terra

DISCOVERY | CREATIVITY | INNOVATION · Winter 2016

THE CARNIVORE QUESTION

Oregon's path toward coexistence with big predators

Oregon State UNIVERSITY

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Volume 11 Number 2 // oregonstate.edu/terra // Winter 2016
Oregon's leading public research university

FEATURES

With access to accurate, real-time weather data, farmers in Africa will be able to expand production with assurance that risks will be covered through crop insurance programs. See "Forecast for Africa," Page 26 (Photo: Climate and Development Knowledge Network).

DEPARTMENTS

Oregon State is Oregon's leading public research university with more than $309 million in research funding in FY2015. 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.

Terra is published by University Relations and Marketing. It is printed by a Forest Stewardship Council certified printer with vegetable-based inks on paper with 55% recycled content (30% post-consumer).

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On the cover: Wildness shows in the eyes of this cougar kitten whose movements are being tracked in an OSU predator study. (Photo: Jim Yuskavitch)

Oregon State UNIVERSITY

Animal Behavior

Walking the dog has been my daily ritual for the better part of 20 years. Our current mutt — a pint-sized rat terrier/blue healer mix named Roo — loyally defends her home turf and isn't kind to strangers. When neighbor kids ask if they can pet the cute dog with the inquisitive face, I thank them for checking with me and warn them away. And when an untended and out-of-control member of her kind bounds toward her, Roo becomes all teeth and snarls.

I keep her on a short leash and take her out at night. An animal behaviorist told us that she is "fear aggressive" and prescribed Prozac — for the dog, not for the owners.

At home, Roo amuses us and keeps the rodents under control, but a reasonable person might say the world would be better off without an animal like this. After all, there are plenty of other dogs — meek, mild and friendly to a tongue-lapping fault — that die unwanted in shelters. There's the risk that, in a moment of the owners' inattention, Roo could inflict harm. Just to go on vacation, we train our pet sitters.

Of course, our relationship to animals is not that simple. It carries caveats and conditions. Our own safety and welfare come first, but these creatures rely on us and deserve kindness and respect. For many people, pets take the edges off a rough day. They provide warmth and companionship. They are nothing less than family members.

If you step outside that circle and consider how we interact with animals in other circumstances — scientists and research subjects, hunters and prey, ranchers and livestock — these relationships become more complex. Our decisions carry implications for health, livelihoods, communities and the environment as well as for the well-being of the animals. Ethical principles — whether codified in law or community practice — guide decisions in each of these arenas and evolve with social norms. Our ancestors earned bounties for killing wolves and other wildlife. Now we are restoring predators to parts of their historical habitats. The Oregon Wolf Conservation and Management Plan walks a line between ranchers' needs and the intrinsic value of a key species.

This issue of *Terra* explores these relationships through studies of predators, grazing and rangeland vegetation and through the literary lens of an Oregon State essayist. We hope you enjoy the journey as much as we did.

Editor

The Accidental Researcher

How a serendipitous undergraduate research job set me on my path

BY CYNTHIA SAGERS, OSU VICE PRESIDENT FOR RESEARCH

I count myself an "accidental" researcher. That's because my career would have turned out quite differently, no doubt, had I not stumbled into a college class that changed everything.

I was an undergrad at the University of Iowa in the early 1980s, working in the hematology lab at the teaching hospital to support my studies, when I signed up for a class in tropical ecology taught by a charismatic young researcher named Stephen Hubbell (now at UCLA). One day he announced that he was taking applications to hire a research assistant. Figuring I'd be assigned to study the colonies of leaf-cutter ants he maintained in a basement lab in Iowa City, I applied. Imagine my shock when he offered me the job, saying: "Congratulations! You're going to Panama."

The leaf-cutter ant, it turned out, wasn't Steve Hubbell's only research subject. Tropical vegetation was another. I was to be part of a team at the Smithsonian Tropical Research Institute making the first-ever census of tree species on Barro Colorado Island.

The year I spent as a crew chief at that remote biological station gave me not just a window but a wide-open door into the methods (and sometimes the madness) of field biology. Day after day, I tromped across the island, caked to my knees in mud and soaked to my skivvies in rain. I learned to estimate tree populations by measuring transects and sampling 50 hectares of tropical forestland. I was enchanted.

The experience led me to become an evolutionary plant ecologist, but not just because of the fascinating subject matter. More significant than my learning about tropical ecology was getting down and dirty in the trenches with working scientists. I was a very young and impressionable person wondering what my life was going to be like. I became convinced, as a 22-, 23-year-old, that this was the most interesting place on the face of the Earth. So many people came through, all of them scientists. There were geoscientists, lots of botanists, mammalogists, ornithologists. Because I was with them every day, working alongside them, sharing meals and jokes and aha moments, I was able to imagine myself as one of them. In fact, I was one of them. That immediacy, that personal and professional intimacy, made all the difference in how I came to view myself and my place in the world.

That's why in my role as Oregon State's vice president for research, I'm so committed to opening the doors of research and discovery to undergraduates like senior Amanda Santos, whom I happened to meet last year at the Organization for Tropical Studies in Costa Rica, where she was working on a project on the coevolution of plants and insects. I was delighted to run across her recently on Facebook wearing, of all things, a Beavers T-shirt! Unbeknownst to me, she had found her way to OSU's Department of Fisheries and Wildlife and the laboratory of associate professor Scott Heppell, one of the outstanding faculty members who demonstrates every day that working with students is tightly woven into the fabric of this university's research enterprise.

To learn about the undergraduate resources the Research Office offers, visit our website at **research.oregonstate.edu/students**.

Mediating Scientific Conflicts

A facilitated process for discovery and solution

BY TODD JARVIS, DIRECTOR OF THE OSU INSTITUTE OF WATER AND WATERSHEDS

Conflicts over the management of water, timber, climate change, endangered species and grazing can tear apart communities and have real impacts on local economies. And when scientists are invited to settle the issues, experts can become mired in their own conflicts.

Even large multidisciplinary research projects can fall into divisions that threaten the scientific process itself. Driven by funding agency calls for "broader impacts," science teams require diverse disciplinary backgrounds that can make it more difficult to build a cohesive vision. Without some form of scientific dispute prevention or conflict resolution, the options for dealing with these conflicts are limited. They can come down to deciding whose expert is "right" or to falling back on the tired cliché of "agreeing to disagree."

Scientific mediation offers another course. To broaden their options and improve communication, scientists and people with a stake in the issue can work together to discover *why* they disagree and to peel back the positions and interests that lie at the heart of conflicts.

While such conflicts can be complex, the scientific mediation process proceeds through a series of well-defined stages. First, participants determine the focus of the topic and set the ground rules for meetings. It is critical at this stage to achieve a shared vision for the outcome, so that participants don't divert the process by steering the discussion in different directions.

Second, members of the group conduct presentations to identify areas of agreement and disagreement and to distinguish what is well-known from issues that are poorly understood.

Third, they work toward a shared interpretation of the science. They may even decide to pursue a joint research project to answer unresolved questions.

When complete, this process results in focused discussions about alternatives. It assumes that all participants are at the table in good faith, although as mediators know, bad-faith negotiating is always a possibility. It can be difficult to spot, but some indicators include: delaying tactics, withdrawal of terms after a tentative agreement has been made and not sending an agent with the authority to make decisions. It can be useful for the participants to agree, when setting up the ground rules, on how to deal with alleged cases of bad faith.

The goal of the process is to isolate the scientific issues separately from personal or political biases of the users of scientific information. Even after the group comes to a consensus on what the science means, overarching conflicts will still exist. Resolving the broad conflict, or reaching an agreement on the merits of a disagreement, will take more deliberation on the part of the participants, but hopefully the scientific mediation process will provide a firm scientific basis on which to make a decision. It will succeed if it increases the quality of communication and trust group members have in each other, the group's capacity for conflict resolution as a whole and the public's trust in the research enterprise and scientific opinions.

In addition to leading the IWW at Oregon State, Todd Jarvis is an adjunct professor at the University of Oregon School of Law. He co-authored an article on www.mediate.com on this subject with Curtis Moore, deputy district attorney in Elko County, Nevada, and a 2014 graduate of the UO law school, and with Andrew Wentworth, who earned his master's in water resources science from Oregon State in 2015.

Swimming Through Science

Culture and biology connect for an undergraduate from Bend

BY NICK HOUTMAN | PHOTO BY CHRIS BECERRA

If science were the Pacific Ocean, Kylie Welch would be halfway to Japan by now. With the persistence of a long-distance swimmer, she has plunged through a double major in biochemistry and anthropology, worked in an oceanography lab and traveled abroad. Still amazed by new experiences, the Oregon State University senior sees herself as a connector between science and the public, between the machinery of biology and the richness of culture.

When she arrived as a first-generation undergraduate at Oregon State in 2011, she jumped in with both feet to pursue a degree in biochemistry and biophysics. Recalling the enthusiasm of her science teachers at Mountain View High School in Bend, the salutatorian was intrigued by the power of DNA, proteins and other molecules.

However, something was lacking. "I wanted a human connection," she says. "I wanted to know what this science means for people across the globe, a person in the United States versus a person in Ethiopia, Romania or India."

So, following her internal GPS, she decided to recalculate her route. She combined the study of molecular machinery with a dive into the humanities. "Biochemistry allows me to see the technical side, but then I could see how it actually affects people," she says. "Cultural anthropology brings it all together. They're two pieces of the same puzzle. Biology affects culture, and culture affects biology."

As if that weren't enough to propel the self-described science lover through her academic career, Welch joined the University Honors College. Small class sizes and research opportunities across the campus fit her desire to learn and to bridge the gap she perceived between science and the public. For her thesis, she began a littoral ocean project in Professor Miguel Goni's lab in the College of Earth, Ocean, and Atmospheric Sciences.

Goni specializes in bridging another divide: how the land influences coastal waters. Think of the Columbia River as a pipeline for soil particles and nutrients from mountain slopes, farm fields and urban streets. Think of Oregon's fabled estuaries — the Nehalem, the Tillamook, the Alsea, the Umpqua, the Coos — as food factories for all manner of sealife, from plankton to salmon to osprey. And as sustenance for humans.

Don't Fence Me In

Welch was drawn by the idea of looking at these cultural hotspots through a chemical and biological lens. Goni, lab manager Yvan Alleau and post-doctoral researchers provided guidance. Welch analyzed water samples, often with friend and fellow student researcher Kaitlin Lebon, and created maps of carbon and nitrogen concentrations along the California Current, from Southern California to Vancouver Island. She traveled to an ocean sciences conference in Honolulu to present a poster that she wrote and designed.

Just for good measure, she participated in two trips overseas, one to Romania with Habitat for Humanity and the other to Ethiopia through The Community Project: Ethiopia.

"When I came to Oregon State, I never imagined I'd be doing all this," Welch says. "One of the biggest surprises for me was learning that science often doesn't go as you expect. But when things don't work, you trace your steps and ask yourself, 'What if we try this?' Professor Goni has been so helpful."

Welch hasn't mapped her future with the same precision that she has applied to the ocean. "I can see myself working in a lab that focuses more on human biology than oceanography, but there are so many opportunities that I don't want to close myself off to them," she says. "If I had done that in the past, I wouldn't have gotten to where I am today."

Kylie Welch, right, collects water samples with OSU professor Miguel Goni, left, and fellow student Kaitlin Lebon.

At the Apex

THE RETURN OF WOLVES TO OREGON SPARKS OLD CONFLICTS AND PROMPTS NEW SCIENCE ABOUT TOP PREDATORS

BY LEE SHERMAN GELLATLY | PHOTOS BY JIM YUSKAVITCH

"Since the dawn of time our ecosystems have been linked and humans have co-existed with flesh-eating beasts as members of the same food chain."

— *David Quammen,* Monster of God

Beth Orning walks along the rim of a steep ravine, the brittle, rime-crusted grasses crunching under her boots. A chill mist shrouds the surrounding hills, where autumn-yellow larches pierce the deep-green stands of ponderosa pine like golden spears.

From a holster on Orning's belt glints a blood-red canister of Counter Assault Bear Deterrent. The pepper spray is standard field gear, just in case she blunders into an aggressive black bear. She stands still for a moment, her gloved hand holding up an aluminum pole fitted with horizontal crossbars. Resembling a '50s-era TV antenna, the instrument is, in fact, a very-high-frequency (VHF) radio receiver. She's picking up a signal. A cougar, silent and unseen in the thick understory, is emitting a beacon from its tracking collar, placed by researchers two years before.

"She's close, about a hundred meters to the north," says Orning, a Ph.D. student studying wildlife biology at Oregon State University. Waiting for her to give the go-ahead is her team of two trained animal handlers and master houndsman Ted Craddock, a frequent partner in the collaborative big-predator research of Oregon State University and the Oregon Department of Fish and Wildlife (ODFW). Craddock's dog Spur, a "high-tan" coonhound bred and trained for moments exactly like this, is hyper-alert, his nose greedily sucking

Beth Orning, an Oregon State University Ph.D. student studying wildlife biology, uses a very-high-frequency (VHF) radio receiver to locate a cougar in northeastern Oregon's Mount Emily Wildlife Management Unit.

in the musky scents of this wild place on the edge of the "Blues," the sprawling mountain range on Oregon's northeastern flank that includes the Elkhorns and the Strawberries.

"OK, she's moving away from us," says Orning. Having closely monitored the big cat's movements for months, plotting them point-by-point on a "cluster map," Orning has strong evidence that cougar No. C216 is raising a litter, born in this hidden ravine four or five weeks ago.

Today's mission, finding and collaring the kittens, will add significant new data to a study of cougar-wolf coexistence in the Mount Emily Wildlife Management Unit. One of Oregon's densest cougar populations has long prowled the unit's forested slopes. Now the cats have competition. Three wolf packs — the Mount Emily, Meacham and Umatilla River packs — have taken up residence here in the past few years. Because these powerful meat-eaters command the very top of nature's food web, biologists call them "apex predators." Orning and her team want to know how the interspecies members of the area's "carnivore guild" compete with each other from atop their shared pinnacle for territory and for food, especially "ungulates" — hooved animals such as mule deer and elk — some of whose numbers have been dropping steeply in this corner of the state.

"Estimating accurate predation rates and determining prey selection for wolves and cougars is critical to understanding the role that both of these top predators play in ungulate population dynamics," says Katie Dugger, assistant unit leader for the Oregon Cooperative Fish and Wildlife Research Unit and lead scientist on the wolf-cougar study. "We want to

Beth Orning adds a radio collar to a 5-week-old cougar cub.

know how expanding wolf populations affect cougar populations, and how predation risk for elk and mule deer populations may be affected by the return of a second top predator to northeast Oregon."

But getting the data is tough. Cougars (*Puma concolor*) lead secretive lives scattered over miles of wild and rugged terrain. "Cryptic" is how Dugger characterizes their behavior. The gray wolf (*Canis lupus*) is somewhat easier to study, she says, but their densities are low. So to find and study these elusive creatures, researchers from OSU, in partnership with the ODFW and the Confederated Tribes of the Umatilla, are using pursuit hounds, rubber leg-hold traps and helicopters. Once they've been captured, the animals are sedated, sexed, aged and collared with GPS and VHF devices for long-term monitoring.

Broadly, such research will help inform wildlife policy and management decisions as wolf numbers grow in Oregon. Since lone wolf OR7 made headlines with his journey across Oregon into California five years ago, wolves have gotten a fast foothold — so fast, in fact, that the target numbers for delisting under the Oregon Wolf Plan were reached several years sooner than expected.

In November, Oregon's wolves were removed from the state endangered species list by a 4 - 2 vote of the Fish and Wildlife Commission. Most commissioners accepted the report made by Oregon's wolf coordinator, OSU alumnus Russ Morgan, that Oregon has enough breeding pairs, healthy pups and genetic diversity among its 81 confirmed wolves to ensure viability. With the federal Endangered Species Act still in force for Western Oregon, along with hefty fines for poaching, the commission was comfortable delisting wolves for Eastern Oregon (roughly east of Highway 97). It will be another year or so, Morgan notes, before wolf populations grow large enough to reach the next phase of the Eastern Oregon plan (seven breeding pairs for three consecutive years), which would give ranchers more flexibility in dealing with problem wolves. For now, however, killing wolves anywhere in Oregon remains illegal unless authorized by fish and wildlife officials.

But critics question the metrics for sustainable wolf populations. The science of "how many wolves are enough wolves?" is uncertain, they argue. OSU wildlife researcher Luke Painter describes one sticking point for wolf defenders: the distinction between a "minimum viable population" and an "ecologically effective population," built on a more rigorous set of possible threats, such as genetic bottlenecks, disease and widespread poaching. Conservation organizations argue that the ODFW's benchmark of eight breeding pairs (four in the east and four in the west) for three consecutive years takes the minimalist approach, one that may not be adequate to sustain wolves over the long term.

In December, conservation groups filed suit, seeking to reverse the decision to delist. Meanwhile, beyond the political and legal fray, researchers like Orning are collecting and analyzing data about wolves and cougars — a duo she calls "charismatic megafauna times two" — in pursuit of data to inform future management decisions.

Sound of a Hound

Spur's sinewy neck is ringed with multiple collars, each sprouting a spiky antenna for receiving GPS or radio signals so that, as Craddock says, "I know how far away he is at all times." As the dog leads the team into the ravine, Orning's long legs effortlessly clear the boulders and deadfall that litter the slope. Suddenly, Spur lets loose a piercing *aurUUGH! aurUUGH! aurUUGH!* He scents a cougar. The sound, somewhere between a roar and a howl, emanates, it seems, from some genetic vestige of a primal hunt, the age-old struggle of life, death and survival. Spur's full-throated baying ensures the team's safety. That's because the big cat, invisible but most certainly watching warily from some not-so-distant promontory, won't come near the den while the dog is on duty.

"OK, we're really close," Orning says quietly. "Now listen for the kittens. It'll sound like songbirds chirping in the underbrush." Then, "I hear them!" The next moment she's bounding up the slope with the team at her heels. A chorus of plaintive mewling leads her to a densely needled tree, its lowest boughs brushing the ground. Orning kneels to peer beneath the branches. From the shadows, three pairs of dark-blue eyes look back at her.

Working quickly, she tattoos an ear, confirms the sex, and takes the weight of each stocky, big-pawed kitten (they range from 4 to 7 pounds). Once their collars are in place, Orning returns the little cougars to their lair. The collars will drop off as the kittens grow. Before she gets back to the truck, she takes a quick look at her radio signal. The mother cat already is hurrying toward the den to check on her offspring and move them to a new, safer, lair. As for the wolves, Orning's tracking gear tells her that, at this very moment, the Meacham pack is loping across a neighboring range.

The study is an outgrowth of the Oregon Wolf Conservation and Management Plan (the Oregon Wolf Plan for short), crafted by ODFW and approved by the commission

10 years ago when wolves were still just a rumor in Oregon. It was only a matter of time, wildlife managers knew, before gray wolves — reintroduced in Idaho and Yellowstone National Park under the federal Endangered Species Act two decades ago — would expand their range into Oregon. After holding a series of technical workshops and public meetings, the commission laid out a framework, not only to conserve wolves but also to improve their public image once they made their inevitable comeback.

Along with broad protections for wolves, the plan mandated research of the kind Orning is conducting under the guidance of Katie Dugger. Monitoring wolves via radio and GPS collars is "critical" for the future success of long-term wolf conservation and management, the plan's authors stressed. The Mount Emily study began several years ago when ODFW wildlife research project leader Darren Clark (then a Ph.D. student at OSU) collected baseline data on cougars. Now that the wolves have come back, the study has expanded to include wolf data, which will overlay the cougars-only data for comparative analysis. Next summer, OSU wildlife ecologist Taal Levi, an assistant professor of fisheries and wildlife, will add bears and coyotes to the carnivore guild under investigation.

Eye of the Storm

By the time Oregon's first documented breeding pair took up residence in the piney passes of the Blue Mountains in 2009, wildlife managers were ready. They had a blueprint, one that straddled the clashing interests of ranchers and hunters on one side and environmentalists on the other. Those splintered views — voiced at a series of emotional town hall meetings around the state — were a perfect microcosm of the rural-urban, east-west rift that long has characterized Oregon opinion and politics.

Dan Edge was smack-dab at the eye of the storm. "As you might imagine, the conversations in Eugene were very different from the conversations in Elgin," says Edge, an OSU wildlife ecologist and associate dean for the College of Agricultural Sciences. He served on the wolf advisory committee and on the wildlife commission while the plan was being crafted.

Five main fears surfaced. Ranchers worried about wolves killing their cows and sheep. Hunters worried about wolves killing too many of the elk and deer they hoped to bag. Parents wondered if wolves would harm their kids. Pet owners feared for their dogs and cats. And might wolves carry diseases that could infect livestock and other wildlife? These were roughly the same fears that gnawed at the early settlers in the Oregon Territory. They organized hunting parties, offered bounties and posed for photos alongside dozens of dead wolves. By the late 1940s, Oregon's wolves were gone.

Distilled, the nub of the wolf question in 2016 is pretty much the same as it was back then: the level of human tolerance for large carnivores. "It seems like it's more a question of values than science," says Levi, who studies bears and other big meat-eating mammals. "It's a question of whether and how we want to live with wolves."

Epiphany on the Prairie

By Patricia Kennedy

Like many wildlife biologists in my generation, my first wolf sighting was in the late 1990s in Yellowstone National Park. With 23 undergraduate wildlife biology majors in tow, I gazed incredulously as the 18-member Lamar Pack stalked a herd of elk; an amazing sight I never dreamed I would see in my lifetime. As a graduate student in the late-1970s we rarely discussed wolf management; bringing them back didn't seem feasible. Social acceptance of wolves was light-years away.

I didn't fully understand the concerns about wolf reintroduction until I found myself decades later staring at several wolf-killed beef carcasses on the Zumwalt Prairie in northeastern Oregon. It was not a pretty sight. The owner who stood next to me sadly murmured, "It's not about the money – we regularly manage economic loss; but I am tasked with taking care of these animals, and at this I failed."

The ecological benefits of wolves and other large predators are indisputable; ecosystems with overabundant prey, such as elk, don't function as well as systems with the full complement of trophic levels. These "complete" ecosystems will likely be more resilient to future impacts from climate change and disrupted fire regimes. In the long term, the ranchers will benefit from these ecosystem services. However, this does not compensate for the grim reality of wolf predation on stock; these losses need to be treated with compassion by society and minimized, preferably with non-lethal methods.

Wildlife biologist Patricia Kennedy is a researcher in the Eastern Oregon Agriculture and Natural Resource Program and Department of Fisheries and Wildlife.

Characteristically, OSU professor Bob Lackey minces no words when he labels the debate "nasty." As a fish and wildlife ecologist who specializes in ecological policy analysis, Lackey challenges his students to solve case studies that mirror real-life ecological conundrums. "There is no right answer scientifically," Lackey says. "Science is not the core of the issue. You can start with the same set of facts, and people will come to opposite political positions. It's a value question in a very, very polarized society."

A Hundred Voices

It was a windswept October day in the coastal town of Florence. Ragged sheets of rain whipped around the parking lot outside the Driftwood Shores motel and conference center. Inside, the meeting room was packed with more than 100 Oregonians sitting shoulder-to-shoulder in tight rows. Along the walls, several Oregon State Police guards wearing handguns scanned the crowd. There were burly guys in cowboy hats and string ties. There were guys wearing camo gear and plaid flannel shirts. A few men had on suits or blazers; one of them sported a red-white-and-blue lapel pin in the shape of a donkey. There were gray-haired women in bright scarves and handmade earrings and quilted vests. There were 20- and 30-somethings wearing designer hiking boots and T-shirts stamped with slogans like "I SPEAK FOR WILDLIFE."

More people were wedged into the 1,700-square-foot meeting room that day than the total number of wolves in the entire 100,000-square-mile state of Oregon. The crowd — a spicy cross-section of Oregon's wildlife stakeholders, from the Oregon Cattlemen's Association to the Sierra Club — was here to tell the wildlife commission their views on large carnivores, especially the proposed wolf delisting. Tensions were running as high as the surf outside.

After a fierce morning tackling the ethics and biology of thinning cougar populations in counties with lots of big cats, the commission turned to whether wolves should be taken off the state endangered species list. "We're not basing our decision on emotion," Chair Michael Finley cautioned the audience. "We're basing it on facts and analysis."

Nonetheless, emotion was at full throttle. A mother from northeast Oregon came forward carrying a towheaded toddler in her arms and described a "probable wolf attack" that had injured the family's working dogs, Scooter and Tom. Another rancher from the same eco-region argued that livestock producers, whose cows and sheep are at risk, are being made to bear an "extreme burden" from wolf activity. Unlike Oregon's urbanites, he said, ranchers have "skin in the game." A representative of the Oregon Hunters Association summed up the position of the majority of the ranchers and hunters in the room, saying, "I'm in favor of delisting as soon as possible."

On the other side of the debate was a representative of the Center for Biological Diversity, who argued that "it's premature to delist" when nearly 80 percent of suitable habitat remains devoid of wolves. "We need peer review, verifiable science, outside experts," he said. A man trained as a biologist stated that 70,000 head of livestock die

In a Forest with Wolves

By Michael Nelson

When the wind nudges the sugar maples, branches rub together and creak, your head snaps to the right, scanning the downed log, the hillside, the horizon line, hovering at the edges of fear and excitement and hope. Relief for a moment, then another creak-snap-scan.

A scat or a print on the trail is a drop in the drama of their lives. Your mind jumps quickly to scenes rich in risk: persistently, attentively patrolling the border of their territory; the chase of an ungulate, ending in a meal or more often a draw.

Quiet and quick inhaled "auhhh"s are deeper, linger longer, in your throat. The tingle of anticipation you sometimes get in your shoulders and arms now appears in your lower legs, even in the soft balls of your booted feet.

This is a forest with wolves. A place where wild things are left to be, a place where hubris, at least for a moment, at least here in this place, is held at bay, replaced by coexistence. To know a place where humility dances with restraint is to know a deep peace.

Beyond your own life lies not only the lives of others but the life of the land yet to be imagined into existence. That future will arrive, one way or another, kicking and screaming and thrashing, or steadily and deliberately. In this forest with wolves you will experience the birth of a new world.

Environmental philosopher Michael Nelson is lead principal investigator for the H.J. Andrews Experimental Forest and a historian for the long-term research project Wolves and Moose of Isle Royale in Lake Superior.

every year in Oregon from causes other than predation. Wolf coordinator Russ Morgan confirmed that as of that day, verified wolf kills for 2015 accounted for seven domestic animal deaths (six sheep, one cow), a level of loss that a Southern Oregon herb farmer characterized as "the cost of doing business." A leader of the nonprofit group Oregon Wild said, "Delisting is not supported by law, science or the public." Urging an independent scientific review, he called the current analysis "specious and speculative," adding that 81 wolves is a "ridiculously low" number, given that research shows Oregon has enough prey and habitat to support 1,400 wolves. "Delisting could be a green light for killing," he warned.

Several wolf defenders, citing the research of OSU's internationally recognized ecologist Bill Ripple, pointed out the protective effects of big carnivores on entire ecosystems — trees and plants, birds and bugs, fish and frogs. In places like Yellowstone or Zion National Park, where wolves and cougars were wiped out in earlier decades, elk and deer had the luxury to linger lazily beside streams, browsing new shoots and seedlings without fear of predation. As a result, willows, aspen and other riparian species died back severely. But when the fierce meat-eaters were returned to their former hunting grounds, the ungulates were once again alert, on edge, moving briskly across the landscape. The trees regenerated. The lush, green groves created shade and cooled creeks. Fish and amphibians flourished. Birds foraged and nested, bees and butterflies distributed pollen, beavers felled trees and built dams.

This "ecology of fear," along with the direct killing of ungulates by large carnivores, limits populations of deer and elk and, in turn, releases plants from over-browsing. Biodiversity cascades through the food web, triggered from the apex by wolves and meat-eating beasts, a woman from Eugene argued, citing Ripple's research on "trophic cascades." She urged the commissioners to "stand up for science."

Something for Everyone

From his office at the Eastern Oregon Agricultural Research Center in Union, director Tim DelCurto picks up his phone one November afternoon after the commission's vote to delist. Reluctantly, he agrees to make a few comments for the record. As a seasoned rangeland researcher, DelCurto is hyper-aware of the issue's extreme sensitivity out here on Oregon's eastern edge. "When someone asks me about wolves, I don't really like to talk," he says with a mirthless chuckle. "There's so much emotion on all sides."

With a bit of prodding, however, DelCurto lays out a perspective that, like the Oregon Wolf Plan itself, seems to offer something for everyone. "I do believe that a healthy balance of predators can have positive ecosystem effects," he says. "But for people who live and ranch out here where the wolves are, it's a source of concern and economic loss." He notes that while the Wolf Plan authorizes monetary compensation to ranchers for documented wolf kills, cows and sheep may suffer other, equally damaging impacts — ones that are more or less invisible and thus much tougher to prove. OSU research has shown, for example, that the mere proximity of wolves to herds (simulated during experiments by recorded howls and wolf urine) can raise stress-hormone levels that reduce fertility in livestock.

"Still, the general attitude is that wolves are here now," DelCurto says. "We have to minimize the impact between wolves and cattle producers by using good practices like burying the carcasses of anything that dies on the ranch, and using other non-lethal measures to keep wolves away. At the same time, the ranchers want to see the state follow the plan, which calls for delisting. My sense is, no one's going to grab a gun and go hunt wolves now that they're delisted. But right now, if wolves are harassing cows, you can't do anything about it. Delisting is a step toward giving ranchers more flexibility, more options, to deal with problem wolves in the future."

Anatomy of a Carcass

Beth Orning, her hair tucked under a baseball cap, steps down from the driver's seat of her OSU-issued Ford pickup near Mount Emily's 4,500-foot summit. Miles to the south, the Elkhorns bump the sky in a plum-colored haze. It's hunting season, so Orning hefts a bright red backpack as an extra measure of visibility.

As she strides across the ridge top, her eyes are locked onto her GPS tracker. Having plotted the previous week's satellite signals onto a "cluster map" in her La Grande lab, she's following her coordinates to locate a "prey acquisition site" — "kill site" for short. In an overgrown patch of shrubby pine, the white bones of a ribcage lay on a bed of fallen needles and cones. Other remains are strewn around the "cougar cache": a hoof, a pelvis, a clump of hair, a jaw with teeth.

"This," she says as she snaps on a pair of purple latex gloves, "was a mule deer." Kneeling in the duff, she sets to work assembling what she calls her "prey puzzle"— figuring out the species, sex, age and condition of the dead animal. Using a small saw, she cuts open a leg bone and scoops out about a teaspoonful of pinkish

marrow. “This should look fatty and white,” she says, transferring the gelatinous sample to a test tube. “The pink color tells me that this deer was in poor condition, not much body fat. The cougar could have been targeting sicker deer, or the whole herd might have been in bad shape.” When she’s back at her lab, Orning will weigh the sample, dehydrate it and then weigh it again to quantify the ratio of water to fat.

For the next three years, Orning will continue to capture, collar and monitor cougars and wolves. She’ll comb through carcasses at hundreds of kill sites. She’ll record her hard-won findings on the cryptic carnivores of northeast Oregon. “We predict that the arrival of wolves is altering cougars’ prey selection and use of habitat,” she recently told a gathering of about 50 scientists and community college students at the Pacific Northwest Research Station Forestry and Range Sciences Lab in La Grande. “Our ultimate goal is to figure out how these behavior changes affect elk and deer.”

Whether people perceive wolves as scary and dangerous or as noble and mysterious, they have come home to Oregon — returned of their own volition, here to stay, under the protection, however imperfect, of a plan that honors the animals’ right to exist while also acknowledging ranchers’ rights to safeguard their herds. While tolerance may trump data for those tasked with quelling fears and making laws, researchers like Orning carry on the science that will help Oregonians better understand and live with their wild brethren in the years to come. terra

Examining the marrow within a carcass helps determine the health and condition of the targeted prey.

Curious Romps Through Reality

Animal icons are Elena Passarello's latest journey

BY ANASTASIA ATHON | PHOTOS BY HANNAH O'LEARY

When Elena Passarello was growing up in Atlanta, she began to write as a way to have "company." Brought up in a house where she was the only child, she made magazines and newspapers for her imaginary friends to read, she says, smiling at the memory of her earliest literary steps.

She found her first flesh-and-blood audience at the neighborhood school-bus stop. She wrote and hand copied a newsletter for the families who lined up each weekday. Although the kids "thought it was lame," the moms loved it.

As a young teen who spent countless hours listening to cassette tapes of The Cure and Elvis Costello, Passarello moved on to music reviews. She'd imagine these early critiques in *Sassy*, a now defunct magazine aimed at teenage female fans of alternative and indie rock.

Now an award-winning assistant professor in the School of Writing, Literature and Film at Oregon State University, Passarello credits her interest in her craft to the influence of her mother, an eighth-grade English teacher and the matriarch of a family she describes as "bookish, library people." Literature was woven into casual gatherings and conversations at the dinner table.

Passarello's first collection of essays, *Let Me Clear My*

Essayist and assistant English professor Elena Passarello finds inspiration in her home office, where cats, she says, help her stay focused on writing.

Throat, was published in 2012 and won the Independent Publishing Book Awards gold medal for nonfiction (aka the "IPPY" Award). A finalist for the Oregon Book Award, she received the prestigious Whiting Award for Nonfiction in 2015, which includes a $50,000 prize and honors emerging writers for their accomplishments and promise.

Her current work in progress — *Animals Strike Curious Poses* — is due in early 2017 and features a lion as well as a spider, a rhino and a sheep. It helps that Passarello is a cat person. She currently lives with three felines, including a three-legged "old lady with lots of opinions" named Charlene.

Art of the Essay

Passarello discussed her work in her Moreland Hall office on a day when the Indian Summer heat necessitated open windows, carrying a backdrop of chatter from passersby below. A bookshelf filled with nonfiction has become a lending library for students who visit during office hours. Most of the books are returned to her, but if they're not, Passarello assumes they were needed elsewhere, which, she notes, "is often the case with great nonfiction." Maggie Nelson's *Bluets*, Anne Carson's *Plainwater* and Marjane Satrapi's *Persepolis* are among the books she's had to replace more than once.

Although the topics Passarello explores in her two books are vastly different — voice and animals — they are linked by cultural impact. "I'm looking for that moment in history where something goes viral and sticks," she says. "My current project explores moments when an animal has become the zeitgeist."

Among her famous subjects are Dolly, the first mammal to be successfully cloned from an adult cell, and Arabella, the spider that became a cultural phenomenon in 1973 as a space-traveling arachnid on Skylab 3. Although Passarello is well into research for this 20-essay collection, she is still finalizing her topics. It would be difficult, she says, *not* to include Cecil, the poached African lion who was shot last year by an American big-game hunter.

"A lot of the scientific reports coming back from Skylab were too much for general audiences to immediately absorb, but people could relate to that spider. Cecil has had such an international impact, and I think something about the fact that

we named him can be explored as a reason for that impact," she adds. "Animals are often a connecting point between a current event and a human response."

It's that need to investigate the curious corners of culture that seems to drive Passarello in her choice of subjects. In *Let Me Clear My Throat*, she takes readers on a trip through the voice as cultural icon. Her essays offer seminal moments — Marlon Brando's "Stella!" scream in *A Streetcar Named Desire*, a Judy Garland concert at New York's Carnegie Hall. One navigates *Tips on Popular Singing by Frank Sinatra*, a 1941 publication by the crooner and his coach John Quinlan.

"With both projects, I realized that the books were about something other than what I thought they were about when I started," Passarello says, as though her discoveries are their own rewards. "I began by simply picking a fixed aspect of human culture and obsessing over it for a few years. Each one also is a window into a topic I feel connected to: now, animals, and with my first book, performance."

Although she majored in writing and literature at the University of Pittsburgh, Passarello became absorbed in theater classes and, after graduating, worked as an actor for several years in Equity theaters and as voiceover talent. Later, she decided to return to graduate school and received her master's of fine arts from the University of Iowa's top-rated writing program.

It was during her years in the Hawkeye state that she developed her mastery of nonfiction, ironically in part, by taking a fiction-writing workshop. "Moving the chess pieces in a fictive world is not where my engine is," Passarello says. "For me, the way my imagination works, I need boundaries. I find the cage of reality and research to be more creative; the real world ignites my creativity."

She draws inspiration from the work of Michel de Montaigne, one of the most significant philosophers of the French Renaissance and the father of the modern essay. Montaigne was known for popularizing the form as a literary genre, melding anecdotes and autobiography with intellectual insight.

Pat Madden, an English professor at Brigham Young University, teaches creative nonfiction and became a fan of Passarello's after reading her essay, "Of Singing," in the *Iowa Review*. The piece also was listed as a notable essay in *The Best American Essays 2008*.

"It struck me as a piece that was of the Montaignean tradition," he says. "It wasn't purely narrative, and it wasn't just recounting an experience. It was thinking. Her work is intellectually rigorous and requires work on the part of the reader to make and follow the connections. But it also rewards the reader because she's done so much work herself in researching. It's kind of a joyous romp through curiosity."

Flip Charts and Sticky Notes

Research plays a key role in Passarello's process, which begins

Advice for Aspiring Writers

Elena Passarello says that she has never met an impressive writer who doesn't read more than she writes. Here are some of her tips for those who want to pursue the craft:

» Read. Read. Read. And not just for story. Take notes in the margins, dissect sentences and paragraphs, make maps of structure.

» Examine obsessions. The old adage is "write what you know," but Passarello thinks it's better to "write what you can't stop thinking about."

» Gather friends. Few people write in a vacuum. Fellow writers are needed to vent, help edit and inspire. Form a writing group or go to local readings and festivals.

» Don't think about publication. Writers must "make the art" before the world can read it.

» Get a cat. Having a cat curl up on a warm lap is a great way to focus, forcing writers to stay in their chairs and keep working.

with an idea that becomes a journey displayed on huge pieces of flip-chart paper on the wall above her desk. To stoke her thinking as she writes, each essay gets its own page of treatment, chock-full of handwritten notes with arrows from one point to the next, as well as assorted colored sticky notes scattered around the page.

"I spend a lot of time chewing on topics," Passarello says. "It's a very ruminative process. It starts with researching a topic for months. You go down so many false avenues and sort of get lost. You have to be very patient and trust that something — a connection, a format, a question — will jump out at you and teach you how to make the essay work."

The work proceeds from a draft through three to four edits before it's submitted to an editor for several more rounds of revisions. "There's a lot of picking at the scabs for a very long time," Passarello says of the laborious and sometimes painful step-by-step process.

So what's next for Passarello in addition to her teaching? She's leaning toward a diversion from essay collections. The idea of a "chapter book" on comedy — nonfiction, of course — intrigues her. As she speaks, her mind is already in enthusiastic motion, eyebrows arching, smile forming.

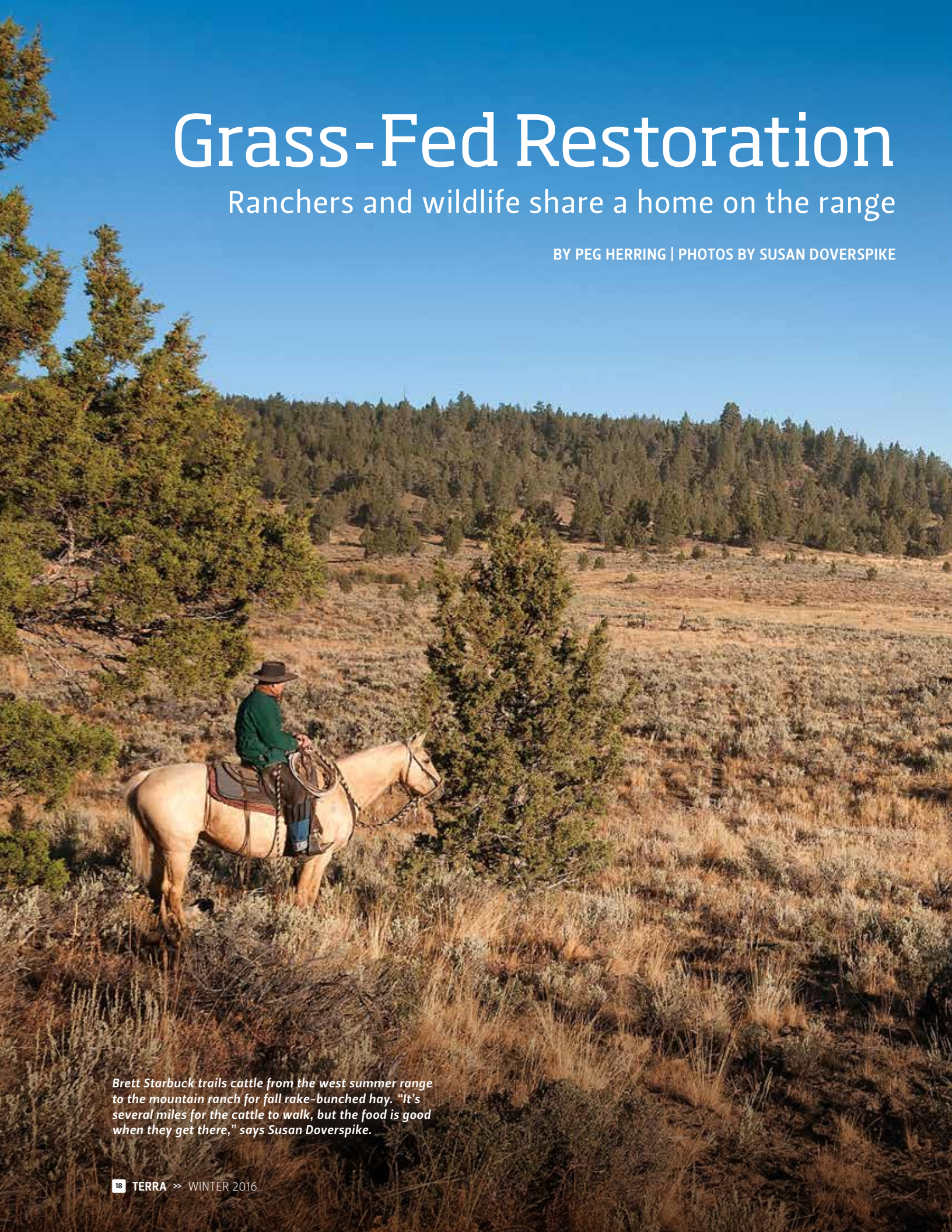
"How do you learn to be funny?" Passarello asks. "You know? For hundreds of years, there have been schools for clowns, and now there are circus clown colleges and improv comedy workshops. I'd like to see if comedy really can be taught by trying — and probably failing — to learn how to be funny myself." terra

Passarello maps extensive research on flip-chart paper, which includes sticky notes, drawings and other information that is key to her writing process.

Grass-Fed Restoration

Ranchers and wildlife share a home on the range

BY PEG HERRING | PHOTOS BY SUSAN DOVERSPIKE



Brett Starbuck trails cattle from the west summer range to the mountain ranch for fall rake-bunched hay. "It's several miles for the cattle to walk, but the food is good when they get there," says Susan Doverspike.

John O'Keeffe's pick-up truck bumps through a landscape of gnarled sagebrush and bunchgrasses near the Nevada border in southeastern Oregon. "This is good sage-grouse habitat," O'Keeffe tells me, gesturing across a broad horizon toward the Warner Mountains. He should know. O'Keeffe is a leader in sage-grouse conservation, helping to restore the bird's habitat of native grasses, sagebrush and wetlands across much of Eastern Oregon. And he's a rancher.

From the sagebrush upland, we descend toward a lush mountain meadow, emerald green from early summer rain. Ranching in Eastern Oregon is a sustainable industry, powered by photosynthesis, turning grass into food for people, O'Keeffe explains. As the incoming president of the Oregon Cattlemen's Association, he is working tirelessly to help ranchers develop ecosystem-based management plans that encourage healthy native landscapes for sage-grouse and livestock alike. "We're resetting the clock and restoring native habitats," he says. "Sage-grouse is just one of the species that benefit."

If you visit Eastern Oregon only to drive through it, you might not notice much beyond a vast sagebrush sea. But gradual shifts from bunchgrass to annual grass, and from sagebrush to juniper, have had a huge, negative impact on the people and wildlife who live here. This iconic western landscape that once covered 150 million acres has shrunk by half and faces threats from wildfire, invasive weeds, oil and gas development and subdivision.

For decades, ranching in the arid West was attacked by anti-grazing activists, who cited examples of trampled streams and overgrazed land. In 1986, writer Edward Abbey described the western range as "cowburnt." Many things have changed since then, including livestock grazing and the way people on both sides of the fence have learned to work together. The name-calling has been replaced by conversations about wildlife habitat, ecological health and quality of life. Increasingly, environmentalists are looking to ranchers to help save the sagebrush sea.

160-Acre Farms

Burns is an Old West town in the heart of Oregon's sagebrush-grassland ecosystem. Here, in a cluster of dust-colored buildings south of town, is the Eastern Oregon Agricultural Research Center, a collaborative laboratory shared by Oregon State University and the U.S. Department of Agriculture's Agricultural Research Service. Scientists and OSU Extension faculty provide research to guide restoration and management of the sagebrush grassland.

"It's a big region, and some of the most extensive research and most innovative collaborations are coming from right here, in Eastern Oregon," says David Bohnert, an OSU animal scientist and center director. The current focus of some of that research and collaboration is, of course, on the greater sage-grouse, a bird that is considered a key indicator of the health of the sagebrush ecosystem. But restoring the grassland goes far beyond protecting one species. "Conservation benefits a lot of other wildlife, like mule deer and pronghorn, brush rabbits and songbirds," Bohnert adds. "Our job is to understand the complexity of this ecosystem, and help people restore its function and structure."

Tony Svejcar is the center's research leader. Standing at his desk, surrounded by reports that go back to the center's beginnings in 1935, Svejcar recounts some of the history that has shaped the arid West. "Think about the original Homestead Act, signed by President Lincoln in 1862," Svejcar says. "It offered people 160 acres to encourage western settlement. But it was hard to survive on 160 acres in most of the arid West." As a result, low-lying sites near water were homesteaded and dryer uplands were left unclaimed, heavily grazed, and hotly contested. "More than a few Hollywood films featured 'range wars' from this little segment of history," Svejcar adds.

As conflicts flared, the federal government sent Major John Wesley Powell to evaluate the West and assess its suitability for farming. Powell reported in 1878 that a farm in this region should be at least 2,560 acres, with boundaries based on watersheds for access to scarce water. However, for the 98 percent of western land he deemed unsuitable for farming, Powell proposed conservation and low-density, open grazing.

The U.S. Congress ignored Powell's recommendations. "Most people in Washington, D.C., had no idea what this region was like," Svejcar says. "And many still don't."

Instead, Congress encouraged settlement of the West based on the theory that "rain follows the plow," that farming would result in increased precipitation. What actually resulted was 70 years of unrestricted grazing and severe damage to the land. Svejcar recounted how flooding in Utah caused whole hillsides to flow into towns because there was no intact vegetation left to hold the soil in place.

Eventually, the effects of overstocking, drought and the Depression brought about the Taylor Grazing Act in 1934. It required grazing permits issued only to ranchers who owned private property where livestock could be kept part of the year, to eliminate constant pressure on public land. The following year, the federal government established a study site west of Burns as a place to test strategies

for rangeland management. Today, Svejcar's research team still maintains the 16,000-acre Northern Great Basin Experimental Range and the fenced study plots that have excluded grazing since the 1930s.

Here, as it turns out, is a ready-made site to observe the effects of permanently removing cattle from the sagebrush grassland, as anti-grazing activists had advocated. The exclosure plots have been spared long periods of heavy grazing that elsewhere had left land battered, weedy and prone to fire.

In the 21st century, parts of the sagebrush grassland that had historically burned every 50 to 80 years now burn every 4 to 10 years. The experimental range allowed Svejcar's team to compare the effects of fire on grazed and ungrazed plots. The results have been surprising. Native perennial grasses that had dominated the ungrazed plots were killed by fire and did not reestablish, even now after 15 years. In their place, invasive weeds took hold. In contrast, plots that had been moderately grazed through the decades showed marked recovery of perennials following fire. Grazing had reduced the amount of dead material built up around the bunchgrass crowns, so fires burned less hot.

This research is important to Eastern Oregon residents who are facing much more frequent — and catastrophic — wildfires. Fast-growing weedy annuals, such as cheatgrass and medusahead, have overtaken perennial bunchgrasses, fueling bigger, hotter blazes. In the summer of 2012, three wildfires in southeast Oregon burned a million acres; as a result, 10 percent of the state's existing sage-grouse habitat went up in smoke.

At higher elevation sites, where medusahead and cheatgrass have yet to dominate, western juniper is advancing. Drive through southeast Oregon and you'll see slopes dotted with juniper woodlands where, 150 years ago, there had been only sagebrush. Invading juniper sucks up groundwater, desiccating native shrubs and grasses and ruining habitat for sage-grouse and other wildlife.

"My grandfather came to this land from Ireland in 1907," O'Keeffe tells me. "Through that time, we've watched juniper advance." Over the last few years, he's removed western juniper from 4,500 acres of his ranch, encouraging the return of native plant communities. "It's improved our ranching operation, better watershed function, better forage," O'Keeffe says. "The work coming out of the Burns lab is helping us understand how to manage the land for ecosystem function."

Fire, grazing and logging have all caused problems when they occurred in the wrong place at the wrong time and too intensely. But researchers and land managers are finding that, if used strategically, these disturbances can become tools to control weeds, prevent juniper invasion and limit the extent of wildfire. Good management can improve the ecosystem just like bad management can harm it. The trick is to know which is which.

Grazing with Spreadsheets

Jack Southworth's ranch is in a high mountain valley near Seneca, a place that holds the state record

The long drought creates dusty trail conditions for Oregon State graduate Jesse Svejcar, but the work is vital for rural communities. Beef cattle are Oregon's No. 1 agricultural commodity, bringing in more than $922 million in 2014.

Rodney Johnson trails cattle off their summer range to the mountain ranch. "The cattle are anxious to get there, and the ride is easy, so our very skilled buckaroos bring out their ropes to practice throwing loops," says Susan Doverspike. "They rig a breakaway honda (a loop knot), so they actually don't catch anything, but it gives their arms practice in placing their loops."

for lowest-ever winter temperature (minus 54 degrees Fahrenheit in 1933). In this region, where frost can occur in any season, Southworth has developed a grazing management plan of very short duration and very long recovery. From May to July, he moves his cows every two or three days to fresh pastures, where they won't return for months, possibly for more than a year.

In a spacious workshop at his ranch headquarters, Southworth diagrams the basis of his plan on a flipchart. "We want dense stands of healthy perennial grasses and shrubs, streams shaded with willows for fish and beaver, open forests with trees of various ages and cattle well-adapted to this environment."

He shows me a complex spreadsheet that tracks about 500 steers and heifers through a rotation of 50 pastures that he's subdivided into smaller paddocks of 40 to 60 acres each. "Rangeland planning is not shooting from the hip," he tells me. He calculates stocking rates based on the changing weight of the growing animals, the changing height of the growing grass, precipitation, temperature and other variables. Ranch hand Winnie Browning refers to the spreadsheet each time she moves the cattle, setting up a half-mile or more of electric fence to contain the herd for 72 hours. "Ideally, we won't graze here again for 13 months," Southworth says. That way, the grass has a full year to recover and will be grazed at a different point in its growth cycle.

Among the tenets of good ranch management, Southworth strives for sustainability of the land and the community. "We plan around what the grasses need, what the cattle need, and what Winnie needs," he says with a smile. "Sometimes our priority is for Winnie to go camping with her kids." And then he adds, "We've stopped thinking about how to do more with less, using machines. Now we're thinking about how to do more with more, with more people, more jobs, more support for families, to rebuild communities around ranching."

A big step toward rebuilding the community occurred in 1986 among a handful of Oregon ranchers. Beef prices were low, interest rates were high, profits were nonexistent, and the accusation of "cowburnt" echoed across the West. That year, 14 ranching families in Eastern Oregon got together to consider a new direction for the cattle business. They decided to leave the commodity market and create their own market focused on certified hormone-free beef and environmental sustainability requirements.

Their effort eventually grew into Country Natural Beef, a rancher-owned cooperative, now with over 120 ranching families across the western states. Jack and Teresa Southworth were among the founding members. Jack drafted the ecological stewardship guidelines used by the Food Alliance, a nonprofit organization, to certify each member ranch.

15 Acres Per Cow

Good land stewardship is the guiding principle for Susan and Mark Doverspike. I met them and their son Steven at one of their family ranches west of Burns. They represent the fourth and fifth generations of the Hotchkiss Company. "Susan's family, the Hotchkiss Company name, has always had a good reputation," says Mark. "We continually strive to improve the ranch and the range, to make the land better for the next generation."

Each generation is expected to add new ideas and value to the ranch. "We kick them out," Susan laughs, which means, Steven explains, that each generation is encouraged to leave the ranch, go off to college and work somewhere else before coming back to the ranch with new ideas and experience.

As we stand on a rise overlooking the ranch, we talk about what it takes to raise cattle on land with 11 inches of annual rainfall. Working high-desert lands means building ecosystem health from the ground up, soil and water first, then grass and forage, then livestock. For example, to keep cows out of sensitive riparian areas, the Doverspikes have installed solar pumps to move water into troughs and away from forest streams.

"It takes a lot of acres to run a ranch in this region, about 15 acres per cow per month," Susan says. "Our buckaroos are on the range every day, moving cows to avoid over-grazing." The buckaroos (from the Spanish, *vaqueros*) examine the cows for body condition and general health. And they examine the land for evidence of improvement or need for repair, as they move cattle through the season from lowland meadows to sagebrush grassland and forest pastures. The Doverspikes have a management strategy for each of these ecosystems on public lands.

All managers of public lands are required to draft management plans every 10 years, and that includes all ranchers who hold grazing permits. Perhaps those permits were easily renewed in the past, but not anymore. Today, ranchers must demonstrate that their management practices meet or exceed the ecological goals established for the public lands they graze. Just like plans drafted by the U.S. Forest Service or Bureau of Land Management, grazing allotment plans involve a team of rangeland resource specialists (botanists, archaeologists, wildlife biologists and so forth) who prepare a detailed environmental assessment, as required by the National Environmental Policy Act, to assess the impacts of livestock grazing on all of the other resources on the allotment. These reports are open to public comment and agency review before a final decision is made. Through this process, ranchers are expected

Last summer, when the J.C. Oliver ranch was burning during the Canyon Creek Complex fire, neighbors came together to help protect the livestock. "It's just what we do in our country!" says Susan Doverspike.

Invasive Grass

Invasive grasses such as cheat grass, *Bromus tectorum* (right), and medusa-head, *Taeniatherum caput-medusae*, increase fire severity and degrade the quality of forage on the range. (Cheat grass illustration by Cindy Roché and medusahead by Linda Vorobik and Hana Pazdirková, courtesy of the Utah State University Herbarium and the Oregon Flora Project)

"My great grandparents homesteaded this place," says Susan Doverspike. "The native-grass meadows are harvested into rake-bunch feed for excellent fall pasture for the cattle after they come off their summer range."

to function like land managers on the public lands they are permitted to use, working to improve the condition and providing evidence of beneficial impact.

"We take measurements of the grass before we enter a pasture and when we leave it," Susan Doverspike explains, kneeling in the grass to show me how to calculate height-weight ratios to measure plant biomass. "That's one of many ways we track plant productivity to keep these high-desert lands healthy."

And it's working. The Hotchkiss Company has received many stewardship awards, including the Forest Service Chief's Award for range management.

Room to Boom

Ranchers who graze federal lands must adhere to multiple expectations for public lands and address a huge list of variables, including the condition of existing plant communities, the timing and duration of grazing, the geography, even the weather. Dustin Johnson, an Oregon State University Extension range ecologist in Harney County, helps ranchers develop plans to enhance sage-grouse habitat and monitor the effect of their management actions.

Sage-grouse need a variety of habitats throughout the year, Johnson says. First, they need open areas where males perform their puffed-up, booming displays in early spring. In the nearby cover of bunchgrass and sagebrush, hens establish nest sites where they hunt protein-rich ants and beetles. Later in the summer, hens and chicks seek broad-leaf plants along low-lying streambeds and wet meadows, much of it on private land. As summer turns to fall, their diet switches almost exclusively to sagebrush leaves, which sustain the population throughout the long winter.

Because they use so many parts of the landscape, the greater sage-grouse is a barometer for assessing the health of the sagebrush ecosystem. In the 1800s, these birds numbered in the millions, but much of their habitat has been lost to subdivision, land conversion and oil-and-gas development. Their numbers sharply declined, prompting the U.S. Fish and Wildlife Service in 2010 to consider listing the sage-grouse as a

threatened or endangered species.

Leaders in Oregon's ranching community accepted the challenge to develop conservation plans using the best science available. They aimed to improve conditions for sage-grouse and potentially avoid the need for federal regulation. Agencies adapted incentive programs to encourage wildlife conservation through sustainable ranching. As a result, the Fish and Wildlife Service, in a decision announced in September 2015, withdrew the greater sage-grouse from the candidate species list, in part because "unprecedented conservation partnership across the Western United States has significantly reduced threats to the greater sage-grouse."

However, the decision clearly noted that the "greater sage-grouse will still require intensive, conservative management into the future ... and a concerted effort by all partners — public and private — to maintain and advance conservation measures, and control impacts to the bird and its habitat." And so, work continues at the Eastern Oregon Agricultural Research Center.

Back near his home in Adel, John O'Keeffe recounts the day last year when he hosted U.S. Department of Interior Secretary Sally Jewell on a tour of his conservation projects. She was impressed. Following the tour, she said, "What's been done in Oregon, and it's been done in a relatively short time frame, is something that provides a model other states can follow."

Ranchers like John O'Keeffe, Mark and Susan Doverspike and Jack Southworth are reversing decades of damage on public lands, part of a powerful collaboration to apply science toward healing the sagebrush sea.

"We're leaving this land in a lot better shape than we found it," O'Keeffe says. terra

Peg Herring is the director of communications for the College of Agricultural Sciences and editor of Oregon's Agricultural Progress *magazine at Oregon State University.*

Taking Stock of Restoration

Digital photos become a research tool

Grazing helps to shape ecosystems, but the effects depend on management and the environment. Stream bank or upland meadow? Willow or sagebrush?

Over much of the 20th century, cattle grazed in the Hart Mountain National Antelope Refuge in southeastern Oregon. In riparian areas where animals had congregated, channels were eroded and vegetation was sparse. Cattle were excluded from the refuge in 1991. Since then, scientists have documented increases in willows, aspen and other plants in those areas.

Using digital photography, Oregon State University researchers have now quantified the recovery. By comparing historical photos to modern images and categorizing land cover pixel by pixel (the minute dots that comprise an image), they calculated increases in vegetation and reductions in bare soil.

Researchers photographed this stream channel in the early 1990s (left) and again from the same location in 2013. (Photos courtesy of Bill Ripple)

Graduate student Jonathan Batchelor worked with William Ripple, a Distinguished Professor of Forestry, to compare 64 pairs of photos taken over 23 years. Only 6 percent of what was bare soil in the early 1990s remained in that condition when new photos were taken in 2013 and 2014.

Fourfold increases in willows and rushes were among the results they reported last year in the journal *Environmental Management*.

FORECAST FOR AFRICA

Weather stations serve schools, farmers and fishermen

BY NICK HOUTMAN

(Photo courtesy of Engineers Without Borders, Oregon State University)

In the summer of 2012, Zachary Dunn climbed onto the roof of a red-brick schoolhouse in Lela, a small village in southwestern Kenya. A crowd of children milled about on the ground, watching him attach a small weather station to the peak. It was the rainy season, overcast and cool enough for a long-sleeved shirt. Plots of maize, cassava and sweet potatoes near the school promised a good harvest.

Thinking it to be a teachable moment, the Oregon State University engineering student stopped what he was doing and looked at one of the kids below. "Do you know what this is?" he asked, holding the arm of one of the instruments. "Yeah," said the boy. "That's an anemometer."

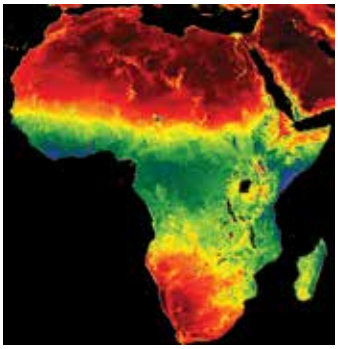
"I was blown away," Dunn said later. "I thought, 'Whoa, how did he know that?' He was about 10 years old. OK, I realized you need to check your assumptions at the door."

Dunn completed his work and paused to gaze at the surrounding landscape, a green-and-brown patchwork of farm fields, shrubs and trees. Lake Victoria (*Nam Lolwe*, to the local Luo people), the largest body of freshwater in the tropics, lay just over the horizon to the west. As a member of Oregon State's Engineers Without Borders chapter, the native of Albany had come to Lela to improve the community's access to clean drinking water. The students had helped the residents drill a new well and build a rainwater collection system.

The weather station was key to the project's success. Linked to the cellphone network and the Internet and designed by Decagon Devices, a company in Pullman, Washington, it would enable students to keep tabs on conditions in Lela — solar radiation, rain, wind, relative humidity and temperature. Additional sensors in a water storage tank would tell them how much water was being stored for later use. If a pipe became clogged or a valve sprang a leak, they could detect the problem and arrange a fix.

"It occurred to me that this was a way to make sure that these development projects are sustainable," says Dunn. "If you have these sensors that you can use to monitor a project, you can make sure it's still working years after it was installed."

Across the developing world,



Left, Africa's rain belt shows up as a green swath in this Meteosat-derived map of evapotranspiration. (Photo courtesy: EARS Earth Environment Monitoring Ltd, Delft, Netherlands). Right, Oregon State graduate Zachary Dunn, the East Africa field director for TAHMO, adjusts a weather station. (Photo courtesy of Zachary Dunn)

poorly maintained wells and water systems are a significant problem. It's estimated that up to a third of the wells installed in Africa to provide drinking water have failed for lack of maintenance.

For Dunn, the project in Lela was a modest beginning, but the experience planted a seed that has grown into his dream job. After receiving his bachelor's in engineering, he started a master's in public policy and returned to Kenya with financial support from a Boren Fellowship (created by former U.S. Senator David Boren of Oklahoma to bolster international relationships). However, before he settled into an apartment in Nairobi and dug into his thesis project, he signed on as the East Africa field director of a new nonprofit organization, the Trans-African HydroMeteorological Observatory (TAHMO).

Two professors, Oregon State hydrologist John Selker and Nick van de Giesen at the Delft University of Technology in the Netherlands, started TAHMO in 2010 with a grand vision: Transform Africa from being the world's most poorly monitored continent for weather to being the best. They plan to install 20,000 weather stations across sub-Saharan Africa in a network that will give a badly needed boost to farmers, fishermen, businesses and water management agencies.

The technology they are using — no moving parts, highly precise, connected to cellphone networks, powered by a solar cell half the size of a credit card — could lead to a sea change in monitoring the weather in other parts of the world. And to develop homegrown expertise, they are challenging and training college students in Nigeria, Kenya and other countries to come up with their own weather monitoring innovations. TAHMO researchers at Oregon State and Delft include experts from Africa (Senegal, Eritrea, Nigeria, Ghana and Kenya) as well as the United States and the Netherlands.

Sustainable Technology

For most people, knowing the weather is a matter of convenience. It helps us decide how to dress or whether or not to take an umbrella to work. However, in places with frequent storms (think Oklahoma and Kansas in the spring), it's a matter of life and death. On East Africa's Lake Victoria, which experiences thunderstorms more than 200 days per year, an estimated 5,000 fishermen drown or are killed by lightning strikes annually.

And while storms can destroy farm crops through flood, hail or high winds, the slow and inexorable strangle of a drought can deal just as deadly a blow. On a trip to Africa in 1985, Selker saw firsthand what that meant for farmers and herders in Kenya and Somalia. He had gone there with his wife, ceramacist Laurie Childers (they had

(Photo courtesy of the Climate and Development Knowledge Network)

met at Aprovecho, the sustainable technology education center near Cottage Grove), to make fuel-efficient biomass cooking stoves. Childers was also developing a construction manual for small ponds to capture runoff.

"In rain-fed agriculture, you need rain every week, but with a storage pond like this, you only need rainfall once a month," says Selker. The drought that year was severe, but farmers who had these small ponds were able to water their crops and feed their families.

It was an aha moment for Selker, who estimated that for about $1 billion, water storage ponds could be dug for every farmer across the Sahel, from Somalia to Mali. He returned to the United States to complete a master's and Ph.D. in hydrology at Cornell, where he met van de Giesen. But the lesson he learned in Africa stayed with him: The right technology could make a profound difference in peoples' lives.

Weight of Water

In 1991, Selker came to Oregon State as an assistant professor in the Department of Agricultural Engineering (now Biological and Ecological Engineering). Combining his bachelor's in physics (Reed College, 1981) with expertise in the flow and measurement of water, he devoted himself to research on groundwater, pollution (nitrate contamination) and water temperature. He worked on water quality issues in Oregon, collaborated with scientists in Chile and developed techniques for environmental sensing with fiberoptic cables in Switzerland. It wasn't until 2006 that he returned to Africa at the invitation of his graduate-school friend.

Van de Giesen was in Ghana looking at a new way to address a poorly measured part of the hydrologic cycle. What if, he wondered, we could determine the amount of rainfall intercepted by trees by precisely measuring how much their trunks are compressed by the weight of water? It is not just a matter of idle curiosity. Trees capture huge amounts of water, much of which evaporates back into the atmosphere, reducing how much filters into the ground, feeds rivers or becomes available for agricultural crops. An accurate picture of this process — known as "interception" — is critical to understanding water flows.

They were able to measure the compression of trees to within a micron, but testing the idea that trees could function as a type of water meter would require local weather information. "I asked Nick where we could get data on rainfall, humidity and temperature," Selker recalls. "He said, 'John, they don't exist here.'"

Although there are many weather stations on the continent, many areas are not monitored, and few stations outside of South Africa report data in a timely manner. "Many of them send data by mail at the end of the month," says van de Giesen, "and there are difficulties in sharing data from one country to another."

The more they talked, the clearer it became: They could fill a gaping hole in Africa's environmental knowledge by taking advantage of the ongoing revolution in electronic sensors and the rapid growth of cellphone networks. With a new generation of sensors, they could monitor the weather as it happens at a lower cost and with greater accuracy and reliability than is possible with conventional weather stations.

"It was kind of a pipe dream," Selker says, "but think of this: The sensor in a wristwatch that measures barometric pressure is more accurate than the best barometric sensor available 50 years ago for any amount of money. And it runs on a watch battery for 10 years for $2."

Accessible on Africa's ubiquitous cellphone network, real-time weather data could provide fishermen on Lake Victoria with timely warnings about storms. It could enable public safety officials to move people out of harm's way before a flood. It could enable crop insurance companies to make policies more accessible to farmers, thus setting the stage for badly needed increases in food production.

For help with weather monitoring technology, the hydrologists turned to Decagon Devices, the company that built the station installed by Zachary Dunn in Lela. Decagon specializes in electronic sensing of the environment. It calculates wind speed by sending an acoustic signal through the air and measures rainfall electrically as drops of water drain through a collection cup, one at a time.

It turned out that Decagon also had a plan for a new weather station network connected through cellphones, but the company hadn't identified a market. "So we got excited," Selker says, "and have been working with them for years, going step-by-step through the different sensors to validate them.

"But," he adds, "the technology is kind of the toys part. Anyone can buy a weather station. Anyone can put it up, but keeping it running is the trick. Sustainability is really the critical part. How do we pay for it, and how do we organize it to stay running? We need to sell the data to companies and share it freely with governments and researchers for the public good."

Building the TAHMO network across sub-Saharan Africa would take a business plan and a trusting relationship with every country in the region. "It was a real chicken-and-egg problem," says Selker. "If you don't have coverage in an area, you don't have anything to sell. Where could we get started?"

Learning to Speak Swahili

In Nairobi, Dunn was considering how TAHMO could work most effectively in Kenya. He remembered what he had learned during the water project in Lela and talked with his friend Paul Olang'o, the son of Lela's village elder who had also moved to the Kenyan capital.

"My time in Lela grounded my understanding of Kenya in this rural, agricultural experience," says Dunn. "Lela is an agrarian community. It taught me that this is what Kenya is. Nairobi is a modern city of three million people where the electricity is on 24/7 and Wi-Fi is faster than what I had at home in Oregon. But Nairobi is not like most of Kenya. Two-thirds of the people in Kenya depend on agriculture."

To have a broad reach, TAHMO would need to serve rural farming communities.

To deepen his understanding of the culture, Dunn started taking Swahili classes. Kenyan officials speak English fluently, but by learning their language, he also showed them respect. He sent a letter to the Kenya Meteorological Department and was invited to give a presentation about TAHMO. Over a period of about six months, he and Kenyan officials developed a memorandum that would enable weather-monitoring efforts to go forward with the government's approval.

The plan was relatively simple. Give weather data freely to the government and to researchers but sell it to businesses: crop insurance companies working with farmers, financial companies managing long-term investments, phone companies designing weather apps for their customers. Companies regularly buy weather data, which are critical for effective planning and development, says Dunn. (In the United States alone, the annual value of weather forecasts has been estimated at $30 billion.)

The agreement that TAHMO signed with Kenya in 2014 became the model for those signed in Malawi and Ghana. It has also inspired discussions with governments in Uganda, Nigeria and Rwanda. "We are going country by country. It's a painstaking effort," says Selker.

For van de Giesen, those relationships are fundamental to TAHMO's long-term success. "On the ground, it's African people who have to move this forward," he says. "It needs to

LOOKING FOR TROUBLE

When weather stations go bad

The reliability of a weather station is subject to the wanderings of wildlife. Frogs crawl into rainfall collection buckets. Insects build nests in air tubes. Rodents chew through wires. And that's on top of damage from dust, high winds, ice and hail — or simple equipment failure.

Maintaining weather station networks is a labor-intensive enterprise, says Tom Dietterich, professor in the Oregon State School of Electrical Engineering and Computer Science. With a $1 million grant from the National Science Foundation, Dietterich aims to automate part of the process by detecting bad data through software. "Our goal is to reduce the number of meteorologists you need to run a network," he says.

Dietterich and Ph.D. student Tadesse Zemicheal, a graduate of the Eritrea Institute of Technology, are testing computer algorithms — instructions that treat data like the ingredients in a recipe — to identify faulty stations in a network. Detecting damaged sensors would enable technicians to prioritize stations that are performing badly rather than visit them all on a predetermined schedule.

Zemicheal grew up in Asmara, Eritrea's capital. He came to Oregon State after searching for a program that applies artificial intelligence to sustainability.

Dietterich's team includes John Selker and Michael Piasecki, a specialist in informatics at the City College of New York. They are also collaborating with the Oklahoma Mesonet, which Dietterich calls "the world's best weather network."

be an African initiative. In Nigeria, we had a sensor design competition, specifically targeted at Africa. People were so appreciative saying 'Yes, we can make our own sensors.' They have been taking the initiative."

Growing Food

In the past year, TAHMO hired Gilbert Mwangi, a graduate student at Jomo Kenyatta University in Kenya who won the design competition in 2013. He has installed more than two dozen stations in Kenya, Uganda and Tanzania (mostly at schools; see sidebar), and others have been located in the Democratic Republic of the Congo, Nigeria, Ghana and other countries. TAHMO has received $1 million from the Global Resilience Partnership (sponsored by the Rockefeller Foundation, USAID and Sida, a Swedish development agency), to develop an early warning system around Lake Victoria in collaboration with Earth Networks, an environmental monitoring company.

Since weather data provide the basis for crop insurance, TAHMO is working with ACRE Africa (Agriculture and Climate Risk Enterprise Ltd.) to manage and expand its weather station network in Kenya and Rwanda.

At the top of Selker's and van de Giesen's agenda is the need to feed a growing global population. "When we're done, monitoring the African climate will be an order of magnitude better than any other place in the world," says Selker. "That's our goal. There's no other place in the world that has consistent instrumentation like this. There's no other place that has uniform and dense spacing.

"Africa is going to be the most important continent for food production," he adds. "That's where the big potential is. One-third of the continent is primed to grow whatever crop you'd like to. This is a resource unequaled in the world. This will make Africa a leader in the coming century." terra

(Photo courtesy of Engineers Without Borders, Oregon State University)

SCHOOL TO SCHOOL

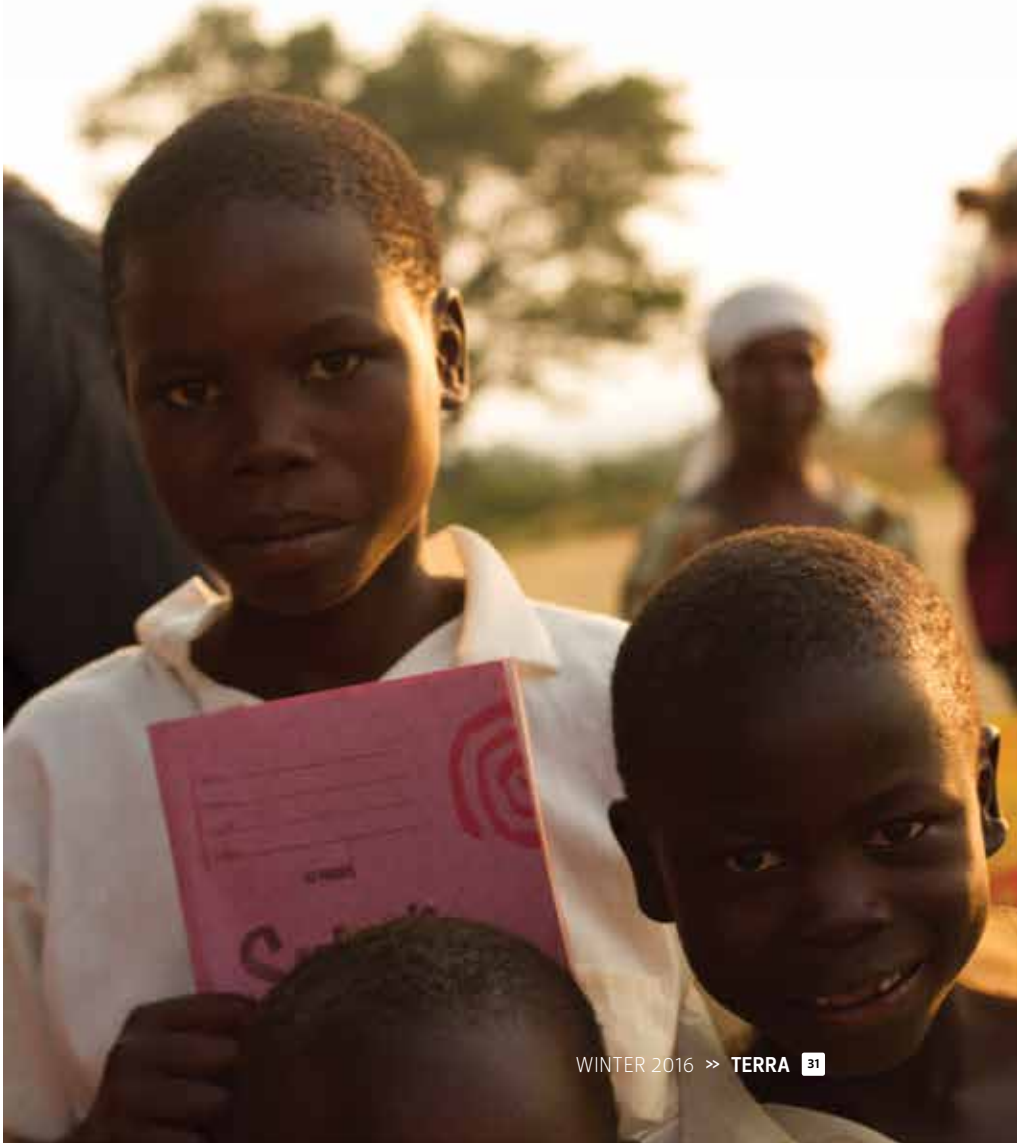
How's the weather in your country?

In the western Kenya city of Kisumo last spring, Leah Tai expected to meet with a few teachers from only three schools. The Oregon State graduate student in Water Resources Engineering was serving as a school program coordinator for TAHMO.

In short order, she found herself at a workshop having lunch with 60 teachers. "They were from all around the region, telling me about their science programs," says Tai. "They were excited to have someone from an international group present." One school had built ponds so the students could learn how to raise and harvest fish. They literally turned their lessons into lunch.

Schools in Kenya have become crucial partners with TAHMO by installing weather stations and collaborating with sister schools in Europe and the United States. In Corvallis, Adams Elementary School installed a Decagon weather station last September and has just started communicating with the St. Scholastica Primary School north of Nairobi.

In Idaho, Pam Aishlin, a geologist at Boise State University, has linked four local schools with TAHMO partners. "This kind of sharing about climate brings the students an understanding of what daily and seasonal life is like for their peers," she says. "Teachers and students are looking forward to using data from their joint school weather stations in math, science and computer courses."



Familiar Faces

For those with disabilities, a positive identity starts with community

BY NICK HOUTMAN

In the midst of a conversation about disability science, student research projects and her own scholarly endeavors, Kathleen Bogart pauses. How will the world be different if she succeeds in her work, the interviewer asks. What will change?

A social psychologist at Oregon State University who studies the stigma of being viewed as "disabled," as less than whole, Bogart hopes to see more scientists tend to this neglected aspect of her field. But when she turns to the emotional benefits of developing a positive identity as a complete human being, her voice rises.

"Disability isn't seen as a social identity with the same validity as other conditions like race or gender. But it is. It's a really important identity," she says. "People with positive identity have pride in their community and disability. They are less likely to have anxiety and depression. They tend to have higher satisfaction with life."

These observations stem from Bogart's research and guide her current thinking. She and her colleagues in the United States and Denmark have worked for the past decade to understand how people viewed as being disabled respond to the social stigma that often accompanies their appearance or behavior. And they have developed methods for educating people who don't face that challenge — the feeling of isolation or rejection — but may unwittingly foster it in others.

Although humans are well-equipped to communicate through a variety of channels (voice, gesture, words, expression), being presented with an unusual situation can be uncomfortable, Bogart says. "If a person with facial paralysis walks into a room, people can tell that something is different, but they can't quite figure out what it is," she explains.

So they may fall back on assumptions. For example, people may think that someone with a disability isn't intelligent or that she's unfriendly. Educating the public about rare conditions helps to change such reactions, Bogart has found in her research, and to generate more positive interactions.

"There are realities in the ways our bodies work, but society has the power to create a disability or not. When you say the problem of disability is in an individual's body, and when the people who diagnose that problem are medical professionals, then the problem is specific to one person and can only be fixed by experts. It belies the long-term problem that disability is also socially constructed," Bogart explains.

There Must be a Textbook

Bogart's commitment to her research stems from an experience she had as an undergraduate at Louisiana State University, not far from her childhood home in Baton Rouge. She was preparing to do a paper for a psychology class, one that focused on an aspect of her own life. She was born with facial paralysis, a condition that, in her case, stemmed from Moebius Syndrome. As a student, she assumed naively that people had studied the psychology of people with Moebius, that there would be textbooks on the socialization, identify formation and other features of people with this condition.

Although facial paralysis from all causes (head injury, stroke, Parkinson's disease, Bell's palsy) affects about 130,000 Americans annually, she discovered a grand total of two papers on the topic.

"I realized this was something I could do, that I was motivated to do," she says. It was a life-changing moment. The young woman who had been majoring in both psychology and English, who had worked as an intern at *The Southern Review*, a top literary journal, talked with her professors and chose the less traveled path. She dedicated herself to delving into "ableism," discrimination against people on the basis of their physical abilities.

In her graduate programs at San Francisco State and Tufts University, Bogart found mentors who helped her navigate through the impact of facial expression on communications. She studied the many ways in which people with disabilities compensate to make themselves understood, to share their thoughts and feelings, to make social connections. She encountered a professor who championed disability rights and the development of a positive group identity for people with disabilities.

As an assistant professor in the School of Psychological Science at Oregon State, Bogart directs the Disability and Social Interaction Lab. With funding from the National Institutes of Health, she and her students have looked at how people with facial paralysis compensate for their inability to communicate through raised eyebrows, a narrowing of the eyes or a smile. They have found — by making videos of people with facial paralysis talking about their lives — that providing information to people without facial paralysis can lead to more positive perceptions of people who have the condition.

Power in Identity

In one of the first quantitative studies of disability identity, Bogart and her students focused on people with multiple sclerosis. Having a positive identity as a member of a group with the disease, the researchers found, tends to reduce depression and anxiety.

The power of developing that feeling of community came home to Bogart in a study that she conducted with Amanda Hemmesch, a colleague at St. Cloud University in Minnesota. The researchers surveyed attendees at a conference for people with Moebius Syndrome.

"In general, people are in contact with others on the Internet, but they don't often have a chance to meet others face-to-face except for that conference," says Bogart.

There was a "clear feeling of pride in being surrounded by other people who look like me for the first time in my life. They experienced a significant reduction in stigma and an increase in social comfort. That was a really powerful experience for them. It was transformative." terra

Kathleen Bogart, left, leads the Disability and Social Interaction Lab at Oregon State. Among her students are Nicholas Davis, far right, and Mariah Estill. (Photo: Karl Maasdam)

Prehistoric Sampling and Futuristic Forecasting

Climate researchers dig into the past and model the future

For two weeks last fall, the whole world convened in Paris to tackle the looming dangers of a warming planet. President Obama, Secretary of State John Kerry and Microsoft mogul Bill Gates were among the luminaries who took the stage at the 21st annual UN Framework Convention on Climate Change. The conference mission: to drive home the urgency of sustained climate action, codified in a worldwide agreement.

On December 12, 195 nations signed an historic pact, pledging to limit global temperature increases while mitigating climate impacts already in the pipeline. Meanwhile, scientists at Oregon State University continue to contribute important climate-change findings to the global discussion, derived from sources as diverse as ocean-floor sediments and advanced computer models. Here's a look at several significant new studies from Oregon State.

Willamette Basin Outlook

Less snowpack, more wildfire, but ample water expected down the road

As the century unfolds and greenhouse gases trap more and more solar heat in the Willamette River's vast drainage, native fish like salmon and steelhead will lose access to the cold waters they need to survive. Timbered mountains that feed the watershed will succumb more and more often to wildfire. Moisture will fall mostly as rain, leaving many high peaks bereft of snowpack, historically one of the Pacific Northwest's water-holding mainstays.

The outlook, however, is not as dire as these recent findings suggest — at least for the next 85 years. That's because Oregon's largest river basin boasts a robust system of massive dams, including Fern Ridge on the Long Tom River and Detroit on the North Santiam River, to harness and hold millions of gallons of water in deep reservoirs that can be tapped in dry times. By century's end, when other U.S. regions likely will face critical shortages, the Willamette River basin is expected to have sufficient water to fill the needs of farms, industries, cities and households, even as human habitation soars.

These are the conclusions of a multiyear study funded by the National Science Foundation and led by Oregon State University in partnership with several other universities. "The dams built above the Willamette Valley were engineered to reduce the risk of floods, but they also do a valuable job in storing water for use during summer," notes OSU environmental scientist Anne Nolin, lead investigator for the five-year, $4.3 million Willamette Water 2100 Project.

More Empty Stomachs

Lower yields and higher prices could threaten food security

Global crop yields could drop as much as 15 percent if fossil fuel emissions remain high over the next few decades. Prices would spike in response, hitting pocketbooks with increases as high as 30 percent. So concludes an international team of experts — among them John Antle, an agricultural economist at OSU — who presented its analysis at the 2015 Paris climate talks.

"Agriculture has adapted to various shifts in climate over time, but the concern now is how rapidly things are changing," says Antle, the study's co-leader. "We have a growing global population and increasing pressure on water, soil and other resources. Even without climate change, feeding the world would likely get harder."

The team noted, however, that forward-looking technological, economic and policy decisions could greatly mitigate the destabilizing effects of climate.

Warm-Water "Blob"

Ancient evidence shows "eerie resemblance" to today's low-oxygen zones

In the late '50s, people knew *The Blob* as a low-budget, sci-fi horror movie. In today's science lingo, "The Blob" refers to something much less fanciful but potentially just as scary as the gelatinous alien life form from the Hollywood classic.

Today's Blob, a massive swath of warm water recently discovered along the North Pacific coast, worries scientists because sustained warming in the ocean can lead to "hypoxia" — low-oxygen "dead zones" that disrupt marine food webs by killing the plankton upon which other marine life depends.

Now, scientists at Oregon State have uncovered evidence that similar dead zones arose abruptly thousands of years ago during periods of rapid warming. After analyzing the chemical and organic fingerprints in layers of prehistoric, deep-sea sediments, Ph.D. student Summer Praetorius reports that current conditions are "eerily reminiscent of past conditions that gave way to extended periods of hypoxia."

Earth's ancient oceans responded rapidly to global warming, says oceanographer Alan Mix. "Many people have assumed that climate change impacts will be gradual and predictable," Mix says, "but this study shows that the ecological consequences of climate change can be massive and can occur pretty fast, with little warning."

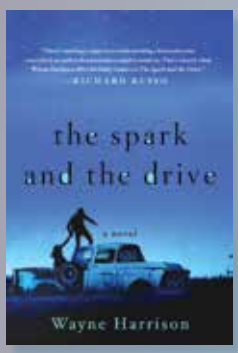
Book Notes

Recent publications by Oregon State faculty

The Last Love Song

Tracy Daugherty

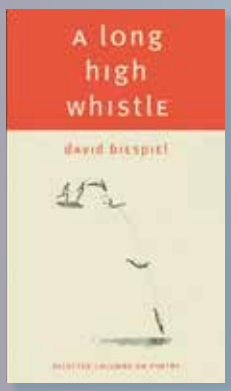
This work by professor emeritus Tracy Daugherty is the first printed biography of American writer Joan Didion. The narrative traces her life from her youth in Sacramento to her marriage and partnership with her late husband, writer John Gregory Dunne, and beyond.



The Spark and the Drive

By Wayne Harrison

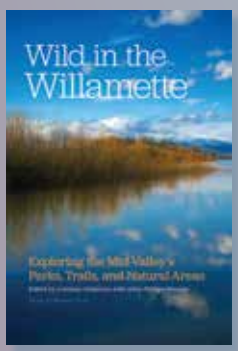
This debut novel by Wayne Harrison, a writing instructor, is a haunting story that illuminates the blue-collar with keen and tender-hearted prose. Sections of the novel have appeared in *The Atlantic* and *Best American Short Stories 2010*.



A Long High Whistle

David Biespiel

This collection of essays by English and creative writing instructor David Biespiel discusses the work of nearly 100 poets, past and present. With passion, wit and common sense, he articulates the mysteries of poetry and poetry's essential role in our civic and cultural lives.



Wild in the Willamette

Edited by Lorraine Anderson and Abby Phillips Metzger

Inspired by late professor Gail Achterman and co-edited by OSU writer Abby Metzger, this outdoor guide to the mid-Willamette Valley is infused with essays by notable local authors as it connects readers with the best hiking, biking and paddling the mid-valley offers.

New Muscular Dystrophy Drug

Advance in personalized medicine

A drug developed in Corvallis and Perth, Australia, to treat a genetic disorder may also represent a promising advance in personalized medicine. Eteplirsen targets Duchenne muscular dystrophy, which leads to muscle degeneration and weakness. The pharmaceutical emerged from research by Patrick Iversen at Oregon State and is now being developed by Sarepta Therapeutics.

Duchenne arises from genetic mutations that stop muscles from making a crucial protein, dystrophin. Symptoms become apparent between the ages of 3 and 5, nearly always in boys. "This is a devastating disease," says Iversen. "Few people with Duchenne live past their 20s."

Eteplirsen works by changing the expression of the mutated gene, enabling muscles to make dystrophin. This approach, adds Iversen, a research professor in the Department of Environmental and Molecular Toxicology, could lead to treatments for many other rare genetic diseases.

As of December 2015, Eteplirsen was under review by the U.S. Food and Drug Administration.

Fat and Bones

Gene therapy shows promise for saving bone during weight loss

"Yo-yo" dieting isn't just a problem for your clothing budget as you try to keep up with your fluctuating jean size. It's also bad for your bones.

As unwanted pounds melt away, a dieter's skeleton typically loses mass and strength. When the pounds come back, the lost bone doesn't. That conundrum is the focus of research at Oregon State University. "We're trying to determine if there's a way to lose excessive weight while preserving bone density," says Urszula Iwaniec, a bone-health specialist in the College of Public Health and Human Sciences.

A hormone that regulates hunger in the brain may hold the key, new research suggests. Rats that received injections of leptin directly to their brains lost as much as 20 percent of their bodyweight without losing bone, Iwaniec and her colleagues found. Plus, the lost weight — much of it abdominal poundage — stayed off.

"Using leptin at the level of the hypothalamus to control weight is where, at some point, we believe we're going to be able to control weight gain," says Iwaniec, while cautioning that a lot more study is needed before the therapy becomes a treatment for humans.

Capsules of Chemicals

Insecticides show more toxicity inside tiny pellets

Packaging certain insecticides inside tiny plastic pellets may amplify their toxicity in the environment, a new study suggests. The same chemical used naked — suspended only in water — was significantly less toxic than its capsulated counterpart, researcher Stacy Harper reported recently in the journal *Environment International*.

The chemical in question (a "pyrethroid" whose active ingredient is called "lambda-cyhalothrin") is widely used by farmers to rid their crops of pests such as aphids, Colorado beetles and butterfly larvae. Sold under labels like Demand, Karate and Warrior, these insecticides often come to the marketplace encased in microscopic or nano-sized capsules, says Harper, an environmental toxicologist at Oregon State University. Encapsulation is thought to improve the product's dispersal and durability, she explains.

For her study, she wanted to know whether capsule size matters in the level of risk to animal and human health. The answer turned out to be no, at least for this study. When she exposed the embryos of zebrafish to the chemical in a range of dosages, she found that capsules of all sizes were equally toxic to the embryos, causing tremors, paralysis, malformations (brain, eyes, fins and other organs) and death.

The big surprise was that the chemical alone, minus the capsules, was far less toxic to the developing fish.

Going forward, Harper says, zeroing in on the toxic impacts of using capsules and other "carriers" for chemicals will be critical to making sure current environmental protections are adequate.

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.

Driving on Natural Gas

New technology can fill up in 15 minutes

A recent graduate of the Oregon State University Advantage Accelerator/RAIN Corvallis continues to drive its business forward — including all the way to the White House.

Bend-based Onboard Dynamics, which is commercializing research by OSU-Cascades energy systems engineering professor Chris Hagen, was one of the 32 startup businesses nationwide invited to the first-ever White House Demo Day last summer. CEO Rita Hansen and vice president and co-founder Jeff Witwer pitched their company to President Barack Obama, investors, entrepreneurs and foundations.

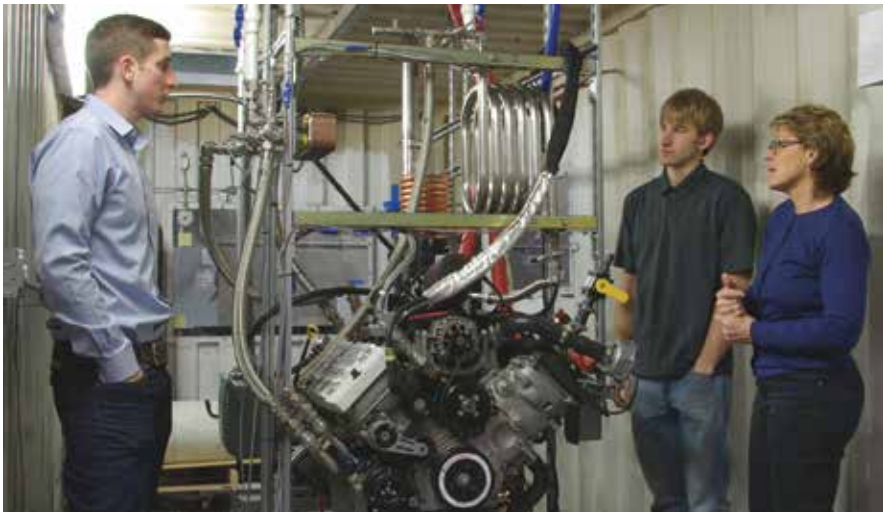
Presenting at the White House gives Onboard Dynamics "a tremendous amount of leverage" for commercializing its technology to use a vehicle's own engine to compress natural gas, says Hansen. The company is aggressively assembling a network of industrial partners to help bring its products to market, including natural-gas utilities, truck engine manufacturers and firms developing natural-gas refueling systems.

Onboard Dynamics sees fleet operators as the most promising first customers and is partnering with the Deschutes County Road Department to test a Ford F-250 truck equipped with a compressed-natural-gas (CNG) engine. The company expects its first commercial products to be available in mid-2016.

The Advantage Accelerator/RAIN Corvallis has been instrumental in moving Onboard Dynamics from concept to commercialization. The company has received financial support from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E), the Oregon Nanoscience and Microtechnologies Institute (ONAMI), Oregon BEST and Oregon State University's Venture Development Fund, as well as from strategic partners and private investors.

Hagen's research addresses the major challenge for fueling vehicles with compressed natural gas: lack of infrastructure. There are only 800 public CNG stations nationwide, compared to more than 160,000 gasoline stations. So Hagen has developed technology that uses automotive engines to compress natural gas from an existing low-pressure gas line. The technology can be deployed either as a mobile refueling system or integrated into a vehicle's own engine.

Since Onboard Dynamics was founded in 2013, the company and its technology have evolved. Hagen's initial design used one cylinder of a six-cylinder engine for compression. For further development, Onboard Dynamics chose Ford's 6.2-liter "Boss" V-8 engine, employing as much of the existing engine as possible. During fill mode, four of the cylinders fire, driving four cylinders that compress fuel rather than burn it. The dual-mode engine can refuel itself in about 15 minutes.



Onboard Dynamics CEO Rita Hansen, far right, discusses efforts to commercialize a new natural-gas engine with engineers and Oregon State alumni Robert Elgin III, left, and Shaun Mayea. (Photo: Carla Perez)

To discover what the **Oregon State University Advantage** and the **Advantage Accelerator program** can do for your business, contact Brian Wall, assistant vice president for research, commercialization and industry partnering, 541-737-9058, brian.wall@oregonstate.edu. **oregonstate.edu/advantage**

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*Considered for listing under the Endangered Species Act, the greater sage-grouse (*Centrocercus urophasianus*) has been a focus for rangeland management by ranchers, scientists and government agencies. See "Grass-Fed Restoration," Page 18. (Photo: Jeannie Stafford/USFWS)*