

grow

Wisconsin's Magazine for the Life Sciences • Spring 2009

agriculture • food • health • environment



Cry Wolf

Inside gray wolves' stunning comeback—and uncertain future



COLLEGE OF AGRICULTURAL & LIFE SCIENCES
University of Wisconsin-Madison

MANURE ENTREPRENEURS •

IN SEARCH OF EXTREME MICROBES •

DO PROBIOTICS WORK?



TAKING THE HEAT: The steaming waters of a bubbling mud pot in Yellowstone National Park are no match for extremophilic microbes, which have a remarkable ability to survive tough conditions. Microbiologists are interested in what else bugs like these can do. Read more on page 20.

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Wisconsin's Magazine for the Life Sciences

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Gray wolves have made a remarkable comeback in Wisconsin, but as their numbers have grown, so have clashes with humans and wildlife.

Is hunting wolves the next step?

By Erik Ness

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ON THE COVER:

A gray wolf peers out from its wooded habitat at the Milwaukee County Zoo.

Photo by Wolfgang Hoffmann

Dean Molly Jahn

The Lessons of Henry A. Wallace



I've been catching up on some history lately—history that I believe points us toward the future.

I recently had a chance to see an excellent documentary about Henry A. Wallace, Franklin Delano Roosevelt's first secretary of agriculture and second vice president. I had of course been well aware of Wallace's contributions to the science and practice of agriculture, but I had not understood until I watched this film just how relevant Wallace's story may be to our present circumstances.

Wallace was one of the first farmers to apply modern principles of systematic scientific experimentation in his farming operation. Based on his experiments with hybrid corn seed, he launched one of the pillars of the agricultural industry, Pioneer Hi-Bred, in 1926. But he was above all a visionary thinker who was willing to challenge the status quo, and he was called into public life at the precise time that such people were desperately needed.

As FDR's agriculture secretary, Wallace designed revolutionary concepts

We envision a future where farms provide our food and the foundation of a new energy economy, but to achieve it, we must remember the legacy of Henry Wallace.

that bolstered the farm economy in the height of the Great Depression. He put into place programs that stabilized farm income, controlled food production and prevented soil erosion—steps that paved the way for our most productive era in the history of agriculture and set the stage for the Green Revolution.

Wallace understood that economic prosperity grows from the roots of sound agriculture and food policy. As our country emerged from the Dust Bowl, agriculture led the country's recovery. When our food systems and our farmers regained security, the way was opened for the great industrial and technological revolutions that followed.

Today we again find ourselves in critical need of Wallace's brand of bold, persistent experimentation. And again, agriculture must be the steward of hope. We envision a future where farms provide our food and the foundation of a new energy economy, but to achieve it, we must remember the legacy of Henry Wallace. He showed us that sound investments in agricultural research and policy pay off, even in the hardest of times.

The documentary Henry A. Wallace is available through Iowa Public Television. Visit www.iptv.org for more information.

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On Henry Mall

News from around the college

Working It

More CALS students gain real-world experience through internships.

In days not so long ago, an internship ranked as a rare plum on a student's resume, a unique and coveted experience that few could claim.

Not anymore. According to a recent survey by the CALS Office of Undergraduate Programs and Services, 43 percent of students who graduated from the college last spring had completed at least one internship for academic credit before earning their degrees. And Christina Klawitter, CALS' former director of career services, says that interest in internship opportunities is continuing to rise among both students and employers.

"I see students interning everywhere from small, family-owned farms to multinational companies and everything in-between," says Klawitter, who helped build up the internship program before accepting another campus job last fall.

For students such as Josh Burling, an internship can connect classwork with real-life experience in meaningful ways. Burling, who hopes to pursue a career in forestry, spent last summer working with Nicolet Hardwoods, a 100-year-old, family-owned business headquartered in Laona, Wis. Shadowing veteran forester Steve Guthrie gave Burling an insider's view of the industry from the forest to the mill floor—a perspective that no textbook could recreate.

"It gave me good real-world experience with the economics of the wood industry and how the market affects what you're doing in the field," he says.

Chelsea Cervantes had similar luck with an opportunity much farther away. Cervantes, who is double majoring in soil science and agricultural and applied economics, made contacts on her own to set up an internship with the German Protestant Institute of Archeology in Jordan, where she worked on a wetland irrigation project. The experience has



helped define her career goals, which include working for an international company on water issues.

"It actually created more opportunities than I ever imagined," Cervantes says.

But students aren't the only ones who benefit from internships, says Klawitter. For employers, interns can bring a fresh perspective and a needed hand to take on neglected projects. And while many interns are paid, others work for academic credit or are supported by gifts from donors, making hiring students an economical option for companies.

"To me, internships are win-win-win: good for the companies, good for the universities and good for the students," she says.

—CAMILLE ROGERS

Student Chelsea Cervantes consults with Carl Dowse BS'78, manager of irrigation projects for The Bruce Company, where Cervantes works as an intern to augment her education.

Legacy of the Dam

To restore a former reservoir, CALS scientists battle history in the soil.



Ana Wells and professors John Harrington (left) and Nick Balster (right) measure soil respiration in a former dam basin at Franbrook Farm.

For most of the past 150 years, Wisconsin's proud Badgers might as well have been beavers, so busy were they damming the state's rivers and streams. To produce electricity, provide water for livestock and control floods, Wisconsin built some 3,800 dams by official estimates—or as many as 10,000 by unofficial counts—more than any other state.

As those structures grow old, obsolete and hazardous, however, many dam owners are embracing a new, free-flowing era, dismantling the dams and returning waterways to their natural course. But as long-submerged lands spring back to life, the consequences of dams can linger long after the structure is gone.

That's what soil scientists Nick Balster and Ana Wells and restoration expert John Harrington MS'83 are finding at the UW's Franbrook Farm, where they are trying to restore a native prairie at the site of a 43-year-old dam removed in 2003. But the scientists have found that soils flooded for decades hold stubborn traces of their past. For one, they've uncovered a striking lack of variety in the knee-deep sediments that piled up during the dam's lifetime and buried the more diverse soils underneath. This uniformity could explain why former reservoirs usually cultivate monotonous blankets of invasive weeds after they are drained, confounding attempts to establish native plantings.

At the same time, the researchers have discovered swirling patterns of nutrients, bulk density and other soil properties that were laid down when the dam was breached and water surged through the break. How these patterns might influence the distribution and growth of native species—including their ability to stand up to weedy invaders—is now a major thrust of the trio's work.

Surprisingly, the researchers say no one else has really done this before. "We're asking the question, 'How much do soils matter in the restoration of these basins?'" says Balster. "As people who love to study soil we're going to say, 'A lot! Soils likely drive the whole thing.' But as scientists, we don't know yet."

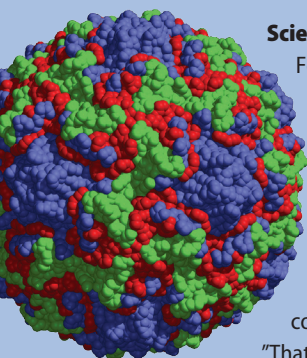
In the meantime, they've been fascinated to watch the development of land that had been underwater and devoid of terrestrial life for decades.

Thousands of earthworms have wiggled down into the fresh dirt, for example, while waves of different invasive plants have washed over the ground each year. And over time, the researchers expect these plant and animal pioneers will feed and mix the nascent soils, transforming the site yet again.

"That's what has been fun for me," says Balster. "You rarely get the opportunity as an ecologist to study and watch primary succession of a plant community into new soils. But we have it here."

—MADELINE FISHER

Something to Sneeze At



Molecular model of a cold virus

IMAGE: INSTITUTE FOR MOLECULAR VIROLOGY

Science may not have a cure for the common cold, but now we have its playbook. In

February, a team of researchers from several institutions—including UW-Madison's Institute for Molecular Virology—revealed the genome sequences of all 99 known strains of the cold virus, the first time the viruses' genetic mechanisms have been exposed in full. "We know a lot about the common cold virus," says Ann Palmenberg PhD'75, a biochemistry professor who led the study, "but we didn't know how their genomes encoded all that information. Now we do, and all kinds of new things are falling out." For instance, scientists might find weak spots in the viruses' genetics that new drugs can be designed to attack. But don't shelve the Kleenex just yet: Palmenberg says cold viruses have a knack for swapping genetic sequences when they meet inside a cell.

"That's why we'll never have a vaccine for the common cold," she says. "Nature is very efficient at putting different kinds of paint on the viruses."

Biofuel Two-Step

Chemical process may be an option for turning biomass into fuel.

In the mad rush to come up with quick, easy ways to turn biomass into fuel, biochemistry professor Ron Raines may have a solution. And it's literally a solution.

Using some inventive chemistry, Raines and graduate student Joseph Binder created a unique mix of solvents and additives that can dissolve cellulose, the tough but energy-rich molecules in inedible parts of plants and trees. After its solvent bath, cellulose is converted into a platform chemical known as HMF, from which a variety of other commodities can be made. Among those end products is a potentially promising biofuel known as DMF, which is sometimes used as a gasoline additive.

While other researchers have been able to turn glucose or fructose into HMF, Raines says this process removes the need for pretreatment of cellulose-rich biomass.

"What we did was show how to do the whole process in one step, starting with biomass itself," he says. "This solvent system can dissolve cotton balls, which are pure cellulose. And it's a simple system—not corrosive, dangerous, expensive or stinky."

The approach also bypasses another problem that has so far vexed biofuels researchers: lignin, the glue that holds plant cell walls together. Often described as intractable, lignin molecules act like a cage protecting the cellulose they surround. However, Raines and Binder used chemicals small enough to slip between the lignin molecules, where they work to dissolve the cellulose, cleave it into its component pieces and then convert those pieces into HMF.

After the second step of turning HMF to DMF, the overall yield for the biomass-to-biofuel process was 9 percent, meaning that 9 percent of the cellulose in the corn stover samples used in the experiment was ultimately converted into biofuel. "The yield of DMF isn't fabulous yet, but that second step hasn't been optimized," says Raines.

But he is excited about DMF's prospects as a biofuel. DMF, he notes, has the same energy content as gasoline, doesn't mix with water and is compatible with the existing liquid transportation fuel infrastructure.

The discovery comes on Raines's first foray into biofuels development, which was supported by UW-Madison's Great Lakes Bioenergy Research Center. Additional support was provided through a National Science Foundation Graduate Research Fellowship awarded to Binder.

—NICOLE MILLER MS'06

How to make a marshmallow peep

Among the infinite variety of Easter candies, Peeps are unique.

It's not their shapes (they come as eggs, bunnies or chicks) or their shrieking neon colors. What sets these ubiquitous treats apart is their texture—a squishy-soft mixture of marshmallow and sugar kind of like a tiny seat cushion. Crafting that sugary sponge involves some simple food chemistry, says CALS food scientist Rich Hartel, who writes about Peeps in his new book, *Food Bites*.

Here's how the perfect Peep is hatched:

Mix the basic ingredients. Like most candies, Peeps start out as a warm solution of sugar and corn syrup. Colors and flavors are added to this gooey slurry, as well as gelatin.

Add air. The slurry passes by a heating tube to whip in zillions of tiny air bubbles to make the mixture foamy. Here's where the gelatin comes in. Gelatin adheres to the surface of air molecules, surrounding the bubbles and keeping them intact throughout the process. Sugar and starch molecules slide in between the gelatin-encased air bubbles.



Squirt the shape and sugar up.

The fluid marshmallow goo is squeezed through a nozzle that traces the desired shape on a conveyor, like using a tube of icing to decorate a cake. Colored sugar crystals rain down to coat the newly hatched Peeps as they rush

by. Eyes, made of carnauba wax, are then painted on.

Sink your teeth in. Fresh Peeps should have a pillowy softness in your mouth. But if a package is left open in low humidity, the matrix of sugar molecules can dry out, creating what Hartel calls "petrified Peeps." Some fans claim that's the only way to eat them.



Spraying Smart

Eco-Fruit growers find natural pest control pays off.

When Bob Barthel was growing up on his family's fruit farm, his father had two pest control tools: a sprayer and a calendar that told him when to use it.

There's still a sprayer in Barthel's shed, but the calendar is history. Instead, Barthel and his wife, Nino Ridgway MS'83 PhD'86, rely on traps for catching insects, magnifiers for identifying them, on-farm weather stations that transmit data to the farm's computers and software that helps them make sense of it all.

"We use daily temperatures, leaf wetness readings, humidity and wind speed to model insect development and fungal infection periods," explains Barthel, a grower in UW-Madison's Eco-Fruit Project, which promotes reduced pesticide use on fruit farms. "Where Dad had to spray once a week, we know when the moth is flying, when the eggs are laid and when (they are) going to hatch. So we can time it exactly to put a material down if needed to stop the wormy apple."

The complex system, known as integrated pest management, has helped the couple cut pesticide use by 40 to 70 percent since they took over the operation. It's also a big reason why the Barthel Fruit Farm became the first orchard in Wisconsin to qualify for "green payments" from the Natural Resources Conservation Service's Conservation Security Program, a five-year-old federal scheme that rewards farmers for actions that protect the land, air and water quality, and wildlife.

Growers such as the Barthels are a big reason behind the success of the Eco-Fruit Project, a part-



Eco-Fruit apples thrive while getting fewer doses of pesticide.

nership between the university and the Wisconsin Apple Growers Association that uses grower-to-grower networks to encourage greater use of integrated pest management. Barthel and Ridgway have been leaders in using integrated pest management for apples and helping educate other growers, says Michelle Miller BS'83 MS'93 of UW-Madison's Center for Integrated Agricultural Systems, which manages the project.

But the Barthels have their own reasons for embracing IPM. Aside from the environmental benefits and the cost savings, the approach makes life on the farm safer and more pleasant.

"Pesticide spraying is the worst job on the farm," says Barthel. "Why do it if you don't have to?"

—BOB MITCHELL BS'76

MICRO • BREW • OLOGY

It sounds like a student's wildest dream—a course in which the homework is beer.

But Microbiology 375: Introduction to Zymurgy is no party. The new course—built around pilot-scale brewing equipment donated to the college by MillerCoors—aims to teach upper-level microbiology students the finer points of fermentation, a process used to produce foods like bread and wine, antibiotics and pharmaceuticals such as human insulin. Students must show off mastery of this science while making four progressively more challenging brews, which are graded for quality and purity. And while instructor Jon Roll BS'88 PhD'96 says students do have an opportunity to sample their work, beware: This is one class that cards. Only students over 21 can participate in class tastings.

Student Russell McMinn pours ground malted barley into a mash tun during CALS' new class on the scientific techniques of fermenting beverages like beer.



Lethal Weapon

Soils may harbor a surprising prion killer.

Scientists have tried about everything to kill prions, the pernicious pathogens that are believed to cause chronic wasting disease and a host of other fatal brain diseases. Fire doesn't work. Nor do radiation, chemicals or autoclaving, all of which reduce the infectivity of prions but fail to completely eliminate them.

But Joel Pedersen, a CALS professor of soil science and environmental chemistry, may have uncovered a surprising new weapon against prions—and it's been underneath our feet all along. Pedersen and his collaborators have found that birnessite, a common mineral found in soils, can penetrate prions and degrade the proteins, offering a hopeful new strategy for decontaminating prion-infected soils.

Previous studies have shown that prions can survive in soil for at least three years. It is likely that these prion reservoirs play a critical role in spreading the pathogen among animals. "We know that environmental contamination occurs in deer and sheep at least," Pedersen says.

Birnessite, an oxidized form of manganese found in poorly drained soils, is among the most powerful oxidants in nature, says Pedersen. But while the mineral degrades prions in solution, the team has yet to test whether it can do the same to prions in soils. If it can, birnessite may become a useful tool for cleaning prion-infected soils in barnyards and the wild. "I expect that its efficacy would be somewhat diminished in soil," says Pedersen. "It's something we'll explore."

—TERRY DEVITT

Number Crunching

55 PERCENT OF WISCONSIN RESIDENTS SAY THAT DUCKS ARE REQUIRED FEATURES OF A WETLAND, and 54 percent say the same thing about open water. Neither are, and that could signal a problem for stemming the destruction of Wisconsin's remaining wetlands, says life sciences communication professor Bret Shaw, who led the survey. "The poll's results suggest that people are much less familiar with the drier, less obvious wetlands," which typically face the biggest threats from development and agriculture. The good news: 84 percent of respondents said they were concerned about Wisconsin's loss of wetlands, which Shaw says is a remarkable shift in attitudes toward wetland preservation.

brent mccown

BS'65 MS'67 PhD'69



- **job** Professor of Horticulture
- **lab** Multiple sites, including a research lab in the Horticulture Building and field locations around the state
- **what I do** Research and teach about the growth and propagation of various plants, including cranberries, trees and other varieties

What's the research question on your mind right now? Lately I've been doing a lot of work on sustainable cropping units. We're asking how we can document the benefits these systems can provide to an ecosystem.

What's the most unique feature of your lab? Our horticulture laboratory contains a unique facility to support the maintenance and growth of crop plants in sterile test-tube environments.

Where do you get your best work done? For my deepest and most complex data collection, it's in the field. For my deepest and most complex writing, it's alone at our small home in the hills of southwest Wisconsin.

What's your desktop picture? The dominant cranberry flower.

Name something personal in your office and why you keep it there. Thank-you letters and special gifts from past students and visiting associates. These help to keep my mind positive and remind me why I am doing all this work.

Why did you go into research as a career? That's easy. Nothing more exciting than discovering something that was never known before, especially if it involves some cool interactions between different organisms and might lead to understanding a practical problem.

What's the most stimulating part of your day? Teaching—it is even more stimulating than research. I often say the teaching and working with students gives me my high every day, and that's why this is such a great job.

What's the coolest thing you've learned in your work? How to reverse the vegetative developmental cycle of perennial plants like trees. By focusing on the right tissues and using some laboratory growth control techniques, we can mostly rejuvenate an adult tree. But the approach does not work for some plants such as oaks, and no one knows the gene basis for this phenomenon.

WISCONSIN



Seeing the Forest for the Fish

It's been a tough century for fish on Wisconsin's Bayfield peninsula.

Their problems started when the region was logged in the late 1800s. Without the shade of a forest canopy to slow the pace of spring thaws, trout streams surged with melt water, overwhelming newly hatched trout and depositing layers of sand over the gravel beds where fish spawn.

But even when forests returned, the fish continued to struggle. The spring floods persisted, turning trout streambeds into "a sand desert," explains Dennis Pratt, a fisheries biologist with the state Department of Natural Resources.



Younger, thinner trees surrounding trout streams like this one in Bayfield County may be changing the pace of spring thaws.

So why didn't the return of trees help save the fish? To answer that, Pratt turned to CALS forest ecologist David Mladenoff MS'79 PhD'85, who began to suspect the reason for the rapid melt was in the trees.

"I spent a lot of time thinking about what could be different about the pre-settlement forest, and the big thing was the big evergreen conifers that had dominated the landscape," Mladenoff says. "We lost those large conifer trees like white pine, red pine,

hemlock and cedar." In their place, aspen and other trees grew, making for a younger, more open forest. Mladenoff theorized that the conifers' dense branches and evergreen needles kept snow from reaching the ground and created more shade, extending the time needed to melt off the snowpack.

To test the theory, graduate student Jordan Muss picked 33 sites on the peninsula where relatively pure stands of nine tree species live. For the next three winters, he visited each site to measure the snow on the ground and calculate how much water it held. He says he found significantly more snowpack underneath deciduous species than under the conifers, supporting the notion that the amount of snow on the ground is directly linked to the density of the canopy above. Mladenoff plans to incorporate the findings into a model that predicts how forests change over time under certain management practices, which could help forest managers identify species or cutting strategies that lead to less snow on the ground and a longer melting period.

"When any resource manager has a tool like that model, it gives them better options to set land management goals that also protect the fishery," says Pratt. "This tool is giving them a better opportunity to both set that goal and get there. It's a real positive thing for both the forest and the fish."

—BOB MITCHELL BS'76

HONDURAS



Playground Design is More than an Exercise

One of the failings of university learning is that the work of students sometimes can get left on the shelf. Assignments, though faithfully completed, too often don't make it out of the theoretical.

So imagine the thrill for Curt Staats, a senior majoring in landscape architecture, to stand in a remote Honduran village and see one of his school projects come alive in grass, sand and stone.

Under the direction of professor Sam Dennis, Staats designed a children's playground for the townspeople of Orica, a small village in central Honduras where his church has done service work. He and Dennis have since led two service-learning trips to the Central American country, where teams of students and community volunteers are working to build Staats' vision.

"This is really the first big project I've worked on," says Staats. "It's pretty exciting to see it come together."

Children from the Honduran village of Orica are eager to dig into building their playground. Meanwhile, Sam Dennis and Curt Staats test out the equipment (below).



The playground grew from a church trip to Honduras, during which Orica's mayor described his town's need for a place for children to play. Staats, a former woodworker who returned to school to study landscape design, volunteered to lay out a playground on a patch of city land.

To design the park, Staats drew on Dennis' research, which focuses on using natural elements to stimulate community and creative play. In Honduras, students have worked side-by-side with local laborers to make the design a reality, installing equipment, planting gardens and hauling sand from a nearby river to fill sandboxes.

"We're carrying blocks or digging a trench together, and that becomes a way for us to have something in common," says Dennis. "It's a true partnership that continues to deepen over time."

—MICHAEL PENN

SENEGAL



Putting African Onions in the Pink

West Africans are choosy about their onions. In produce markets, people turn up their noses at red or yellow bulbs, preferring only the pink-hued onions of a locally grown variety known as *Violet di Galmi*.

Because red, yellow and pink onions all grow from this variety, onion growers end up taking a loss

on the undesirable shades. And that's a problem that Tropica Sem, a West-African seed company that supplies most of those growers, would like to see solved.

In 2007, the company called on CALS onion breeding expert Michael Havey MS'83 PhD'84 to help them grow a higher percentage of pink onions in their production fields near Dakar, Senegal's capital city. Havey showed Tropica Sem's breeders how to stabilize the pink-color trait in their population of *Violet di Galmi*.

"I showed them how you can select plants that breed true for pink bulbs and then make what we call a synthetic population," says Havey, a horticulture professor and a researcher for the U.S. Department of Agriculture. "It's a population that's been developed using the best of what existed naturally in the open-pollinated cultivar."

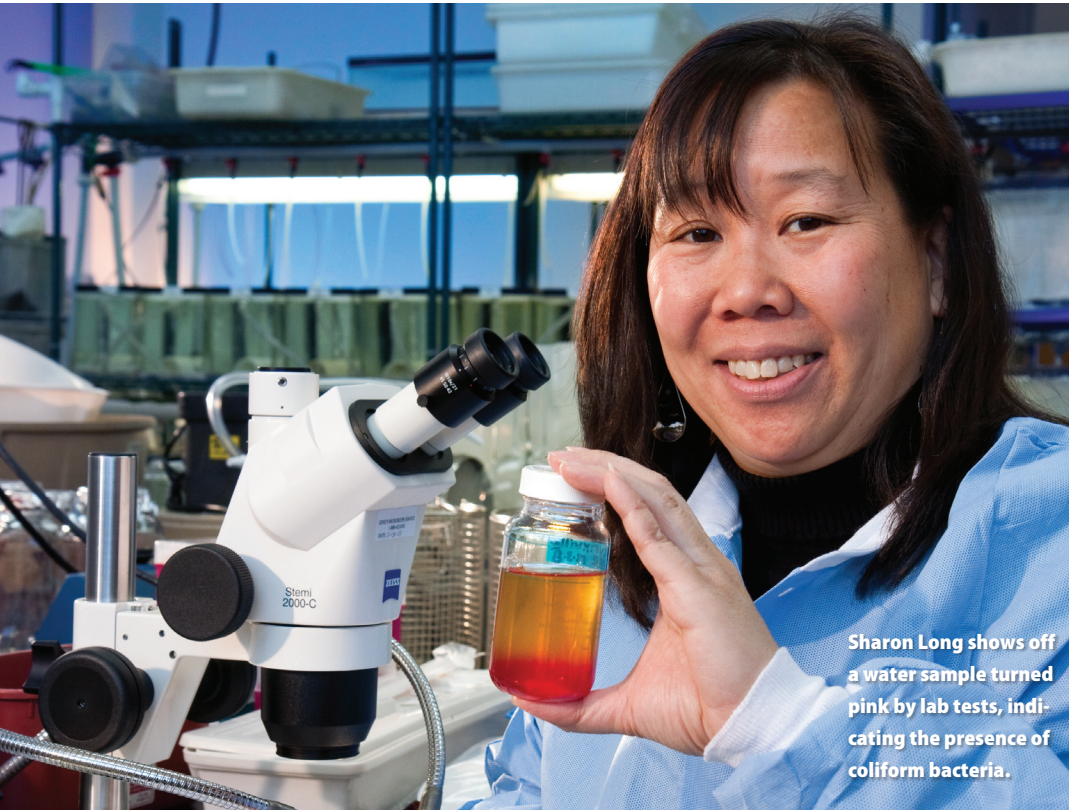
But Havey brought something else, as well—a collection of onion seeds for a plant he developed in UW's Walnut Street Greenhouses and Arlington Experimental Farm. The seeds will enable the company to develop hybrid onions, which although more expensive than traditional open-pollinated varieties, could open new markets for African onion growers.

"One of the goals of this work is to help small seed companies in Africa so that not all of the seed is coming from outside the continent," says Havey, "but, instead, these local seed companies are able to serve their individual markets."

—NICOLE MILLER MS'06

What's in the Water?

When disease-causing microbes find their way in Wisconsin's water supply, **Sharon Long** uses the tools of microbiology to spot them—and find their source.



Sharon Long shows off a water sample turned pink by lab tests, indicating the presence of coliform bacteria.

And you need people who can solve problems. One of the things I really like about Wisconsin is that it's so interdisciplinary by nature. I can have a foot in all of these camps and hire students from each of those areas.

Q Your work with the State Laboratory of Hygiene is very applied. Is it common for a professor to have that role?

Yes, that's been the tradition. The lab is technically part of the university, and they always try to have a strong connection to the research community here. My role is really to bring in the research perspective—to bring in the tools that allow us to figure out what might be making a water sample unsafe and how the pathogens got there.

Q Where do the samples come from?

All over the state. The lab is a client-based service, and so anyone can send a sample in to be analyzed. We get a lot of samples from private well owners who want to be sure that their well hasn't been contaminated by animal waste or other things. And we also test for a number of municipalities, including Madison and Milwaukee.

Q Is this routine testing, or are you investigating problems?

It can be both. For instance, we did a lot of testing after the floods last summer. When people came back to their homes, many were worried about flood waters going over the tops of the wells, and a fair number of those tests did come back unsafe.

Q What happens then?

Well, in that case, we worked with the Department of Health and Family Services and the Department of Natural Resources to get information out to people in the affected areas. Generally, the first thing they do is super-chlorinate the well and pump it through. Then, if it comes back contaminated again, we try to find out what's in there and where it may be coming

SHARON LONG is an associate professor of soil science in CALS, but that title only hints at her multidimensional role for the university and the state. As director of environmental microbiology for the Wisconsin State Laboratory of Hygiene, Long runs a public-service unit that analyzes some 60,000 water samples each year, part of the state's effort to keep its wells and drinking water safe from microbial contamination. As if that weren't enough to keep her busy, she has appointments in UW-Madison's Nelson Institute for Environmental Studies and the College of Engineering's civil and environmental engineering department.

Q What's with all of your titles?

Well, my work is very interdisciplinary. When you're talking about tracking pathogen sources in water—and keeping them from reaching people—you need access to people with a bunch of different backgrounds. You need people who understand microbiology. You need people who understand public health. You need people who understand laboratory testing.

from. We start looking to see if there's a continuing source of contamination.

📍 And that's where your research comes in.

Right. The first level of testing generally just tells you about the presence or absence of coliform bacteria, which we use as a broad-level indicator because they live in almost every warm-blooded animal. So that test tells us that we may have some kind of contaminant getting into the water supply. Then the question becomes what kind of contamination we're dealing with and in what quantity. There is a standard set of microorganisms we can look for, and that's the path that pretty much any public-safety lab would follow.

But if the question becomes about more than just identifying the particular pathogen, we do have some tools that allow us to start to figure out where the pathogens came from. The field is called microbial source tracking, or MST. We have tests that can tell us whether the source of the pathogen was human or non-human, and there are even some tests that allow us to go deeper than that and ask what kind of animal was the source of the contamination. For example, we

📍 It sounds like CSI.

It is. But really, it has only been within the past 10 years that science has progressed enough to do this. People have been studying source tracking since the 1970s, but we're finally getting to the point where we can apply it with some level of certainty.

📍 I understand you've used this technology recently in a contamination problem at a restaurant in Door County. Can you tell me more about that case?

Yes, that was really fascinating. This was a brand-new restaurant in one of the popular vacation areas up there, and not long after it opened, a number of people got sick. The concern was that since there was a lot of agriculture in the area that maybe there was contamination from animal waste. But when we applied our source tracking, we found human markers, meaning that it had to be a human source. It turned out that a pipe from the septic holding tank was not hooked up properly, and the sewage was going straight down into the aquifer and reaching their well.

“People have been studying source tracking since the 1970s, but we're finally getting to the point where we can apply it with some level of certainty.”

can do a test where we discriminate between grazing animals and all other animals, which could tell us if the contamination was coming from a nearby farm or some other source.

📍 How can you tell?

Every species of animal has a unique intestinal environment and therefore a unique mix of microorganisms that live in that environment. The idea is to use some high-level microbiology to identify differences in the microorganisms that can tell us where they lived. So if we have contamination in a new residential development that is located next to an active swine farm, you want to look at those microorganisms and figure out whether they came from humans or pigs. If it's humans, you would want to look at the septic system as a likely source of contamination, but if it's pigs, you'd try to see if animal waste was contaminating the water supply.

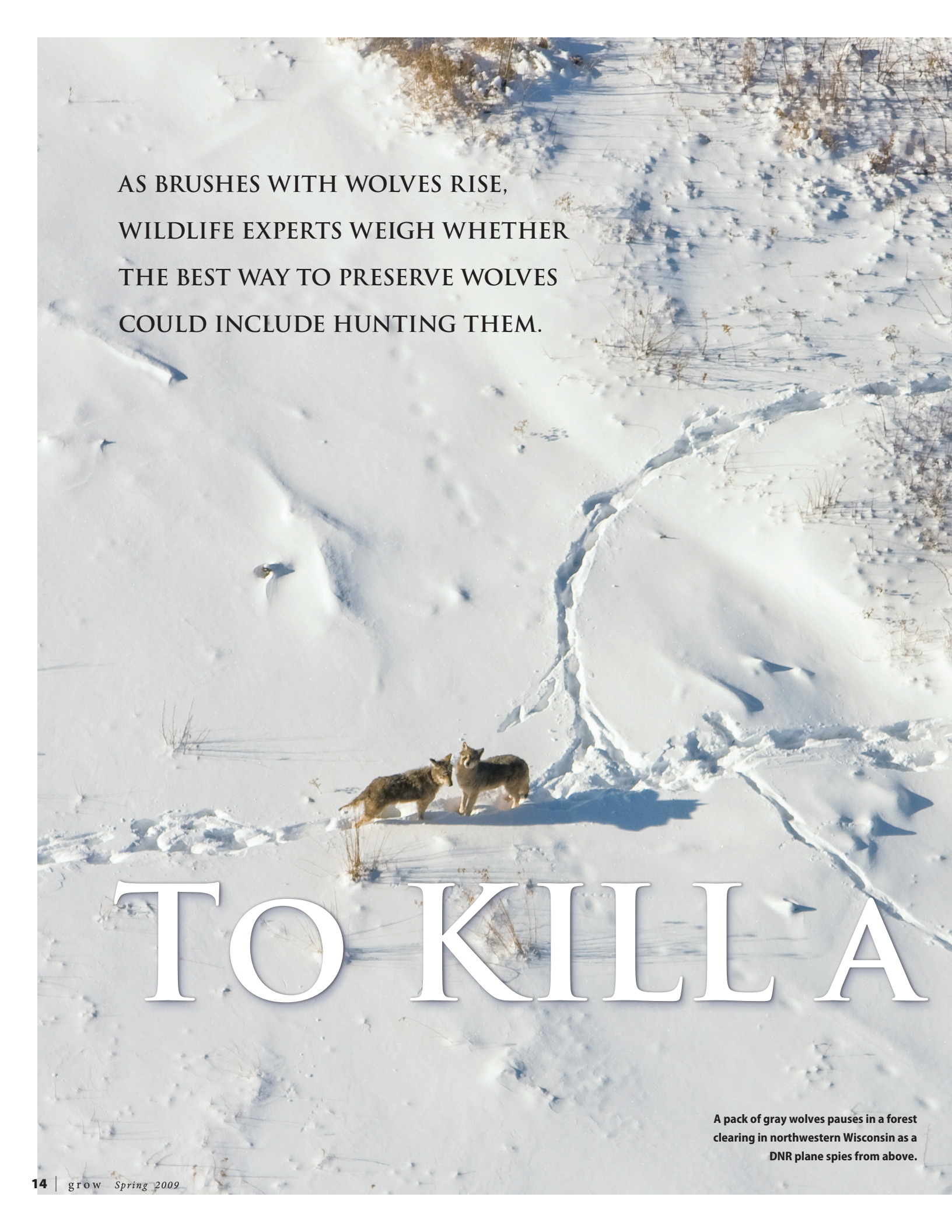
📍 Do you think pegging the source as human helped identify that problem?

Certainly, because it put the focus on the septic system. It was a brand-new system, and it was very well designed, so there wasn't much reason to suspect it would be a problem. But the test caused the county to go back and reevaluate it.

I hear the restaurant has since put in a state-of-the-art system for treating its well water. They've probably got the cleanest water in Door County now.

📍 That's good news. But seeing all these cases of contamination—does it ever make you think twice about drinking tap water?

Not at all—at least not in this country. One of the societies I belong to is the American Water Works Association, and at their annual conferences they actually pay extra to make sure that all of the water bottles are filled with tap water. We've got great water, and I never think twice about it. 📍

An aerial photograph of a snowy forest clearing. Two gray wolves are standing in the lower center of the frame, facing each other. The ground is covered in a thick layer of snow, with some dry grass and small shrubs visible. The lighting is bright, casting soft shadows. The text is overlaid on the upper left portion of the image.

AS BRUSHES WITH WOLVES RISE,
WILDLIFE EXPERTS WEIGH WHETHER
THE BEST WAY TO PRESERVE WOLVES
COULD INCLUDE HUNTING THEM.

TO KILL A

A pack of gray wolves pauses in a forest clearing in northwestern Wisconsin as a DNR plane spies from above.



EVEN BEFORE WE SEE THE WOLF, WE SMELL IT—a powerful, feral odor like wet dog and wild places. The scent is stronger than usual, muskier. It’s also a little off.

A wolf’s sensitive nose would quickly identify that taint of blood and death, but wolves don’t generally arrive at the Wisconsin Department of Natural Resources’ Science Operations Center in working order. This one lies lifeless on its left side atop a stainless steel table, nose toward a blue surgical cart stacked with supplies for cutting and sampling. It is one of five wolves believed to have been shot around the 2008 gun deer season—a federal offense, given that at the time the gray wolf was listed as an endangered species.

“NOT ONLY DO THEY NOT REQUIRE WILDERNESS,

Veterinary specialist Julie Langenberg begins her forensic investigation with probing fingers, working the animal thoroughly from tooth to tail. The eyes and tongue are deformed from the animal's stint in a DNR evidence freezer, but apart from this and the red gash on its belly, the wolf looks healthy. Long legs below powerful haunches. Thick, mottled coat. Supple, alert ears, one scarred from an old tussle.

It's clear the wolf has been shot, but due diligence is Langenberg's job. She turns the wolf over to reveal another, smaller wound near the muscular front left shoulder. This is probably where the bullet entered, and the incision begins here. A cut down the leg reveals an angry stain of internal bleeding.

Langenberg's scalpel follows the line of fire through bone, tendon and muscle, finally revealing a deep pool of blood within the chest cavity. Her fingers strain the viscera until she finds what remains of the heart. The left chambers are intact, but the right side has been shredded by the bullet. Death came quickly—the wolf would have staggered only a few steps before lying down and bleeding out.

It was a perfect shot, leaving little doubt it was fired with deliberate and lethal intent. Whether the shooter knew he was taking down a wolf is the question. People often mistake wolves for other animals, especially in places where they're not expecting them. And 20 years ago, nobody expected this many wolves in Wisconsin.

As Langenberg works, Adrian Treves watches with careful attention. An assistant professor of environmental studies at UW-Madison, Treves is co-investigator of the Living With Wolves project, a research effort to understand wolves and the controversies that surround them. Treves spends a lot of time trying to figure out why and where



wolves kill calves and hunting dogs, but he also studies people and their attitudes toward wolves—why, for example, someone would take the legal risk of shooting one. Whoever shot this wolf faces a \$2,000 fine and a three-year loss of hunting privileges. Yet of the hunters he and his colleagues have surveyed, 10 percent say they would take the shot if they saw a wolf while hunting.

That sentiment was ratified last spring when the Wisconsin Conservation Congress, an advisory board to the DNR, voted 4,848 to 772 in favor of hunting gray wolves in Wisconsin. Although many steps would have to be taken before the state would approve a wolf hunt—and animal-welfare and conservation groups are already considering their responses—the vote is one of several signs that wolves are losing the

protected status they have enjoyed for the past quarter century. The wolf was removed from the federal endangered species list once already in March 2007, and it may be de-listed again soon. Depending on who you ask it is a sign of their remarkable recovery or the beginning of their doom.

For Treves and the handful of other scientists who research wolves, these shifting attitudes raise a host of new questions: Can Wisconsin's wolf population withstand a hunt? Would a hunt actually help protect it? And how do we even discuss the option, given the heated opinions surrounding the topic? How Wisconsin deals with these issues—and the decisions that flow from that discussion—could profoundly rewrite one of the greatest environmental comeback stories of all time.

THEY WILL LIVE ABSOLUTELY EVERYWHERE."

SURVIVAL STORY

For thousands of years, native people and wolves lived together throughout the Upper Midwest. Wolves were an important part of the Ojibway creation stories, regarded as early kin to humans. But many European settlers brought with them an antipathy reflected in fairy tales—a deeply rooted memory of the big, bad wolf. They often demonized wolves, and between hunting and habitat destruction, the animals' numbers declined. In Wisconsin, they disappeared entirely: the last known native wolf died after being hit by a car in 1958.

The environmental awakening that began in the 1960s relaxed attitudes against the wolf, and, under the protective shield of the 1973 Endangered Species Act, packs began to rebound. While wolves have been famously reintroduced to Yellowstone National Park, the Wisconsin wolves came on their own, expanding from packs that had survived in the deep recesses of Minnesota's Boundary Waters.

Because the wolf was believed to be a wilderness species, no one figured the population would get too big in more fragmented Wisconsin. Conservation groups set a rough goal of around 80 wolves for the state, but few imagined it ever happening. Diseases such as sarcoptic mange and canine parovirus kept numbers low, and in the mid 1980s agencies began talking about closing roads to encourage their recovery.

The idea drew the interest of David Mladenoff MS'79 PhD'85, a professor of forest and wildlife ecology, who set out to study how wolf-friendly Wisconsin's landscape was. Using GIS maps and computer modeling, he looked at where wolves had already established themselves and mapped out similar habitat throughout the state. Then he took it to its logical conclusion. "What if wolves actually fill up the stuff that

we've mapped," he says. "What might that mean?"

Mladenoff's projections stunned Adrian Wydeven, a conservation biologist who has led the DNR's wolf team for nearly 20 years. "David was estimating we'd be able to have 350 to 500 wolves in the state," he recalls. "At the time, that just seemed incredible." But the population kept growing, pushing south and west. Official counts now put the Wisconsin wolf population at between 537 and 564.

When Mladenoff rebuilt the model last year with fresh data, he found that while wolves still prefer more remote areas, they have occupied much more of the landscape. "Not only do they not require wilderness, they will live absolutely everywhere," he says. "As long as you don't kill them, or hit them with a car, and there are enough deer, they're fine. And of course, sometimes things substitute for deer."

Chiefly what substitutes are livestock, especially young calves and sheep, and hunting dogs. Between 1980 and 1988, when Wisconsin's wolf population hovered in the teens and twenties, there were only three recorded incidents of wolves killing pets or livestock. But as the population has grown, so have the losses. The DNR says there were 47 cases involving wolf attacks last year. Most of the livestock are calves on beef farms, and the DNR compensates farmers at full market value for lost animals. Wolves also attack hunting dogs, typically when dogs get too close to denning sites on training runs. In 2008, 21 hunting dogs were recorded killed by wolves. The state compensates these losses, too, up to a maximum of \$2,500 per dog.

Adrian Treves and his wife, Lisa Naughton, began their collaboration on wolves in Wisconsin with a stack of the complaints submitted by farmers and hunters. The DNR hoped that Naughton, a UW professor of geography who specializes in human/wildlife interac-

tions, would have some insight on the mounting frustration with wolf attacks. But she was under tenure deluge at the time and gave the folder to Treves. "It was all the complaints—the whole story for each farmer," he recalls. But as he read, he became more and more fascinated. He had expected a monolithic opposition from those who had lost valued animals to wolves. Instead, the range of opinions flowed from seeing wolves' natural beauty to a scorched-earth desire to get rid of them all.

And so was born the Living With Wolves project. Treves concentrates on the patterns of wolf attacks—why some packs depredate and others don't, and why some farms are vulnerable while others are unscathed. Naughton concentrates on public attitudes and damage payments. Both admit they've been drawn further into the wolf project than they expected.

"The fact that wolves made it back on their own into Wisconsin, into a place inhabited by and used by people, gives me more hope for the places I work in the rest of the world where there isn't a big pristine place to put wildlife in," explains Naughton.

At the same time, Naughton and Treves understand that the wolves' success hinges delicately on people's willingness to put up with them. Attitudes toward wolves somewhat resemble attitudes toward politics: About a quarter of people just don't care at all. Another quarter care very deeply, some passionately opposed and some passionately protective. These are the party faithful—bear hunters and anti-hunters—who are unlikely to change their minds. Then there are the swing voters, those who care about wolves and can be convinced with data.

But within that framework are fascinating nuances. For example, Wisconsin residents have been asked repeatedly how many wolves the state should have, and each time the question is asked, the

A line of wolves darts into the shadows of a northern Wisconsin forest, where the animals have rebounded from virtual extinction.

number has increased, roughly paralleling the state's actual wolf population. But even as the support for a larger population rises, sentiment for some kind of wolf control is rising as well.

"People seem willing to tolerate a larger population of wolves, but at the same time they are less tolerant of the problems associated with wolves," says Treves.

SHEEP'S CLOTHING

The wolf's shifting status as an endangered species provides a window into that conflict. In March 2007, the U.S. Fish and Wildlife Service moved to de-list the wolf in areas that it deemed the wolf population sufficiently recovered, causing a coalition of animal-welfare groups—including the Humane Society, Help Our Wolves Live, Born Free USA and Friends of Animals and Their Environment—to sue to prevent a potential hunt. In September 2008, those groups won, and the wolf was re-listed in the Great Lakes region. In January of this year, the outgoing Bush administration announced intent to again de-list wolves in the western Great Lakes and northern Rockies, but the action was stalled by the Obama administration. Few expect that this action will be the last in the wolf's on-again, off-again saga.

Even pro-wolf groups appear divided. Several science-based environmental groups, including the Natural Resources Defense Council and Defenders of Wildlife, did not join the Wisconsin suit, but instead joined a suit over the de-listing of Rocky Mountain wolves. Treves says the rift reflects a philosophical difference: Animal-welfare groups focus on protecting every individual animal, while the more-traditional environmental groups are interested in the overall health of the population.

That divide makes the DNR's policy choice difficult. If the wolf is removed



from the endangered species list, the agency will have to weigh hunting as one of the state's potential wolf-management strategies—a decision that is bound to be controversial no matter which way it goes. "Extremes tend to get featured in the media, and if you go to any kind of public meeting about wolf management, you'll often get representatives of interest groups on either extreme who will say things that don't quite match even their constituencies," says Treves. "And that creates a polarized atmosphere."

That's where the now-silent majority will have its power. How will they interpret the expanding wolf population and the proposals to deal with it? That's what managers like Wydeven want to know and what researchers like Naughton and Treves want to find out.

"A reading of where public attitudes are coming from gives us a sense of what kind of things we can propose," says Wydeven. What kind of regulations will work. Where wolves can live and be accepted as wild neighbors. But

also where a growing wolf population is likely to pose problems.

Certainly, Wydeven knows that patience with wolves wears most thin among those who suffer their losses. "The people who accept these large predators are often the people who don't live near them," he says. "If you look at the people who are living in areas where wolves actually are, (attitudes) still tend to be negative. And I think for long-term viability, we need to do a better job getting better acceptance by people living close to wolves."

Naughton notes that damage payments can help alleviate some of those concerns. "What better way to balance the very uneven costs and benefits of conserving something like a wolf?" she asks. "Most of the U.S. and Wisconsin love the idea of having wolves. But it's a few people who have to absorb the cost by having to be at risk of losing pets and livestock. Compensation doesn't necessarily change individual attitudes about wolves, but it does buy wolves precious political space."

Going to **Extremes**

By Nicole Miller MS'06

**Extremeophilic microbes
have learned how to deal with
near-boiling temperatures
and other brutal conditions.
To microbiologists, that makes
them fascinating—and useful.**

In search of hot springs
to sample, scientists
hike along Yellowstone's
White Creek, which is fed
entirely by the dozens of
springs that dot its path.

KELLY GORHAM





On the icy boardwalk above Black Pool, Tom Schoenfeld is working as fast as his numbing fingers will allow. He lowers a hose into the steaming pool, one of dozens of hot springs in the West Thumb portion of Yellowstone National Park, and then slides the other end into a keg-sized plastic jug. Shuffling along the slick wood planks, he begins piecing together the rest of the water filtration system that he developed for Lucigen Corporation, a Madison-area biotech company where he is vice president of enzyme discovery. The system, which concentrates the bacteria and viruses living within the spring, takes about 30 minutes to set up and an additional two hours to produce a couple of liters of teeming liquid. And though Schoenfeld arrived here at the break of dawn on this freezing September morning, he barely has enough time to get his work done before the tourists arrive. Tourists always delay things.

Despite its name, Black Pool is gemstone blue and perfectly clear. Its scalding waters produce a thick steam that rises from the pool and floats across the boardwalk, enveloping Schoenfeld in a fine mist. Water droplets soak his clothes and frost



A thick mat of colorful microbes carpets the outflow channel of Yellowstone's Octopus Spring, where water is so scalding that only a few microbes survive.

KELLY GORHAM

his eyelashes. As he reaches to switch on the generator that powers his equipment, he hesitates. There's water all over it—and on the electrical cords leading to the pumps.

"Wear your gloves when you turn that on, man," says David Mead, Lucigen's president, who has accompanied Schoenfeld on seven visits to Yellowstone's hot springs. As much as they can, the two look out for each other in the field and so far so good. Neither has been electrocuted, and they hope to keep it that way.

Electric shock, however, is only one of many perils they face collecting biological samples from Yellowstone's springs. Once, a herd of unruly bison flushed the researchers from the edge of a backcountry pool, forcing them to wait several hours before they could return to collect Schoenfeld's equipment. Another time, hiking through a dense forest, Mead tripped and narrowly missed impaling himself on the jagged branch of a downed tree. But above all else, they worry about the hot

springs themselves. According to the book *Death in Yellowstone*, at least 19 people have died after falling or jumping unwittingly into the park's pools, which are heated by an underground volcano. And as the book relates in sometimes gruesome detail, no matter how quickly a person scrambles out, falling into near-boiling water is a death sentence.

But for Schoenfeld and Mead, these risks are worth taking. That's because they believe there are million-dollar microbes living in the park's pools—bugs that, if found and studied, could unlock the doors to major medical breakthroughs and biotechnological advances. And if history is any guide, the bugs are almost certainly there, surviving and thriving in conditions that would kill almost any other form of life.

All Schoenfeld and Mead have to do is find one of them.

Welcome to the adventurous world of extreme microbiology. Like hundreds of other research scientists, Mead and Schoenfeld travel to Yellowstone to seek out extremophiles—microorganisms

that thrive in extremes of temperature and pressure and other inhospitable environments. These bacteria and viruses survive not only in hot springs but in metal-contaminated soils, pools of acid and lakes so salty that crystals bejewel the shoreline. The researchers who seek them out are partly motivated by curiosity, but also by the realization that extreme forms of life, like high-endurance athletes, have some extraordinary abilities. They harbor powerful proteins—known as enzymes—that enable them to make the most of their surroundings, efficiently turning otherwise inaccessible materials into the food and energy needed to sustain life.

"The bottom line," explains UW-Madison microbial geologist Eric Roden, who teaches an undergraduate course on extremophiles, "is that extremophiles can do things that other organisms can not."

Scientists first stumbled onto these rare organisms just a half century ago, when microbial ecologist Thomas Brock, then a professor at Indiana Uni-

"The bottom line is that **extremophiles can do things that other organisms can not."**

versity, found a type of bacteria living in Yellowstone's Mushroom Spring. Brock, now an emeritus professor of bacteriology at UW-Madison, had been searching for an ecosystem hot enough to support only a few forms of life. On a field trip to Yellowstone in 1964, he began examining the spring's outflow channel. Starting at the cool end of the channel, where a lush, colorful mat of organisms covered the streambed, he worked his way up to hotter and hotter sections.

"When I got up close (to the spring), I started seeing this stuff," says Brock, who joined the UW-Madison faculty in 1970. "It didn't have any pigments. It didn't have any chlorophyll or anything like that, but it looked like it was alive."

And it was. Brock was able to grow and study this "stuff" in the lab, and in this way discovered the first extremophile, a heat-loving bacterium he named *Thermus aquaticus*, which is capable of growing at temperatures up to 80 degrees Celsius, not far below the boiling point of water. (Later, it was discovered that *T. aquaticus* lives in most residential hot water heaters, a harmless squatter.)

While this discovery inspired some of Brock's academic peers to start studying extremophiles right away, the part of the story that galvanized commercial bioprospectors came two decades later, when Kary Mullis of Cetus Corporation requested a sample of *T. aquaticus*, among a number of other thermophiles, from a microorganism distribution facility. Mullis was searching for heat-tolerant enzymes that could expedite a common, but cumbersome, DNA analysis procedure called the polymerase chain reaction, or PCR. By chance, the enzyme from *T. aquaticus* worked wonderfully. It's hard to overestimate the impact that this enzyme, known as Taq polymerase, has had on science; it lies at the heart of genetic testing, as well as the forensic

technique known as DNA fingerprinting used to solve crimes and determine paternity. In 1991, Cetus sold the pertinent patents to Hoffman-La Roche for \$300 million, and since then, this technology is believed to have generated more than \$2 billion in royalties.

The commercial success of Taq polymerase helped spark a wave of entrepreneurial interest in extremeophiles. Researchers began to plumb remote environments that had previously been assumed too harsh to support life—places such as permafrost soils, deep-sea vents and the acidic channels flowing from contaminated mines. The microorganisms turned up through these efforts comprise a motley and interesting group. Some munch on dynamite. Others are able, after exposure to huge doses of radiation, to fix their DNA in just a few hours. Another group thrives in lakes as acidic as battery acid.

"I just think they are cool from a biology point of view," says Charles Kaspar, a professor of bacteriology at CALS who has researched extremeophiles. While his main research program cen-

ters around understanding the bacterial pathogen *E. coli*, Kaspar has indulged an interest in acid-tolerant organisms, studying a microbe isolated by a former UW colleague from an abandoned mine in California. He hopes to travel to Costa Rica to scour an acidic lake on top of a volcano for similar bacteria.

But extremeophiles have major implications for the biotechnology, medical and manufacturing industries as well. Their enzymes are used to facilitate certain large-scale reactions, such as extracting metals from composite rock and converting chemicals into new forms. Some of Kaspar's work, for instance, led to the engineering of an acid-tolerant strain of yeast designed to improve ethanol production. But extreme life is at play in more mundane processes, as well. The protein-busting enzymes at work in some laundry detergents trace their roots to thermophilic

Becky Hochstein, a former Lucigen staffer now at Montana State University, scoops water from one of Yellowstone's 10,000 hot springs in a search for heat-loving life.



KELLY GORHAM

Some like it hot

4 microbes that thrive in extreme conditions

• *Thermus aquaticus*



Where it lives: In near-boiling water, from hot springs to hot water heaters. **How it does it:** *T. aquaticus* has adjusted the composition of its cell wall so it doesn't melt at high temperatures. It also contains proteins

and enzymes that function best in the heat. **Notable achievement:** The key enzyme used in some types of genetic testing—Taq polymerase—comes from this bug.

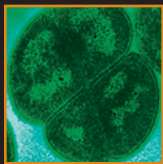
• *Ferroplasma acidiphilum*



Where it lives: In the highly acidic drainage pools of abandoned mines. **How it does it:** By constantly pumping protons out of its extracellular space to keep its internal pH levels close to neutral. **Notable achievement:**

F. acidiphilum uses the iron in pyrite (fool's gold) as an energy source and produces sulfuric acid as a waste product.

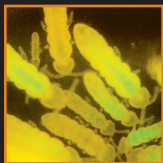
• *Deinococcus radiodurans*



Where it lives: About anywhere—deserts, acid lakes, frozen tundras and even sites of extreme radiation. **How it does it:** *D. radiodurans* has an extraordinary ability to quickly fix its DNA. During lean times

it hunkers down and waits for things to get better, and then when the time comes it quickly fixes its DNA and reproduces itself. **Notable achievement:** Researchers are exploring whether its DNA reassembly mechanisms can be used to piece together fragments of DNA recovered at crime scenes.

• *Pseudomonas putida*



Where it lives: In soils contaminated with solvents like toluene and naphthalene. It also munches on polystyrene foam, a substance that was previously believed to be non-biodegradable. **How it does it:** *P.*

putida's diverse metabolism allows it to be a rather indiscriminate eater. In a pinch, it is able to generate energy by breaking down nasty organic pollutants, detoxifying them in the process. **Notable achievement:** The first organism to be patented, this bug is a potent bioremediator, used to clean up toxic soils.

The agencies said, "Sure it's a fishing expedition,"

bacteria.

"It makes sense to go to natural organisms for biologically active molecules," explains Jo Handelsman, a UW-Madison professor of bacteriology, "because these molecules have evolved, in many cases, over billions of years of natural selection...to perform (a certain) role in nature."

Bioprospecting is one of the major thrusts of the Great Lakes Bioenergy Research Center, the U.S. Department of Energy-funded research effort charged with developing non-food sources of biofuels that is housed in the UW-Madison bacteriology department. The GLBRC helped fund Lucigen's expedition to Yellowstone in the hopes that Mead and Schoenfeld might uncover naturally existing microbes that are exceptionally good at breaking down wood and plant material. By searching in hot-water environments, the researchers hope to find bugs that not only can degrade biomass but are already well adapted to the high temperatures used in the early stages of biomass conversion.

But finding the desired bugs is an inexact science. While Mead and Schoenfeld have worked out some rough guidelines about which pools to sample, they really have no idea what they will scoop up from any given pool. Using the jury-rigged system he designed, Schoenfeld probes the park's hottest pools, searching for viral enzymes for DNA analysis applications. As Schoenfeld monitors his system's progress, Mead meanders around to find nearby springs, measuring each one's temperature and acidity. When he sees a pool with a few bits of decayed grasses or twigs, he gets especially intrigued. Such pools seem likely to harbor bugs that survive by degrading plant material. When the conditions seem right, he dons a heat-proof glove and submerges a liter-sized plastic bottle to collect a sample for analysis back at the lab.

Mead has been lucky before. While working as a staff scientist in a UW-Madison chemistry lab, he helped develop a technology known as TA cloning that became a multi-million dollar product for Invitrogen, the California biotech company that licensed the approach. This success, as well as subsequent research experiences, inspired him to start Lucigen in his basement. "But you know what they say about lightning striking twice," he laughs.

In 2000, Mead hired his first employee, Schoenfeld, who proposed the idea of bioprospecting among Yellowstone's hot springs for viral enzymes. "When I first started thinking about this type of research," says Schoenfeld, "I pulled out some review papers that said people were detecting (viruses in) ocean water and lake water, but nobody had even thought about hot spring water." Before joining Lucigen, he'd already proposed this idea at two other Madison-area biotech companies and been shot down. Scooping up a super-bug containing a super-enzyme not only relies on luck, but some tricky lab work. Before it can be identified, the gene that encodes that super-enzyme must survive the sample preparation process, which often involves chopping all of the sample's genetic material into more manageably sized pieces. Finally, should the enzyme be found, there remains the monumental task of developing it into a useful product that people will buy.

"Until you come up with a product to sell, (the discovery of an enzyme) doesn't really matter," says Schoenfeld. "And you need to make it user-friendly so the customer can just open up a kit and make it work."

While Mead was undaunted by the challenge, he says it was tough finding funding for Lucigen's field expeditions. Even when they finally succeeded, winning a Small Business Innovation Research grant from the federal gov-

but if it works it would be worth it."

ernment, the reviewers didn't hesitate to make their reservations known. "Reviewers don't usually fund fishing expeditions," says Schoenfeld. "But in this case they said, 'Sure, it's a fishing expedition, but if it works, it would be worth it.'"

Schoenfeld applied for a research permit from Yellowstone, which approves between 30 and 50 such permits for microbial research each year. Early on, they met with some luck. Just as their first grant was running out, they discovered a new type of DNA polymerase—an enzyme similar to the famous Taq polymerase, but with some promising differences—in one of the springs along the park's Firehole River. They spent five years developing it into a basic PCR kit for DNA analysis. Now, capitalizing on this enzyme's unique properties, Schoenfeld is in the process of developing a 30-minute diagnostic test that can be used to detect a number of viral and microbial infections, including HIV and tuberculosis. It would require no equipment, and if he can get it to work, Schoenfeld is optimistic that he can make it precise enough to recognize one flu strain from another.

But in many ways, bioenergy is an even bigger gamble. Mead and Lucigen scientist Phil Brumm began building a library of enzymes for the industry several years ago, but they did so recognizing that the industry they hope to sell to does not yet exist. To date, no industrial process for the conversion of plant material to biofuels has proved cost-effective, and research on new methods of bioconversion remains in its infancy. Even as Mead fills his bottles with potentially promising bacteria, he does so with the knowledge that it may take years of lab work before he can say what he has—and whether it can play a meaningful role in making plant-based ethanol a commercial reality.

And that's one of the hard realities of bioprospecting. Although the pos-




David Mead teeters over a boardwalk as he checks the temperature and acidity of a pool, which tells him whether it may be a good source for biomass-degrading extremeophiles.

sibilities are enticing, the work involves a level of delayed gratification. On their visits to Yellowstone, Mead and Schoenfeld stick to their daily routines, performing the repeated tasks of setting up equipment, sampling and packing up with cold efficiency. The only inspirational moments come from the setting—the vast western sky, the steaming landscape, the glimpses of eagles and elk. Otherwise, the hours are filled with hiking and waiting—and hoping that the next bottle will pull up the microbial Moby Dick.

The trips usually span three or four days, but they can still feel incessantly long. The hours getting into and out of the park. The hikes laden with 40-pound packs of equipment. The nights spent at the kitchen sink, re-filtering samples to separate bacteria from viruses. Then an early bedtime so

they can rise and repeat the whole thing the next day.

By the end of their seventh trip to Yellowstone, Schoenfeld will have collected five samples of concentrated viruses, and Mead will have filled more than 20 plastic bottles with bacteria-laced spring water, covering nearly 10 miles of trail in the process. From this catch, they'll continue the search for Lucigen's first million-dollar enzyme, a goal that—as long as it's still ahead of them—will lead them to hot springs sites year after year. They don't plan to stop until they find what they are looking for. It's business, of course, but also something more.

"It's like hunting or fishing in a way," explains Schoenfeld. "The same brain chemical that makes people fish makes us go back for more (enzymes). You want to get the big one." 



Back-End SOLUTIONS

No way around it:

**Dairy farming means putting up with a lot of crap.
But what if dairy's biggest headache became its most reliable asset?
It's happening on one Wisconsin farm.**

By Kate Tillery-Danzer MS'08

VISIT JOHN VRIEZE'S EMERALD DAIRY in northwestern Wisconsin and you'll be struck by what's missing: It doesn't stink. That ripe, rich aroma of rotting manure that so often wafts from the barns and lagoons of dairy operations is absent. On most days the air carries only a hint of silage or fermenting fodder. And Vrieze works hard to keep it that way. "If I'm having a beer on my deck at 10 o'clock at night," says the 56-year-old farmer, whose family has been dairying for more than 100 years, "the last thing I want is to sit out and smell my manure. So why would I expect my neighbors to want to put up with that?"

That Vrieze can breathe in the fresh air around Emerald is no small feat. Cows are prodigious animals when it comes to poop, excreting between 85 and 120 pounds of the stuff every 24 hours. This works out to a good-sized German Shepherd of waste created by every cow, every day. So for a farm like Emerald—which houses 1,650 dairy cows—that means some 150,000 pounds of manure on any given afternoon. Seventy-five tons of dung. Fifty thousand gallons of waste. If it's not fouling up the air, where is it all going?

The answer is that Vrieze's manure is hard at work. It's coursing underground through 36-inch PVC pipes, fractionating into useful components and nourishing a surprising list of living things. Through a combination of expensive technology and innovative design, Vrieze squeezes his cows' patties for every last drop of utility. Instead of managing manure as a problem, he sees it as an opportunity.

"The goal is in two years to have as much net income off the back end of the farm as from the dairy," says Vrieze, who also owns the nearby, 1,050-cow Baldwin Dairy.



At Emerald Dairy, John Vrieze expects one day to make as much money from manure byproducts like biosolids as he does from milk.

Dairy farmers have long held a love-hate relationship with manure. On one hand, it's full of carbon-rich fibers and nutrients, especially nitrogen, phosphorus and potassium, which act as natural fertilizers and help condition the soil for planting. On the other, manure smells

awful and often contains viruses and bacteria such as *E. coli* that can pose serious threats to human health if ingested. In 2006, spinach tainted with manure-borne bacteria on a California farm killed three people and sickened more than 200.

Soils only accept a limited amount of manure's nutrients before shedding them into runoff water, leading to algal blooms and other far-reaching environmental problems. Farmers can help prevent runoff by spreading manure over wider swaths of land, but that too has drawbacks. For one thing, it means owning (or renting) a hefty parcel of land. And manure is not the easiest substance to move around, either. At 75 to 92 percent water, it's heavy and expensive to ship or store.

Farmers also have to pay attention to another part of manure they can't see—the gases. A recent United Nations report says the livestock sector is currently responsible for a significant share of human-related greenhouse gases: 9 percent of carbon dioxide, more than 37 percent of methane and more than 65 percent of nitrous oxide. While many farmers have doubts about global

“IF OUR REAL GOAL IS TO DEVELOP A SUSTAINABLE ECONOMY, the only way to do it is to use the whole myriad of biological materials—all of them.”

climate change and their potential to affect it, most acknowledge that these data are likely to lead to new restrictions and regulations on emissions in the years to come, which is why Vrieze agreed to serve on Governor Jim Doyle's Climate Change Task Force last year. “I've been trying to tell my industry it doesn't matter if you're talking about believing global warming or don't believe in global warming or whether you do or don't think man has an impact on climate change,” says Vrieze. “I drive around my dairy almost every day thinking of another way we can reduce our carbon footprint because someday I think we'll get regulated.”

MANURE ENTREPRENEUR

Vrieze started revamping his farms' manure management practices piece by piece in 1999, the same year Emerald Dairy was constructed. A member of the CALS Board of Visitors, he pulsed dairy and engineering experts for new ideas, but Doug Reinemann BS'80 MS'83, a professor of biological systems engineering, recalls that he was clearly ahead of the curve.

“John was sort of the catalyst of a group that got together from the UW, the (Wisconsin) Department of Ag and the Department of Natural Resources to look at this issue of greenhouse gas production and carbon sequestration on dairy farms,” says Reinemann. That group secured funding from Wisconsin's Focus on Energy program to evaluate how dairy farms can play a larger role in the growing market for green agriculture. With Vrieze's help, they are also trying to quantify how much carbon dairy farms might be able to trap and store—which may help pave the way for cow-powered carbon trading.

But it is Vrieze's own operations that may offer the most intriguing model of where dairy in Wisconsin might be headed. The systems in place on his

two dairies resemble something out of a Willy Wonka movie, combining off-the-shelf technology and improvisations of Vrieze's own design. Together, they create an integrated loop that helps turn one of dairy's biggest headaches into a surprisingly versatile player in its economic and environmental future.

It all starts in the barn. Three times a day tractors outfitted with rubber scrapers shovel mounds of manure through grates and into the gravity-driven pipes that whisk it all away. Then the magic begins. At Emerald Dairy, the pipes lead into a patented mix-plug-flow anaerobic digester, designed by GHD, Inc., which looks like a giant, underground shoe box. The manure spends three weeks inside the oxygen-free shell, slowly being decomposed by specialized bacteria that break down its carbohydrate structure and convert its sugars into gases. The ultimate prize is methane, which can be used as an on-farm power source or sold to power utilities. The process also kills off pathogenic bacteria, creating contaminant-free byproducts that can be used in other ways around the farm.

Currently, 22 anaerobic digesters operate in Wisconsin, and at least nine more are under construction. The net effect is to turn energy-consuming operations into energy producers. At the Crave Brothers Farm in Waterloo, Wis., for example, anaerobic digestion enables the 800-cow farm to produce 230 kilowatt hours of energy, enough to power the dairy, an on-farm cheese factory and 150 homes.

The downside is the cost. Digesters can easily run close to a million dollars to purchase and install—a price tag that puts them out of reach for many small- and mid-sized dairies. And selling energy isn't all that profitable. Wisconsin farmers are helped by the state's renewable energy portfolio standard, which requires investor utilities to get a specified amount of their power from

cleaner sources and guarantees those green-energy suppliers a subsidized rate of eight cents per kilowatt hour. “It's that eight cents that really makes it practical for people to do it,” says Reinemann. “It's still not a money-making proposition, but at least it becomes possible to do it financially.”

Alternatively, farms can contract with third-party companies like Clear Horizons, an organic-waste management operation that owns the digestion equipment at the Crave farm. Clear Horizons footed the up-front costs and manages the maintenance of the facility in exchange for rights to sell the energy captured by the digester. “The farm gets what's more of a soft benefit,” says Karl Crave BS'06, son of one of the Crave dairy's co-owners and project manager at Clear Horizons. “Basically they get a system without paying for it, so they get their manure processed essentially for free. And they also get things that go along with it, like odor reduction, greenhouse gas reduction and better nutrient management with their manure.”

Because Vrieze's utility doesn't offer the green rate, he bypasses the grid altogether and converts his methane into compressed natural gas, which he sells to the Northern Natural Gas Company. Specialized trucks arrive twice a day to collect the gas and inject it directly into the pipeline. But he's found additional benefits to digesters, as well. At his Baldwin dairy, he rigged the technology to suit the soon-to-be-built 27,000 square foot aquaponics system which will grow tilapia fish and leafy greens using water fed by leftover digester heat and nutrients.

And back at Emerald, he's fashioned a bioreactor to take advantage of the excess heat there. The digester warms water that runs through a tall rack of tubes filled with two strains of algae. To help the algae grow, he adds some of the super-concentrated nutrients leftover

from the digester. Under the fluorescent lights, the tubes glow an eerie green.

Vrieze is not sure what to do with his algae yet. Initially he planned to press it for oil to make the biodiesel that fuels several of his farm machines. Now he thinks the green stuff might have a higher-value use.

He's considered feeding it to his cows as an Omega 3-rich supplement or even incorporating it into dairy products as a nutraceutical. He says he needs more research to figure out the best application. Last fall he dropped an algae-filled bucket on the desk of CALS associate dean Ben Miller with a plea to find someone who could probe its potential.

"When I showed up," Vrieze laughs, "I said, 'Here it is. Now do something with it.'"

FIBER OPTIONS

That pretty much sums up the challenge offered by manure: Here it is, and it's here to stay. So what do we do with it? At the USDA Forest Products Laboratory, a federal facility housed on UW-Madison's campus, that quest drives a team of researchers who are studying biosolids—the odorless, sawdust-like powder left over from the digestion process. One intriguing idea is to use this material, which is full of fiber that isn't fully digested by microbes, to make fiberboard.

At FPL, Jerry Winandy has led efforts to experiment with recycled materials such as wood chips, sawdust, reclaimed cardboard and paper waste for years. Adding manure to that mix only makes sense, he says. "If our real goal is to develop a sustainable economy in the long run, the only way to do it is



At the USDA's Forest Products Laboratory, fibers from manure are pressed into wavy composite boards that are light and strong—and not at all smelly.

to use the whole myriad of biological materials that right now we use or we throw away or we don't even think of using—all of them."

In 2006, Winandy teamed up with Tim Zauche, a UW-Platteville chemistry professor with big dreams of developing value-added manure products, on a project to make composite boards using manure fibers. With a \$30,000 grant from the Wisconsin Department of Agriculture, Trade and Consumer Protection, they built a bench made from manure fibers, which they took to last year's World Dairy Expo. There were a few predictable jokes about its origins, but Zauche wasn't fazed. "We have this solid—we have to do something with it," he says.

Now manure-based composite boards may be closing in on commercial reality. John Hunt, an FPL research engineer with a specialty in recycled products, has refined the process for making the boards, molding them into a honeycomb-like structure similar to the inner core of I-beams. The resulting boards are one-fifth the weight of traditional composite boards but just as strong. And thanks to Hunt's design tweaking, unlike regular boards, these composites require no additional resins such as formaldehyde, which could be a plus for some chemical-conscious

consumers. A California company, ECOR-Noble Environmental Technologies, plans to market the boards later this year.

Despite what people may think, the boards don't smell. The panels look and perform just like any other composite board, says Hunt. The fibers from manure are superheated twice during the processing of the boards, and by the time they're ready for paneling, he says, they bear no resemblance to their bovine

origins.

"Really, we're not using manure. We're using cellulosic material," he says.

While it remains to be seen if consumers feel the same way, there are signs that the market for manure-based products is expanding. One company in Connecticut is selling biodegradable, manure-based flower pots, which are placed directly into the ground, where they feed nutrients to plants while they degrade. And the Elephant Conservation Center in northern Thailand is peddling products like paper, cards and fans made from the fibers of elephant dung to support the plight of pachyderms in the region.

And if consumers are ready to accept this "cellulosic material" in their bookshelves and note cards, what about their shopping bags and Pepsi bottles? That, too, could one day be possible, says Kerem Gungor, a researcher in CALS' biological systems engineering department who is studying bioplastics, which are alternative forms of plastic made from organic material.

Currently, the most prevalent technique for making bioplastics involves using pure materials such as glucose, often from corn, as a substrate for microbes that produce PHA, a biodegradable polymer that has similar properties to petroleum-derived plastics like

GOING with the **FLOW**

ON FARMS SUCH AS JOHN VRIEZE'S EMERALD DAIRY, every scrap of cow manure makes its way through a multi-stage process that plays out over the course of several weeks. Along the way, the foul stuff is broken down into an array of useful component parts that can be sold or reused on the farm.



THE PIE

Average dairy cows produce between 85 and 120 pounds of manure a day, most of which is scraped through grates in the barn floors and swept off to a lagoon or holding tank.

COLLECTION

Gravity carries manure through PVC pipes into a pit or a tarp-covered lagoon, where the manure is pumped into an underground anaerobic digester.



PHOTOGRAPHS BY ERICK DANZER

BREAK IT DOWN

In the oxygen-free environment of an anaerobic digester, specialized bacteria slowly chew up manure, creating a series of byproducts.

ANAEROBIC DIGESTER

THE BYPRODUCTS

BIOGAS

Methane gas from decomposing manure is captured and converted into usable forms of energy.

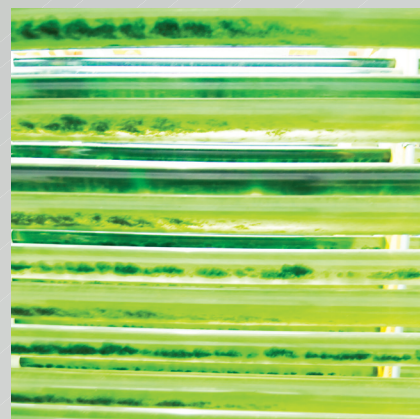
- **ENERGY** for farm operations
- **ADDITIONAL POWER** that can be sold to utilities



FIBER & NUTRIENT-RICH BIOSOLIDS

Rid of malodorous gases, these fibrous bits of partially digested manure can be turned into an array of products.

- **BEDDING** for cows
- **FERTILIZERS** and soil additives
- Materials such as **DECOMPOSABLE** flowerpots
- **FIBERBOARD**
- Potential feedstock for **CELLULOSIC ETHANOL**
- Potential source for **BIOPLASTICS**



LIQUID EFFLUENT

Nutrient-rich concentrate—often called tea water—can be used to fertilize soils.

- **BIOREACTOR FUEL**

Vrieze uses nutrients in water to feed a bioreactor that grows algae

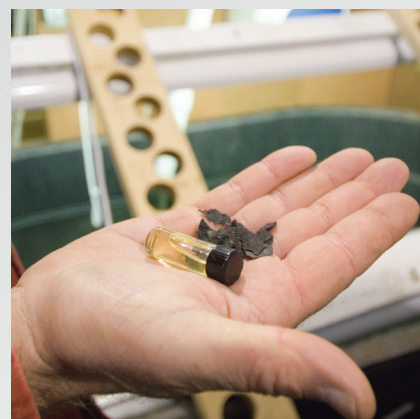
- **CLEAN WATER**

With additional processing, effluent can be sanitized potentially to the point of drinkability. Vrieze is awaiting a DNR permit to use the water he purifies with this technology.



OTHER BIOSOLIDS

Clay-like solids can be made into pellets, which can be burned for heat or turned into nutrient-rich ash that is used as a fertilizer.



VRIEZE IS NO TREE-HUGGING ENVIRONMENTALIST. His interest in trapping greenhouse gases on his farm is driven largely by economics.

polypropylene and polyethylene. But corn is not the only organic material capable of harboring PHA-producing microbes. Manure can, too, but because so much of its fibers are comprised of tough, hard-to-digest lignin, it hasn't really been considered a good alternative for producing PHA. But fresh off a research project centered on phosphorus removal—one of the chief problems associated with too much manure—Gungor felt motivated to give it a try. Although he's a long way from any commercial application, Gungor thinks the idea of poo-based plastic is compelling enough to keep working at it.

LIQUID ASSETS

So that takes care of the solids, but what about the water? As they turn manure into powder, anaerobic digesters suck out thousands of gallons of cocoa-colored, nutrient-filled liquid. To deal with this output, Vrieze once again turns to specialized technology—a customized wastewater treatment system that creates two separate liquid byproducts. The first is a nitrogen-rich fluid that Vrieze pumps onto 2,100 acres of cropland using a drag hose system—a contraption that resembles a hefty fire hose attached to claw-like cultivators. Using this, Vrieze injects the liquid six inches deep into his soil.

The other end product is clean water. That's right, clean water from cow manure.

Using reverse osmosis and filtration, Vrieze's equipment purifies water to the point that it's essentially potable. (Vrieze claims it's on par with distilled water sold in stores.) So far, Emerald is the only dairy in Wisconsin—and maybe in the country—to use this technology, says Liz Grinager, project manager of ISS, the company who built Vrieze's system. Vrieze plans to discharge this reclaimed water onto his fields, where it will infiltrate the

soil and flow to a constructed wetland that will provide drinking water for his cows. He's undergone an extensive vetting process with both the Environmental Protection Agency and the state DNR and is awaiting final approval.

All told, it's a far cry from the old days. Vrieze remembers when fertilizer was cheap and when farmers sometimes piled manure by the side of the road for the taking.

"It used to be, 20 years ago, my nutrient management plan was based on how cold it was," he says. "If it was 20 degrees below zero, the manure got about 50 feet away from the barn and the spreader went out. If you were busy, it got to the first field behind the barn."

The trouble with those methods is now pretty evident. The old conventional wisdom was that the land could serve as a phosphorus bank, building up a nutrient reserve as insurance for lean growing seasons. Farmers bought up phosphorus fertilizer and added supplements to their dairy cows' diets, making their manure piles rich in the nutrient. We know now that it's less like a bank and more like a curve of diminishing response. Once the optimal level of soil phosphorus is exceeded, it does little for the crops—and it becomes more likely to wash away with the rains.

Wisconsin's soils run phosphorus-rich, which is why the state's nutrient management plans are based on soil phosphorus instead of nitrogen. This means farmers have to first know the existing phosphorus levels in their soils and then take into account how much of that nutrient their crops will take up before they plan their applications.


But calculating the precise prescription of needed nutrients is a complex matter. Crops usually require nitrogen to phosphorus ratios of 6:1 to 8:1, but the ratio in manure is usually around 4:1 to 5:1. So it's easy to heap too much phosphorus onto the land while trying to meet the crops' needs for nitrogen.

That's one reason alternative uses for manure make sense. But not everyone is sold on the idea. Many farmers are still leery of the costs. And many advocates of small-scale farming worry that systems like Vrieze's encourage even larger confinement operations, both because of the large capital investments involved and the fact that dealing with manure now represents one of the largest barriers to increasing herd size.

Doug Reinemann expects that the technology won't please everyone. "It depends on what shade of green you're talking about when you talk to environmentalists," he says. For people who think there should be no animal agriculture, wide adoption of anaerobic digesters might seem like a turn in the wrong direction. But if you accept that animal agriculture is a relatively fixed part of the portfolio, at least for now, Reinemann says, "then it comes down to a question of producing animal products in the most environmentally sensitive way that we can. And that's exactly, in my view, what John's looking at."

But the ultimate irony is that Vrieze is no tree-hugging environmentalist. His interest in trapping greenhouse gases on his farm is driven largely by economics.

At a recent dairy conference, Vrieze spoke with an official from Wal-Mart—a retail chain known for its bottom-line thinking—about the company's current efforts to encourage its dairy suppliers to reduce their carbon footprints. To Vrieze that speaks volumes about what mainstream consumers want.

"We started asking the question, 'What do you, Mr. Wal-Mart, think the carbon footprint is on a gallon of milk?' Well, it happens to be 10.4 pounds of carbon," he says. "If I can say my carbon footprint is 3 (pounds), and if greenhouse gas emissions and global warming is really high on your list as a consumer, maybe you'll choose to buy my milk instead of somebody else's." 

Working Life

dairy

A Herd of Their Own

School trains a new generation of dairy and livestock farmers.

Steven Davis's family has a dairy farm, and he'd like to keep it going. Sarah Stodola has had it with office work; she wants a farm lifestyle. Jason Heberlein plans to milk 500 dairy goats. Laura Miller works on a dairy farm and would like to be milking a herd of her own, but she's worried about the cost of land.

Such are the dreams of students in this year's Wisconsin School for Beginning Dairy and Livestock Farmers, a program of the UW-Madison's Farm and Industry Short Course that aims to bring new blood into Wisconsin's best-known industry. Those dreams have a good chance of coming true. Roughly 80 percent of the 14-year-old program's graduates are actively farming, and about half of those have their own operations.

The school centers around a seminar on pasture-based livestock operations led by Dick Cates, who has raised beef cattle on pasture for more than two decades, and Jennifer Taylor, who graduated from the program in 1995. "We are a training and mentoring program," says Cates. "Other professions have a way to train new people. Agriculture doesn't have that, especially for people who are not from farms."

Most of the 62 students enrolled this year take the seminar along with other courses in the Short Course curriculum. But since not all aspiring farmers can come to campus, more than a third participate via webcast in remote classrooms at six locations across the state.

Topics range from goal setting to business management to designing a low-cost milking parlor. As a final project, each student writes a business plan, which is reviewed by farm management experts.

Working farmers do much of the teaching. On the first day, Mike Klinker, a 2003 WSBDF grad, told the class how he started up on a shoestring, refitting an old barn with salvaged stalls and buying used equipment on a pay-as-you-go basis. "Invest your money in assets that make money," he advised.

Jennifer Taylor echoed that: "Lease facilities. Beg, borrow or share equipment," she exhorts the students. "Invest in cows. They generate returns and produce calves to build the herd. They are truly cash cows."

—BOB MITCHELL BS'76

The Grow Dozen | 12

Alumni who are making a difference in the **dairy** industry

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James and Robert Baerwolf

BS'93, Agricultural Education;
BS'96, Dairy Science



James and Robert Baerwolf

Third-generation dairy farmers James and Robert Baerwolf have made a splash with Sassy Cow Creamery, one of Wisconsin's most hailed farm-to-market milk operations. Using milk from the Baerwolfs' 400-cow traditional herd and 100-cow organic herd, Sassy Cow is one of the first farmstead dair-

ies in the state to offer both traditional and organic milk, which are sold directly to consumers through local markets and an on-site retail store.



Wendy Fulwider

About the Dozen

These 12 alumni represent the stunning depth and breadth of CALS graduates' accomplishments. Selections for the list are made by the Grow staff and are intended to reflect a sample of alumni stories. It is not a ranking nor a comprehensive list. To read more about CALS alumni, go to www.cals.wisc.edu/alumni/

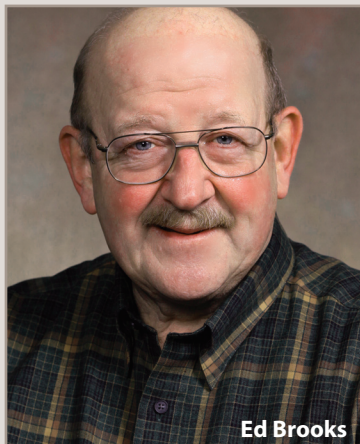
Next issue: Wild things

Know someone who should be in the Grow Dozen? Email us at: grow@cals.wisc.edu

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UNLESS NOTED

Ed Brooks

BS'65, Agricultural Economics
After 18 years as chairman of the board of Foremost Farms and its predecessor, Wisconsin Dairies Cooperative, Brooks took his career in a new direction last year. In November he won a seat in the Wisconsin State Assembly and now represents the 50th district, encompassing his hometown of Reedsburg. But Brooks is no stranger to building legislative alliances.



Ed Brooks

As chairman of the board of the Wisconsin Federation of Cooperatives, he worked to pass a new state statute for cooperatives and played a significant role in forming the Farmers' Health Cooperative of Wisconsin. Last year the WFC gave Brooks its highest honor, recognizing his lifetime achievements building and supporting dairy cooperatives.

Dan Considine

BS'68, Food Science
Wisconsin has more dairy goats than any other state, and Considine is a big reason why. At Sunshine Farms, near Portage, Wis., he has bred numerous national-champion goats, winning the American Dairy Goat Association's title of premier breeder 14 times. With more than four decades of goat breeding under his belt, he's now one of the most recognized leaders in the industry and has traveled the world to promote goats as dairy animals. He's served

multiple terms as president of the ADGA and is on the board of directors of the Wisconsin Dairy Goat Association.

Wendy Fulwider

MS'04, Dairy Science
Fulwider's love for animals stems from her childhood experiences growing up on her family's dairy farm near Fond du Lac, Wis. But it was her graduate research on cow comfort at the Arlington Research Station that sparked her interest in animal behavior and welfare. She went on to Colorado State University to study with animal scientist Temple Grandin, a noted advocate of humane treatment of livestock animals. After earning her Ph.D. in 2007, Fulwider took a job with Organic Valley, the nation's largest organic-farmer cooperative, as an animal husbandry specialist. She now works with producers to evaluate their handling and housing practices and improve animal well-being.



Peter Giacomini

Peter Giacomini

BS'79, Dairy Science, Agricultural Economics

As chief operating officer of AgSource Cooperative Services, Giacomini has helped thousands of farmers harness the power of science. He helped build the firm from a small Wisconsin-based cooperative into one of the nation's largest dairy herd improvement firms, which also provides feed, environmental and agronomic testing for farmers across the country. In 2006, Giacomini and AgSource worked with the UW School of Veterinary Medicine to develop the Transition Cow Index, an innovative tool for monitoring cow health and performance. He has also maintained strong ties with his alma mater, both professionally and personally, and currently serves as chair of the CALS Board of Visitors.

Tim Griswold

BS'89, Agricultural Journalism

Griswold has been a key architect behind many facets of the dairy industry during the past 20 years. Dairy insiders know him as the man who led Wisconsin's 2020 Initiative, a state loan and grant program designed to encourage dairy producers and processors to modernize and expand. After leaving state government in 2004,

Griswold joined Monsanto's dairy business unit, where he now oversees sales of Posilac, one of the most commonly used supplements for increasing milk production in dairy cows. Griswold is also on the board of the Wisconsin Dairy Business Association, an industry coalition that is active in promoting dairy growth in the state.



Bob Holterman

Bob Holterman

BS'82, Dairy Science

In 15 years as vice president of marketing for Accelerated Genetics, Holterman became one of the key figures in the worldwide export of dairy genetics. He recently launched a new venture, RJH Group, which will focus on developing new markets for companies seeking to expand overseas. The company is also exporting specialty feed products for beef and dairy cows and offering consulting services on nutrition, reproduction and genetic improvement. While it's always a risk to strike out on one's own, Holterman has had success following this route before. He funded his CALS education by starting his own business as a professional hoof trimmer in high school.

Lloyd and Daphne Holterman

BS'80, Dairy Science; BS'81, Agricultural Journalism

Back in 1980, Lloyd Holterman was milking 70 cows with his parents on their family dairy farm. Now he has more than 800 in his herd at Rosy-Lane Holsteins, which he operates with his wife, Daphne, and partner Tim Strobel FISC'99, on 1,200 acres near Watertown, Wis. The Holtermans have grown the business by thinking vertically. They raise their own heifers and operate a trucking subsidiary to ship their milk. And it's a lot of milk, too—more than 8,000 gallons a day. The couple also has been active in international dairy development, hosting a stream of international visitors on their farm. Daphne organized an international forum for women in dairying as part of last year's World Dairy Expo.



Lloyd and Daphne Holterman

The Grow Dozen



Pete Kappelman

Pete Kappelman

BS'85, Dairy Science

Kappelman's blend of small-farm roots and business savvy makes him a force in both the barn and the boardroom. Eighteen years after being named the Wisconsin Farm Bureau's young farmer of the year, he co-owns Meadow Brook Dairy Farm in Manitowoc, Wis., and chairs the board of directors of the powerful Land O'Lakes cooperative, where he has served on the board since 1995. He also sits on two national dairy councils—the National Milk Producers Federation and the National Dairy Promotion and Research Board—and has a significant role shaping U.S. dairy export policy. He's been president of the Professional Dairy Producers of Wisconsin and chairman of UW's Center for Dairy Profitability—and when he's not busy with those things, he finds time to coach his kids' basketball teams back in Manitowoc.

Pete Knigge

BS'69, Dairy Science

In 2000, Pete Knigge and his brother, Charles, dove headlong into the dairy modernization movement by becoming Wisconsin's first dairy farm to use robotic milking equipment. Now, the Knigges' 105 cows basically milk themselves, ambling up to the automated machinery whenever they feel full. Knigge says the equipment does the work of two full-time employees, saving labor costs and freeing up his time to focus on other aspects of running the Omro farm.

Jill Makovec

BS'00, Dairy Science, Agricultural Journalism; MS'02, Dairy Science

Raised on a dairy farm in Muscoda, Wis., Makovec fulfilled a dream of many young dairywomen by becoming Wisconsin's 60th Alice in Dairyland in 2007. She spent a year as the state's most visible dairy ambassador, traveling more than 40,000 miles to promote Wisconsin's food, fuel and fiber industries. Makovec, who has also worked with Wisconsin Fairest of the Fair committee and the Association of Women in Agriculture, ended her Odysseyan public-relations stint last May, but she remains tuned in to rural life as an account executive with Learfield Communications, representing the Wisconsin Radio and Brownfield Ag networks.



Ron Paris

Ron Paris

BS'77, Dairy Science

When Ron Paris began turning milk from his neighbor's farm into cream-line yogurt, he figured he might sell a few gallons to locals in cheese-crazy Green County. But Sugar River Dairy, which he runs with his wife, Chris, an alum of the UW-Madison dance program, has earned fans throughout Wisconsin. The Parises now churn out 4,000 pounds of yogurt a week in their Albany, Wis., dairy, and they are mainstays at Madison and Milwaukee farmers' markets. Ron also has worked with a local distributor to bring artisan dairy products like his own to customers' doors.



Jill Makovec

GROWING UP with four brothers, Mark Crave learned early how to play well with others. On the Craves' farm near Waterloo, Wis., he and brothers Charles, George and Tom (all graduates of CALS' Farm and Industry Short Course) share the duties—and the honors, too. They've won a pile of awards for their artisan cheese, made in a factory on the farm, and at last year's World Dairy Expo, the four jointly earned the title of Dairymen of the Year.



● **For some of us, it's hard to imagine running a business with siblings. How do you and your brothers do it?**

Well, it's difficult for me to answer that because I've done it for so long. There are definitely different dynamics to being in a family business. It forces you to do a lot of things that you should do anyway in any profession—treat each other with respect, as adults, as professionals—and if you do those things you get along pretty well. It's when you revert back to some of your childhood tendencies or carry a lot of baggage that you start running into trouble

● **Which of you has the hardest job?**

I'd say that I'm the key ... Seriously, it's pretty complex. I'm the herd manager, and I'm responsible for all of the cattle and all of the people that take care of the cattle. If this were a factory, my role would be production manager, because everything we do, be it growing crops or fixing tractors or changing tires, it all comes back to producing milk. That's our only revenue stream here—producing milk and selling surplus livestock.

● **For a lot of family-run businesses, the key to success is sticking to tradition—if it ain't broke, don't fix it. So how do you keep the business fresh and new?**

It's definitely a balancing act between using the experience you have and incorporating it into new technology. And to be honest, I think a lot of progressive farmers have done a good job of doing that. We've always tried to take what we know, look at the new technology and say, 'Okay, this makes sense to us because of the background we have,' whether it be from our experience as farmers or our education.

● **So why did having the cheese factory on the farm make sense to you?**

We're in the specialty cheese business, so we do have to differentiate ourselves. You used the term 'fresh,' and that's really a proper term—we try to keep it fresh and we try to bring people out to the farm. We try to show people that we do things from the field to the cows to the cheese—every step. And that's what seems to get people excited. It's a good-quality product, and we can show them where it comes from.

● **One cool feature of your web site is that each of your wives contributed recipes using your products. Are they involved in any other areas of your business?**

George's wife, Debbie, works full-time with the cheese factory—she helped develop the web site. My wife has a full-time job, so she has no day-to-day involvement with the farm, other than what I tell her over the dinner table.

● **Do you have a favorite recipe?**

I like a lot of them, but one of the favorites is the one that (my wife) Tina contributed—the toffee torte. It's rich and good after a holiday meal or something like that or with a cup of coffee. It's a family recipe that she modified to use our cheese.

Five things everyone should know about . . .

Probiotics

By James Steele

1 | Probiotics are microbes that can do good things inside your body. Certain bacteria and fungi can help our bodies fight disease and work more efficiently. In fact, we already have a lot of these helpful microbes—known as probiotics—inside our digestive tracts. But many people add more by consuming probiotic supplements designed to combat specific ailments.

2 | For such small creatures, probiotics have grown very big. While a few proponents have been arguing their benefits for decades, probiotics were virtually non-existent in the mass market 20 years ago. That began to change with the introduction of products such as Dannon Activia, a probiotic-enhanced yogurt. Aided to some extent by Dannon's aggressive marketing efforts, public awareness of probiotics has risen from 9 percent in 2001 to 31 percent last year. Now consumption is skyrocketing, and in 2007 alone, 750 new probiotics products were launched in the United States.



Dannon's Activia yogurt claims its probiotic bacteria promote digestive health.

3 | These things just might work. In the past, academic researchers, including myself, were highly skeptical of the health claims made about probiotics products. The research was so poorly designed and executed that it made proponents look like snake oil salesmen. However, in recent years, the body of evidence has grown more and more compelling, and many well-constructed studies now have shown health benefits from specific bacterial strains at specific doses.

4 | The key is getting the right microbe—in the right amount. Different microbial strains do different things, and if you don't have exactly the right one for your needs, you may be wasting money. For example, the bacterium *Lactobacillus rhamnosus* can mitigate diarrhea after a course of antibiotics, but only if a patient consumes 10 billion to 20 billion cells of the LGG strain per day over a period of 10 to 14 days.

5 | Buyer beware: Labels on probiotics products aren't uniformly helpful. Many product labels are incomplete, omitting key information about strains and doses. Some labels even make misleading health claims. Before starting a regimen of probiotics, it's a good idea to do some extra research. Look online or contact the manufacturer to gather all the data.

James Steele, a CALS professor of food science, studies the bacteria that influence Cheddar cheese flavor. A few years ago, he expanded his research program to include the mechanisms by which probiotics influence human health.

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Fill out your answers online. Ace our quiz and we'll enter you in a drawing for a gift box of Babcock Hall cheese. Go to www.cals.wisc.edu/grow/ for more details.

Animal
Sciences:

It has been demonstrated that dogs can be trained to detect estrus in cattle. Which of the following senses is being used by the dog to accomplish this task?

- a. Smell
- b. Sight
- c. Touch
- d. Hearing

From Animal Sciences 434: Reproductive Physiology, taught by John Parrish

Plant Pathology:

What is one of the major reasons that Wisconsin has not experienced a late blight outbreak in potatoes for several years?

- a. The development through breeding of resistant potato varieties.
- b. The development of improved fungicides.
- c. Growers have been planting disease-free seed.
- d. Weather conditions have not been conducive for late blight growth.

From Plant Pathology 300: Introduction to Plant Pathology, taught by multiple professors

Genetics:

DNA fingerprinting can best be described as:

- a. A technique used to determine an individual's unique sequence of DNA base pairs
- b. A technique used to determine whether a given protein binds to a region of interest within a DNA molecule
- c. Sum total of all alleles in the breeding members of a population at a given time
- d. The number of offspring left by an individual

From Genetics 466: General Genetics, taught by John Doebley

Landscape
Architecture:

One of America's best-known planned communities emerged in Wisconsin during the 1930s as part of the New Deal Suburban Resettlement program. It is:

- a. Shorewood
- b. Greendale
- c. Middleton Hills
- d. Fairbanks Flats

From Landscape Architecture 260: History of Landscape Architecture, taught by Arnold Alanen

Aquaculture:

What type(s) of fish would one eat to maximize consumption of Omega-3 fatty acids? (More than one answer may be correct.)

- a. Marine fish
- b. Freshwater fish
- c. Inactive fish, which store a high percentage of their fat in close proximity to edible muscle
- d. Active fish, which store a high percentage of their fat in close proximity to edible muscle

From Animal Sciences 305, Introduction to Meat Science and Technology, taught by Jeffrey Malison

LAST ISSUE: Answers were 1: b; 2: b; 3: f; 4: b; 5: c. Congratulations to Steven DeLonay BS'85, of Medford, Wis., who was randomly selected from the six people who aced our Final Exam and wins a free box of Babcock Hall cheese.

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BUG'S EYE VIEW

What happens when you look at the world through the eyes of an entomologist? You get images such as these, captured by CALS entomology students and faculty.

Check out the full gallery at www.cals.wisc.edu/grow/.



MICHAEL HILLSTROM



DANIEL MAHR

DAVID DOYLE



NAUGHTON AND TREVES UNDERSTAND THAT THE WOLVES' SUCCESS HINGES DELICATELY ON PEOPLE'S WILLINGNESS TO PUT UP WITH THEM.

HUNTING THE HUNTER

Hunting actually might have the same effect. Naughton notes that bears cause far more economic damage than wolves, but they generate fewer complaints. Could that tolerance be driven to some extent by the rising popularity of bear hunting? "There is a kind of alienation from wolves that hunting may remedy," she suggests.

But the interplay of hunting and damage payments gets tricky. Compensation payments come from the DNR endangered resources fund, which includes proceeds from sales of wolf license plates and income tax checkoffs. More than a quarter of these contributors say they deeply oppose public hunting of wolves, suggesting they might stop giving if the state authorizes a hunt. That could mean a loss of a half million dollars, more than could be offset by the sale of hunting permits.

And budget might be the least of the issues raised by a proposed hunt. Tim Van Deelen, an assistant professor of forest and wildlife ecology, says hunting wolves would throw all kinds of new variables into the management equation. "Harvesting wolves is different," he cautions, especially when compared to the brute-force numbers game we play with deer. "There are a million or more deer, but perhaps only about 600 wolves. Each individual removal is proportionately a much bigger part of the population."

If a hunt were to adopt the state's goal of 350 wolves outside of Indian reservations, Van Deelen points out, the state would need two kinds of hunts—one to nearly halve the population to the target, and then an annual removal of around 40 wolves to maintain that level. And we really know very little about the impact a hunt might have on pack structure.

"Let's say as part of your public hunt you wipe out the alpha female. You wipe

out reproduction for that pack for at least the first year. Does the pack stay together? Or do you wipe out reproduction for the next year? Those are things we haven't been able to predict yet," he says. Three hundred and fifty may seem like plenty of wolves, but in terms of population dynamics, it creates a system that is unstable and difficult to manage.

A bigger target population would be more stable, but it would also create a doubled-edged problem. While wolf advocates would be most likely to support a larger pack, they will likely oppose any hunt. And the groups most actively pushing a wolf hunt—including deer and bear hunters—want fewer wolves, not more. Furthermore, Wydeven believes a wolf hunt would have to be surgically planned to target wolves that were posing a particular threat to dogs and livestock. And it's unclear that hunters would even be interested in a hunt this proscribed.

"We need to have a discussion about acceptance for more than 350 wolves," Van Deelen says. "Is the level of wolf damage that we're incurring here so intolerable that we need to cut the population almost by half? I don't think so. Like a lot of natural resource issues, the agenda is set by the people who scream the loudest."

MIDDLE GROUND

David Mladenoff ponders the math. "Five hundred wolves? A million deer? We can have a lot more wolves," he says. "But that's unfortunately not what's going to happen. I think we're seeing that change in attitude already. And the irony is that we can actually probably have more wolves in the state if we're able to have some kind of active management."

Wydeven wants to wait and see. He's hopeful that allowing property owners to remove problem wolves, an option that was briefly in force, may become available again if the wolf is taken off

the endangered list. If that happens, he says, "it's possible that we might start seeing the population stabilize at a level that's reasonable for the landscape, that there may not be a need for a public harvest."

But people need to change some habits, as well. Bear hunters need to think twice about where and when they run their dogs. And farmers may need to change some husbandry practices to protect young livestock. Those who live near wolves need to appreciate and accept that wolves have changed their definition of home.

Mladenoff remembers giving a talk, perhaps a decade ago, where he laid out how we would eventually reach this point in our relationship with wolves. A student approached afterward, very frustrated. "Why can't we just leave the wolves alone?" she asked. "I really feel the same thing," he answered. "But there is no place on the planet that is unmanaged, if you use 'managed' in a sense of either intentional or unintentional human impacts. No place. And this is how we affect this part of the planet."

Then he wound around to a message that feels even more apt today. "If we want to have some of these components of natural systems around," he told the student, "we just have to be more creative about our attitude toward this wild/non-wild dichotomy. We have to have a different attitude."

For most of our history, that attitude has been to vilify and kill wolves however we could. Then we swung wildly to the other extreme, adopting them as sacred icons of untamed wilderness. And as Naughton warns, "neither is going to be an appropriate model for living with wolves. Ultimately, to learn to live with wolves, we have to figure out how to make fair rules and live with each other—meaning people who have very different values about wolves and nature." 