terra
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Eye to Eye

Looking for Life in a Tropical Rainforest

DIFFICULT TERRAIN

Researchers and the people who document their work often travel on the edge. Portland photographer Gary Braasch trains his lens on scientists who work in what he calls “difficult terrain”: alpine mountaintops, Antarctic ice sheets and glacial valleys. In a recent presentation for OSU’s Spring Creek Project for Ideas, Nature and the Written Word, Braasch showed images from his new book *Earth Under Fire*, including this one taken from an ice cave on the Antarctic Peninsula.

OSU entomologist Chris Marshall knows about difficult terrain. To get to his latest collecting spot, he flew into a remote rainforest and traveled by canoe for two days with native guides. Jaguars stalked the underbrush where he searched for bugs. Electric eels lurked in the streams he crossed. For Marshall, facing these risks was worth the opportunity to find species unknown to science.

Landscapes formerly inhabited by North American Indians have become difficult for other reasons: Toxins contaminate the plants, soils and waters that sustained their ancestors. Scientists with the Confederated Tribes of the Umatilla Indian Reservation are working with OSU’s Department of Public Health to detail the risks faced by people who want to return to ancient ways.

And in the Oregon Cascades, researchers are investigating another kind of difficult terrain, the environmental consequences of modern forest harvesting practices. Industrial forestry sustains communities and Oregon’s forest products economy. Scientists and landowners have teamed up through OSU’s Watersheds Research Cooperative to understand how modern forest management affects stream ecosystems.

Research on the edge can be global but also nano — the scale where biology and medicine intersect with quantum physics. It can be social, examining the implications of past housing discrimination. And it can be fragile, revealing the fate of tropical coral reefs in the face of warming waters, acidification and fishing pressures.

I invite you to join these journeys in this issue of *Terra*.

— Nick Houtman,
Editor

(Photo: © Gary Braasch/Earth Under Fire)

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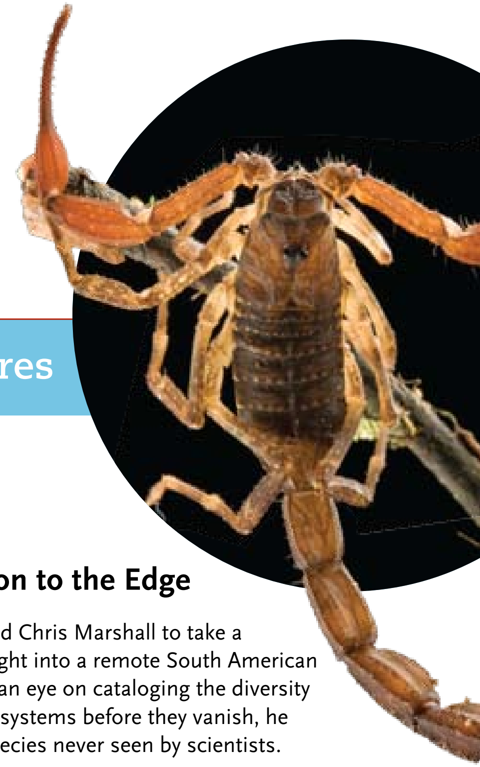

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OSU is Oregon's largest public research university with $191 million in research expenditures in FY2007. Classified by the Carnegie Foundation for the Advancement of Teaching in its top category (very high research activity), OSU is one of only two American universities to hold the Land-, Sea-, Sun- and Space-Grant designations. OSU comprises 11 academic colleges with strengths in natural resources, earth dynamics and sustainability, life sciences, entrepreneurship and the arts and sciences.

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On the cover
Tiger beetles (family: Carabidae) are common in the Americas, but only South American species sport orange legs. In the Pacific Northwest, some species are threatened by habitat loss. (Photo: Piotr Naskrecki, Director of the Invertebrate Diversity Initiative at Conservation International, Research Associate with the Museum of Comparative Zoology at Harvard University.)

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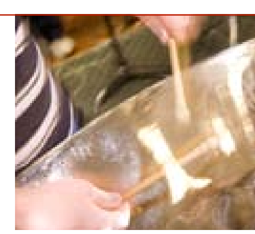
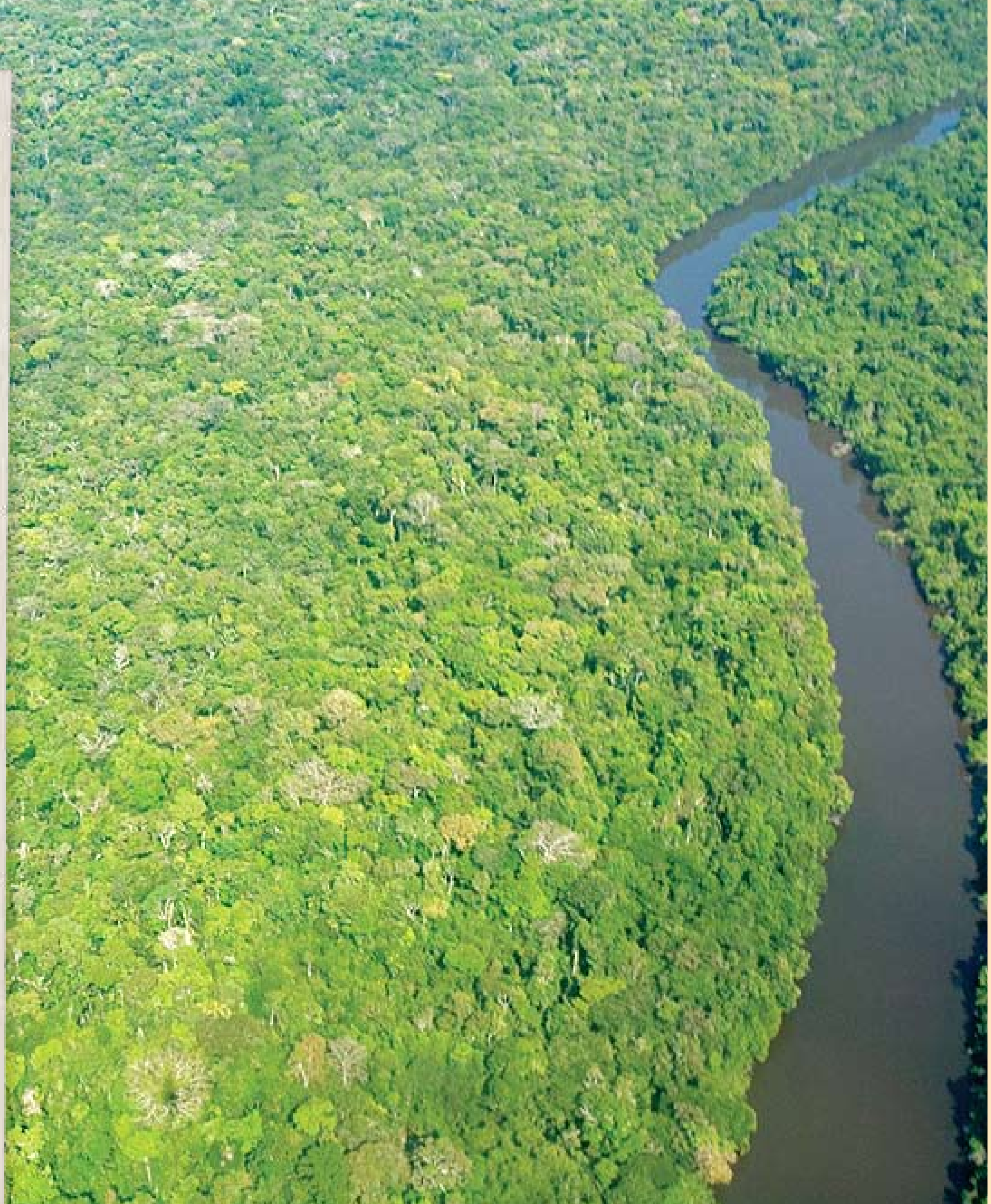


Expedition to the Edge



An OSU scientist braves an uncharted rainforest in a search for rare and endangered species

by Lee Sherman

Chris Marshall had collected insects in a lot of unusual places. But scrounging for a rare species of moth in the fur of a three-toed sloth had to be the weirdest.

It happened one black, sweltering night in the unexplored rainforests of northern Guyana in 2006. The OSU entomologist, rousted from his hammock by a commotion in camp, switched on his headlamp. He found himself looking into the frightened eyes of a docile, moon-faced mammal captured by the native guides assisting the scientific expedition.

The two-foot tall creature, whose coarse, shaggy hair glistened with a green patina of algae, sat quietly as Marshall gently searched its back for specimens of the *Bradipodicola hahneli* ("sloth moth"), which lives exclusively in this hairy habitat. Then, without warning,

Traveling for two days by dugout canoe up the Essequibo River brought Chris Marshall face to face with a three-toed sloth (above, first recorded sighting in Guyana) and a katydid displaying a threat response to ward off predators. (Photos: Piotr Naskrecki)

the sloth turned to face the researcher. Before Marshall could react, the animal wrapped its powerful, apelike arms around him. With the sloth's hot breath on his neck, Marshall felt a rush of adrenaline as he visualized its peg-like teeth and its four-inch hooked claws.

"I had a furry, wild animal clinging tightly to my body with its face inches from mine," Marshall recounts. "I couldn't have pried it off without great effort. It was then that I realized I didn't really know whether these animals are friendly or aggressive."

No blood was spilled that night. The guides disengaged the sloth and sent it slouching up the nearest tree. Marshall, meanwhile, sealed his hard-won specimens into tiny plastic vials. Before the journey was over, the zoology faculty member would fill thousands of such vials, as well as glassine envelopes and zip-locked, ethanol-filled polyethylene bags, with bugs destined for arthropod collections in Corvallis and the Guyanese capital of Georgetown. Among the specimens shipped out of the jungle were several beetles never seen by scientists. To identify his discoveries would require months of meticulous lab work and tedious database searching.

"It's always exciting to identify a new species, but there's no automatic definition of how that's done," Marshall explains. "Some scientists are turning toward using a certain percentage of difference in DNA, but there's still skepticism about that approach. More traditionally, we look at things like shape, body structure, male genitalia, ability to interbreed and other attributes of an organism. Integrating all of this information into a coherent notion of a 'species' can take months or years. That's the main reason it takes so long to identify everything from a trip like this."

The expedition's finds — which in addition to the beetles included new species of katydids, butterflies, catfish and frogs — will contribute to scientific understanding of the Guyana Shield and other tropical rainforests at risk from extraction industries such as drilling, mining and logging, as well as deforestation for agriculture. Conservation International, one of the expedition's sponsors, has designated "biodiversity hotspots" like the Guyana Shield as "the richest and most threatened reservoirs of plant and animal life on earth."

"The air was calm, full of the eternal hum of insects, a tropical chorus of many octaves, from the deep drone of the bee to the high, keen pipe of the mosquito." – Sir Arthur Conan Doyle, *The Lost World*, 1912

Marshall and a team of researchers from Venezuela, Colombia and the United States had joined Guyanese scientists in this South American wilderness to seek insects, birds, reptiles, amphibians and fish that are unique to this place, a land so otherworldly, so untouched, that it inspired Sir Arthur Conan Doyle's 1912 tale of remnant dinosaurs. In this "lost world" known as the Guyana Shield, vast plateaus of ancient granite rise 3,000 feet above a jungle canopy whose shadows hide jaguars as elusive as ghosts and snakes as thick as tree trunks. Mazes of rivers breed electric eels, stingrays and caimans (cousins of the crocodile). Also swimming in the teeming waters is one of the world's largest

"Bug Poop Grows Trees" (BPGT)
Insect collection aids ecological research

In Andrew Moldenke's forest ecology course, students get the BPGT acronym drilled into their heads from Day One. Oregon's fabled old-growth forests owe their existence to insect digestion, and the professor wants to make sure nobody forgets it.

"Old, decayed, and decaying logs and other detritus," Moldenke explains to author Jon Luoma in the 1999 book *The Hidden Forest: The Biography of an Ecosystem*, "have been ground, digested, and redigested many times over" by relentless legions of hungry arthropods (invertebrates with segmented bodies, external skeletons and jointed limbs).

By the thousands, specimens of these voracious dirt makers — millipedes, mites, centipedes, beetles, springtails, microspiders, pseudoscorpions — are preserved, labeled and catalogued in Cordley Hall, home of the Oregon State Arthropod Collection, one of the most extensive university collections in the United States. The museum's 6,000 glass-topped drawers, stored in endless rows of stainless-steel cabinets, also hold pollinators — the bees, butterflies and moths that inhabit the forest understory and canopy. Aquatic insects are archived there, too, along with larval insects and those that live in grasslands and deserts. There are water striders, stinkbugs, cicadas, leafhoppers, scorpions, grasshoppers, crickets and conifer pests such as the hemlock wooly adelgid and the spruce budworm. Even insects from a rare, glacier-dwelling order called "ice crawlers" can be viewed in OSU's bug museum.

This "taxonomic library of arthropod life," as Luoma calls it, houses the largest repository of Pacific Northwest insects in the world. Among the scientists who pore over the collection are researchers from the H.J. Andrews Experimental Forest, an old-growth research site in the Cascades jointly managed by OSU and the U.S. Forest Service. Bug life can be a "precision barometer" — what Luoma calls an "arthropodmeter" — of site-specific ecological conditions. "A knowledgeable entomologist might, by simply analyzing the species of tiny organisms in a handful of soil, describe in astonishing detail the ecosystem above," he explains.

Entomologist Chris Marshall, hired in 2005 to manage and

Bright yellow stripes and orange legs on this grasshopper warn potential predators of a distasteful meal (Photo: Piotr Naskrecki)

freshwater fish, the arapaima, which can grow to 10 feet in length and weigh more than 400 pounds.

"Ironically," Marshall notes, "the arapaima is related to the minnow."

But it's the bugs, millions and millions of them, that dominate the landscape. Like the "sloth moth," which subsists on blue-green algae growing on the slow-motion mammal, each species exists in perfect adaptation to a precise niche in the biosphere. Scarabs scour the forest floor for dead things and manure. Mantises disguise themselves as sticks or leaves. Butterflies "puddle" on moist soil, resembling seas of pale-green petals as they ingest salts and minerals. Katydids clutch smaller bugs in their spiny legs and crunch them with their powerful jaws. Lightning bugs glow like sparks from campfires. Ants use their shovel-shaped heads to plug their burrows against predators. Other ants spy their prey with giant, high-resolution eyes.

Guyana's butterflies, dragonflies, scorpions and spiders were intriguing to Marshall, who curates and manages the Oregon State Arthropod Collection (see sidebar). But his scientific investigations were focused elsewhere. While his fellow entomologists concentrated on ants and katydids, he attended to his specialty: beetles. The jungle boasts beetles that shine like obsidian and others that shimmer with rainbow iridescence. Even though he's an expert on the glossy black beetles of the family *Passalidae*, Marshall admits to having a soft spot for the drabber members of the world's vast and varied beetle species, estimated at 5 million. "I like the small, humble brown beetles better than the big, showy ones," he says. "I find it more interesting to sift through the unobtrusive, obscure groups. Fewer collectors care about them, so they're much less studied."

This tray from OSU's Arthropod Collection contains long-horned beetles from Africa, Asia and South America. (Photo: Karl Maasdam)

curate the collection, has been energetically building upon the existing 3 million samples preserved with pins on archival foam called Polyzote (dry-mounted), on glass slides (slide-mounted) or in borosilicate vials (wet-mounted). His recent expedition to South America, for example, added thousands of specimens to the collection's tropical holdings. Lab renovations, including new microscopes with fiber-optic lights, nine-digit barcode scanners and a searchable database of the 700-volume library are among the improvements spearheaded by Marshall. The latest: a high-grade digital imaging system purchased with a $70,000 grant from the OSU Office of Research.

"Our goal," says Marshall, "is to make the collection an increasingly valuable resource for entomologists, forest scientists, geologists and agronomists the world over."

To arrange a visit to the collection, see *osac.science.oregonstate.edu*

Born To Love Bugs
Living a boyhood obsession

There are two kinds of entomologists: those who love insects intellectually and those who love them viscerally. Without a doubt, Chris Marshall fits into the second category.

The love of bugs smote him early, and it smote him hard. He grew up combing the fields and woodlands of his New England neighborhood with a glass jar and a copy of the *Junior Golden Guide to Insects*. In the beginning he used a butterfly net. But the fluttering *Lepidoptera* didn't fascinate him nearly as much as the creeping *Coleoptera*, the hard-winged beetles secreted among rotten logs and fallen leaves. Young Chris's finest moments were stalking tiger beetles along reedy creek beds and unearthing carrion beetles in the detritus of hardwood forests.

When he hit his teens, however, Chris veered away from insects. He majored in evolutionary biology at Reed College in Portland, where he dabbled in frog research. His first job after graduation — studying amphibians in a Harvard University herpetology lab — failed to inspire him.

But his long-dormant love of bugs was stirring. At Harvard he enrolled in his first-ever formal entomology class. Then, one fateful day he dropped in at the Museum of Comparative Zoology, where Harvard's insect collection is housed. A week later, he was volunteering. "I had never been behind the scenes at a natural history museum," he recalls. "I knew right then I had found where I wanted to be. I fell in love."

It wasn't long before he was doing graduate work at Cornell. He was struggling to find a compelling Ph.D. research topic when he took a six-week ecology course in Costa Rica with the Organization for Tropical Studies. "I was flipping logs, looking for bugs, and I saw these big, shiny black beetles," he recalls. "What was really neat about them was that they were teeming with these little mites." Once home, he learned that there is an entire fauna of mites found exclusively on this one species of patent-leather beetle. The co-evolution of these two organisms became the subject of his doctoral thesis.

He came to the Oregon State Arthropod Collection in the fall of 2005 after a stint with the Smithsonian Institution and another with the Field Museum of Natural History in Chicago. As curator, Marshall oversees 3 million specimens from the world over, the perfect job for channeling what he readily admits is a compulsion.

"A lot of people are rabid bug collectors as kids," he says. "Most of them get over it. I never did."

Some of the bugs he encountered, however, were not so appealing. The ubiquitous ticks, for instance, forced him to soak his clothes in pyrethrins (pesticides made from chrysanthemum flowers). Malaria-bearing mosquitoes made sleeping nets mandatory. To foil swarms of sticky, persistent black flies, which can carry river-blindness disease in their painful bite, Marshall worked in long sleeves despite the oppressive heat. "The horsefly was everyone's bane," he says. "We couldn't get away from them. One day we were hiking through a swamp of spiny palms. It was hard to walk, and it was real wet, very humid and muggy. That's where the horseflies were the worst they could possibly be."

Another perilous pest was the sandfly. Smaller than an ordinary mosquito, this insect transmits a disease called *Leishmaniasis*. The protozoan, a microscopic single-celled organism, can cause devastating wounds that destroy skin and mucous membranes, causing massive scars. Worse, some victims have lost ears and noses.

Why would Marshall and his fellow researchers risk life, limb and nose in this inhospitable place? Beyond the basic motives of science (delving into mysteries, uncovering clues, connecting dots) and beyond the more prosaic goal of beefing up the bug collections at Georgetown and at OSU, they were driven by the urgency of an endangered ecosystem. The expedition was part of an ongoing movement to protect the shield's extraordinary biodiversity from human exploitation. In cooperation with a small group of Amerindians indigenous to the Guyana Shield, the Guyanese government has set aside a 1.5 million-acre swath of the rainforest as a preserve. Funded by the Smithsonian Institution, *National Geographic* and Conservation International, the expedition carried out a "rapid biodiversity assessment" — in essence, a marathon collecting binge for zoologists — to help document the scope of Guyana's species diversity. One set of specimens would go to the Center for the Study of Biological Diversity at the University of Georgetown.

The mission had a cultural component, as well. The native guides and porters were naturalists-in-training. Members of the Wai Wai tribe have been tasked with managing the preserve, protecting the animals and plants living along the mighty Essequibo River and its tributary, the Sipu, against poachers, loggers and miners. Investigating their ecosystem along with the university-trained scientists, the Wai Wai were preparing to become para-biologists and rangers, formalized roles for the people who have been Guyana's unofficial "forest keepers" for generations.

> "Once some bandy-legged, lurching creature, an ant-eater or a bear, scuttled clumsily amid the shadows."
>
> – A.C. Doyle

A nighttime predator in the tree canopy, this katydid uses spikes on its legs to subdue prey. The feast this night was a pygmy mole cricket. (Photo: Piotr Naskrecki)

Marshall first met his guides after the expedition embarked in early October 2006 from a small airfield on the outskirts of Georgetown. A reluctant flyer, he felt the color drain from his sweat-beaded face as the twin-prop plane lifted off and rose above a patchwork of small farms and scattered houses. Soon, from the window of the droning aircraft the entomologist saw nothing but the rainforest's emerald canopy stitched to the sky in every direction.

The flight, it turned out, was just the first of Marshall's many white-knuckle experiences in Guyana. The plane touched down near the banks of the Essequibo, where the Wai Wai guides, "druggers" (equipment porters) and "line cutters" (machete-wielding trailblazers) were waiting to take the team upriver. In this trackless forest, modes of travel are two: foot and canoe. Several dugouts, hand-carved of dark purple heartwood in the ancestral Wai Wai tradition, sat on the riverbank. But in a jarring clash of cultures, each primitive boat sported a shiny outboard motor. The 750-horsepower Evinrudes, lent to the expedition by Conservation International, have obvious advantages over paddles for transporting several entomologists, an ornithologist, an ichthyologist, a herpetologist, a mammalogist and a water-quality expert — as well as hundreds of pounds of food and gear — deep into the lost world.

The boats pushed off. The tangled green understory, lush and luminous in the filtered sunlight, closed around the travelers. It wasn't long before Marshall noticed water pooling around his feet, apparently seeping through a crack in the heartwood hidden under bulging bags of gear. During the two-day journey, whenever the canoe struck a submerged log with a loud *crack*! (as it did every now and then), he halfway expected the vessel to split in two "like a peapod" and dump the researchers into waters as brown and opaque as chocolate milk. But the craft, which the Wai Wai patched each night with sticky, resinous bark scrapings, was sound and sturdy in its ancient design. It never foundered.

After the researchers disembarked, they spent another day hiking into the forest to reach their first survey site.

It's Marshall's expertise as a coleopterist (beetle specialist) that made him vital to the expedition. That's because beetles, particularly dung beetles, are important components of tropical rainforest systems. "Dung beetles are important decomposer organisms, involved in nutrient recycling, seed dispersal and the control of vertebrate parasites," British researcher Andrew Davis and colleagues wrote in the *Journal of Applied Ecology* in 2001. "Consequently, dung beetles are a useful indicator group because they reflect structural differences between biotope types."

The lowly dung beetle or scarab (family *Scarabaeidae*), largely ignored after its heyday as a deity in ancient Egyptian mythology, has recently reclaimed some of its lost stature, this time as an indicator organism. All over the planet, from Australia to Southeast Asia, ecologists and entomologists study scarabs as gauges of ecosystem well-being and harbingers of stress.

"There is a lot of interest in dung beetles globally because of their ability to reflect changes in ecosystem health and land usage," says Marshall. "Each species has specific soil and forest ecological needs, and some of them are linked to very specific vertebrate fauna — mammals and birds. As mammal and bird diversity declines, so does the scarab beetle associated with that habitat."

Collectors lure scarabs with baited traps. However, packing in buckets of hog manure, the usual bait, would be impractical in Guyana. And because scarabs are fast and efficient manure removers, finding it in the rainforest can be difficult. So Marshall and other dung beetle experts are sometimes forced to resort to human excrement.

"It's not the ideal bait," Marshall hastens to explain. "There is an ongoing effort to create a synthetic lure. But scarabs' sense of smell is extremely sensitive, and designing an imitation for manure is actually more complex than it might at first appear."

Distasteful as dung beetle baiting might be, the strategy brings speed and efficiency to ecological research. "With passive traps," the entomologist explains, "you can do a survey of the dung beetle in 24 to 48 hours that can serve as a surrogate for the months of work necessary to survey birds or mammals."

When he wasn't baiting traps and collecting captive scarabs, Marshall was chopping open rotting logs in search of his other Guyana get-list priority: patent-leather beetles. As shiny and black as Sunday-school shoes, these showy bugs have intrigued him since the 1990s when he was a Ph.D. student at Cornell, not so much for themselves but for their symbiotic bond with another species of bug, the mite (see sidebar, "Born To Love Bugs").

One late afternoon near dusk, alone and far from camp, he was hurrying to collect his captive scarabs before the light failed. His excitement about finding a rare specimen in his trap dissolved instantly when he heard a sound in the brush. He froze, his senses on hyper-alert as the crunch-crunch-crunch of large feet on leaf litter got louder and louder. He weighed his options: Stick around and take pictures or back away slowly. Both hoping and fearing that the unseen creature was a jaguar, the researcher sucked in his breath and decides to stand his ground, focusing his video camera on the rustling shadows. When the beast emerged into the dappled light, it was standing just feet in front of him: a giant South American anteater, *Myrmecophaga tridactyla*, its funnel-like nose snuffling the earth in search of termites. The gangly, bushy-tailed animal stood up on its hind legs, looked curiously at the researcher and then lumbered away, snout to the ground.

Just another bug collector.

Sharing Guyana's rainforests with the sloth and the anteater are arthropod species in the hundreds of thousands. Only a few thousand have been identified and cataloged. That ratio is reflected worldwide: Just 2 million of Earth's total number of animal and insect species — estimated as high as 30 million — have been described, according to the World Conservation Union's Species Survival Commission. Faster than scientists like Marshall can find and identify unknown life forms, others are disappearing forever. More than 15,000 species are at high risk for extinction, and the rate is speeding up as the Earth warms and habitats shrink.

For Marshall, knowing what's at stake dwarfs the danger and discomfort of rainforest exploration.

"The knowledge gained far outweighs the risks," he says. "It's only through these types of expeditions that biologists discover new species and work toward our ultimate goal of documenting the Earth's insect diversity."

The global race to understand patterns of biodiversity and ecology is in full-tilt, Marshall says. "When a species goes extinct, we lose a piece of the puzzle forever," he stresses. "To complete the whole picture, we need to do two things: halt or reverse the trends that are driving extinctions and share specimens with the world's natural history museums.

"We need to preserve as many pieces of the puzzle as possible. And we need to do it quickly." terra

> "...during the hot hours of the day only the full drone of insects, like the beat of a distant surf, filled the ear...."
>
> — A.C. Doyle

See more about OSU's arthropod collection at *osac.science.oregonstate.edu*

The Proboscis Hypothesis
Were dinosaurs bugged to death?

Was the mighty dinosaur done in by a midge?

Very likely, argues OSU zoologist George Poinar in his new book, *What Bugged the Dinosaurs? Insects, Disease and Death in the Cretaceous*. Midges, together with millions of other Cretaceous insect species, may well have landed the "final knockout blow" to the giant reptiles by infecting them with deadly parasites and pathogens, Poinar and coauthor Roberta Poinar explain in their richly descriptive narrative.

This "gradualist" theory on the dinosaurs' mysterious demise contrasts with the "catastrophist" theories most in vogue. But the theories can be reconciled, according to Poinar. In the wake of an ancient global cataclysm — an asteroid strike, a volcanic eruption, a climate swing — even mega-lizards like the 12,000-pound T. rex would be weakened and stressed, he explains. Debilitated, the dinosaurs were vulnerable to bug-borne diseases such as malaria and leishmania.

The 100 million-year-old fossils Poinar studies are not mineralized bones unearthed in archaeological digs. Rather, they are specimens of ancient insects entombed for eons in chunks of golden resin, amber collected from Burma, Lebanon and Canada. Preserved perfectly in Poinar's laboratory are the beetles, aphids, flies, gnats, termites, leafhoppers, grasshoppers, scorpions, ticks and midges that shared the Cretaceous landscape with stegosaurs, velociraptors and triceratops.

Illustration courtesy of George and Roberta Poinar

"The minute but mighty insects have exerted a tremendous impact on the entire ecology of the earth, certainly shaping the evolution and causing the extinction of terrestrial organisms," Poinar writes. "The largest of the land animals, the dinosaurs, would have been locked in a life-or-death struggle with them for survival."

The dinosaurs lost that struggle. But the mighty arthropod lives on.

Targeting Cancer
New option for finding, imaging tumors

A new method for locating, imaging and possibly treating tumors is emerging from research in the Oregon State University College of Veterinary Medicine. Working with Gene Tools LLC, an Oregon biotechnology company, scientists have created a molecule that, when injected into the bloodstream, acts like a bloodhound on the trail of a crook by searching out and latching onto tumor cells.

The molecule, known as a peptide, becomes active in the low-pH environment near a tumor cell, changes shape and embeds itself into the cell membrane. Peptides are made of amino acids, the building blocks of proteins. While the method has immediate applications for detecting and defining tumors, it may also deliver other diagnostic and therapeutic agents to growing cancers, providing an alternative to current medical practices.

"Treatment for breast cancer and other cancers often takes what is commonly called the 'cut, poison and burn' approach," says John Mata, assistant professor and lead author on a report in the December 2007 issue of *Nanomedicine: Nanotechnology, Biology and Medicine*. "Patients that are diagnosed with cancer are often treated by combinations of surgery, toxic chemotherapies and radiation."

Nanotechnology, the use of tiny molecules designed for specific tasks, may provide a less invasive way of fighting cancer in humans and animals, according to Scott Gustafson, a veterinary surgeon and former OSU faculty member, who was a co-investigator on the study.

"Our demonstration of specific delivery of molecules used to diagnose tumors is an important step in the future of medical diagnosis and treatment using nanomedicines," Gustafson says.

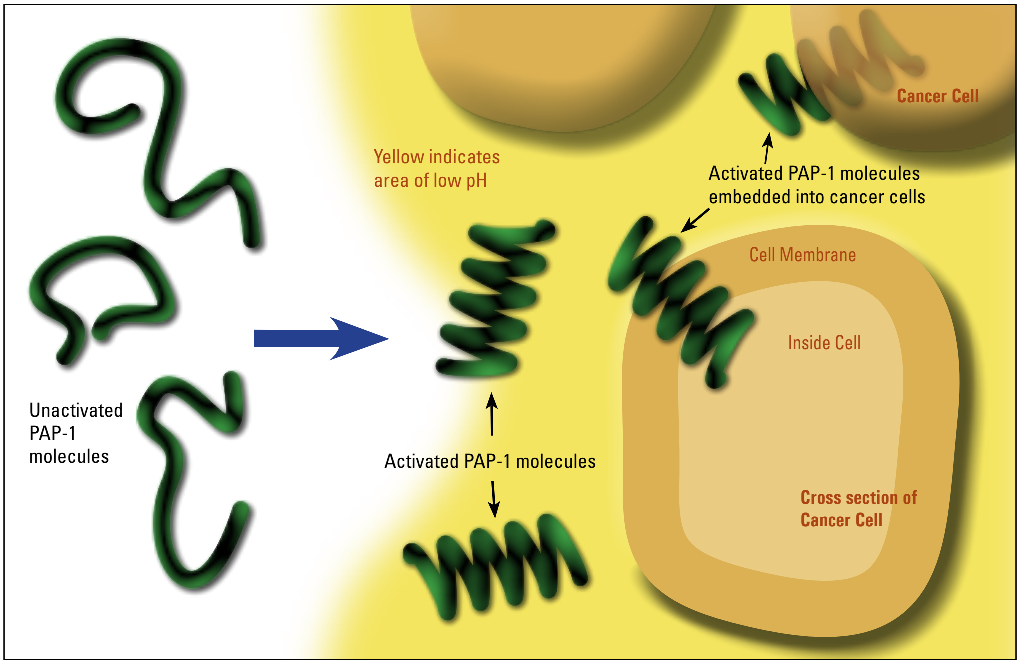
The researchers used a peptide called PAP-1 to target the cancer cells. The compound of 18 amino acids was developed by James Summerton, a former OSU biochemist and founder of Gene Tools LLC of Philomath. The key was designing a peptide that would respond to low pH. Peptides that embed into membranes occur naturally; however, there are few examples in nature of peptides that will change at very narrow pH ranges to do so.

As tumor cells divide, they grow rapidly and use up the available blood supply, creating hypoxia, or a low level of oxygen. They also use more glucose than normal adjacent tissues. These differences can acidify (reduce pH) the space between the cells within the tumor. As the molecules diffuse into the area, the low-pH environment "throws on a chemical switch," Mata says, directing the peptide to embed into the tumor cells.

Attaching other molecules to the peptide is not just a theory. The researchers have already used a radioactive element, technetium-99, which they bound to the PAP-1 peptide, to illuminate tumors in mice. The technique allowed researchers to visualize the physical movement of their nanotech molecules in real-time using gamma scintigraphy. Additional studies demonstrated pH-specific activation using fluorescent probes attached to PAP-1.

Other OSU scientists participating in the project work in OSU's colleges of veterinary medicine, pharmacy and engineering.

– Nick Houtman



Before being "activated" PAP-1 molecules resemble cooked spaghetti. As the PAP-1 molecule enters the area of low pH surrounding cancer cells, it changes shape into a coil, then embeds into the cell membrane. (Illustration: Jill Bartlett)

Learn about biomedical research in the OSU College of Veterinary Medicine at ***oregonstate.edu/vetmed/biomed/biomed.htm***.

Researcher profile

John Mata, a senior research assistant professor of biomedicine in OSU's College of Veterinary Medicine, specializes in cancer therapies and plant-based compounds that have anti-cancer or cancer protective properties. His studies apply to animal and human health. A former post-doctoral researcher in the College of Pharmacy, he is also affiliated with OSU's Center for Gene Research and Biotechnology.

(Photo: Karl Maasdam)

SACRED LANDSCAPE

Tribes confront the cultural risks of contaminant exposure

By Lee Sherman

PICTURE THIS: You come home from work to find a rusty, 55-gallon drum of radioactive sludge leaking on your living room rug.

That's what the native people of the Columbia River Basin face on a monumental scale. Tribes that have lived for centuries on the sweeping plateaus of northeastern Oregon and southeastern Washington are struggling to restore a landscape and a way of life damaged by dams, industrial pollution and nuclear waste from a World War II plutonium factory. And the Columbia Basin tribes are not alone. Degradation and contamination of ancestral lands threaten American Indian cultures across the United States. The Navajo Nation in Black Mesa, Arizona, is battling coal mining. The Oglala Sioux in Pine Ridge, South Dakota, are fighting uranium extraction. Mohawks in Akwesasne, New York, are protesting PCBs in groundwater. The list goes on and on.

"The lives of indigenous people are embedded in, even emergent from, the environment," observes Barbara Harper, an associate professor affiliated with OSU's Department of Public Health and manager of environmental health for the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). "It is their living room, their grocery store, their pharmacy."

To help tribes weigh the risks to health and culture from contaminants, OSU researchers and tribal scientists have developed a unique tool, the *Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual*. The guidebook, funded by the U.S. Environmental Protection Agency (EPA), explains how to trace pollutant pathways into natural resources (soil, water and air) and then into the human body (lungs, skin and mouth). And, drawing on historical and archaeological evidence, it recreates traditional lifestyles in scenarios of four Western tribal groups, including the Confederated Cayuse, Walla Walla and Umatilla of the Columbia watershed.

By using the manual to overlay contamination pathways with traditional practices, native communities can quantify the risks of living off the land as their forebears did.

"There are many unique exposure pathways that are not accounted for in scenarios for the general public, but may be significant to people with certain traditional specialties such as basket making, flint knapping, or using natural medicines, smoke, smudges, paints and dyes," the guidebook states. The report does not focus on existing illness or other health conditions potentially related to traditional or contemporary lifestyle practices.

Tainting Ancient Ways

The Cayuse, Walla Walla and Umatilla people have lived on the sagebrush steppe beside the Columbia for 11,000 years. In the old days, salmon swam and leapt at the center of their existence. The red-fleshed Chinook was the religious and cultural nexus sustaining spirit as well as body. Like all the original inhabitants of the continent, they were inseparable from the landscape in which they fished, hunted, gathered and studied the complex ways of nature. Millennia of ecological investigation formed the basis of

As one of North America's most productive salmon grounds, pre-dam Celilo Falls was an important gathering place for tribes from throughout the Columbia River Basin and beyond. (Photo: Irwin McFadden, circa 1950)

Environmental workers retrieve 55-gallon drums of radioactive waste from a burial site at Hanford's central plateau in 2005. (Photo: U.S. Department of Energy)

their seasonal traditions and bound them together in a timeless, Earth-driven rhythm.

Today, the Columbia River salmon are depleted. The ones that remain contain mercury and a host of other pollutants from mining, agriculture and other sources according to U.S. EPA studies. Some of the lands and waters of the plateau tribes became further compromised in 1943 when, as part of the Manhattan Project, the U.S. government sited its Hanford plutonium facility on 586 square miles along the river between the Saddle Mountains and Rattlesnake Hills. Today, the Hanford Nuclear Reservation is one of the nation's most contaminated Superfund sites — places that must be cleaned up under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. The law provides broad federal authority to respond directly to hazardous substances that may endanger public health or the environment.

The Department of Energy's (DOE) Office of Environmental Management treats and disposes Hanford's 50 million gallons of "highly radioactive, highly hazardous" liquid waste stored in 177 aging underground tanks, according to the DOE Web site. Also dumped on the site are 2,300 tons of spent nuclear fuel, 12 tons of plutonium and 25 million cubic feet of solid waste. Leaching into the river are groundwater plumes containing chemicals such as chromium, uranium, strontium-90, tritium and technetium-99.

"Parts of the Hanford site are so badly contaminated with radioactive waste that full environmental restoration is impossible," according to the Nuclear Safety Division of the Oregon Department of Energy. "Contamination has reached groundwater and the nearby Columbia River."

Under Superfund law, the tribes have special status as "sensitive populations," those who are disproportionately exposed. Poisoning the land violates tribal treaty rights, notes Stuart Harris, a tribal member, OSU graduate (Geology, '91) and coauthor of the manual. The tribes retained their rights to fish and hunt, gather roots and medicinal plants, pick berries and graze horses and cattle on their ancestral lands when they signed the Treaty of 1855. A landmark ruling in 1974, the Boldt decision, affirmed the Indians' guarantee to traditional salmon harvests.

But exercising those rights "depends on the health of the natural resources," argues Harris, a scientist for the CTUIR who analyzes contamination risks. Those rights run infinitely deeper than treaty language granting access to particular riparian or terrestrial parcels, Harris says. In fact, they go even beyond Indians' rights to physical health. What's at stake is the very culture that the Columbia Basin peoples inherited from ancestors who stood on the plateaus surveying the bounteous waters of the continent's second-largest river, even as the last ice age was retreating.

"The environment constitutes a cultural homeland where the people and their genetics coevolved with the ecology over thousands of years," says Harris. "Impacts to the environment directly impact the health of my people and put my culture at risk."

Heritable Rights

In the old days, a river dweller consumed about 500 pounds of salmon a year. If someone ate that much fish in today's toxic environment, Harper bluntly predicts, "they'd be sick or dead." Contamination levels in foods, water and soils have been well documented. And exposure risks for average American suburbanites have been calculated by scientists with the EPA and others. What no one had previously established, however, was the exposure risk for Native Americans who live, or wish to live, a traditional, land-based lifestyle.

"Risk-assessment scientists typically aren't trained to look at risks holistically, to investigate entire lifestyles," says OSU Professor of Public Health Anna Harding. "Public health experts, on the other hand, are trained to look at risks very broadly — not focusing only on medical impacts but considering community well-being as well."

"The salmon return year after year to the remnants of their homes, as they promised our people in the beginning."

— Stuart Harris, Director, Department of Science and Engineering, Confederated Tribes of the Umatilla Indian Reservation

That's why Harper, Harris, Harding and former OSU nutrition scientist Therese Waterhaus sought EPA support to develop a risk assessment tool tailored to Indian Country.

"It is a matter of environmental justice," argues Harding who served on an EPA scientific advisory board from 2002 to 2007.

Harding recalls with clarity a crystallizing moment in her career. The year was 1992. The movement for environmental justice (insiders call it EJ) "was just getting up a head of steam," she says. As a researcher in environmental health, she was invited to attend the nation's first federally sponsored EJ summit in Washington, D.C. Leaders from tribes and other ethnic communities across the U.S. were there, too, at the invitation of the government. The summit opened with a panel of federal agency reps seated on a raised platform, talking about their accomplishments in EJ. One by one, community members rose from their seats and began lining up at microphones positioned around the auditorium. "They said, 'We're not going to just sit here and listen,'" Harding recounts. "'We need to be the ones telling *you* what the issues are and what the research agenda needs to be.'"

The organizers quickly adjourned the session, revamped the agenda and reconvened the summit in a collaborative spirit. "It was probably the most interesting and groundbreaking meeting I've ever been to," Harding says.

Returning to the land is an aspiration for many tribes, explain Harper and her colleagues, who have become national leaders in developing ecologically-based traditional lifeways scenarios for assessing risks to tribal members. "Even though tribal lands have been lost and resources degraded," they write, "the objective of many tribes is to regain land, restore resources, and encourage more members to practice healthier (more traditional) lifestyles and eat healthier (more native and local whole) food."

The desired goal, they say, "is to restore the ecology so that the original pattern of resource use is both possible (after resources are restored) and safe (after contamination is removed)."

Switching from eating salmon to, say, Bumblebee tuna or Big Macs may seem like a reasonable choice to non-native observers. But such choices are not simply alternatives on a menu. That's because salmon is not, for the Columbia River tribes, merely a culinary option. It is a cultural imperative. Salmon is not just something to have for dinner. It is the nucleus around which revolve social networks, kinship patterns, seasonal customs, religious beliefs and educational practices. Orbiting around this hub are all the other activities that define the culture, such as weaving baskets or sweating in steam-filled lodges (see sidebar).

"You can't just substitute something else for salmon," says Harding. "Whatever you use as a substitute won't have the same cultural and traditional uses or meanings."

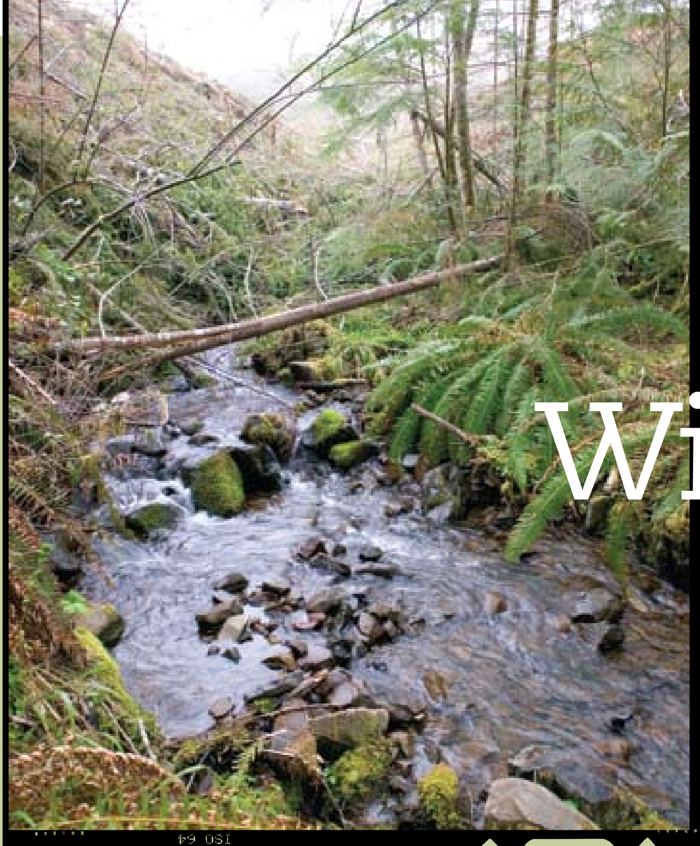
To learn more about the environmental risk report for traditional Native American lifestyles, see ***hhs.oregonstate.edu/ph/tribal-grant***

Baskets of Concern

Food is only the most obvious way contaminants enter the human body. Poisons also come in through the pores of the skin and the lobes of the lungs. Living in intimate contact with the landscape, as many indigenous peoples do, raises the risks of exposure. Traditional practices of the Umatilla members of the Columbia Basin create pathways for contaminants. Here are two examples:

Woven Baskets For countless generations, indigenous women of the Columbia Basin scoured the lush riverbanks, gathering dogbane, willow, cattails and reeds. They wove the plants into containers for storing food and mats for sitting and sleeping. Beyond being useful, the implements are beautiful — their colors, patterns and designs embodying millennia of tradition. But they are more than tangible artifacts of a culture. Weavers are bound together as they work, braiding their unique histories and identities into the plant strands. Today, wading into the rich riparian muck can be hazardous to health. Riparian zones act as "sinks" for pollutants such as heavy metals (mercury, cadmium, copper, lead), and cattails and other waterside plants take up these pollutants. All of them can be absorbed by the weaver as she works, both through her skin and, because she holds strands in her teeth as she weaves, through her mouth.

Sweat Lodges A religious ceremony of ritual and physical purification begins when family members choose a site near surface water or a well, then gather branches, clay, moss and leaves to build a 6-foot-diameter dome-shaped sweat lodge. White fir boughs or woven mats cover the floor. Carefully selected rocks are heated in a fire and piled inside the lodge. Finally, water (sometimes infused with medicines) is poured over the rocks. Clouds of steam fill the structure. Contaminants from the water, plants and rocks are absorbed through the lungs and skin of the practitioners, who traditionally are introduced to the sweat lodge as toddlers. Traditional practitioners may use the lodge twice a day for an hour and may drink an extra liter of water each time to stay hydrated.



In the 1960s, studies of Alsea River watershed logging (below) led to the nation's first water-quality regulations on forest management. At Hinkle Creek (left), scientists and landowners are evaluating the impacts of contemporary practices. (Alsea photo courtesy of the Oregon Forest Resources Institute; Hinkle Creek photo courtesy of the Watersheds Research Cooperative)

Windows on Watersheds

A clear look at industrial forests

by Nick Houtman

To the list of problems for watershed research, add dam-building beavers. Last fall, in the rippling waters of Flynn Creek near the Coast Range town of Toledo, Oregon, scientists had placed a probe to take continuous measurements of dissolved oxygen. When the instrument shut down abruptly, hydrologist George Ice went to check. "I saw that the cord was cut," he says. "A beaver had gnawed it off and stuffed the probe into its dam." The amused vendor, the Hach Company, provided a free replacement.

Ice and other researchers are updating a pivotal forest science project in Flynn Creek and the surrounding Alsea River watershed. Here, from 1959 to 1973, scientists conducted the first comprehensive forest watershed study in North America. "That was a very important, seminal piece of work," says Arne Skaugset, Oregon State University hydrologist and director of the Watersheds Research Cooperative. "It set the standard for stream temperature research. It was one of the few watershed studies that had a robust fisheries component."

The results provided the scientific basis for forest management regulations and contributed to the Oregon Forest Practices Act of 1971, the first in the nation to address water quality protection. Back then, harvesting activities weren't particularly kind to aquatic systems. Fish-bearing streams were literally buried in wood debris, says Ice. Logs might be dragged across or even down channels without regard for the bed and banks. Loggers sometimes removed and burned debris because of concerns that it would impede fish movement. Without riparian vegetation to hold soil and shade streams, sedimentation and water temperatures increased.

But the Alsea study, which documented the consequences of those operations, has become outdated by the modern practices — riparian buffers, better road-building techniques, debris treatment — that it helped to set in motion. "We really need to evaluate how today's forest practices are working," says Skaugset. "We have results from these original studies, but the old data are not terribly relevant for what's going on right now."

To update the scientific basis for forest management practices, teams of scientists from OSU, federal and state agencies have joined forest landowners in a three-pronged initiative. In the watersheds of the Alsea River, Trask River (east of Tillamook) and Hinkle Creek (east of Sutherlin in the Cascades), they are installing monitoring equipment and collecting water-quality data. They are measuring water flows, sediment concentrations and changes in water chemistry and stream temperature. In headwater streams and below tributary junctions, they are evaluating aquatic food webs by studying organisms from the smallest midges and stoneflies to the steelhead, salmon and cutthroat trout that have run in these waters for eons.

These aren't majestic, old-growth tracts. They are the kind of working industrial forests that comprise just under half of Western Oregon's forestlands. For scientists and land managers, the questions are about more than the complexity of forest ecosystems. They're also about balancing environmental quality with economic value, the health of fish populations with tree harvesting, the quality of water downstream with the need to build roads in steep terrain.

"We're always developing new management tools," says Ice, who received his Ph.D. at OSU in 1978 and works for an industry-supported environmental science organization, the National Council for Air and Stream Improvement. "Now we're looking at more subtle questions: Where and how wide should those buffers be? What types of road systems should we install? Can we enhance streams by opening portions of the stream (to sunlight) or putting wood in those channels to increase productivity?"

Reliable answers to such questions will take time. In the Trask River Watershed, studies began in 2006, and harvesting won't occur until 2012. In the Alsea watershed, monitoring has been conducted off and on since 1959, and no harvesting is projected until 2009 or 2010. However, at Hinkle Creek, the first answers are starting to trickle in. Three master's students have completed their theses on summertime stream temperatures, cutthroat trout survival and downstream propagation of temperature effects. Scientists have accumulated five years of data at nearly 50 locations. In the winter of 2005-06, the landowner, Roseburg Forest Products, cut the first trees, and researchers are beginning to analyze stream ecosystem changes.

"We're passionate about science-based forestry," says Phil Adams, timberlands manager for the company. "We understand the need for regulation to protect water and fish resources in Oregon through our Forest Practices Act. As we go forward, it needs to continue being efficient and based in science."

The 4,534-acre Hinkle Creek watershed was last harvested in the 1940s. A continuing round of cuts is planned for the south fork, but Roseburg Forest Products has agreed not to harvest trees on the north fork until 2011, thus leaving it as an undisturbed control. The

Inside the Hinkle Creek project

Stream flow

Measuring flow rate and and stream height reveals how water moves through the landscape. Researchers are also tracking stream sediment loads using the next generation of computerized water-sampling devices. Arne Skaugset's water-quality lab analyzes more than 2,000 samples per year from the Hinkle Creek, Trask, Alsea and Oak Creek (near Corvallis) watersheds.

Insects

Aquatic insects serve as water-quality indicators and as food for fish and other animals. Judith Li, retired professor of fish and wildlife, and two research assistants, Bill Gerth and Richard van Driesche, are evaluating insect populations and life-cycle patterns. Pre-harvest monitoring reveals a stream ecosystem that is "in pretty good shape," says Gerth. Adds Li, "After comparing the first samples post-harvest, we may be observing shifts in patterns of drift and emergence associated with logging."

Fish

Steelhead and cutthroat trout are on the move, and a team led by Bob Gresswell and Doug Bateman of the U.S. Geological Survey (both have courtesy appointments at OSU) is tracking them throughout the watershed. PIT (Passive Integrated Transponder) tags inserted into almost 2,000 fish make them register like groceries at the checkout counter every time they pass one of 30 electronic gates. The tag "allows us to see without really harassing the fish, whether they are selecting different kinds of habitat," says Bateman.

Amphibians

Pacific giant salamanders are the most abundant amphibian species in Hinkle Creek streams. Working with John Hayes of the University of Florida and Mike Adams of the U.S. Geological Survey, Ph.D. student Niels Leuthold in the Department of Forest Science has been surveying in both the north and south forks to determine occupancy rates. By combining results of hydrology, insect and fish studies, researchers hope to resolve questions about the impact of harvesting on amphibians.

experimental design is known as paired watersheds. During the pre-harvest phase, researchers confirmed that the two watersheds can be used as predictors of each other. To date, researchers have installed nearly a quarter-million dollars' worth of equipment.

In the winter of 2005-06, the company harvested 380 acres in five units in the south fork, enough to deliver 3,281 truckloads of logs to local mills. Harvest blocks were located in non-fish-bearing headwaters, where regulations do not require riparian buffers. Next winter, harvesting operations are scheduled for land along downstream fish-bearing reaches.

Batteries Not Included

When Kelly Kibler was looking for graduate schools, the Pacific Northwest caught her fancy. Within days of arriving in Corvallis in June 2005, the dreadlock-wearing forest engineering master's student from North Carolina hustled down I-5 to Sutherlin to join Skaugset's hydrology crew at Hinkle Creek. Mornings began with loading sample bottles, fluorescent dye, batteries and other gear into a pickup. Once past a yellow gate a half-hour outside of town, the crew left the pavement on Roseburg Forest Products' gravel logging roads.

Kibler threw herself into the project, serving as a crew member and focusing her own thesis on water temperature impacts from logging. "It was exactly the kind of work I wanted to do. Multi-disciplinary across the sciences, physical and ecological, policy and management. Pretty applied. Just the ticket," she says.

Working with Skaugset, Amy Simmons (faculty research assistant), Tim Otis (master's student in forest engineering) and Nick Zegre (Ph.D. candidate, forest hydrology), Kibler helped to maintain computerized water-sampling devices and data recorders that monitor water temperature. She ran tests on water samples containing fluorescent dyes to determine how much groundwater was entering streams. She carried 40-pound marine batteries sometimes as far as a half-mile from the road to keep equipment operating. She reached under slash, logging debris left over headwater streams, to take measurements of light reaching the water.

For her master's thesis, Kibler analyzed stream temperature profiles in six streams, four located just below clearcuts in the South Fork and two in the unharvested North Fork. She controlled for changes in weather and other conditions and compared data from pre- and post-harvest periods. Her findings were mixed and unexpected. In the South Fork, daily maximum temperatures dropped in one stream, rose in another and remained unchanged in two. However, mean temperatures decreased in all four, possibly reflecting the influence of slash cover and increased groundwater flow into the streams. Branches left by logging operations cast shade over the streams roughly equivalent, she found, to the original tree canopy cover. "Without that slash, all four streams might have been significantly warmer after harvest," says Kibler.

OSU Watersheds Research Cooperative

Networking is key in watershed science. The WRC spurs collaboration by researchers from OSU, government and private companies. Members contribute money or in-kind resources such as land and expertise. Current WRC projects include the Hinkle Creek, Trask and Alsea projects. Funding has come from state and federal funds as well as WRC members. The WRC has scheduled a watershed research conference for Oct. 13 and 14, 2008 at OSU.

Contact the WRC at *watershedsresearch.org*, 541-737-1348

Watersheds Research Cooperative

OSU hydrologist Arne Skaugset is director of the WRC.

Moving Targets

In addition to being a research lab, Hinkle Creek provides an educational setting for more than 600 Roseburg fifth-graders who visit the watershed every year, says consulting forester Javier Goirigolzarri. High school students and the Oregon Board of Forestry have also toured the research sites.

"The Watersheds Research Cooperative is probably the leading effort (in the United States) to look at the effectiveness of contemporary practices," says Ice. The future of forest policy is at stake. Results from the Hinkle Creek, Alsea and Trask projects may guide regulation as attention is focused more on watersheds than on single pollutants, more on how watersheds respond to disturbance than to whether pollutants such as sediment and organic materials exceed a threshold level.

"Sediment, temperature, dissolved oxygen and nutrients are highly variable in time," says Skaugset. "You can go out to a highly degraded watershed and collect a water sample at the right place and time, and it would look great. If you go out into the middle of the Santiam Wilderness Area during the middle of a large winter storm, there will be muddy water. So you have to capture that variability if you want to look for changes due to timber harvesting.

"It's a very tough problem," he concludes. "All three of these studies and other studies in the Pacific Northwest are right on the forefront." terra

Learn more about the Hinkle Creek project at *watershedsresearch.org/HinkleCreek/HinkleCreek.html*

Thinking Like a Physicist
OSU leads a national effort to reform upper-level physics education

Walk into an upper-level college physics classroom almost anywhere in the country, and you'll see students sitting down, listening to the professor and taking notes. Despite years of education research showing that students learn better by being active, the common curriculum for juniors and seniors in physics still emphasizes passivity. In recent years, a revolution in teaching methods has replaced rote learning with active engagement in introductory classes. Upper-level instruction has remained resistant to change.

At Oregon State University, advanced physics instruction has already made the transition. Ten years ago, Corinne Manogue and colleagues (see sidebar) in the OSU Department of Physics overhauled their whole approach to teaching. They turned the focus from lecture to action, from professor to student, from rote learning to problem solving. They redesigned a classroom where students collaborate around tables and sketch and share ideas on small white boards. They concentrate on topics that are central to the understanding of subdisciplines (such as classical mechanics, optics or electromagnetism) normally treated in separate courses. They can shift from presentation to group discussion to lab in seconds. No lecture-style seating or time to rest for these physicists-to-be.

"Learning this way was extremely exciting," wrote OSU graduate Ethan Bernard in 2003. "And I remember toying with the application of basis functions, vector fields and canonical ensembles to diverse things like taste, color, economics and evolution. I learned faster in Paradigms that at any other time in college."

"To my knowledge, OSU is the only university in the country to do this overhaul in the upper division," says Manogue. Begun in 1997 as a modest effort to accommodate students enrolled in engineering physics internships, the OSU reform initiative has received more than $1 million in National Science Foundation support, including a 2007 grant to write two new textbooks, to create a detailed Web site and to adapt abstract mathematical tools to specific circumstances in physics.

Since 1999, Manogue has presented the program, known as Paradigms in Physics, to educational conferences and to more than a dozen of the nation's 760 degree-granting physics departments. Elements of the curriculum are being adapted at other universities such as Texas A&M and the University of Colorado.

Paradigms strives to give students a rich understanding of the many approaches that physicists take to problem solving. Power, says Manogue, comes with mastery of the tools that physicists have developed in concert with mathematicians and software engineers. So the Paradigms courses — three-week intensive classes that meet daily — revolve around ten fundamental topics (oscillations, central forces, one-dimensional waves, and periodic potentials, for example) and the equations, graphs, computer visualizations and narratives that define those topics.

"Typically, students get exposed to a topic once in an advanced course," says Manogue. "They either get it or they don't. But that's not the way a lot of people learn. They learn by doing things over and over again in different contexts."

In a typical junior-level class, Manogue poses a problem and asks students to discuss it, to define it in mathematical terms and to describe the solution in words. As students talk, she stops to listen at each table and asks leading questions, challenging students on their choices of words or equations. Whether dealing with the oscillations of a string, an electromagnetic charge in space or the forces that affect planets as they revolve around the sun, students are encouraged to think like physicists.

In the senior year, students use many of the same tools to explore more advanced topics in subjects such as quantum mechanics or electromagnetism. By building on what they learned in the previous year, they reinforce their knowledge and gain confidence.

It Takes a Team

Paradigms in Physics is the result of a collaboration among OSU faculty in math, physics, and science and mathematics education. Collaborators include Corinne Manogue, Janet Tate, David McIntyre and Philip Siemens in physics; Tevian Dray and Barbara Edwards in math; and Emily van Zee in science and math education.

In a Paradigms class, OSU physicist Janet Tate works with students investigating the properties of oscillations. (Photo: Karl Maasdam)

"Active engagement is not just good for the students. It's valuable for the faculty member to get immediate input about what the students are thinking," says Corinne Manogue. (Photo: Karl Maasdam)

"About mid-year, they start saying things like, 'I'm starting to understand what it means to be a physicist,'" says Manogue. "Or what it means to solve physics problems. It's almost like they were undergoing a phase transition, where they just start thinking differently."

Manogue suspects that the changes in learning stem from the philosophy of active engagement, but pinpointing which methods are critical takes systematic assessment. In 2007, the department hired Assistant Professor Dedra Demaree to lead physics education research and bring these active engagement ideas to the large-enrollment introductory courses.

And the department's home in Weniger Hall is scheduled to receive an upgrade in its classroom facilities in the near future. In rooms now equipped with standard lecture-style seating, the department is working with Peter Saunders in OSU's Center for Teaching and Learning and the Classroom Renovation Committee to incorporate designs that can accommodate more active learning approaches.

–Nick Houtman

Learn more about OSU's Paradigms in Physics program at *physics.oregonstate.edu/paradigms*

On the Road

Vince Rossi, OSU physics graduate ('03) and current Ph.D. student, is studying biomedical optics. He has also served as a teaching assistant in the Paradigms in Physics program. Last fall, Rossi worked at Texas A&M University where he helped Professor Jairo Sinova to adapt the Paradigms approach in two physics courses. "It wasn't until I came back as a graduate student that I realized how good Paradigms is," he says.

Family Business Portrait
Firms neglect plans for nurturing new leadership

(Illustration: Rob Dunlavey)

Family businesses are the bedrock of the U.S. economy. But as company founders and CEOs age, failure to plan for the future puts many family firms on uncertain footing.

That is the conclusion of a national survey conducted by OSU and Seattle University with Seattle-based Laird Norton Tyee, the Northwest's largest privately held wealth management firm. The 2007 survey found that 60 to 70 percent of family businesses with revenues topping $5 million have neglected to lay the groundwork for the next generation of company leadership.

"The most surprising finding of our survey is the lack of formal planning, including strategic business and succession plans, for many family businesses," says Rich Simmonds of Laird Norton Tyee, who collaborated with OSU's Austin Family Business Program, which offers succession planning workshops, and Close to the Customer (C2C) program to design and execute the study. "If the trend continues, it could have a detrimental long-term effect on these companies."

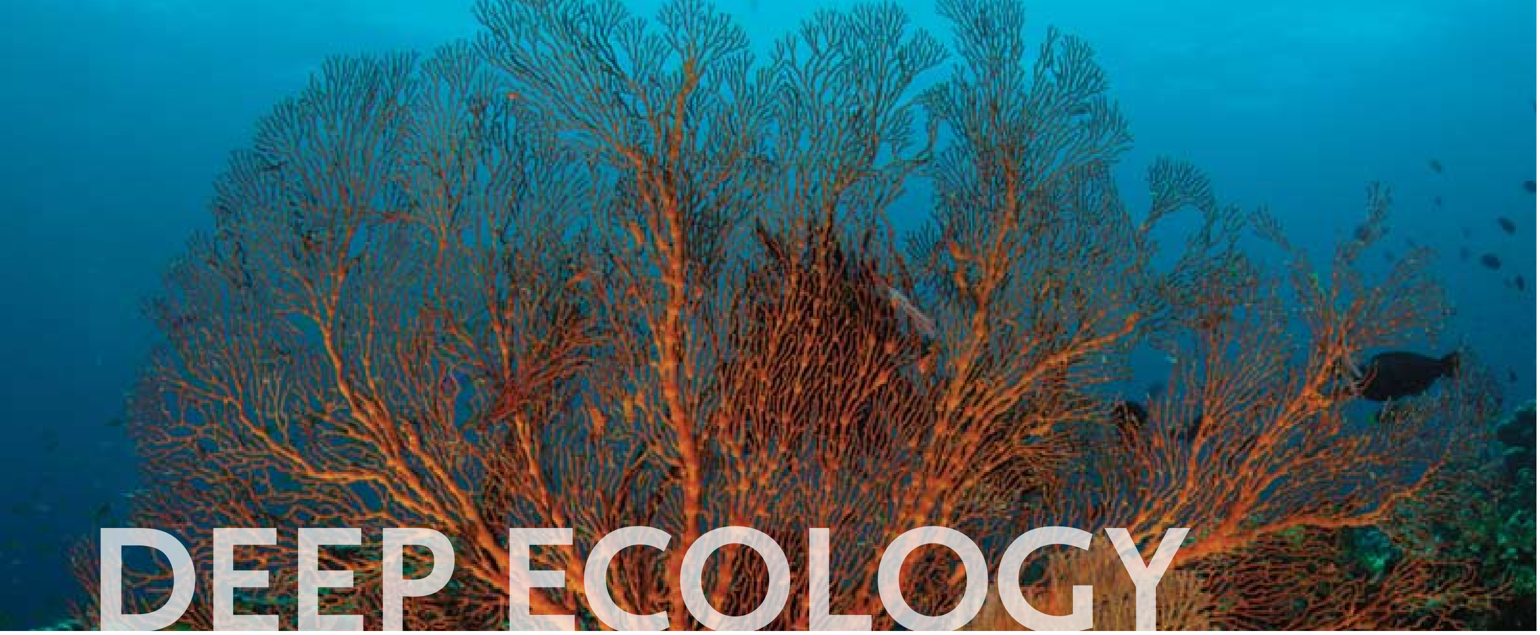
Two big roadblocks hamper planning: the pressure of managing day-to-day operations, and the difficulty of confronting old age, illness, disability and death. Family-business heads tend to see themselves as indistinguishable from the company itself. They often have a tough time imagining the business carrying on without them, the survey found. But if the business is to remain viable when the founder is gone, steps should be taken long before a crisis strikes to designate and prepare a successor, Laird Norton Tyee counsels.

Red flags popped up in other areas, including a lack of written strategic plans and reliance on informal governance structures.

"The survey was designed to paint a broad overview of what's going on in family businesses across America," says C2C's Director Nicole Brown, who executed the survey with marketing professor Hal Koenig.

–Lee Sherman

To read the complete study, *Family to Family: The Laird Norton Family Business Survey 2007*, visit *familybusinesssurvey.com*



DEEP ECOLOGY

Orange sea fans (Melithea sp.), *such as this one off the coast of Papua, New Guinea, can reach 15-feet wide. (Photo: Daniel and Robbie Wisdom)*

From coral reefs in the tropics to Oregon's rocky banks, Mark Hixon investigates coastal marine fishes

by Lee Sherman

When talk turns to the mud-dwelling creatures of the deep seafloor, Mark Hixon jumps up from his swivel chair, strides to a cabinet in his office and swings open the door. Taking out a long cardboard box, he gently lays it on his desk.

"This," he says, reaching inside, "is a sponge from just off the Oregon coast. Isn't it cool?"

He holds up the dried organism, an 18-inch-long spire the color of raw pinewood, delicately honeycombed. Its tousle of roots tells you why scientists long classified sponges, mistakenly, as plants. In your hand it is nearly weightless.

"There's a whole host of things that live down there," says Professor Hixon, an internationally known marine ecologist in OSU's Department of Zoology.

The astounding array of seafloor organisms — brittlestars and bivalves, marine worms and sea pens, cold-water corals and sponge species by the score — plays a vital role in ocean systems by providing food and shelter for finfish and shellfish. Before manned submersibles and remotely operated vehicles (ROVs) gave scientists direct, deep-water access, Hixon says, many viewed the teeming ocean mud as empty ooze. Now they know the seafloor is the "nursery" for many of the finned species humans eat.

Hixon's research on fish population dynamics has taken him to most of the planet's oceans, both temperate and tropical. One of the world's leading authorities on coral reefs, he has been cited in scientific journals more often than any other coral-reef ecologist in the Western Hemisphere over the past decade, according to the Thomson Institute for Science Research. He was ranked third worldwide behind two scientists who live adjacent to coral reefs year-round.

One big mystery relevant to both fisheries management and marine conservation is whether and how isolated populations of adult fish are linked. Understanding these links will help answer questions such as, Can protecting fish in one location compensate for overfishing in another location? Hanging in the balance are decisions about marine reserves that, while designed to sustain fisheries, have raised fishing industry concerns.

In two ongoing studies — one in Hawaii, the other in the Bahamas — Hixon and his graduate students are investigating connections among isolated populations of coral-reef fishes. They are studying the demographics of the yellow tang on Hawaii's Big Island and the bicolor damselfish in Exuma Sound off the Bahamas. They are sampling DNA from adult and juvenile fish at multiple reefs. Their goal is to understand the drift patterns of fertilized eggs and larvae that travel with tides and currents in a process known as "larval dispersal." And they are testing whether a high level of larval connectivity is also reflected in the population dynamics of adult fish.

Ultimately, the answers will guide conservation and management, not only of fish, but of the reefs themselves. These complex ecosystems brim with more species than anyplace on the planet, even tropical rainforests. And many are dying. Pollution, global warming and overfishing have degraded about 20 percent of Earth's coral reefs so far. Another 50 percent are at risk. In Hawaii, the yellow tang, coveted by the aquarium trade for its brilliant color, was depleted until the state created marine reserves along the Kohala-Kona coast to protect them. Preliminary data from Hixon and his colleagues suggest the reserves are working. "Long-term policy about marine reserves must be based on data rather than hearsay," he says. The yellow tang genetics, still being analyzed in Hixon's lab, will reveal which of Hawaii's reefs need replenishment from spawn drifting in from highly productive "source" reefs and where those respective reefs are located.

In waters off the Bahamas in 2006, Mark Hixon collected juvenile coral-reef fish for tagging. (Photo courtesy of Mark Hixon)

Researcher profile

Since he came to OSU in 1984, Mark Hixon has received research support from the National Science Foundation and National Undersea Research Program of the National Oceanic and Atmospheric Administration. In 2004, the ISI Citation Index recognized him as the most cited author in the Western Hemisphere on coral reef ecology in the past decade. His reports have appeared in the journals *Science*, *Fisheries*, *Ecology*, *American Naturalist* and *Proceedings of the National Academy of Sciences*, among others.

Ocean Views

In his three decades as a fish ecologist, Hixon has dived in oceans from the Pacific to the Atlantic, the Caribbean to the Coral Sea. Studying marine science at UC Santa Barbara was, for him, just a natural extension of a sea-centered boyhood as a surfer and the son of a naval officer. As the family moved from one coastline to another, young Mark — a fan of *Sea Hunt* and ocean explorer Jacques Cousteau — had a recurring dream: He would be standing on the beach trying to imagine what lived beneath the heaving seas when, suddenly, the water would disappear, revealing fishes "swimming around in the air."

As a doctoral student in the 1970s, he shivered through dozens of bone-chilling dives in cold-water kelp forests. These days, he relies on small research submarines in the frigid northern waters as he studies the ecology of coastal marine fishes, focusing on what naturally regulates populations and sustains biodiversity. His scuba gear gets used mostly in warm-water ecosystems.

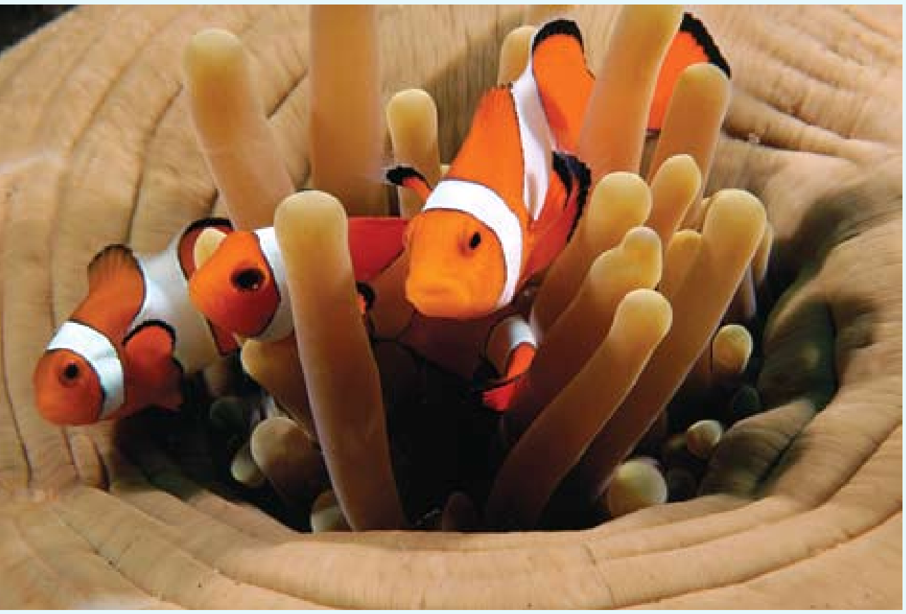
The tropical reef research part of OSU's top-ranked effort in conservation biology has relevance here in Oregon. "Off Oregon, it's impossible to gather the enormous amount of data we can extract from warm, clear tropical waters," Hixon says. "However, once our methods are developed and tested in the tropics, we can bring them home to Oregon."

Such research is timely. Governor Ted Kulongoski is leading an initiative to create marine reserves in the Oregon Territorial Sea to replenish and preserve the state's marine ecosystems and fisheries. Hixon's work will help test the effectiveness of Oregon's reserves. For example, in the 1990s, Hixon, who chairs the Marine Protected Areas Federal Advisory Committee, witnessed a post-trawl patch on Oregon's continental shelf from the portal of a research sub named Delta. He and his team were surveying fish populations on the rocky reefs between Bandon and Cape Blanco, a fish-rich outcrop called Coquille Bank, when they stumbled upon a muddy area deeply scarred by groundfish trawl nets. An adjacent area unmarred by trawl tracks provided a readymade control site. The researchers decided to conduct a comparative study, the first-ever documentation of trawling impacts on the deep mud seafloor off North America's West Coast.

The contrast was stark. About half as many groundfish species were living in the trawled area as in the untrawled area. Numbers of individuals, too, were significantly lower in the trawled site. Most striking, though, was the disparity in sea pens and other invertebrates. Members of the jellyfish phylum, the fragile, soft-bodied sea pens stood out brightly in Delta's spotlight as it scanned the sediment in the lightless depths. Forests of the flowerlike stalks of yellow-and-orange polyps were anchored in the untrawled mud. But where the nets had passed, sea pens were virtually absent, Hixon and Brian Tissot of Washington State University reported in the *Journal of Experimental Marine Biology and Ecology* last year.

*This lionfish (*Pterois volitans*) swam to within six inches of the camera as the shot was taken. "We think that he saw his reflection in the glass and was trying to scare off his 'rival,'" says photographer Robbie Wisdom. (Photo: Daniel Wisdom)*

Data alone won't save our oceans. "People must feel it here," Hixon says, placing his hand over his heart, "to value not only themselves and the present, but also to value others and the future."



This false clown anemonefish (Amphiprion ocellaris) *isn't the Nemo of the famous Disney movie. True clown anemonefish have more black markings. (Photo: Daniel and Robbie Wisdom)*

Sea pens and other such invertebrates can't swim away when their habitat is disturbed. Nor can they quickly rebound. These "sessile, slow-growing, long-lived species," Hixon notes, "are likely to recover slowly" from the effects of bottom dragging.

"What we saw off Coquille Bank," Hixon concludes, "was completely consistent with studies conducted all over the world showing that bottom trawling has severe impacts on seafloor habitat." Unfortunately, Hixon and Tissot's findings were dismissed by the Oregon trawl industry, which questioned their validity, despite appearing in a peer-reviewed scientific journal.

"My greatest frustration as a scientist happens when any special interests reject peer-reviewed science," says Hixon. As Chair of the Ocean Sciences Advisory Committee for the National Science Foundation, Hixon notes that rejection of scientific findings about climate change and ocean acidification stem from the same attitude. Hixon likes to quote Aldous Huxley, author of *Brave New World*: "Facts do not cease to exist because they are ignored."

For Hixon, biology and conservation have become inseparable as threats to the oceans continue to grow. "The challenge," he says, "is to successfully walk the fine line between scientific objectivity and personal advocacy. Some scientists refuse to walk that line, but I did not abdicate my citizenship when I became a scientist." Discovering how to connect science (left-brained and analytical) with public engagement (right-brained and passionate) is as urgent to Hixon as tracking fish movements across reefs. Data alone won't save our oceans. "People must feel it here," he says, placing his hand over his heart, "to value not only themselves and the present, but also to value others and the future."

To that end, he and Professor of Philosophy Kathleen Dean Moore, director of OSU's Spring Creek Project for Ideas, Nature and the Written Word, are investigating the psychology of conservation communications: how to craft messages that effectively change minds and behaviors.

Mark Hixon wants our progeny to inherit a world still relatively intact. He wants tomorrow's children to have a chance to dive into the pulsating rainbow of biodiversity that is the tropical reef. "You feel as if you've fallen into a universe of stars," he says. "It really, truly is amazing." terra

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To learn more about Mark Hixon's research, see *oregonstate.edu/~hixonm*

Meet the photographers, Daniel and Robbie Wisdom

Protecting tropical reefs is a passion for these two graduate students in OSU's College of Oceanic and Atmospheric Sciences. The Idaho natives plan to live in Australia where they can pursue scuba and underwater photography. Both are enrolled in OSU's Marine Resource Management program. Daniel works with Assistant Professor Kelly Benoit-Bird analyzing fish-school movements with high-frequency sonar. Robbie is studying cooperative marketing programs for small seafood micro-canners in the Pacific Northwest with Gil Sylvia, superintendent of the Coastal Oregon Marine Experiment Station in Newport.

Brain Storm
Inspired by neuroscience

Fourth-year biochemistry/ biophysics major Taralyn Tan conducts genetic experiments in OSU's animal sciences lab with the savvy of a seasoned researcher. (Photo: Jim Folts)

Like a lot of undergrads, Taralyn Tan is footing her college bills with loans, scholarships and part-time jobs. But while most students are pulling shifts at the espresso bar or pizza parlor, Tan is sequencing genes in a biochemistry lab.

The fourth-year biochemistry/biophysics major and Honors College student is investigating livestock genetics. In OSU's animal sciences laboratory, she assists Professor Fred Stormshak in the search for markers of atypical mating behavior in sheep, a collaborative study with Oregon Health and Science University and the U.S. Sheep Experiment Station in Idaho.

As she lifts a tray of dripping microfuge tubes from a water bath and transfers them to a PCR (polymerase chain reaction) machine, Tan explains the intricacies of the research, funded by the National Institutes of Health: "cutting up" strands of DNA from purified animal tissue, ligating (attaching) the pieces to strips of synthetic DNA, and then amplifying (replicating) the DNA to obtain the genetic sequences of interest. She seems as conversant in mRNA, bubble PCR and sexually dimorphic nuclei as most 21-year-olds are with iPod, MySpace and Bluetooth.

"Her vocabulary is hard to wrap your mind around," says Kevin Ahern, senior instructor and Tan's academic advisor. "She's teaching *me* words." She has impressed others as well. Tan has received OSU's Presidential Scholarship and a nationally competitive Goldwater Scholarship. In 2008 *USA Today* selected Tari for its second-team All-USA College Academic Team.

The only thing more striking than her scientific fluency is her cool assuredness in the lab. This forest of flasks is, without a doubt, Tan's habitat. She seemed destined for science as early as second grade. The oldest child of an IT manager and schoolteacher in Salem, Oregon, little Tari loved dissecting owl pellets. The 7-year-old also authored a story about a lunar monster who was fearsome, not because he roared and gnashed his teeth, but because he ate gravity.

Her fate was sealed on the first day of high school chemistry when the teacher performed a series of spectacular chemical reactions. Watching, wide-eyed, as the compounds morphed from clear to pink through all the colors of the rainbow, she thought: "Wow, that's so cool! Things you can't see are governing the reactions." When her 16th birthday rolled around, she shunned the usual "girl" gifts and asked for a chemistry set. "Are you sure?" her mother asked, shaking her head in disbelief.

"My mom thought that was the weirdest thing," Tan says, grinning.

At OSU, Tan has never doubted her devotion to laboratory science. "I cannot envision a better undergraduate experience. I've been in a lab every single day since my first day as a freshman. All my friends are working in labs. You can start by taking research for credit, or you can start by washing glassware. Kevin says all undergrads need to do research." During the summer, Tan participated in OSU's annual Howard Hughes Medical Institute research program.

But her longtime intention to become a pediatrician was rocked after a summer 2007 internship in India. Two months shadowing doctors in the southern state of Tamil Nadu opened her eyes to certain realities of medicine that clashed with her own disposition. At clinics in two Indian hospitals, one for leprosy patients, Tan became restless watching the same symptoms, diagnoses and treatments over and over. "There was so much repetition — 100 cases of vitiligo (a chronic loss of pigment) in the skin clinic, for instance," she says. "I realized that just seeing runny noses all day in general pediatrics wouldn't suit my interests."

Shaken, she headed back to Corvallis for her senior year in the throes of an identity crisis.

The crisis was quickly resolved. A teaching assistantship in biochemistry awaited her that autumn, and it gave her the "missing puzzle piece," she says. "I loved teaching college-level biochemistry. I loved putting my own spin on the material so that students would get it. It was so satisfying to see those 'ah-ha' moments."

Now, rather than working with little kids as a physician, she plans to work with college kids as a professor while conducting research in neuroscience. With her minor in psychology, Tan is especially keen on studying chemical pathways of perception, how the brain registers pain, for instance, or senses heat and cold.

"The human brain is the final frontier," she says. "It's the last black box for scientific discovery."

– Lee Sherman

Tan has launched an "unhoused" sorority, Sigma Delta Omega, for OSU women majoring in science. For details visit ***oregonstate.edu/groups/sigmadeltaomega***

MUSICAL PANACHE

OSU steel drum ensemble taps into Caribbean rhythms

by Nick Houtman

OSU percussionist Bob Brudvig is leading a five-person ensemble in a practice session on the second floor of historic Benton Hall. It may be winter in Corvallis, but the music makes you forget the drizzle outside. It evokes palm trees, Caribbean sun and pre-Lenten carnivals. Brudvig works the melody on his chrome-plated steel drum, tapping out notes in rapid succession to an arrangement of "Gimme de Ting" by Trinidadian calypso legend Lord Kitchener. A base guitar and marimba harmonize as bongos and drums carry the rhythm. Time to dance.

The group sometimes known as Dr. Bob's Steel Drum Extravaganza, according to Sam Kincaid, band member and recording specialist in the OSU music department, has been bringing its energetic sound to Willamette Valley performance stages, weddings and other events for the past two years. Its repertoire emphasizes calypso and soca (an up-tempo dance form developed from calypso), traditions from Trinidad where its signature instrument, the steel drum or pan, was born.

"You know what it is the minute you hear it," says Kincaid, who, as co-owner of RQM Strings, also builds and sells hollow electric guitars. "It is really bright. Some pans are a little more mellow sounding, but once you hit those high notes, it really cuts through. It catches people's attention just like that. If we're playing outside, maybe a marimba piece, people will notice and keep walking. When you're playing the pan, it pulls their attention in right away."

It's a sound that Brudvig hopes to turn into new opportunities for OSU music students. "I think it could really take off," says the assistant professor. "It's not like the violin where you have to study first. Immediately you can play a note. The sound and the music that is performed are really infectious."

Most of the ensemble's seven to eight members get a single academic credit for their work, much less than their many hours of practice would justify. Money from performances pays for expenses such as new songs and instrument maintenance. Steel drums are notorious for going out of tune and have to be adjusted regularly, says Brudvig. "It's kind of a scary thing. They (tuners) turn the drum over and take their hammer, wack them, maybe pop it back from the other side."

"Percussion departments have seen it as a nice way of bringing in world music," says Bob Brudvig, leader of OSU's steel drum ensemble. (Photo: Frank Miller)

Muffin Tins and Garbage Can Lids

In music classes, Brudvig introduces OSU students to a variety of percussion instruments, including the standard drum set, the vibes and marimba. His repertoire ranges from classical to contemporary. The OSU graduate (business and music) and native of Albany, Oregon, keeps a busy performance schedule with symphonies, operas and other groups in Oregon and Arizona, where he did his DMA (doctor of musical arts) at the University of Arizona. In Tucson, he combined his percussion talents with two harpists in a group known as Starfire, which toured in the United States and Japan.

"The steel drum is the newest member in the family of percussion instruments," Brudvig explains. It grew from the culture of colonial Trinidad in which the British government, fearing the possibility of uprisings, prohibited the islanders from using skin drums to communicate during most of the year. The rules were often relaxed in the weeks before Lent, allowing street parades and musical competitions for the annual carnival. With drums banned, musicians turned to hollow bamboo sticks, which they pounded on the street during parades. These so-called Tamboo-Bamboo bands were prohibited as well, says Brudvig, and metal objects — muffin tins, cooking pots, garbage can lids — replaced bamboo. Musicians eventually found ways to use the ubiquitous 55-gallon barrel made available by Trinidad's thriving oil industry.

Conversations about this history inevitably turn to Ellie Mannette, who is credited with creating the modern steel drum in the 1940s. The musician from Trinidad introduced the instrument to the United States a decade later and led workshops from 1983 to 1986 at Portland State University's Haystack School of the Arts in Cannon Beach. OSU music professor Michael Coolen attended those sessions and learned to play and to make a steel drum. He founded an 11-member OSU steel drum band, Pura Vida, in the late 1980s, but a continuing case of tinnitus (ringing in the ears) eventually forced Coolen to stay away from loud, percussive music and discontinue the band. He had most of the steel drums auctioned off, but he kept one, which he now lends to the OSU ensemble.

In Trinidad, steel drum music continues to thrive. Annual competitions ("Panorama" and "Pan Is Beautiful") are held during the carnival season. Bands can have as many as 100 players, and although most emphasize Afro-Cuban styles, some specialize in European classics. "Initially, in the 1960s and 70s, a lot of these groups started off playing orchestral transcriptions," says Brudvig. "Most of these guys in the orchestra don't read music. So it was learned by rote. They were learning a complete Mozart Symphony by ear."

The instruments have also evolved. The lead pan on which Brudvig plays melodies in the OSU ensemble starts at middle C and covers slightly more than two octaves. Others in the pan family — tenors, guitars, cellos, basses — extend to progressively lower notes. Large bands also have a section known as the "engine room," which keeps all the drummers on the beat by rapping out the rhythm on a drum set or steel brake drum.

Oregon is hardly a center for the instrument on the West Coast (that distinction belongs to the Seattle area), but Mannette's Haystack workshops continue to echo in the state. James Leyden of Portland, who worked with Mannette on the East Coast and arranged for his Haystack appearances, offers a wide variety of steel drum arrangements at a Web site, www.hillbridge.com. A Mannette protégé, Dennis Martin of La Center in southern Washington, builds and sells steel drums, and the band he started, Rhythmical Steel, performs in schools and at public events in Washington and Oregon. Two Eugene groups, Island Accents and the all-female group Steel Magnolias, are active in Oregon.

Brudvig hopes to ride interest in the steel pan to build on the OSU music department's ongoing public school programs and to expand performance opportunities for OSU percussion students. He expects students would agree with the observation of Rear Admiral Daniel Gallery who founded the U.S. Navy Steel Drum Band. After hearing a Trinidadian steel pan group in 1957, Gallery said, "The music just got inside me and shook me up." terra

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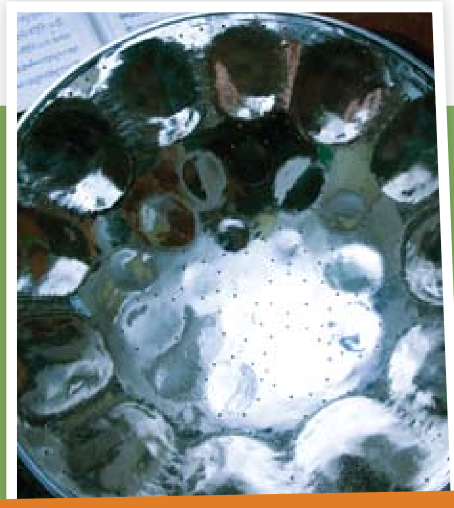
Learn more about OSU's Department of Music at *oregonstate.edu/cla/music*

Lloyd Gay, a steel pan maker in Trinidad, built Bob Brudvig's lead pan in 1998. The standard price then was $750. Pans start today at about $2,000. (Photo: Frank Miller)



OSU Percussion on the Move

OSU percussion players performed at the annual Northwest Percussion Festival at Eastern Washington University the first weekend in April. On June 1, the OSU Wind Ensemble will perform a composition for solo percussion and wind instruments by Gregory Youtz at Carnegie Hall in New York City. Youtz teaches at Pacific Lutheran University in Tacoma, Washington.

In June, Brudvig and the OSU Chamber Choir will be in Tubingen, Germany, for the 25th anniversary of the Congress Bundestadt exchange program. The program will include a commissioned piece for marimba and choir by composer Tomas Svoboda, now retired from Portland State.

(Illustration: Edel Rodriguez)

A House Divided

A basis for black reparations

By Jonathan Kaplan, associate professor and chair of the Department of Philosophy, and Andrew Valls, assistant professor in the Department of Political Science

An excerpt from "Housing Discrimination as a Basis for Black Reparations"
Published in Public Affairs Quarterly, *July 2007*

The renewed interest in the issue of black reparations, both in the public sphere and among scholars, is a welcome development because the racial injustices of the past continue to shape American society by disadvantaging African Americans in a variety of ways. Attention to the past and how it has shaped present-day inequality seems essential to both understanding our predicament and to justifying policies that would address and undermine racial inequality. Given this, any argument for policies designed to pursue racial justice must be, at least in part, backward-looking, justified partly as compensation for the wrongs of the past. . . .

An important part of the story about racial inequality today is the history of housing and lending discrimination in the second half of the 20th century. Home equity, for many Americans, is a very important source of wealth, and the decades after World War II were ones of rapid home equity growth. They were the decades that saw the creation of a large, mostly suburban, middle class. But the middle class that was created was mostly white, and this was due largely to government policies that (in many cases intentionally) excluded blacks from the opportunities to get into the home market and benefit from home equity growth. . . .

The largest cost borne by black Americans is the result of the racist policies of the FHA and other government organizations from the 1930s through most of the 1960s. These policies made it much easier for white Americans to acquire and profit from residential real estate property and simultaneously made it harder for black Americans to acquire and profit from such property. The inability of black Americans to purchase housing on the same terms as white Americans priced many black Americans out of the market entirely; part of the ongoing inequality in home ownership rates can be traced directly to such impacts. Further, in many places that blacks might wish to live, FHA policies made it impossible for them to purchase homes and created incentives for white property owners in the area to discourage racial integration — multiracial neighborhoods would not be rated as highly by the FHA and hence property values could very well drop as mortgage loans, based on FHA ratings, became more expensive and/or harder to secure. While no doubt many white property owners during this time were in fact racist in the traditional sense of the word, even if such property owners were not adverse to living in the same neighborhood as black Americans, the FHA policies pressured them to favor (and enforce) segregation.

Aside from the lower rates of home ownership by black Americans, these policies resulted in homes in predominantly black neighborhoods not increasing in value nearly as much as those in predominantly white neighborhoods. Again, even if white Americans had wished to buy homes in racially "mixed" neighborhoods, they were unable to acquire mortgage loans guaranteed by the FHA in order to do so. This created a demand for new (de facto segregated) housing developments and no doubt increased the market demand in existing predominantly white neighborhoods, while simultaneously lowering the market price (by lowering demand) for housing in predominantly black neighborhoods.

Perhaps the most lasting legacy of these FHA policies is the high degree of residential racial segregation and the attendant differences in the opportunities afforded to black and white Americans. Most obviously, these include access to high-quality educational opportunities, as well as access to local financial institutions, health-care resources and other tangible neighborhood assets.

Read the complete paper by Kaplan and Valls at *oregonstate.edu/%7Ekaplanj/Reparations.pdf*

Among the "watchable" species being studied by OSU wildlife ecologist Bruce Dugger is the dusky Canada goose, which is competing with cacklers and farmers for grass in the Willamette Valley. (Photo: Karl Maasdam)

A New Lens on Wildlife

What do the following Oregon animals have in common: the northern red-legged frog, the chestnut-backed chickadee, the western pond turtle and the river otter? All fall into the traditional wildlife designation "non-game."

"It's a catch-all category for those species that aren't being managed for hunting or fishing," says OSU wildlife ecologist Bruce Dugger.

That once-undifferentiated lump of mammals, birds, reptiles, amphibians and insects was reinvented in the public's imagination thanks to an OSU-trained biologist with a vision. The year was 1979. Bob Mace was sitting in his office at the Oregon Department of Fish and Wildlife, thumbing through a thesaurus and calling out words to his secretary. He was brainstorming, searching for a term that would ascribe greater perceived value to animals like chipmunks and porcupines, songbirds and shorebirds, dolphins and whales, salamanders and lizards. "Hmm, what about 'watchable'?" the ODFW deputy director asked. "That's it!" his secretary exclaimed.

The watchable wildlife movement was born. It has since spread across the nation. Nearly 40 states now actively promote wildlife viewing with guidebooks, viewing sites and other programs to connect the public with animals in their woodland, wetland, freshwater or saltwater homes.

Professor Dugger is carrying on that movement as holder of the Mace Chair for Watchable Wildlife. Endowed by Bob and Phyllis Mace in 1993 along with two undergraduate scholarships, the chair in OSU's Department of Fisheries and Wildlife is a legacy to the couple's commitment to wildlife conservation, habitat restoration and ecological research.

An expert in wetland birds, Dugger studies the habits and habitats of rare and endangered waterfowl in the Americas and Pacific islands. His current research agenda includes the dusky Canada goose, the fast-dwindling Brazilian merganser and Hawaii's koloa ducks.

But what got Dugger started in avian science wasn't a scarce or showy species. It was a creature both small and common. He was 12, summering with his family in the Grand Tetons, wearing waders and casting a hand-tied caddis fly across a cold river. The fish weren't rising. Tired and frustrated, his eyes wandered to the brushy bank. A flash of color flickered. Equipped with binoculars and a Golden field guide, he made his first official bird ID: a yellow warbler.

"After that," he recalls, "I found myself spending more time chasing the birds in the bushes than the fish in rivers."

Public outreach, including the cultivation of "citizen scientists" — volunteers who collect data for researchers — is a central mission of the Mace endowment. To that end, Dugger is dovetailing with OSU's Oregon Explorer Web site to create a portal for watchable wildlife: one-click access to viewing opportunities statewide.

"Before the 1960s and '70s, hardly anyone cared about frogs and dragonflies," Dugger says. "Bob Mace helped change the way people think about small animals."

Learn more about opportunities to view wildlife and participate in research at Bruce Dugger's Web site, *fw.oregonstate.edu/Dugger*

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Butterfly net in hand, OSU entomologist Chris Marshall strides through a Wai Wai village during an international expedition to the rainforests of Guyana in 2006. Since then, a large, thatched-roofed cultural center has been built on the village site, destined to become a museum to educate local children about Wai Wai heritage. See "Expedition to the Edge," Page 2. (Photo: Piotr Naskrecki)

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

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