

tterra



A world of research & creativity at Oregon State University • Spring 2007

Guardians of the Groves

Top Predators Hold the Key to Biodiversity

Stories That Heal | Nature's Glue | The Zinc Link | Forged in Fire

Plowing New Ground

Start over.

Plow new ground. Turn over a new leaf. Spring is a time for renewal, for moving ahead. It's a powerful time, conveying hope and optimism. Salmon return to spawn, birds fly north to nest and people plant crops with an eye on the weather.

These and other signs can feel bittersweet. Fewer salmon are returning, a result of development on land and possible changes at sea. Changing wind patterns are associated with the seasonal appearance of low-oxygen water along the coast, creating a "dead zone." Oregon's diverse and productive agricultural sectors face both opportunity and risk as potential sources of new fuels and products to replace foreign oil.

Nevertheless, a sense of optimism and renewal underlies OSU research. How else to explain students who come here to study these and other problems that beg for solutions? In this issue of *Terra*, read about Patrick Luke who, after serving in the U.S. Marine Corps and working on commercial fishing boats, has come to Corvallis to study fisheries management. His goal: to help repair the weakening bond between people and fish.

Science can create the basis for solutions that enable us to renew communities and economies. In the College of Veterinary Medicine, Luiz Bermudez and his team are discovering details about Johne's disease, which is incurable and is blamed for about \$1.5 billion in annual losses to the U.S. dairy industry. Their work is already yielding new ideas for reducing that cost.

Research on potential bioproducts and biofuels thrives on the hope that solutions can be found to our dependence on oil and other fossil energy sources. Algae-generated electricity, new ethanol-based technologies, extruded wood-plastic composites and dandelion-based latex are some of the ideas that are under scrutiny at OSU.

Our cover story suggests that, ironically, renewal sometimes comes from an "ecology of fear." By controlling populations of deer, elk and other browsers, wolves and cougars enable streamside ecosystems to thrive. We may have these top predators to thank for some of our spring riches.



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For deer and elk, lingering too long by a stream or in a meadow can be risky when wolves and cougars are on the prowl. That's good news for a diverse ecosystem, from seedlings to butterflies.

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The bacteria that cause Johne's disease kill cattle. Their relatives kill people. Researchers in OSU's College of Veterinary Medicine are learning how these microorganisms go about their dirty work.



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Listen to Bill Ripple describe the "ecology of fear" from a meadow in Yellowstone National Park and see photos of his research activities.

Read an OSU Ph.D. student's description of what it's like to work in the lab of one of the world's most often-cited scientists.

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OSU is Oregon's largest public research university with \$193 million in research expenditures in FY2006. 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 natural resources, earth dynamics and sustainability, life sciences, entrepreneurship and the arts and sciences.

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Cover illustration by Ellen Weinstein





Large carnivores promote
healthy ecosystems
by keeping browsers
on edge

by Lee Sherman





The millions of visitors crowding Utah's magnificent Zion Canyon in recent decades have caused cougars to retreat, leaving mule deer free to browse with little fear. (Photo: Bob Beschta)

In a remote corner of Zion National Park, a small herd of mule deer browse quietly. Through the sun-dappled canyon burbles North Creek, its waters cool and clear, its banks green and reedy, alive with frogs, butterflies and birdsong. But this pastoral scene in southern Utah has a dark subtext, subtle yet unmistakable in the taut posture of the animals. Their heads come up often, their eyes scan the landscape, their long ears swivel this way and that, alert for the snap of a twig, the crouch of a tawny haunch.

Cougars are on the prowl.

In this “landscape of fear,” the highly vigilant deer move across the terrain quickly. Linger too long beside rivers and creeks, far from escape routes, is risky. So in a predator-rife ecosystem like North Creek, sparse numbers of deer browse less intensively, leaving more uneaten vegetation behind. OSU researchers William Ripple and Robert Beschta call this behavior “risk-sensitive foraging.” The result — low disturbance to soils and organisms in fragile riparian zones — is a huge boon for the ecosystem, the scientists say.

“In our research, we’re seeing a significant behavioral shift among deer and elk resulting from this fear of being preyed upon by large carnivores,” explains Ripple, a professor of forest resources in OSU’s College of Forestry. “We think this vigilant behavior, in which ungulates are constantly alert and moving, may be having a large, positive effect on ecosystems.”

As evidence, he points to a second canyon just over the ridge, where cougar are rare. The teeming biodiversity of North Creek forms a stark contrast to Zion Canyon, which is close to the roads, parking lots and other amenities that draw tourists, repel cougars and attract deer. Ripple noticed the startling difference one day when he



was standing along the shady streambed with a clipboard, recording data as Beschta called out measurements. He was casually observing the many colorful butterflies — the swallowtails and monarchs, the satyrs, sulphurs and spread-wing skippers — fluttering above gaudy bursts of wildflowers. The life forms around him were rich and abundant. “I was practically stepping on frogs and toads, they were so thick,” Ripple recalls. But nearby Zion Canyon, the comparison site for the study, had a relative paucity of species.

At that moment, the professors decided to broaden the focus of their study from trees and streams to species abundance and biodiversity. What they found in Zion Canyon were stream banks badly eroded and largely bereft of such “indicator” species as cattails, scouring rushes, Welsh asters and cardinal flowers. At North Creek they found canyon tree frogs and red spotted toads to be 100 times more common, lizards three times more common, and butterflies five times more common than in Zion Canyon. Even populations of native fish, such as the speckled dace and the virgin spinedace, appeared to be higher in the cougar-friendly ecosystem.

Lords of the Rings

However, it was Zion Canyon’s missing trees — the cottonwoods that typically grow thick along healthy river systems — that reaffirmed for the two OSU researchers what they have been seeing in other areas of the West: the pivotal role of cougars and other big predators, particularly wolves, in maintaining ecosystems.



“A deep chesty bawl echoes from rimrock to rimrock, rolls down the mountain, and fades into the far blackness of the night....Only the mountain has lived long enough to listen objectively to the howl of a wolf.”

— Aldo Leopold, *A Sand County Almanac*, 1949

The two forestry professors, independently, had long been interested in riparian tree species — cottonwoods, aspen, willow — which are diminishing in Western landscapes. In 1996, Ripple heard a presentation by fellow forestry professor Beschta about the malfunctioning ecosystem in Yellowstone National Park, as evidenced by stressed tree populations. “At that time, I was interested in aspen — not predators, not wolves, just aspen,” Ripple recalls. “Bob talked about aspen trees in Yellowstone becoming decadent, disappearing, dying out. And young ones were not growing to replace the old ones as they died. Entire groves of aspen had disappeared in recent decades.”

The mystery of the dying aspen captured him. So, with his then-Ph.D. student Eric Larsen (now a professor at the University of Wisconsin), he headed to Yellowstone. While he was there, he had an epiphany of sorts — not in the field, but in the visitor center. Hanging high on the wall was a large poster, a magnificent photo of a yellow-eyed wolf standing in a thick grove of healthy aspen. “The wolf’s stance made him look like the guardian of the aspen,” Ripple reports. “I suddenly thought, ‘Hey, wolves protect aspen.’”

What he and Larsen found confirmed his hunch — a hypothesis first advanced by the father of wildlife conservation, Aldo Leopold, more than a half-century before: that large carnivores are critical to maintaining healthy ecosystems at every trophic level — that is, every link on the food chain. “We found that aspen tree regeneration has diminished since the 1930s, beginning soon after all the wolves were killed off,” he says.

In the recent Zion study, the latest in nearly 10 years of cumulative research supporting their hypothesis, Ripple and Beschta turned up still more evidence. After measuring trunk diameters, taking core samples and counting rings, they found an astounding cottonwood age gap between the two canyons. The number of cottonwoods taking root and growing to maturity after 1940 was 38 times higher in

North Creek than in Zion Canyon — 892 trees per kilometer compared with 23 trees per kilometer — as reported in the journal *Biological Conservation* in December 2006.

What happened in 1940 that caused cottonwoods to crash in Zion Canyon? According to the scientists, the precursors to the collapse occurred a couple of decades earlier, causing a chain reaction all the way down the biotic pyramid. This “trophic cascade” — a top-down domino effect in which carnivores affect herbivores, and herbivores affect

plant biomass — hinged on the disappearance of the big cats, which were driven to more remote reaches of the park when tourists, drawn by Zion’s sculpted cliffs and canyons, began coming by the busload. Established in 1918, the park saw visitor numbers quickly balloon. In the 10 years between 1924 and 1934, yearly visits grew eight-fold, from 8,400 to 68,800. (In 2006, more than 2.5 million people visited the park.)

As crowds became bigger, cougars — notoriously shy, elusive animals — became noticeably scarcer. As early as 1938, park naturalist C.C. Presnall warned of the impending imbalance. He wrote, “Human use of the park was, and no doubt always will be, concentrated in Zion Canyon, causing profound changes in the delicate balance between deer and their natural predators.”

Unafraid, the deer in Zion Canyon browsed at their leisure. Young cottonwoods, a mule-deer delicacy,

were largely devoured, leaving few seedlings to sustain the groves of gnarled giants, whose leaves quake playfully in the wind, whose branches shelter birds and shade streams, and whose roots anchor soils.

The Packs Are Back

The Zion study, funded by the National Park Service, replicates the mounting body of findings by Ripple and Beschta, now an emeritus professor who has retired from the classroom but not from the field. In study after study, region after region, landscape after landscape, they have



Willows along Slough Creek in northern Yellowstone Park grew from about knee-high in 1995 — the year wolves were reintroduced to the ecosystem — to “well over my head” by 2003, reports OSU forestry professor William Ripple, who attributes the new lushness in part to elk herds’ more cautious browsing. (Photo courtesy of William Ripple)



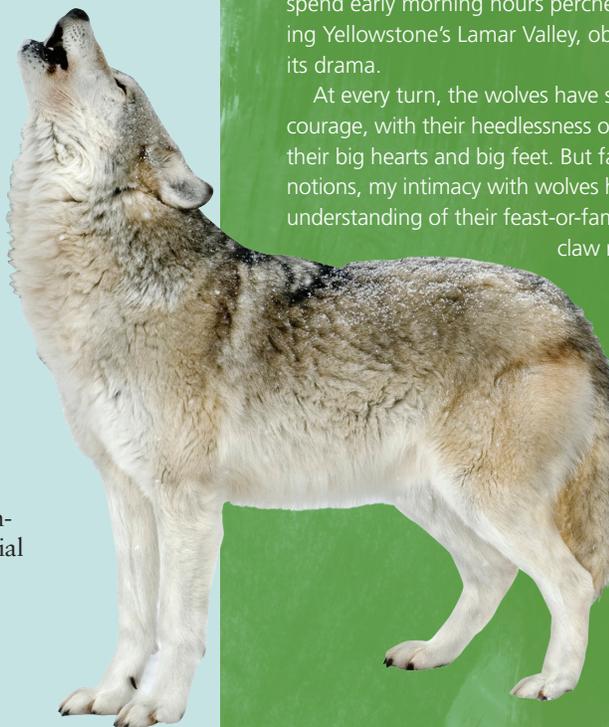
(Photo: Ottmar Bierwagen, Spectrum Photofile Inc., photographersdirect.com)

found the same ecological benefits from “apex predators” — the big carnivores at the peak of the ecological pyramid. The layered sandstone, limestone and shale of the desert southwest, the craggy timberlands of the Rockies, the vast openness of the Great Plains all share that common ecological mechanism — the trophic cascade. “The signature we’ve been seeing on all these sites,” says Beschta, “is the removal of the top carnivore, causing systems to decline.”

This ecosystem unraveling happens not only because the actual killing declines, but also because the *fear of being killed* diminishes. Fearful foraging, quite simply, spares plants, which provide food, habitat and soil stability for the myriad organisms at the base of the biotic pyramid. In the 1990s, ecologist Joel Brown coined the term “ecology of fear” to describe the phenomenon. These kinds of top-down species interactions have been reported by scientists in diverse ecosystems from the Bering Sea to the tropics.

Yet another recent OSU study points again to that same signature. In South Dakota’s Wind Cave National Park, the scientists discovered that new cottonwoods and bur oaks virtually stopped taking hold in the late 1800s and early 1900s, when wolves, grizzlies and other big meat-eaters were wiped out. “So to the question, Do wolves have a role in maintaining ecosystem integrity?,” Beschta remarks, “the answer is ‘Yes’ in capital letters.”

Ripple’s graduate students are continuing to build upon the evidence base laid by Ripple and Beschta. Jeff Hollenbeck, a recent Ph.D. student, evaluated potential trophic cascades effects on aspen condition and cavity-nesting birds in the northern Yellowstone ecosystem. Joshua Halofsky, a landscape ecologist with the Washington Department of Natural Resources, is just completing his doctoral thesis studying the potential



On Red Owl Mountain

By Cristina Eisenberg

In the rural West, geography defines us.

I live with my husband and teenage daughters on the shoulder of Red Owl Mountain, one of the many mountains that make up the Swan Range, which is part of the crazy quilt of ranges that forms the Rocky Mountains in northwest Montana.

Our cabin lies at the north end of a shoestring valley between the Swan Range and the Mission Mountains. The Swan River flows through this valley, with the Continental Divide a few miles east, as the eagle flies. The grizzly and wolf populations outnumber the human population here, giving new meaning to coexistence and sustainability.

Since moving here in the mid-1990s, we had heard wolves howl from the shoulder of our mountain. We had found their tracks pressed into the snow outside our cabin door. But we had never seen them — not until one misty August morning while my young daughters and I knelt in our garden, peacefully pulling weeds. A doe burst out of the forest and tore across the meadow, two wolves in close pursuit. One black, the other gray, they closed in on the doe’s haunches. In less than two heartbeats they pierced the woods on the far side of the meadow, leaving a wake of quaking vegetation.

This drama, which unfolded not 20 feet from us, sparked my quest to understand these large predators — both in relation to ecosystems and to human beings. My inquiry has taken me into wolf dens with field biologists and has led me to a wolf kill on my land so fresh the earth was still wet with blood. It has taken me to contentious meetings with hotheaded ranchers and equally hotheaded wolf advocates. It has compelled me to spend early morning hours perched atop a high knoll overlooking Yellowstone’s Lamar Valley, observing wolf life unfold in all its drama.

At every turn, the wolves have surprised me — with their courage, with their heedlessness of the politics of humans, with their big hearts and big feet. But far from giving me romanticized notions, my intimacy with wolves has left me with a pragmatic understanding of their feast-or-famine existence and tooth-and-claw role in a biotic community.

Cristina Eisenberg is a Ph.D. student in Forestry and Wildlife, OSU College of Forestry. She is currently at work on a book about trophic cascades, *Landscapes of Hope: Trophic Cascades and Biodiversity*, for Island Press.



“Herbivore population sizes will be determined by the supply of lions, tigers, leopards, cougars, cheetahs, hyenas and wolves, not by the supply of grass.”

— David Quammen, *Monster of God*, 2003

link between plant growth and elk behavior in Yellowstone and how the presence or absence of wolves affects that link.

Ph.D. student Cristina Eisenberg, who lives in the wilds of Montana (see sidebar), is working with an interagency research team in Montana’s Glacier National Park and Alberta’s Waterton Lakes National Park (an area spanning the U.S.-Canada border known as the Waterton-Glacier International Peace Park) to study elk ecology and habitat maintenance. The team includes researchers from the universities of Calgary and Alberta, as well as OSU. With the help of global positioning system (GPS) radio collars, the scientists will track 50 elk and several wolf packs to learn critical details about how elk forage, travel and interact with humans and wolves. Eisenberg’s role in the \$1 million study, funded by Shell Canada and operating with educational, government, industrial and conservation partners, is to investigate trophic cascades involving wolves, elk, aspen and other aspen-dependent species such as beavers and songbirds.

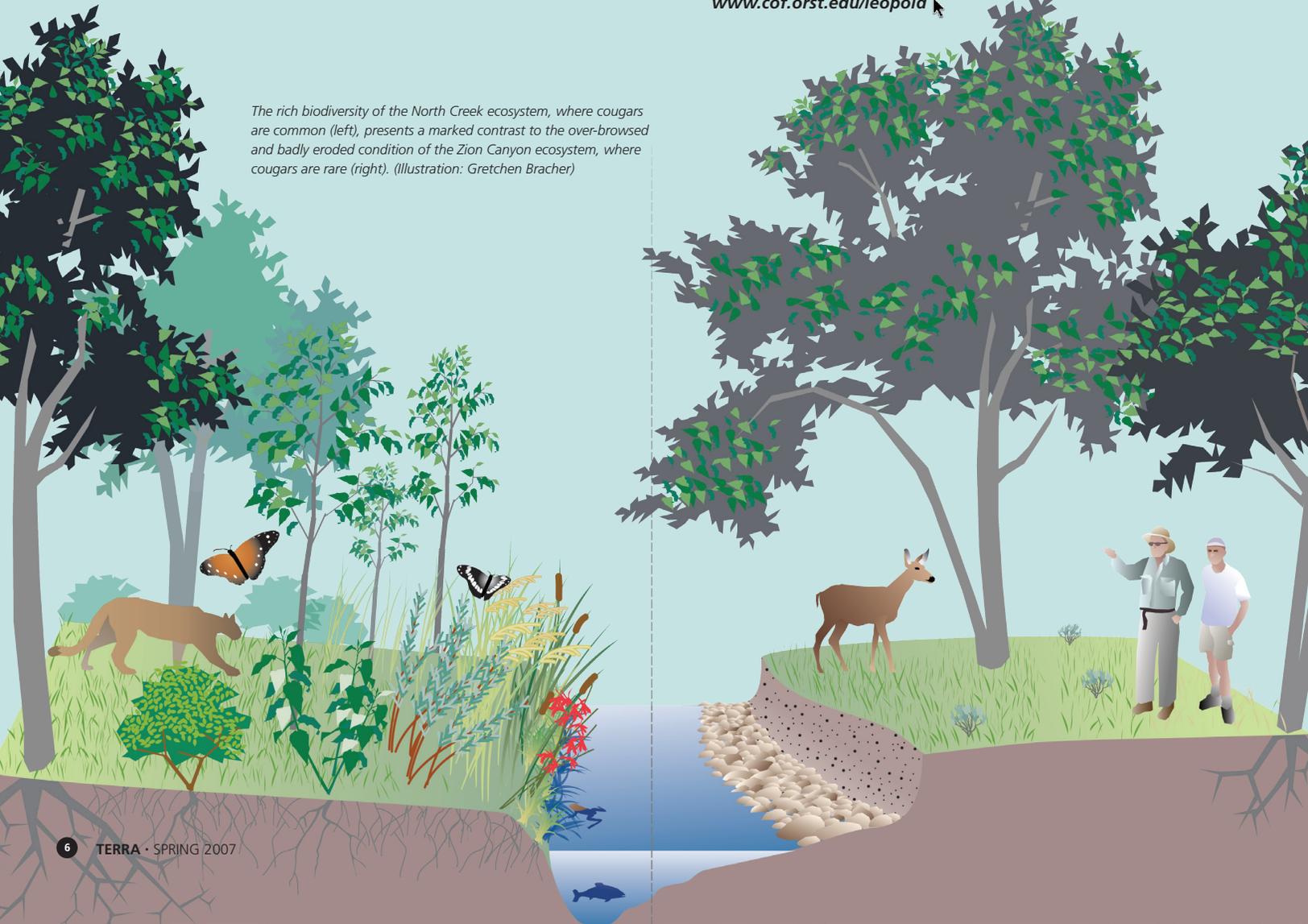
The Apex of Change

In Yellowstone, where the researchers got their first clear glimpse of cascading effects, recent OSU studies suggest that trophic cascades can also work as a powerful means to restore an ecosystem. Wolves have made a comeback there, reclaiming their place in an ecosystem that has declined steeply in their absence — ever since ranchers, hunters and government agents exterminated them in hopes of making rangelands safer for cattle and woodlands more bountiful for human hunters. “Putting those predators back into the system again, like the return of wolves to Yellowstone, appears to reverse the process,” Beschta says.

Ripple agrees. But he remains circumspect. “Ecosystems are quite resilient,” he says. “The initial recovery of plants since wolf reintroduction in Yellowstone is impressive and exciting to see. We’re hopeful for a pretty strong recovery in the long run, but it could take many, many decades.” **terra**

Learn more about the Leopold Project and hear Professor Bill Ripple explain how wolves affect an ecosystem at www.cof.orst.edu/leopold

The rich biodiversity of the North Creek ecosystem, where cougars are common (left), presents a marked contrast to the over-browsed and badly eroded condition of the Zion Canyon ecosystem, where cougars are rare (right). (Illustration: Gretchen Bracher)



Lessons From the Zumwalt Prairie

Grazing for nature

When Marcy Cottrell Houle headed to the Zumwalt Prairie in the 1980s with her topo maps, tree-climbing gear and raptor leg bands to study hawks, she assumed wildlife and cows were incompatible. After all, that was the prevailing view — and there were millions of overgrazed acres across the West to prove it. So when the OSU grad student found hawks flourishing alongside cows in the northeastern Oregon rangelands, she was stunned.

Livestock, she hypothesized, might actually enhance native ecosystems if — and it's a big if — it is managed for the health of the vegetation.

A quarter-century later, OSU is following up on Houle's work with new research at the Zumwalt, one of North America's last native bunchgrass prairies. A study designed to tease out the optimal stocking rates — cows per acre — for healthy populations of ground-nesting birds began in November 2005 with funding from the National Research Initiative of the USDA Cooperative Research, Education and Extension Service. The research team, led by ecologist and avian specialist Pat Kennedy, will compare the impacts of low, medium and high concentrations of cows on grassland birds of national conservation concern, such as horned larks, western meadowlarks and savannah sparrows. Under investigation, too, are the insects they eat — mainly crickets and grasshoppers — along with soils and plants.

For the experiment, four 400-acre parcels have been fenced off in the Nature Conservancy's Zumwalt Prairie Preserve.



(Photo: iStockphoto.com, Rob Hunt)

“The range condition of an area of grassland is truly the pulse beat of the health of the ecosystem.”

Marcy Cottrell Houle, *The Prairie Keepers*

Each parcel has been further divided into pastures, in which different concentrations of cows — from zero to as many as 20 or 30 — will be grazed.

The team hopes to shed more light on those earlier findings of Houle and others — findings that suggest benefits to well-managed grazing. Kennedy, a professor in the Department of Fisheries and Wildlife whose office at OSU's Eastern Oregon Agricultural Research Center is west of the Zumwalt, just over the Wallowa Mountains, expects moderate numbers of cows to have a neutral — or even positive — impact on the prairie ecosystem. “At very low stocking rates and in areas where there are no cattle,” she explains, “high grass densities may actually be prohibitive for feeding and nesting of native bird populations.”

Kennedy's colleague Tim DelCurto concurs. “I expect we will see that grazing to a certain degree stimulates good forage rates,” says DelCurto, a beef cattle specialist who runs the Eastern Oregon research center.

And what's good for forage on the Zumwalt — deep-soiled bunchgrass species such as Idaho fescue and bluebunch wheatgrass — is also good for the cows that eat it. DelCurto calls it a win-win strategy. “We can have our cake,” he says, “and eat it, too.”

Learn more about the Zumwalt Prairie study in Oregon's Agricultural Progress magazine, extension.oregonstate.edu/oap/fall05/



Where Cows and Buteos Roam

“In general, the rangeland was in good condition, which benefited the ground squirrels and hawks, as well as the cows and elk. All told, what was happening here was positive and advantageous to wildlife; and what's more, it seemed in balance. Ranchers, squirrels, cows, grass, trees, water, hawks, in balance....The Zumwalt was a shining example of good stewardship over long generations, but would it stay this way, I wondered, with all the changes threatening it, all the factions pulling on it and desiring to be its keeper?”

From *The Prairie Keepers*, by Marcy Houle, reissued in 2007 by OSU Press (originally published in 1995). On the Web at oregonstate.edu/dept/press/



Nature's Glue

Kaichang Li teaches soybeans to act like shellfish

by Lee Sherman

Soy may help prevent cancer not only on your kitchen table but also in your kitchen table.

Across campus from OSU's Linus Pauling Institute, where nutrition scientists have been studying soybeans' place in a healthful diet (see "The Zinc Link," page 22), another OSU scientist has found a way to use those same protein-rich beans in everyday wood products — paneling, cabinets, desks and, yes, the table where you eat your meals. These soy-based wood composites are free of the cancer-causing chemical formaldehyde, which for decades has been a mainstay of adhesives used in plywood, particleboard and furniture.

The wood adhesive breakthrough of Kaichang Li, an associate professor in OSU's College of Forestry, is just one of many bio-based products and processes under investigation in labs across the university. While Oregon Governor Ted Kulongoski, the Oregon Innovation Council and others work to secure Oregon's prominence in the new "carbohydrate economy" — drafting bills to boost bio-fuels development and considering a new bio-products research initiative — OSU scientists are at work on the technical challenges. Among them: wood-plastic composites made from recycled carpets, botanical sources of natural rubber, wastewater-generated electricity, cellulose as a source of ethanol and edible coatings for fresh foods (see Growing Technology sidebar.)

Although Li made his bio-based discovery just a few years ago, his interest in nontoxic composites dates back to his post-doctoral studies at the University of Georgia, where he was researching ways of making wood pulp with fungi.

His Scandinavian colleagues told Li about seeing the "reddish skin" of woodworkers using formaldehyde-based glues in their native Sweden. "They all said those glues are nasty materials to work with," says Li.

But it wasn't until a weekend at the Oregon Coast several years later that true inspiration hit. Equipped with a plastic bucket and rubber boots, Li was scouring the craggy outcroppings for mussels in anticipation of a savory seafood dinner. Suddenly, he was struck by the tenacity with which the blue-shelled mollusks clung to the rocks, even as waves pummeled mercilessly and tides tugged relentlessly. Taking some of these tough little shellfish back to his lab, he began investigating their natural super-glue. Prior studies of the proteins forming the mussels' stringy, clingy tentacles showed a unique combination of amino acids, clearly an evolutionary adaptation to the mussels' ecological niche. Such a powerful, waterproof bond was just what the wood-products industry needed to replace the formaldehyde-based formulas, Li concluded.

The trouble was, mussel protein is rare. It wouldn't be practical or, more to the point, cost-effective, to use it directly. Still, the idea had formed and, just like those stubborn mussels, Li wasn't about to let go. The scientific question he began to investigate with funding from the U.S. Department of Agriculture was, Can you convert an abundant protein — such as soy — into a strong and water-resistant adhesive like the mussel protein? The commercial question was, Can you make the new adhesive at a price competitive with the traditional resin, which costs only about 30 cents a pound?

Using a state-of-the-art extruder donated by ENTEK, Professor Kaichang Li is developing a strong, lightweight, nontoxic wood-plastic composite — just one of several lines of investigation in Li's lab, including soy-based adhesives and wood-based tire components. (Photo: Karl Maasdam)

Li was pretty sure the answer to both questions was yes. "Protein is protein," he points out, "and all proteins consist of different combinations of amino acids."

In comparing mussel and soy proteins, Li discovered that the amino acid compositions of the two proteins are quite distinct. Mussels contain high levels of certain amino acids that are lacking in soy. At the same time, mussels lack certain amino acids that are abundant in soy. So, using mussels as a model, Li and his research group experimented with chemically modifying the soy protein. They blocked some of the soy amino acids, those that the mussels lack. Simultaneously, they transferred mussel amino acids into the soy. "We turned soy proteins into mussel adhesive proteins," Li says.

Manufacturing the mussel-mimicking adhesive via the chemical-modification route, however, would be too costly. So, to make the new adhesives competitive with traditional adhesive technologies, Li developed a "curing agent" that could readily modify soy under heat during the production of wood-composite panels.

Finally, with funding support from Columbia Forest Products and Hercules Inc., Li's group honed the process for commercial use, running scaled-up experiments and mill trials.

"For 50 years," Li says, "the wood products industry has been arguing about what levels of formaldehyde emissions are safe for humans. But now some companies are taking a different approach — instead of explaining how much formaldehyde is wafting out of their wood products, they're saying, 'Our products are essentially formaldehyde-free.'"

Li's bio-based breakthrough — which he calls a "whole new concept" in wood composites — is revolutionizing the nation's \$4.4 billion wood adhesives industry. The Portland-based behemoth Columbia Forest Products — North America's largest manufacturer of hardwood plywood and hardwood veneer — is carving out a significant niche in the fast-growing "green" housing and construction fields. It took less than three years after OSU patented three adhesive formulas and licensed them to Delaware-based chemical giant Hercules Inc., for Columbia

Strips of an experimental wood-plastic composite roll off an extruder as Kaichang Li (left) works alongside Kirk Hanawalt, ENTEK Extruders vice president and chief operating officer, and postdoctoral research associate John Lu. ENTEK, a Lebanon, Oregon, firm, donated the \$180,000 machine to OSU last fall. (Photo: Karl Maasdam)



> Growing Technology

From microbes to plants, OSU researchers are leveraging biological materials to develop a variety of new products. Here are some highlights:

Cellulose Power

Professor Michael Penner in the Department of Food Science and Technology is studying one of the holy grails of the bio-based fuel industry: the economical conversion of woody plant materials into ethanol and other value-added products.

In the Pacific Northwest, where woody biomass is an abundant source of potential energy, the search for enzymes that can break down the tough-walled cellulose holds huge promise. Unlike the starches found in agricultural crops like corn, which can be easily converted to sugar and then to liquid fuel, woody materials are, in Penner's words, "recalcitrant" to conversion — that is, they require extra chemical intervention before they reach the simple-sugar stage. Penner's lab is working on cost-effective ways to attain this critical "sugar platform."



Bleaching Agent

Fungi that commonly colonize old tree stumps may benefit the paper industry and the environment.



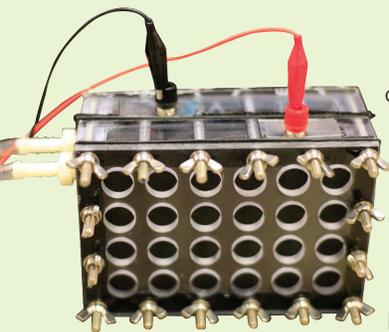
In the Department of Chemical Engineering, Christine Kelly is using white-rot fungi and yeast to create a nontoxic alternative for bleaching paper. She has transferred a gene from the fungi, which produce an enzyme that degrades

lignin, into yeast that can be cultivated under industrial conditions.

While the enzyme — manganese peroxidase — has shown promise as a bleaching agent in the laboratory, Kelly and Curtis Lajoie, a research professor in Civil, Construction, and Environmental Engineering, are refining the production process. Their goal is to coax the yeast to create an active, stable and highly concentrated enzyme that can replace currently used chemicals.

Microbe Energy

Turning sewage into voltage is the aim of Assistant Professor Hong Liu's research in OSU's Department of Biological and Ecological Engineering. Some bacteria living in wastewater can kick off electrons from pollutants. So Liu is developing microbial fuel



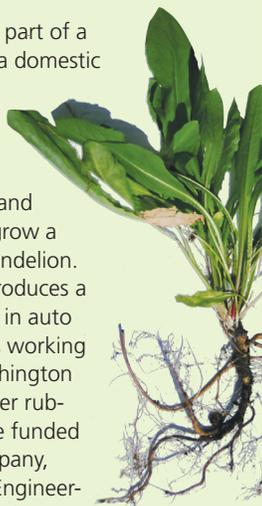
cells to capture the energy stored in wastewater, while simultaneously treating the water. She envisions a day when developing nations, such as her native China, will have waste-treatment facilities powered by the very waste they process, making them energy

self-sufficient and thus more widely affordable.

Liu is also working with Kaichang Li in Wood Science and Engineering to generate electricity from wood. A mixture of the hundreds of small, organic compounds in hydrolyzed wood, the researchers have recently discovered, can be converted directly into electricity with microbial fuel cells. "Liu and I are seeking funding to build the world's first integrated, portable, compact system for generating electricity directly from wood," says Li.

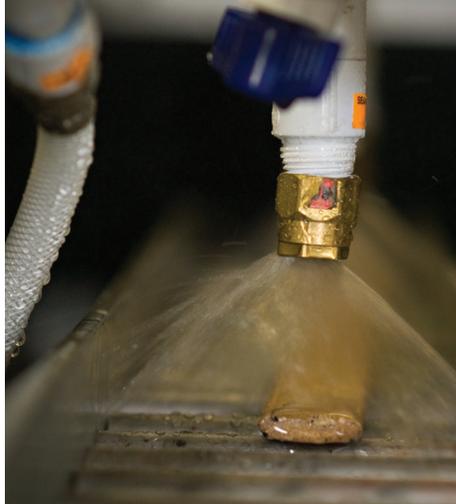
Natural Rubber

OSU agronomist Daryl Ehrensing is part of a private-sector initiative to develop a domestic source of natural rubber. With support from Akron, Ohio-based start-up Delta Plant Technologies, Ehrensing is principal investigator for the Department of Crop and Soil Science breeding program to grow a high-yield variety of the Russian dandelion. The plant, native to Kazakhstan, produces a high-quality latex that can be used in auto and aircraft tires. Other universities working on the project are Ohio State, Washington State and Montana State. In another rubber-related project at OSU, this one funded by a German rubber chemical company, Kaichang Li in Wood Science and Engineering is investigating ways to use cellulose crystals instead of silica and carbon black in tire manufacturing.



Food Coatings

Yanyun Zhao, an associate professor in the Department of Food Science and Technology, is focusing on the freshness, health benefits and market value of foods. She is developing biodegradable and edible films and coatings to prolong the shelf-life of perishable delicacies such as strawberries and other small fruits. Other projects include vacuum impregnation and infusion techniques for value-added fruit and vegetable products.



The hot composites get doused with a cooling spray of water, causing them to solidify, as they come out of the extruder. (Photo: Karl Maasdam)

to convert its seven hardwood plywood plants to the nontoxic soy-based adhesives. The company, which produces more than half of U.S. interior wood composites, estimates that it replaced 47 million pounds of formaldehyde-based resins with soy-based adhesives in 2006.

This year, Columbia is beginning production of formaldehyde-free particleboard. Plywood and particleboard have distinct adhesive requirements, Li notes. Plywood uses the glue to bind thin layers of wood. Particleboard, on the other hand, is formed from sawdust-like bits of wood bonded together. One particleboard plant can consume as much adhesive as five plywood plants, according to Li.

"Particleboard creates a dramatic new demand for soy-based adhesives," he notes.

For Oregon, whose forest industry employs more than 85,000 workers statewide, novel wood products like Li's adhesive help fuel demand and bolster communities, particularly in rural counties hit hard by recent downturns in logging and manufacturing. Wood-plastic composites offer another potential boost. Li's research team is developing a nontoxic alternative for outdoor construction: decks, cabins and children's play structures. The new material, besides being strong and lightweight, would be free of such hazardous chemicals as arsenic and chromate, found in some treated wood.

The research focuses on the adhesion between the water-absorbing wood and the water-resisting plastic. Better adhesion translates to stronger materials. A novel wood-plastic composite using recycled carpets and wood is the team's latest breakthrough.

Wood can also be a competitive source of liquid fuel in Oregon. A recent analysis by OSU economists found that ethanol made from wood cellulose yields the highest "net energy" return (84 percent), compared with canola (69 percent) and corn (20 percent) after subtracting production and transportation costs.

Just as fuels made from these sources can reduce U.S. dependence on foreign petroleum, soy-based adhesives can lessen the nation's need for foreign sources of natural gas, from which formaldehyde is derived. "I get lots of phone calls about this new adhesive," says Li. "One person said, 'This is one of the greatest inventions I've seen in the past 50 years in terms of affecting peoples' lives.'" **terra**

To learn more about Kaichang Li's research on adhesives and composite materials, see woodscience.oregonstate.edu/faculty/Li/

Fishing for Life

Every spring, the Umatilla people of northeastern Oregon join other Columbia River tribes in celebrating the return of the salmon. Growing up on the reservation in the foothills of the Blue Mountains east of Pendleton, Patrick Luke learned to appreciate the bond between fish and people. When he wasn't helping to tend the family's horses, he was fishing with his dad for salmon and steelhead on the Columbia and the Umatilla rivers.

After graduating from Weston McEwen High School in Athena, Oregon, he left home at age 17 to join the U.S. Marines, serving in Beirut, Lebanon. Discharge in hand, Luke headed to Alaska where he worked on crabbers, longliners and salmon boats out of Sitka, Dutch Harbor and Kodiak, going as far as the Bering Sea.

Now, Luke is casting his future in a new direction. He wants to help repair the fraying link between fish and people by becoming a fisheries biologist (or "a fish doctor," according to his 8-year-old son Cody). Fish and the aquatic communities they depend on, Luke believes, are "important to all of us, Native or not."

Working on the slippery decks of commercial fishing boats did little to prepare Luke for academic pursuits. The transition to university life was difficult, he says, but he had help from friends and mentors in OSU's Native Americans in Marine and Space Science (NAMSS) program and at the university's cultural centers, particularly the Native American Longhouse. And then there is his work ethic: "I look at school like a full-time job," he says.

In addition to his coursework, the senior in the Department of Fisheries and Wildlife has walked the streambeds of northeast Oregon. His quarry: invasive New Zealand mudsnails that can degrade ecosystem integrity, consuming algae that fuel the aquatic food web on which salmon and other fish depend.

Last summer, during a National Science Foundation-sponsored Research for Undergraduates program at OSU's Hatfield Marine Science Center, he worked with mentors Tony d'Andrea (College of



During the summer of 2006, aquatic organisms from about two meters deep in Yaquina Bay accumulated in this sampling device built by Patrick Luke at the Hatfield Marine Science Center in Newport. Luke's focus was ghost shrimp larvae, right, which emerged into the bay in three distinct pulses. (Photo of Luke by Anthony d'Andrea. Photo of ghost shrimp by OSU Ph.D. student Cara Fritz)

Oceanic and Atmospheric Sciences), Ted DeWitt (U.S. Environmental Protection Agency) and Brett Dumbauld (U.S. Department of Agriculture) to study ghost shrimp in Yaquina Bay.

Ghost shrimp are native to Pacific Coast estuaries from Baja to British Columbia and of particular interest to oyster farmers whose operations can be disturbed by the shrimp's tunnel building activities. The research is aimed at understanding the patterns of ghost shrimp distribution and when and under what conditions they spawn and molt through their five life stages.

Inspired by the memory of his dad's respect for education, Luke has succeeded in ways that still seem to surprise him. He received a first runner-up award from the

Oregon Chapter of the American Fisheries Society in 2006 for his poster on the mudsnail. And he capped off his Yaquina Bay experience by receiving top honors for his poster in a class on coastal ecology and resource management.

For his senior project, Luke is focusing on western American shad, a prolific non-native species in the Northwest. He has been collecting samples for genetic studies of shad strains from several river systems and comparing them to shad populations in the eastern U.S.

Ultimately, Luke's journey is personal. "I know what a lot of people value. I'm passionate about my research and what I try to do. What I do affects the fish, and the fish affect the people."

Mental Health Lifeline

The most important visitors to Stacy Ramirez's office walk around her desk and sit in a chair next to her. As they talk, Ramirez catches subtle cues about her visitors' emotions, whether or not they are taking their pills or maybe hearing voices again. "I can tell by their eyes if there's something going on that I need to ask them about," she says.

Ramirez is a clinical assistant professor in the College of Pharmacy. In addition to teaching classes on pharmacy management and operations, she meets daily with a dozen or more residents at Mid Valley Housing Plus, a residential support facility in Corvallis for people with mental illness. She shares an office with Mid Valley case manager Sam Ortiz where she answers residents' questions, administers medications — some by court order, others on request — and serves as a liaison with physicians.

No longer focused only on dispensing prescriptions, pharmacists increasingly serve as consultants and sometimes as lifelines for people with chronic illness — diabetes, high blood pressure, schizophrenia. The hope is that as specialists in drug effectiveness and interactions, pharmacists can help stabilize lives and reduce hospital visits. For people with mental illness, that includes staying out of jails and homeless shelters.

In collaboration with OSU faculty members Ann Zweber in Pharmacy and Ray Tricker in the Department of Public Health, Ramirez will evaluate the consequences of her work at Mid Valley, documenting impacts on patient quality of life, interactions with police and visits to the emergency room. Just getting started, the research could have broad



Before coming to OSU in 2006, Stacy Ramirez spent 20 years in community pharmacy in a variety of roles, primarily in management and pharmacy operations. Today, in addition to teaching, she works with residents of a mental health treatment facility in Corvallis, including Mike Christensen, lower left. (Photos: Karl Maasdam)

implications for developing an innovative role for pharmacists in the health care system.

"I have a patient that I see once a week," says Ramirez, who serves on boards of directors at Mid Valley and the Oregon State Pharmacy Association. "He let me know that he was hearing voices, and the voices were telling him not to take his medications, not to listen to me anymore. So I got a hold of his physician, made some adjustments to his medications, called and checked on him to make sure he was taking them, to see if the voices had come back. He's doing much better now.

"Now that's hard to quantify. What did that do? Did it save him a hospital trip? Maybe," she adds.

As a mental health specialist, Tricker served on the Governor of Oregon's Task Force on Mental Health in Oregon. In 2006, he invited Ramirez to work at Mid Valley. The nonprofit organization now accommodates about 65 clients. Two to three new requests for services — a warm apartment, transportation, counsel-

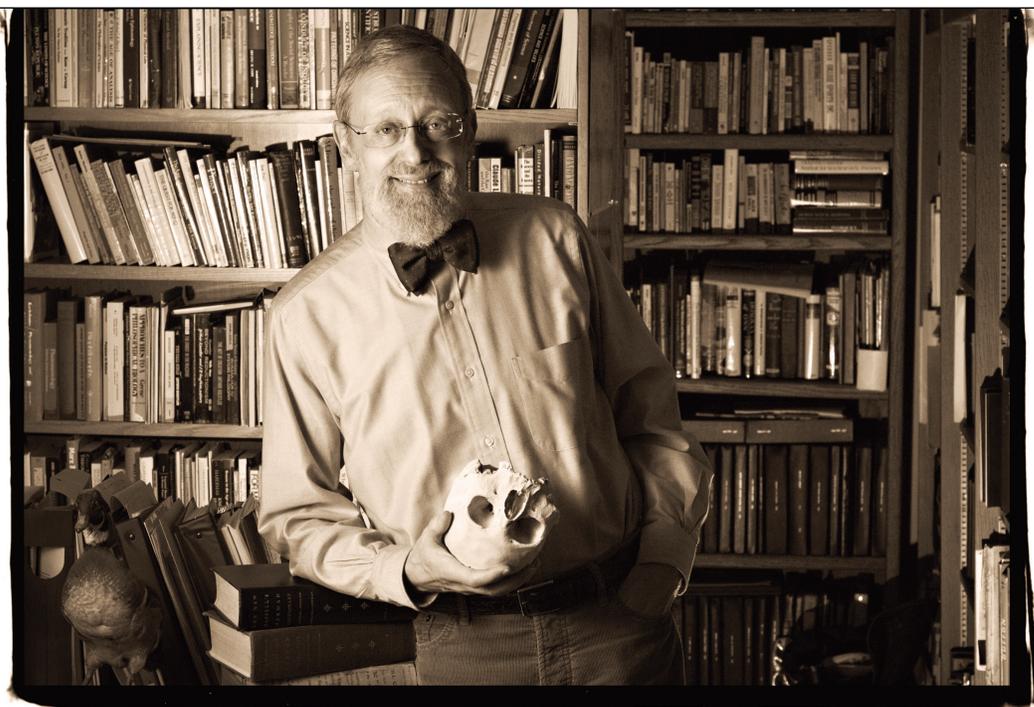
ing, case management (known in mental health circles as an Assertive Community Treatment model) — arrive weekly, says Tricker, who is also on Mid Valley's board and has worked with the nonprofit organization for more than a decade.

At OSU, he offers students in his public health courses the chance to work with Mid Valley residents. Students gain valuable field experience, assisting residents with everything from shopping to a regular exercise program known as Walking Warriors.

"The goal is to find ways to create conditions that prevent people from relapsing," Tricker says.

In her meetings with Mid Valley residents, Ramirez sees the need daily. "These patients have multiple psychiatric issues," she says. "They know that unless they see someone every day, their chances of staying on their medication are not as good."

For more information about the OSU College of Pharmacy, see pharmacy.oregonstate.edu



(Photo: Karl Maasdam)

Teaching Evolution Central to science

Most textbooks treat evolution as “just another topic” rather than as the overarching theory that ties life systems together, says OSU Distinguished Professor Paul Farber. “Evolution, which synthesizes the disparate disciplines of the life sciences, rarely emerges in biology courses or texts as the unifying thread that makes sense of all the material,” Farber wrote in *The American Biology Teacher*, May 2003.

This approach, he argues, misses a rich teaching opportunity.

An historian of the life sciences, Farber worries about U.S. schools’ lackluster record on teaching Charles Darwin’s world-rocking discoveries. He laments the findings of a 2000 study by the Thomas B. Fordham Foundation, showing that 19 states do a “weak to reprehensible job,” 12 omit the word “evolution,” and four skip over biological evolution altogether. Despite court rulings upholding evolution’s rightful — indeed, central — place in science classes, countless children are denied instruction in this linchpin of biological principles because it contradicts

“If we can move the study of biology toward what excites biologists and away from what makes students’ eyes glaze over, we shall have accomplished an important and valuable task.”

Paul Farber, chair, OSU Department of History

the religious tenets of certain conservative congregations and communities.

The debate over life’s origins and transformations is as divisive today as it was during the famous Scopes “monkey trial” of 1925, when a Tennessee teacher was tried for suggesting that humans evolved from apes. But the way Farber sees it, evolution offers a perfect platform for exploring the fundamentals of scientific investigation with students — and in the process, shifting their thinking on this highly charged question.

It begins, he says, with an understanding of the nature and history of science. Students should be taught that science is not a rigid set of explanations to be memorized but a dynamic process, changing over time as a “lineage” of questions is posed and tested. Farber posits that if students better understood how scientists derive facts, hypotheses, theories and laws, they might better distinguish between various ways of knowing — that knowledge built upon a chain of evidence is of an entirely different sort than that contained in, say, scriptural texts.

Students should learn, too, that today’s titanic clash of beliefs about evolution is not inevitable. Many leading theologians and scientists of Darwin’s day found natural selection to be perfectly compatible with Christianity. “The majority of the American biologists who accepted evolution in the late-19th century did not believe it posed any threat to religion, but, quite the contrary, felt their religious beliefs were strengthened by it,” Farber notes. “It is not an either/or situation: science or religion.”

Once students see that “there are many ways to reconcile evolution with religion,” he concludes, “they realize that evolution is not the flame-breathing dragon of atheism, but a theory that explains biological phenomena, that relates bodies of information, and that guides research, and like other aspects of science, is open to many philosophical and religious interpretations.”

To learn more about Paul Farber’s research on the history of science, see oregonstate.edu/cl/history/faculty/farber/



FORGED IN FIRE

SCIENTISTS WANT TO KNOW HOW FIRE SHAPES THE REGION'S FORESTS

by Nick Houtman

In the life of a forest, fire can be a frequent and demanding companion. How often the flames visit and whether they stay low, licking the tree trunks, or flare into the canopy, becoming what foresters call a “stand replacement fire,” can determine the character of the forest for centuries. Or until the next fire.

It's a story that two OSU Ph.D. students are coming to know intimately. Alan Tepley (forest science and geosciences) and Jorge Ramirez (mathematics) are part of a research team that is taking a hard look at how fire affects the forests of Oregon's western Cascades. In this steep ridge and valley terrain, the plot gets complicated. Fires can be fickle, burning one stand completely while leaving its neighbors untouched or lightly scorched. The result is a crazy quilt of stands with varying ages and compositions.

What controls these kinds of fires — and thus the structure of our forests — is of concern to policymakers as well as to scientists. The nation regularly spends more than \$1 billion a year fighting forest fires, and western U.S. forests are expected to be at greater risk of burning in a warmer world. The long-term consequences of a more intense fire regime are poorly understood.

Through painstaking fieldwork and mathematical modeling, Tepley, Ramirez and their colleagues are demonstrating how forest stands evolve in the face of fires that occur repeatedly over centuries. Their work is supported by a National Science Foundation-funded education program (see sidebar).

Coring Into the Past

For his part, Tepley has looked to the forest. During the past two summers, he has pointed his gray Honda Civic toward the mountains, hiking deep into the woods. He has twisted tree-coring devices (breaking them more than once) into the hearts of centuries-old Douglas firs, hemlocks and red cedars.

The pencil-thin cores contain a record of growth rings that reveal a tree's age and its yearly growth. Across the Fall Creek and Blue River watersheds, Tepley has collected data for almost 2,000 trees in 77 linear plots, each longer than a football field. Some of the sites are in one of the nation's premier forest research facilities, the H. J. Andrews Experimental Forest, which also served as his base camp.

Back in Corvallis, Tepley is scrutinizing each core under a microscope. He has already identified six distinctly different forest histories, each representing what scientists call a successional pathway. Each is associated with a position on the landscape, from shady north-facing slopes to sunny hillsides. Tepley's cores show that stands in the Fall Creek watershed tend to burn more frequently and less severely than those in the neighboring Blue River watershed. All stands in Fall Creek show evidence of fire within the last 200 years, but in Blue River, several stands show no fire evidence within the last 400 to 500 years.

Terrain turns out to be critical in setting the stage for how severely and how often fire visits a given stand of trees. “In certain locations, topography may consistently either reduce fire frequency or moderate fire severity,” Tepley has written in summarizing his work to date. “These places may function as refuges for old trees. Also, they may play important roles as a seed source for plant species or as temporary habitat for animal species following disturbance to the surrounding landscape.”

Tepley began his forest ecology career in Michigan where he has worked in oak-hickory, jack pine, and northern hardwoods forests. The son of a physicist and a social worker received his bachelor's and master's degrees at the University of Michigan. For the state's natural heritage program, he reviewed land surveyor notes from the early 1800s, contrasting frequent observations of burned trees with modern forests in which fire had been suppressed. “For me, fire has always been a part of studying forests,” he says.

Insight From Mathematics

Since the 1970s, researchers have known that the western Cascades represent something special in forest fire science. That's because many different forest histories exist side-by-side in these mountains, the result of what scientists call a "mixed-severity fire regime." Tepley and his advisers — Julia Jones in the Department of Geosciences and Fred Swanson, a U.S. Forest Service scientist who conducted much of that work in the '70s and is associated with the OSU Department of Forest Science — hope the tree core data will reveal just how such fire regimes influence the modern forest.

"There's been a lot of controversy in the Pacific Northwest about ancient forests, which mainly are 500-year-old stands that were regenerated after fires during the 1500s. So the character of the landscape for which Northwesterners feel an affinity was shaped by the history of fire," says Jones.

"We have a forest today that results from a particular, maybe even a peculiar, series of events," she adds. "We tend to think of that as inevitable, but it wasn't."

In short, the modern forest could have turned out differently. Had fires burned more frequently or more intensely in the past, today's forests could have stands with different ages or proportions of species. To think about what different fire histories might mean for forest development, the forest scientists have turned to mathematics and Jorge Ramirez.

Born and raised in Medellín, Colombia, Ramirez received his civil engineering degree at the Universidad Nacional de Colombia. Both his parents are mathematicians, and he equally enjoys soccer and collaborating with scientists to solve problems. For OSU fire researchers, the problem is how to relate the age structure of the forest to the frequency and intensity of fire.

Ramirez's fire model — a set of equations that describe forest development as a function of fire — is intended to help scientists explore this issue by enabling them to see the consequences of different fire patterns. "This model is not for prediction. It is a conceptual model. The point is to get insight," Ramirez says.

TRAINING SCIENTISTS FOR THE FUTURE

The forest fire project is part of an innovative graduate student training program sponsored by the National Science Foundation. Known as the Ecosystem Informatics IGERT (Integrative Graduate Education and Research Traineeship), the program prepares students for science jobs by bringing them together with experts in a range of disciplines to analyze ecological processes. The 23 Ph.D. students currently enrolled in IGERT span disciplines from computer science and mathematics to forestry and geography.

Principal investigators at OSU include Julia Jones, geosciences; Mark Harmon, forest ecology; Ed Waymire, mathematics; and Tom Dietterich and Bruce D'Ambrosio, computer science. To learn more, see ecoinformatics.oregonstate.edu

Ramirez started with simple assumptions. "We assume fires occur randomly in time at a fixed rate. We assume a fire will kill trees under a certain age. There will be some rules about how trees (regenerate) after a fire. Let's see what that gives you," he says. Mathematicians can help scientists reduce the complexity of what they observe in nature, "to bring it (the process) back to the bare bones."

For Tepley, Swanson and Jones, modeling is also a tool for thinking about the future forest. "The data I have represent what has happened over the past 500 years. But ultimately it would be interesting to know what else could happen," Tepley says. "Modeling has the ability to picture the range of possibilities."

Knowing those possibilities could help guide forest management if climate change affects precipitation, temperatures, insect outbreaks and fire in the Northwest. "Were refuges buffered from past climate variability?" asks Swanson. "Might they be buffered in the face of future climate change? If we want to encourage old growth in the future, are those the places where we might have the best chance of being successful?" **terra**

For more information about research at the H.J. Andrews Experimental Forest, see www.fsl.orst.edu/lter/

(Photo: Santiago Uceda)

TREES CORES TELL STORIES

Insects also take a toll on the forest. In his cores, Alan Tepley suspects he has found evidence of a spruce budworm outbreak in 1739, lasting until about 1750. The Douglas fir core (top), a host species, shows sharply reduced growth compared to a western hemlock (not a preferred host) at the same site. Black dots are made by researchers in counting the rings.



1739

1750



1739

1750





Stories that Heal





nce upon a time in an Oregon river valley, there lived a woman named Dale-Elizabeth Pehrsson. At the big university where she was a teacher and researcher, her students called her Dr. Dale. When visitors walked into Dr. Dale's office at the College of Education, they noticed something very important about her: She loved working with children. Toys and dolls and posters in bright colors filled every niche. Picture books filled every shelf. And her blue eyes sparkled with excitement whenever she talked about using stories to help children heal.



BY LEE SHERMAN
PHOTOGRAPHS BY KARL MAASDAM

"In times of trauma and stress," she would tell her visitors, "books and stories can buttress children's self-concept, cultivating self-worth and calming the storm."

So at the turn of the millennium, the OSU associate professor for counseling education teamed up with OSU's social science reference librarian — Associate Professor Paula McMillen — to develop literature-based tools and trainings for grad students preparing to work with troubled kids.

A paper-and-pencil questionnaire designed by Pehrsson for evaluating children's books has evolved into the Bibliotherapy Education Project, featuring a searchable database of 600 titles. The project Web site, launched in 2003, has drawn queries from 40 states and at least half-a-dozen countries.

The professors have developed workshops for mental health professionals, which they are adapting for teachers and librarians. With funding from the Association for Creativity in Counseling, a branch of the American Counseling Association, they are conducting a national study to investigate the scope and reach of bibliotherapy across the U.S. Another study exploring cultural responses in book choices aims to sharpen counselors' sensitivities and, ultimately, to enhance the development of positive ethnic, racial or cultural identity among young clients.

"All the research I do," says Pehrsson, "is aimed at improving counselor competency in working with children."

Monsters To Vanquish

Long before they teamed up at OSU, both professors had discovered the therapeutic powers of the technique known as "bibliotherapy," defined variously as "helping with books," "guided dialogue about books" or "literature as a catalyst for growth and healing." Pehrsson and McMillen each used bibliotherapy in their previous careers, McMillen as a clinical psychologist and Pehrsson as a pediatric nurse, play therapist and family counselor. The technique, which is used with people of all ages, is especially suited to kids. Related to other expressive techniques such as play therapy and art therapy, it gives children a psychological pathway — a backdoor of sorts — to feelings they're not able to analyze, articulate or access directly.

Bibliotherapy — coined as a term in 1916 and established as a practice at the Menninger Clinic in the 1930s — has grown steadily in popularity among teachers, school counselors, mental-health therapists and librarians. Today, bibliotherapy is a many-headed creature. It looks quite different from setting to setting, morphing to meet client needs and practitioner expertise, spanning a continuum from "developmental" to "clinical" — from wrestling with the normal ups and downs of life, to dealing with extreme trauma or emotional disturbance. A teacher or librarian will typically use stories developmentally to address topics like



starting kindergarten, fending off bullies or understanding cultural differences. Clinical interventions, on the other hand, belong strictly in the offices of trained mental health professionals.

Ironically, even as the child taps deep emotions through a fictional character — a motherless bat named Stellaluna who tries to fit in with a flock of birds, a cub named Koko Bear whose parents are divorcing, a little girl named Sara whose best friend, Rune, drowns in a lake — that character shields her from those feelings' full impact. The story forms a “safe container,” a place to explore emotions while keeping a comfy distance from them; they are, after all, happening to Stellaluna or Koko Bear or Sara, not to the child. Couched in metaphor, wrapped in fantasy, fictive emotions can instruct, gently, through example and empathy. “Books can provide a buffer, a psychological distance or safety net for exploring issues that can elicit emotional intensity,” Pehrsson says.

Unlike a sleepy-eyed bedtime story, clinical bibliotherapy is hard work. “We’ve got worries to figure out,” Pehrsson would tell her young clients. “We’ve got monsters to vanquish!”

Bibliotherapy can enhance personal insight, suggest alternatives, diminish isolation, clarify values, stimulate discussion, foster empathy and nurture ethnic identity and pride, according to Pehrsson and McMillen. It can be applied, they say, to an “astounding” range of problems: Aggressiveness, adoption, addiction, grief, depression, nightmares and homelessness are just a few.

But it’s not without dangers and drawbacks. The OSU professors warn that bibliotherapy’s benefits depend heavily on the practitioner’s training and skill. While skillful story work can help kids cope with tough circumstances, a clumsy or careless venture into stories about sensitive topics — death, divorce, abuse, abandonment — can further disturb or damage a vulnerable child, they caution. Says Pehrsson: “If it’s a really scary topic and you open that book, you may be pushing something on the child they’re not ready for.” Adds McMillen, “All the things that can make bibliotherapy powerful in a positive way can make it powerful in a negative way.”

One Enchanted Story

Bibliotherapy’s power stems from the ancient and universal enchantment of stories, the professors explain. Fairy tales, fables, myths and epic narratives have been vehicles of culture and wisdom throughout human history. “We are creatures who learn through stories,” says Pehrsson, who is clinical editor of *Play Therapy* magazine. “Stories, like human lives, have a beginning, a middle and an end. For children to understand and make sense of the world, a story is a very logical fit. It’s how we’re wired.”

Related to bibliotherapy is a strategy that Pehrsson calls “collaborative story writing” or “co-storying.” The therapist starts a story (“Once upon a time long, long ago, there was a...”) and the child picks up the thread. One of Pehrsson’s former clients, a little girl named Savannah, invented a character called “Savannah Horsie.” When Pehrsson suggested that “Savannah” was feeling scared or sad or worried, the child quickly and firmly corrected the therapist — “Not Savannah — Savannah *Horsie!*” When the feelings were safely contained within the invented character, the little girl was free to explore different scenarios and alternative endings with Pehrsson, who would pose such questions as, “What would happen if...?” Eventually, the child was able to transfer the feelings to her own life.

“I would start by reading a story aloud about a character who’s been through a similar situation — a character who models resiliency or success but also the pain and the sadness that goes along with it,” Pehrsson explains. “Over time, children would start to tell their own stories about the character. And the character would become stronger and braver.”

The theory behind this transformation was first described by bibliotherapy pioneer Caroline Shrodes in 1950. She explained the underlying dynamic — what happens in the subconscious mind — as a series of three processes: identification, catharsis and insight. First, the child recognizes his own feelings in the character. Second, his repressed or conflicted feelings begin to surface. Third, his recognition of the universality of his experience makes him feel less isolated and thus more empowered.

“Allegorical stories can bypass conscious and unconscious defenses,” Pehrsson explains.

Unfortunately, the current evidence for the effectiveness of fictional story therapy is mostly anecdotal. Although studies show therapeutic benefits for self-help books for adult mental-health problems such as anxiety and sexual dysfunction, rigorous research on using imaginative literature in clinical or school settings is still on the horizon. Several of Pehrsson’s master’s and doctoral students, under her guidance, are conducting research projects that will move the field forward, quantitatively (see sidebar). Her emerging counselor cadre is making important contributions to a scientific literature base that may validate what Pehrsson knows from experience: Stories have the power to heal. **terra**

To learn more about the Bibliotherapy Education Project and the Bibliotherapy Evaluation Tool, visit bibliotherapy.library.oregonstate.edu

“The right story at the right moment is an arrow to the heart. It can find and catch what is hiding inside the reader (or the listener), the secret hurt or anger or need that lies waiting, aching to be brought to the surface.”

— Bruce Colville, children’s author, 1990



Bibliotherapy in Kenya

It was at the bedside of a dying relative that the idea for Daphne Kagume’s doctoral dissertation took hold. As her beloved uncle succumbed to AIDS in a Kenya hospital, the OSU graduate student witnessed the heartbreaking isolation that so often afflicts AIDS patients in her native country.

She resolved to help.

With guidance from Dale-Elizabeth Pehrsson, her Ph.D. committee chair in the College of Education, Kagume is designing a study using traditional African stories to enhance coping and quality of life among victims of HIV/AIDS. The study will be both a descriptive and statistical analysis of the impact of bibliotherapy — the use of books and stories for emotional healing — in Kenyan support groups. To ensure the cultural and psychological suitability of the books, Kagume will rate them with the Bibliotherapy Evaluation Tool developed by Pehrsson and McMillen. To get hard data about the effectiveness of bibliotherapy, she and Dana Doerksen, fellow Ph.D. candidate and co-researcher from Eugene, Oregon, will administer a pretest and a posttest using a Health-Related Quality of Life (HRQoL) scale for HIV/AIDS-affected patients. One such scale is the MOS-HIV (Medical Outcomes Study HIV Health Survey) developed by the Centers for Disease Control. A control group will also be used. Because quantitative data on the effectiveness of bibliotherapy — particularly the use of fiction — are scarce, Kagume and Doerksen’s research will add valuable findings to the field.

In-depth interviews will capture personal narratives about HIV and bibliotherapy. “The interviews will give voice to people experiencing HIV/AIDS,” says Doerksen. “For many researchers, self-reported data such as these are at least as important as statistical data.”

The daughter of school administrators, Kagume left Kenya’s lush, coffee-rich highlands for undergraduate study at the University of Nairobi. When she headed to OSU to earn a master’s in business administration, she barely knew where Oregon was. “I just heard that it doesn’t snow here,” she says ruefully, glancing out at the frozen remnants of the

latest winter storm. But by the time she finished her MBA, she knew her heart would never be in balance sheets and bottom lines.

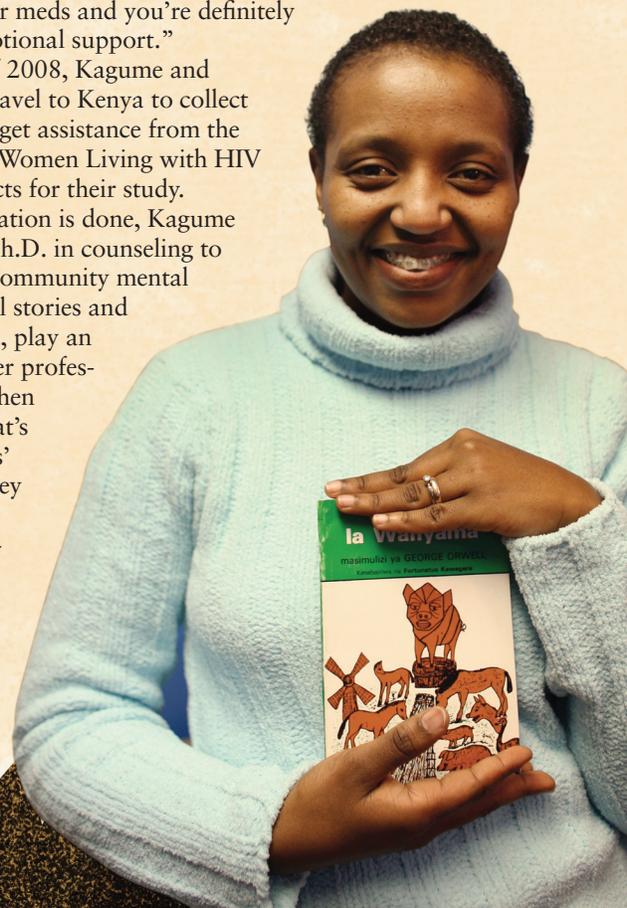
“I realized it was important to me to do something that adds value to people’s lives,” she explains.

Doerksen had her introduction to Africa when she spent a month in Tanzania as a staff member with World Vision, an international agency dedicated to empowering local communities with projects such as health clinics, water treatment, education for girls and micro-loans for women. “It was right after 9/11,” she says. “I grew more during the three or four weeks I spent there than at any other time in my life.”

Because of the stigma of HIV/AIDS in Kenya, patients typically wait too long to seek medical help and then keep their diagnosis a secret from friends and family. “If you’re not talking about it,” Kagume says, “you’re probably not taking your meds and you’re definitely not getting any emotional support.”

In the summer of 2008, Kagume and Doerksen plan to travel to Kenya to collect data. They hope to get assistance from the Kenya Network of Women Living with HIV in identifying subjects for their study.

When her dissertation is done, Kagume intends to put her Ph.D. in counseling to work in a Kenyan community mental health agency. Local stories and books will, she says, play an important role in her professional practice. “When stories relate to what’s happening in clients’ lives,” she says, “they can improve their emotional functioning and live more fully as members of their community.”



(Photo: Santiago Uceda)

By identifying the molecular machinery involved in Johne's disease, Luiz Bermudez and Marta Alonso-Hearn (top and below) hope to provide the basis for new treatments. Johne's has been estimated to cost the U.S. dairy industry as much as \$1.5 billion annually. (Photos: Karl Maasdam)



Minding the Dairy

Scientists reveal a killer's M.O.

by Nick Houtman

Little matters more to dairy farmers than the purity of their product and the health of their animals. So when Warren “Buzz” Gibson, co-owner and herd manager at the Lochmead Dairy in Junction City, Oregon, heard six years ago that an incurable cattle disease called Johne’s (pronounced “yo-knees”) could threaten his reputation for quality, he had all of his cows tested and continues to monitor annually, despite never having had a positive test.

Across the Oregon Coast Range at the Tillamook Creamery Association, Mark Wustenberg works with farmers to test for Johne’s and manage their herds to reduce other disease risks. “Our goal is to make sure this disease does not adversely affect our milk supply,” says the association’s vice president for dairy services.

Statewide, more than 50,000 cows in 200 of Oregon’s 350 herds are tested annually for the disease, according to the Oregon Department of Agriculture. Of herds tested in Oregon, Johne’s appears to be present in 60 to

70 percent at a low level (1 to 2 percent) of infection, says ODA field veterinarian Bruce Mueller. While other cattle diseases such as brucellosis have waned, the Johne’s threat has stimulated a national research and education campaign funded by the U.S. Department of Agriculture (USDA) at universities across the country, including OSU.

Gibson, Wustenberg and their peers have good reason to be vigilant. The cause of Johne’s — a bacterium known as *Mycobacterium avium paratuberculosis* (or MAP) — can survive for years in soil without losing its ability to infect. The organism lives in manure left by infected animals in pastures and barn stalls. When it reaches a newborn calf, it spreads slowly through the animal’s system with no apparent ill effects. But within two to five years, growing intestinal distress leads to diarrhea, weight loss and reduced milk production. By the time symptoms appear, death is imminent.

The MAP bacterium infects dairy herds worldwide and has been estimated to cost the U.S. industry \$200 million annually in lost milk revenues alone. The financial impact soars to \$1.5 billion when reduced milk production, decreased feed efficiency and expenses for replacement cattle are taken into account.

Moreover, a possible association between Johne’s in cattle and Crohn’s disease in people raises human health concerns. For now, studies to determine whether the same organism causes both diseases have reached differing conclusions. According to the Johne’s Information Center at the University of Wisconsin, no cases of Crohn’s have been linked to milk consumption.

Before he came to OSU in 2002, microbiologist Luiz Bermudez studied the Johne’s pathogen in wild and domesticated animals. Because of its importance to the animal agriculture industry, he now leads a research team that has discovered new details about how the organism goes



about its dirty work in cattle. While a vaccine and other treatments can now reduce the severity of the disease, what Bermudez and his colleagues are learning could lead to more effective medications.

Understanding the tricks that MAP uses to evade an animal's immune system could also improve treatment for other infectious diseases. That's because as a class of microorganisms, *Mycobacteria* are responsible for scourges such as tuberculosis, leprosy, chronic lung problems and secondary infections in AIDS patients. Some *Mycobacteria* are common in soil and water. Others live harmlessly in humans until stress compromises our immune systems, giving the microbes an opening to multiply and cause further harm.

Most Deadly Infection

Conventional wisdom about Johne's holds that transmission most commonly occurs through the consumption of manure-contaminated grass and hay. However, in 2006 Bermudez and his colleagues reported in the journal *Infection and Immunity* that it may be through another route — when a newborn calf first sucks at its mother's udder — that the most deadly infection occurs. They compared the infectious ability of MAP cells grown in milk to those grown in a standard laboratory broth. The result: Those milk-raised cells were more than 10 times as effective in entering a model animal cell. "This is the most infectious form of the microorganism that the calf can get," says Bermudez.

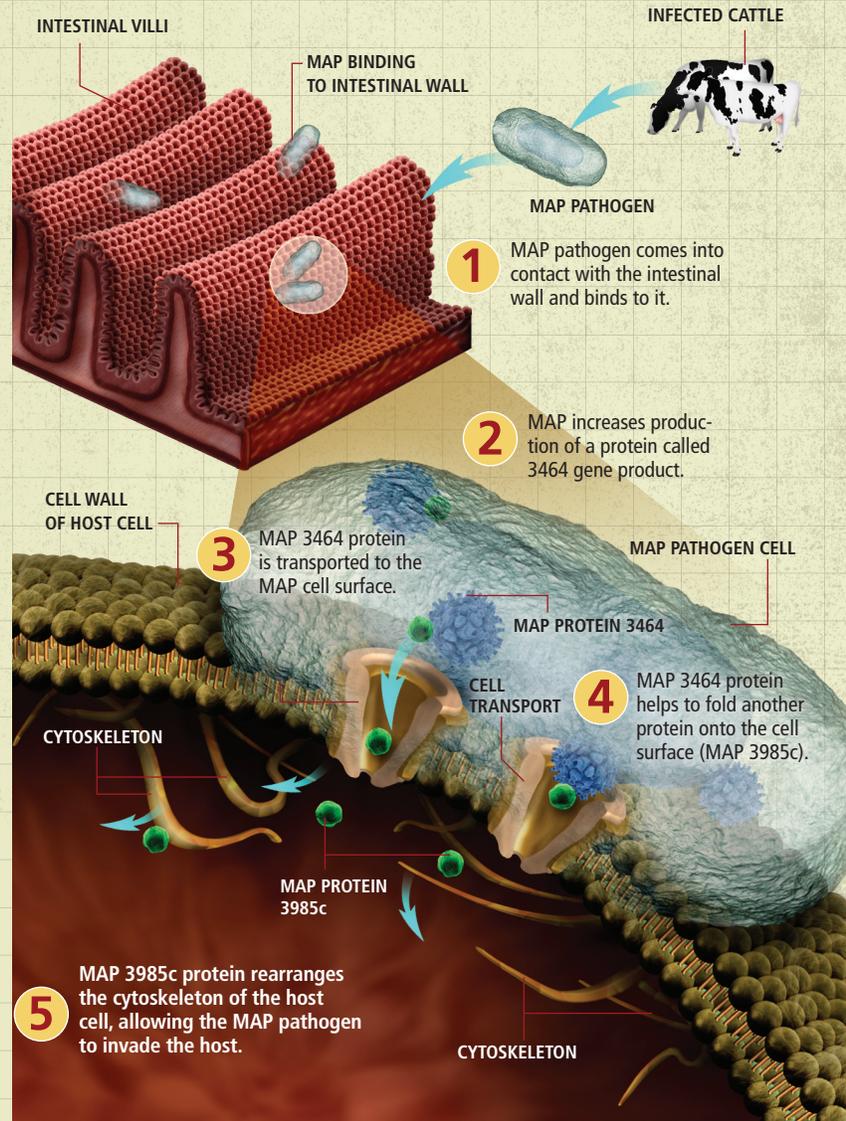
That report followed a series of papers describing the ability of *Mycobacteria* to invade host cells and to thrive inside those cells without being destroyed by the host's immune system. Now, unconfirmed results of further research suggest that the OSU team has identified a mechanism that could prove to be the organism's Achilles heel: the genes and proteins involved in binding the pathogen to a host cell and getting it inside the cell. Like a Trojan horse, once inside cell walls, MAP subverts the cell's own machinery, eventually killing it and releasing a new wave of infection (see sidebar illustration). The new work was conducted by a team including lead author Marta Alonso-Hearn, Lia Danelishvili and Lisbeth Meunier-Goddick at OSU and Dilip Patel, a former OSU scientist now at the University of Tennessee, Knoxville.

"The bacteria are not supposed to get inside those cells," says Bermudez. "For the first time, we have shown that the bacterium has a mechanism that interacts with the host cell and makes the host cell ingest it. This is a very sophisticated mechanism."

Until a more effective vaccine or a less costly treatment is found, however, monitoring and prevention through good sanitary practices are still a farmer's best protection, adds Bermudez. He serves on the scientific advisory board of a national research initiative known as the Joint Integrated Johne's Disease Program at the University of Minnesota, a collaboration of 21 universities funded by the USDA.

For Buzz Gibson, testing for Johne's amounts to good insurance. Annually, he insists that his veterinarian take blood and fecal samples from 35 to 40 cows and send them to

Paratuberculosis (MAP) and a Host Cell

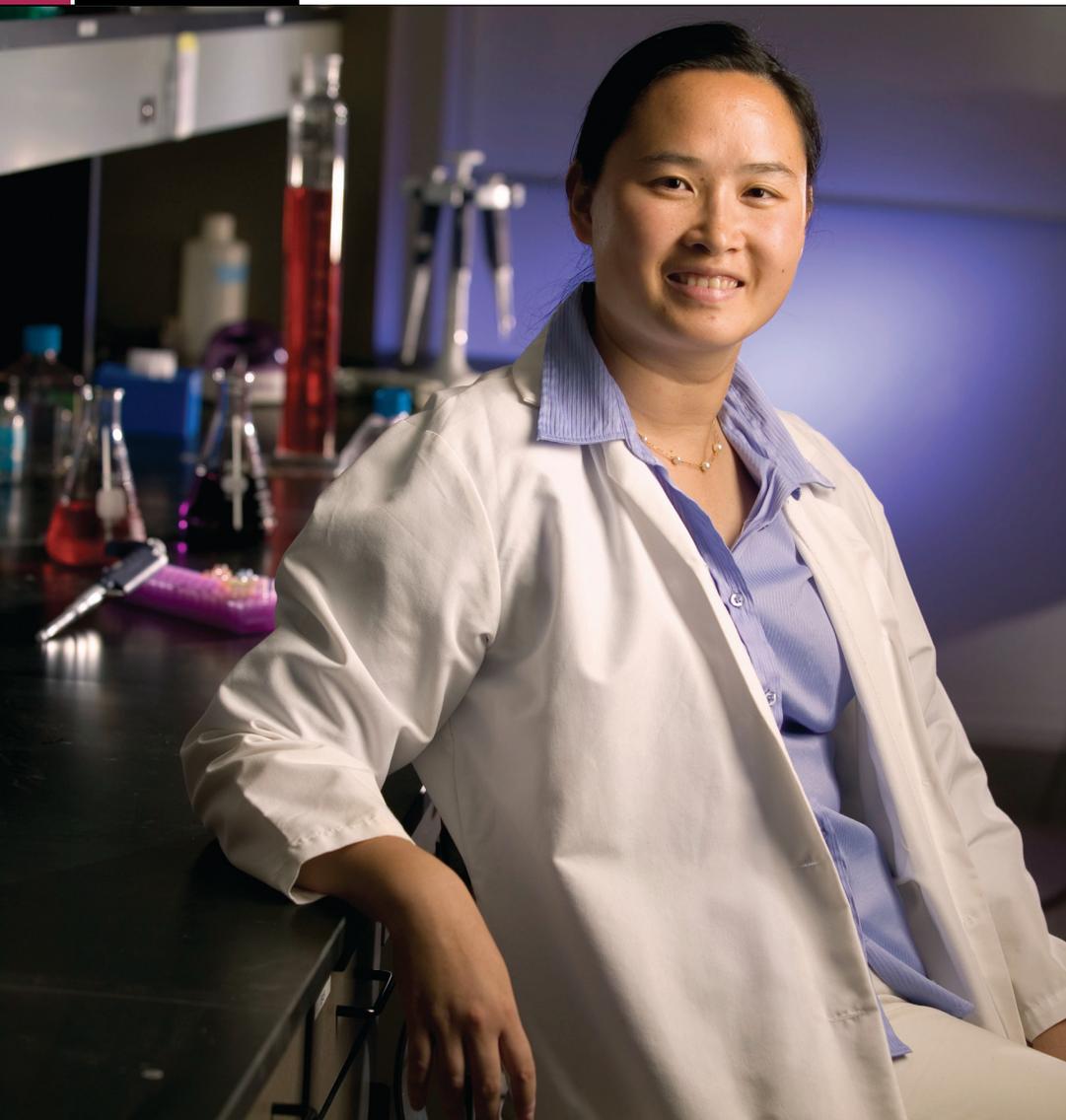


(Illustration: Tina Ullman, based on unpublished data from M. Alonso-Hearn, et al)

the ODA Animal Health Lab in Salem for analysis. "I want to be ready. I don't want to wake up one morning and see a headline linking Johne's and Crohn's," he says.

The Lochmead dairy milks 580 Holsteins daily, supplying the company's 44 Dari Mart stores from Cottage Grove to Corvallis. The herd is now one of four in Oregon — in addition to those owned by Dean and Patti Tohl in Tillamook, Jack Perrin in Woodburn and OSU in Corvallis — to receive the state's highest level of certification for those that have tested negative for Johne's. **terra**

To learn more about Luiz Bermudez's research in the OSU College of Veterinary Medicine, see oregonstate.edu/vetmed/biomed/bermudez.htm



OSU nutrition scientist Emily Ho spends her days delving into the mysteries of micronutrients — particularly zinc — in the prevention and development of cancer. “Not all cancers have a strong dietary component,” Ho says. “Prostate cancer, colon cancer and breast cancers are the ones that seem to respond to diet.” (Photo: Kelly James)

And even though U.S.-born Chinese have lower rates of prostate cancer than U.S.-born Caucasians (37 cases versus 58), their incidence remains staggeringly high when compared to their Chinese-born peers.

Clearly, life in America puts men at greater risk for prostate cancer. Diet is the most likely culprit, according to Ho. Along with several of her LPI colleagues, Ho is looking hard at the soy-tea-veggie synergy — and the West-East dietary gap. Americans eat just 1 to 3 milligrams of soy each day, compared to the Japanese intake of 10 to 50 milligrams. Fewer than 10 percent of Americans drink even one cup of green tea a day, while the Asian diet typically includes three or four cups. And those critical cruciferous vegetables? Only 12 grams a day in the U.S., versus 55 grams in Japan.

“In the U.S., most of the cruciferous vegetables are either cabbage or broccoli,” notes Ho. “In Asia, we eat a whole *gamut* of cruciferous vegetables, things like bok choy and other traditional Asian greens that are not widely consumed by the typical American family.”

In addition, she has zeroed in on a single nutrient with a unique link to the prostate: zinc. Ubiquitous in the body — found in muscles, bones, organs, cells and fluids — this trace element is most concentrated in the male reproductive system. Semen’s zinc level is 100 times higher than blood’s. And the prostate gland, which produces seminal fluid, contains the highest zinc concentration of all soft tissues.

To Ho, zinc deficiency is a likely smoking gun in the prostate cancer mystery.

“We know that as prostate cancer develops, zinc levels decrease in the epithelial cells — the cells that line the prostate gland,” she says. “But we don’t know why. It intrigues me. I want to try to figure it out.”

Ho’s fascination with the complexities and conundrums of science began when she was growing up near Toronto, the daughter of an engineer and a nurse.

The Zinc Link

When you eat a steaming bowl of tofu and bok choy while sipping a cup of rain-flower tea, you may be doing more than just having dinner. You may also be fighting cancer.

Together, the ingredients of a traditional Asian diet — soy, green tea and vegetables in the cabbage family — may create a potent anti-cancer force in the human body, says OSU nutrition scientist Emily Ho. Sorting out the biological and chemical mechanisms that explain the apparent protective power of these and other nutrients — particularly zinc — is the focus of Ho’s research.

“In the development of cancer, there’s not just one thing going wrong at the cellular level — there are a lot of different things going wrong,” says Ho, an assistant professor in the College of

Health and Human Sciences and the Linus Pauling Institute. “Like a lot of chronic diseases, cancer has a complex etiology. So instead of looking for one magic bullet for cancer prevention, it makes more sense to look at a combination of nutrients.”

The Asian diet may contain the secret to preventing the most prevalent cancer among American men: prostate cancer. Ho, whose parents are Chinese-Canadian immigrants, points to the stunning gap between U.S. and Chinese rates: fewer than two cases per 100,000 Shanghai-born Chinese versus 58 cases among U.S.-born Caucasians. But even more revealing is how that gap narrows dramatically when Chinese men live in the U.S. for five years or more — catapulting to 23 cases, according to recent data published in the *International Journal of Cancer Research*.



(Photo: Kate Rivera)

While other students were slogging through biology and math because they *had* to, she was riveted to cell diagrams and algebraic equations. It was at the University of Guelph where she found her field — along with a mentor to guide her way. A summer research internship with a biologist studying genetic mutations and antioxidants in fruit flies awakened Ho's interest in DNA and antioxidant nutrients. That in turn led her to the nutrition department, where a professor named Tammy Bray was also doing antioxidant research. Bray's work seemed less theoretical than the fruit fly studies, more immediately applicable, more directly linked to pressing problems. Nutrition science appealed to Ho's pragmatic and altruistic streaks. Inspired,

tangle of challenges. As a component in more than 300 proteins, such as p53 — a DNA-repair protein that becomes mutated in more than half of human tumors — it clearly plays a role in fending off rogue cell growth. "We know that zinc combats oxidative damage from free radicals," Ho says. "We know that it plays a role in DNA repair, and that it has important anti-inflammatory properties. We know that it helps shut off proliferation of mutant cells. But the *mechanism* for these processes is still unknown."

The world's best food source for zinc is the oyster. Half a dozen fried oysters will give you 100 percent of your daily require-

type vegetables — in prostate-cancer risk. Collaborating with Oregon Health & Science University, she is conducting a "retrospective" study, looking back at the dietary histories of 400 to 500 older men. Of particular interest is how much broccoli, cauliflower, Brussels sprouts and other cruciferous veggies they've eaten. Blood will be examined, too, for tell-tale DNA changes called "epigenetic alterations," which scientists now know can lead to abnormalities that in turn lead to cancer.

"What we're finding," says Ho, "is that sulforaphane, a compound that's found in cruciferous vegetables, can help reverse some of these epigenetic alterations."

That certain elements, minerals, vita-

The Asian diet may contain the secret to preventing the most prevalent cancer among American men: prostate cancer.

too, by Bray's deep reserves of drive and dedication, she became Bray's protege.

"Tammy *definitely* has one of those infectious, enthusiastic personalities," says Ho. "She's a tough lady to keep up with, so everyone in her lab has a really strong work ethic and a lot of passion about what they do."

Ho followed her mentor to Ohio State University to get her Ph.D., and then went to UC Berkeley for postdoctoral work. After Bray became dean of the OSU College of Health and Human Sciences, Ho applied for a position in the Nutrition and Exercise Sciences department. "I'm very happy to have Tammy as my boss again," says Ho, whose husband, Malcolm Lowry, is also at OSU, doing immunology research in the Microbiology Department.

Ho is attacking the prostate-cancer riddle on a number of fronts — both in the lab and in the field. Just understanding the biochemistry of zinc presents a

ment. Coming in second is beef, although three ounces of pot roast provide only half the zinc in six of the slippery shellfish. But as Ho cautions, loading up on any one nutrient — particularly in synthetic form as a tablet or capsule — may not be effective in promoting health and preventing disease. Her research, and that of her fellow LPI scientists, suggests that whole foods and natural, full-spectrum supplements contain not just essential nutrients, but essential *combinations* of nutrients. In rat studies, for instance, she and her colleagues have found soy and tea together have a much stronger anti-tumor effect than either food alone. The same two foods also combine to significantly reduce hyperplasia (rapid, abnormal enlargement) in rat prostates. "Soy and tea," Ho says, "may inhibit signals in proteins that ultimately contribute to cancer."

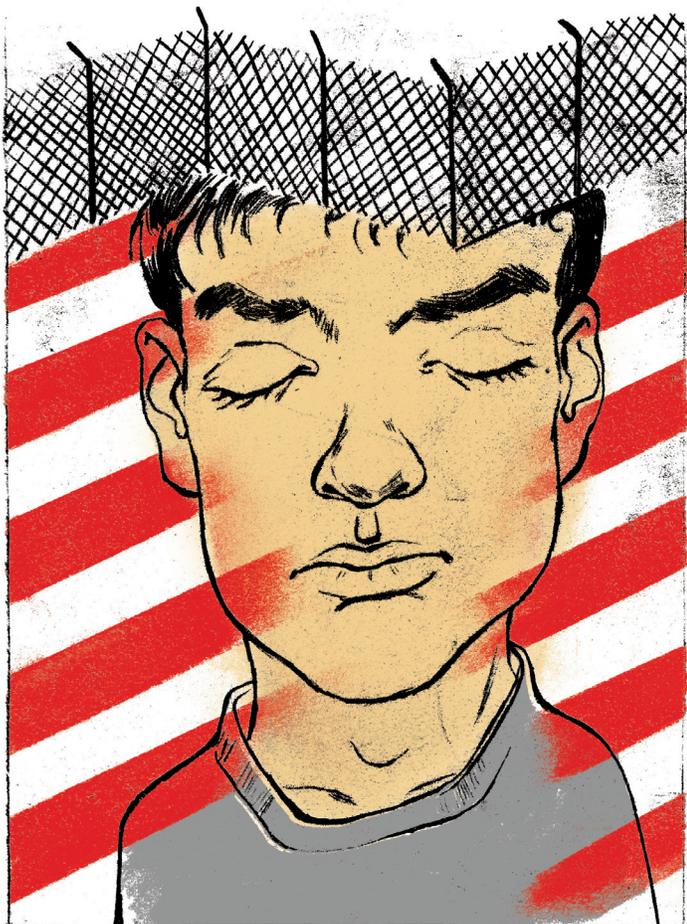
She's looking, too, at the other key ingredient of the Asian diet — cabbage-

mins and compounds occur side-by-side in nature is, Ho says, "no accident." Teasing out the mechanisms of one microscopic substance — zinc, for instance — is daunting enough. Figuring out the interactive roles of an entire complex of substances is the holy grail of the nutrition sciences.

For Ho, that quest comes down to something very personal, something very human. "I feel like the research we do — even though it's mostly basic science, with my students working at a lab bench with a pipette — ultimately could have a big impact on my own family and yours," she says. "That's what's exciting for me."

— By Lee Sherman

To learn more about Ho's research on zinc and prostate cancer, see lpi.oregonstate.edu/ss05/zinc.html



(Illustration: Edel Rodriguez)

Young Immigrants Growing up in a strange land

By Nick Houtman

Coming of age in a new land is an American story. Children who bridge two cultures — their parents' homeland and their adopted country — struggle to find a transnational identity and to succeed. In a child's mind, memories of friends, familiar play places and sounds compete with a strange world and unintelligible language. In school, peers dress differently and may ignore or make fun of a newcomer. It's a common experience, no matter a child's previous social status, ethnicity or place of origin.

For Mexican children coming to Oregon with their families, the journey often includes farm labor, worries about legal status and adjustment to a cold climate. A team of Oregon State University and University of Oregon researchers has now collected some of their stories in a new

report, "One-and-a-Half Generation Mexican Youth in Oregon: Pursuing the Mobility Dream," due to be published in the *Latino Research Review*, a journal at the State University of New York at Albany.

The authors — Erlinda Gonzales-Berry (chair, Department of Ethnic Studies), Marcela Mendoza (University of Oregon) and Dwaine Plaza (associate professor, Department of Sociology) — interviewed a dozen Oregon State University students who were 7 to 15 years old when they left friends and family behind to start a new life in *el Norte*. The youths' parents, undocumented farmworkers, legalized their status through the Immigration Reform and Control Act of 1986. The researchers' goal was to identify the barriers — personal, social and economic — that keep many of these youths from fully contributing to their new homeland.

The late 20th century increase in Mexican immigration resulted in a 144 percent rise in Oregon's Hispanic population between 1990 and 2000. The authors analyze the youths' experiences in the context of this history and of acculturation theory, which relates identity development to crossing cultural divides. They conclude with recommendations for public policies aimed at increasing the chance that

“It's really difficult for us to be the first in the family to go to college. We have to learn English, learn the American way of how professors expect you to behave and do in school. You have to deal with everyday discrimination and prejudice.” – Student participant in mobility study

children in similar circumstances will be successful in their new country.

While the report protects students' identities, it describes memories of home and stories about crossing the border, going to school and the crucial support of families and peers in adjusting to college life. Common themes stand out: nostalgia for childhood, dependence on families, struggles with language and prejudice and alienation in high school.

At OSU, these students found support through OSU's cultural centers, especially El Centro Cultural César Chávez, as well as the Migrant Education Program and the Minority Education Office. Several reported that involvement in MEChA (Movimiento Estudiantil Chicano de Aztlan, or Chicano Student Movement of Aztlan), a nationwide student movement, transformed their lives.

The students' experiences have important lessons for policymakers. “Given the growing number of Latino/Hispanic school children in the Oregon school system today,” the authors conclude, “policymakers and educators need to think about how to equip them with the tools and strategies for successful integration rather than having them experience downward assimilation in the future.”

Read the full report on the Web at oregonstate.edu/cla/ethnic_studies/oneandhalfgenerationreport.pdf



Grinding Out Lessons From the Earth

When Jeremiah Oxford, a master's student from Coos Bay, Oregon, isn't in class or writing a paper, he puts his mind to that most unacademic of tasks: grinding rocks. Tedious as it might sound, his work in Robert Duncan's lab in the College of Oceanic and Atmospheric Sciences isn't a punishment. Instead, he is preparing samples of volcanic rock that, when analyzed by a recently developed dating technique, may add details to the story of Earth's violent past.

Students and other scientists in Duncan's lab use rocks from around the world — the Columbia River basin, western India and undersea mountains from the South Pacific to the North Atlantic — to reveal a pattern of massive lava flows that make Mount St. Helens seem puny in comparison. These events occurred millions of years ago, says Duncan, associate dean for student programs, and had wide-ranging consequences, from the creation of petroleum reservoirs to global extinctions of plant and animal species.

Duncan and his team were the first to apply a chemical dating technique to the study of massive lava flows. Their reports have been widely cited in the scientific literature, resulting in Duncan becoming one

of the 250 most frequently cited geoscientists in the world, according to the ISI Web of Science, a scientific information service.

Educational opportunity — the chance for students to be engaged in science — is the other side of the research coin for Duncan, the Rohm Professor of Oceanographic Education at OSU. Created in 1991 by a gift from Alice Rohm, the endowment supports his work with initiatives such as the Native American Marine and Space Science (NAMSS) program, Teachers at Sea and Suitcase Lessons, a set of marine science educational activities.

"I enjoy working with students and helping to excite them with the opportunity to do research," says Duncan who teaches introductory oceanography. He also directs the NAMSS program, pairing students with faculty mentors in five OSU colleges. In turn, these students teach elementary and middle school students through OSU's SMILE (Science and Math Integrative Learning Experiences) program and the annual Salmon Camp at the Oregon Museum of Science and Industry. NAMSS students have a 95 percent graduation rate, with 55 percent going to graduate school.

Framed by OSU's library of ocean sediment cores collected from around the world, Robert Duncan, right, explains to Paul Walczak of Nehalem, Oregon, how the cores are catalogued. Then a master's student, Walczak is now a faculty research assistant in the College of Oceanic and Atmospheric Sciences. (Photo: Dennis Wolverton)

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Mule deer are vigilant in the presence of predators. As deer, elk and other browsers keep moving to stay one step ahead of cougars and wolves, they leave behind tree seedlings and other vegetation that support a diverse ecosystem. For more information about this "ecology of fear," see "High Alert," page 3. (Photo: Gary Zahm, U.S. Fish and Wildlife Service)

Listen to OSU researchers, follow their stories and see more photos, at oregonstate.edu/terra.

