



# terra

A world of research & creativity at Oregon State University • Summer 2006

## Fragile Giants

New Threats in a  
Post-Whaling Era

**Green Power**  
Plugging into Nature

**To Conquer Vitamin E**  
The Last Frontier

**Tense Times**  
Teens Coping  
with Stress

A close-up photograph of several green corn leaves, showing their characteristic V-shape and vein structure. The leaves are in sharp focus in the foreground, with a soft, blurred background of more leaves and a bright, overcast sky. The overall color palette is dominated by various shades of green, from vibrant lime to deep forest green.

# Sustainability

Sustainability can mean different things to different people. Some think energy, replacing fossil fuels with biodiesel, wind or other renewables. To others it's about managing natural resources — forests, fisheries, agricultural lands — for long-term health and productivity. To people in business, it's also about staying afloat financially. Take farms for example. Whether or not an eastern Oregon ranch or a Willamette Valley vegetable farm is sustainable depends on the cost of fuel, water, fertilizers and other factors.

Across the board, three themes define sustainability: economy, environment and community. Becoming more efficient, reducing waste and providing jobs all contribute to sustainability goals. They are also the hallmarks of businesses that have weathered the vagaries of natural, economic and political cycles to continue producing food and fiber year-in and year-out. That's no small feat in a rapidly changing world. New hurdles appear regularly: higher energy prices, changing regulations, increasing competition for water.

OSU research is helping to create the foundation for new sustainable practices. For example, OSU's Institute for Water and Watersheds and the OSU Extension Service are working with communities in the Umatilla and Klamath basins to solve water problems. This issue of *Terra* describes how Bruce Mate's marine mammal studies are helping to maintain whale populations around the globe. Work on renewable energy sources is expanding alternatives to petroleum and coal, benefiting rural communities as well as the environment. On the social side, a study of adolescent stress aims to ease that often turbulent time of transition for our youth.

More information about sustainability at OSU is available at [oregonstate.edu/sustainability/](http://oregonstate.edu/sustainability/)



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*OSU is Oregon's largest public research university, with \$209 million in research funding in 2005. One of only two American universities to hold the Land-, Sea-, Sun- and Space-Grant designations, OSU is comprised of 11 academic colleges with strengths in natural resources, earth dynamics and sustainability, life sciences, entrepreneurship and the arts and sciences.*

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**On the cover,**

It's easy to see why the humpback whale's scientific name (*Megaptera novaeangliae*) means "large winged of New England." OSU photographer Craig Hayslip was ready when this one breached off the Farallone Islands near San Francisco on August 4, 2005. (© OSU Marine Mammal Program)



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# Tracking the Great Whales

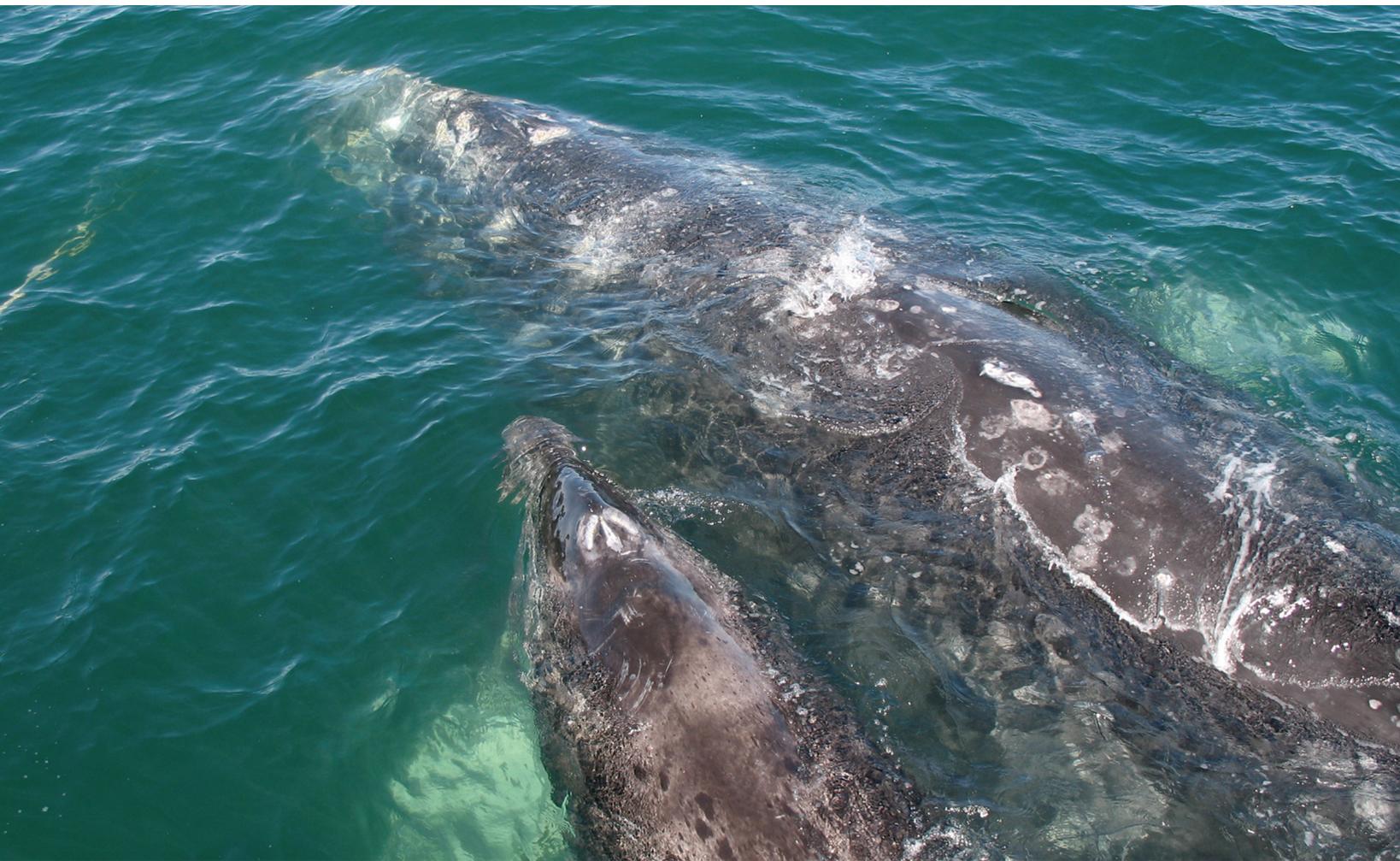
By Lee Sherman

Bruce Mate's pioneering tagging technologies are helping protect marine mammals from human impacts.

Bruce Mate has scudded most of the world's oceans at the prow of Avon and Zodiac Hurricane inflatables. Using a crossbow or an air gun, the OSU marine biologist has spent several decades attaching radio transmitters to animals that, despite their enormous size, live largely out of sight beneath the opaque surface of the sea. Following a distant spout, a momentary fluke, a sudden breach, Mate has tagged fin whales in the Mediterranean off the coast of France and sperm whales in the Gulf of Mexico. He's tagged right whales off Nova Scotia and grays off Baja. Bowheads in the Canadian Arctic. Humpbacks off the coast of Africa and in the Hawaiian archipelago. Blues off Chile or traveling the Pacific from California to Costa Rica.

But it's at his office on the Oregon Coast where his research pays off in data. Every morning when he sits down at his desk at the Hatfield Marine Science Center in Newport, Oregon, and logs onto his PC, Mate has a window into the feeding habits and





*OSU's Bruce Mate was a leading scientist in recent efforts to protect the warm waters of Mexico's San Ignacio Lagoon, where gray whales like this mother raise their newborn calves. Below, an elephant seal pup, recently weaned, lolls on the beach at the island of Benito del Oeste off the Pacific Coast of Baja, home to many colonies of seals and sea lions. (Photos: Carol DeLancey)*

migratory travels of each tagged animal. That's because the electronic signals emitted by the tiny transmitter lodged in its skin are picked up by instruments on weather satellites, whose relayed data translate into longitude and latitude on the researcher's computer. "Next to the whales and God, I'm the first to know where they are," Mate likes to say.

Aside from its value as basic science — fact-finding about whales' hidden lives — Mate's work holds real, and urgent, import for the fate of endangered and threatened

species. The cutting-edge research that has propelled him into the elite of marine mammal scientists has, for example, helped to preserve critical habitat for grays in the breeding lagoons of Baja and to prevent fatal ship strikes of North Atlantic right whales, which teeter on the edge of extinction. "I don't want whales to become the next spotted owl," says Mate, who holds the Marine Mammal Research Professorship. Using science to prevent problems before they occur is one of his most important aims.



## Monitoring Whales with a Mouse

One drizzly day last November Mate, still tanned from a fin whale expedition to the south of France, ignores the hundreds of e-mails that have piled up in his absence, instead clicking on the folder labeled “Grays.” He’s stunned by what he finds. Four of the mother whales he tagged off Baja in March have traveled hundreds of miles north of their expected summer feeding grounds in the Bering Sea. Having weaned their calves by now, three of them are still in the high Arctic, lingering in the Russian waters of the Chukchi Sea even as winter nears. A fourth tagged mother has been killed by Russian whalers who, under International Whaling Commission rules, are allowed to harvest 145 grays annually.

The other surprise is the duration of the data stream: Eight months after tagging, the transmitters are still working. It’s a testament to how far the technology has come. When Mate tagged his first whale back in 1979, the signals from the crude, radio-monitored device reached a mere five miles. He had colleagues listen to receivers from their offices at irregular intervals along the coastline. “I spent a lot of time waiting for phone reports to come in,” he recalls, ruefully.

In 1983, he became the world’s first researcher to track a whale by satellite — a humpback off Newfoundland. Since then, he and the staff at the Marine Mammal Program have pushed the technology relentlessly. With funding from the Office of Naval Research, the Minerals Management Service and the Marine Mammal Commission, he has overseen several generations of tag designs. Today’s model is compact and lightweight, made of surgical-grade stainless steel and infused with long-lasting antibiotics to prevent infection. Super-streamlined, it’s also designed to resist drag and the pressures of deep-water dives.

The goal of the tagging, ultimately, is to protect whales from the myriad human activities that might harass, harm or kill them — seismic exploration and drilling for oil and gas, sonar, ship collisions, fishing-gear entanglements, pollution and industrial development near sensitive marine habitats.

“Most stocks of large whales are so depleted, they’re under full international protection; everybody’s keen to see them recover,” Mate notes. “But we’re powerless to know what to do unless we know where they go throughout the year and what puts them at risk there. So in my research program, we concentrate on answering the questions, Where? When? and Why? by tracking the animals, month-to-month, season-to-season, across the planet.”

The answers do more than make protection possible. They change our understanding of how the ocean works. For example, Mate and other researchers have shown that whales and other marine migrants are sensitive to small differences in water temperature. These differences are often associated with “fronts” between water masses, boundaries that affect the ocean just as atmospheric cold and warm fronts affect the weather. By tracking where whales go, analyzing what they eat

and monitoring such water fronts, scientists have discovered new patterns in ocean productivity. They have found hot spots, areas where migratory species congregate. They’ve learned how food availability changes from one place to another, knowledge that can be used to predict available habitat and how human activities affect the health of marine mammal populations.



## Looking into Inquisitive Eyes

When a calf is born in the warm waters of San Ignacio Lagoon — one of only four gray whale calving areas in the world — it unfolds its one-ton body as it surfaces for its first breath. Here on the Pacific coast of Baja, it

*A Royal Polaris crew member steers a skiff through the crystal-clear waters off Baja to pick up eco-tourists after an island ecology hike during the OSU Marine Mammal Program Gray Whale Expedition in March. (Photo: Carol DeLancey)*



## Anatomy of a Career

Bruce Mate, OSU Professor of Fisheries and Wildlife, Oceanography  
Hatfield Marine Science Center

He was a Midwest kid, a self-described “technical nerd” who hung out with ham-radio buffs and fell in love with a girl who played flute to his percussion in the school band. Before he headed to Oregon with his bride, Mary Lou, to become a marine biologist, Bruce Mate had never laid eyes on an ocean. He had, however, seen a pickled sea urchin. That’s because a gifted biology teacher named Mr. Barker, hell-bent on hooking his skeptical sophomores, would order exotic marine specimens from Carolina Biological Supply. Another of Mate’s role models was ocean explorer Jacques Cousteau.

Mate’s interest in intertidal invertebrates quickly got eclipsed, however, during his first graduate seminar when UCLA marine mammal expert George Bartholomew revealed that the migratory habits of sea lions were a mystery. Mate headed straight to the library to find out for himself. After scouring the literature, he was astonished to learn it was



true. The indefatigable graduate student took this knowledge gap as a personal challenge. Armed with a pre-doctoral fellowship from the National Science Foundation, he made marine mammal history by figuring out the sea lions’ migration patterns.

After finishing his Ph.D. in biology at the University of Oregon, he secured funds from the newly formed U.S. Marine Mammal Commission to do the first range-wide survey of pinnipeds on the West Coast. Every month for a year, Mate would fly a single-engine Cessna with his left hand, while holding a camera out the window with his right. (The single-lens-reflex Canon F-1, with its telephoto lens, bulk film pack and motor drive, weighed 12 pounds.) Back in Newport, he processed the film and “counted the nose of every

seal and sea lion” from British Columbia to Mazatlan, Mexico. That was 30 years ago. He’s been tracking the movements of pinnipeds and cetaceans (with Mary Lou at his side) ever since joining the OSU faculty in 1973. Today, he holds the directorship and endowed chair of the Marine Mammal Program. Here are a few highlights of a career that has earned him international acclaim:

### GENERAL RESEARCH INTERESTS

#### Marine mammals:

- Critical habitat identification for endangered whales, population assessment, behavior (mating, feeding), seasonal migration
- Marine mammal competition with fisheries and aquaculture
- Development of high-tech research tools including satellite-monitored radio tags

### SELECTED SCIENTIFIC COMMITTEES AND PROFESSIONAL SERVICES

- Scientific adviser to U.S. Marine Mammal Commission (10 years, most recently 1995-2000)
- International Whaling Commission, (invited expert five years, most recently 2006)
- Committee member, International Union for the Conservation of Nature, Species Survival Commission

- Member of International Scientific Advisory Committee to Mexican Minister for the Environment on Industrial Development Proposals for Gray Whale winter reproductive habitat (1996-2000)
- Society for Marine Mammalogy, founding Secretary (1982-1988) and founding Treasurer (1982-1992).

### RECENT RESEARCH

Identification of migratory routes and habitats of large whales:

- Right whales in the North Atlantic (2000) and South Atlantic (2001)
- Sperm whales in the Gulf of Mexico (2001-present)
- Blue whales off southern California (1998-01, 2004-5), Mexico (2001-2), and Chile (2004)
- Humpback whales off Hawaii (1995-2000), Southeast Alaska (1997), Gabon, Africa (2002), Mexico (2003) and California (2004-5)
- Fin whales in the Sea of Cortez (2001), Mediterranean Sea (2003, 2005) and California (2004)
- Gray whales off Mexico, tracked to Russian high Arctic (2005)

### AWARDS

- Marine Mammal Investigator of the Year, Office of Naval Research, 2001
- Marine Conservationist of the Year, Long Beach Aquarium, 2000

will gain as much as 20 pounds a day on its mother’s fat-rich milk, as it grows strong enough to make the 10,000-mile roundtrip migration to its summer feeding grounds in the Arctic.

Each year after the calves are born, Mate leads an ecology tour for 30 adventurous neophytes eager for a close-up look at wild whales. It’s a 30-hour trip from San Diego aboard the chartered, sport-fishing vessel Royal Polaris. After their second night at sea, the eco-tourists awake in the 50-square-mile lagoon, anchored inside a 360-degree panorama alive with rainbowed spouts, glistening black flukes, bobbing heads (grays “spy hop,” thrusting their noses above the water’s surface to look around), thunderous breaches, and even the occasional “Pink Floyd” — a whale-watchers’ euphemism for the five-foot penis that a male sometimes displays when pursuing a female.

Seeing this teeming congregation of whales, visitors can barely imagine that in this tranquil spot, 19th-century whalers slaughtered grays by the hundreds, and that by the early 20th century the species had been nearly wiped out. A worldwide ban on hunting gray whales, established by the League of Nations in 1937 and continued in 1946 by the International Whaling Commission, has allowed the grays to rebound to their pre-whaling population of about 18,000. The species has been so successful, in fact, that the IWC has established a sustained quota of gray whales for the indigenous people of Chukotka, Russia, who use them to feed mink and fox bred for furs.

For Mate’s intrepid band of eco-tourists, the view from the deck of the Royal Polaris is just the teaser. Climbing into small fiberglass motor-boats called *pangas*, the visitors head

out among the grays led by experienced local guides, who, along with the Mexican government, tightly regulate the eco-tourism trade here. Out in the lagoon, the guides slow the motors to a quiet idle. Then, everyone waits.

When a longtime guide named Alvaro points and whispers, “*iballena!*” (“whale,” in Spanish), a sudden sense of vulnerability descends on the group of six afloat in their 20-foot craft. As the 45-foot creature with flippers five feet long approaches — pushing its 35-ton form through the saltwater with a 1,000-pound tail that could snuff a human life like a swatter flattens a fly — they hold their collective breath. The great mottled body passes silently through the dappled sea beneath them. The little boat rocks softly, undisturbed.

One of 30 eco-tourists on Bruce Mate's March whale expedition, Jan Whittlesey, a retired teacher from Hillsboro, Oregon, touches a gray whale mother, while the calf looks on. (Photo: Carol DeLancey)

A few minutes later, another whale emerges from the depths. At her side swims a calf. The humans, having by now exhaled, reach into the water and splash. And something remarkable happens. The mother whale rises to the surface with her month-old calf balanced on her back, its pale gray skin lustrous in the sunlight. After getting a good look at the boaters, the calf slips back into the water and swims toward the splashing hands. Just inches from the boat, it lifts its head. The humans find themselves face-to-face with the spiky hairs that sprout forward of the whale's dual blowholes. The primeval-looking "knuckles" on the last third of its back, hinting of mythical beasts and ancient origins. The black eyes that seem to gaze back at the people with frank curiosity. And when their fingers stroke its rounded nose, its skin feels like a neoprene wetsuit, only smoother.

These whales are among the "inquisitives" — an estimated 10 percent of the stock of San Ignacio — who seek interaction with humans. Mate, in fact, was one of the original researchers to document this "friendly" behavior on an expedition early in his career. So in the mid-1990s, when the U.S. Marine Mammal Commission heard about the \$120 million salt-extraction project that Mitsubishi Corp. and the Mexican government were planning to build in the Vizcaino Desert Biosphere Reserve bordering the lagoon, it sent Mate to meet with concerned Mexican activists and ecologists. For even though grays have rebounded, Mate considers them — and indeed many marine mammal species — still in jeopardy because of the many ways their habitats can be compromised by humans. The saltworks, slated for this pristine birthplace of whales (and countless other species of flora and fauna), might have put this population of grays at risk.

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“Next to the whales and God, I’m the first to know where they are.”

— Bruce Mate  
Director,  
Marine Mammal Program

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In his 2001 book *Eye of the Whale: Epic Passage from Baja to Siberia*, author Dick Russell reports that Mate was “the first biologist to take a stand on citing concerns about the saltworks.” In a letter to colleagues in 1995, Mate expressed one of his top concerns — a planned pier for loading salt onto ships for export. The mile-long dock would have been exposed to winter storms and waves from summer hurricanes. If it failed, operations would



have shifted to a tug and barge operation inside the mouth of the lagoon, creating an impediment to the whales.

Mate was appointed to a seven-member advisory panel of international marine experts to guide and review an environmental impact assessment process for the Mexican minister of natural resources. The panel provided “14 pages of concerns — things we felt needed to be addressed,” Mate later told Russell. “This was not limited to whales; we discussed fish and shellfish and larval forms, freshwater utilization for a community that would have to grow, even coyotes in the desert and garbage disposal.”

After years of public and behind-the-scenes efforts among corporate, government, scientific and environmental interests, the “saltworks war” ended happily for the grays when Mexican President Ernesto Zedillo canceled the project in 2000. “It would,” Zedillo said, “irreversibly alter the area’s aesthetics.”

Those aesthetics — the contradictory images of a desert landscape that is both tough and vulnerable — remind Mate’s eco-tourists that the treasures of Baja are not limited to whales. They include the flowers, soft-hued, blooming on barbed cactuses. The pelicans, wheeling above beaches strewn with pink shells and bleached bones. The elephant seal “weaners,” lolling in the sun like overstuffed duffel bags. The gangs of juvenile sea lions, who followed the *pangas* in clamorous undulations. The bottlenose dolphins, who escorted the Royal Polaris out of the lagoon — a swirling, leaping, bow-surfing honor guard.

### Saving the Last Survivors

The gray whales are thriving now. But other species that were also decimated by whalers’ harpoons have not

returned to healthy numbers. One of the most critically endangered is the North Atlantic right whale, which got its name from whalers who considered it the “right” one to kill because it swims slowly, floats when dead and is loaded with blubber, prized for lamp oil in the days before electric lights. (Many other products were produced from whale carcasses, including corset stays, buggy whips and brushes.)

From its estimated pre-whaling population of 12,000 to 15,000, the North Atlantic right whale today clings tenuously to existence. Only 300 to 350 individuals now summer in the nutrient-rich waters off Maine, Nova Scotia and Newfound-

land — what author Tora Johnson (*Entanglements: The Intertwined Fates of Whales and Fishermen*) calls the “ragged remnants of a vast tribe.” Scientists like Mate speculate that the species’ naturally low birthrate (mature females have only one calf every three to five years, in contrast to the grays’ rate of one every two years) makes any death outside normal attrition devastating to the overall population.

Collisions with seafaring vessels are the major anthropogenic (human-related) cause of right whales’ demise. Of the right whales found dead, in fact, fully half have been hit by ships. In part, that’s because their feeding grounds overlap some of the world’s busiest shipping lanes — waters where freighters, tankers, ferries, cruise ships and fishing boats make thousands of trips. Between 1986 and 2005, ship strikes took the lives of at least 19 right whales — and those were only the documented fatalities. The injuries observed by

researchers include severed tails, shattered skulls, internal hemorrhages, deep cuts and gashes. Mate is still haunted by the sight of one whale that had been eviscerated by a propeller.

When Canadian marine biologist Moira Brown of the Center for Coastal Studies in Massachusetts launched a campaign to limit whales’ vulnerability to ship collisions,

Mate’s research played a significant role. The travels of nine right whales he tagged in the late 1990s showed they were in constant danger. “Right whale distribution,” Mate and colleagues concluded in 1997 “coincided with areas extensively used by humans for fishing, shipping and recreation.”

In 2000 Mate and then graduate student Mark Baumgartner (now a scientist at the Woods Hole Oceanographic Institution) investigated the movements of right whales feeding in the Bay of Fundy. Data from them and other scientists convinced a collaborative group of shippers, fishermen and Canadian officials in 2003 to adopt scientists’ recommendation to move shipping lanes four miles to the east — an unprecedented action that reduced the risk of ship strikes in the bay by at least 80 percent.

Scientists and environmentalists have now turned their attention to U.S. waters. The National Marine Fisheries Service has, for example, recommended lowering speed limits for vessels off the eastern seaboard, where right whales travel annually to their breeding grounds off Georgia and Florida. A 2004 NMFS report cites data (right whale migration patterns and routes, speed and distance traveled, residency periods and dive durations) from studies by Mate

and other scientists in support of the proposal.

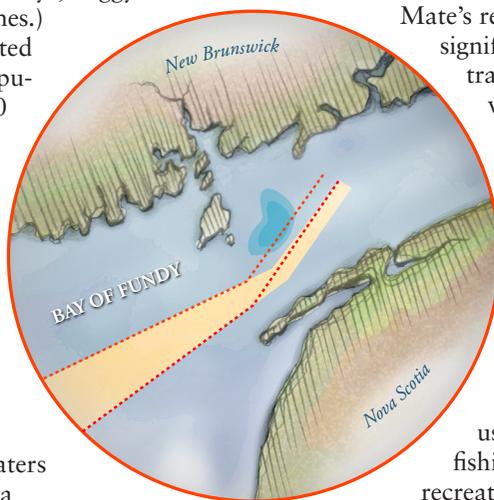
The other big threat facing North Atlantic right whales is fishing gear. New England Aquarium scientists have documented dozens of entanglements with nets and lines in recent decades. They have reported whales with lines through their mouths and wrapped around flippers, head and back. One whale with “three tight wraps from gillnet” over its back was later found dead with line cut into the dorsal body cavity and “wrapped around both flippers and underside.”

The detritus of human enterprise and entertainment — helium balloons, aluminum pull-tabs, plastics by the ton, nylon netting that even a whale can’t break — too often winds up in the world’s oceans, and takes the lives of countless sea creatures. That fact is brought home forcefully for visitors in a graphic photo display at the Hatfield Marine Science Center. The recent travelers to Baja witnessed it firsthand: a sea lion wearing a piece of fishing line cinched around her neck. It had cut its way into her skin, forming an ever-tightening noose. Watching her scratch at it with her flipper, Mate shook his head. “Eventually,” he said, “it’ll kill her.”

For the precarious North Atlantic right whale, these kinds of entanglements are tragic not just for the individuals, they’re ominous for the species as a whole. “Almost 60 percent of North Atlantic right whales are scarred by gear entanglements,” Mate says. “Some years, all of the calves are scarred before they’re a year old. That’s not tolerable!”

## Creating a Corps of Advocacy

Mate’s findings are not limited to academic journals and scientific papers. He’s been quoted widely in the popular press, including *National Geographic*, and he makes the evening news whenever whales beach themselves on the Oregon Coast. He’s been featured on the Discovery Channel, the PBS science programs “Nova” and “Nature,”



■ Dense whale population  
■ New shipping zone  
⋯ Old shipping zone

and several BBC specials with world-renowned director and producer Richard Attenborough, including a recent episode of “Blue Planet.”

Reaching ordinary people about the plight of whales and their cousins gives Mate deep professional satisfaction. For more than 20 years, he reached that broader constituency as a member of the Oregon Sea Grant Extension faculty. Mate believes that when marine mammals are under siege, their strongest shield is public outrage girded by scientific evidence — the kind of evidence that, as Mate likes to say, “will hold up in court.”

That kind of evidence is critical to resolving such issues as the ongoing conflict between salmon fishermen and sea lions in the river systems of the Northwest. The competition for coho and chinook makes headlines across the region year after year. Yet studies by OSU and others suggest that there is more to it than a simple predator-prey relationship between marine mammals and fish. That’s because sea lions have historically had a voracious appetite for a salmon nemesis: the lamprey, a parasitic fish that attaches itself to juvenile and adult salmon. In the 1980s, an Oregon Sea Grant-funded study by Mate and his colleagues found that lamprey topped the sea lions’ diet in the Rogue River. “Lamprey are anadromous (they spawn in fresh water and migrate to sea), like salmon,” Mate says, “and each female that makes it upstream lays 100,000 eggs. Seals and sea lions are thought to be the reason lamprey populations in Oregon rivers have declined.”

Since that study, the picture has changed. Salmon numbers have plummeted while more sea lions, which are protected by federal law, have been making their way upstream. More research is needed to end the bitter debate.

To settle this and other human-animal conflicts, Mate is spearheading the creation of an international Marine Mammal Institute at OSU. In June, Markus Horning, director of the Laboratory for Applied Biotelemetry and Biotechnology at Texas A&M University at Galveston, became the latest scientist to join the multidisciplinary team that will study marine mammal ecology from many different angles — behavior, acoustics, physiology, genetics and seasonal distribution. Horning specializes in pinnipeds and other diving animals. With scientists at the Alaska Sea Life Center in Seward, Alaska, he leads a study of Steller sea lions, using a new implanted tag technology that reveals details about foraging patterns and other aspects of an animal’s life history.

Mate continues to develop his program at the Hatfield Marine Science Center as the foundation of a worldwide effort to understand and manage marine mammals. Because in the end, extending the scope and reach of science, Mate says, is the best hope for the future of the world’s ocean dwellers. **terra**

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To learn more about research in OSU’s Marine Mammal Program, see [oregonstate.edu/groups/marinemammal](http://oregonstate.edu/groups/marinemammal)



## To Hear Whales Breathe

“There is magic in the air.” Not a sentence one would expect to see in association with research and field science, is it? But the great thing about science is that it so often skates along the edge of understanding; and just past that edge are mysteries that sometimes seem like magic. It’s the pursuit of those mysteries, the demystifying of the magic, that drives so many scientists.

I’ve been fortunate to work with a group of cetacean scientists for five years and have seen quite a few mysteries explained, but each explanation gives instant rise to at least one new question, and usually more. That’s one of the greatest frustrations, and the greatest pleasures, of working in a scientific field.

And there’s another great pleasure as well: sharing knowledge with others. This one, I believe, is the true end goal of science. It’s not just about discovery; it’s about dissemination. Knowledge is nothing if it’s not communicated.

The Marine Mammal Program’s annual Baja Expedition is about all these things: discovery, understanding, sharing. It’s a rare opportunity for people of all backgrounds to learn, answer questions and ask new ones. Our passengers can see elephant seal pups roll over each other and teach themselves to swim, watch juvenile California sea lions make a beeline toward a boat because they’re curious about us and touch a whale because that whale chooses to be touched. As a staff member of these expeditions, I find it just as much fun to watch others make these discoveries as it was to make them myself.

One of the questions I’m often asked on this trip is, do I ever get jaded? Am I tired of it yet, seeing the same things each year? The quick answer is, no way. The longer answer takes the form of a short story.

Our time in San Ignacio Lagoon includes a trip to a particular beach that I adore. It’s located at the north entrance to the lagoon and is literally covered in places with shells and bones. Most of our passengers take great delight in beachcombing this area and quickly spread out as they wander in pursuit of that next interesting or beautiful thing. But I usually sit. Because if we can get to this beach at the right time of day, an amazing thing happens: the wind dies down, the lagoon calms and sound carries. So if I can find a quiet spot to just sit and listen, I can hear whales breathing. I hear them all over the lagoon. Some are close to me; others can be over a mile away — far enough that I see the blow a half second before I hear it.

There’s only one word to describe what it’s like to sit in the sun, on a spectacular beach in a pristine environment, and listen to whales breathe. Magic.

So no, I never get jaded. Because there is, quite literally, magic in the air.

— Story and photo by Carol DeLancey,  
OSU Marine Mammal Program



# To Conquer Vitamin E

Trekking through the last frontier of vitamin exploration

By Lee Sherman

Maret Traber's experiments feature an eclectic collection of subjects: rats and tropical fish, overweight people and ultramarathon runners, apples and baked goods.

That's because the focus of her research — vitamin E — is among the most complex and least understood of the micronutrients. So she and her graduate students study it from all sorts of angles: metabolism in rodent livers, protein transporters in zebrafish, nutrient interactions in humans stressed by obesity or grueling physical activity and blood plasma levels in muffin eaters.

Teasing out E's elusive secrets from her laboratory at OSU's Linus Pauling Institute has earned Traber international prominence in the world of nutrition science.

Her most recent discovery proving the synergistic action of vitamins E and C in the human body has far-reaching implications. But bigger breakthroughs are ahead.

"More than 80 years after the discovery of vitamin E, we still don't know its specific molecular functions. This is the last frontier in vitamin research," says Traber, who is also a professor in the OSU Department of Nutrition and Exercise Sciences.

Vitamin E's status as a nutritional conundrum stems from its many chemical forms. The term "vitamin E" is an umbrella covering a "family" of at least eight structurally related compounds that occur naturally in plants — four tocopherols and four tocotrienols. Yet the human body rejects all of these except one form of tocopherol called alpha.

The term tocopherol has its roots in an early discovery: it is essential to successful production of offspring. Hence, it takes its name from the Greek words *tokos* ("childbirth")

One of the world's leading vitamin E experts, Maret Traber (right) investigates the complex biochemistry of this essential micronutrient in her lab at OSU's Linus Pauling Institute, where she and biochemist Debbie Mustacich are conducting experiments on the ability of vitamin E to alter the protein levels and activity of liver enzymes involved in the metabolism of drugs. (Photo: Cheryl Hatch)

and *pherein* ("to bear"). It's the alpha form whose role in the human body is best known as an antioxidant — that is, it protects normal cells that are under oxidative stress.

Sources of such stress include tobacco smoke and, on the opposite end of the lifestyle spectrum, punishing road races. These stressors can trigger the production of free radicals, which rob molecules of their electrons and damage normal cells. Antioxidants like vitamin E — sometimes called "radical scavengers" — can head off the molecular damage that leads to chronic diseases such as cancer, Alzheimer's and heart disease.

Because of work by Traber and other scientists, we also know that vitamin E doesn't work alone. In a report published this year in the journal *Free Radical Biology and Medicine*, Traber, along with Dean Tammy Bray of the College of Health and Human Sciences and then graduate student Rich Bruno (now at The Ohio State University), revealed a metabolic link between E and C. They knew from prior LPI research that smoking depletes vitamin E in plasma. They also knew that, in test tube experiments, the two vitamins work together. But whether the two nutrients "talk" to each other in the human body had not been clearly demonstrated. The study comparing 24 college-age smokers and nonsmokers found that daily vitamin C supplements of 1,000 milligrams blocked the depletion of E in the smokers by as much as 45 percent. Researchers from the University of Washington, Columbia University and Brock University also collaborated on the study.

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“It's the Mt. Everest of micronutrients.”

— Maret Traber  
Professor,  
Linus Pauling Institute

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One of the surprises of this E-C synergy stems from the old adage, "oil and water don't mix." Vitamin E dissolves in fat, while vitamin C dissolves in water. As anyone who shakes up the vinaigrette knows, oil and water separate as soon as the shaking stops. Nevertheless, chemists have shown that E and C can get together through a series of complex chemical steps. It was Traber's team that moved the science from the test tube to the dinner plate, demonstrating the interactions between vitamin E and the foods we eat.

But eating E-loaded foods — sunflower seeds and almonds, spinach and dandelion greens, oils pressed from canola, cottonseed, safflower or olives — isn't sufficient to protect you against free radicals. As Traber has shown, an adequate intake of its co-antioxidant, vitamin C, is also critical. If you're taxing your cells by smoking or by running the McDonald Forest 50-K Ultramarathon, you'll need to bump up your C intake to compensate.

If you're among the 95 percent of American adults who aren't getting the 15-milligram daily requirement and decide to take an E supplement, many nutritionists recommend a full-spectrum pill — one that contains the less-understood tocotrienols as well as the tocopherols. Traber "vehemently" objects to this stance. Her studies have shown that *only* alpha-tocopherol is vigorously retained by the human body, while the other forms are metabolized and excreted. Her studies show, too, that synthetic alpha-tocopherol is only half as effective as natural alpha-tocopherol.

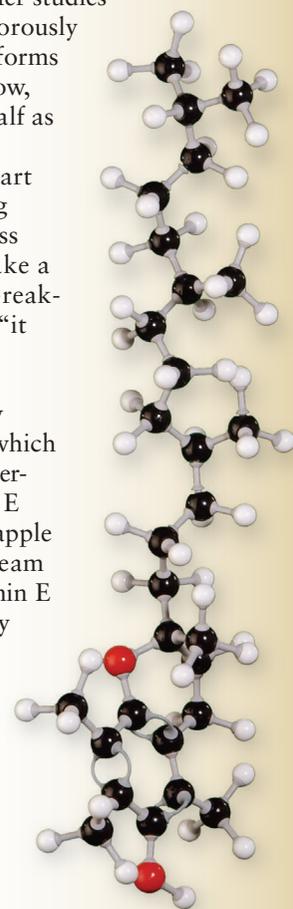
These concerns, however, touch on only part of the vitamin E-interaction puzzle. Popping an E supplement is futile, for instance, unless you take it with a fat-laden meal. "If you take a vitamin E with a glass of water and call it breakfast as you run out the door," Traber says, "it doesn't do you any good at all."

She and researcher Yanyun Zhao of OSU's Department of Food Science and Technology showed this E-fat dependency in a study in which Zhao coated apples with vitamin E as a preservative. The scientists then measured vitamin E absorption in subjects who ate an E-coated apple compared with those who ate a bagel and cream cheese along with their Granny Smith. Vitamin E absorption was much lower in the apple-only eaters than in those who also had the bagel and schmear.

Other common causes of oxidative stress include obesity and diabetes. Traber has launched a collaborative study with vitamin C expert Mark Levine at the National Institutes of Health to investigate how vitamin E requirements differ among obese, diabetic and normal women. Using state-of-the-art biokinetic technologies on 30 female subjects at the NIH hospital in Bethesda, Maryland, the researchers will be exploring such questions as: How is it absorbed and transported in the body? How does it interact with fat? How does it interact with C?

In yet another new NIH-funded study, Traber will look at how vitamin E interacts with therapeutic drugs. The \$1.4 million, four-year investigation will focus on the metabolic pathways in rats' livers for regulating vitamin E and pharmaceutical drugs — and on how those compounds interact.

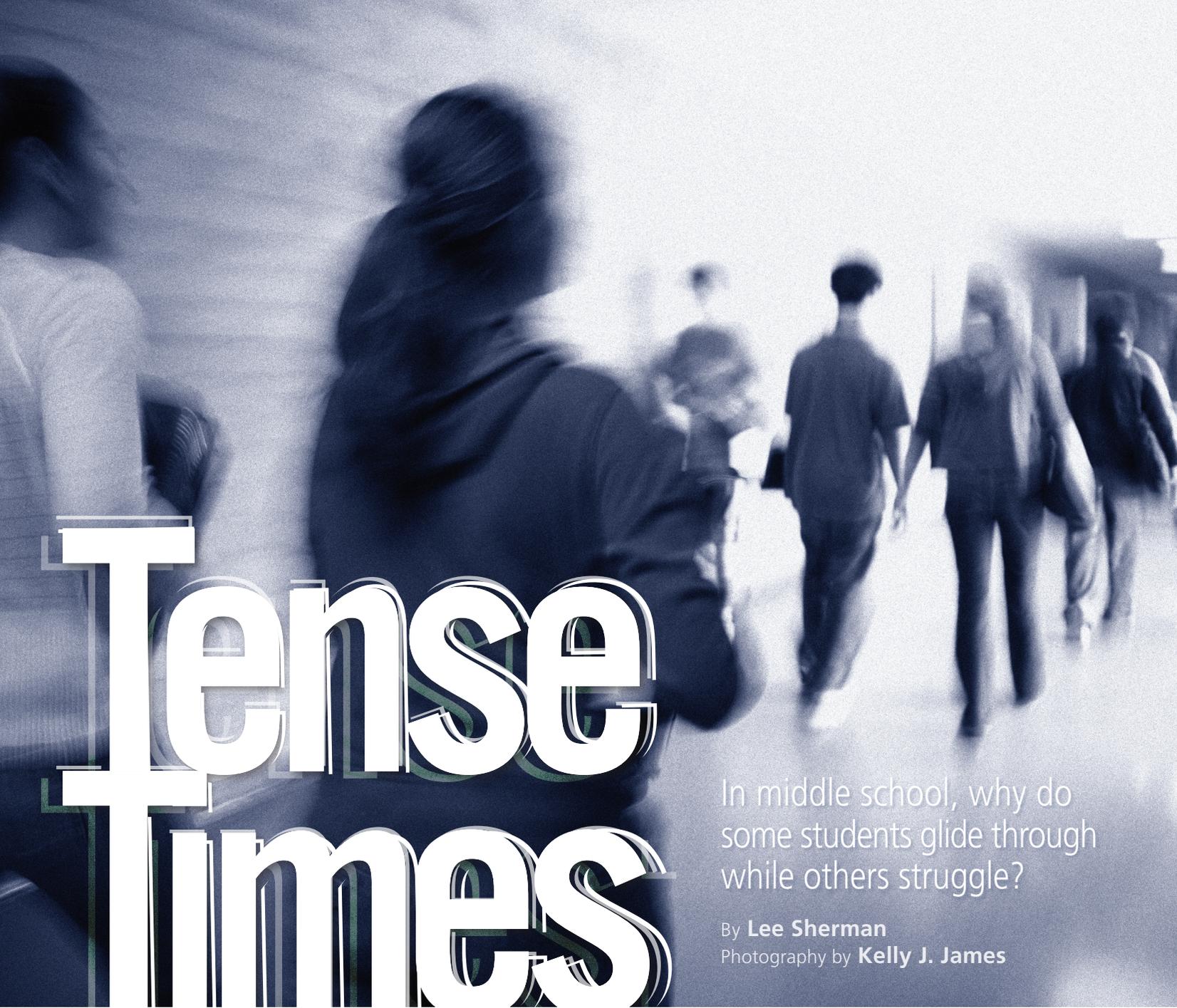
"For all the other vitamins, we know *exactly* what they do and how they do it at a biochemical level," Traber says. "But E is still a huge unknown. It's the Mt. Everest of micronutrients." **terra**



Vitamin E  
(alpha-tocopherol)

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To learn more about the Linus Pauling Institute's micronutrient research, see [lpi.oregonstate.edu/](http://lpi.oregonstate.edu/)



# Tense Times

In middle school, why do some students glide through while others struggle?

By **Lee Sherman**

Photography by **Kelly J. James**

Middle schools are roiling cauldrons of stress. As if acne, algebra, orthodontia and runaway hormones weren't tough enough, young teens also face intense pressure to be liked.

For sixth-graders in Benton County, broken friendships and hurtful rumors hold more dread than bad grades or angry parents, researchers at OSU have learned.

"Middle school is a scary place," says Jennifer Connor-Smith, a psychology professor who is leading a three-year study on adolescent coping strategies.

Her assessment is not just professional — it's also personal. She admits to having been an adolescent "stress case" herself. As an undersized child with an oversized intellect, Jennifer Connor had skipped second grade. The straight A student earned in math never eased the social discomfort she felt among her older, bigger classmates. The fear

that "nobody would like this short little pipsqueak" only got worse as she headed off to junior high in Littleton, Colorado.

The memory of that grinding anxiety has motivated her research, even as a doctoral candidate at the University of Vermont and as a post-doc at UCLA. Her current study, funded by the National Institute of Mental Health, delves into the causal links between personality type and coping strategies. How, she wondered, does temperament interact with various ways of



handling stress to predict outcomes for adolescents? Why do some kids glide through stressful situations emotionally unscathed, while others lash out aggressively — or sink into depression?

If social scientists could discover what kinds of strategies work best for which kinds of kids, Connor-Smith reasoned, school counselors and clinical psychologists could more effectively teach coping skills to children struggling with anxiety, depression or aggression, customizing the intervention for each child's unique makeup. Tailored therapies are certain to work better than generic ones, she says, to prevent the depression, drug use, school failure and violence that can derail the lives of troubled teens. Helping kids manage the often wrenching transition from



*OSU psychology Assistant Professor Jennifer Connor-Smith (center), along with undergraduate researchers Janelle Quest and Kathryn Cellerini, is investigating the complex interaction of personality and stress management in adolescents.*

## Undergrads in the Lab

Undergraduate researchers Janelle Quest and Kathryn Cellerini have been working shoulder-to-shoulder with their professor Jennifer Connor-Smith to identify and isolate the factors that influence adolescent stress management.

As part of a cadre of research assistants in OSU's Department of Psychology, they are getting the kind of nuts-and-bolts experience in social science that typically comes along only for graduate students. They are helping to design questionnaires and "protocols" for observing and rating kids' behaviors, interviewing students and their parents, measuring physiological responses to stress in the laboratory, and collecting and analyzing data.

"Working in the lab has given me a chance to really understand what goes into developing the knowledge base in psychology," says Quest, who started college as an engineering major. "It's given me a whole new perspective on my education because I'm taking an active part in what I'm learning, compared to cramming for a midterm and then forgetting everything afterward."

Cellerini, who entered OSU in pre-med before switching to psychology, says her strong science background has been a big plus. "Genetics and chemistry are really helpful in psychology," she says.

This work has helped both young women solidify their career goals. Quest (who completed her degree requirements last spring) rounds out the 30 hours she spends in the psych lab each week with a graveyard shift at the Children's Farm Home, where she works as a treatment specialist for troubled youths. A Northwesterner born in Anchorage and raised in Eugene, Quest plans to counsel children and families after earning her Ph.D. in clinical psychology. "I want to make a difference," she says. "Working with younger kids is best — the earlier, the better."

Cellerini, an Oregonian from the rural community of Colton, also aspires to a doctorate in clinical psychology, with an emphasis in child development. "I feel that I'm at my best," she says, "when I'm working with kids."



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“For boys, middle school is a little bit like *Lord of the Flies*.”

— Jennifer Connor-Smith  
Assistant Professor,  
Psychology

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elementary to middle school can give them a big leg-up, socially, academically and emotionally.

To figure out how stress and personality interact, the researchers began by gathering data about “social stressors” (difficult interactions with peers) and “life stressors” (academic and domestic problems) from about 400 students at middle schools in Philomath and Corvallis, Oregon. The questionnaires also probed emotional, behavioral and coping issues. A 150-student subset of that group was then brought to the OSU psychology lab for individual testing. Connor-Smith has trained a cadre of undergraduate researchers (see sidebar) to administer a set of “standardized stressors”— for example, having the child solve a math problem aloud and give an impromptu soliloquy about friendship in front of a video camera. To measure the subject’s level of “involuntary stress reactivity,” the team

used electronic monitors and sensors to track heart rate, blood pressure, and skin moisture. Finally, each subject was videotaped during an eight-minute interaction with a parent.

Although the data are still being crunched, a couple of early findings have emerged. First, a child who tends to be anxious — one whose heart rate

and blood pressure spike in times of stress — needs to use different coping skills than a more easy-going child. “When your heart is pounding, your thoughts are racing, and you feel sick to your stomach, that’s not the time to try to reason through what you’re going to do,” Connor-Smith concludes. “That’s the time to pull back and get yourself together before you step forward to do some problem-solving.”

Behavior that typically is viewed as a failure to cope — disengagement, avoidance, denial — can actually benefit highly anxious people, she says, as long as they follow through with more active strategies after they calm down.

Second, the study suggests that coping skills are gender sensitive. Strategies that work well for girls, the researchers have found, can backfire for boys. A sixth-grade girl who seeks social support — who goes to her girlfriends and says, “I’m sad, Ashley hurt my feelings”— is likely to get nurturance and support. But a sixth-grade boy who says, “You hurt my feelings” risks getting teased and laughed at.

After watching kids talk about their problems on hours and hours of videotape, Connor-Smith saw two clear sets of rules. “The girls talk a lot about feelings and about their network of alliances — how

Ashley told Caitlin that Savannah was upset with Lindsay because Lindsay told Caitlin,” she reports. “You almost have to diagram it.” Adolescent boys, on the other hand — despite growing tolerance for “sensitive” males in the broader society — tend to keep their feelings to themselves. Thus, a sixth-grade boy who’s upset is unlikely to reveal his pain to his peers. And while he may shrug it off — “It didn’t bother me; I’m cool” — such bravado may mask unresolved feelings that can fester or erupt.

“For boys,” Connor-Smith observes wryly, “middle school is a little bit like *Lord of the Flies*.”

Her data also show that when parents model warmth and empathy, their kids handle stress better. Supporting the child’s autonomy is also critical. “Children do best when parents encourage them to think for themselves and to draw their own conclusions about what they should do next, rather than issuing edicts,” says Connor-Smith, adding, “Thank goodness my mom did this for me, or I may never have survived junior high.”

So far, the findings support the professor’s hypothesis that when it comes to stress management, “One size does not fit all.” Her hope is that the study can guide new approaches to coping-skills interventions and improve mental health for middle schoolers at this intensely vulnerable, enormously formative time in their lives. **terra**

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To read about research in the Department of Psychology, see

[oregonstate.edu/cia/psychology/](http://oregonstate.edu/cia/psychology/)

## Genome Explorer

“I like to think of it as Lewis and Clark venturing into the unknown. We have to report on what we see and make sense out of it.”

— Larry Wilhelm

Larry Wilhelm knows computers, but they weren't his first love. In 1985, the Monmouth, Oregon, native graduated from OSU with a bachelor's degree in microbiology and went to work for a biotechnology firm, Synergen, in Boulder, Colorado. “That's where I got my feet wet in computers,” he says, learning to organize and analyze data coming from molecular biology labs. He also did a stint with HP's laptop division in Corvallis.

Today, with one foot in computer technology and the other in biology, he is using

DNA sequences to identify new genes and build the foundation for a more profound understanding of the microbial world. As a Ph.D. student in a lab run by OSU microbiologist Steve Giovannoni, Wilhelm uses online databases to characterize new species of microbial life in the oceans.

“We have 18 new genomes coming down the pipeline in this lab alone,” he says. “There's just a ton of data out there. I like to think of it as Lewis and Clark venturing into the unknown. We have to report on what we see and make sense out of it.”

With new DNA sequences in hand, Wilhelm searches gene databases for close similarities or matches. He delves into databases that link genes and proteins. And he looks at many genes at once to discover differences between organisms that may reveal their evolutionary history and how they function in their ecosystem. The field is known as “bioinformatics.”

One surprise already produced by this young discipline: The diversity of the microbial world has been largely underestimated.

“Modern techniques indicate that most of the microbes in the world are unknown. We have reason to believe that they are there but really don't know anything about them.”

Ultimately, Wilhelm hopes the new knowledge will lead to practical benefits such as new drugs, effective pollution control and more efficient industrial processes.

To explore research in the Department of Microbiology, see [microbiology.science.oregonstate.edu/](http://microbiology.science.oregonstate.edu/)



## New Life from Black Water

Forget about clear, pristine waters. The real action for some scientists is in dark swamps where black stained water has the acidity of vinegar. While such places might seem inhospitable to life, they provide OSU scientists with a trove of potential candidates for new antibiotics.

In the College of Pharmacy, researchers are screening hundreds of microorganisms from the Black Water Ecosystem on the island of Borneo. Their goal: new compounds to fight tuberculosis and other infectious diseases.

“Indonesia is a real hot spot for biodiversity,” says Mark Zabriskie, a professor in the Department of Pharmaceutical Sciences. Zabriskie and his colleagues Phil Proteau and Taifo Mahmud are studying compounds produced by bacteria and fungi. The scientists look for ways to enhance the antibacterial properties of these compounds through genetic engineering and/or chemical modification.

Work on the Indonesian microbes got under way in 2005 when Dwi Andreas Santosa, director of the Indonesian Center for Biodiversity and Biotechnology, brought 750 samples of microorganisms to OSU. Santosa has isolated about 10,000 microbial species, many of which may be new to science.

In the past, scientists have scoured soils and other environments for antibacterial compounds, but the frequency of finding novel drug leads has been slowed by difficulties in culturing unique microbes in the laboratory. The Black Water Ecosystem is significant because so much of its microbial life is poorly studied.

*Electron micrograph of tuberculosis cells is courtesy of Clifton E. Barry, III, and Elizabeth Fischer, National Institute of Allergy and Infectious Diseases.*

The OSU researchers and their students are culturing the microbes and determining the antibacterial potential of each one. They also compare promising species to known microorganisms by focusing on a small DNA fragment, a kind of molecular bar code. It tells them if a species is already known and whether it is likely to produce novel natural products.

“Ultimately, as we go through this screening process, we'll find new compounds and then go after the genes to study how a promising antibiotic is made and see if we can get analogs produced by genetic manipulation and chemical modification,” says Zabriskie. By documenting the potential for new antibiotics, the researchers hope to attract grant funding that would allow them to understand the chemistry leading to new drugs.

To learn more about OSU's College of Pharmacy, see [pharmacy.oregonstate.edu/](http://pharmacy.oregonstate.edu/)



## After the Fire

On a winter day last February, it was standing room only in the Medford, Oregon, city hall. The attraction was a congressional hearing on salvage logging after wildfire, and so many people wanted to attend that the Medford fire chief waived the 200-person room capacity limit.

Technical reports rarely generate headlines. But in January, arguments about a one-page salvage logging paper by a team of five OSU researchers and one from the U.S.D.A. Forest Service in the journal *Science* had splashed across newspapers nationwide and spilled over into the political aisles. The paper focused on the ecological effects of post-fire salvage logging two and three years after the Biscuit fire in southwestern Oregon.

The debate, however, covered broader ground: academic freedom, funding and research ethics. It also revealed social tensions over forest management values and involved OSU scientists and their collaborators who are deep into more than a half-dozen studies on the environmental consequences of salvage logging and forest response to fire.

Testifying that day in Medford was, among others, the paper's lead author, OSU graduate

student Dan Donato. The firestorm that followed the publication, he said, underscored the scarcity of scientific data on the subject. The *Science* paper reflects observations after three years of work on the effects of salvage logging on natural regeneration and wood that, if left on the ground, could fuel future fires. He noted that the study is one of the few on this topic to use a rigorous approach based on scientifically approved methods and design with replication and control plots in logged and unlogged areas.

Nevertheless, Donato took criticism, standing his ground while becoming what *The Washington Post* called the hearing's "principal punching bag." Representative Brian Baird (D-Washington), co-sponsor with Greg Walden (R-Oregon) of legislation to speed approval of salvage logging, questioned Donato's integrity

and accused him of "deliberate bias." Retired Bureau of Land Management manager Richard Drehobl called the paper a "gross misuse of the data," charging that it presented no new or useful information.

Among others who testified, Hal Salwasser, dean of the OSU College of Forestry, and Jerry Franklin of the University of Washington emphasized the importance of research to management. Science and regular monitoring, they said, need to inform forest management, which should anticipate disturbances such as wildfires and adapt as new information emerges.

And the panel also heard from statisticians. Fred L. Ramsey, OSU professor emeritus, and Manuela M. P. Huso, a consultant with the OSU Department of Forest Science, had re-analyzed the data. They testified that the Donato team's analysis supported the findings, which Huso called "quite robust."



Photoillustration: Chris Hunter

### Forest Fire and Salvage Logging Research An OSU Sampling

#### Fire severity

Fires do not burn evenly across the landscape. OSU Ph.D. student Jonathan Thompson is working with Tom Spies of the Forest Service to understand how weather, topography, vegetation and previous management activities such as salvage logging affect fire severity. Working with OSU Professor Klaus Puettmann, Ph.D. student Lori Kayes is investigating restoration and regeneration efforts following high severity fire in southwest Oregon (the Timbered Rock fire).

#### Natural regeneration

After a fire, trees and other plants may sprout profusely or not at all. OSU Senior Faculty Research Assistant Jeff Shatford is working with Hibbs to understand what controls the regeneration of shade-intolerant conifers in several burned areas.

#### Salvage logging and wildlife

Just as plants vary in their response to fire and logging, so do wildlife species. Forest Science Professor John Hayes, Research Assistant Tom Manning and graduate student Rebecca Cameron are studying the influence of salvage logging on habitat quality and abundance of birds, bats and small mammals

in logged and unlogged forests. In a separate study, Hayes and Michelle Cannon, a graduate student working on a dual degree in Forest Science and Fisheries and Wildlife, are studying breeding birds in burned and adjacent unburned forests. Working with Robert Anthony in the same department, Darren Clark is working on spotted owls in burned areas of southwest Oregon (Biscuit and Timbered Rock), and Joe Fontaine is working on short- and long-term response of birds and small mammals to salvage.



The Medford hearing touched only a small part of OSU's ongoing research on this topic. In cooperation with the Forest Service, the Bureau of Land Management, the Oregon Department of Forestry and other agencies, OSU scientists focus on a range of fire-related factors: wildlife, natural regeneration, soil, fire severity and pre-fire conditions, including past salvage logging. These and other studies will help to fill critical information gaps. A 2001 Forest Service review found only 21 studies worldwide on the environmental effects of post-fire logging. Only 14 compared logged areas to unlogged controls.

Nevertheless, dead and living trees have long been harvested after fires. And relying on both natural regeneration and planting, foresters have traditionally sought to spur tree growth as quickly as possible, says David Hibbs, OSU professor of Forest Science and coordinator of OSU's Cooperative Forest Ecosystem Research Program. As a result, forest managers have a rich bank of practical experience in reaching that goal. For their part, researchers focused on barriers to plant growth, the productivity of plant communities and forest succession over decades. One example: the College of Forestry's Forestry Intensive Research program, begun in 1980 to evaluate reforestation options on shrub-dominated sites in southwest Oregon.

In recent years, a shift in social values has led to a change in science. Hibbs notes that the view of fire as destruction has broadened to include a focus on the ecological factors that support forest regeneration. This view recognizes that fire is part of a natural system that sets the stage for an entire ecosystem.

The shift is important because it implies a

changing response to fire. To some, practices such as ground-based salvage logging are generally inconsistent with natural ecosystem restoration. On the other hand, forest managers maintain that quick action such as logging, tree planting and even disposal of logging debris can spur tree growth in places dedicated to timber production. Such practices are expensive, and logging provides a source of revenue to help offset the costs.

*“In a more open landscape, fires typically stayed low and large trees survived. Now when fires occur, they often kill everything. There's no habitat left.”*

David Hibbs  
Professor, Forest Science

The need to resolve the debate brings some urgency. A century of fire suppression has led to dramatic changes, especially in dry forests, adds Hibbs. Trees occupy former grasslands, and forests that had an open understory have become dense. This thicker growth may benefit spotted owls and other forest dwellers, but the additional wood also provides the fuel for more intense fires.

“In a more open landscape, fires typically stayed low and large trees survived. Now when fires occur, they often kill everything. There's no habitat left,” says Hibbs. Moreover, a return to historical fire regimes is not possible. “We're in a whole new ballgame,” he adds.

Ongoing studies receive funding from sources that include the Forest Service, the Bureau of Land Management and other federal agencies operating through the Joint Fire Science Program. They could help answer a variety of questions about post-fire management on a site-by-site basis: how many, if any, trees to cut; what harvesting techniques to use; whether and how to control competing vegetation; what, when and where to replant. These studies will improve the scientific basis for a range of management options, providing guidance to forest managers and researchers.

— By Nick Houtman



Learn more about projects underway in the Cooperative Forest Ecosystem Research program at [fsl.orst.edu/cfer/](http://fsl.orst.edu/cfer/)

## Vegetation and wildlife

Continuing their study of salvage logging, plant and tree growth, wildlife and fire risk are the team that produced the *Science* paper. Led by OSU Forest Science Professor Beverly Law, the team includes Donato and John Campbell in Forest Science, Joe Fontaine and Doug Robinson in Fisheries and Wildlife and Boone Kauffman of the Forest Service. In particular, they are interested in the effects of re-burn. What are the consequences of a second high severity fire within two decades of the first fire?

## Riparian zones

Areas along rivers and streams provide important ecological habitats and may respond to fire in a different manner than surrounding uplands. Graduate student Jessica Halofsky is working with Hibbs to understand fire behavior in riparian zones.

## Shrubs

Most shrubs come back after fire from root sprouts or the seed bank, but if they are damaged or killed by logging operations, will they recover? OSU graduate student Maria Lopez and Hibbs will begin a study this summer to answer that question. Shrubs provide an important food source and cover for wildlife, and some types of shrubs provide nutrients to growing trees.

## Soil fungi

Soil fungi play a crucial role in forest ecosystems by recycling nutrients. Matt Trappe, a Ph.D. student in the Environmental Sciences Program, is studying the effects of prescribed burning on mycorrhizal fungi in an old-growth ponderosa pine forest in Crater Lake National Park. Trappe is working with Kermit Cromack, OSU professor emeritus, and Jim Trappe and Efrén Cazares of the Department of Forest Science, to understand fungal activity after fire.



## The Weight of Wine

For Jim Kennedy, it's all about mouth feel. The sensation of wine on the palate can be silky and smooth or coarse and hard. Wine experts call it texture. And along with color, taste and aroma, a luscious texture can cause some people to plunk down \$100 or more on a bottle of Pinot noir or Cabernet.

Kennedy is a wine chemist in the OSU Department of Food Science and Technology, and he is trying to put his finger on what creates great texture in red wine. Armed with such information, he says, winemakers could add substantial value to Oregon's wine production as well as to the grape crop itself. It was the state's fourth most valuable fruit crop (behind winter pears, sweet cherries and apples) in 2005, worth about \$36.5 million, according to the OSU Extension Service.

"If you think about how you sense red wine, first there's the visual aspect," Kennedy says. "Then you smell it. That's the most complicated part of it. There are hundreds and hundreds of volatiles (aromatic compounds) in wine. Then you taste the wine. You've got organic acids and some alcohols. Then you feel the wine as it's in your mouth. That's the final sensation. I attribute it to tannins, that astringency, a dryness."

Tannins — a class of compounds with arms-length names (proanthocyanidins, for example) that can readily react with proteins and other molecules — are the focus of Kennedy's research. But texture is more complicated than tannins, and Kennedy and his colleagues are still trying to tease out all the factors. "We don't have standards for



*Wine tasting in Kennedy's lab is serious business. Tasters sip, swirl and spit out the sample and cleanse their palates with water. While individual reactions vary, Kennedy identifies patterns in sensory data. (Photo: Kelly J. James)*

texture," he says. "It is such an elusive little thing to figure out, a tough nut to crack."

The issue is critical for the wine industry. "Texture is one of the two or three sensory measures of great wine," says Harry Peterson-Nedry, founder and winemaker at the Chehalem winery in Newberg and a member of the Oregon Wine Board. "The feel on the palate, the weight of the wine in the mouth, is extremely important." Winemakers want to maximize texture, but they lack techniques that are reliable and effective, he adds.

A chemist with industrial experience in experimental design, Peterson-Nedry has provided wine samples for Kennedy's texture experiments, and the two men have given joint presentations at the annual Oregon Wine Industry Symposium. "Jim Kennedy is one of the premier tannin chemists in the world," he says. The wine board, which funds Kennedy's research (along with the U.S. Department of Agriculture and the American Vineyard Foundation), is impressed with his multifaceted approach, collaborating with other OSU researchers with expertise in yeast, flavor and viticulture.

"We're lucky to have Jim," adds Rollin Soles, Soles, co-organizer of the annual symposium and winemaker at the Argyle Winery in Dundee. Kennedy's research, he says, will create the tools for the industry to promote wine texture through practices in the vineyard and in the winery. And those tools need to be adaptable. "If you live in Oregon, you know how conditions can change from wet and cold one year to hot

### Stewards of the Vineyard

According to the Oregon Wine Board, more than a third of Oregon's 709 vineyards are certified for sustainable practices and 14 percent farm organically. Through the Salmon Safe and LIVE (Low Input Viticulture and Enology) programs, vineyards minimize chemical use, reduce erosion and use beneficial insects to control insect pests. (Photo: Lynn Ketchum)



and dry the next. We have to move with Mother Nature to achieve balance in our wines," he says.

In order to find the chemical fingerprint of texture, Kennedy and his colleagues are working with Peterson-Nedry, Soles and others in the industry to study growing conditions that influence the vigor of the vines and the chemical composition of the grapes. The location of grape clusters on the vine, says Kennedy, affects exposure to sunlight and tannin concentrations in grape skins. Researchers are monitoring the changing chemical environment inside growing fruit, starting from the time when tannins are first produced.



*Is wine texture affected by how grapes are crushed? To find out, OSU master's student Fiorella Cerpa Calderón of Arequipa, Peru, made five lots of Cabernet and is testing them with chemical and sensory methods. (Photo: Kelly J. James)*

In the laboratory, they experiment with winemaking techniques and submit the results to chemical analysis and the ultimate judges — human tasters. (Lest this appear to be high living disguised as science, Kennedy says of one recent batch of samples, "They were all pathetic.") Working with Kennedy is an international team of undergraduate and graduate students and a visiting professor and Ph.D. student from Chile on a Fulbright Scholarship.

They have made progress, publishing reports in agricultural and wine industry journals and offering information to growers at the annual Oregon industry symposium. But what they have is just part of the story.

"We understand the skeleton (the tannins)," Kennedy says. "Now we're going to put the flesh on."

Kennedy has been studying tannins for more than a decade. During his doctoral research at UC Davis in the mid-1990s, Kennedy was looking for a change in tannins that could be related to winemakers' perceptions of grape ripeness. "They can go out in the vineyard one day and say they (grapes) are not ripe, and the next day, they are," says Kennedy. "Well, what's an unripe tannin versus a ripe tannin? The winemakers would say, 'we don't know but we can identify it.'"

Despite developing new techniques for analyzing tannins, Kennedy didn't answer the question in chemical terms during his work at Davis or during his subsequent fellowship at the University of Adelaide in Australia. Determining ripeness is still more art than science, and it remains a holy grail for scientists.

Kennedy's passion for wine comes from more than chemistry and a desire to help an industry grow. He makes his own — about a barrel a year — and prefers reds. "I love making wine, and I love red wine, but I definitely leave the science out of it. Just the passion. It keeps me grounded in the laboratory," he adds.

His first attempt at Pinot noir, Oregon's signature wine, was less than successful. When he came to Corvallis in 2001, Kennedy bought the grapes, crushed them and fermented the juice. He had high hopes. The best wine he had ever tasted was a Pinot noir with a "velvety texture." He learned first-hand why this grape has earned a reputation for difficulty. "It was the worst wine I ever made in my life," he says.

When it comes to texture, some wines "carry" tannins better than others. Pinot noir is known as a "temperamental" grape. Tannin concentrations that work in a Zinfandel or a Cabernet can turn a Pinot noir harsh.

Moreover, the source of tannins makes a difference. Skin tannins tend to be "soft" and "more approachable" than seed tannins, says Kennedy, creating a wine that is ready to be consumed sooner. Thus, a selective emphasis on skin tannins helps winemakers produce a balanced wine that matches a trend in wine consumption. Most buyers tend to drink their wine within 24 hours of purchase.

## Pinot Paradise

I can see the license plates in 2030: Oregon, Pinot Paradise. And there's something ironic about that, isn't there? I mean, here we are, a state that for the longest time was known for timber

and salmon, home-grown products rising up out of the land and water, and basically we wiped out those products, but in the future we will most certainly be known for another home-grown product that

rises up out of the land and water, one that is endlessly renewable and sustainable and environmentally stewardly and all, one that reflects the agricultural bent of the state and its people and history, and respect of the land, and intelligent responsible land use, and attentiveness to the natural world, and the entrepreneurial itch, and the urge for communal enterprise, all the stuff that we think of as very Oregonian. Which is pretty cool.

From *The Grail*, by Brian Doyle, 2006, published by OSU Press. On the Web at [oregonstate.edu/dept/press/](http://oregonstate.edu/dept/press/)



Historically, Oregon's wine industry has built a reputation for small, family-run businesses producing high-quality wines, especially Pinot noir. That grape accounts for about half of the state's 14,000 acres of vineyards, which are concentrated in the north Willamette Valley's hill country southwest of Portland. However, the industry is expanding at the southern end of the valley, eastward into the Columbia and Walla Walla valleys and into southern Oregon where it tends to be hotter and drier.

Kennedy and his colleagues hope their research will help to guide the industry's growth. Their studies are maturing just as the texture of Oregon's wine industry is changing, becoming a more robust reflection of the state.

— By Nick Houtman

Read about OSU wine research and find sources of information and expertise at [wine.oregonstate.edu/](http://wine.oregonstate.edu/)



# Green Power

## Plugging into nature

By **Lee Sherman**

Illustrations by **Christina Ullman**

Oregon leaders on both sides of the political aisle struck a unified note last January, calling on scientists and entrepreneurs to step up R&D in alternative energy technologies.

At the annual statewide economic summit in Portland, Governor Ted Kulongoski challenged the state to be “a leader in bringing energy independence to America.” Both U.S. senators voiced strong agreement. Democrat Ron Wyden vowed to lead an effort to make Oregon “the green-energy capital of the world” by investing in forest biomass technology. And Republican Gordon Smith noted that the development of alternative fuels is “absolutely essential to our nation’s future.”

Alternative energy sources can be found in places as plentiful as seawater and as ordinary as corn. The challenge is to capture and convert those natural stores of energy efficiently and economically. To that end, OSU got a considerable boost in 2004 when it was named one of the nation’s five Sun Grant Centers by the federal Sun Grant Initiative for “bio-energy” — power derived from living organisms or their by-products. As the lead university for a nine-state region, OSU will use its four-year, \$8 million grant to develop technologies for turning agricultural products into clean, renewable fuels.

Meanwhile, in labs across campus — from microbiology to nanotechnology, chemistry and engineering — OSU’s energy studies are already yielding important findings. Research on two of the Pacific Northwest’s most bountiful untapped resources — ocean waves and forest biomass — were featured in the last issue of *Terra* (Spring 2006). Here, we take readers inside some of OSU’s other leading endeavors in the “green” revolution.

### Powered by Canola

Biodiesel is free of the metals and harmful chemicals that plague petroleum products — so free, in fact, that it is “essentially harmless to the environment,” notes OSU chemical engineering professor Goran Jovanovic. “If it spills on soil or in waterways, nature will take care of it in a few days.”

A blend of alcohol (ethanol or methanol) and oil from food plants such as canola or soy, biodiesel offers a non-polluting option for powering not only cars and trucks, but also boats, chainsaws, lawnmowers and recreational vehicles such as four-wheelers and snowmobiles. It also promises to open lucrative new markets to farmers.

But there’s a roadblock to widespread use: production methods that are slow, inefficient and energy intensive. So Jovanovic and a team of researchers affiliated with the Oregon Nanoscience and Microtechnologies Institute (ONAMI) are pioneering a way to manufacture biodiesel that is not only fast and streamlined, but also portable.

In contrast to biorefineries, where big batches are stirred in giant vats for hours, Jovanovic and his fellow scientists can make the fuel in 10 minutes or less by using microtechnology. Here’s how it works: Thirty parallel channels — 100 microns wide, about the width of a human hair — are etched into a plastic plate smaller than a credit card. Thin streams of alcohol and oil are injected into each “microchannel.” Because the alcohol and oil molecules are in close contact all along the channel, the chemical reaction that turns them into biodiesel happens 100 times faster than it does in the macroscopic reactors typically used in large refineries. Thousands of the microchannels stacked side-by-side to create a microreactor the size of a suitcase could produce one million gallons of biodiesel a year.

Jovanovic envisions small farmers producing biodiesel right beside their canola fields — or even consumers whipping up personal-sized batches of biofuels in microchannel reactors available online or at the local big-box store. Freed from dependence on giant power companies and oil-rich countries, Jovanovic says, “Every single person would be empowered to produce energy for themselves.”

### Harnessing Hydrogen

Oceans and freshwater lakes contain an ancient class of microscopic organisms that could be the holy grail of hydrogen production: cyanobacteria.

To power a new generation of clean energy systems, OSU bioengineers are studying ways to harness hydrogen from these super-abundant microbes. Formerly called “blue-green algae” because of their plant-like ability to harvest sunlight, cyanobacteria use solar energy not only to make life-sustaining sugars — they also can make hydrogen. Roger Ely and Frank Chaplen are researching ways to tap that fuel source for tomorrow’s commuters, homeowners and businesses.

Their work centers on overcoming a stumbling block: oxygen. Cyanobacteria stop making hydrogen when oxygen is present. So, with \$900,000 from the U.S. Department of Energy, the team hopes to develop a new capability in these photosynthetic bacteria — “oxygen tolerance.” Once the researchers solve the oxygen puzzle, cyanobacteria could eliminate the biggest barrier to affordable hydrogen production — fossil fuels. Most hydrogen today is produced from petroleum. Besides adding greenhouse gases to the atmosphere, the net energy gain is negligible. If OSU’s engineers can exploit the cycle of one of Earth’s oldest, most plentiful organisms, hydrogen could make gasoline obsolete.

Calling cyanobacteria the “ideal energy device” because they are non-toxic and low-cost, Ely believes that eons of evolution and adaptation can help us learn how to capture and convert solar energy. “Nature,” he says, “has worked this out so well.”



## Nuclear Renaissance

OSU’s recent breakthroughs in reactor safety signal the rebirth of an industry long dogged by the risk of radioactive leaks.

An international leader in the development of failsafe ways to extract energy from atoms, Professor José Reyes has for a decade been steering the design of nuclear reactors that reduce risk through simplicity. The valves, pumps and pipes that operate older plants mechanically are replaced by natural forces — gravity, convection, evaporation and condensation — that, in case of an accident, cool the core “passively.”

“We’re moving toward a new safety culture in the development of nuclear power,” says Reyes, who directed a 14-nation research program on passive nuclear technology at the United Nations International Atomic Energy Agency in Vienna in 2004. Recently certified by the Nuclear Regulatory Commission, one new-era model tested at OSU for Westinghouse could be under construction in a few years, he predicts. Known as the AP-1000, it has been selected for six new nuclear power projects announced in the last year by U.S. energy utilities.

One of the ultra-safe reactors on OSU’s drawing board is a compact modular unit that can be sealed up and loaded onto a train for transport. Requiring no onsite fueling, it poses a near-zero risk for leaks. When buried safely in underground silos, these self-contained reactors could help fill worldwide demand for small-scale, portable energy systems. Another planned model has the potential to be a double-duty renewable. It operates at ultra-high temperatures, actually “cracking” water molecules to free up hydrogen. By making hydrogen at the same time it generates electricity, the thermal reactor could light houses and fuel cars, cleanly and cheaply.

Reyes is the first holder of the Henry W. and Janice J. Schuette Chair in the Department of Nuclear Engineering and Radiation Health Physics at OSU.

## Blowin’ in the Wind

When it blows strong and steady, wind is a cost-effective energy source. To guide decisions on wind-farm development, many Northwest agencies, developers and farmers rely on OSU’s long-term “wind feasibility” studies and research.

An early frontrunner in wind research, OSU’s Energy Resources Research Laboratory (ERRL) specializes in assessing wind-power potential for private and public landowners. One community sizing up its wind power is the Warm Springs Indian Reservation in central Oregon. Whether tribal lands are windy enough to justify investment in a large-scale commercial wind farm is the subject of a five-year study commissioned by Warm Springs Power Enterprises. The university is also partnering with Bonneville Power Administration on a wind forecasting/integration study and with the Oregon Energy Trust, loaning anemometers to electricity customers of Portland General Electric and Pacific Power who want to measure the wind potential of their home or business.

For wind to become a “prominent and dependable” energy resource in the region, reliable ways of predicting and measuring wind are critical, says Stel Walker, professor of mechanical engineering and ERRL director. “This is very important in the Pacific Northwest,” he notes, “where the region’s complex topography has a strong influence on the strength and variation of the wind.”

## Catching Some Rays

Using furnaces as hot as 1,700 degrees centigrade, OSU chemists and engineers are forging novel compounds that could give new life to the solar energy industry. Their research into advanced solar-cell materials — ones that absorb more light, produce higher voltage and work more efficiently — holds promise for an exponential expansion of sun-based power generation. “Most of the solar technologies in use today date back at least 25 years,” says Douglas Keszler, Department of Chemistry chair. “The cells you put on your roof are only about 10 percent efficient. We’re looking for high-performance materials with at least 25 percent efficiency.”

With funding from the National Renewable Energy Laboratory, Keszler and electrical engineering professor John Wager are investigating oxides as the “optimal materials” to replace yesterday’s solar-cell mainstays — silicon (capturing only a limited light spectrum), cadmium telluride (hazardous to the environment), and copper indium diselenide (scarce and expensive). When Keszler looks into the future of solar energy, he doesn’t see millions of rooftops sporting solar panels, installed and maintained by homeowners. Rather, he imagines neighborhoods drawing electricity from nearby “solar farms,” built and operated by local power companies.

“There’s so much solar energy available,” says Keszler. “One peak hour of sun shining on the U.S. provides enough energy to power the whole world for a year. It’s incredible to me that the world’s solar program isn’t 10 times its current size.” **terra**

To learn more about OSU energy research, see [enr.oregonstate.edu/research/clusters/lse.html](http://enr.oregonstate.edu/research/clusters/lse.html)

## Maps Help Plow New Ground for Oregon Grass

Two OSU scientists have produced the first collection of maps that show climate, soil characteristics and plant species suitability for the People's Republic of China. Their China atlas is the result of 10 years of research and has paid off by increasing grass exports from Oregon to the world's most populous nation.

The 296-page atlas, *Visualizing China's Future Agriculture: Climate, Soil, and Suitability Maps for Improved Decision Making*, was compiled by David Hannaway and Chris Daly. Hannaway is a forage crops specialist in the Department of Crop and Soil Science, and Daly, a climatologist in the Department of Geosciences, directs an OSU climate mapping group.

Land managers in China are interested in forage grasses to support livestock production and to control soil erosion problems on rangelands. They also want turf grasses to beautify their cities and suburban areas.

Hannaway and Daly worked with the Oregon Grass Seed Council to evaluate turf, forage and conservation plants for use in China and to determine the market potential for Oregon-grown grass seed. Before 1992, Oregon sold no grass seed to China. In 2003, Oregon growers exported to China more than 14 million pounds valued at \$8 million to \$10 million.

With funding from the U.S. Department of Agriculture and the State of Oregon, Daly and Hannaway conducted applied research, educational demonstrations and workshops throughout China. Both faculty members are part of the OSU China Working Group, a cooperative effort between OSU and the People's Republic of China to identify mutually beneficial research and education projects and programs.

Learn more about OSU's China Working Group at

[oregonstate.edu/international/CWG/index](http://oregonstate.edu/international/CWG/index)

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OSU researcher Chris Daly created PRISM, a spatial data analysis tool, to map climatic parameters such as precipitation, temperature and dew point. OSU is conducting PRISM climate mapping projects in the United States, Canada, Europe and elsewhere.



Calligraphy by Allen Q. Wong, Corvallis  
Chinese characters for Ryegrass.

## Training for a Science-Smart Workforce

Innovative businesses need savvy employees, people who know science and understand commerce, people like Bill Becker and Akihide Takagi. They are taking advantage of OSU's Professional Science Master's Program, which fills a labor-pool need, combining business courses with science and providing students with new career choices.

Becker, 48, is on leave from the Oregon Department of Environmental Quality. "What I really want to do is get into management, get more involved at the organizational level," he says. "But I'm a scientist. I don't have much experience in business. I needed a non-thesis program with internship possibilities. This program fit me from the get-go."

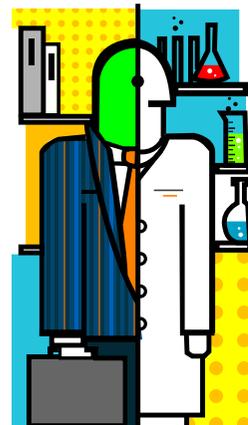
In 2005, Takagi, 26, was one of the PSM program's first six graduates. He had received his bachelor's in microbiology from OSU in 2003 and wanted to work in biotechnology. "Development of new therapeutics and diagnostic techniques requires people to have both science and business," he says. Takagi started work in April as a medical representative for Otsuka Pharmaceuticals in Japan.

Begun in 2001 with a \$400,000 Alfred P. Sloan Foundation grant, the program has 22 students working in four tracks: botany, environmental science, biotechnology and physics. They combine technical work with classes in research ethics, business management and communication. And they are a diverse group, coming from Asia, Africa and throughout the United States.

Ursula Bechert manages the program in the colleges of Science and Agricultural Sciences and says that students work in teams on case studies with off-campus organizations. "Industry would love to see some of our graduates enter into their workforce because they can serve as liaisons between the scientific and business communities, understand basic marketing concepts and communicate with customers on a more realistic level," she says.

To learn more about the Professional Science Master's Program, see

[professionalmasters.science.orst.edu](http://professionalmasters.science.orst.edu)





## Greening the Bottom Line

In the business world, profit has long been the standard for performance. Red ink on the bottom line raises red flags with investors. However, companies are increasingly judged on their social and environmental behavior as well as economics. Business researchers are thus focusing on what they call the “triple bottom line” — the economic, social and environmental aspects of sustainability — to evaluate company operations.

“When we talk about sustainability, we’re really saying we have to redefine business performance,” says Mark Pagell, associate professor in the OSU College of Business. “Our research looks at performance in all three areas.”

Pagell directs research for the college’s Sustainable Business Initiative and specializes in operational evaluation and supply chain management. What he and OSU emeritus professor David Gobeli found in a 2004 survey suggests that many business managers do not put the notion of a “triple bottom line” into practice. Managers report a willingness to address social (defined as protecting employee well-being) and economic issues, but they

*Stahlbush Island Farms uses sustainability principles to raise Marionberries, wheat, squash, spinach, sweet potatoes, broccoli and other crops. The company sells frozen and canned products to retail markets nationwide. Surveying Marionberry vines at one of the company’s locations south of Corvallis is Tina Galloway, Stahlbush procurement manager. (Photo: Kelly J. James)*

are reluctant to deal with environmental issues. The OSU survey is one of the first attempts to understand managerial attitudes toward sustainability.

Since the mid-1990s, business researchers, including Pagell and Gobeli, have consistently found that environmental improvements are good for profits. The OSU team suggests that academics and regulators need to do a better job of communicating that message. “Companies have to be shown that that common wisdom — that dealing with environmental issues is bad for profits — is wrong,” says Pagell.

Clearly, many companies have gotten it. The Oregon Sustainability Board features sustainable business case histories on its Web site ([sustainable.oregon.org/](http://sustainable.oregon.org/)). Meadowood Industries, Inc. (Albany) manufactures building materials from straw that is left from the annual harvest of ryegrass seed. Coastwide Laboratories (Wilsonville) has earned U.S. Environmental Protection Agency praise for its Sustainable Earth® floor cleaning products. Hewlett-Packard (manufacturing plant in Corvallis) has a global program to recycle printer cartridges and other e-waste. Last January, Sustainable Northwest, a Portland-based nonprofit, recognized Stahlbush Island Farms of Corvallis and Norm Thompson Outfitters of Portland with its first Cecil D. Andrus Award for Leadership in Sustainability and Conservation.

Despite the positive publicity, some business owners look forward to the day when sustainable practices are simply business-as-usual. “Sustainability shouldn’t be a hip thing or a buzzword,” Stahlbush Island Farms co-owner and OSU alumna Karla Chambers told *The Daily Journal of Commerce* in January. “It should be a very practical concept for resource use and allocation.”

One of the challenges in a global economy and a focus of Pagell’s research is the supply chain. “When you look at manufacturing in general, about 60 percent of the cost is outsourced. Most companies are buying far more than they are doing themselves,” says Pagell. Suppliers generate social and environmental impacts, even though their names may not show up on clothing labels and new-car stickers.

Pagell and Zhoahui Wu, assistant professor in the College of Business, are collecting data from companies to determine what a sustainable supply chain might look like. “We’re looking all over for companies that have figured out a part of this,” companies that are good at one or two things, such as product design, risk reduction or internal operations.

Monitoring the “triple bottom line” performance of every business partner, no matter how small, is daunting. No one has come up with a truly sustainable supply chain, adds Pagell. Nevertheless, the challenge is critical to measurements of business performance and to investor confidence. Companies that can put sustainability into practice across the board are likely to be the business leaders of the future.

To learn more about the Sustainability Initiative in the College of Business, see

[bus.oregonstate.edu/programs/sustainability.htm](http://bus.oregonstate.edu/programs/sustainability.htm)





*Animals and plants have adapted to the shifting tides and pounding waves of intertidal zones. Can they adapt to the influences of a changing climate and coastal development? Bruce Menge, second from left, and Jane Lubchenco, middle, have devoted their lives to understanding coastal ecosystems and sharing their knowledge with students. (Photo: Kelly J. James)*

## Coastal Winds, Changing Seas

The winds were late last year, but when they did arrive, they blew harder and longer than normal. The result: a series of “bizarre events” in Oregon’s normally productive coastal waters. OSU marine biologists Jane Lubchenco and Bruce Menge say that early in the summer, water temperatures were as much as 10 degrees Fahrenheit warmer than normal. Phytoplankton productivity was down about 80 percent. Seabirds washed up on beaches. The Dungeness crab season opened late.

And when the winds finally kicked in, the system went into overdrive. Cold, nutrient-rich water flooded into the coastal zone from the deep sea. Phytoplankton proliferated, creating water the color of pea soup and leading to a loss of oxygen, a “dead zone.” The record crab harvest reflects a lag in biological response — it may take three to four years, the time it takes male Dungeness to reach commercial maturity, to see if last year’s events reduced the crab population.

Lubchenco and Menge hold the Wayne and Gladys Valley Chair in Marine Biology and lead the Partnership for Interdisciplinary Studies of Coastal Oceans ([www.piscoweb.org](http://www.piscoweb.org)), an ambitious West Coast marine research program involving scientists at OSU, Stanford,

UC–Santa Barbara and UC–Santa Cruz. Last summer may be a preview of things to come, they say, as the global ocean system changes in response to increasing levels of greenhouse gases in the atmosphere.

Such changes call attention to the bounty that humans now reap from the world’s coastal oceans and to the risk that those resources now face. Commercial fisheries, recreational opportunities, wildlife, bustling coastal communities — all depend on a healthy ocean.

“Currently we manage fisheries, coastal development, forests, rivers, all individually. In reality all of those activities have impacts on the near-shore coastal ocean. We have to think about doing things differently, and that requires understanding how the ecosystem works and how it’s changing. That’s what PISCO does,” says Lubchenco.

The Valley endowment has provided stable support for Lubchenco’s and Menge’s internationally known work since 1995, helping them to leverage more than \$50 million in additional research funds. “The Valley Chair has allowed us to dramatically expand and intensify our research efforts, and make new discoveries that would not have been made without the support of the Valley Foundation,” says Menge.

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*Majestic and powerful, humpback whales along the West Coast average 35 to 40 tons and can be up to 52 feet long. Despite their size, they are known for their playful behavior, leaping high and slapping their flippers on the water. OSU Marine Mammal Program photographer Craig Hayslip documents whale sightings as part of researcher Bruce Mate's whale tagging efforts. He caught the tail of this humpback off the Farallone Islands near San Francisco on August 24, 2005. See "Tracking the Great Whales," page 2. (Photo: Craig Hayslip © OSU Marine Mammal Program)*



Listen to OSU researchers, follow their stories and see more photos, at [oregonstate.edu/terra](https://oregonstate.edu/terra) 

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