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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But the Alsea study, which documented the consequences of those operations, has become outdated by the modern practices — riparian buffers, better road-building techniques, debris treatment — that it helped to set in motion.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

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.

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 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*

Researcher Profile

Arne Skaugset, associate professor in the OSU Department of Forest Engineering, directs the Watersheds Research Cooperative and is the principal investigator on water quality and hydrology on the Hinkle Creek Paired Watershed Study. In addition, he leads research efforts in the hydrology of forest roads and watersheds, alternative design and environmental performance of aggregate surfaced forest roads and slope stability. His research interests emphasize pragmatic, applied solutions to environmental problems that result from the intensive management of forests. He collaborates with researchers in the Forest and Rangeland Ecosystem Science Center of the U.S. Geological Survey and the Forest Science Laboratory of the U.S Forest Service. He has received research funding from U.S Forest Service, Bureau of Land Management, Oregon Forest Industries Council and Forest Research Laboratory.

Hinkle Creek investigators include:
OSU — Judith Li and Bill Gerth, Department of Fisheries and Wildlife; Lisa Ganio, Kermit Cromack, and Douglas Bateman, Department of Forest
Science; Amy Simmons, Department of Forest Engineering
U.S. Geological Survey — Robert E. Gresswell; Michael Adams in the Forest and Range Ecosystem Science Center.

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