi thriller *I, Robot* (2004) in which machines that look eerily like humans leap with Spiderman-like agility. And to the more laid-back robotic health-care assistant in *Robot and Frank* (2012), which walks like a human as an accomplice to an elderly criminal.

Real robots are far from being able to move efficiently with dynamic forces similar to those exerted by legs, feet, tendons and muscles. But engineers at Oregon State University are making strides with a two-legged innovation dubbed ATRIAS. Designed and built in Corvallis, ATRIAS and its counterparts at the University of Michigan and Carnegie Mellon University in Pittsburgh are helping engineers to delve into the complexities of animal locomotion. Equipped with such capabilities, robots will serve a variety of practical needs.

The day is coming when these machines will walk up and down stairs, over rough terrain or on a crowded sidewalk with a safe, steady, reliable gait. In our homes, they will perform routine tasks that enhance the quality of life for people in need of assistance. They will do things that humans take for granted — grasp and turn a doorknob, open curtains and wash dishes. In more extreme circumstances, they will assist us in emergencies by entering damaged buildings, putting out fires and withstanding radiation or toxic fumes that would kill a human in seconds.

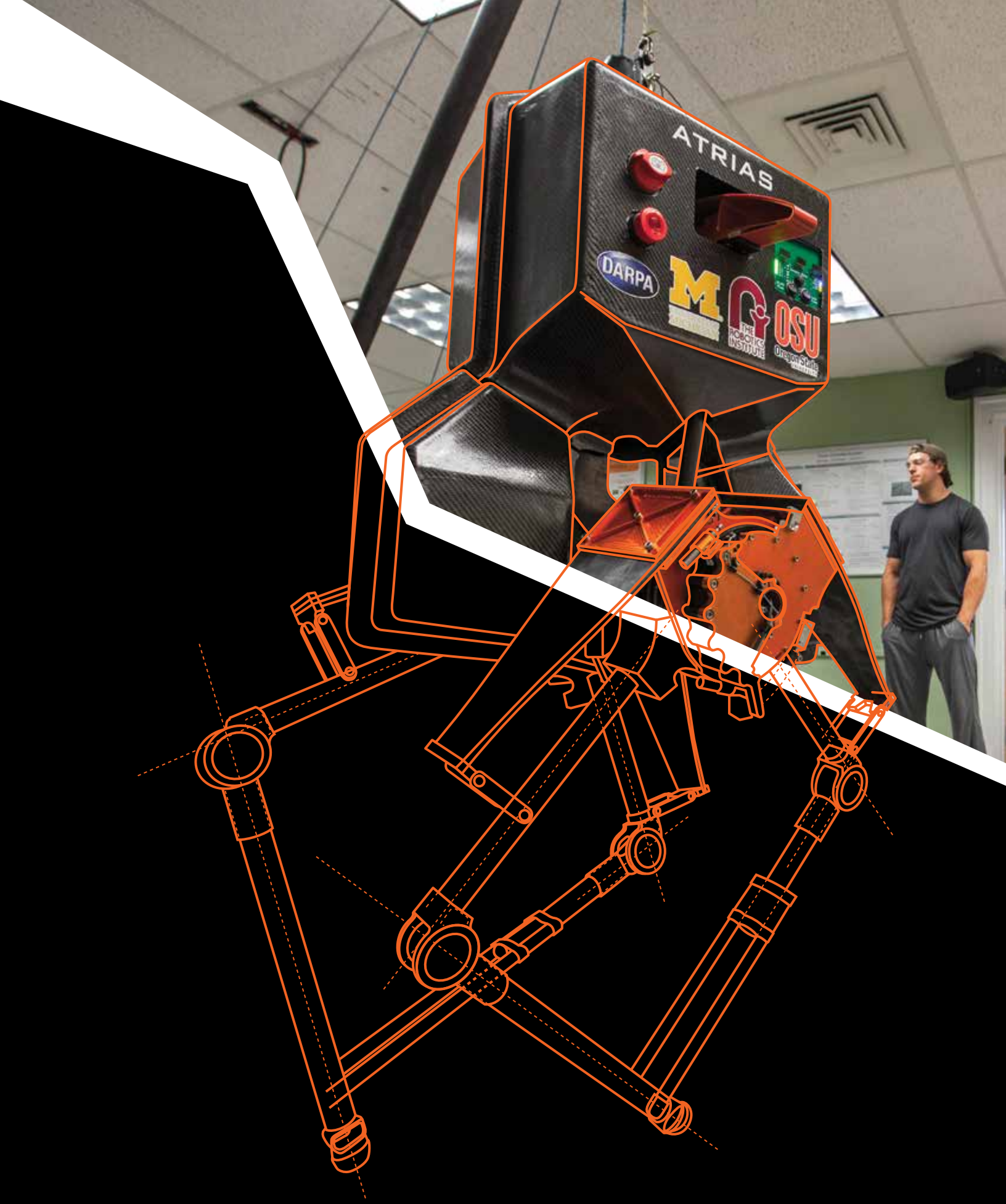
"It's completely inevitable," says Jonathan Hurst, a leader in Oregon State's growing robotics program. "It's possible to have robots that walk and run and manipulate things and do all the physical interactions that people can do. We have physical proof. I can do it. Why not a robot? Where will it happen first? That's the question."

### A Natural Step

It will happen in Oregon if Hurst and his colleagues are successful. Hurst was Oregon State's first "roboticist" when he arrived in 2008, lured by the efforts of OSU professors Kagan Tumer, a specialist in multi-agent control systems, and Belinda Batten, then head of the School of Mechanical, Industrial and Manufacturing Engineering, or MIME. Now Hurst is one of almost a dozen OSU researchers who focus on the challenges of building practical machines that exhibit the three primary qualities of any robot: They sense their surroundings, analyze their options and take action.

To support their quest, they have raised more than $24 million from the National Science Foundation and other agencies. The College of Engineering is raising funds to renovate historic Graf Hall on the Corvallis campus to accommodate the program.

In a basement lab equipped with a circular test track, Hurst and a team of undergraduate and graduate students designed ATRIAS to literally have springs in its step. These thin flat fiberglass plates, which have the physical properties of a diving board, are part of a system that imparts lively but controlled energy to the process of locomotion. "This is the first robot in history to demonstrate this kind of natural walking gait, where quantitatively we can say that center of mass motion, the ground reaction forces and the physics of the system match what animals are doing," explains Hurst.


ATRIAS
DARPA
OSU

*On an assembly containing motors that power ATRIAS, sensors read fine lines on stainless steel strips to indicate the position of the leg joints and springs. (Photo: Jim Carroll)*

Hurst had two local shops — King Machine and Ram-Z — build parts for ATRIAS. And in addition to the robot used for research at OSU, he shipped models to his alma mater, Carnegie Mellon, and to a lab run by his long-time colleague Jessy Grizzle at the University of Michigan.

As a graduate student, Hurst worked with Grizzle to design and build ATRIAS' predecessor known as MABEL. In 2012, they were recognized among 10 "Breakthrough Innovators" by *Popular Mechanics*. Since then, MABEL has been retired as a research robot and performs for the public in a traveling educational exhibit, now at the Field Museum of Natural History in Chicago.

## Learning to Drive

Christian Hubicki, a Ph.D. student in Hurst's lab, works on the software that controls ATRIAS. "This robot is like a high-end sports car. It's difficult to control, and it takes a pro to drive it. We have to rise to be that pro," he says. "There's no remote control. We're teaching this machine to walk, and we have to invent things all the time."

The learning goes both ways. Hubicki and his peers perform computer simulations to test their ideas before they put them into practice on ATRIAS, but surprises happen. For example, to test software designed to enable the robot to walk through soft terrain, Hubicki once put a bucket of gravel on the lab's test track. His simulations indicated that the machine would hop once or twice before losing stability. Instead, after it hopped into the gravel, the machine jumped 12 more times and then leapt out of the bucket onto the solid surface. Hubicki was shocked. "The controller (software) was a lot more stable than we predicted," he says.

Such experiences underscore the difficulty of trying to mimic nature. "Locomotion is simple and at the same time incredibly complicated," says Hurst. "Animals can do amazing feats of agility and stability running blindfolded in the dark over relatively uneven terrain. We're trying to solve the problem of how legged locomotion works. If we can understand it, we can replicate it."

For inspiration, Hurst and his team look to animals that predate humans: birds. Some species in this ancient branch of life may appear ungainly on land, but birds have successfully adapted walking and running to a wide range of body sizes. Ostriches have been clocked at more than 40 miles per hour. A guinea hen can adjust to obstacles on the fly and maintain a stable running gait.

It's no accident that ATRIAS walks more like a bird than like the robots in *Star Wars*. In 1977, R2-D2 and 3-CPO seemed futuristic. Now they look quaint. In turn, ATRIAS may be the forerunner of machines that even Hollywood can't quite imagine. terra

## Virtual Robotics Challenge

In 2015, Hurst will demonstrate ATRIAS at an international robotics display in Pomona, California. The event is part of the Virtual Robotics Challenge, a competition organized by the Defense Advanced Research Projects Agency (DARPA).

While Hurst isn't in the competition, fellow OSU roboticist Ravi Balasubramanian is participating on a team that includes engineers from Virginia Tech, the Delft Technology University in The Netherlands and a company, Torc Robotics. Balasubramanian studies the mechanics of grasping and manipulation and has developed a mechanical system to restore hand function for accident victims.

*"Birds have evolved bipedal locomotion longer than humans," says OSU roboticist Jonathan Hurst. "We're still climbing down from the trees, evolutionarily speaking." (Photo: Jim Carroll)*

# REWRITING the Script

## A scholar gives voice to the forgotten women of Irish theater

BY LEE SHERMAN

CHARLOTTE HEADRICK LAUGHINGLY calls herself an "American mutt."

What she means is that she, like just about everyone else in this land of immigrants, springs from a colorfully diverse ancestry. Her Huguenot forebears — those "fierce, Calvinistic Protestants" — figured most prominently in the stories she heard growing up in Knoxville, Tennessee. But she was aware, too, of another branch of the family, the Celtic branch, the Scots-Irish who came to America decades before the potato famine refugees arrived on Ellis Island. In recent years, she has traced her genealogy back through the MacMillans from County Derry, her sixth great grandfather Doyle (a soldier in the Revolutionary War), and the Hickeys on her maternal grandmother's side. But during her childhood, the Irish half of the clan floated in the family lore more ghostlike than embodied history.

"I was always interested in the Irish in my family," says Headrick, a professor of theater at Oregon State University. "My grandmother would talk about ancestors; I remember her talking about the Doyles. But it was kind of vague. You're a kid, you know? This stuff just sifts through you."

Yet in that sifting, something stuck. She found herself "gravitating toward the Irish writers," first as a Ph.D. student at the University of Georgia and later as a faculty member at Oregon State. The Celtic pull took hold for good in the 1980s after a serendipitous meeting. While attending a Thanksgiving celebration with friends one night, Headrick met a Ph.D. student from the University of Oregon. Her name was Eileen Kearney, and she was knee-deep in her dissertation on pioneering Irish playwright Teresa Deevy.

"We had a conversation, and I said something about how I'd always been interested in Irish drama and almost wrote my dissertation on the great 19th-century Irish melodramatist Dion Boucicault," Headrick recalls. "And Eileen said, 'Well, you should come back to it.' She planted a seed."

That seed, having sprouted and branched over the subsequent four decades of research, both in the United States and Ireland, will reach full maturity in November. That's when co-editors Headrick and Kearney will see the release by Syracuse University Press of their many-years-in-coming anthology of Irish women playwrights. Titled *Irish Women Dramatists 1908 – 2001*, the collection features seven plays spanning the 20th century, when "the quiet rumble of feminist enlightenment" began shaking loose ancient cultural and political bonds in Ireland. Its cover photo — a clump of yellow wildflowers bursting out at the base of a traditional gray Irish

*Charlotte Headrick directed* The King of Spain's Daughter, *a play by Irish playwright Teresa Deevy, at Oregon State University in fall 2013. (Photo: Jim Folts)*

*In* The Sugar Wife, *which Headrick directed at OSU in 2012, a devout Irish Quaker woman confronts the contradictions in her life. (Photo: Jim Folts)*

stone wall, taken by Kearney in the Aran Islands — is a quiet metaphor for its contents.

"The plays anthologized here illustrate the views of women in their own voices, voices that have been silenced by being marginalized," Headrick and Kearney write in their introduction. "These playwrights have given us works that stretch our imaginations, cover a myriad of themes, and challenge the stereotype of what it means to be Irish."

## Laughing in the Teeth of Death

Headrick's was a Southern childhood. Family stories of the Civil War — including the 1865 *Sultana* steamship disaster near Memphis, which her great-great-great grandfather survived — were told over fried okra, black-eyed peas, greens sautéed with onion and garlic and cornbread baked in her grandmother's No. 8 cast-iron skillet. Those flavors and aromas still stir up the snugness and warmth of home in her memory.

The Northern Irish influence could be felt all over the South, she says, the result of a "large wave of immigration" from the Emerald Isle starting in the 1700s. "There's a reason Margaret Mitchell made Scarlett an O'Hara," Headrick notes.

The Civil War classic *Gone With the Wind* is far from the only literary twining of the two cultures. Another dovetailing takes place at the funny bone. "Gallows humor," Headrick calls it — "you know, laughing in the teeth of death." This grimly ironic style of humor, shared by Irish and Southern writers, was the subject of the first paper she presented at the American Conference for Irish Studies.

"It's a legacy in the dramatic literature of the American South — the commonalities in humor that you find in Irish drama and Southern drama," she says, adding that her own sense of humor trends toward the dark side. "I think it's probably healing in some way."

## Beyond Mothers and Whores

A series of snapshots chronicles Headrick's most recent trip to Ireland. In Dublin, she poses beside the North Earl Street statue of legendary Irish novelist James Joyce. In Galway, she stands beside another statue, this one commemorating the "Magdalenes" — the unwed pregnant girls and women forced to toil in Ireland's commercial Magdalene Laundries run by Catholic nuns during the 18th, 19th and 20th centuries. (The Magdalenes have entered the consciousness of American moviegoers through a pair of movies, *The Magdalene Sisters* in 2002 and *Philomena* in 2013.) Headrick's two photos — one of the highly celebrated Joyce, the other of the mostly anonymous Magdalenes — symbolize the two ends of Irish literary culture at the start of the 1900s: men on the inside wielding power and influence, women on the outside required to conform to strict dictates of tradition and religion.

One of the plays in Headrick's anthology, *Eclipsed*, by Patricia Burke Brogan, takes audiences into the hearts of Magdalene women whose babies were taken from them. Through Brogan's 1992 play, which has been performed in places as far-flung as Peru and Belgium, audiences have shared the sorrow of these stories. In 2010, when Galway city leaders proposed moving the Magdalene statue from a busy thoroughfare to an out-of-the-way location, Brogan told the *Connacht Tribune*, "I'll chain myself to the statue" in protest. In 2013, Headrick spent seven weeks in Ireland as a Moore Visiting Fellow at the National University of Ireland, Galway, researching the production history of Brogan's play.

Unlike novels, whose characters come to life inside the mind of the reader, plays must be performed to fulfill their literary purpose. But staging takes backing, both financial and professional. Without the imprimatur of the powers that be, new playwrights may never see their words come to life in front of an audience.

For more than 100 years, the arbiter and gatekeeper of Irish drama has been the Abbey Theatre, formerly

the National Theatre of Ireland. There, audiences from the world over line up to see the works of Irish luminaries like Samuel Beckett and W.B. Yeats. But with a couple of notable exceptions, including Yeats' affluent friend Lady Augusta Gregory (who co-founded the Abbey Theatre with him in the early 1900s), very few women have broken in.

*Headrick poses by James Joyce's statue in Dublin.*

"The Abbey has an abysmal record of producing plays by women — abysmal," Headrick says. "If your play didn't have a character in the categories of mother or whore, it was rejected."

So for a very long time, scripts by talented Irish women sat on shelves, unseen, unheard and unpublished. But these days, women playwrights are pushing the parameters of access and content in Ireland.

"Women playwrights today are examining their own status in society as well as the status of other powerless groups," Headrick and Kearney write in their book. Unflinchingly, these playwrights are tackling some of life's toughest issues: battered wives and bigamy, female prisoners and family violence, searing poverty and labor strife. And, not content to remain under the thumb of the theater establishment, they have looked beyond the Abbey to form their own companies and produce theater on their own terms. "There's more to Irish drama than what takes place in a pub or a kitchen," Headrick wryly notes.

For her part, Headrick works tirelessly to not only study but also stage Irish plays. At Oregon State, for instance, her recent directorial highlights include Deevy's *The King of Spain's Daughter* and *The Sugar Wife* by Elizabeth Kuti. She also has guest-directed numerous Irish plays throughout the Pacific Northwest as well as in Texas, Oklahoma, Georgia, Kentucky and Indiana.

For Headrick and Kearney's book, theater critic and scholar Patrick Lonergan of the National University of Ireland, Galway, wrote a blurb summing up its contribution to Irish drama: "Women characters dominate the Irish stage — yet, for decades, Irish women dramatists have been neglected, ignored and sometimes deliberately marginalized. This wonderful new anthology takes an important step toward addressing and redressing that problem." terra

## Seven Plays

The seven plays collected in the soon-to-be-released anthology *Irish Women Dramatists 1908 – 2001* (Syracuse University Press, November 2014), edited by Eileen Kearney and Charlotte Headrick, delve into universal themes ranging from friendship in old age to childbirth out of wedlock. They are:

**Lady Augusta Gregory**
*The Workhouse Ward (1908)*
This one-act comedy is about the quarrelsome yet codependent bond of two infirm old men living in a late-18th century workhouse.

**Teresa Deevy**
*The King of Spain's Daughter (1935)*
An imaginative, dreamy young woman faces a cruel choice in this play: enter a loveless marriage or go to work in a factory.

**Anne Le Marquand Hartigan**
*I Do Like To Be Beside the Seaside (1984)*
In this tragi-comedy, friendship makes life bearable for two elderly people in a dreary old-folks' home — until they're threatened with separation.

**Dolores Walshe**
*The Stranded Hours Between (1989)*
Two women characters rise up in this play to reject the authority of a controlling husband and a patriarchal God.

**Patricia Burke Brogan**
*Eclipsed (1992)*
This play about a Magdalene laundry portrays four mothers who have lost their children to adoption, institutionalization or death.

**Jennifer Johnston**
*Twinkletoes (1993)*
In this monologue, a woman whose imprisoned IRA husband is never coming home careens between fanciful longings and a fettered life.

**Nicola McCartney**
*Heritage (2001)*
Set in Canada, this play portrays the conflicts that arise when a young Irish woman and her family start a new life in a new country.

# ACCIDENTALLY BLUE

## Patented OSU pigment draws industry interest

BY NICK HOUTMAN

Mas Subramanian didn't expect to find a brilliant blue pigment when he was looking for new semiconductors. But the Milton Harris Chair Professor of Materials Science in the Oregon State University Department of Chemistry was shocked in 2009 when he saw a graduate student take a powder with a vibrant blue hue out of a laboratory furnace.

The student was worried. He thought it was a mistake.

"We were trying to find a material with novel magnetic properties for electronics applications, but it didn't work. I didn't think it would have a special color. I expected it to be brown or black," says Subramanian, who grew up in Madras (now called Chennai), India, and received his Ph.D. at the Indian Institute of Technology. "But when I saw what he had, I knew this was something unusual."

The new blue is stable and relatively nontoxic. Produced at temperatures in excess of 2,200 degrees Fahrenheit, it reflects infrared energy and may thus help to cool buildings and reduce air-conditioning costs. And it can be "tuned," says Subramanian, to produce a range of shades from sky blue to nearly black.

Since publishing the discovery in the *Journal of the American Chemical Society*, Subramanian has worked with artists (such as Portland-based Rebecca Shapiro), paint manufacturers, energy conservation companies and the German chemical firm Merck KGaA, which makes pigments for coatings (automobiles, aircraft), plastics, inks and cosmetics. Even the U.S. Navy has expressed interest since ships painted with the heat-reflecting pigment may be less visible to detection through infrared imaging.

*Pigment chemistry competes with electromagnetic materials for attention in chemistry professor Mas Subramanian's lab at Oregon State University. (Photo: Karl Maasdam)*

Merck, one of the world's oldest chemical and pharmaceutical companies, combines colorants with particles of mica, silica or alumina to give them a vibrant sheen. The firm has even developed a line that changes hues as the viewer's perspective shifts. Although the company supplies pigments to some of the world's largest manufacturing companies, it continues to look for colorants that work better in complex mixtures and have environmental benefits.

The promise of Subramanian's discovery has prompted Merck to fund an ongoing research program in his lab. The company's customers are always looking for ways to create new color effects and to reduce the use of heavy metals, says Gerhard Pfaff, senior director of research and development for Merck.

"New pigments should improve application properties, for example, in the paint industry. This means, besides special color effects, a better adaptation of the pigment surface to the binder systems," says Pfaff in an email. "Only a very few university groups in the world are working in this field. The development of new colorant systems based on a fundamental understanding of inorganic materials and their structure is an intelligent way to create innovative new pigments."

## Crystal Light

The new OSU blue stems from an unusual crystal arrangement known to chemists as "trigonal-bipyramidal coordination." Even though chemists have known for decades that such structures exist, no one had proposed that they would provide the basis for new vibrant colors. By introducing manganese ions into the crystal, Subramanian's team intended to make new materials with effective magnetic properties for use in

*(Left) Portland artist Rebecca Shapiro used the new OSU blue pigment in her encaustic (molten beeswax) painting,* Summer's Eve 2011. *(Right) By replacing manganese with elements such as titanium, zinc and copper, Mas Subramanian has produced durable new purples, greens, oranges and yellows.*

computer hard drives. Instead, they created a material with surprising light-absorption properties that result in shades of blue. Subramanian has added zinc and titanium to produce a range of purples. He and his team have substituted iron for manganese to produce a new orange pigment, and they are exploring the use of copper and titanium to make green. Other elements produce yellows and browns.

Chemical theory did not predict that such a structure would generate intense colors, says Subramanian. His lab still focuses on semiconductors, and although his students produce papers on new materials with novel magnetic and electrical properties, pigment chemistry competes with electronic material research for their attention.

"We are making new pigments based on a mineral called hibonite, which is normally found in meteorites," Subramanian says. "They are blue sometimes, and we are now producing them in our laboratory furnace using cheap raw materials."

## Renaissance Blue

The search for dazzling blues has occupied artists and explorers for millennia. Neolithic artisans fashioned beads from lapis lazuli (a silicate mineral mixed with flecks of iron pyrite, aka fool's gold) mined in what is now Afghanistan. Marco Polo marveled at quarries of the valuable mineral, and Italian Renaissance painters had access to it through trade routes managed by Venice.

Lapis lazuli became the basis for a high-value pigment known as ultramarine. Until the discovery of Prussian blue (ferrocyanide) in the early 1700s, ultramarine was the blue of choice and used to evoke a sacred quality in religious art. However, ultramarine costs about 10 times more than Prussian blue, and artists gradually shifted to the less expensive color.

Today, pigments are still woven with economics. "The price of paint is not the big deal. Durability is the problem," says Subramanian. Pigments made from organic materials tend to fade in sunlight and require costly repainting. Moreover, some blue pigments, such as Prussian blue, have toxic properties.

The search continues for pigments that are durable, nontoxic, energy efficient and tunable to a variety of shades. Subramanian has produced blues, greens, yellows and oranges, but he would love to find a good red. "Reds that have good color use mercury and cadmium," he says. "They are not environmentally desirable." terra

## Innovation: Smart Bike Helmet

### Alert is sent after an accident

Bike helmets have long proven their worth by helping to prevent head injuries. Now a team of OSU student interns who worked at Intel last summer has turned the durable plastic shells into an emergency beacon, communicator and diagnostic tool in the event of an accident.

Equipped with electronics that can detect and analyze a crash, the helmet can send messages to designated contacts with details about location and the bike rider's condition. It can ask the rider questions to help diagnose the likelihood of a concussion. And like the black box on an airplane, it stores crash data that can shed light on dangerous intersections and road conditions.

The helmet stems from a project spearheaded by students in the CreateIT Collaboratory, an industry-sponsored technology think tank in the School of Electrical Engineering and Computer Science directed by OSU engineering professor Don Heer. The collaboratory was launched with start-up funding from the Tektronix Foundation.

## New Labs Focus on Stormwater, Floods

### Facilities supported by Oregon BEST

When floods arrive, hydrologists scramble. They run computer models to evaluate the need for evacuation. They gather data to understand impacts on fish, soils and water quality. Now, Oregon State researchers have access to two new labs that enable them to test theories before the downpour.

A Multipurpose River Hydraulics Research Facility is located at the O.H. Hinsdale Wave Research Lab. It includes a recirculating system and a concrete platform for independent, simultaneous experiments.

Near Avery Park in Corvallis, the OSU-Benton County Green Stormwater Infrastructure Research Facility offers three independent cells for testing water treatment technologies. Stormwater is stored in underground tanks and pumped into the cells for experiments. Education and outreach activities will also be carried out at the lab.

Two OSU assistant engineering professors, Arturo Leon and Meghna Babbar-Sebens, direct the River Hydraulics Lab and stormwater facility respectively.

Oregon BEST, a statewide nonprofit research organization, has provided funding for both labs. Other support comes from the U.S. Environmental Protection Agency, Oregon State University, the Oregon Water Resources Department, Benton County, Northwest Research Associates and the Pacific Northwest Transportation Consortium.

## Green Neighborhoods Lead to Better Birth Outcomes

### Researchers gathered data on more than 64,000 births

Where the grass is greener, pregnancies tend to be full-term, and babies tend to have higher birth weights. The findings hold up even when results are adjusted for factors such as neighborhood income, exposure to air pollution, noise and neighborhood walkability, according to researchers at Oregon State University and the University of British Columbia.

"This was a surprise," says Perry Hystad, an environmental epidemiologist in the College of Public Health and Human Sciences at Oregon State and lead author of the study. "We expected the association between greenness and birth outcomes to disappear once we accounted for other environmental exposures such as air pollution and noise. The research really suggests that greenness affects birth outcomes in other ways, such as psychologically or socially."

In a study of more than 64,000 births, researchers found that very pre-term births were 20 percent lower and moderate pre-term births were 13 percent lower for infants whose mothers lived in greener neighborhoods.

# FY14 OSU Research Grants Total $285 Million

## Rise in federal support leads the way

In the fiscal year that ended June 30, Oregon State University's growing research enterprise achieved its second highest level of funding support ever: $285 million. "The success of our researchers in competing for grants shows we have a portfolio that is broad and deep," says Ron Adams, Oregon State's interim vice president for research.

An 11 percent rise in federal awards from $154 million in 2013 to **$171 million** in 2014.

A record for business and industry investment, up 46 percent since 2010 — from $36 million in 2013 to **$37.2 million** in 2014.

A continuing rise in technology licensing fees to $5.9 million in 2014, up **120 percent** since 2010. Primary products included transparent transistors, formaldehyde-free adhesives and wheat.

## Success in STEM Fields

### NSF grants aim to diversify the workforce

**Two five-year grants from the National Science Foundation aim to increase the participation of women and underrepresented minorities in science, technology, engineering and math disciplines, or STEM, at Oregon State University.**

**Through a program known as ADVANCE, OSU will recruit and promote women in STEM fields and implement policies to address needs across race, sexual identity, social and class differences. Women have historically been underrepresented in the STEM fields in academia. In 2012, 23 percent of Oregon State's STEM faculty, including faculty in the social and behavioral sciences, were women.**

**Efforts to help minority students succeed in STEM fields will focus on the colleges of science, engineering and agricultural sciences. The OSU program will use proven methods such as peer mentoring, small cohort-based orientation classes and workshops given by upper-division STEM students.**

*Max Paradiz, a biochemistry and biophysics major at Oregon State University, works with physics researcher Weihong Qiu. (Photo: Kevin Ahern)*

# Technical Assistance

Students develop robots to empower people

*Ben Arvey, left, navigates while lead designer and engineering undergrad Ben Narin provides instructions. (Photo: Hannah O'Leary)*

Last summer, Ben Arvey took an electric wheelchair for a test drive. He blinked his eyes, and as the Google Glass on his head relayed those small movements through the Internet, the chair moved forward. With no assistance from Arvey, it swerved to avoid a table and then straightened out as though traveling down a hallway. For good measure, since he was in a robotics lab, he passed Harris, the lab's human-sized personal robot, and gave it a high-five.

Under the guidance of Oregon State robotics professor Bill Smart, Arvey and his fellow students (many are in the University Honors College) want to empower people with disabilities. Their idea: Equip an electric wheelchair with an operating system that can respond to verbal commands or eye blinks.

"Robotics has practical benefits for people," says Ben Narin, project leader and a senior in Electrical Engineering and Computer Science. "We want to make someone's life better."

Such a chair could be particularly useful for people with ALS (aka Lou Gehrig's disease), who gradually lose control of their muscles. As their arms and legs become disabled, a smart wheelchair could enable them to go from room to room or even outside to feel the wind and sun on their face.

To facilitate the project, the ALS Association of Oregon provided Smart's lab with a Permobile power rehabilitation chair. It tilts and uses leg extensions to reduce the patient's risk of developing sores.

"We want to make it so the wheelchair will autonomously navigate," says team member Jasper LaFortune. "You just tell it where you want to go, and it will take you there."

The students' goal isn't to create a device that does everything for you, adds robotics graduate student William Curran. "We call it 'shared autonomy.' You're not controlling the robot, but it's not completely autonomous. It gets to the whole point of personal robotics. Our research is about robots interacting with people."

In contrast to systems designed from the ground up, the OSU innovation can be mounted on an off-the-shelf wheelchair. This approach would enable people to adapt the technology to their individual needs.

This fall, Narin and his team plan to test their system on chairs used by ALS patients in Massachusetts and California.

## Meet the Undergrads

These students in Bill Smart's lab are in the School of Electrical Engineering and Computer Science.

**BENJAMIN NARIN**, Eugene
Goal: An autonomous wheelchair to increase the standard of living for individuals with extreme disabilities.

**CAMERON BOWIE**, Clackamas
Goal: Software to create floor maps that can help guide a wheelchair in a manner similar to the GPS in our cars.

**JASPER LAFORTUNE**, Moscow, Idaho
Goal: Program to enable robots to mimic the way a person might navigate from room to room — such as down the right side of a hallway.

**BEN ARVEY**, Corvallis
Goal: Assistance for programmers who use the Robot Operating System — or ROS — which is hosted at Oregon State's Open Source Lab.

**DUY NGUYEN**, Ho Chi Minh City, Vietnam
Goal: A method for protecting a robot owner's identity.

### NATIONAL ATTENTION

Arvey, Curran and Thomas Thornton, an OSU summer research student and an undergraduate from Colby College, were selected from more than 200 applicants to give a presentation to ROSCon, the national Robot Developers' Conference, last September in Chicago.

THE OREGON STATE UNIVERSITY ADVANTAGE

Connects business with faculty expertise, student talent and world-class facilities, and helps bring ideas to market and launch companies.

# Partnership Advances the Cutting Edge

## Blount International and OSU collaborate on saw technologies

You might expect that the state that produces the country's largest amount of softwood timber would also host leaders in the chainsaw industry. One of those firms, Blount International in Portland, has increased its focus on new approaches to power systems, production efficiency and consumer safety. As partners in Oregon State's Advantage program, the company is working with OSU researchers to advance the state of the art in saw technologies for agriculture, construction and landscaping in addition to forestry.

"We are pursuing multiple projects with OSU researchers," says Jamie Munn, R&D engineering manager with Blount, which sells products in 115 countries. "We'll see practical outcomes that we can develop as prototypes and integrate into our product lines."

Blount's production process will be the focus of a holistic study to determine how to incorporate environment, safety and health into product costing methods. The project is led by Karl Haapala and Javier Calvo in the School of Mechanical, Industrial and Manufacturing Engineering (MIME) and Anthony Veltri in the College of Public Health and Human Sciences.

Julia Zhang in OSU's School of Electrical Engineering and Computer Science will apply her expertise in electrical power systems to the practical challenges presented by outdoor power equipment. By participating in product design reviews, she will gain insights into problems that can be tackled in her research.

In John Parmigiani's lab in MIME, a new apparatus is enabling researchers to push the boundaries of what chainsaws can do. Since one of two new testing machines that Parmigiani designed and built is located at Blount in Portland, complementary tests can be run in both locations.

Parmigiani and his students have tackled product development questions with Blount through the state-funded Oregon Metals Initiative, and now the company has supported projects in his lab with a six-year agreement.

Blount's work with OSU goes beyond product testing and research. The company also provides supplies (saws, chains) for Oregon State's student-based logging crew. In turn, Blount employees go into the field with OSU woodcutters to see how their products perform firsthand.

To implement the outcomes of research projects, Blount is working with the OSU Research Office to develop a "pre-paid" arrangement for intellectual property.

*OSU engineer John Parmigiani is working with Blount International in Portland on improved chainsaw technologies. (Photo: Jan Sonnenmair)*

To discover what the **Oregon State University Advantage** and the **Advantage Partnerships program** can do for your business, contact Brian Wall, Director, Office of Commercialization and Corporate Development, 541-737-9058. **oregonstate.edu/advantage**

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*Mangrove forests provide ecosystem services (improved water quality, erosion control, biodiversity) to people throughout the world. This is true in rural areas as well as in urban zones, such as Abu Dhabi, United Arab Emirates (pictured here). When they occur on the coastal edges of deserts, such as on the Arabian Peninsula, mangroves may be the only forests in the entire country. In urban environments, they are highly valued for their beauty, birdlife, fish habitat and coastal zone protection. See "Blue Carbon," Page 16. (Photo: J. Boone Kauffman)*