terra

A world of research & creativity at Oregon State University • Winter 2009

Salmon on the Run

Find out why it's not too late to bring them back

TB: Targeting an Old Foe | Bone Builders | Lessons From the Magic Planet

RESILIENCE

Three times a week, as dawn breaks over the Willamette Valley, 25 women show up at the Benton Center gym in Corvallis. Their exercise clothes are loose and casual. No spandex for this crowd. On average, they're my mother's age and as feisty as they are friendly. "Oh, there's men creatures in here," clucks one when she sees me and a photographer. "Watch where you point that camera," says another.

They hang up coats and put on tennis shoes. Some don weighted vests. Under bright lights and past mirrors and brightly colored exercise balls, they begin to walk around the gym. They share the latest news about themselves ("I walked four miles yesterday to see a friend") and their families ("At the bone lab yesterday, my grandson got all excited because he got to see my skeleton"). Then they collect in a circle so the instructor can lead them through exercises that have them stretching, lunging, panting and "glistening" (not sweating, says one) for an hour.

For these women, the Better Bones and Balance class provides more than a few laughs and a faster pulse. It generates resilience. For some, it has already meant the difference between avoiding a fall and taking a trip to the hospital. OSU laboratory tests confirm that exercisers strengthen muscles and maintain or increase bone mass, reducing the risk of debilitating injury.

Resilience, the ability to adapt or recover from injury, comes into play in our cover story, too. Salmon researchers aim to increase the resilience of this iconic Northwest fish. The future of salmon depends on two things: their ability to respond to habitat changes and our management of hatcheries, watersheds and harvesting practices.

Resilience is also a cultural asset. *Teaching Oregon Native Languages* offers a view of language diversity at the time of statehood. Today, the native language movement is preserving knowledge and experience that has been encoded in the way people speak.

As exercisers know, building resilience takes work and commitment, but it's well worth the effort. Our future depends on it.

— Nick Houtman,
Editor

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OSU is Oregon's largest public research university with more than $231 million in research funding in FY2008. 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
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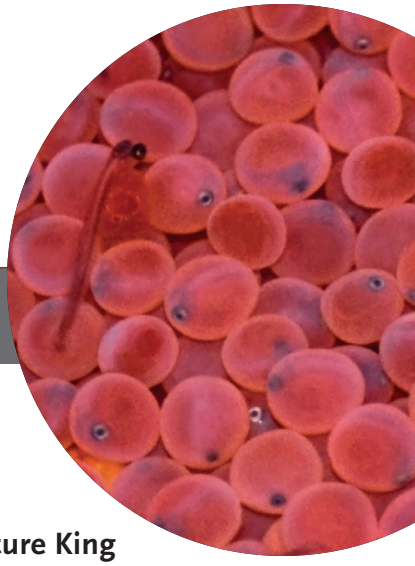

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Pick your favorite cause to explain Oregon's declining salmon runs: predators, hatcheries, dams, water pollution, urban development, agriculture, over-fishing, climate change. While opinions abound, scientists are finding clues that may help this Northwest icon endure.

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The risk of falling rises as we get older, but researchers and fitness instructors have a prescription: Better Bones and Balance. Even if you're 88 years old, there's a class for you.

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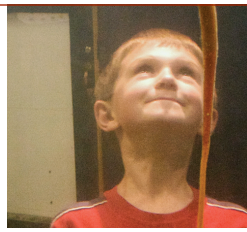
When Jerry and Diane Plante went to the Hatfield Marine Science Center in Newport, Oregon, they discovered more than they bargained for. They became part of a movement that is breaking new ground in science education.



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It took a potato launcher, a canoe and a helium-filled balloon to propel a high-tech scientific enterprise during an international workshop at the H.J. Andrews Experimental Forest.

Once and Future King

Salmon could rebound if we're willing to pay the price

by Mark Floyd

Meriwether Lewis and William Clark were early witnesses to the majesty that is the salmon in the Pacific Northwest. When the explorers first came upon the confluence of the Yakima and Columbia rivers, they observed a scene that was both confusing and awe-inspiring. Wrote Clark:

"This river is remarkably Clear and Crouded with Salmon in manye places and I observe in assending great numbers of Salmon dead on the Shores, floating on the water and in the Bottoms which can be seen at the debth of 20 feet."

Lewis and Clark may not have known about the wondrous life cycle of the salmon, but the aboriginal peoples of the Pacific Northwest certainly did. Salmon provided an abundant and predictable protein source that was cured, smoked and dried. It provided sustenance through bone-chilling winters and was traded to inland tribes for obsidian or other goods.

The value of salmon was soon recognized by others. In 1824, the Hudson's Bay Company sent barrels of salted salmon to London. Although they spoiled, the industrialization of the resource had begun. By 1865, the first cannery was established on the Columbia, and by the end of the century, canneries could be found on the Rogue, Umpqua, Nehalem, Nestucca, Alsea, Coquille and Siletz rivers, and on Tillamook and Yaquina bays.

Over-fishing began to take its toll on the mighty salmon. As westward migration brought more people into the Northwest, dams were built and stream-side forests were cut. Eroding soils buried spawning grounds in sediment, and complex river channels became pipelines. Wastes poured into once-pristine waters.

The finger of blame for declining salmon runs has pointed at these and other factors: sea lions, birds, aquaculture, development and hatcheries. Climate change and ocean conditions may trump them all.

Salmon seiners on the Columbia River, 1914 (Photo courtesy of the U.S. Geological Survey)

Since Oregon's commercial salmon fleet brought in nearly $50 million at the dock in 1988, revenues have steadily declined. Recreational fishing has boosted rural communities, but the salmon economy has stalled. In 2008, the commercial season was closed along the California and Oregon coasts. If the decline has been a process of death by a thousand cuts, restoring salmon runs may require the application of a thousand small bandages. We are finally admitting that we don't know quite as much about salmon as we thought we did, but the research is catching up.

More than two-dozen scientists in four OSU colleges and colleagues in state and federal agencies are studying the salmon life-cycle. Their work is generating a rare feeling about the future of this Northwest treasure. It is called hope.

The following stories suggest what it will take for this symbol of the Northwest to thrive.

Running the Gauntlet

Salmon have struggled past dams for decades, but the harm may go deeper than we think. Certainly the towering hydroelectric dams on the Columbia River have served as a barrier to adult salmon migrating upstream to spawn. Then scientists discovered that hundreds of thousands of juvenile fish met their demise on the way downstream to the ocean, victims of poorly designed fish passageways and spillways.

But the full risk of dams may be underappreciated, according to Carl Schreck, who has spent much of his career studying the young fish.

Schreck is a U.S. Geological Survey scientist with a courtesy appointment in OSU's Department of Fisheries and Wildlife. A leading expert on the impacts of stress in fish, he received the Meritorious Presidential Rank Award last year at a White House ceremony for his contributions to fisheries science. His studies suggest that juvenile salmon may be harmed by the stress they endure as they navigate the Columbia's hydro system.

"Stress in fish delays development," Schreck says. "It also suppresses the immune system, which can increase the chance that fish will be susceptible to disease or parasites. Even though the data suggest that a certain percentage of juvenile salmon survive the freshwater phase of their migration, their weakened condition can be the difference when a young salmon (known as a smolt) needs to adapt to a saltwater environment."

Additional risks stem from chemical contaminants and changes in water flow rates and temperatures. Despite the complexities, Schreck is optimistic that science and engineering are beginning to make a difference. New fish passage technologies and increased water release over spillways have improved smolts' initial survival past the Columbia River dams, he says.

Instead of feeding on endangered Columbia River salmon, Caspian terns eat Tui chub at their new home on Crump Lake in Southern Oregon. (Photo: Lynn Ketchum)

But when smolts delay their migration for days before trying to navigate past the first dam, the added stress could be setting them up to fail once they enter the ocean.

Starting with Smolts

One possible solution: start with a healthier smolt.

Shaun Clements is a former OSU research associate and colleague of Schreck, now working as a biologist with the Oregon Department of Fish and Wildlife. During a study of juvenile salmon on the Columbia, he compared the health and vigor of smolts that were captured at Lower Granite Dam. His research team inserted radio and acoustic transmitters into the young fish at the dams to trace their migration downriver.

"One day, we'd get a group of fish that were released from one hatchery and they'd be relatively weak, then a few days later we'd get a bunch of fish from a different hatchery, and they would be robust," Clements says. "Hatcheries weren't the only variable — sometimes fish from the same hatchery would range from poor to excellent in quality, possibly due to environmental factors such as water temperature in the reservoirs.

"These same mechanisms may also apply to wild fish where we see different watersheds producing smolts of differing quality," he adds. "The point is that the quality of smolts entering into the system can have an impact on their ability to survive the entire migration and the transition into the ocean."

Good Breeding

Such differences among young salmon — why some are 98-pound weaklings and others strut their stuff — may be influenced by hatchery practices. In 2007, OSU geneticist Michael Blouin published a study on steelhead, a close relative of salmon, in the journal *Science* documenting a stunning loss of "reproductive success" at a Hood River, Oregon, hatchery. He reported that 15 percent fewer offspring of first-generation hatchery-raised fish returned to spawn as adults than did the offspring of wild fish. And second-generation hatchery fish produced about half the number of surviving offspring as first-generation fish. The first- and second-generation hatchery fish were raised in the same environment, so the difference between them must be based on genetics.

"We weren't surprised by the effect," Blouin says, "but we were certainly surprised at how quickly it happened."

Scientists aren't sure why. Certainly, hatcheries provide an artificial environment for young fish that offers plenty of food and little danger — conditions that could lead to vulnerability once they leave their concrete cocoon. In the wild, he says, natural selection continually purges fish species of genetic weaknesses.

Designing and managing hatcheries to emulate natural conditions may help offset the reverse Darwinism they engender, Blouin adds, but then the mortality rate for the fish would rise. "At some point, if we are down to a 3-percent survival rate for the fish, what's the point of the hatcheries?"

Despite their flaws, hatcheries could play a role in helping salmon and steelhead runs rebound, but there are knowledge gaps to overcome. "We don't know what genetic selective processes are going on at hatcheries," Blouin says. "We do know that a population cannot be adapted to two different environments at the same time. If there is strong selection process for the artificial environment, then the fish will be maladapted to the wild."

Blouin plans to conduct tests at the Oregon Hatchery Research Center near Alsea, a collaborative venture between OSU and the Oregon Department of Fish and Wildlife. He'll focus on optimal growth rates for fish and at genetic differences between smolts that come from wild fish, hatchery fish and crosses.

Rivers Transformed

Over the last 200 years, habitat loss for salmon and steelhead has been epidemic. On some river systems, dams have slowed currents, eliminated miles of habitat and blocked upstream spawning and rearing tributaries. Logging, agriculture and residential and urban development have had similar impacts on free-flowing rivers.

For thousands of years, Oregon's anadromous fish have survived droughts, floods, landslides and other natural disruptions. The encroachment of humans has been a different story.

OSU fisheries ecologist Stan Gregory says one of the most damaging environmental changes caused by humans has been the transformation of complex, braided river systems into single-channel streams that essentially mimic pipelines.

"If you look at what many Northwest rivers were like a couple of hundred years ago," Gregory says, "you would see multiple channels that spread the impact of flooding, slowed down currents and created holding places for migrating and resident fish. Development and the transition of the land from floodplain and riparian forests to pastures and housing tracts have eliminated that complexity from many river systems. Dams and flood control have reduced the beneficial effects of floods that create floodplains, scour pools, deposit riffles and create complex channels that provide cold-water habitats."

Healthy streams with vibrant ecosystems have another benefit. They remove excess nitrogen that is generated by human activities (principally urban development and agriculture) and thus help maintain suitable fish habitat. In a study published in the journal *Nature*, Gregory and a team of 30 other scientists found that river systems that maintained their complexity could filter out 40 to 60 percent of the nitrogen taken up by the river system within 500 meters of the source where it entered the river.

"It does this by filtering the nitrogen through uptake by tiny organisms such as algae, fungi and bacteria that live on rocks, pieces of wood, leaves or streambeds, and releasing it harmlessly into the atmosphere," Gregory says. "But to work effectively, the stream has to have an opportunity to absorb the nitrogen we put in the river instead of sending it immediately downstream."

For thousands of years, Oregon's anadromous fish have survived droughts, floods, landslides and other natural disruptions. The encroachment of humans has been a different story.

Understanding the importance of historic river channels is key to giving young salmonids adequate habitats for their seaward journey.

Taking Terns

Juvenile salmon and steelhead may spend a year or more in rivers and streams before entering the Pacific Ocean, where a host of potential predators await. But their freshwater adventure also is fraught with peril. Until recently scientists may have underestimated just how dangerous their trek is. Clues have begun to emerge from studies of Caspian terns, large gull-like birds with a taste for salmon.

By the late 1990s, the world's largest Caspian tern population had become established on the Columbia River's Rice Island, some 21 river miles from the ocean. The terns had seen their own habitat disappear, and they immediately took to this sandy dredge-deposited soil. Scientists began to wonder if there might be too many of the fish-eating seabirds in one location, so an OSU-led research team studied the terns' diet.

Research Partnership Aims To Sustain Commercial Fishery

A bleak salmon outlook on the Sacramento River all but wiped out offshore fishing in the Pacific Ocean last year, ironically tabling a revolutionary research project that could sustain future fisheries while protecting such weak runs.

The OSU-led Collaborative Research on Oregon Ocean Salmon (CROOS) project is a unique partnership between scientists and commercial fishermen. Leaders hope to get it back on track in 2009 and expand its study of salmon behavior and migration in the ocean.

The multifaceted study employs the fishermen to log catch data and clip fishes' fins, which are sent to Michael Banks' laboratory at OSU's Hatfield Marine Science Center. There, Banks and his team run DNA tests to determine the river basin of origin for each fish. Results from fish caught in 2007 indicate that genetic testing accurately pinpoints fish origins.

The goal is to learn where specific runs of fish travel in the ocean. Such knowledge could enable fishery managers to protect weak stocks while allowing fishermen to target healthy runs. Despite the 2008 hiatus, the researchers expanded their partnership and plan to work with California and Washington fishermen in 2009.

"We also are working with the fishermen on some unique marketing concepts, including an online database of information about where the fish were caught that consumers purchase in a store," says OSU seafood economist Gil Sylvia. "You buy a fish, scan the barcode, and up pops the history of the fish and the fisherman who caught it."

(Jim Haron photo provided by the Lincoln County Historical Society)

The findings were startling. Researchers estimated that the single colony of nesting terns — about 9,000 pairs — were consuming as many as 12 million young salmon each year, an estimated 10 percent of the juvenile population from the entire Columbia River Basin that survived to the estuary.

"When we looked at what the terns on Rice Island consumed, we found that three-fourths of their diet was juvenile salmon and steelhead," says Daniel Roby, OSU professor of fisheries and wildlife. "That is not good. Rice Island was, perhaps, the worst possible location for the world's largest Caspian tern colony, if your goal is restoring the 13 threatened or endangered stocks of Columbia Basin salmon and steelhead."

The findings prompted the U.S. Army Corps of Engineers to team up with OSU and move the colony to new habitat on East Sand Island, located just five miles from the ocean. Surrounded by saltier waters, the island offered terns a wider variety of fish, including herring and anchovies. Almost immediately, consumption of the juvenile salmon and steelhead was cut in half. "But," Roby says, "that's still too many endangered fish."

So the OSU researchers partnered again with the corps to begin developing new nesting sites away from the Columbia River altogether. Last spring, they finished work on a newly constructed island on Crump Lake in the Warner Valley, near Lakeview, Oregon. In the first year, the project attracted 428 nesting pairs of Caspian terns. Thirty birds carried research bands identifying their origin and five were from East Sand Island, more than 300 miles away.

Other island nesting sites are being developed on Sumner Lake, the Fern Ridge Reservoir near Eugene, Lower Klamath National Wildlife Refuge near Klamath Falls and in the San Francisco Bay Area. As new sites become available, the corps will reduce the amount of tern nesting habitat along the Columbia.

Victory at Sea

Nothing has a greater impact on salmon survival than the oceans where they can spend one to five years. Yet scientists acknowledge that what happens to salmon here is still largely a mystery. Water temperatures and prey abundance seesaw from year to year and place to place. No one really knows what that means for salmon.

During the last few years, scientists have begun pulling back the curtain. OSU studies of hypoxia, or "dead zones," have led to a greater understanding of the ties between physical processes and biological responses. This complex intersection is where you'll find Bill Peterson, a NOAA (National Oceanic and Atmospheric Administration) biologist who works at OSU's Hatfield Marine Science Center in Newport.

For the past 10 years, Peterson has participated in a Bonneville Power Administration project analyzing the distribution of juvenile salmon off the West Coast and using genetic tracking to determine their rivers of origin. The findings help explain why the Columbia River can have a robust run of salmon during the same year the Sacramento River and the Willamette River have historic low returns.

After they leave their river systems, juvenile fish from many of Oregon's coastal rivers, along with those from the Willamette and the Sacramento, congregate just off the Oregon coast. In 2005, when delayed upwelling caused a lack of biological productivity, there was little food, and many of that year's young salmon starved. The effects were seen when few adults returned to spawn in 2008.

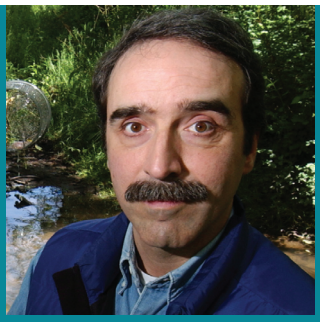
From Headwaters to the Ocean

OSU scientists collaborate with state and federal colleagues on salmon studies in hatcheries, high-desert streams, estuaries and the marine environment. In addition to those described in the accompanying story, here is a sampling of salmon expertise at OSU.

David Noakes

Professor, OSU Department of Fisheries and Wildlife, and Senior Scientist, Oregon Hatchery Research Center

David Noakes coordinates research at the Oregon Hatchery Research Center, jointly managed with the Oregon Department of Fish and Wildlife. In his own research, he studies animal behavior and development, evolution, ecology and genetics. He has focused on fish species from the Arctic to the tropics in freshwater and marine systems.



Guillermo Giannico

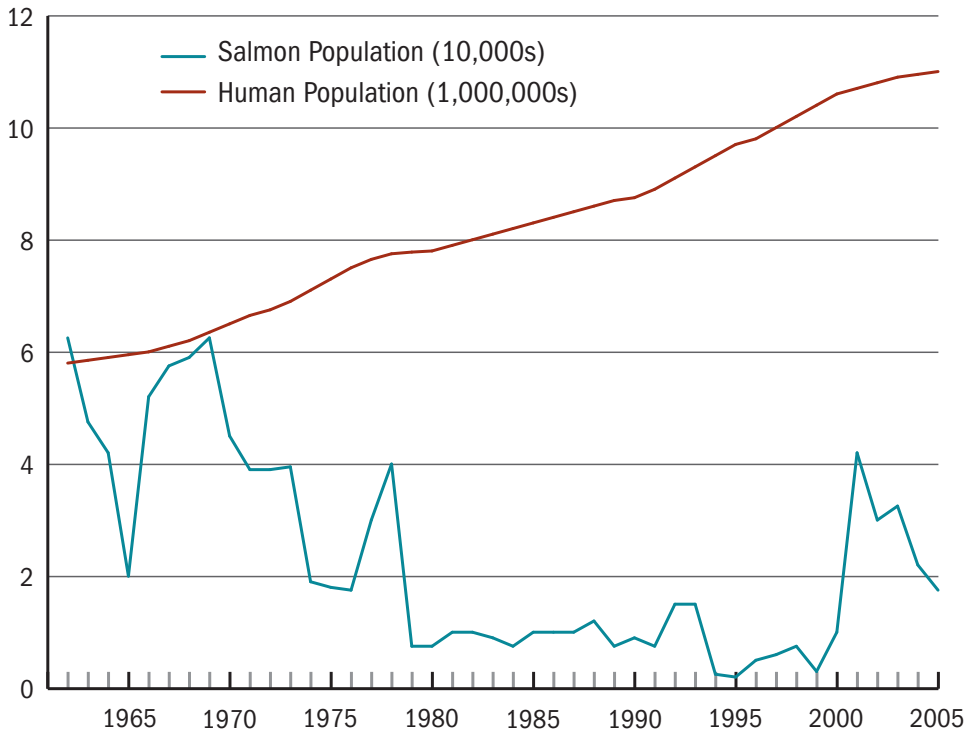
Associate Professor, OSU Department of Fisheries and Wildlife, Extension Fisheries Specialist

Guillermo Giannico studies salmon and trout distribution and habitat selection in freshwater and estuarine systems. He has developed educational materials on salmon biology and watershed management in support of the Oregon Plan for Salmon and Watersheds.

"Columbia River spring chinook stay off the Oregon coast for only a few weeks," Peterson says. "In our 10 years of sampling, we've caught Columbia River juveniles just off our coast only in May and June. By July, perhaps earlier, they have left the area for parts unknown, whereas most coho salmon stay locally. If you look this year at chinook salmon in Alaska, they're doing well. So it's possible that Columbia River juveniles head to the same place as Alaska juveniles."

Peterson speculates that young Columbia River salmon may migrate toward a unique ecosystem several hundred miles off the Northwest coast. In that deep, cold water, lipid-rich (high-fat) fishes known as myctophids, or "lantern-fish," provide a bountiful diet for a variety of marine life.

Cold-water regimes also play a role, says Peterson, who has a courtesy appointment as a professor in OSU's College of Oceanic and Atmospheric Sciences (COAS). His studies have found that juvenile salmon survival increases dramatically when cold-water zooplankton species are dominant. The copepods' high lipid levels may enrich the oceanic food chain and allow salmon to grow fast enough to survive their first year at sea.

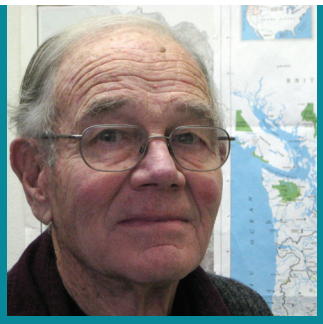


As the Pacific Northwest's population grows, chinook salmon runs on the Snake River are declining. Sources: salmon data, Idaho Department of Fish and Game; population data, Washington Department of Transportation. (Graph: Doug Weiss)

Scott Heppell

Assistant Professor, OSU Department of Fisheries and Wildlife

Scott Heppell is a fish ecologist who studies how physiology, behavior and life history traits affect the interactions between fish populations, their respective fisheries and the environment. He has studied the salmon carrying capacity of Eastern Oregon's John Day River and teaches a course on the biology and management of salmon in the Pacific Northwest.



Bill Pearcy

OSU Professor Emeritus of Oceanography

Bill Pearcy is a pioneer in "salmon oceanography." He convened the first scientific meeting on the role of salmon in ocean ecology in 1983 at OSU's Hatfield Marine Science Center in Newport, Oregon. Starting in 1959, his research focused on Oregon coho salmon and culminated in the writing of *Ocean Ecology of North Pacific Salmonids* in 1992. He received the 2003 Wooster Award from the North Pacific Marine Science Organization Science Board for lifetime achievement and remains active in research and professional panels.

Hiram Li

Oregon Cooperative Fish and Wildlife Research Unit, Professor of Fisheries, OSU Department of Fisheries and Wildlife (retired)

Hiram Li continues an active research program on fish habitats and the factors (stream temperatures, invasive species and landscape features) that affect aquatic communities. He has evaluated mathematical models of proposed salmon recovery measures, developed an assessment method for regional habitat analysis and testified on salmon restoration before Oregon legislators.

The John Day River Basin in Eastern Oregon features some of the state's most productive salmon habitat. On the Middle Fork, OSU engineer John Selker is collaborating on a restoration project with state and federal agencies and the Confederated Tribes of the Warm Springs Reservation. (Photo: Lynn Ketchum)

"Cold-water copepods hibernate during the winter, much like bears, and to survive the winter, they store high amounts of lipids, or fats," Peterson says. "These copepods, in turn, are eaten by juvenile anchovies, herring, smelt and euphausiids (krill), boosting the fat and energy content of those species and making them highly nutritious delicacies for young salmon, as well as other predators.

"A fat salmon," Peterson says, "is a happy salmon."

And, he adds, there may be good news on the horizon. Last year, the Pacific Decadal Oscillation, a pattern of climate variability that shifts every 20 to 30 years, was the most negative, or cool, it's been since the mid-1950s. The ocean was incredibly productive during 2008, and the salmon that did return appeared to be well-fed and healthy. Forecasting is always risky, he says, but salmon stocks will likely be on the upswing.

No Room at the Inn

So what does the future hold for Pacific Northwest salmon? If there is a cautionary note to recent strides, it comes from Robert Lackey, a senior scientist at the U.S. Environmental Protection Agency's Western Ecology Division in Corvallis and a courtesy faculty member at OSU. In 2003, Lackey created the Salmon 2100 Project with OSU faculty members Denise Lach (College of Liberal Arts) and Sally Duncan (Institute for Natural Resources). They recruited 33 salmon scientists, policy analysts and wild-salmon advocates to offer their solutions for saving the fish by the year 2100. EPA awarded Lackey its highest honor, the EPA Gold Medal, for his work.

Their collective conclusion was that current recovery efforts would fail unless we take a substantially different path. There was also broad agreement that the changes necessary to save wild salmon may be politically or culturally unpalatable. Lackey says that scientists and resource managers need to take a strong, realistic look at the future and tackle the biggest factor affecting the future of salmon. It isn't dams, or water quality, or even ocean conditions, he says.

It is us: "our choices, our priorities, our unwillingness to come to grips with simple tradeoffs.

"If society wishes to change the future for wild salmon, something must be done about the unrelenting growth of human population levels along the West Coast," says Lackey. "By 2100, there could be 200 million to 250 million people in the region, quadrupling the population barely 90 years from now. Consider the demand for houses, schools, stadiums, expressways, automobiles, malls, golf courses and sewage treatment plants. Society's options for sustaining wild salmon in significant numbers would just about be non-existent. Even given all this, there are still salmon recovery options that are likely to be ecologically viable and probably socially acceptable, but the range of options continues to narrow."

OSU's Schreck concurs and points out that climate change introduces an added dimension. The situation may be dire, he says, but it is not hopeless.

"Are we willing to give up the things we like to save the salmon?" Schreck asks. "We can plan for growth, make wise resource allocations, handle water and sewage requirements and limit our urban footprint. It's not too late to help salmon recover — but we may have to be selective.

"There may be areas, rivers or watersheds, that can't be recovered. We should first identify those places where fish runs are robust and make sure we protect them so they stay that way. Then we need to find those that are marginally in trouble and begin to fix them. But we need to get going now. There isn't a lot of time to waste." terra

(Illustration: Scott Laumann)

Was Nature Ever Wild?
The human face in environmental restoration

When Spanish expeditions explored what is now the Santa Barbara, California, region in the 16th and 17th centuries, they found thriving native communities. Explorers' diaries reported that the Chumash people were farming, harvesting shellfish and crafting canoes from local trees. Since then, archaeologists have documented more than 8,000 years of human habitation there.

For OSU historian Anita Guerrini such evidence of human influence on the land must be considered in modern restoration efforts, whether for salmon, marine mammals or birds such as the snowy plover.

"The goal of restoration is to create a self-sustaining environment," says Guerrini, who came to OSU last summer as one of two holders of the Thomas Hart and Mary Jones Horning Chair in the Humanities. "You have to figure human use into it. You can't just say, 'OK, if we take the people out, this is what's going to happen.' But you can't just take people out. You have to deal with that."

In her previous post at the University of California, Santa Barbara (UCSB), Guerrini taught in the history and environmental studies departments. She was a member and chair of UCSB's Institutional Animal Care and Use Committee. Her focus on restoration arose unexpectedly from what started as a narrow historical study of an oceanfront reserve on the UCSB campus. Bordered by a heavily urbanized area, the land is the target of plans that include development restrictions and ecological restoration.

In the course of her study, Guerrini discovered that both she and UCSB marine ecologist Jenifer Dugan had an interest in expanding the kinds of evidence that could be used to set restoration goals. They collaborated on a three-year project funded by the National Endowment for the Humanities to explore the role of history in restoration.

Their report (upcoming in *Restoria*, edited by Marcus Hall) cites examples of dramatic coastal change and concludes that restoration should go beyond a specific set of conditions. "In this coastal context, it can only mean restoring the ecological processes, not a particular point in time," they write. "Larger answers to the challenge of developing restoration goals for the . . . coasts of the world will require a synthesis of physical and ecological dynamics and processes, anthropology, history, sea level change, natural and cultural resources, and human population growth and needs."

National parks, especially those that preserve history, face a similar challenge, Guerrini says. "Gettysburg is an example of this. It's an historic but also an ecological site. How do you preserve history while making it ecologically sustainable? Do you keep the trees as they were in 1863?" she asks.

Guerrini has published on the history of European science, medicine and animal experimentation. She is currently working on a book about the groundbreaking contributions of animal anatomical studies to the study of natural history in Paris during the reign of Louis XIV. She has been a visiting fellow in Paris, Canberra and Edinburgh as well as at the OSU Center for the Humanities.
– Nick Houtman

> "A byword of American restoration is that wild nature precludes human presence (or at least European human presence). In the United States, the ideal of a pristine nature still resonates."
>
> — Anita Guerrini

Lunging for Life

Next year, a class for 90-year-olds

By Nick Houtman | Photos by Karl Maasdam

"Keep your tummies in. Arms up. Shoulders down. Up and over!" The sound of 25 pairs of feet thumping a wooden floor echoes through the Benton Center gym. On cue from fitness instructor Shelly Morris, the all-female class steps on and off platforms that range from four to 10 inches high, some participants moving quickly, lifting legs, planting feet, stepping to the side and going back in reverse.

Morris cheers on her students: "You're looking great this morning! Best all week."

"Of course. Women don't sweat. We glisten!" one exerciser laughs.

It could be any exercise class anywhere except for one thing: Many of these women are the last people you'd expect to see in a gym. One celebrated her 88th birthday the previous week. If you saw a member of the class crossing the street, you'd be tempted to offer her a hand. "Nothing would annoy her more," says Beth Lambright, one of Morris' co-instructors, to the nodding agreement of several women in the class. "These women are more likely to help *you*."

Self-paced routines instill confidence. Kathy Gunter admits that if she had approached exercises for older women with a competitive attitude, many would have objected. "They had no problems telling me what they thought," she says.

Fear of Falling

The class known as Better Bones and Balance has its roots in a 1994 Oregon State University research project and addresses one of the most significant health risks for older Americans. According to the U.S. Centers for Disease Control, one in three people over 65 falls in a given year. The results are too familiar: broken hips, concussions and other bone-rattling traumas that, in 2006, sent about 1.8 million seniors to emergency rooms. Accidental falls are the leading cause of injury-related deaths among the elderly.

Reducing those risks is the purpose of Better Bones and Balance. Through a prescribed routine of self-paced stretching and weight-bearing exercises that build muscle, bone mass and confidence, the class equips seniors to safely handle everyday chores — getting dressed, doing the laundry, vacuuming floors, carrying groceries.

"Most seniors in the United States cannot stand on one foot for 30 seconds," says Lambright. "Mine can stand like that for two minutes. We do things forever on one leg so that if they start to fall, they have time to figure out where they want to go. Or we train their legs to go out to the side where they can catch them and break the energy of the fall."

Next year, she plans to start a class for 90-year-olds.

Better Bones and Balance grew from research by Christine Snow, former director of the OSU Bone Research Laboratory, and by Ph.D. student Janet Shaw, now a professor at the University of Utah. "Christine saw that athletes who participated in high-impact sports such as gymnastics, where the landing forces are very large, had extraordinarily high bone mass in comparison to other athletic populations," says Kathy Gunter, assistant professor in OSU Extension's Family and Community Development Program and the Department of Nutrition and Exercise Sciences. Gunter did her Ph.D. work with Snow. "Obviously we can't have older adults dismounting off the (balance) beam and the impacts associated with that. The question came down to: How can we safely increase the load on the skeleton in a group-exercise setting and effectively increase or preserve bone mass?"

Lunges and Heel Drops

Snow and Shaw developed a series of weight-bearing exercises and demonstrated in a controlled study that specific techniques (heel drops, chair stands, jumps, side and forward lunges) could increase strength and maintain bone density in post-menopausal women. It was first known as the weighted-vest program, says Gunter, because participants wore a vest whose weight can be adjusted. Weighted vests are now a common feature of fitness programs, but the researchers started with fishing vests and rolls of pennies.

The women who volunteered for the study were so convinced of the benefits that, after it was completed, they worked with Benton County Extension agent Donna Gregerson (one of the participants in the study) to continue the exercises through the Benton Center, part of Linn-Benton Community College.

The program allows seniors to work at their own pace and encourages socializing. It is now offered in senior centers and community colleges from Portland to Medford and in California and Washington state. In Corvallis, more than 300 people are enrolled in 19 separate classes at the Benton Center.

"Popular" may be an understatement. "When registration opens up each term at the Benton Center, the classes fill up in about 10 minutes," says Lambright.

While this response pleases Gunter, she believes it's not enough. She has taught exercise classes and, in the OSU Bone Research Laboratory, studied the impacts of jumping

exercises across the lifespan, demonstrating the benefits for bone health in children and the elderly. Convinced that the practices need to be more widely available, she and Lambright (whom Gunter calls "a true champion of the cause") have led workshops to train fitness instructors and women's health program managers. They see a particular need in rural areas. "Not every rural community has a cadre of people who are going to be trained and take this back to their communities," says Gunter. "I believe it's our responsibility to create a toolkit that would allow communities, YMCAs or senior centers to have their personnel trained."

Personal Virtual Trainer

In addition to instructor training, she is spreading the word through a Web site (http://extension.oregonstate.edu/physicalactivity/bbb/). And with an eye on physicians who could prescribe the program in a clinical setting, she is working with OSU engineer Ron Metoyer on technology to create a virtual personal trainer for people at risk of fall injuries. A patient could turn on her TV and watch a personal trainer lead her through the exercises, says Gunter. It could play over the Web, and responses to questions could be communicated to the clinician who would monitor the patient's fall incidence and possibly the response to exercise while training. They have received funding for a pilot project from OSU's Center for Healthy Aging Research and applied for a grant from the National Institutes of Health.

Gunter is also advising a graduate research project targeting more than 250 current Better Bones and Balance participants. In Ph.D. student Adrienne McNamara's study, class participants will wear accelerometers (devices that measure acceleration) and heart monitors to quantify the forces their bodies encounter and time they spend in vigorous routines. Researchers and students at the Bone Research Lab will monitor the participants' strength, balance and bone density. The goal is to see if there is a "dose-response" relationship, if benefits accrue like interest in a bank account the longer one participates. It could be, Gunter says, that participants encounter a plateau, that beyond a certain level of activity, strength and bone mass do not improve.

"Nice Recovery"

Among participants at the Benton Center, there is no doubt about the value of Better Bones and Balance. Many credit it with saving them from a fall or speeding their recovery from illness or surgery. Lois Osen, 83, recalls a recent visit to Portland. "I was looking up at a building, took a step and nearly fell off the curb," says. "But I caught myself and didn't fall." Then she smiles. "As I was walking down the street, a man looked at me and said, 'Nice recovery.'"

"I like the fact that she (the instructor) lets you go at your own pace," adds Jean Marie Walker. After going through a round of chemotherapy for breast cancer, Walker found that the class helped her to regain strength.

The benefits show up in daily activities. "I was vacuuming at home with a canister vacuum and started to trip," says Elaine Facto. "But I automatically did a side step over it and didn't trip. I thought 'Wow, how did that happen?'" Facto used to feel uncomfortable walking on a slope in her own yard, but now she feels safe and in control.

"The average senior can come in here and do this," says Lambright. "Most seniors are terrified of signing up for an exercise class. They think it'll be fast. They'll have to wear spandex, and they won't like the music. But you can come here and shuffle in and walk out stronger." terra

Kathy Gunter has taught Better Bones and Balance and now trains others to lead the bone- and muscle-strengthening exercise classes.

Researcher Profile

Kathy Gunter didn't always favor the more casual approach to fitness. "I was a three-sport athlete in high school," she says. "I played soccer, basketball and softball. Later on in college I got hooked on road cycling. I was on a trade (commercially sponsored) team and did the Olympic trials in 1996. That was five hours of training a day."

Gunter doesn't use that kind of competitive approach in Better Bones and Balance. Her seniors prefer to socialize and work at their own pace. They would have headed out the door, Gunter adds, if she had tried to impose a more rigorous routine.

In her research, Gunter works on both ends of the age spectrum. In 2008, she published research results demonstrating that young children increase bone density 3 percent to 8 percent by following prescribed jumping exercises, leading to reduced fracture risk as adults. These benefits continued even after exercises were stopped.

Her research on older adults has been supported by the Bill Winkler Fund in the Center for Healthy Aging Research, the OSU Bone Research Laboratory and the Family and Community Development program in Extension.

Committed to a Fault

Ajeet Johnson is digging into Central Oregon's violent past

Skiing and rock climbing just weren't enough. Growing up in Central Oregon's spectacular landscape, Ajeet Johnson challenged the backcountry of the Cascades. She pulled herself hand-over-hand up Smith Rock and carved down slopes at Mt. Bachelor, but over time, she became curious about the forces that shaped the terrain and will influence its future.

Over the last four years, Johnson has gone from jamming her boots into toeholds and plowing through deep powder to mapping data and measuring fault lines. She received scholarship support for her research and graduated with a bachelor's in geosciences from Oregon State University last summer. Today, she is pursuing her master's at OSU.

Her wonderment at the origins of mountains has morphed into a question that has concerned geologists for decades: Why does the expanding Basin and Range region of the American West — one of the most geologically active in the continental United States — come to an abrupt end in the area east of Bend known as the High Lava Plains?

The answers could have implications for Central Oregon's future. Population has grown faster (73 percent between 1995 and 2007) here than in any other part of the state. The area has seen more than 75 volcanic events over the past 10,000 years, and while the region's unusual geology provides a source of geothermal energy, it also poses a continuing risk of earthquakes. South of Bend, cinder cones and the 17-square-mile-wide Newberry Crater are reminders of a violent past.

Johnson has focused her research on the Brothers Fault Zone, a complex of relatively young, one- to 10-kilometer-long cracks in the Earth's surface that run from near Bend toward southern Idaho. Conventional wisdom among geologists is that the age of a fault relates to its length and the differences in height (what geologists call "displacement") of adjacent terrain. The problem is that, east of Bend, ancient lava flows cover hundreds of square miles, obscuring faults and complicating analysis of their ages.

In 2007, Johnson started measuring fault lines, distinguishing between those that are partially buried and those that are not. She measured the elevations of hundreds of points along the tops and bottoms of slopes. Using a geographic information system, she analyzed data to see if a standard method would yield ages that were consistent with other evidence.

She received support for her research from the Mark W. Chambers Undergraduate Research Grant in the Department of Geosciences and from the Undergraduate Research, Innovation, Scholarship and Creativity fund in the OSU Office of Research.

In a March 2008 presentation at a Geological Society of America meeting in Las Vegas, Nevada, Johnson reported her findings. In short, her analysis showed two results. For faults that cut across rocks older than 7 million years, growth is revealed by the length and height of the fault scarp, or adjacent slope. Faults that cut younger rocks, however, do not show this relationship. Linking among faults and burial of the landscape by lava flows obscure the fault topography.

For her master's research, Johnson plans to continue studying the forces at work under Central Oregon. Questions remain, she says, about this transition zone between the Basin and Range to the south and the Yakima Folds to the north on the Columbia River Plateau. "The Basin and Range is spreading and is thought to be pivoting from a point in Eastern Washington or Idaho," says Johnson. "What we're learning is important for the growing population here and for educating our future scientists."

– Nick Houtman

In the arid environment east of Bend, erosion is slow. Topography reveals the presence of fault lines where they are not obscured by ancient lava flows. (Photo: Anita Grunder)

As an undergraduate, Ajeet Johnson (left) worked with Andrew Meigs to study the ages of fault lines. Research, says Meigs, requires students to think differently. "If I tell you that something is one way, you're not supposed to nod your head and say 'Yes.' You're supposed to say, 'Why do you know that?'" (Photo: Conner Burke)

Lessons from the Magic Planet

Researchers are engaging the curious in meaningful inquiry

by Lee Sherman
Photos by Jim Folts

The rockfish tank captivates Newport first-grader and oceanography buff Noah Goodwin-Rice during a visit to the Visitor Center at the Hatfield Marine Science Center.

From their oceanfront timeshare in Newport, Oregon, Jerry and Diane Plante were enjoying the view one September morning when they spotted an unusual vessel. Peering seaward through their high-powered binoculars, the retirees could make out a black trawler named Pacific Storm. Tethered to it was a yellow, donut-shaped buoy. Poking out of the buoy was some kind of cylindrical shaft.

Intrigued, the Plantes watched and wondered as the boat and buoy bobbed on the distant swells for four days. "We couldn't figure out what they were doing," says Jerry, a former fraud investigator from Sherwood, Oregon. Adds Diane, a retired schoolteacher: "I don't know why we thought the boat was so fascinating, but we did."

Then, soon after the mysterious boat and buoy disappeared from their picture window, they happened to spot the Pacific Storm tied up near the Yaquina Bay Bridge. Excited, they buttonholed a man working on the dock behind a sign reading "authorized personnel only." He told them they had been armchair witnesses to a floating wave-energy experiment conducted by OSU researchers. He was a member of the science team and suggested they could learn more at the nearby Hatfield Marine Science Center. And that's how the curious couple wound up in the Visitor Center raptly studying an exhibit about OSU's pioneering work in wave energy, oblivious to crowds of school kids jostling around them.

Jerry and Diane Plante are what social scientists these days call "free-choice learners."

Choosing To Learn

"Much of what we learn, we learn because we want to, because events in our lives intrinsically motivate us to find out more," explain Lynn Dierking and John Falk, Oregon Sea Grant professors in OSU's Science and Mathematics Education Department in the College of Science. "Under these conditions, we learn not only what we want, but also where, when, and with whom we want. This is free-choice learning, learning that is guided by learners' needs and interests — the learning that people engage in throughout their lives to find out more about what is useful, compelling, or just plain interesting to them. The Plantes are great examples of free-choice learners in action."

Free-choice learning, a term coined a decade ago by Falk and Dierking, is a new addition to OSU's graduate degree programs and research agenda in science and math education. The initiative launched by Sea Grant and the College of Science is designed both to teach and to study how people learn — particularly about science and math — outside formal school settings. Such learning is "incremental" (gathered in bits and pieces, here and there) and "idiosyncratic" (filtered through the learner's one-of-a-kind lens), research tells us. Driven by intellectual curiosities and practical needs for information, most science and math learning happens not as we sit in a classroom, but as we explore the world around us.

Unique in the United States, OSU's Free-Choice Science and Mathematics Learning program gives graduate students a theoretical grounding in the cultural, social and physical contexts that influence learning. Kids and adults alike build knowledge actively using their highly individualized prior knowledge and experience, the scholars say. With this "constructivist" theory as a foundation, the researchers are designing ways to enhance free-choice learning environments such as museums, science centers and Boys and Girls clubs. Along the way, they hope to forge stronger links among the myriad players in education's "invisible free-choice learning infrastructure," a web of institutions and information sources that includes zoos, aquariums, botanical gardens, libraries, national parks, natural history museums, Web sites, TV shows and after-school programs. Other research is delving into how this infrastructure intersects with schools, universities and workplaces.

Six-year-old Noah and his mom, Cait Goodwin, peer at tide-pool organisms in a wildly popular exhibit, which Rowe is videotaping as part of a study to better understand how people interact with touch tanks.

"Research strongly suggests that the more the separate influential spheres of family, school, work and elective learning overlap in people's lives, the more likely people are to become successful lifelong learners," note Falk and Dierking, international leaders in this new discipline. In short, it's the synergy among spheres that counts.

Before coming to Oregon State, Falk founded and directed the Institute for Learning Innovation in Annapolis, Maryland, a private, nonprofit organization devoted to understanding and facilitating free-choice learning. Dierking was the institute's associate director.

Touching You Back

At the Hatfield Marine Science Center, a bucket of brine shrimp makes you a rock star.

That's because the Visitor Center's touch tanks — shallow-water exhibits where you can stroke a real sea star or interact with a giant Pacific octopus — are the most popular spots. When it's time to feed the organisms inhabiting the simulated tide pool — that irresistible spectacle of phantasmagorical forms in hi-def color — Hatfield's volunteer docents get mobbed as visitors jockey for position and crane their necks to see abalones lunch on tiny shellfish and anemones munch on chunks of squid.

"How can we help make learning deeper?"

Shawn Rowe

Shawn Rowe wants to know why humans go wild over touch tanks and petting zoos. "Hands-on exhibits are ubiquitous, but they're usually inanimate — you can pull a lever or push a button, maybe make them light up," says the researcher. "But when you touch a live animal, it gives a very different kind of response. It's almost like it's touching you back. Emotionally, it's very powerful. There's not a lot of research out there to help us understand that experience."

Rowe, an assistant professor in both Sea Grant Extension and the College of Science, is leading a study to reveal the touch-tank magic. Drawing on his background in linguistics and psychology, the researcher and his team of graduate students are videotaping visitors as they interact with the rainbowed dwellers of the briny tank — the spiky and the spongy, the clawed and the tentacled, the soft-bodied and the hard-shelled. He's also recording visitors' interactions with one another. By analyzing the give-and-take among parents and children, husbands and wives, docents and visitors, teachers and students, Rowe hopes to improve learning outcomes from these beloved exhibits.

"People spend so much time at the touch tanks," he says. "Our research question is, "How can we help make their learning deeper?"

Research questions like these that engross Rowe and his students are real-world puzzles that "bubble up" out of the science center itself, he says. "Here at Hatfield there's a rigorous proof-of-concept and prototyping phase for every exhibit," explains Rowe, whom Sea Grant originally hired to bring educational rigor to the Visitor Center. "We do focus groups, interviews, pre- and post-visit questionnaires, as well as observation and videotaping of visitors."

This real-world cauldron is a hallmark of the free-choice learning graduate program, Falk and Dierking assert. "From the start, students are encouraged to generate questions as they do projects in real settings," Dierking adds. Hatfield is only one of the program's living free-choice learning laboratories. In Oregon, others with active research include the Oregon Museum of Science and Industry (OMSI), Oregon Public Broadcasting and the Oregon Zoo in Portland; the Oregon Coast Aquarium in Newport; the Science Factory in Eugene; and the Boys and Girls Club in Corvallis.

Revealed by Fingerprints

Among the exhibits Rowe and his team are studying is the interactive Magic Planet, a giant "digital video globe" — a spherical computer screen showing such planetary dynamics as wind speed, cloud movements, ocean depths and currents across Planet Earth — actual data that's collected by National Oceanic and Atmospheric Administration and NASA satellites. "There are fewer than 50 of these on public display in the world," Rowe says, gesturing toward the giant glowing globe. "Visitors can't make heads or tails out of a lot of it, so we're helping NOAA turn it into a better exhibit."

Then there's Our Active Earth, an interactive "touch to explore" machine depicting real-time earthquake activity worldwide. The researchers are working with the manufacturer, IRIS (Incorporated Research Institutions for Seismology), and the OSU-based EarthScope program to make it more user-friendly and accessible for all sorts of people, including parents pushing strollers and visitors using wheelchairs. Describing this as "hands-on" research couldn't be more literal: It turns out that smudgy fingerprints on the touch screen revealed some confusion among users about how to access the data.

Another exhibit under investigation is Hatfield's popularity runner-up: the "chaos wheel," a transparent waterwheel that spins continuously, first clockwise, then counter-clockwise, in shifting and unpredictable patterns. Designed to illustrate order hidden in systems that seem random — the ever-shifting shape of Oregon's coastline, for instance, or the uniqueness of individual snowflakes — the exhibit nevertheless fails to convey the intended message to most viewers, Rowe and his students have found. Despite its mesmerizing attractiveness, "people usually come away with the opposite idea it was intended to convey," admits Rowe. "It's a well-loved but poorly understood exhibit."

Making Meaning

All of the findings feed into the larger questions around self-directed learning. Hatfield's resident octopus can be a metaphor for today's educational landscape: many outward-reaching arms offering learning opportunities for free-choice learners of all ages. Hoping to better coordinate this multi-limbed beast, OSU is partnering with several

The Magic Planet, a spherical display for digital data about planetary dynamics, is one of the exhibits being tested and refined by OSU free-choice learning scientists.

organizations — the Association of Science-Technology Centers, the University of Pittsburgh's Center for Learning in Out-of-School Environments (UPCLOSE), and the Visitor Studies Association — to create a new national Center for the Advancement of Informal Science Education (CAISE). Funded by the National Science Foundation, the center will extend the scope and awareness of out-of-school learning. OSU's free-choice-learning researchers want people to know that a science educator isn't just the biology teacher at the high school but also the aquarist who gives "pond classes" for adults raising koi in their backyards. Or that a learning environment isn't only a college engineering lab but also a wave-energy exhibit at the coastal visitor center.

Just ask Jerry and Diane Plante, as they interact with the exhibit that lured them to Hatfield. "Oh, look at this!" Diane exclaims, pushing a button that activates an up-close mechanical demonstration of the wave-energy device they had observed from their oceanfront window.

"The electricity is made between the magnet and the coil," Jerry says as he reads the explanation of the direct-drive mechanism. "It's such a big idea and such a small piece of equipment."

Early in the last century, museums filled display cases with objects — arrowheads, dinosaur bones, stuffed birds, human skulls — and hoped visitors would absorb useful information from viewing them. "Cabinets of curiosity" is one scholar's characterization. But that turned out to be a flawed model. Simply "sticking people in a science-rich environment" doesn't ensure learning, Rowe notes. So, just as weaponry, reptiles, birds and humanoids have evolved over time, so have the museums that display the evidence and tell the stories of those transformations.

"Recently, we've moved to the idea that museums should be a public forum where people come to make meaning," says Rowe. "We're taking visitors seriously as self-directed learners and investigating whether their goals and interests match the museum's goals and offerings — and if not, where do we make the shift?

"Visitors have to be partners in that process." terra

See more about OSU Sea Grant's free-choice learning initiative at *seagrant.oregonstate.edu/freechoice/*

Wired Watershed

Fiberoptics bring new precision to ecosystem sensing

By Lee Sherman

Advanced fiberoptic cable captures finely detailed data, revealing the complexities of forests and watersheds. (Photo: John Selker)

High-tech science got a lift last summer from a curiously low-tech device: a potato launcher.

Puzzling over the best way to string fiberoptic cable through dense, old-growth canopy, OSU scientists devised a "canon" with an air-compression gun and fishing line weighted by a starchy tuber. From a 100-foot research tower in Oregon's H.J. Andrews Experimental Forest, a research assistant spent an afternoon in June launching lengths of Swiss-made cable through towering boughs of Douglas fir and big-leaf maple.

"We needed a projectile with a mass sufficient to place the line, something that would not be hazardous and would not light the forest on fire," explains OSU researcher John Selker. "We tried everything — bows and arrows, slingshots. In the end, we were shooting organic, biodegradable potatoes around the forest."

Transformative Science

Selker, a professor in the Department of Biological and Ecological Engineering, is taking ecosystem sensing to new heights with an advanced generation of high-tech cable. Today's fiberoptics use glass strands so pure that pulses of light zip along the line with little resistance. By detecting the tiny amount of light that scatters back from the source, scientists can measure the temperature of the glass. What that means for monitoring the infinite complexities of ecosystems such as watersheds and ancient forests is an exponential increase in precision, down to hundredths of a degree. Scientists can now take measurements more frequently (every three seconds) at closer increments (every meter) across longer distances (up to five or six miles), capturing spatial structure in three dimensions. The result is an infinitely more nuanced — and thus more accurate — depiction of the natural world.

"With fiberoptics, we're getting about 10,000 times more data than we did with traditional sensors," says Selker, a hydrologist who studies stream dynamics. "We've added a whole bunch of zeroes to the precision of our measurements. This is transformative science. It's changing how we see the world."

Getting finer data about the temperature, relative humidity and evaporation of a stream will vastly improve resource management, Selker predicts. Indeed, warming is one of the greatest dangers threatening watersheds. That's because fish thrive in narrow spectra of water temperature. A few degrees warmer can mean less oxygen, more pathogens and greater stress on aquatic animals. Strategies for stream protection and restoration can be more effective if based on truer readings and better models.

But for its promise to be fully realized, the novel technology needs rigorous field testing. "There are a

Researchers lay cable at Blue Lake Reservoir in Oregon's Cascades for an experiment measuring relative humidity during an OSU-led summer workshop. (Photo: Lina DiGregorio)

whole lot of practical problems to be overcome," Selker says. The sensors need to be carefully calibrated, for example, to correct for things like weld joints in the wires, "jitter" caused by stream flow and albedo (light reflection). "The history of science is littered with great measurement techniques that fizzled because of poorly run experiments," says Selker. "We need to seed the science community with people who know how to do this."

So Selker, along with colleagues at the University of Nevada, the Delft University of Technology in the Netherlands and the U.S. Geological Survey recently led two international workshops to test and troubleshoot fiberoptics and sensing instruments in real-life settings. The National Science Foundation's Consortium of Universities for the Advancement of Hydrologic Science funded the sessions, which were part training, part joint problem-solving — what Selker calls "proof of concept" studies.

Global Enterprise

In June, one of those workshops drew participants from five countries and 12 states to the 15,800-acre Andrews Forest in the western Cascades. The nearly 40 industry-based engineers, university researchers, cable-manufacturer representatives and sensor makers hailed from Germany, Switzerland, the Netherlands, Spain, Quebec, and across the United States — a testament not only to the scientific promise of the new technology but also to its economic potential for cable and instrument manufacturers. In advance of the workshop, giant spools of fiber were flown in from Europe and Taiwan. A setback was narrowly averted when a FedEx driver, running late after losing his way on a logging road, pulled up just in time with his cargo — 360 pounds of high-resolution Swiss cable worth $100,000.

Some of the cable shipped in for the workshops is unique, custom-created just for eco-sensing.

"The cool thing is that we've got industrial participation from every major maker of these instruments — AP Sensing, Sensornet, Sensor-Tran," Selker says. "Then the cable producers — Brugg Cables out of Switzerland, AFL Telecommunications from North Carolina — sent their teams out here to learn how their cables behave in the ecosystem. Our rigorous requirements demand completely new solutions."

Going With the Flow

On Day Two of the five-day workshop, the group breaks up for three experiments: one to measure relative humidity at Blue Lake Reservoir, a second to compare cable types at Andrews experimental watershed 3, and the third to measure stream dynamics and air flow at watershed 1.

As the morning mist dissolves, Selker leads a caravan of trucks and vans to the trailhead at watershed 1.

From there it's a short hike into the rainforest with spools of coiled cable, the researchers' hardhats of industrial yellow and red glaring against the organic greens of mosses and ferns. In the damp, dappled understory, the "stream team" unwinds the high-resolution cable — armored against the razor-sharp incisors of squirrels and muskrats by bright-blue plastic casing — and threads it through steel-eyed stakes driven into carpets of wood sorrel. Inside the blue casing, black and white strands of glass are twisted together to equalize the effect of sunlight absorption (black absorbs light, white reflects it).

Walkie-talkies link teammates wading downstream to those skirting steep ravines, their electronic *bleeip*! *bleeip*! *bleeip*! shattering the silence of this place where Pacific giant salamanders can achieve 12 inches in length and some Douglas firs took root while Michelangelo painted the Sistine Chapel. The cable was installed on bedrock as well as on muddy banks to capture contrasts between groundwater and surface water temperatures. Readings will not only pinpoint groundwater upwellings but also detect how snowpack levels affect stream dynamics from year to year. Ultimately, these powerful tools will help scientists monitor watershed health in the face of global climate change.

Meanwhile, Adam Kennedy, a research assistant in the College of Forestry, leads the "air team" from high in the 100-foot tower. Taking aim with the potato launcher, he shoots lengths of cable this way and that over the treetops into the waiting arms of a professional tree climber posted aloft. The zigzag in the canopy will monitor the ebb and flow of the forest's active airshed.

"We're seeing explosive changes in the field of ecosystem sensing," Selker says. "It's a challenging, opportunity-filled moment." terra

Watch researchers deploy a fiberoptic network at the Andrews Forest, *oregonstate.edu/terra*

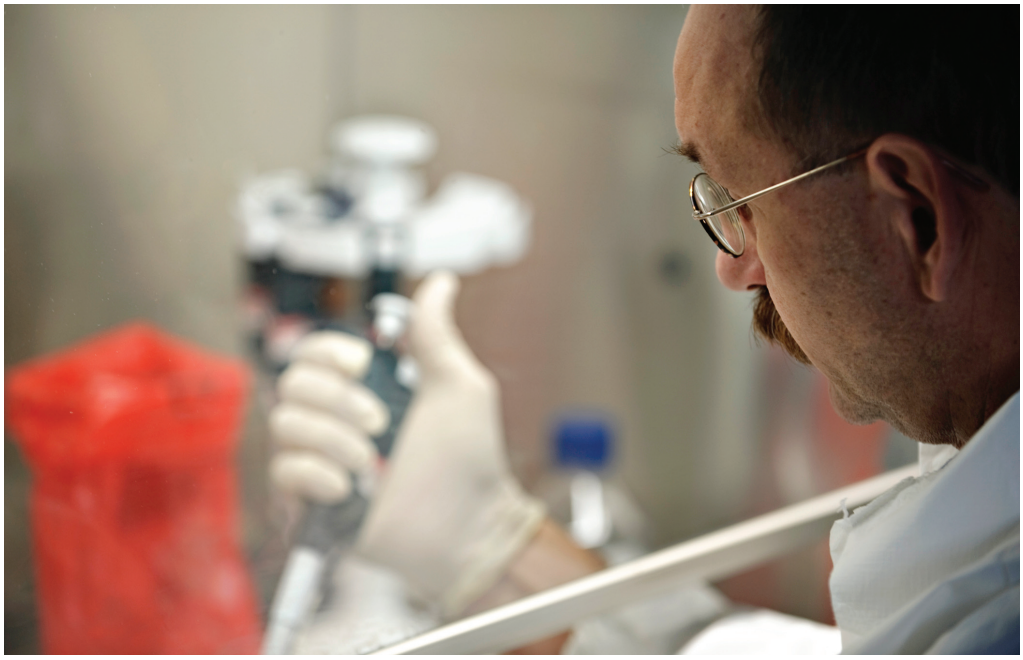
An international group of engineers, scientists and cable experts teams up in the H.J. Andrews Experimental Forest in June, stringing cable along a stream and, with the help of a potato canon from a 100-foot tower, threading it through the old-growth canopy. (Photo: Lina DiGregorio)

John Selker, a professor in the Department of Biological and Ecological Engineering, uses fiberoptics and other sensing and communication technologies to study watershed hydrology. He specializes in tracing contaminant transport, using light-emitting microbes to track groundwater movement and sampling water in the area known as the unsaturated zone (the area between the top of the ground and the water table).

Funding for his research has come from numerous agencies, including the National Science Foundation, U.S. Geological Survey, Consortium of Universities for the Advancement of Hydrologic Sciences, state and federal departments of agriculture, U.S. Environmental Protection Agency and U.S. Department of Energy.

Targeting an Old Foe
Medicine for the new war on tuberculosis

As drug-resistant strains of TB spread around the world, Luiz Bermudez works urgently on new treatments. (Photo: Karl Maasdam)



M. tuberculosis is a tenacious germ.

Armored in a thick, waxy wall impervious to water, the bacterium can lie dormant in the lungs for decades, waiting for a weakness in its human host. When airborne on a cough or a laugh, it can infect a new victim in a simple breath of air. With a flip of a gene, it can dodge healing drugs by mobilizing legions of mutant clones.

Once considered a disease of the past (the last of Oregon's sanitariums were closed in the 1970s), TB is making a comeback. Around the world, more than 8 million people are infected yearly, and 2 million die. Piggybacking on the epidemic of HIV/AIDS, the opportunistic TB pathogen is more dangerous than ever. Some 12,000 strains, each bearing a distinct "genetic fingerprint," have turned up in hospitals, prisons, refugee camps and clinics.

In OSU's biohazard lab, thousands of these strains are undergoing experiments that could give the world its first new TB therapy in four decades. Luiz Bermudez, M.D., is leading an investigation into the anti-TB properties of a drug commonly used to treat malaria. The two-year project is funded by a nearly $1 million grant from the Bill and Melinda Gates Foundation, a major partner in a worldwide race to defeat *M. tuberculosis*.

Some strains have developed fierce resistance to the powerful drugs rifampin and isoniazid, the "backbone of modern anti-TB chemotherapy," explains Bermudez, a professor in the College of Veterinary Medicine. Until recently, scientists believed this potent cocktail had virtually wiped out the killer disease. But new drug-resistant strains have emerged. "Now it is very common for a healthy person to acquire drug-resistant bacteria directly," Bermudez warns. "In terms of public health, that is a nightmare."

The Centers for Disease Control (CDC) has designated some strains as "extensively drug resistant" (XDR) — that is, they survive just about anything doctors throw at them. In the U.S., 17 cases of XDR-TB have been reported.

With drug-resistant TB raging in hotspots such as Russia and Argentina, the Gates Foundation and others (including billionaire philanthropist George Soros, the World Health Organization and the World Bank) have mounted an aggressive 21st-century battle against the resurgent germ.

Of Germs and Genomes

Bermudez studies a family of infectious pathogens called mycobacteria, of which *M. tuberculosis* is one. Hansen's disease, or leprosy, is another. A third is *M. avium*, which attacks humans whose defenses are compromised by conditions such as HIV-AIDS.

Bermudez and his colleagues — pharmacy professor Mark Zabriskie and several post-doctoral assistants — work with the rod-shaped microorganisms inside OSU's Biosafety Level-3 laboratory. (Level 3 is designated by the CDC for airborne pathogens, including anthrax, West Nile virus, typhus and yellow fever.) The Gates-funded study focuses on Mefloquine, a drug that has proven extremely lethal to *M. avium*, both in test tubes and in animals. But there's a downside: Mefloquine causes neurological side-effects — from depression to paranoia — in 15 percent of patients.

In a recent breakthrough, Bermudez was able to isolate the most active compound in Mefloquine. It turned out to have a dual benefit. "The compound that is most effective against mycobacteria is the least toxic of the compounds," Bermudez says.

The agent has also proven effective against *M. tuberculosis* in test tubes. The researcher's goal now is to pinpoint the "essential target" on the DNA of resistant TB mutants. That is, he's looking for the key metabolic gene the germ needs to survive. Once he finds it, scientists can develop new drugs that attack TB in new ways. "Most antibiotics shut down bacteria by inhibiting protein synthesis," Bermudez says. "For Mefloquine, we don't yet know what the mechanism is. But it appears to do more than just inhibit the mycobacteria — it kills it."

In a world where everyone is only a plane ride from everyone else and *M. tuberculosis* can be transmitted in a cough, a sneeze, even a hymn sung with gusto in church, the stakes couldn't be higher.

— By Lee Sherman

Lubchenco Nomination Underscores OSU's National Leadership

The nomination of Oregon State University marine ecologist Jane Lubchenco to head the National Oceanic and Atmospheric Administration reflects OSU's growing leadership in federal environmental science programs. If confirmed, Lubchenco will be the second OSU scientist to head NOAA. Former OSU president John Byrne served as NOAA Administrator from 1981 to 1984. The agency's $4 billion budget supports research and monitoring of fisheries, weather and marine and coastal resources.

Also serving in national agency leadership roles are five professors in OSU's College of Oceanic and Atmospheric Sciences (COAS):

- Michael Freilich, director of the Earth Sciences Division at NASA
- Timothy J. Cowles, program director for the Ocean Observatories Initiative, the National Science Foundation's signature research project on climate change
- Kelly Falkner, director of NSF's Antarctic Ocean and Climate Sciences program
- Jim McManus, associate program director of the chemical oceanography program at the National Science Foundation
- Mark Abbott, COAS dean and member of the National Science Board (and co-chair of Oregon's Global Warming Commission)

OSU scientists also chair federal government committees that guide programs in such areas as marine reserves, social science research, public health, biomedicine and forest resources.

The Oregon coast is both laboratory and teaching arena for Jane Lubchenco, right. (Photo: Kelly James)

Chemistry Goes Green in New OSU-UO Center

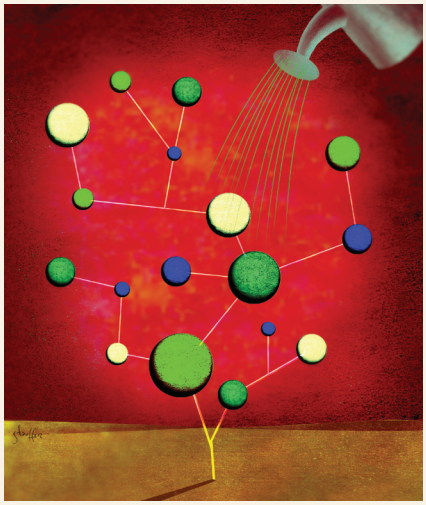
Creating more efficient, environmentally friendly electronics manufacturing practices is the goal of a new Green Materials Chemistry Center at Oregon State University and the University of Oregon. Supported by a $1.5 million grant from the National Science Foundation, scientists will expand their work on effective technologies that reduce greenhouse gas emissions and the use of toxic chemicals.

"The concept is to use new, fundamental scientific advances to drive more efficient production and fabrication methods, use green materials and reduce environmental impacts," says Douglas Keszler, center director and distinguished professor of chemistry at OSU. "The focus will be on electronics and related areas. This is cutting-edge science and technology, and it was born and bred here in Oregon."

State investment in ONAMI, the Oregon Nanoscience and Microtechnologies Institute, has helped to pave the way for the new center which, if successful, could be in line for up to $25 million in federal funding over the next five years.

Dave Johnson, center co-director and Rosaria P. Haugland Foundation Chair in Pure and Applied Chemistry at the University of Oregon, says that state support for ONAMI was key. "ONAMI investments in facilities, increased ties to Oregon and regional industry, an ONAMI spin-out company and the intercampus collaborations were all key elements in putting together this winning proposal."

"Among projects sponsored by the Oregon Nanoscience and Microtechnologies Institute, I believe this new center holds great potential for future growth in both the research enterprise and commercial entities," says Skip Rung, ONAMI president and executive director.



(Illustration: Brian Stauffer)

"Expedition" in Computational Sustainability

Scratch below the surface of a natural resources question and you'll often find a tough nut to crack. The complex interactions among species and their habitats have bedeviled scientists from before Charles Darwin's day to the present, preventing them in many cases from generating information that managers need to develop effective policies.

Now a group of researchers at Oregon State, Cornell and Howard universities; Bowdoin College; and the Conservation Fund, are undertaking a five-year quest to find creative ways of applying computer science to ecological science, bio-fuels and natural resource management. Their work is supported by a $10 million grant from the National Science Foundation.

The project is led by Tom Dietterich at Oregon State with OSU colleagues Clair Montgomery in forestry and Weng-Keen Wong in engineering and with Carla Gomes at Cornell.

"Many scientific fields have come to rely on rapid, large-scale computation to make major advances," says Dietterich, "but the field of computer science has more to offer than just raw computer power. Clever algorithms (recipes for carrying out steps in the computer) have led to major advances in molecular biology and the genomics revolution as well as to advances in computational chemistry and astronomy. We hope to have a similar impact in ecology and natural resource management."

Among the topics that scientists and engineers will pursue are fishery economics, wildlife reserves, species distribution and fuel reductions in forests.

Living Downwind

Pacific Ocean breezes carry more than the smell of the sea. They transport pollutants from Asia to the United States. By collecting and testing the toxicity of particles in Northwest air samples, OSU Ph.D. student Julie Layshock is shedding light on the relative health threat posed by long-distance air pollution.

In support of her work, the Ohio native received a three-year STAR (Science to Achieve Results) Fellowship from the U.S. Environmental Protection Agency.

In OSU Associate Professor Kim Anderson's toxicology lab, Layshock analyzes the chemical composition of particles from coal and oil combustion products known as polyaromatic hydrocarbons or PAHs. Some types of PAHs are known to interact with DNA and thus pose a health threat. In her toxicity analyses, she is comparing particles transported from Asia with those produced locally.

Layshock plans to complete her study in 2010. She hopes to work for a government agency developing new pollution control techniques or reducing human exposure to pollutants.

Discover More OSU Research at Oregonstate.edu/terra.

John Day River Lineman
How do you wire a river? OSU hydrologist John Selker and his research team use a spool of fiberoptic cable and hiking boots that they don't mind getting wet. See photos and listen to Selker describe this collaborative venture between OSU, the U.S. Forest Service, the Confederated Tribes of the Warm Springs Reservation, Oregon Trout and the Nature Conservancy.

John Selker investigates how past mining activities have altered the Middle Fork of the John Day River. (Photo: Lynn Ketchum)

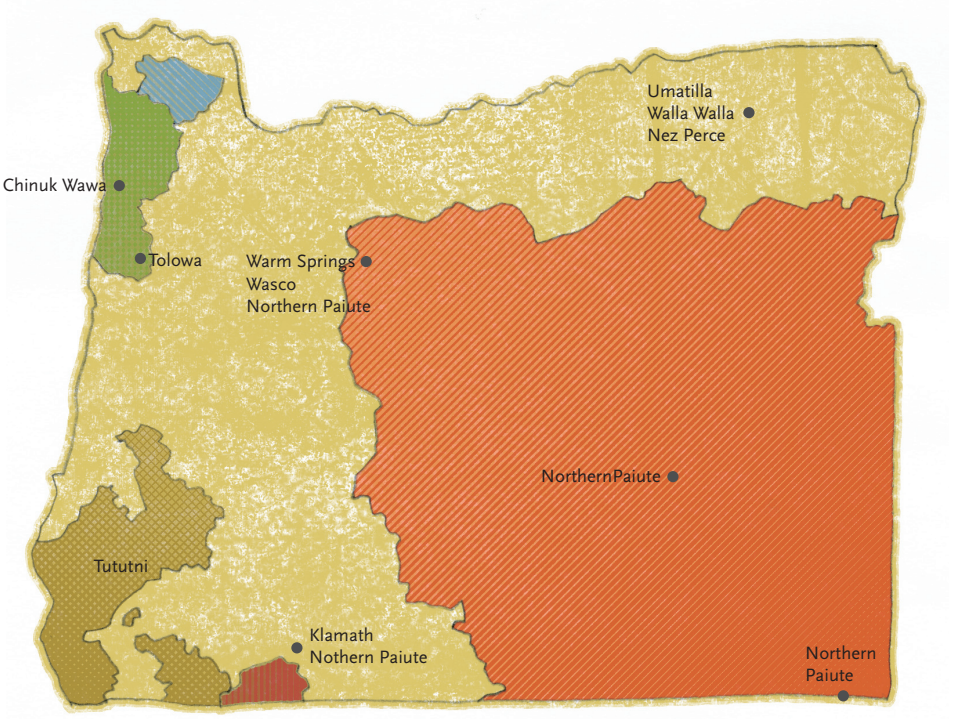
Better Bones and Balance in Action
See where it all started. Former OSU researcher Christine Snow's class demonstrated the techniques that maintain health and confidence for aging adults.

Oregon's Linguistic Landscape

In the year of statehood, Oregonians spoke many languages

Editor's note
Euro-American traders and settlers brought Russian, French, Spanish and English to the region we call Oregon, but native people spoke at least 18, possibly more than 25 distinct languages. By 1859, English was becoming dominant, foreshadowing the almost complete loss of native languages and the development of Chinook Jargon (or "Chinuk Wawa") as a common creole language. Ten of these languages are being revitalized today.

Below, in excerpts from Teaching Oregon Native Languages, *OSU anthropologist Joan Gross offers a glimpse of this linguistic heritage. She and co-authors advocate for support of native language instruction "to promote the value of multilingualism in our society and the deep respect for cultural diversity that it brings."*



What became the state of Oregon, an area stretching south from the Columbia Gorge to the Siskiyous, and east from the Pacific over the Coastal Range and Cascades to the High Desert, was a land of many languages, each one encoding information about the land and how to survive on it. The various languages of Oregon belong to language families as different from each other as English is from Arabic: Athabaskan, Salishan, Shastan, Uto-Aztecan, and a number of families that have been roughly grouped into the Penutian phylum (Chinookan, Kalapuyan-Takelman, Sahaptian, Lutuamian, Molallan, Cayusan, Yakonan, Siuslawan, Coosan). Each of these families consisted of several languages, and each language of several spoken dialects. Even within what might be called the same dialect, each village probably had its own subdialect, differing from neighboring villages in the way certain sounds were pronounced and a few vocabulary words . . . .

In addition to the high value placed on learning multiple Native languages, there was still a need for a means of communication in short-term encounters between speakers of different languages. This need was filled by the creation of a trade language that came to be known as Chinook Jargon. By the time Lewis and Clark made their voyage down the Columbia, there is some evidence of a mixed language being spoken, but it most certainly stabilized into a pidgin language during the fur-trading period.

Both natives and Euro-Americans in the Northwest saw the advantage of this easily learned language. Pidgins have a simplified grammatical structure and are much easier to learn than historically rooted languages that have developed all sorts of unsystematic complexities over the years. Languages that bridge communication gaps between speakers of different languages are know as lingua francas. Chinook Jargon quickly became the lingua franca of the Northwest.

The first European nuns who arrived in the Willamette Valley in 1844 to teach the children growing up in this multicultural area used Chinook Jargon with their students. Several Chinook Jargon words drifted into Northwest frontier English. Words like "tyee" (chief), "skookum" (strong), "tillicum" (friend), "wawa" (talk), and "alki" (soon) were used to metaphorically claim identity with the region. An Oregon congressman in the 1880s talked about how General Sheridan and the translator, Nesmith, conversed in Chinook Jargon back in Washington, D.C. (Once, one of their telegrams was intercepted by the Secretary of War who, seeing the incomprehensible words, suspected a plot was afoot.)

Teaching Oregon Native Languages, by Joan Gross, Erin Haynes, David Lewis, Deanna Kingston and Juan Trujillo, published by Oregon State University Press in 2007, can be ordered online at oregonstate.edu/dept/press/s-t/TeachingORNative.html

On Course

Rob Golembiewski isn't letting the grass grow under his feet

A day after his high school graduation, Rob Golembiewski landed a summer job experimenting with turf grass at Michigan State University. The self-confessed perfectionist says he still loves to work in his yard. (Photo: Lynn Ketchum)

Rob Golembiewski wears a size-13 shoe, but that's nothing compared with the shoes he has to fill. The former head of the golf and turf management program at the University of Minnesota's Crookston campus has replaced Tom Cook as the director of Oregon State University's turf management program.

Thirty-one years ago, the hardworking and revered Cook, who retired this fall, single-handedly created the program, which has produced superintendents at prominent golf courses, including Pebble Beach and Bandon Dunes.

"It's phenomenal what Tom did as a one-man show. I have an appreciation for what he built. I'll be very protective of it, and I look forward to taking it to the next level," says Golembiewski, who launched the golf and turf program at Montana State University and co-owned a landscaping company for six years in Arizona.

He has wasted no time getting down to work. He clocks at least 12 hours a day teaching, picking the brains of industry professionals over lunch and speaking at conferences. On weekends, he's at his office, which he painted himself — a luminous Beaver orange. ("It was a little brighter than I expected," he confesses.)

Right now, he's deciding what research projects to take on.

"I've been visiting with turf breeders, golf course superintendents and landscapers trying to get feedback about what the Pacific Northwest industry sees as key issues," he adds. "I want to do research that impacts the Northwest and the nation."

He plans to continue the program's research on perennial ryegrass, the fertility of annual bluegrass and the performance of certain grass mixtures in shaded conditions. The research is conducted on five acres of experimental plots and putting greens at OSU's Lewis-Brown Farm. Golembiewski intends to expand the putting green area there by up to 10,000 square feet.

He's also looking to enhance what takes place inside the classroom. In December, he met with a committee of industry representatives to hear its thoughts on how graduates of the program have performed at the representatives' companies and how the curriculum stacks up to others.

Unlike Cook, though, Golembiewski doesn't have to scramble to gather grants and donations to fund his employment during the summer. Earlier this year, the family of the late OSU alumnus Nat Giustina announced that it had donated $1 million to endow a professorship for Cook's replacement.

Golembiewski's endowment is a far cry from his first paid job in the business. That was back when he was a teenager taking care of a neighbor's immaculate yard.

"They loved me because I was meticulous," says Golembiewski, 39, the second youngest of 11 children. When it comes to his own yard, the Michigan native describes himself as a perfectionist. "I mow straight lines and pick up every leaf," he says. "I love to work in the yard."

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Abundant salmon runs may yet return to Northwest rivers. See "Once and Future King," Page 2. (Photo: Lynn Ketchum)

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