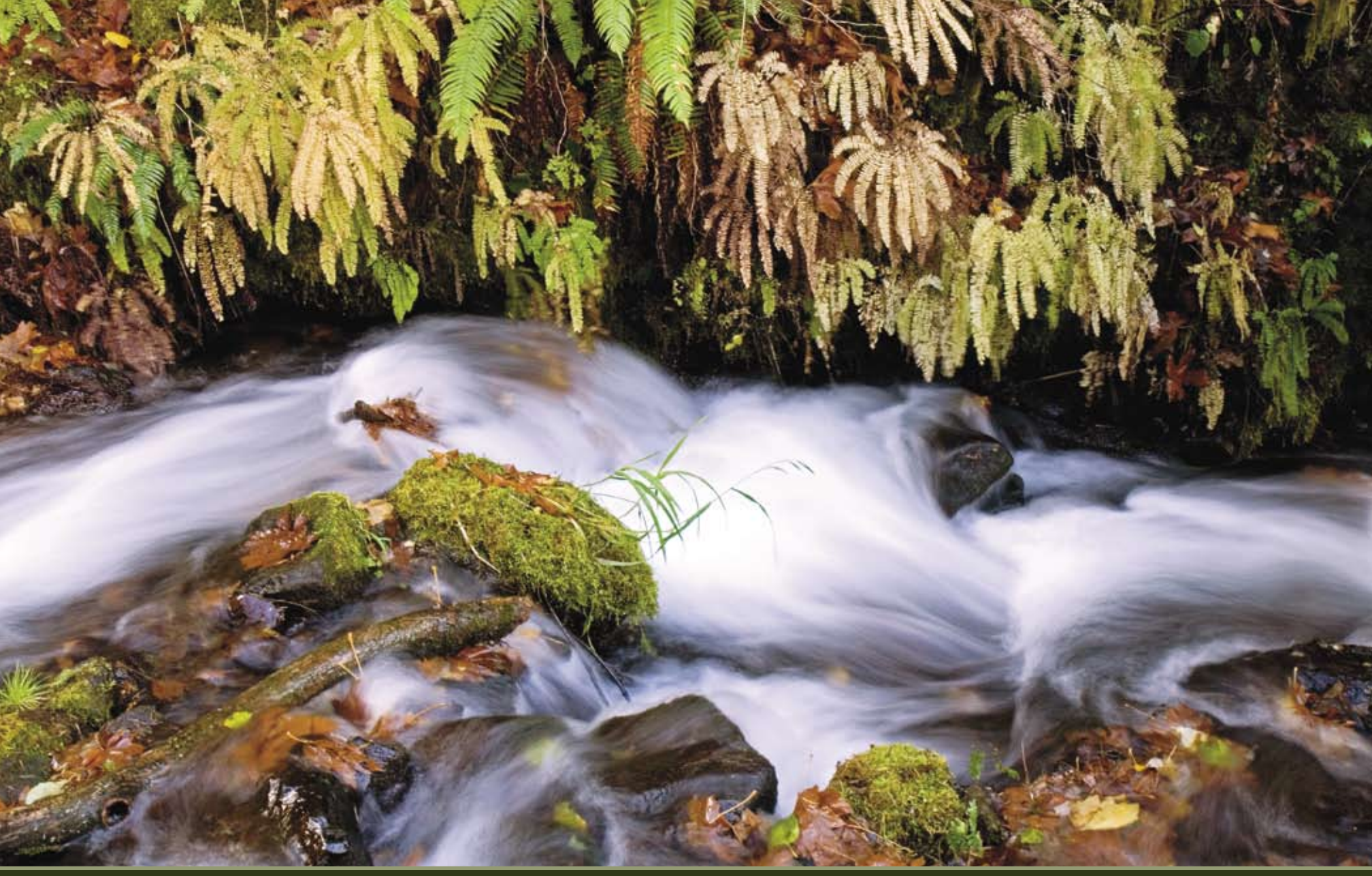

2008 Science Accomplishments of the Pacific Northwest Research Station

VISION AND MISSION

We are highly sought for our scientific leadership and impartial knowledge.
Our mission is to generate and communicate scientific knowledge that helps people understand and make informed choices about people, natural resources, and the environment.

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Columbia Gorge; © Miles Hemstrom

THE SETTING

Broken Top Mountain, Oregon; © Miles Hemstrom

Pacific Northwest Research Station: The Setting

Experimental Areas

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3. Young's Bay Experimental Forest
4. Maybeso Experimental Forest
5. Entiat Experimental Forest
6. Wind River Experimental Forest
7. Cascade Head Experimental Forest
8. Starkey Experimental Forest and Range
9. H.J. Andrews Experimental Forest
10. Pringle Falls Experimental Forest
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Laboratories and Centers

Alaska Wood Utilization and Development Center (Sitka)
Anchorage Forestry Sciences Laboratory
Boreal Ecology Cooperative Research Unit (Fairbanks)
Corvallis Forestry Sciences Laboratory
Juneau Forestry Sciences Laboratory
La Grande Forestry and Range Sciences Laboratory
Olympia Forestry Sciences Laboratory
Pacific Wildland Fire Sciences Laboratory (Seattle)
Portland Forestry Sciences Laboratory
Wenatchee Forestry Sciences Laboratory
Western Wildland Environmental Threat Assessment Center (Prineville)

- 11 laboratories and centers in Alaska, Oregon, and Washington
- 11 active experimental areas (watershed, range, and experimental forests)
- Research also conducted in more than 20 research natural areas (RNAs)
- Headquarters in Portland, Oregon
- Pacific Northwest Research Station is one of five research stations in the U.S. Department of Agriculture, Forest Service
- 421 employees (285 permanent, 136 temporary)

A MESSAGE FROM THE STATION DIRECTOR

Deschutes River, Oregon;
© Miles Hemstrom

The Pacific Northwest (PNW) Research Station delivers high-quality science useful for addressing pressing land management issues. Our success is based on the hard work of many: our scientists, technicians, administrative support staff, and partners. Many retirees continue to volunteer their time and expertise to the station, and their dedication contributes to our success. We now have 17 emeritus scientists, and in the past 2 years I've been proud to appoint our first two women to the program.

Over the years, the station's research has delved deeply into many topics. Before climate change and carbon storage became part of the everyday vocabulary, we had scientists investigating these and other related topics. Now we are in the position to provide science-based tools to help land managers strategize for a changing climate. This year we worked with the National Forest System to disseminate this information to forest managers by hosting several climate-change short courses. We also launched the Climate Change Resource Center Web site as a clearing house for climate-related research by Forest Service scientists in the Western United States. I am very pleased that we were able to help the Olympic and Wenatchee National Forests incorporate climate mitigation strategies into their forest plans.

Water is another topic of increasing public interest that many of our scientists have been studying for years through the lens of their respective disciplines. We continue to deliver science and tools to facilitate management of this valuable resource and its associated aquatic life and riparian systems. Washington's Entiat Watershed Planning Unit, for example, is developing future water storage options and allocation plans based on one of our studies. Also of note, when developing and evaluating options for their new management plan in Oregon, the Bureau of Land Management used a PNW landslide model that enables land managers to identify and prioritize landslide sites with a high probability of affecting a fish-bearing stream either positively or negatively.

Tim LeBarge

Station Director Bov B. Eav

The station also explores areas of new research. For example, we work with partners in the Northwest to establish an urban forest long-term research center in Seattle. Meanwhile in Portland, a study was done to determine the economic benefits provided by the city's street trees. I anticipate that urban forest research will complement our long-standing research areas. Climate change and river health are just a few management issues that don't stop at the city limits or forest edge.

This report notes the variety of ways we share information with others. This year our scientists published 360 publications—of which 176 were journal articles and 42 were books or book chapters. We continue to extend our presence on the Web, in many cases with content unique to that medium, such as online tutorials or multimedia presentations. Communicating directly with our clients remains a valued tradition, and last year about 6,000 people attended symposia, workshops, field tours, and conservation education events sponsored by the station.

The coming year promises to be one marked by change. I am optimistic about our ability to seize new opportunities while remaining a pillar of scientific integrity.

Bov B. Eav
Station Director

Mount Hood, Oregon; © Miles Hemstrom

GOAL 1: Develop a fundamental understanding of ecological, social, and economic systems and their interactions

Key Findings

- Temperature increases projected over the next three decades are likely to cause water volume in seasonal snowpacks to decline to one-third of current levels and melt several weeks earlier in the interior Columbia basin.
- Dissolved organic carbon fluxes from coastal temperate rain forest watersheds in southeast Alaska are the highest reported rates in the world.
- Evapotranspiration in riparian forests plays a key role in regulating daily fluctuations in streamflow in small watersheds during late summer.
- Response to removal of Marmot Dam on the Sandy River in Oregon indicates that, under the right circumstances, dam removal can be an effective strategy for restoring ecosystems.
- Changes in stream temperature are accompanied by species-specific changes in macroinvertebrate size and life history.
- The Biscuit Fire burned more topsoil than expected; loss of carbon and nitrogen in the soil decreased site productivity.
- Lichens indicate patterns of biodiversity, air quality, and climate.
- Height-related trends in leaf hydraulic efficiency may limit growth of tall Douglas-fir trees.
- An Alaska study finds timing of warmer temperatures determines whether rate of tree growth increases or decreases.
- Compounds in the heartwood of certain western conifers exhibit strong antimicrobial activity toward *Phytophthora ramorum*, the pathogen that causes sudden oak death.
- Scientists develop cost-effective methods for genome sequencing to reveal adaptive variation and aid in conservation genetics applications.
- A whole-landscape management strategy may best promote recovery of habitat for the threatened northern spotted owl in dry forests.
- Interactions among environmental threats, such as climate change and invasive species, are key drivers that threaten western wildlands.

Follow the for more information about these key findings.

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Less water volume and earlier melts projected for snowpack

Much of the interior Columbia River basin depends on snowpack for its supply of clean water. In this semiarid environment, competition for water can be particularly intense during the late summer and early fall. Scientists modeled snow accumulation and melt to forecast the effects of increasing temperatures on availability of water from the snowpack.

Outcome: *Watershed planners are using projections about water supply to plan ahead for anticipated shortages.*

Results indicate that within the next 30 years, the volume of water contained in snowpack will shrink to one-third of its current level, and the dry season will likely lengthen by several weeks.

During the extended dry season, water temperatures can be expected to increase as streamflows decrease below current levels. These effects are likely to have profound implications for land management agencies, communities, and aquatic species such as threatened salmon. Washington's Entiat Watershed Planning Unit is using these findings to develop future water storage options and allocation plans.

Contact: Richard D. Woodsmith, rwoodsmith@fs.fed.us, Aquatic and Land Interactions Program

Partners: Oregon State University, USDA Forest Service Okanogan-Wenatchee National Forest

Rick Edwards

A field crew gathers water samples to determine the amount of dissolved carbon cycling through a watershed in southeast Alaska.

Scientists quantify carbon fluxes in southeast Alaska

Coastal temperate rain forests sequester large amounts of carbon because cool, wet conditions inhibit decomposition. They are also sources of carbon. The Tongass National Forest exports as much dissolved organic carbon per year in water as would be removed through harvesting 1.6 million board feet of timber—enough to frame 100,000 homes. Much of this carbon is transferred to aquatic systems where it likely plays a key role supporting production of species such as salmon, shrimp, crab, and others. What isn't incorporated into aquatic food webs enters long-term storage within the marine system.

As the climate warms, the rate at which carbon is released from the soils of coastal temperate rain forests could increase. Station scientists continue to measure rates and controls of major fluxes to better understand the carbon cycle and the interplay between terrestrial and aquatic systems. This information will be used to develop forest carbon management strategies and be applied to regional and national carbon sequestration goals.

Contact: Rick Edwards, rtedwards@fs.fed.us, Aquatic and Land Interactions Program; David D'Amore, ddamore@fs.fed.us, Resource Management and Productivity Program

Partners: University of Alaska Southeast, U.S. Cooperative State Research, Education, and Extension Service

Glacier-fed watersheds differ from those without glaciers and have climate change implications

Watersheds in southeast Alaska will be significantly altered as the climate warms. Currently, 86 percent of the water discharged from the Tongass National Forest comes from large continental watersheds containing glaciers and permanent snowfields. The seasonality of discharge, chemistry, and temperature of glacial rivers is very different from nonglacial rivers in the Tongass. As warming continues, the loss of glacial inputs and changes in the timing of runoff related to changes in snowpack and snow-to-rain ratios will dramatically affect stream habitats and the annual pattern of carbon and nutrient inputs to the marine system.

Watersheds that do not contain glaciers exhibit two peaks annually, a spring snowmelt peak and a fall peak. As the snow line rises, discharge will begin to track precipitation, as is observed in the lowest watersheds, and the spring melt peak will disappear. These changes in annual hydrology will interact with nutrient cycles to change the shape and productivity of river habitats.

Rick Edwards

Warmer temperatures will lead to changes in watersheds currently fed by glaciers.

This research is leading to better modeling of present and changing hydrology of Alaska's streams. Improved models of future runoff will help managers design stream restoration and fish enhancement projects and be used to model potential fish distribution under various climate scenarios.

Contact: Rick Edwards, rtedwards@fs.fed.us, Aquatic and Land Interactions Program; Dave D'Amore, ddamore@fs.fed.us, Resource Management and Productivity Program

Partners: University of Alaska Southeast, U.S. Cooperative State Research, Education, and Extension Service

Moose shape the flood plains of interior Alaska

What moose choose to eat plays a major role in the large-scale, landscape pattern of flood-plain plant communities and within-stand dynamics and element cycling in interior Alaska. Moose herbivory greatly decreased the aboveground biomass and age structure of willow and increased the biomass and density of later successional species, such as alder and balsam poplar. Moose herbivory also greatly increased the rates of carbon and nitrogen input to the soil and the subsequent cycling of those nutrients. At the landscape scale, however, the interactive effects among herbivory, erosion, and deposition of flood-plain soils can change large-scale landscape patterns in major ways that cannot be predicted on the basis of a single factor.

Outcome: *U.S. Fish and Wildlife Service uses findings to test predicted patterns of moose use of the landscape.*

These findings are being used to predict early succession flood-plain dynamics on other river systems of interior Alaska. The U.S. Fish and Wildlife Service, Yukon Flats National Wildlife Refuge, is currently testing the predicted patterns along the Yukon River with an interest in both plant community structure and potential implications for moose habitat quality and long-term moose-habitat interactions.

Thomas Hanley

A researcher examines the effects of moose herbivory in interior Alaska.

Contact: Thomas A. Hanley, thanley@fs.fed.us, Ecosystem Processes Program

Partners: Bonanza Creek Long-Term Ecological Research Program; University of Alaska Fairbanks; U.S. Fish and Wildlife Service, Yukon Flats National Wildlife Refuge

Riparian forests regulate stream flow through evapotranspiration

Scientists found that riparian forests are the primary location of lost streamflow from evapotranspiration in late summer in small watersheds. A study in the H.J. Andrews Experimental Forest explains how daily fluctuations in discharge were generated and why. Observations of daily fluctuations showed that the time lag between maximum evapotranspiration demand and minimum discharge increased, and the amplitude in daily fluctuations decreased as streamflow decreased.

Recently there has been renewed interest in using land management to "harvest" water, especially to augment streamflow during seasonal droughts. This research indicates that vegetation management on upland portions of watersheds may increase total annual water yield, but efforts specifically designed to enhance low-flow discharge in summer would have to concentrate vegetation management efforts in riparian areas.

Also, water quality in many streams is often limited during the summer when low flows combined with high air temperatures raise water temperature, lower dissolved oxygen, and increase concentration of pollutants. This research highlights naturally occurring signals that could be used to improve understanding of watershed processes and help inform management designed to protect or improve water quality.

Contact: Steve Wondzell, swondzell@fs.fed.us, Aquatic and Land Interactions Program

Partners: Montana State University, Pennsylvania State University, U.S. Geological Survey

© Miles Hemstrom

Bridal Veil Falls, Columbia Gorge, Oregon.

Sandy River responds well to Marmot Dam removal

Removing dams that are outdated, unsafe, or pose significant economic or environmental costs has emerged in the last 10 years as a major river restoration strategy. The removal of the 45-foot-high Marmot Dam on Oregon's Sandy River in 2007 was the largest sediment release accompanying any dam removal to date and provided an unprecedented scientific opportunity to predict, monitor, and evaluate how a large energetic river "digests" a mammoth meal of sediment.

Scientists found that an energetic river can efficiently incise and remove very large volumes of unconsolidated stored sediment, even under very modest flows. Most of the channel changes occurred upstream of a bedrock gorge, with only limited changes downstream. The Marmot dam removal clearly demonstrates that under the right set of circumstances, dam removal can be an effective strategy for restoring ecosystem function and connectivity to large rivers, and improving conditions for threatened and endangered species.

Salmon River, Oregon; © Miles Hemstrom ▶

Under the right circumstances,
dam removal can help restore ecosystems.

Gordon Grant

The Marmot Dam on the Sandy River in Oregon was breached on October 19, 2007, to improve habitat for salmon and steelhead.

The results from this project will guide future dam removals for the next decade. It is also a superb example of meshing an engineering challenge with a scientific opportunity to deliver understanding for future use, all within the framework of a dynamic and open public process.

Contact: Gordon Grant, ggrant@fs.fed.us, Ecosystem Processes Program

Partners: Graham Mathews and Associates, Johns Hopkins University, National Center for Earth-Surface Dynamics, National Science Foundation, Oregon State University, Portland General Electric, Stillwater Sciences, University of Oregon, U.S. Geological Survey

Small streams are important sites for nitrogen uptake and processing

Nitrogen is an essential element for life, and historically the Pacific Northwest has had a limited supply. Humans have increased the supply through fossil-fuel combustion and fertilizers. Some of this excess is taken up by soils, but much enters aquatic ecosystems where it can be transported far downstream, potentially leading to noxious algal blooms and oxygen-starved estuaries.

Station scientists found that river networks, particularly small streams, can remove and retain some of this excess nitrogen, but their effectiveness is partly determined by surrounding land use. Across a range of land-use types (forest, agriculture, urban), the ability of small streams to process nitrate declined as ambient nitrate concentrations increased.

The results from these short-term studies are being combined with results from 40-year studies of nutrient export in the H.J. Andrews Experimental Forest. These findings provide guidelines for restoring and maintaining ecosystem functions.

Contact: Sherri Johnson, sherrijohnson@fs.fed.us, Ecosystem Processes Program

Partners: Oregon State University, Lotic Intersite Nutrient Experiment

New technique identifies sources of soil and stream productivity

Scientists have identified a type of dissolved organic material that is easily digested by stream micro-organisms by using a novel modeling technique known

Rick Edwards

A wetland in southeast Alaska.

as parallel factor analysis (PARAFAC). This "labile" organic matter is exported from wetlands and carried downstream. It is generally accepted that soils provide important ecosystem services in the maintenance of terrestrial and aquatic biological systems, but it is difficult to identify the source of this easily degraded material that sustains primary production in soils and streams. The PARAFAC analysis can be used to determine if the type of organic material in watersheds is usable by stream microorganisms, an indicator of proper ecosystem function. Until now, it has been difficult to evaluate management impacts on terrestrial and aquatic systems at this fundamental level. The development of this technique is an important advance, enabling scientists to evaluate soil quality and wetland functions in the coastal temperate rain forest of southeast Alaska.

Contact: David D'Amore, ddamore@fs.fed.us, Resource Management and Productivity Program

Partners: University of Alaska-Fairbanks, University of Alaska-Southeast

Changes in stream temperatures are species-specific

Stream temperature is a major influence on aquatic insect emergence, affecting maturation rates, body size, and fecundity. In laboratory experiments, scientists examined the effects of three thermal regimes on emergence timing and adult body size of three species of common stream macroinvertebrates.

© Miles Hemstrom

For one species in the warmest treatment, scientists observed a shift in timing of emergence of males by 23 days before the females from the same treatment and before individuals of either sex from the other temperatures. A second species showed no change in timing of emergence or size of adults when temperature was elevated, and a third species showed smaller size of adults at higher temperatures.

These findings suggest that subtle changes in thermal regimes, such as those associated with land management or climate change, may have effects on aquatic insect maturation and adult body size that are species-specific. These effects could have repercussions throughout the stream food web.

Contact: Sherri Johnson, sherrijohnson@fs.fed.us, Ecosystem Processes Program

Partners: Oregon Department of Fish and Wildlife, Oregon Department of Forestry, Oregon State University, Watershed Research Cooperative, Weyerhaeuser Company

Trout in Spirit Lake have unusual adaptations

As the closest and largest lake adjacent to Mount St. Helens, Spirit Lake underwent extensive changes during the 1980 eruption. It was transformed from a relatively pristine cold-water mountain lake to a larger, shallower lake containing a warm microbial broth in which no air-breathing organisms survived, including fish. The lake gradually returned to conditions that supported flora and fauna more typical of the Cascade Range over the next decade, but the first trout was not captured until 1993. The rainbow trout population has expanded rapidly, and the fish are exhibiting exceptional growth rates and unusual life histories. They grow fast, have unusual spawning characteristics, and die young, in marked contrast to trout in most mountain lakes.

Outcome: *Chilean scientists look to recovery of Spirit Lake for clues about possible recovery of lakes near currently erupting Chaiten Volcano.*

Rainbow trout.

The unusual adaptations of Spirit Lake trout to the volcanic environment have piqued international scientific interest. For example, scientists in Chile are seeking to extend lessons learned at Spirit Lake to lakes near the currently erupting Chaiten Volcano.

Contact: Charlie Crisafulli, ccrisafulli@fs.fed.us, Aquatic and Land Interactions Program

Partners: University of Washington, U.S. Geological Survey, Washington Department of Fish and Wildlife, Wild Fish Conservancy

Historical forest conditions supported a range of fire severities

To EFFECTIVELY use fire as a land management tool, it is helpful to know the typical severity of historical fires in the area. In this study, scientists found that the suite of forest structural conditions and patch sizes supporting native fire regimes of mixed-conifer forests was broader than was formerly recognized.

After analyzing aerial photos from the early 1900s of unharvested forest on about 750,000 acres in eastern Washington, scientists found that mixed-severity fires were most prevalent, regardless of forest type. The structure of mixed-conifer patches in the eastern Washington Cascades, in particular, was formed by a mix of fire severities. In moist mixed conifers, stand-replacement fire effects were more widespread than surface fire effects, whereas in dry mixed conifers, surface fire effects were more widespread by nearly 2 to 1. The relatively low abundance of old, parklike or similar forest patches in comparison with the abundance of young and intermediate-aged patches, and evidence of partial-stand and stand-replacing fires suggested that variable fire severity and nonequilibrium patch dynamics were primarily at work.

This suggests that some of the contemporary effects from wildfires may better meet management objectives than once thought, particularly when the objective is to create patch conditions achieved through low- and mixed-severity fires.

Tom Iraci

Forest structure is one variable that influences fire severity.

Contact: Paul Hessburg, phessburg@fs.fed.us, Managing Disturbance Regimes Program

Partners: USDA Forest Service Intermountain, Northern, and Pacific Northwest Regions; USDI Bureau of Land Management

Central Oregon's sandy loam soils tolerant to postfire logging

LOGGING ACTIVITIES can compact the soil, reducing its pore size and decreasing oxygen availability and movement of water and nutrients to tree roots. To alleviate compaction, land managers may fracture the subsoil, a practice known as subsoiling.

In this study, scientists examined the effects of compaction and subsoiling after postfire logging on the soil microbes in a mixed-conifer forest in central Oregon.

These bacteria and fungi are a key component of forest ecosystems. They perform the complex biological and chemical processes that render essential nutrients available for the healthy growth of forests. They are essential to maintaining soil health and long-term productivity.

Scientists found differences among stands with respect to relative bacterial species abundance, but no difference among treatments. The cumulative number of bacterial species and fungal species did not differ significantly among the compacted soil, subsoiled, or fire-only treatments. Over multiple sampling seasons, however, slightly more bacterial and fungal species were found in the compacted soil treatment.

These findings suggest that microbial communities in the sandy loam soils in this study were generally tolerant of postfire harvest disturbance.

Contact: Jane Smith, jsmith01@fs.fed.us, Ecosystem Processes Program

Partners: Oregon State University, USDA Forest Service Deschutes National Forest

Sarah Beldin

Researchers study the effects of postfire logging on soil health on the Deschutes National Forest.

Intense wildfire alters forest soil

For the first time, scientists were able to directly measure the effects of hot wildfire on forest soils. The 2002 Biscuit Fire burned about half of twenty-seven 15-acre study plots east of Gold Beach, Oregon, established before the fire.

The fire burned at temperatures over 1,300 °F, as evidenced by the melted aluminum tags across the research plots—this is more than twice as hot as typical prescribed fires. Loss of topsoil and combustion of organic material were higher than most previous estimates. More than 10 tons per acre of carbon and 450 to 620 pounds per acre of nitrogen were lost, and nearly 60 percent of this came from the mineral topsoil below the organic layer.

The loss of topsoil and soil carbon can negatively affect a range of processes including nutrient retention and water infiltration. To replace the documented amount of lost nitrogen would require nitrogen-fixing plants to dominate the forest for decades.

This study illustrates the dramatic effects of intense wildfire on soil nutrients and resulting site productivity. Understanding how fire can alter the available nutrients and thus change the productivity

of a site is essential when undertaking reforestation efforts and projecting future stand development. Also, a forest that grows slower after an intense wildfire than it did before will have reduced rates of carbon sequestration.

Contact: Bernard Bormann, bbormann@fs.fed.us, Ecosystem Processes Program

Partners: Oregon State University, Western Washington University

Scientists estimate carbon emission from Biscuit Fire

How much stored carbon did the 2002 Biscuit Fire release? To answer this question, scientists estimated the amount of carbon in 24 separate fuel "pools" by using prefire data from areas later burned by the Biscuit Fire in southern Oregon. They then used postfire estimates to check combustion factors for the various pools of carbon and estimated 2.9 to 3.5 terragrams of carbon were emitted during the fire. This is about 16 times the annual net ecosystem production of this landscape before the wildfire.

Few studies have attempted to empirically quantify wildfire-induced carbon exchange between terrestrial vegetation and the atmosphere. This study may lead to further use of pre- and postfire data to determine the carbon outputs to the atmosphere from large wildfires. As more pre- and postfire pairs of plots are measured, a better estimate of the carbon released may be modeled.

Contact: David Azuma, dazuma@fs.fed.us, Forest Inventory and Analysis Program

Partners: Oregon State University

Cecile Shohet

Burning during the 2002 Biscuit Fire was so intense in some areas that topsoil was degraded and lost, likely reducing long-term site productivity.

Lichens indicate patterns of biodiversity, air quality, and climate

Scientists found that lichen communities indicate key patterns in air quality, climate, and biodiversity in forests of Washington, Oregon, and California. Increases in atmospheric nitrogen are causing a shift in lichen species composition in many parts of the Pacific Northwest. Lichen community

Hypogymnia imshaugii, *by Sarah Jovan* ▶

Shifts in lichen communities in many parts of the Pacific Northwest suggest that several species will be highly sensitive to climate change.

Sarah Jovan

Nitrophytes are weed-like lichens that thrive in polluted habitat.

composition in the region is also closely patterned on temperature and moisture conditions in the forest interior. The current arrangement of lichen communities suggests several species will be highly sensitive to climate change. Shifting lichen distributions will provide early warning of shifting climate in a region and help forecast how plant communities will respond.

These baseline assessments help natural resource managers identify forests at high risk of degradation from poor air quality as well as areas of high biodiversity and conservation importance.

Contact: Sarah Jovan, sjovan@fs.fed.us, Forest Inventory and Analysis Program

Partners: Oregon State University

Nitrogen oxide fluxes from coastal Douglas-fir plantations identified

Moist coastal forests of the Pacific Northwest often have more available soil nitrogen than inland forests. High soil nitrogen, when combined with adequate soil moisture and warm temperatures, may create ideal conditions for producing and releasing nitrous oxide (N_2O), a powerful greenhouse gas, and nitric oxide (NO), a precursor to tropospheric ozone, one component of smog. Given their potential impacts on climate, it is important to understand the factors contributing to nitrogen oxide fluxes in these forests.

Station scientists found that nitrogen oxide fluxes were dominated largely by NO, and fluxes of N_2O were relatively low from coastal Douglas-fir plantations. The NO fluxes increased with nitrogen availability and temperature when soils were relatively dry. However N_2O fluxes were relatively insensitive to changes in temperature, soil moisture, and nitrogen availability, suggesting that these forest plantations may not become significant sources of this greenhouse gas, given expected near-term climate changes.

Contact: Heather Erickson, herickson@fs.fed.us, Focused Science Delivery Program

As Douglas-fir get taller, growth is limited by changes in leaf function

Height-related changes in leaf function may affect tree growth and forest productivity because leaf stomata are responsible for maximizing photosynthetic carbon gains while simultaneously limiting transpiration to avoid damaging levels of dehydration. The xylem of Douglas-fir needles undergoes structural changes with

John Laurence

Douglas-fir compromise growth to maintain photosynthetic abilities.

increasing tree height that make the needles less vulnerable to hydraulic failure caused by entry of gas bubbles or emboli. This increased hydraulic safety is associated with a reduction in the hydraulic efficiency of the needles, causing them to act as hydraulic bottlenecks. Although this syndrome is likely to result in the maintenance of photosynthesis under conditions of greater foliar water stress, it is also likely to result in increased stomatal restriction of transpiration and carbon dioxide uptake in taller trees while gas exchange is occurring in

this foliage, thus contributing to height-related reductions in tree growth.

These findings are fundamental to understanding how trees cope physiologically with increases in water stress and timing of tree growth in different sites and environments. Basic physiological information informs models used to project the effects of climate change on tree growth and ability to adapt to stresses of a changing environment.

Contact: David Woodruff, dwoodruff@fs.fed.us, Ecosystem Processes Program

Partner: Oregon State University

Tree growth response to climate warming depends on timing

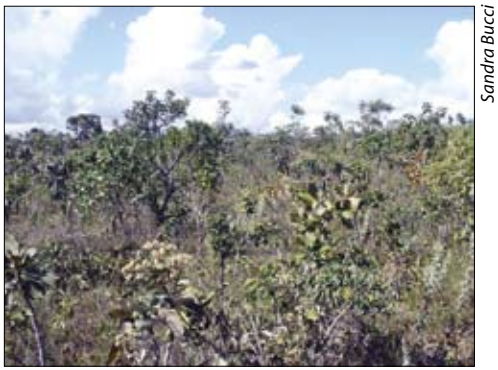
Trees growing at treeline at high latitudes are generally thought to be limited by available warmth, and most studies on treeline report tree growth increases with warmer temperatures. However, population-wide responses of treeline trees to climate remain largely unexamined.

To fill this knowledge gap, researchers systematically sampled 1,558 white spruce trees at 13 treeline sites in the Brooks Range and Alaska Range. Both positive and negative growth responses to climate warming were found. These opposing growth responses were found at all sampled sites, although their relative proportion differed between sites and there was no clear relationship with landscape position.

Without accounting for these opposite responses and temperature thresholds, climate reconstructions based on ring width will miscalibrate past climate, and biogeochemical and dynamic vegetation models will overestimate carbon uptake and treeline advance under future warming scenarios.

Contact: Harold Zald, harold.zald@oregonstate.edu, formerly with the Forest Inventory and Analysis Program

Partners: Oregon State University



Sandra Bucci

Vast areas in central Brazil are covered by this type of tropical savanna known as cerrado.

Dry season has little effect on tree transpiration in tropical savanna

Tropical savannas in Brazil are characterized by large variations in tree density over short distances. As expected, stand-level water loss to the air increased with increasing abundance and coverage of trees. Surprisingly though, tree transpiration showed little seasonality despite a 5-month dry season. Stability of transpiration is attained via reduced leaf stomatal opening that balances the higher evaporative demand during the dry season, and a deep rooting habit that ensures a reliable supply of water year-round.

Scientists are using these findings to better understand the mechanisms that are important in modeling the effects of changing climate.

Contact: Rick Meinzer, fmeinzer@fs.fed.us, Ecosystem Processes Program

Partners: Universidad de Buenos Aires, Argentina; Universidade de Brasilia, Brazil; University of Miami, Florida

Sapwood water storage helps protect trees against catastrophic xylem failure

Water stored in living and dead sapwood tissue can be released into the transpiration stream where it buffers changes that can provoke formation of air emboli and consequent loss of water transport capacity in the tree. Studies conducted on tropical trees in Panama showed that species with higher sapwood water storage capacity experienced smaller daily fluctuations in xylem tension than species with lower sapwood water storage capacity and did not allocate as much of their carbon resources to producing embolism-resistant xylem. These relationships are being explored in Pacific Northwest conifers to better understand how they transport sapwood water along gradients of increasing aridity and summer drought.

Paula Campanello

Researchers use the Smithsonian Tropical Research Institute canopy crane in the Parque Natural Metropolitano near Panama City to measure the photosynthetic capacity of the canopy foliage.

Understanding the fundamental physiology of tree species is critical to predicting growth and vigor under variable conditions. The findings are being used by tree physiologists and groups modeling tree species distribution and performance under different climate scenarios.

Contact: Rick Meinzer, fmeinzer@fs.fed.us. Ecosystem Processes Program

Partners: Universidad de Buenos Aires, Argentina; University of Miami, Florida

Compounds in heartwood may slow spread of sudden oak death

From the public land manager to the homeowner with an oak tree in the front yard, people are looking for ways to limit the spread of *Phytophthora ramorum*, the pathogen that causes sudden oak death.

To address this need, scientists tested the antimicrobial activity in extracts from the heartwood of seven conifers and identified their volatile constituents. They found that extracts from the heartwood of incense-cedar and western redcedar were the strongest inhibitors of pathogen growth.

Outcome: *Scientists identify chemical compounds with potential to increase resistance to sudden oak death.*

A field trial in California showed that heartwood chips from western redcedar placed on the forest floor for 4 months under a host tree with symptoms of sudden

Rick Kelsey

Wood chips from the heartwood of western redcedar appear to slow the spread of pathogen.

oak death significantly limited the accumulation of *P. ramorum* DNA in the litter layer. Heartwood chips or shavings from conifers with strong antimicrobial activity toward this pathogen might be useful in slowing its spread as part of an integrated pest management program.

Also, scientists identified several individual chemicals in the heartwood extracts with potent antimicrobial activity that potentially may be used in products such as foliar sprays to increase resistance against *P. ramorum*.

Contact: Rick Kelsey, rkelsey@fs.fed.us, Managing Disturbance Regimes Program

Partners: Agricultural Research Service, USDA Forest Service Pacific Southwest Research Station, Oregon State University

Scientists develop cost-effective methods for genome sequencing

Vast improvements in DNA sequencing offer unprecedented insight into the connection between genomes and phenotypes—that is, the interactions between an organism's hereditary genetic information and its observable characteristics that may be shaped by its environment. Nevertheless, current sequencing methods emphasize sequencing "depth" (e.g., a genome from one individual) over "breadth" (part of a genome from hundreds of individuals), making them poorly suited to population studies.

To address this need, station geneticists developed cost-effective methods to sequence DNA for population-level studies. Using this "multiplex sequencing-by-synthesis" approach, it is possible to simultaneously sequence 150 chloroplast genomes (plants), 1,100 mitochondrial genomes (animals), or 10,000 genes from an individual in a single sequencing run.

Station geneticists are using these methods to characterize genetic diversity in threatened species, such as the Torrey pine, and to evaluate gene flow in native and managed stands of conifers. They are also using them to examine historical migration in pine species, the role of mutation on adaptation to climate in conifers, host and pathogen interactions, and to categorize taxonomically challenging species based on genetic similarities.

Contact: Richard Cronn, rcronn@fs.fed.us, Resource Management and Productivity Program

Partners: Oregon State University, Santa Clara University, Universidad Nacional Autónoma de México

Dispersed housing development associated with amenity migration affects ecological processes, alters social norms

When large numbers of immigrants move to a community, competing claims may arise over appropriate uses and meanings of the landscapes. Particularly in the Western United States, dispersed housing development, often a result of amenity migration, leads to a physical transformation of the landscape, affecting a variety of ecological and social processes. Forest fragmentation, changes in wildlife migration patterns, alterations in riparian systems, and challenges

Rhonda Mazza

Lee Cerveny

Tourism brings change to coastal Alaska communities.

related to wildland fire management have all been found to increase as immigrants build houses in remote rural areas. Sometimes recreational patterns are altered, which can mean less access to private lands and a variety of management challenges for nearby public lands.

Contact: Linda Kruger, lkruger@fs.fed.us, Human and Natural Resources Interactions Program

Partners: West Virginia University

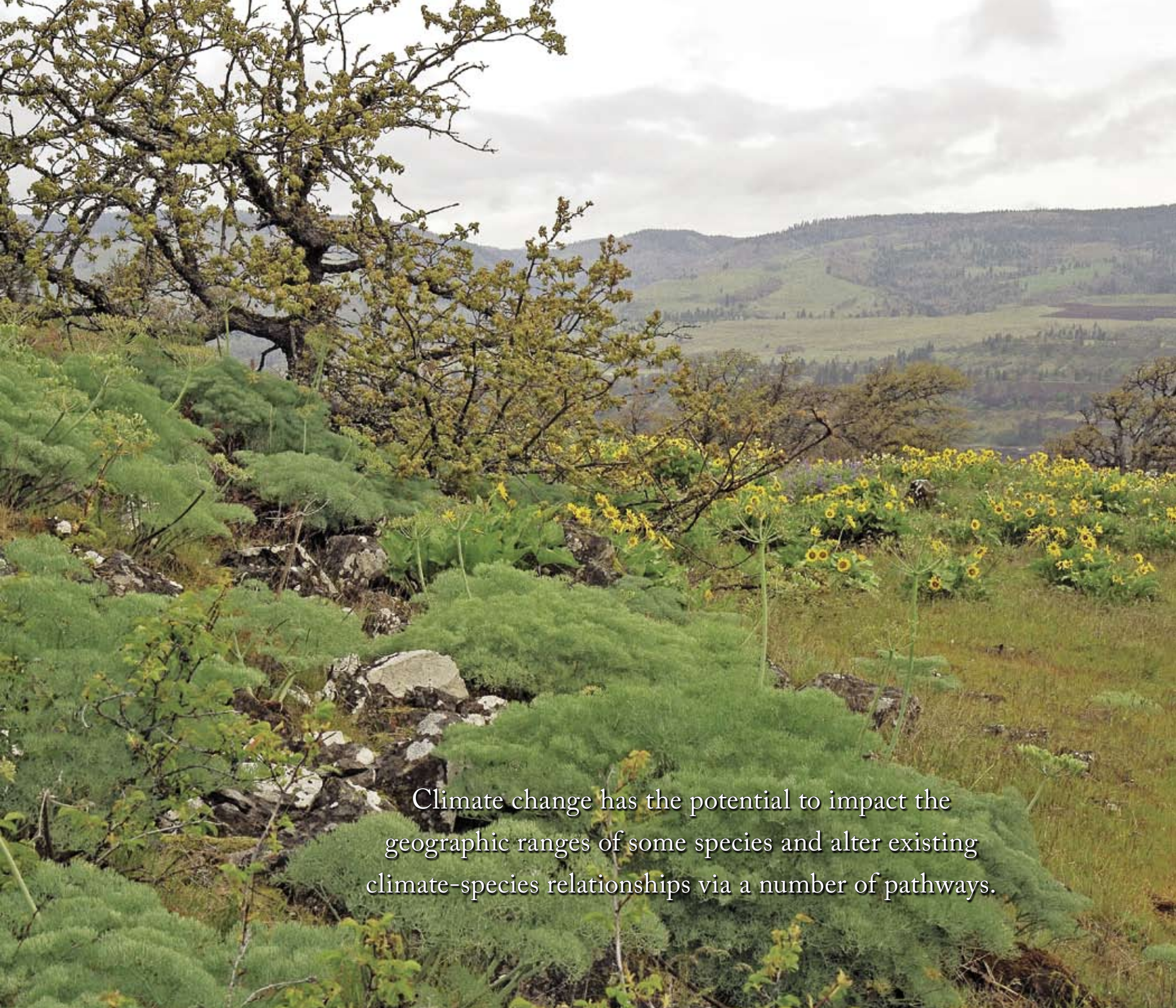
Tourism affects resident interactions with natural and social environment

In coastal Alaska, growth of the tourism industry affects the ways rural residents interact with their natural and social environment. Those whose livelihood or lifestyle depends on unfettered access to natural resources (e.g., fishing, subsistence) and special places found they had to share their use with tourist groups at certain times. Those whose quality of life is determined by a slower pace and small-town values were wary of the arrival of visitors and changes in the rhythm of community life during peak season. Rural residents struggled to adapt to these changes while recognizing the significant economic benefits tourism provides. Uncertainty about the pace and nature of tourism development were widely shared among tourism proponents and skeptics alike.

These findings are the culmination of 4 years of ethnographic research in which 213 indepth interviews were conducted at three sites. Greater understanding of the complex ways tourism affects stakeholders and social groups in coastal Alaska may help regional tourism planners.

Contact: Lee K. Cerveny, lcerveny@fs.fed.us, Human and Natural Resources Interactions Program

Rowena State Park, Oregon; © Miles Hemstrom ▶



Climate change has the potential to impact the geographic ranges of some species and alter existing climate-species relationships via a number of pathways.

Tom Iraci

Habitat lost to wildfire is one issue that points to the benefits of adopting a landscape approach in the recovery strategy for the northern spotted owl.

Restoring spotted owl habitat may take landscape approach

The threatened northern spotted owl continues to decline despite 15 years of intense management effort. One significant threat continues to be the loss of habitat in dry forests from wildfire. Habitat gain and loss from uncharacteristic fire disturbance regimes has been extensively documented by station scientists. Their research has documented landscape dynamics, owl prey demography, and conflicts with competitive barred owls that are directly relevant to recovery plans for the northern spotted owl.

Outcome: *Northern spotted owl recovery plan shifts approach based on new information.*

This information was central in shifting the recovery strategy for northern spotted owl habitat from a species-oriented reserve strategy to a whole-landscape strategy.

Contact: John Lehmkuhl, jlehmkuhl@fs.fed.us, Managing Disturbance Regimes Program

Partners: Sustainable Ecosystems Institute, University of Washington, USDA Forest Service Pacific Northwest Region, USDI Fish and Wildlife Service

Interaction between climate change and invasive species may intensify threats

Exotic and native invasive species are among the most serious threats facing western wildlands. Land managers have traditionally relied on observations and lessons from the past to help plan for the future. However, environmental conditions are changing, and significant changes are predicted for the future.

Working with partners and cooperators, scientists developed a set of rapid threat assessments, syntheses, and modeling projects that focused on the interaction of climate change and invasive exotic and native species on wildland resources in the Western United States.

This work demonstrates that climate change has the potential to impact the geographic ranges of some species and alter existing climate-species relationships via a number of pathways. As a result, many species likely will be able to disperse into novel climate regions and expand their ranges or increase their populations within existing locations.

Contact: Becky Kerns, bkerns@fs.fed.us, Western Wildland Environmental Threat Assessment Center

Partners: EnviroWise Design; ESSA Technologies Ltd.; GEO/Graphics, Inc.; Oregon State University; University of Arizona; University of Idaho; USDA Forest Service Forest Health Protection, Forest Health Technology Enterprise Team, National Forest System, and Western Bark Beetle Research Group; U.S. Geological Survey; Western Regional Pathologists

Imported bark beetle forms new fungal associations in China

The red turpentine bark beetle and the *Leptographium terebrantis* fungus and others in the same genera have a symbiotic relationship: the bark beetle provides the fungi with a place to live and transportation while the fungi play a critical role in the beetle's development and reproduction. The red turpentine bark beetle is native to the United States, and the combined effects of the fungi and this bark beetle on the various species of pine trees they inhabit are relatively benign.

About 10 years ago, the red turpentine bark beetle was introduced to China, most likely via a shipment of logs from the United States. Scientists have discovered that while in China, the bark beetle has formed new associations with different fungal species. Scientists in the United States, China, and South Africa are studying this to better understand the taxonomic positions of these fungi and their ability to incite disease. One concern is that red turpentine beetles that have formed Chinese fungal associates may be reintroduced to the United States and that their effect on trees may no longer be as benign.

Contact: Charles G. "Terry" Shaw, cgshaw @fs.fed.us, Western Wildland Environmental Threat Assessment Center

Partners: Nancy Gillette, USDA Forest Service Pacific Southwest Research Station; USDA Forest Service Forest Health Protection; University of Pretoria, South Africa

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Northeastern Washington.

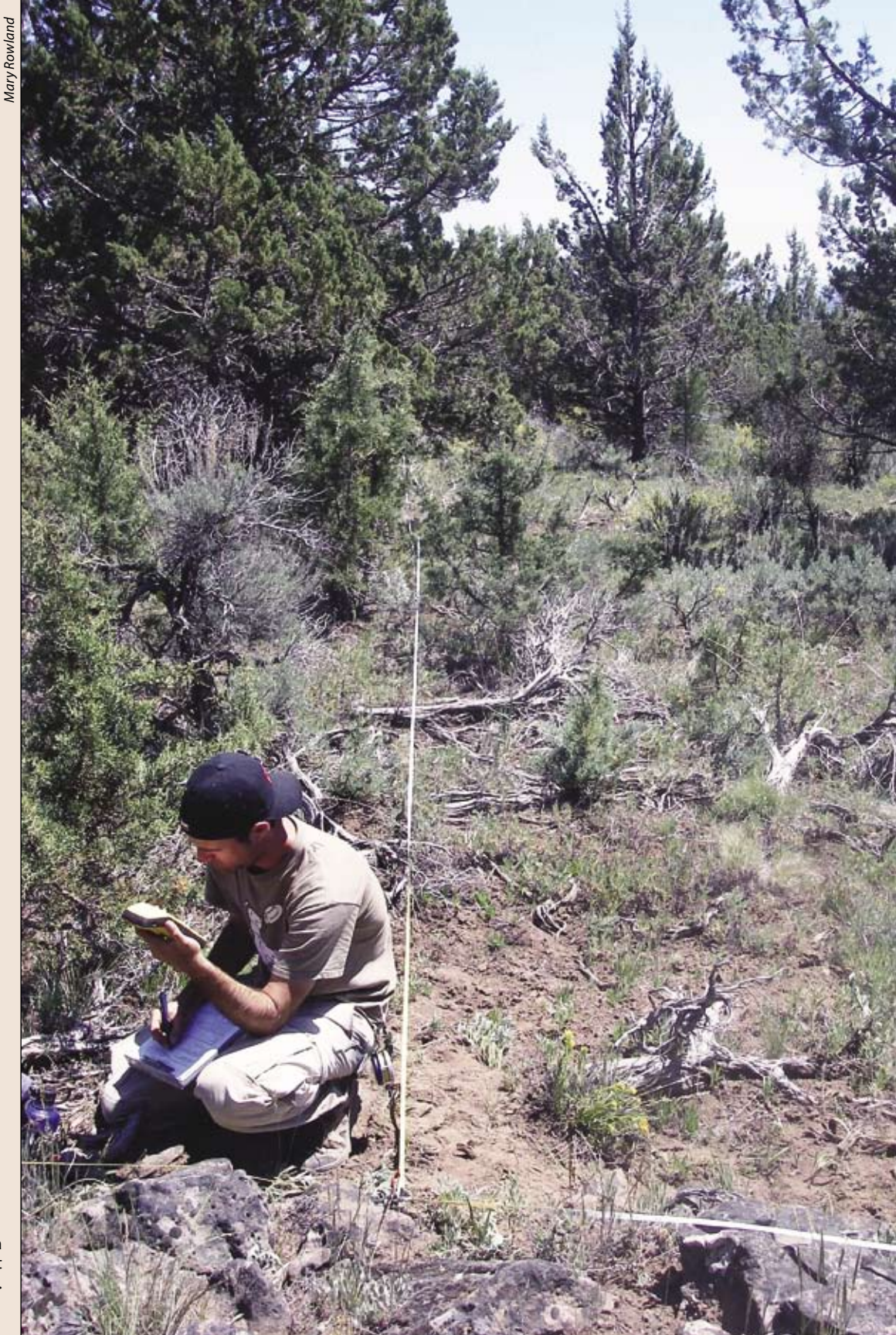
Near Gilchrist, Oregon; © Miles Hemstrom.

GOAL 2: Assess the status and trends of ecosystems and natural resources and their uses

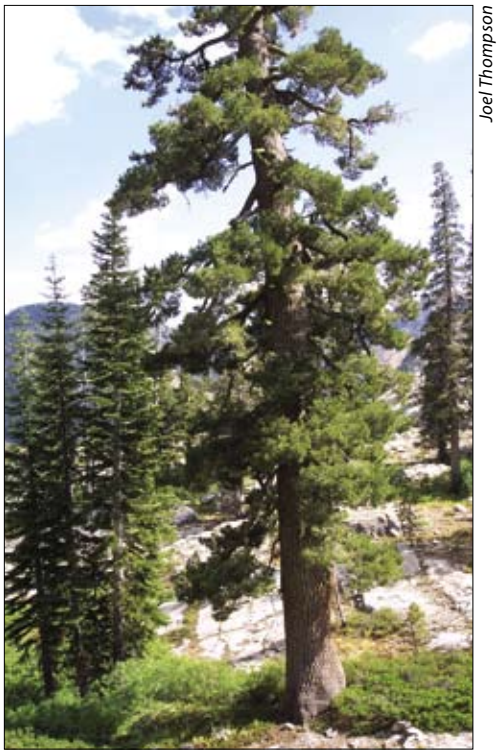
Key Findings

- Two reports highlight key findings from 2001–2005 inventory data across all forest land in California and Oregon. Topics include fuel loading, land use change, air quality, timber availability, climate change impacts, and much more.
- Models estimate carbon stocks and flux in California forests circa 1990.
- Live and dead tree biomass is below the historical range of variation in the Oregon Coast Range.
- Modeling of Canada lynx habitat in North America shows potential habitat loss in the United States and gains in Canada under various climate scenarios.
- Two-thirds of the global polar bear population is at risk of dying by 2050 if environmental conditions change as predicted.
- Numbers of juniper per acre have increased in the last 140 years, threatening sagebrush habitat in central Oregon.
- Street trees in Portland, Oregon, provide $1.1 billion in benefits, far outweighing their maintenance costs.

Mary Rowland



Collecting data from a sagebrush study plot near John Day, Oregon.



Joel Thompson

Annual data collected by field crew provides critical information about the status and health of the Nation's forests.

New 5-year reports summarize forest conditions in California and Oregon

Scientists summarized and interpreted basic information about the public and private forest land in California and Oregon. These reports establish a baseline against which future conditions can be compared and trends can be identified. These data can be used for the Forest Service's reporting on international criteria and indicators of sustainability. They can also be used for regional and state-level assessments of various topics including biomass, carbon flux, fuel loading, and fire risk; land use change; status and change in oak woodlands; air quality; timber availability; and the impacts of climate change.

Policymakers and practitioners have found the information yielded from state-specific equations for calculating carbon storage particularly useful. California policymakers are using this information as they develop the state's carbon policy.

These reports are the first to be published in response to a Congressional mandate in the 2002 Farm Bill. They are based on annual data gathered under the new, standardized national inventory method in which a portion of all plots in each state are measured each year.

Contacts: Glenn Christensen, gchristensen@fs.fed.us (California report); Joe Donnegan, jdonnegan@fs.fed.us (Oregon report), Forest Inventory and Analysis Program

Partners: Bureau of Business and Economic Research, California Department of Forestry and Fire, Oregon Department of Forestry, USDA Forest Service Pacific Northwest and Pacific Southwest Regions

Scientists find low regeneration levels for California's blue oak and valley oak

California's oak woodlands may not be sustainable. Scientists examined the latest 5 years of statewide data and found evidence that regeneration and recruitment among blue oak and valley oak may be insufficient for a stable population. They have been monitoring these species for 30 years and know that blue oak, valley oak, and coast live oak forest types have been characterized by low numbers of saplings during that time; however, better information is needed on growth and mortality to be able to project future population trends.

Oak sustainability is of interest to many Californians, and several pieces of recent legislation focus on oak conservation. Loss of California oaks has a social impact

Tara Barrett

Many oak woodlands in California have few seedlings or saplings present.

disproportionate to the area on which it occurs because oak woodlands are found in the high-visibility areas where people live, work, and play.

Contact: Tara M. Barrett, tbarrett@fs.fed.us, Forest Inventory and Analysis Program

Partners: California Department of Forestry, University of California Integrated Hardwood Range Management Program

Airborne laser scanner used to characterize forests on Kenai Peninsula

The Alaska forest inventory program is charged with inventorying extensive and remote areas of forest where it is often prohibitively expensive to establish plots at an adequate sampling intensity to meet target levels of precision. Using an airborne laser scanner may be an efficient and cost-effective way to accomplish this task.

Scientists tested its accuracy by using light detection and ranging (LIDAR) data to estimate forest stand size, land cover type, and forest density at 32 plots across Alaska's Kenai Peninsula. Height, area, and species type of individual trees were derived from the three-dimensional LIDAR point cloud, LIDAR-based canopy height models, and LIDAR return intensity information. A quantitative comparison of the LIDAR and field-based condition classifications at the subplot centers indicates that LIDAR has potential as a useful sampling tool in an operational forest inventory program.

Pete Bisson

Spider Lake, Olympic National Forest

Contact: Hans Andersen, handersen@fs.fed.us, Forest Inventory and Analysis Program

Partners: University of Washington

Individual tree species can be identified using LIDAR technology

Scientists tested the ability of airborne laser scanners to produce data allowing them to identify the species of individual trees. These light detection and ranging (LIDAR) data were collected in Seattle's Washington Park Arboretum at two times of year: when trees had leaves and when they did not. For this purpose, scientists found LIDAR data were more useful for species discrimination when collected from trees with no leaves.

Also, scientists found that the intensity values of the LIDAR data for different species were related not only to reflective properties at a particular wavelength, but also to a presence or absence of foliage and the arrangement of foliage and branches within individual tree crowns.

The use of airborne laser scanning data has the potential to significantly increase the efficiency of forest inventory, especially in remote regions such as interior Alaska. If LIDAR can provide both structure and species information, the utility and value of the technology for forest inventory applications will be significantly increased.

Contact: Hans Andersen, handersen@fs.fed.us, Forest Inventory and Analysis Program

Partner: University of Washington

Historical evidence suggests that forests of the Oregon Coast Range could be managed to sequester more carbon than they do now.

Scientists model carbon stores and flux in California forests

California wants to lower its greenhouse gas emissions to 1990 levels by 2020. As part of this process, the legislature mandated a state-wide greenhouse gas inventory. In support, PNW scientists modeled estimates of forest carbon stores and flux for California circa 1990. They estimated annual carbon flux on the 7.97 million acres of timberlands outside of national forests at 2.9 terragrams per year. With continuing annual inventories, the Forest Inventory and Analysis Program will provide future monitoring data on carbon flux across all forest land ownerships, productivity classes, and reserve statuses, as well as providing the basis for understanding the dynamics of carbon transfers from live trees to wood products, bioenergy, or atmospheric emissions via fire.

Outcome: *California legislature and other state agencies use carbon estimates to develop policy.*

The legislature used this information in the California Assembly Bill 32 framework for carbon monitoring and emissions reduction. Other clients, such as California Air Resources Board, the Fire and Resource Assessment Program of CALFIRE, the California Board of Forestry, and the California Climate Action Registry Forestry subgroup have used this information to generate options for intensified monitoring activity that would deliver sufficiently precise estimates of carbon flux to support policy development and carbon trading frameworks.

Contact: Jeremy Fried, jsfried@fs.fed.us, Forest Inventory and Analysis Program

Partners: California Climate Action Registry, USDA Forest Service Pacific Southwest Research Station

John Laurence

Biomass in Oregon Coast Range is lower than in the past

Scientists examined the historical variation in live and dead tree biomass under the historical disturbance regime of the Oregon Coast Range. They found that current amounts of live and dead biomass are much lower than what occurred in this region before the high-intensity wildfires of the early settlement period and intensive timber management of the 20th century.

This means these forests could probably sequester more carbon. This assessment provides the basis for understanding carbon management across a mixed-ownership landscape and is the first study to estimate the range of variation in terms of live and dead biomass.

Contact: Thomas A. Spies, tspies@fs.fed.us, Ecosystem Processes Program

Partners: Oregon State University, South Dakota State University

Carbon dynamics can be evaluated with inventory plots and satellite imagery

Forests are both a sink and a source of carbon. Quantifying the direction and amount of change in forest carbon storage is necessary to evaluate the contribution of forests to global warming.

Scientists combined data gathered from inventory plots in western Oregon in the mid-1990s and mid-2000s with Landsat satellite images taken in 2-year intervals, stand age maps, and models of carbon accumulation as forests age. They compared changes in carbon estimated from maps, images, and a model with inventory results at both plot and landscape scales. The model overestimated carbon amounts at the plot and landscape scales for both inventory periods, but the change in forest carbon estimated by the model was well within the standard error of the inventory estimates—which indicated a 7-percent increase during the period. Further analysis indicated that the satellite imagery may have detected short-term changes in rates of harvest or development patterns that were not obvious in the inventory data. Landsat imagery has been collected since 1972. This study illustrates the potential in using satellite

◀ *Oregon coast, by Tom iraci*

imagery and models to estimate forest areas that were not measured accurately before 1990 or to project future changes.

Contact: Andrew N. Gray, agray01@fs.fed.us, Forest Inventory and Analysis Program

Partners: Oregon State University, Western Washington University

Lynx likely to lose habitat in United States, may gain it in Canada

Scientists simulated the responses of terrestrial ecosystems in North America to the historical climate and nine future climate scenarios on a 5-minute-resolution spatial grid using MC1, a dynamic general vegetation model. The model simulations were part of a joint project with The Nature Conservancy and the U.S. Forest Service investigating potential impacts of climate change on the habitat of the endangered Canada lynx. The simulations show extensive loss of lynx habitat in the conterminous United States and potential habitat expansion in Canada under all of the future climate scenarios.

Outcome: *The Nature Conservancy uses model simulations to focus conservation efforts for Canada lynx.*

The climate data sets have been shared with the Remote Sensing Application Center and other research groups upon request.

Contact: Ron Neilson, rneilson@fs.fed.us, Managing Disturbance Regimes Program

Partners: Oregon State University, The Nature Conservancy

Keith Aubry

Wolverines use spring snow to build their dens.

Spring snow cover defines the bioclimatic niche of the wolverine

Wolverines need spring snow cover to build dens where they raise their young, but recent research reveals that they also need this habitat component for other aspects of their life history. Scientists discovered this by developing a satellite-based image of persistent snow cover from 24 April to 15 May and found strong concordance with an expert-based map of wolverine distribution. They found more than 99 percent of 553 wolverine reproductive dens in Scandinavia and North America occurred within the spring snow cover, as did 88 percent of wolverine telemetry relocations from eight recent wolverine studies in western North America.

This layer of spring snow provides a spatially explicit habitat model for the wolverine that can be used to test hypotheses about population connectivity, movement corridors, and genetic relatedness. Scientists can also use this model to predict the potential effects of climate change on the geographic extent and connectivity of wolverine habitat, and identify future refugia where conservation efforts are likely to be most effective.

Contact: Keith B. Aubry, kaubry@fs.fed.us, Ecosystem Processes Program

Partners: Alaska Department of Fish and Game, B.C. Ministry of the Environment, Columbia Basin Fish and Wildlife Compensation Program, Northern Rockies Conservation Cooperative, Norwegian Institute for Nature Research, Swedish University of Agricultural Sciences, The Nature Conservancy, The Wolverine Foundation, USDA Forest Service Rocky Mountain Research Station, Wildlife Conservation Society Wildlife Research and Management

Two-thirds of global polar bear population at risk by 2050

A station scientist developed models, in close coordination with a leading polar bear biologist from the U.S. Geological Survey (USGS), of polar bear carrying capacity and population response to historical, current, and future human stressors, environmental conditions, and habitat states under climate change scenarios. Arctic sea ice is projected to melt at an accelerated rate, and study results suggest a high probability that two-thirds of the current global polar bear population may face great reductions or local extirpations by mid-century. This work was used by the U.S. Fish and Wildlife Service and U.S. Department of the Interior in their decision to list the polar bear as a threatened species.

Outcome: *Federal agencies use these findings to inform their decision to list the polar bear as a threatened species.*

Contact: Bruce G. Marcot, bmarcot@fs.fed.us, Ecosystem Processes Program

Partners: Alaska Science Center, University of Wisconsin, U.S. Geological Survey, USDI Fish and Wildlife Service

Bruce Marcot

These polar bears at the Portland Zoo may be better off than their wild counterparts, if the climate warms as predicted.

Web site: Forest Carnivore Surveys in the Pacific States

Description:
This interactive Web site provides an archival and retrieval system for occurrence data on forest carnivores in Washington, Oregon, and California. Data were obtained during standardized surveys using remote cameras or trackplate boxes. The Web site also contains all verifiable records for the Canada lynx, wolverine, fisher, coastal populations of marten, and mountain red fox. These five forest carnivores are of greatest conservation concern in the region.

Use:
The first step toward conserving forest carnivores is to accurately map their geographic distributions and evaluate the extent to which current and historical ranges may differ.

Prior to this Web site, the compilation of verifiable occurrence records for conservation purposes was done by hand on an ad-hoc basis, and resulting data were not maintained in a permanent archive. It was very challenging to avoid duplicating survey efforts or to prioritize the locations of future surveys. The results of surveys conducted by different agencies or groups are archived in perpetuity and may be combined and compared on a regional basis. This Web site is an essential tool for any public or private biologist working to conserve forest carnivores in the Pacific States.

Partner:
USDA Forest Service Geospatial Services and Technology Center

How to get it:
http://maps.fs.fed.us/carnivore/Modules/application/home.html

Contact:
Keith B. Aubry, kaubry@fs.fed.us
Ecosystem Processes Program

Effects of budworm outbreak analyzed for private lands in eastern Oregon

Between 1980 and 1994, eastern Oregon was plagued by a severe outbreak of western spruce budworm. The budworm eats new growth of coniferous trees, thus weakening or killing the tree. Researchers estimated the effects of the outbreak on private forest land in eastern Oregon and found a 10-percent growth reduction resulting from defoliation. Tree mortality was estimated to have doubled in the 5-year period 1987–1992, compared to the 10-year period 1977–1987 for Douglas-fir, grand fir, and white fir. The ponderosa/lodgepole pine group did not show this difference.

Outcome: *Oregon Department of Forestry uses study to brief governor about extent of budworm damage.*

David McComb, U.S. Forest Service, Bugwood. org

Budworm larvae.

The Oregon Department of Forestry used these findings to brief the governor about the extent of budworm damage in eastern Oregon. This information also will be useful when land managers consider options to address future outbreaks.

Contact: David Azuma, dazuma@fs.fed.us, Forest Inventory and Analysis Program

Partners: Oregon Department of Forestry

Case studies identify factors leading to development on private forests

Approximately 1 million acres of forest are converted to more developed uses annually. Recent research found that 44 million acres of private forest are projected to be affected by residential development in the coming decades. In a followup study, station scientists examined commonalities and differences in land development patterns in northwest Washington, southern Maine, and northern Georgia.

Commonalities in conditions and trends across the three regions include a changing forest ownership, proximity to large metropolitan areas, and the influence of historical settlement patterns and transportation networks on residential development. Differences in factors influencing residential development among the study areas include the influence of seasonal home development, the land use planning systems in place, and the effect of topography.

Contact: Eric White, emwhite@fs.fed.us, Human and Natural Resources Interactions Program

Partners: USDA Forest Service State and Private Forestry, Cooperative Forestry

Rhonda Mazza

A new housing development adjacent to private forest land near Damascus, Oregon.

Encroaching juniper threaten sagebrush habitat

Sagebrush and other native shrublands in the Western United States are threatened by encroaching pinyon-juniper woodlands. In this study, scientists applied a pinyon-juniper risk model to the John Day province in central Oregon. They found that 140 years ago, prior to settlement by Euro-Americans, western juniper were scattered across the landscape with up to 7 trees per acre. Current densities of juniper younger than 140 years are much greater, ranging from 30 to 185 trees per acre, indicating most junipers in the study area were established postsettlement.

Canopy cover of sagebrush was lower in areas where the juniper canopy cover was most dense, a finding reported elsewhere. Low sagebrush and mountain big sagebrush communities in central Oregon may have the highest risk of future woodland encroachment. Juniper densities were greatest in the 1- to 3-foot-tall size class within these sites, suggesting relatively recent tree establishment but future growth and infilling.

Maps derived from this model will help land managers anticipate the magnitude and spatial patterns of potential sagebrush habitat loss from encroaching juniper woodlands.

Contact: Mary Rowland, mrowland@fs.fed.us, Managing Disturbance Regimes Program

Partners: USDA Forest Service Rocky Mountain Research Station, Remote Sensing Applications Center, Washington office, and Western Wildland Environmental Threat Assessment Center

Mary Rowland

Juniper densities have increased since Euro-Americans first settled in Oregon.

Forest biomass mapped for conterminous United States, Alaska, and Puerto Rico

Scientists mapped the distribution of biomass across the conterminous United States, Alaska, and Puerto Rico. The map is based on a spatially explicit data set of aboveground, live forest biomass complied from the national Forest Inventory and Analysis Program. Map-based estimates of forest area and forest biomass compared well with traditional plot-based estimates for individual states.

The map was produced by using moderate-resolution geospatial data. It can be used to direct future efforts using higher resolution geospatial data and further ground reference. Subsequent maps also can be used to illustrate gross changes in forest biomass distribution.

Contact: Kenneth Winterberger, kwinterberger @fs.fed.us, Forest Inventory and Analysis Program

Partners: USDA Forest Service International Institute of Tropical Forestry, Northeastern Research Station, North Central Research Station, Remote Sensing Application Center, Rocky Mountain Research Station, and Southern Research Station

Atlas maps current and potential distribution of Mexican bark beetle

Bark beetles belonging to the genus *Dendroctonus* are a wide-ranging and important disturbance agent in the pine forests of Mexico. As the climate changes, Mexican bark beetles may migrate north into U.S. forests, potentially causing widespread mortality. A new atlas maps the present and potential distribution for bark beetle species. The atlas also quantifies the frequency of specific pine-bark beetle associations found in historical collections and provides new information on the host specificity. Researchers created a beetle threat index and used it to map where beetle populations might have the largest impact on 25 native pine species.

The atlas can be used by researchers in a variety of biogeographical studies to further describe the distributions of bark beetle populations relative to their host species and their potential distribution under future climate scenarios. Managers can use the atlas to understand where bark beetles will likely have future impacts on pine forests in Mexico.

Contact: Alan Ager, aager@fs.fed.us, Western Wildland Environmental Threat Assessment Center, Jane L. Hayes, jlhayes@fs.fed.us, Managing Disturbance Regimes Program

Partner: Escuela Nacional de Ciencias Biológicas, México

Geoffrey Donovan

Portland's street trees are estimated to provide a $45 million benefit each year.

The benefits of street trees in Portland, Oregon, far outweigh their costs

Does the size or type of tree in front of a home influence the home's sale price? This study found that crown area within 100 feet of the house, and number of trees fronting the house were significant. When combined, these two variables add an average of $7,020 to the price of a house in Portland, which is equivalent to adding 106 finished square feet to a house. Extrapolating to the entire city, the total value of Portland's street trees is $1.1 billion. When converted to an annual value, this translates to a $45 million benefit annually. For comparison, the city of Portland estimates that the annual maintenance of Portland's street trees costs $4.6 million.

Outcome: *Cities of Portland, Tigard, and Gresham, Oregon, incorporate study findings into their urban forestry plans.*

In addition, these benefits spill over to neighboring houses—perhaps the most significant finding from the study. If home-owners have a tree outside their house, only about half the benefit goes to them. The remaining half spreads to

neighbors within 100 feet. Currently, homeowners bear all the costs of street tree maintenance. Because they do not receive all the benefits, individual homeowners are unlikely to plant enough trees to maximize Portland's urban tree potential.

This study was done in close collaboration with the city of Portland and has attracted interest from the Multnomah County Assessors' Office, State and Private Forestry, Oregon Urban and Community Forestry Program, and several local arborists and landscape architects. In addition, the cities of Tigard and Gresham, Oregon, have incorporated the study into their urban forestry plans. The study was also featured in the June issue of *Portland Monthly* and on Oregon Public Broadcasting.

Contact: Geoffrey Donovan, gdonovan@fs.fed.us, Human and Natural Resources Interactions Program

Partners: City of Portland Urban Forestry Program, National Institute of Standards

Continue to Part 2 (goals 3 and 4)

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Mount Hood, Oregon.

Skokomish River Valley, Washington, by Pete Bisson

GOAL 3: Develop science-based options for informed management

Key Findings and Tools

- Surrogate species can be effectively used in conservation planning to represent broader sets of species that would be too numerous to effectively manage individually.
- Scientists map adaptive diversity in ocean spray, an important restoration shrub; the map serves as a guide for seed collection and native plant restoration and revegetation.
- Scientists determine the geographic and taxonomic scope of an amphibian disease implicated in the decline and extinction of numerous amphibian species.
- A model identifies the initiation sites for landslides and assesses the likelihood of a landslide reaching a fish-bearing stream in western Oregon.
- Scientists develop new framework for wildfire risk assessment and fuel treatment planning.
- A landscape analysis of dry forests helps cross-ownership restoration projects and evaluation of biomass supply in eastern Washington.
- Biomass studies highlight areas where cost of fire-hazard-reduction treatments could be offset by sale of products.
- Cost of treatments, including prescribed fire treatments, were generally higher in the West than in other regions of the country.
- The quality of wood from spruce and hemlock stands that were precommercially thinned was found to be equivalent to unthinned stands in southeast Alaska.
- Trees 25 to 80 years old from southeast Alaska yield quality timber for high-value products.
- Classifying recreation visitors by trip type leads to better estimates of visitor spending than classifying visitors by the type of activity they engage in.
- California officials use the station's smoke forecasts to inform the public about wildfire-related air quality concerns.
- Compacted trails created by tree harvesting equipment may not reduce growth of trees in or near the trails.

Tom Iraci

Surrogate species are an effective tool for conservation planning

How can the Forest Service and other federal agencies best address the conservation needs of hundreds of species of concern in land use planning? There are often too many species to consider each individually, even though all species of concern must be considered under federal laws and regulations.

Outcome: *Forest Service and BLM adopt surrogate species approach to conservation in the interior Columbia basin.*

Using surrogate species or groups of species as proxies for broader sets of species may be one way to address this dilemma. Scientists demonstrated this in the interior Columbia basin. An effective surrogate approach requires specific objectives, a regional geographic scale, explicit scientific criteria for selecting and linking surrogates to the larger set of species, tests of logic and consistency, identifying and demonstrating how knowledge gaps are addressed, and monitoring the effectiveness of management applications.

The surrogate species approach and guidelines are scientifically defensible and efficient, enabling managers to save substantial time and money. The Forest Service and Bureau of Land Management (BLM) are using these guidelines and approach in more than 50 administrative units in the interior Columbia basin. Also, the Forest Service has incorporated the approach and guidelines in its national planning direction, including proposed regulations to update guidelines for the National Forest Management Act.

Contact: Michael Wisdom, mwisdom@fs.fed.us, Managing Disturbance Regimes Program

Partners: The Nature Conservancy, USDA Forest Service National Wildlife Ecology Program, USDI Bureau of Land Management

Mary Rowland

Data collection on a sagebrush study plot near John Day, Oregon.

Different timber harvest scenarios lead to significant differences in future carbon sequestration on U.S. public timberlands

Terrestrial carbon sequestration can mitigate global climate change and could help offset greenhouse gas emissions from all sectors of the U.S. economy. Public forests in the United States represent approximately 20 percent of the U.S. timberland area and 30 percent of the U.S. timber volume. With such a large standing timber inventory, management of this resource affects the amount of carbon sequestered by public forests. To help decisionmakers understand the carbon implications of potential changes in public timberland management, researchers compared a baseline timber harvest scenario with two alternative harvest scenarios and estimated annual carbon stock changes associated with each.

A scenario that eliminated timber harvests on public lands increased the amount of carbon sequestered annually by 17 to 29 million metric tons (MMT) of carbon between 2010 and 2050—as much as a 43-percent increase over current sequestration levels on public timberlands. This scenario also offset up to 1.5 percent of total U.S. greenhouse gas emissions. In contrast, a more intense harvest scenario similar to harvest levels that prevailed in the 1980s

Todd Morgan

Public forest lands yield 30 percent of the U.S. timber volume.

resulted in annual carbon losses of 27 to 35 MMT. These losses represented a 50- to 80-percent decline in anticipated carbon sequestration associated with the existing timber harvest policies.

Contact: Ralph Alig, ralig@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Environmental Protection Agency, Duke University, Oregon State University, Texas A&M University

Scientists model potential impacts of climate change on California's ecosystem services

Station scientists were key contributors in a project examining the potential impact of climate change on services provided by California ecosystems. They simulated potential changes in vegetation distribution, associated carbon pools and fluxes, and wildfire occurrence in California under nine future climate and greenhouse gas emission scenarios.

Outcome: *Climate change study informs California governor and legislature.*

This output was given to The Nature Conservancy, which is translating it into ecosystem services values for carbon, water availability, forage production, and carbon sequestration. Project results will be published in the 2008 Climate Change Impacts Assessment, the Second Biennial Report to the California Climate Action team, which submits these reports to the governor and the state legislature.

Contact: Jim Lenihan, jlenihan@fs.fed.us; Ron Neilson, rneilson@fs.fed.us, Managing Disturbance Regimes Program

Partners: California Energy Commission, Oregon State University, Scripps Research Institute, The Nature Conservancy

Scientists map seed zones for oceanspray based on climatic variables

Land managers generally try to use locally adapted and genetically diverse plant materials in restoration and revegetation efforts. Oceanspray (*Holodiscus discolor*) is an important restoration shrub in the Pacific Northwest; genetic variation exists within the species because local populations adapt to local conditions. In this study, station geneticists identified the patterns of genetic diversity of oceanspray related to climatic variables, such as average December minimum temperature, by characterizing the variability in growth and physical characteristics for individual shrubs from 39 locations in western Oregon and Washington.

Landslides may be important sources of wood and spawning gravels, which are building blocks for fish habitat.

As part of this study, scientists produced a seed zone map for land managers that illustrates adaptive patterns of genetic diversity of oceanspray within the Pacific Northwest. The map can be used to guide seed collection and deployment for native plant restoration and revegetation activities.

Contact: Matt Horning, mhorning@fs.fed.us, Resource Management and Productivity Program

Partners: Corvallis Plant Materials Center and Tangent Service Center, USDA Natural Resources Conservation Service

Pivotal research contributes to amphibian conservation worldwide

Working with researchers around the world, a station scientist determined the geographic and taxonomic scope of chytridiomycosis, an amphibian disease implicated in amphibian species decline and species extinctions. The aquatic fungus that causes the disease is widely detected in the Americas and Australia, patchy in Africa and Europe, and not yet seen in wild amphibian populations in Asia.

The disease has been detected in 59 percent of countries sampled, 85 percent of U.S. states, and 56 percent of the species sampled, including 17 anuran (frog and toad) families and 5 caudate (salamander) families.

This project is an unparalleled example of collaboration among scientists. Data were collated from more than 2,000 sites worldwide. The data are accessible on an interactive Web portal with

Charlie Crisafulli

mapping capabilities (http://www.spatialepidemiology.net). Maps associated with the project have been used in various publications such as *Nature* and the *Seattle Times* to increase awareness of this disease.

Contact: Dede Olson, dedeolson@fs.fed.us, Aquatic and Land Interactions Program

Partners: Amphibian Specialist Group, World Conservation Union; Department of Infectious Disease Epidemiology, Imperial College, London, UK; Partners in Amphibian and Reptile Conservation

Landslide model useful in managing fish habitat

The role of landslides in creating and maintaining fish habitat is a much-debated topic among scientists and land managers. Land managers traditionally worked to minimize the occurrence of all landslides. However, recent research suggests that landslides may be important sources of wood and spawning gravels, which are building blocks for fish habitat.

Outcome: *Federal agencies use landslide initiation and runout model to develop and evaluate land management plans.*

Scientists developed a model for western Oregon that identifies landslide initiation sites and assesses the likelihood that a landslide from that site will reach a fish-bearing stream. The model has been adapted to estimate relative volumes of wood that might be delivered to a stream. When using the model, managers will be able to identify and prioritize landslide sites with a high probability of affecting a fish-bearing stream either positively or negatively. The model facilitates analysis of alternative management scenarios, enabling the user to assess the potential for cumulative management effects.

This model was used extensively by the Oregon Bureau of Land Management to develop and evaluate options for their new land management plan. It was also used by the Aquatic and Riparian Effectiveness Monitoring Plan of the Northwest Forest Plan.

Contact: Kelly Burnett, kmburnett@fs.fed.us, Aquatic and Land Interactions Program

Partners: Earth Systems Institute, USDI Bureau of Land Management Oregon, Oregon Headwaters Research Consortium, USGS Biological Resources Division

◀ *Salmon River, Oregon; © Miles Hemstrom*

When evaluating salmon habitat, life stage of salmon matters

Researchers analyzed the relationships between salmon life-history stages and landscape characteristics at multiple spatial scales to assess salmon distribution and abundance. For adult salmon, researchers found conditions across a large scale helped explain salmon distribution and abundance. Mean precipitation of the watershed, for example, and the percentage of large trees in the riparian buffer at the subbasin level were significant variables. For juvenile salmon, however, researchers found local conditions, such as the percentage of sand in spawning beds and the distance from pools to spawning beds explained juvenile abundance and habitat occupancy better than did large-scale landscape conditions.

This information is useful when designing management activities to maintain and recover stream ecosystems and when developing monitoring programs to evaluate the effectiveness of management activities.

Contact: Rebecca Flitcroft, rflitcroft@fs.fed.us, Aquatic and Land Interactions Program

Partners: Oregon Department of Fish and Wildlife, Oregon State University

Juvenile coho salmon move through culverts at lower flows than expected

Streams that are intermittent during the summer but flow during the winter period can be critical rearing areas for juvenile coho salmon in the Oregon Coast Range. During the dry summer, these streams become disconnected from the main stem. This study found that fish begin moving into these streams with the first high flows of the fall season and over a much shorter period than previously thought. Most of their movement occurs, however, during low to moderate flows. Current design criteria for culverts assume that fish move through them during a wide range of flows.

These results provide management and regulatory agencies with valuable insights about the timing of coho salmon movements through culverts and will influence the design and placement criteria for culverts.

Contact: Bruce Hansen, bhansen@fs.fed.us, Aquatic and Land Interactions Program

Partners: Environmental Protection Agency, Oregon Department of Fish and Wildlife, Oregon State University, USDI Bureau of Land Management

Pete Bisson

For juvenile salmon, the amount of sand in spawning beds and distance from pools to spawning bed are particularly important.

Peak flow assessment completed for BLM Plan Revisions

Station scientists assessed the science relating to the effects of forest management on peak streamflows in the Pacific Northwest (PNW). The Bureau of Land Management (BLM) used this assessment in their revised management plan for western Oregon. Scientists analyzed several decades of peak flow data from experimental watersheds across the PNW and developed novel relationships to guide forest managers in assessing the risk of peak flow increases and channel responses in different geographic regions within the PNW. The results of this effort were published in general technical report PNW-GTR-760.

Outcome: *BLM uses assessment in management plan for western Oregon.*

Contact: Gordon Grant, ggrant@fs.fed.us, Ecosystem Processes Program

Partners: USDI Bureau of Land Management

Applying ecosystem resilience theory to communities aids understanding of social and economic changes

During the last 30 years, many rural natural-resource-dependent communities have experienced a downturn in their commodity-oriented industries and an upsurge in activities such as recreation, tourism, second-home ownership, and retirement inmigration. Scientists applied the concept of adaptive cycles from ecosystem resilience theory to display these historical changes in three amenity-transition communities: McCall, Idaho, Leavenworth, Washington, and Prineville, Oregon. Scientists interviewed key informants and used historical records and social and economic indicators to document social and economic changes in these communities since the 1950s. These changes were depicted using stages of the adaptive cycle: exploitation, conservation, release, and reorganization.

This study shows how resiliency theory and adaptive cycles can be used to identify potential community-based indicators of adaptive capacity, sources of vulnerability and resiliency, and opportunities to build adaptive capacity. This study also suggests this method may be useful for integrating social and economic change with ecological dynamics in large-scale, integrative studies of socioecological systems.

Contact: Dale Blahna, dblahna@fs.fed.us, Human and Natural Resources Interactions Program

Pete Bisson

The Dungeness River, Washington.

Mark Nechodom

Forest biomass removed to reduce fire hazard can be used to produce electricity. Above, a biomass plant in California.

Landscape analysis facilitates cross-ownership restoration projects and evaluation of potential biomass supply

The forests of the eastern Cascade Range are ecologically complex. A century of human use, however, has fundamentally changed forest structure and processes, making a complex system even more challenging to manage. New uncertainty about the impact of climate change compounds the challenge of long-term management of east-side forests.

Forest landscapes and many management issues transcend property boundaries. However, forest management activities in the east Cascades are generally applied at a stand scale within an ownership, rather than a landscape scale across ownerships. Scientists conducted a landscape analysis to reveal the effects policy and land management activities have on forest ecosystems across multiple ownerships in eastern Washington. The analysis examined how fire exclusion and past management created current forest conditions. The resulting report also discusses methods for increasing forest resiliency, conservation of older forest conditions, and developing biomass use.

The Washington Department of Natural Resources, tribal and private landowners, and other interested parties are using information from this analysis to plan integrated restoration projects, examine potential biomass supply, and inform policy discussions.

Contact: Miles Hemstrom, mhemstrom@fs.fed.us, Focused Science Delivery Program

Partners: Tapash Cooperative, The Nature Conservancy, Washington Department of Fish and Wildlife, Washington Department of Natural Resources, USDA Forest Service Pacific Northwest Region, Yakama Nation

BioSum model optimizes fire hazard reduction and bioenergy capacity

The BioSum model is a tool for optimizing fire-hazard-reduction treatments and determining the economic feasibility of using material removed during treatment for traditional timber products or to produce bioenergy.

Outcome: *BioSum Model is used at local and regional levels to identify bioenergy opportunities.*

Scientists applied BioSum to a 25-million-acre study area in western Oregon and northern California. They found the study area is capable of annually producing (1) $590 million in net revenue; (2) 6 to 12 million green tons of biomass; and (3) 0.8 to 1.2 billion cubic feet of merchantable wood over the

course of a decade. This assumes a 10-year implementation and depreciation of the biomass plants constructed to support fuel treatment on all acres for which treatments would achieve fuel reduction benefits.

Under this scenario, fuel hazard would be reduced on 2.8 to 8.1 million acres while providing bioenergy capacity of 496 to 1009 megawatts—enough to power a city of 500,000 to 1,000,000 people.

Several clients have requested custom analyses using BioSum. Lakeview, Oregon, used the model as a basis for decisions on sizing a planned bioenergy facility; the California Department of Forestry and Fire used it to evaluate forest practices policy options; and it has been used in a regional analysis of opportunities to attract bioenergy investment capital in New Mexico, to assess bioenergy development feasibility in central Oregon, and in support of forest planning on the Shasta-Trinity National Forest.

Contact: Jeremy Fried, jsfried@fs.fed.us, Forest Inventory and Analysis Program

Partners: USDA Forest Service National Fire Plan, Western Forest Leadership Coalition

Eini Lowell

Certain parameters must be met before producing electricity and biofuels from forest biomass becomes economically feasible.

Biomass studies lead to strategic thinking regarding fuel reduction treatments

Many forests in the Western United States are prone to larger, more severe wildfires than they were prior to settlement by Euro-Americans. Reducing fire hazard can be costly, but studies by station scientists indicate areas where the cost for fuel reduction treatments potentially may be offset by the sale of products removed during treatment.

Outcome: *Western Governors' Association uses study techniques to evaluate potential to produce electricity and biofuels from all forests in the Western United States.*

Tree size, species, and proximity to a processing facility are some of the factors that determine the salability of wood removed during these fuel reduction treatments.

A study focused on southwest Oregon and northern California found that large trees often need to be removed to accomplish fire-hazard-reduction goals, even when one objective is to minimize the amount of merchantable timber harvested. This is because the crowns on these trees are so large, they are often key factors in

Tool: Harvest Cost-Revenue (HCR) Estimator

Description:
This Windows®-based financial and engineering software calculates the cost of wildfire fuel-reduction treatments on a project-by-project basis. It may be used to evaluate cost-per-acre thresholds for logging contractors, appraise contract bid rates, or assess stumpage values for ponderosa pine stands in the Southwest United States. It illustrates variability in fuel reduction costs as related to the level of fuels reduction achieved, volume of merchantable wood removed from different forest stands, and availability of markets for removed material.

Use:
The HCR Estimator allows users to examine ways to lower harvesting and transport costs through various levels of in-woods processing. It also provides a decision-support tool to help evaluate economic limitations of different fuel reduction treatments given current product markets for small-diameter material. It can be used to identify potential value-added products that may present opportunities to support community industries that require low capital investment while providing employment for residents of northern Arizona.

How to get it:
http://www.fs.fed.us/pnw/publications/gtr748/

Contact:
Eini Lowell, elowell@fs.fed.us, Human and Natural Resources Interactions Program

Partners:
Greater Flagstaff Forest Partnership, Inc.; High Desert Investment, Inc.; Northern Arizona University; Perkins Timber Harvesting; Skyline Resources; USDA Forest Service Coconino National Forest, Forest Products Laboratory, Rocky Mountain and Southern Research Stations

both torching (crown fire initiation) and crowning (crown fire spread). This information will help fire managers evaluate fuel conditions at a variety of spatial scales and consider various scenarios for reducing fire hazard. These studies are particularly useful for showing how treatment effectiveness and timber volumes might differ given different policy directions or budget constraints.


Todd Morgan

National forests are using the techniques developed for this study to evaluate potential stewardship contracts, and the Western Governors' Association used them to evaluate the potential to produce electricity and biofuels from all forests in the Western United States.

Contact: Jamie Barbour, jbarbour01@fs.fed.us, Focused Science Delivery Program

Partners: USDA Forest Service Southern Research Station, Oregon Department of Forestry

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Study evaluates investments in fuel treatments and gains in resource protection

Researchers evaluated the cost and effectiveness of prescribed fire, mechanical treatments, and mechanical treatments plus fire on seven long-term study sites that are part of the national Fire and Fire Surrogates Program.

Results indicate that treatments costs, including prescribed fire, were generally higher in the West than published costs for other regions in the United States. The cost of these treatments could be offset, in some cases, by the value of the harvested timber. This study also found that these three treatments are likely to reduce the severity of fire, which in turn, may decrease the need for immediate suppression. These noted benefits may expand the range of available treatment options. This information can be used to compare the financial and technical feasibility of various fuel reduction treatments to address tradeoffs associated with different resource and budget scenarios.

Contact: Jamie Barbour, jbarbour01@fs.fed.us, Focused Science Delivery

Partners: Joint Fire Science Program, Oregon State University, Texas Tech University, University of California (Berkeley and Davis), USDA Forest Service Alaska Region

Quality of wood in thinned and unthinned stands assessed

Areas of Prince of Wales and Mitkof Islands were harvested before 1970, with resulting regeneration forming dense stands of Sitka spruce and western hemlock. Some sites were thinned between 1962 and 1985 to several levels of residual stocking. Adjacent, unthinned control stands were available for comparison. To determine whether treatments had influenced wood quality, trees from the thinned and unthinned stands were harvested and sawn into dimension lumber. Researchers found that the wood quality in the thinned stands was not significantly different from wood quality in the unthinned stands.

Outcome: *Tongass National Forest uses results from wood quality study to plan future management.*

The Tongass National Forest is using information from this study to appraise potential timber operations in second-growth timber stands, and to plan future thinning operations in densely regenerated stands.

Contact: Eini Lowell, elowell@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Alaska Department of Natural Resources, Ketchikan Wood Technology Center, USDA Forest Service Forest Products Laboratory, Tongass National Forest, Southern Research Station

Pete Bisson

A second-growth stand of spruce and hemlock on the Olympic National Forest.

Tool: Fuel Reduction Cost Simulator (FRCS) variants

Description:
The Excel®-based FRCS model estimates the cost of harvesting and collecting biomass from small trees and from forest residues associated with commercial logging operations. The model has variants for the western, southern, and northern regions of the United States.

Use:
These new variants of FRCS have been used to develop forest biomass supply curves for all forested counties in the continental United States. The original version was published in 2004 and was limited to forests of the interior West. A request to use the model for a nationwide assessment of the economic supply of biomass available from farm and forest residues and biomass plantations to support bioenergy and biofuels led to this extension of the capabilities of FRCS so that all regions of the United States could be evaluated. In addition, an independent cost module was developed that permits users to easily update costs of diesel fuels, equipment, and labor in any part of the country. Production equations from numerous studies on biomass harvesting operations in different regions of the country were incorporated so that users can select the most relevant equations for their needs.

How to get it:
http://www.fs.fed.us/pnw/data/frcs/frcs_home.htm

Contact:
Dennis Dykstra, ddykstra@fs.fed.us, Human and Natural Resources Interactions Program

Spruce trees killed by bark beetles on Alaska's Kenai Peninsula can be used to make wood-plastic composites.

Young-growth timber can be used for high-value products

Roughly 200,000 acres of trees 25 to 80 years old on the Tongass National Forest are scheduled for treatment in the next 10 years. Species such as red alder, Sitka spruce, and western hemlock have regenerated in areas originally harvested under the 50-year contracts that supported Alaska's pulp mills.

Scientists conducted several studies to evaluate the quality of this young-growth timber and found it can be used for high-value timber products. Grade yields of red alder lumber are comparable to older trees harvested in the Lower 48 States and Canada. Sitka spruce and western hemlock can be used for high-quality house logs, and the shipping weight can be reduced 38 percent by removing the bark and allowing the logs to air dry for a year.

In many of these stands, crown closure inhibits the growth of understory vegetation that would support deer and other wildlife. Thinning and selective removal of these trees may promote the development of the forest understory, and subsequently, food for wildlife.

Contacts: Allen Brackley, abrackley @fs.fed.us, Human and Natural Resources Interactions Program

Partner: Ketchikan Wood Technology Center

Alaska beetle-killed wood can be used to make wood-plastic composites

Bark beetle epidemics have killed countless trees on more than 1.4 million acres of Alaska's Kenai Peninsula. These standing dead trees pose a severe fire hazard to the communities of Homer, Kenai, Soldotna, and others. Community leaders and forest products manufacturers want to know if the beetle-killed wood can still

Vikram Yadama

Manufacturing wood-plastic composites could provide economic benefits to Alaska's Kenai Peninsula.

◀ Kenai beetle kill mitigation project, by Tom Iraci.

Tool: ArcFuels

Description:
ArcFuels is a library of macros within the ArcMap® GIS software. It links (1) key wildfire behavior models, (2) fuels and vegetation data, (3) Microsoft Office software, and (4) ArcGIS. It is used in fuel treatment planning and wildfire risk analyses to streamline wildfire threat and mitigation assessments. The ArcMap framework helps specialists leverage local data and existing fire models to address project-specific issues that typify many fuel treatment projects.

Use:
In 2008, four workshops were held to train nearly 100 fuel specialists to use ArcFuels and related programs.

How to get it:
http://www.fs.fed.us/wwetac/arcfuels/

Contact:
Alan Ager, aager@fs.fed.us, Western Wildland Environmental Threat Assessment Center

Tool: Enhanced MAPSS Fire Forecasting System

Description:
The MAPSS Fire Forecasting System continuously updates monthly forecasts of fire danger and drought looking 7 months ahead for the conterminous United States. The forecasts are based on output from the MC1 Dynamic General Vegetation Model, and recent enhancements allow better characterization of fire danger in shrub and grass regions.

Uses:
For the 2007 fire season, the MAPSS Fire Forecasting System predicted 8,221,775 acres burned in the conterminous United States as compared to the observed 8,796,309 acres burned. A comparison to the large-fire locations observed in 2007 and provided by the National Interagency Coordination Center showed that 62 percent of the locations were successfully predicted by the forecasting system. Currently, nearly 200 land managers from various resource agencies are alerted each month to new fire forecasts posted on the MAPSS Web site via an ever-growing e-mail list.

Contact:
Jim Lenihan, jlenihan@fs.fed.us,
Managing Disturbance Regimes Program

be used to produce wood products. If so, having a market for this raw material could help offset fire hazard reduction activities.

To address this question, station researchers evaluated the mechanical and physical properties of wood-plastic composites produced using wood flour from beetle-killed spruce. They found it is a viable way to use beetle-killed spruce trees. Results also showed that the manufacturing facilities can be started with relatively low capital inputs, and that there could be significant benefits for rural employment and economics.

Contact: Eini Lowell, elowell@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Alaska State Division of Forestry, USDA Forest Service Chugach National Forest, Washington State University

Method improved for estimating recreation-visitor spending

Estimates of national forest recreation-visitor spending are used with estimates of recreation visits and economic models to identify the contribution of national forest recreation to the economies of local forest communities. Traditionally, visitor spending estimates were classified by various recreation activities (camping, hiking, fishing, etc.). Using visitor spending data collected as part of the National Visitor Use Monitoring program from more than 20,000 national forest recreation visitors, PNW researchers showed that the type of recreation trip (i.e., day or overnight trip, local or nonlocal trip) better explained variation in the spending of recreation visitors than did recreational activity. Although the visitor's recreation activity has some influence on visitor spending, ultimately a trip-type approach to visitor classification yields visitor spending estimates that are more reliable and more easily transferred across national forests.

Outcome: *Multiple forest planning activities and analyses at the regional and national levels use improved visitor-spending estimates.*

The spending averages estimated using this approach have been used in forest planning activities in the Forest Service's Northern, Eastern, and Rocky Mountain Regions; by the Bureau of Land Management in Montana; and in national Forest Service recreation reports. These spending averages have been incorporated in Natural Resource Information System computer applications, and in the TMECA

To estimate visitor spending, researchers find trip type rather than activity is a better indicator.

Tom Iraci

The Three Sisters, Oregon

computer application for use in National Forest System Travel Management analyses.

Contact: Eric White, emwhite@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Michigan State University, USDA Forest Service Planning Analysis Group

Visitors differ in their preference for managing postfire recreation

Outcome: Willamette National Forest uses findings to develop a postfire recreation monitoring plan.

The 2003 B&B Fire burned much of the Mount Jefferson, Mount Washington, and Three Sisters Wilderness areas in the Deschutes and Willamette National Forests. Forest managers wanted to know how best to manage for recreation after fire. Research focused on the Eight Lakes Basin within the Mount Jefferson Wilderness, where day hiking, backpacking, climbing, and horse camping are traditional uses. Visitors were asked about their past use, changes in use after the fire, and preferences for managing postfire recreation. Use declined slightly in burned areas 1 to 2 years later; however, these declines appeared less than those caused by the fee demonstration program implemented in 1998.

Visitors differed in their preferences for managing postfire recreation, with some visitors preferring little or no management, some preferring access and use restrictions coupled with site development, and some preferring either access and use restrictions or site development alone.

The Willamette National Forest used these findings to develop a recreation monitoring plan for the B&B Fire area.

Contact: Jeff Kline, jkline@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Oregon State University, University of Idaho, USDA Forest Service Willamette National Forest

New framework helps assess wildfire risk

Scientists developed a framework for assessing wildfire risk that can be used in fuel treatment planning. As part of this process, they evaluated the factors that control spatially explicit burn probabilities, such as spatial patterns of fuels, topography, and wind. They then incorporated burn probability models and risk modeling with planning tools and applied these tools to large landscapes to test fuel treatment management hypotheses.

Scientists completed an initial wildfire risk analysis using this framework for the Ochoco National Forest. These results will be incorporated into the forest's wildfire management plan. Scientists made several presentations about this work to managers and fuel specialists with the Ochoco National Forest and Washington office staff.

Contact: Alan Ager, aager@fs.fed.us, Western Wildland Environmental Threat Assessment Center

Partners: University of California Berkeley, The Nature Conservancy, USDA Forest Service Ochoco and Deschutes National Forests and Rocky Mountain Research Station

Alan Ager

A new decision framework may help forest managers reduce the risk of uncharacteristic wildfires.

Tom Iraci

Smoke forecasts help protect the public's health.

Smoke forecasts used to alert public

The station and its partners provided smoke predictions for the October 2007 wildland fires in southern California. Using the BlueSky smoke modeling framework developed in part by station scientists, the group provided daily 48-hour forecasts of surface smoke concentrations. Fire management officers, incident commanders, and public health officials used these forecasts to much success. In July 2008, the team was asked to provide similar support for fires in northern California.

Outcome: *California fire managers and public health officials use station's smoke and fire weather predictions.*

The smoke and fire weather predictions were used extensively by fire management personnel and public health officials in California. They were also used in briefings to Forest Service leadership and the Presidential Cabinet.

The station and its partners also are providing fire weather model predictions for meteorologists with the Incident Command System and others. Working with the California Air Resources Board (CARB), AirFire has deployed five smoke monitors in northern California as part of a Joint Fire Science Program (JSFP) project. The monitoring locations are providing data for the JFSP project, additional CARB monitors, and public health officials.

Contact: Narasimhan Larkin, larkin@fs.fed.us, Managing Disturbance Regimes Program

Partners: Desert Research Institute; Sonoma Technologies Inc.; USDA Forest Service Southern Research Station and Washington office State and Private Forestry Fire and Aviation Management

Prefire fuel treatments can reduce postfire tree mortality

The value of fuel treatments and other silvicultural practices aimed at reducing wildfire hazard and severity had not been conclusively demonstrated over large areas. To address this, scientists capitalized on the 175,000-acre Tripod Fire that burned through many well-documented fuel treatments on the Okanogan-Wenatchee National Forest in 2006.

Scientists determined the lowest postfire mortality in the forest overstory occurred in areas that had been heavily thinned and received a surface fuel treatment. This indicates that thinning plus surface fuel treatment greatly reduces fire hazard.

These findings validate thinning plus fuel treatments as an effective method for reducing fire hazard and modifying fire behavior and fire severity on the Okanogan-Wenatchee National Forest. The results are also applicable to other dry forests in the West that contain ponderosa pine and mixed-conifer forest.

Contact: David L. Peterson, peterson@fs.fed.us, Managing Disturbance Regimes Program

Partners: University of Washington, USDA Forest Service Okanogan-Wenatchee National Forest

Fuel treatments likely need to be repeated

In many fire-prone forests in the United States, changes over the last century have resulted in overstory structures, conifer densities, down woody structure, and

Andrew Youngblood

A prescribed burn at the Metolius Research Natural Area.

Outcome:
The Joint Fire Science Program and the Wallowa-Whitman National Forest use study results to synthesize ecological effects of fuel reduction treatment.

fuel loads that deviate from those described historically. These conditions elevate the fire hazard. Fuel reduction treatments are one method for reducing fire hazard, but as scientists found, single applications of thinning and burning fuel-reduction treatments do not permanently mitigate the nearly 80 years of fire exclusion and fuel accumulation in low-elevation dry forests in northeastern Oregon.

Scientists used the Fuel Characteristics Classification System to construct a representative fuelbed for each study unit and then calculated three indices of fire potential as measures of the change in fire hazard resulting from treatments. Surface fire behavior, crown fire behavior, and fuels available for consumption returned to pretreatment levels within 6 years, indicating that repeated fuel reduction treatments may be needed to reduce the risk of uncharacteristically severe wildfires.

Contact: Andrew Youngblood, ayoungblood@fs.fed.us, Managing Disturbance Regimes Program

Partners: Joint Fire Science Program, USDA Forest Service Wallowa-Whitman National Forest

Scientists compile a new fuels data set for alternative postfire reforestation treatments

Management decisions for postfire restoration must balance the benefits of revegetation against risks associated with the development of fuels and potential for reburn. After the 2002 Timbered Rock Fire in southwestern Oregon, scientists established eight alternative vegetation restoration treatments and applied them to 40 experimental treatment units. For 4 years, they have monitored the dynamics of vegetation community development, snag abundance and condition, and fuel loading on those units. Each treatment unit provides a prospective fuels model, and these

Tool: Air Quality Impacts Planning Tool (AQUIPT)

Description:
The AQUIPT is designed to help land managers predict the probable impact of smoke from a potential fire, planned or unplanned. It combines the historical weather data of the North American Regional Reanalysis with the Fuel Characteristics Classification System and the BlueSky Framework. Users are able to enter their burn prescription parameters (e.g., maximum and minimum relative humidity, maximum windspeed, and time of year) and AQUIPT will provide a statistical summary of the potential smoke impacts.

This summary includes maps showing average release of fine particulate matter, probability of a location experiencing a significant impact, or maximum release of fine particulate matter produced by all historical episodes meeting the specified conditions. The AQUIPT can also model other nonfire sources of air pollution including industrial emissions and dairy farms.

How to Get It:
Contact Narasimhan Larkin, larkin@fs.fed.us, Managing Disturbance Regimes Program

Tool: A field guide to predict delayed mortality of fire-damaged ponderosa pine

Description:
This field guide for land managers can be used to determine the probability of mortality for an individual tree, or the proportion of trees projected to die within a stand. It is recommended for use in any stand throughout southeastern Oregon or northern California. In the absence of a more accurate validated model, the field guide can be used for ponderosa pine elsewhere in Oregon and Washington. It can be used for trees damaged by prescribed fire or wildfire and is applicable to trees ranging from 3 to 83 inches in diameter and of various ages.

Contact:
Walt Thies, wthies@fs.fed.us. Managing Disturbance Regimes Program

More information:
Gen. Tech. Rep. PNW-GTR-769. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 16 p. http://www.fs.fed.us/pnw/pubs/pnw_gtr769.pdf

data will be used in simulation studies to evaluate the effects of treatments on potential fire behavior at stand and landscape scales.

This ongoing study will provide relative measures of potential fire risks associated with the early phases of active vegetation restoration in burnt forests typical of southwestern Oregon. Managers can use this information to better design the landscape application of vegetation restoration and fuels management treatments.

Contact: Paul Anderson, pdanderson@fs.fed.us, Resource Management and Productivity Program

Partners: Oregon State University, USDI Bureau of Land Management

New model predicts fuel consumption in sagebrush

Before this project, little research had been done to quantify and model fuel consumption in shrub-dominated ecosystems. Quantifying fuel consumption is critical for evaluating fire severity, and for effectively modeling fire effects such as smoke emissions, plant and tree mortality, and wildlife habitat restoration.

This project is developing new consumption models for shrub-dominated ecosystems where a substantial portion of the fuelbed is composed of living and upright vegetation. They differ from models

Clint Wright

Scientists are using data collected before and after this prescribed burn near Lakeview, Oregon, to develop a fuel-consumption model for shrub-dominated ecosystems.

Clint Wright

A prescribed burn in sagebrush near Steens Mountain, Oregon.

for forested systems where most of the fuelbed is composed of dead and down organic matter.

A preliminary model for big sagebrush has been published and incorporated into the fire management decision-support software Consume 3.0. Consume 3.0 has been taught at technical fire management workshops and conferences. Additional models to predict biomass consumption in other shrub-dominated ecosystems such as pine flatwoods, chamise chaparral, and pitch pine scrub are under development.

Contact: Clinton S. Wright, cwright@fs.fed.us, Managing Disturbance Regimes Program

Partners: Joint Fire Science Program, University of Washington

Decision framework helps evaluate risks

Station scientists developed a series of questions to guide fire research and a framework to address these questions. The framework provided an approach for examining the adequacy of existing frameworks, and another for addressing business functions such as fuels treatment budgeting, planning, and application at various spatial and temporal scales; allocating suppression resources around the country; and real-time suppression actions.

Contact: Charles G. "Terry" Shaw, cgshaw@fs.fed.us, Western Wildland Environmental Threat Assessment Center

Partners: Joint Fire Science Program

Tool: BlueSky framework, version 3

Function:
The BlueSky smoke modeling framework forecasts smoke concentrations and trajectories, including the cumulative effects of smoke from multiple wildfires and prescribed fires, long-distance smoke movements, and smoke movement over a 24- to 48-hour period. Version 3 can be used as a modular system that incorporates the most common fire consumption, emissions, plume rise, and dispersion models. By integrating SMARTFIRE output, it also includes better fire location and size information. The framework computer code was completely overhauled to allow users to integrate custom modules or models and adjust parameter settings.

Use:
The SMARTFIRE component of BlueSky version 3 has been positively received by representatives of the Environmental Protection Agency, the National Wildfire Coordinating Group, and the National Interagency Coordination Center, among others. The version 3 rewrite also led directly to the Smoke and Emissions Modeling Intercomparison Project funded by the Joint Fire Science Program, and is being examined for use in other science areas including fuels treatment and effects.

Contact:
Robert Solomon, robertsolomon@fs.fed.us, Managing Disturbance Regimes Program

How to get it:
http://getbluesky.org/

Tool: Annotated bibliography on fire-bark beetle interactions

Function:
This synthesis and annotated bibliography examines literature regarding current trends in fire and bark beetle activity in western forests, beetle effects on fire activity, and fire effects on beetle activity. The project was undertaken to meet the needs of forest managers in the Western United States who are facing more fires and the most extensive bark beetle outbreaks recorded for the region.

Contact:
Becky Kerns, bkerns@fs.fed.us, Western Wildland Environmental Threat Assessment Center

Partner:
University of Wisconsin

How to get it:
http://www.fs.fed.us/wwetac/publications/WWETAC_Fire-BB_InterX_25Feb2008.pdf

Large-scale thinning may push bark beetles into other stands

Scientists used the Westwide Pine Beetle Model and Fire and Fuels Extensions of the Forest Vegetation Simulator (FVS) to simulate a bark beetle outbreak under different fuel treatment scenarios on a 173,000-acre landscape on the Deschutes National Forest. They also analyzed effects of a thinning strategy on subsequent dynamics of a simulated beetle outbreak.

John Laurence

The simulations suggested that thinning stands greatly reduced endemic bark-beetle-caused tree mortality. However, when a beetle epidemic was simulated by inducing drought stress, the beetle population migrated from outside the study area and attacked trees throughout the landscape, even when the majority of the area was thinned. A conclusion from these simulations is that large-scale thinning treatments do not reduce beetle-caused tree mortality under epidemic conditions. The results are supported by several published field studies.

This work resulted in a modeling framework tool that can be used to integrate the long-term potential impacts of bark beetles and management activities into landscape planning for wildfire risk and fuels treatments.

Contact: Alan Ager, aager@fs.fed.us, Western Wildland Environmental Threat Assessment Center; Jane L. Hayes, jlhayes@fs.fed.us, Managing Disturbance Regimes Program

Partners: USDA Forest Service Central Oregon Insect and Disease Service Center, Forest Health Technology Enterprise Team

Logging-induced soil compaction not always detrimental to tree growth

It is conventional wisdom that when logging activities compact the soil, tree growth is negatively affected. Some have suggested that equipment trails should be tilled to ameliorate the compaction. Station scientists, however, have found that equipment trails are not always detrimental to tree growth, and ameliorative treatments may not be necessary on many sites. Three studies published this year indicate that tree growth of seedlings on equipment trails or growth of older trees adjacent to equipment trails was not reduced, and in some cases was increased, when compared to growth away from such trails.

Several caveats pertain, however. The impacts of harvesting equipment on soils will differ depending on initial soil

Thomas Terry

Researchers find that soil compaction is not always detrimental to tree growth.

conditions as well as conditions during harvesting operations. Equipment trails need to be properly designed for local conditions and the appropriate equipment selected for the project. And the conclusions only apply to soil compaction, not to other factors that could be associated with equipment traffic such as removal of topsoil, puddling, or establishment of nondesirable vegetation on disturbed areas.

Contact: Richard Miller, emeritus scientist, millersoils@aol.com, Resource Management and Productivity Program

Partners: Agenda2020, Mississippi State University, Oregon State University, Plum Creek Timberlands, Weyerhaeuser Company, USDA Forest Service Olympic National Forest

Tool: The Canopy Fuel Estimator

Description:

Fire behavior models need information about the type, quantity, and distribution of forest canopy fuels to predict potential fire movement and risk over the landscape. The Canopy Fuel Estimator (CFE) is a new software tool that characterizes canopy fuels over large areas using airborne laser scanning (LIDAR) data. The software automates the process of computing vegetation structure metrics from LIDAR data and then uses these metrics in canopy-fuel regression models to map canopy-fuel weight, crown bulk density, canopy base height, and canopy height across a landscape. Currently, CFE only includes fuel models applicable to forests in western Washington; however, the system allows users to use model sets based on their own regression results for forests in any area.

Use:

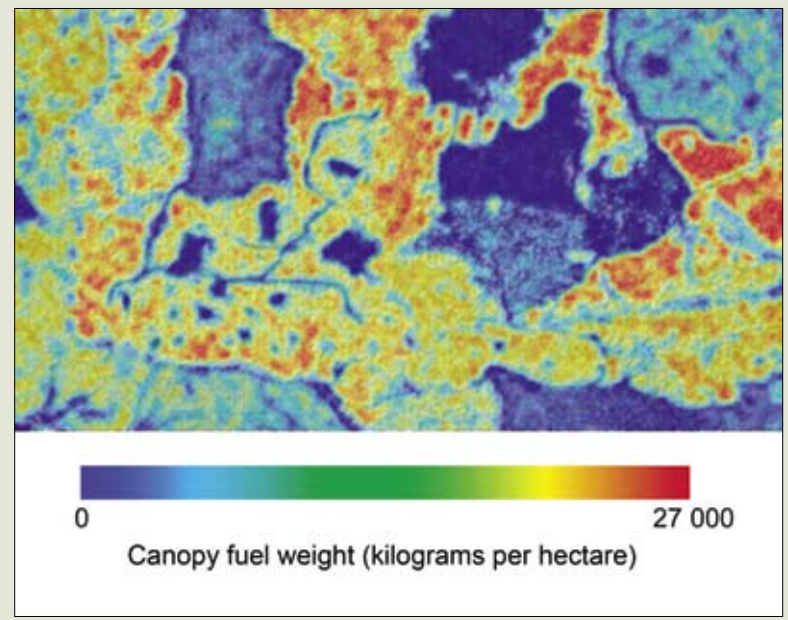
The CFE produces spatially explicit, high-resolution estimates of canopy fuel characteristics over large areas. Such data provide managers with baseline information describing canopy fuels. When used with fire behavior modeling software such as FARSITE, these data help managers predict fire severity and fire behavior across entire landscapes. The CFE approach was used to map canopy fuels over 100,000 acres at Fort Lewis Army Base in Washington. Several national forests, Bureau of Land Management, National Park Service, and several state land management agencies are undertaking large-area LIDAR vegetation mapping projects that can use the CFE package to better map canopy fuels.

How to get it:

CFE is available for download at http://orsys.cfr.washington.edu/cfe/cfe.html.

Contact:

Robert J. McGaughey, bmcgaughey@fs.fed.us, Resource Management and Productivity Program



The Canopy Fuel Estimator uses LIDAR data to determine where forest canopy conditions are most likely to support a crown fire.

Warren Devine

Researchers trench the perimeter of a plot to exclude competition from tree roots at this study site in Fort Lewis, Washington.

Root competition limits development of Douglas-fir saplings

Scientists examined the growth and morphology of Douglas-fir saplings in thinned, mature stands of Douglas-fir after excluding different types of root competition. Stem growth of saplings increased by 27 percent, and foliar biomass increased by 33 percent where root competition from overstory trees was excluded. Tree root exclusion also increased frequency of buds and bud size on saplings and the retention of needles more than 4 years old.

Root competition from understory vegetation did not affect saplings because their development was already limited by shading and soil water competition from overstory trees. Although low- or moderate-intensity thinning of mature Douglas-fir may provide short-term increases in understory light, development of Douglas-fir saplings will likely be limited by the intense root competition from overstory trees. This finding helps public and private land managers who are interested in managing multiaged Douglas-fir stands.

Contact: Warren Devine, wdevine@fs.fed.us, Resource Management and Productivity Program

Partner: Fort Lewis Military Reservation

Understory vegetation of young Douglas-fir forests is resilient to low-intensity thinning

Scientists initiated the Uneven-Age Management Project on the H.J. Andrews Experimental Forest in the late 1990s to evaluate alternative thinning practices for converting young, second-growth Douglas-fir plantations to stands that are diverse in their structure, age, and species composition.

After 5 years of multiple thinning treatments that removed few to many trees in any given area, researchers found relatively little change in the abundance and composition of the understory plant communities. The dominant woody shrubs and fern species regrew after each thinning treatment. Scientists found that the light to moderate degree of disturbance was not sufficient to offset the vigorous growth of preexisting species, or to permit the establishment of different species.

The process of stand conversion from a uniform, even-aged structural condition to a more variable, diverse uneven-aged structure requires several repeated thinnings.

If the management goal is to increase the abundance and diversity of understory vegetation in young, second-growth Douglas-fir forests in the western Cascades, more substantial thinning treatments may be needed to create larger openings in the forest canopy.

Contact: Paul Anderson, pdanderson@fs.fed.us, Resource Management and Productivity Program

Partner: USDA Forest Service Willamette National Forest

Rick Edwards

Western hemlock and Sitka spruce respond well to thinning

The primary objective of the Cooperative Stand-Density Study, a long-term silviculture experiment located on the Tongass National Forest, is to understand how western hemlock-Sitka spruce stands of different ages and site productivities respond to a range of thinning intensities. This study was initiated in the 1970s. After 20 years, data were analyzed from 128 permanent study plots distributed over 250 miles. Scientists found that thinning well-stocked, even-aged, mixed-species stands of western hemlock and Sitka spruce in southeast Alaska significantly increased growth in thinned stands relative to that of unthinned stands, the effect being greater for younger stands or stands growing on more productive sites.

The models developed in this analysis will help land managers predict how western hemlock-Sitka spruce stands of different ages and site productivities respond to different thinning intensities in terms of diameter growth during the first 20 years after treatment.

Contact: Michael McClellan, mmcclellan@fs.fed.us, Resource Management and Productivity Program

Partner: USDA Forest Service Tongass National Forest

Tool: Improved oak growth equations

Description:

Forest managers often use growth models to predict how trees will respond to different treatments. Previously, the equations used to predict growth and survival of Oregon white oak were based on only a few dozen trees, and those equations under-predicted growth when the results were compared to remeasured research plots. Station researchers created a data set of growth plots for Oregon white oak based on more than a thousand trees from several sources and then developed equations that were incorporated into a new release of the publicly available growth model ORGANON. The new equations predict the species to grow faster and be more responsive to management than was previously expected.

Use:

New equations predicting growth and survival of Oregon white oak have been published and the results compared to the models previously available. The new equations were recently used in a landscape analysis of various management alternatives at Fort Lewis Army Base, Washington.

How to get them:

Contact Connie Harrington, charrington@fs.fed.us, Resource Management and Productivity Program

Tool: New snag and log sampling methods and software

Description:
Snags and logs provide essential habitats for many forest animals, and land managers routinely monitor these structures in relation to other management goals. Accurate and efficient methods for sampling snags and logs have been integrated with software to facilitate evaluation of snag and log management and status in relation to other uses, including timber harvesting, firewood gathering, and other types of human access in the Northwestern United States.

Use:
These new methods and software eliminate large sources of sampling bias present in past methods and increase sampling efficiency by more than 50 percent compared to past methods, none of which had software to facilitate sample design and data analysis. These methods, software, and results from their application are being used by national forests in eastern Oregon, eastern Washington, Idaho, and western Montana as part of forest planning, revisions, amendments, and environmental assessments and impact statements.

Contact:
Michael Wisdom, mwisdom@fs.fed.us,
Managing Disturbance Regimes Program

Tom Iraci

Number of retained trees more important than retention pattern

In the Pacific Northwest, retaining live trees in harvest units is an integral part of forest management practices on federal lands, yet the ecological benefits that result from various levels or patterns of retained trees remain speculative. The Demonstration of Ecosystem Management Options (DEMO) study was established in 1994 to address these information gaps.

Treatments represent strong contrasts in the level (15 to 100 percent) and pattern (dispersed vs. aggregated) of retention in mature Douglas-fir forests. A variety of ecological and microclimatic responses were measured, and public perceptions of visual quality were evaluated.

Short-term results indicate that the level of green-tree retention has a greater influence than does the pattern of retention on most ecological and social response variables.

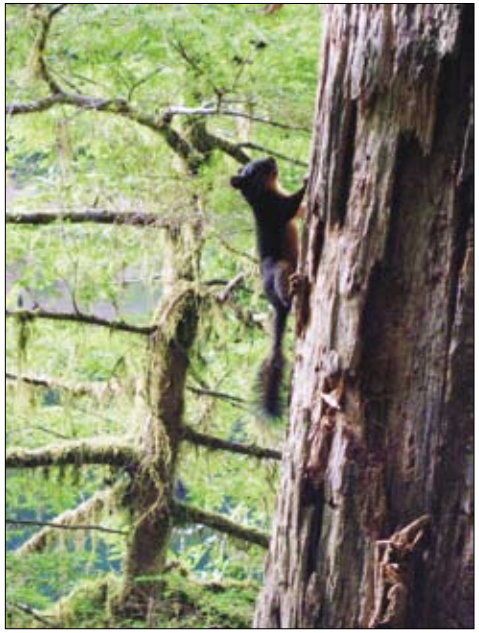
Scientists found that combining relatively large (at least 2.5 acres) aggregates of uncut trees with dispersed trees at levels considerably greater than the current minimum standard of 15 percent may be the most effective strategy for conserving species that are sensitive to disturbance, ameliorating environmental

stresses associated with overstory removal, and gaining public acceptance of variable-retention harvests.

These and other key findings were presented and discussed at a technology transfer workshop for forest managers in November 2007 and at the IUFRO conference *Old Forests, New Management* in February 2008 held in Tasmania.

Contact: Charley Peterson, cepeterson@fs.fed.us, Resource Management and Productivity Program; and Keith Aubry, kaubry@fs.fed.us, Ecosystem Processes Program

Partners: Oregon State University, University of Oregon, University of Washington, USDA Forest Service Umpqua and Gifford Pinchot National Forests, Washington State Department of Natural Resources



Pete Bisson

Pilot study refines techniques for mapping ecology, climate, and topography

Scientists completed initial work on a pilot study to develop and refine "nearest neighbor" mapping techniques for a nationwide project. This project will use forest inventory data, satellite image and ancillary data, and nearest neighbor techniques to construct a moderate-resolution national data set of forest attributes.

These data products will be used in applications ranging from localized scenario modeling (e.g., fire, insects, pathogens, critical habitat) to broad ecosystem modeling (e.g., carbon sources/sinks, climate changes, and ecosystem services).

Forest resource managers and policymakers increasingly require spatially explicit, border-to-border data products that provide statistical summaries for a large array of forest attributes at small to large spatial extents. Nationwide forest attribute data products that are currently available offer coverage for only a few forest attributes of interest and generally lack useful measures of statistical validity.

Contact: Jerome Beatty, jbeatty@fs.fed.us, Western Wildland Environmental Threat Assessment Center

Partners: Michigan State University, Northern Research Station, Oregon State University, USDA Forest Service Forest Health Technology Enterprise Team and Remote Sensing Applications Center

More information: See the Nationwide Forest Imputation System Web site at http://blue.for.msu.edu/NAFIS/

Tool: Ecosystem Management Decision Support (EMDS) 4.0

Description:

EMDS 4.0 provides integrated, multiscale landscape analysis and planning for any spatial scale or combinations of scales. EMDS is an extremely general solution framework that has been applied to many environmental management problems around the world since its initial release in 1997.

Use:

This latest version maintains compatibility with contemporary operating systems and geographic information systems (GIS) widely used in the U.S. Department of Agriculture, Department of the Interior, and state, federal, and private institutions. A significant improvement is the implementation of .NET, a programming interface that increases speed and stability. The latest version also offers an alternative, stand-alone implementation for less technically inclined end users who may be uncomfortable with conventional GIS interfaces. EMDS 4.0 supports evaluation of performance with respect to outcomes over the long term, thus supporting a key requirement of environmental management systems.

Contact:

Keith Reynolds, kreynolds@fs.fed.us, Managing Disturbance Regimes Program

How to get it:

http://www.institute.redlands.edu/emds/

Mecca Flats, Deschutes River, Oregon; © Miles Hemstrom

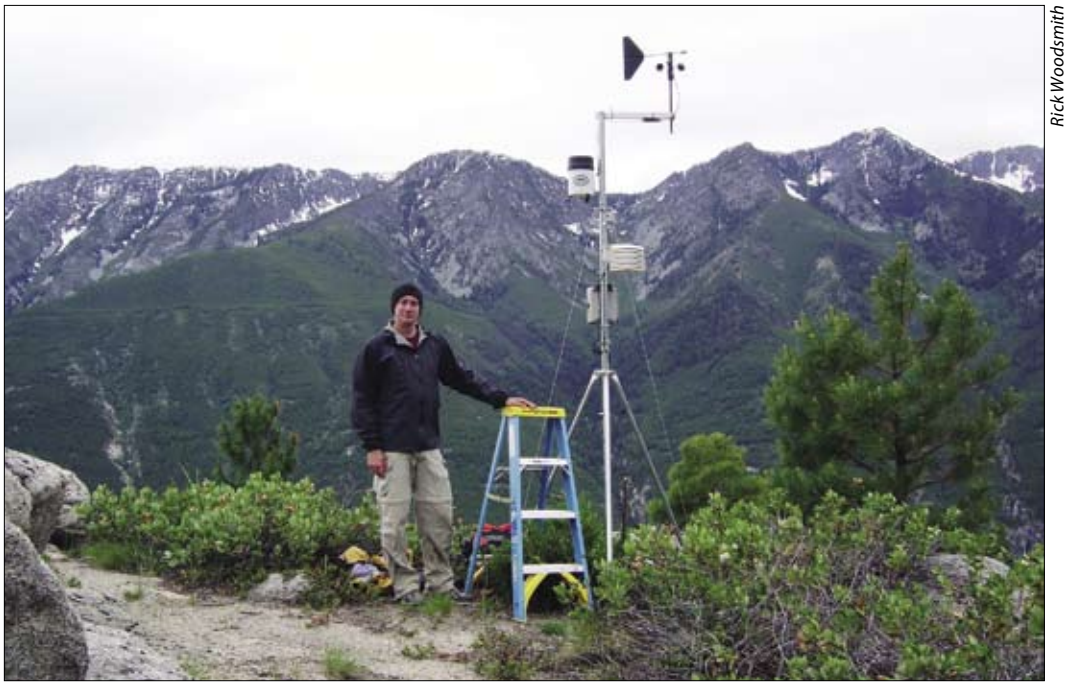
GOAL 4: Communicate science findings and enhance their application

Key Products

- The Climate Change Resource Center Web site was launched to provide information for land managers developing adaptation and mitigation strategies for climate change.
- Options for climate change adaptation for national forests were summarized for the first time.
- Scientists taught a course to help land managers understand how various types of vegetation models can be used in decisionmaking that addresses the uncertainty of future climate.
- A new online multimedia guide provides field procedures on assessing and designing culverts that provide optimal passage for fish and other aquatic organisms.
- Land and fire managers identified their needs for science information as they manage aquatic ecosystems in fire-prone landscapes.
- Youth from inner-city Portland, Oregon, explored watersheds and wildlife as part of a long-term program conducted by the station and its partners.
- Books about rare and little-known species, forest and human community connections, Mount St. Helens, and more were coauthored by station scientists.

Frank Vanni

Researchers at Starkey Experimental Forest and Range, Oregon.



Rick Woodsmith

Station scientists identify climate change adaptation options

Only recently have the Forest Service and other federal agencies begun thinking about ways to adapt to a changing climate. Station scientists contributed to the first effort to summarize adaptation options for national forests and provide the scientific basis for those options. The report, *Synthesis and Assessment of Adaptation Options for Climate Change in National Forests*, was done as part of the U.S. Climate Change Science Program.

Outcome: *Olympic National Forest is implementing climate-smart actions in operational management and long-term planning.*

Also, station scientists and the University of Washington Climate Impacts Group, have established a long-term science-management partnership with the Olympic National Forest to develop locally focused adaptation options for addressing climate change. Through workshops, presentations, and consultations, they are providing the scientific basis for implementing climate adaptation management and planning on the Olympic National Forest. Further workshops explaining the Olympic National Forest pilot project have been conducted with other national forests in the region, and similarly focused planning processes to address climate change may be implemented on other regional forests.

Contact: David L. Peterson, peterson@fs.fed.us, Managing Disturbance Regimes Program

Partners: National Center for Atmospheric Research, U.S. Environmental Protection Agency, University of Washington, USDA Forest Service Olympic National Forest

Station and Pacific Northwest Region address climate change together

The station and Pacific Northwest Region are coordinating their response to climate change through the Climate Change Strategy Group. The group works with leadership and employees to develop ways to reduce our carbon footprint and to manage forests so they can adapt to climate change. The group hosted a Climate Change Short Course in Portland, Oregon, for 200 Forest Service employees to familiarize them with current climate change information and concepts. It has also coordinated a series of sustainable operations and green team workshops across Oregon and Washington, and shared approaches for adapting to and mitigating climate change effects with numerous national forests.

Contact: Becky Gravenmier, bgravenmier @fs.fed.us, Station Director's Office

Partners: USDA Forest Service Pacific Northwest Region

More information: Presentations from the Climate Change Short Course are available at http://www.fs.fed.us/ccrc/video/

Station contributes to national primer on climate change and water

Climate Change and Water: Perspectives From the Forest Service is a brochure that succinctly explains the vital role healthy and resilient watersheds have in maintaining clean water supplies, and how these watershed services could be compromised if the climate changes as projected. It outlines steps resource professionals and landowners can take to prepare for climate change, manage for watershed resiliency, support entrepreneurial projects, advance knowledge, and connect with the public. It emphasizes that actions taken now can minimize future impacts.

Contact: Michael Furniss, mfurniss@fs.fed.us, Communications and Applications Group

Partners: USDA Forest Service National Forest System and State and Private Forestry

More information: See *Climate Change and Water: Perspectives From the Forest Service* at http://www.fs.fed.us/emphasis/products/water-climate-brochure.pdf

John Laurence

Scientists teach course on climate change, vegetation models, and decisionmaking

Climate change and its impacts add another layer of complexity to the decision environment encountered by forest managers, planners, policymakers and other decisionmakers. Planners and managers have long used vegetation models for decisionmaking and communications, but these models differ in their ability to handle uncertainty.

Station scientists developed and taught a course that examined different classes of vegetation models with particular emphasis on their utility for management and planning under climate uncertainties. The course also reviewed generalities of climate change that are useful for decisionmaking purposes. Video presentations from this short course are available online, and scientists are developing a publication on vegetation modeling and climate change.

Contact: Charles G. "Terry" Shaw, cgshaw@fs.fed.us, Western Wildland Environmental Threat Assessment Center

Partners: JISAO CSES Climate Impacts Group at the University of Washington, USDA Forest Service, Rocky Mountain Research Station

More information: See http://forestryvideos.com/videos/

Web site: Climate Change Resource Center

Description: The Climate Change Resource Center (CCRC) Web site is a new resource for land managers developing adaptation and mitigation strategies for climate change. The site offers educational information—including basic science modules that explain climate and climate impacts—as well as decision-support models, maps and simulations, and toolkits that address common Forest Service management and planning situations.

In addition to a more technical subset of educational resources, such as an annotated bibliography and more than 20 topic papers, the Web site also features a primer on climate change and a growing suite of video lectures that may interest more general audiences, including members of the media and other interested publics.

Since the site's launch in March 2008, it has received 11,040 visits. Visitors are from all 50 states, Puerto Rico, and 101 other countries.

The CCRC is a collaborative project of the Pacific Northwest, Pacific Southwest, and Rocky Mountain Research Stations and the Western Wildland Environmental Threat Assessment Center.

How to get it:
http://www.fs.fed.us/ccrc/

Contact:
Michael Furniss, mfurniss@fs.fed.us, Communications and Applications Group

Online tutorial leads to improved aquatic organism passage through culverts

Station scientists produced an online, multimedia guide for field procedures on assessing and designing culverts that provide optimal passage for fish and other aquatic organisms. The tutorial takes the place of a 1-week course, thus saving time, eliminating travel costs, and reducing participants' carbon footprint. The tutorial is highly interactive and includes video, audio, animation, live field forms, and links to other resources.

Outcome: *Land and road managers nationwide use online course to improve fish passage through culverts.*

It covers 50 topics relating to safe, effective culvert inventory and assessment. This tutorial complements a national guide written by a station scientist.

The online tutorial is being used nationwide by land and road managers working for counties, states, timber companies, the Bureau of Land Management, Forest Service, and National Park Service.

Contact: Michael Furniss, mfurniss@fs.fed.us, Communications and Applications Group

Partner: San Dimas Technology and Development Center

More information: See "A tutorial for procedures for inventory and assessment of road-stream crossings for aquatic organism passage" at http://www.fs.fed.us/pnw/pep/PEP_inventory.html

Case studies facilitate advanced learning about culverts and fish passage

Once basic principles are mastered, advanced learning takes place through case studies.

This is widely recognized in law and medicine, but also holds true for other professions. Hydrologists, engineers, and other land and road managers who work to ensure safe roads and passage of aquatic organisms have contributed to 46 case studies from across the country. Designing and constructing road stream crossings can be complex, and a wide variety of solutions can exist, depending on the situation. It is also an inherently expensive endeavor, and mistakes can be very costly. Accessible online, these cases emphasize the application of general principles, the means used to address a wide variety of site conditions, and the lessons learned. The Federal Highway Administration has adopted this resource in its effort to guide design and retrofit of highway culverts for fish passage.

Outcome: *Federal Highway Administration uses case studies to guide design and retrofit of culverts.*

Pete Bisson

Contact: Michael Furniss, mfurniss@fs.fed.us, Communications and Applications Group

Partner: USDA Forest Service Washington office Engineering and Fisheries

More information: See http://www.stream.fs.fed.us/fishxing/case.html

Progress made toward managing fish and fire in the same landscape

The long-term effects of fire on aquatic ecosystems are not well understood. During a two-part workshop, land managers and fire managers identified their information needs for managing aquatic ecosystems in fire-prone areas. Scientists then developed summaries of existing research, theories, and models in response to the problem areas identified by the land and fire managers.

This effort produced a specific outline of research needed to help policymakers and land and fire managers make more informed choices. The national Joint Fire Science Program is using this assessment of research needs to determine subsequent study programs. The Pacific Northwest and Rocky Mountain Research Stations will use the information to guide new research, syntheses of existing research, and science delivery efforts.

Contact: Jamie Barbour, jbarbour01@fs.fed.us, Focused Science Delivery

Partners: The Keystone Center, USDA Forest Service Pacific Northwest Research Station, USDI Bureau of Land Management, U.S. Fish and Wildlife Service

Alan Ager

More research is needed to effectively manage fish and fire in the same landscape.

Introducing more kids to the wonders of the woods

To get more children and young people outdoors, the station contributes to several conservation education programs. One of these is Inner City Youth Institute (ICYI), which provides natural resource education programming to Portland, Oregon, youth. It targets minority and underrepresented communities as a way to encourage students to pursue higher education and careers in natural resources and environmental fields. ICYI received the Forest Service's 2008 More Kids in the Woods challenge cost-share funding for a new Watershed and Wildlife Exploration project. About 200 students participate in ICYI programs annually.

Becky Bittner

Students at the ICYI summer camp learn to identify tree species.

Contact: Becky Bittner, bbittner@fs.fed.us, Communications and Applications Group

Partners: Portland Public Schools, Oregon State University, Urban League of Portland, USDI Bureau of Land Management

Climate change task force begins evaluating genetic and silvicultural options

Station scientists and their colleagues at Oregon State University have formed a task force of forest managers, forest geneticists, tree breeders, silviculturists, and tree physiologists to explore management options for adapting to the effects of climate change on forests in the Western United States.

As part of its outreach education efforts, the task force developed a Web site to inform the public about the potential

Tool: Electronic "feeds" brings research to users

To better meet user's needs, the station has made its popular content available through electronic subscriptions. Subscribing to a Really Simple Syndication (RSS) feed causes new publications or press releases to be automatically delivered to the subscriber's computer.

Currently, more than two dozen feeds are available. Subscribers can receive specific publications, such as *Science Findings*, or notification about new publications under a variety of topic areas, including climate change, fire, or forest management. Because users subscribe to just those feeds that are of interest to them, RSS puts users in control of the information they receive from the station.

How to get it:
See http://www.fs.fed.us/pnw/RSS/index.shtml

Contact:
Tiffany Dong, tdong@fs.fed.us, Communications and Applications Group

effects of climate change and forest management options. The site has links to relevant publications, presentations, and upcoming workshops.

Contact: Brad St. Clair, bstclair@fs.fed.us, Resource Management and Productivity Program

Partner: Oregon State University

For more information: See http://tafcc.forestry.oregonstate.edu/index.html

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TimeMap rounds up 150 years of research

Research activities in the Copper River Delta and Cordova Ranger District of the Chugach National Forest date back more than 150 years. Until recently, a person would have been hard pressed to locate some of these studies or find reliable records of what was done over the years. To address this need, researchers constructed an online visual index arranged by time and topics. This innovation in knowledge management allows users to see all research and management activities on a single "map," arranged by time, in all disciplines and topics. This index facilitates discoveries and preserves a wealth of information and history.

Contact: Michael Furniss, mfurniss@fs.fed.us, Communications and Applications Group

Partner: USDA Forest Service Chugach National Forest

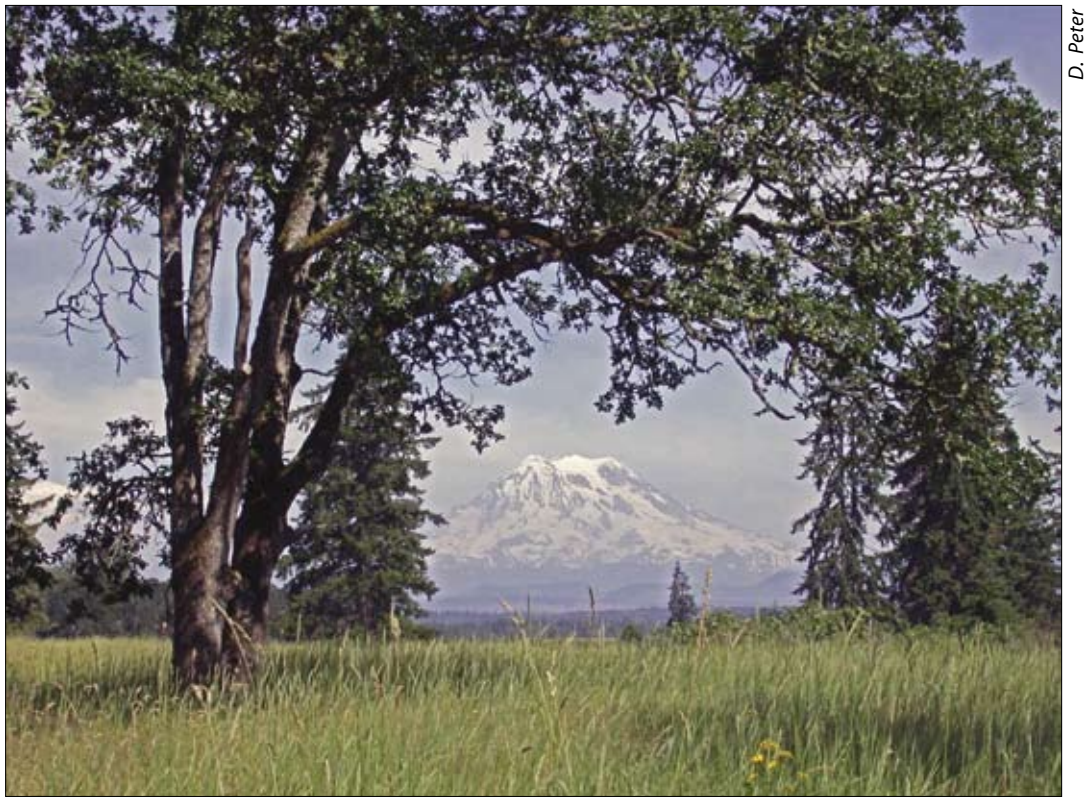
More information: http://www.fs.fed.us/pnw/timemaps/crd/

PNW Media Highlights, 2007–2008

The devastating winter floods in Washington State's Lewis County prompted a number of news stories in December 2007. Reporters sought the expertise of hydrologist Gordon Grant when they had questions about the relationship between the area's past logging and building practices and the massive floods. Grant was quoted in stories run by *The Bellingham Herald*, *The Seattle Times*, *The Chronicle* (Centralia, Washington), and *The Columbian* (Vancouver, Washington). Later, Grant was quoted in stories on Oregon's Marmot Dam removal and on glacial melt at Mount Rainier and the possibility of debris flows. Stories appeared on the television program *Oregon Field Guide* and in *USA Today*, *The Seattle Post-Intelligencer*, and *The Olympian* (Washington).

Research wildlife biologist Keith Aubry and colleagues were featured in several news articles highlighting their work to study the elusive wolverine in the North Cascades and describing the capture and radio-collaring of the study's sixth animal. Stories appeared in several outlets, including *Audubon* magazine, *The Everett Herald* (Washington), *The Wenatchee World* (Washington), and *Methow Valley News* (Washington).

Also generating coverage was the discovery that extracts from the heartwood of yellow-cedar can halt the growth of sudden oak death, a dangerous pathogen responsible for widespread tree death in



D. Peter

Once widespread, oak communities now occupy as little as 1 percent of their historical range in some areas of the Pacific Northwest.

California and Oregon. The study was co-led by research forester Rick Kelsey, who was interviewed for stories that appeared in *Agricultural Research News* and *Capital Press* (Salem, Oregon).

Research forester Connie Harrington's studies on the region's declining oak communities also drew attention. Once widespread in parts of the Pacific Northwest's lowlands, oak communities now occupy as little as 1 percent of their historical range in some areas. Stories on Harrington's research and the species' plight appeared in newspapers all along the Interstate 5 corridor—the historical range of the oak—including The *Seattle Post-Intelligencer*, *The Olympian* (Washington), *The News Tribune* (Tacoma, Washington), *The Chronicle* (Centralia, Washington), and *The Corvallis Gazette-Times* (Oregon).

Contact: Sherri Richardson Dodge, srichardsondodge@fs.fed.us, Communications and Applications Group

Station funds five new Agenda2020 studies

Agenda2020 is a national partnership committed to sustainable forestry and its application in the United States. Funded by the Forest Service and the American Forest and Paper Association (AF&PA), the partnership fosters research exploring numerous high-priority areas.

From 2002 to 2007, numerous collaborative studies were established in the Pacific Northwest through a combined new investment of $2,592,000 from the Pacific Northwest Research Station, $465,000 in matching funds and in-kind from timber companies, and $196,000 in-kind from universities. This year the station, AF&PA Western Research Committee, and Bureau of Land Management awarded funding to the following studies:

- Developing red alder growth and yield models
- Predicting genetic gain using growth models and genetic-gain trials
- Managing forest plantations in the Pacific Northwest: additional site characterization and instrumentation for paired-tree fertilization
- Performance of Douglas-fir as determined by climatic differences between seed sources and planting sites

- Effectiveness of modern forest practices for maintaining water quality and fish habitat in headwater streams of western Oregon using paired watersheds

Contact: Charley Peterson, cepeterson@fs.fed.us

Partners: American Forest & Paper Association, National Council on Air and Stream Improvement, Oregon State University, Plum Creek Timber Company, Port Blakely Tree Farm, University of Washington, USDI Bureau of Land Management, U.S. Geological Survey, Weyerhaeuser Company

Station provides science review for regional planning activities

The station routinely provides science support to federal land use planning efforts by developing new products, synthesizing findings, and providing consultations and scientific reviews. This year, the station completed a science review of a regional process for evaluating aquatic ecological sustainability. The review included scientists from Pacific Northwest and Southwest Research Stations and the National Marine Fisheries Service. The review provided constructive feedback that will help national forests in Oregon and Washington ensure that the best available science is considered as they revise forest management plans.

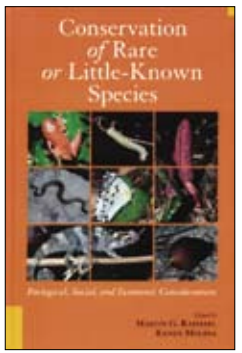
Contact: Becky Gravenmier, bgravenmier@fs.fed.us, Station Director's Office

Partner: USDA Forest Service Pacific Northwest Region

FEATURED PUBLICATIONS

Conservation of Rare or Little-Known Species

Conservation of Rare or Little-Known Species, edited by Martin Raphael and Randy Molina, evaluates approaches and management options for protecting rare or little-known terrestrial species. It also addresses social and economic implications of alternative conservation approaches. The book brings together leading ecologists, biologists, botanists, economists, and sociologists to classify approaches, summarize their theoretical and conceptual foundations, evaluate their efficacy, and review how each has been used. It fills a gap in conservation biology literature by emphasizing the potential importance of species that often constitute the majority in many ecological communities.



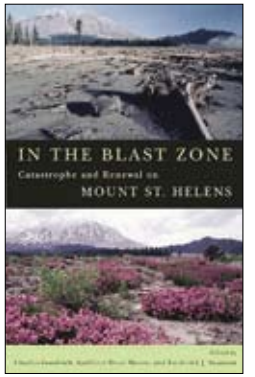
Contact: Martin Raphael, mraphael@fs.fed.us, Ecosystem Processes Program

Partners: Oregon State University, Society for Conservation Biology, The Nature Conservancy, USDA Forest Service Rocky Mountain Research Station, USDI Bureau of Land Management, USDA Forest Service National Forest System, USDI Fish and Wildlife Service, USGS Biological Resources Division

More information: Raphael, M.; Molina, R., eds. 2008. Conservation of Rare or Little-Known Species. Washington, DC: Island Press. 392 p.

In the Blast Zone: Catastrophe and Renewal on Mount St. Helens

The Long-Term Ecological Reflections program brings together nature writers, poets, philosophers, and scientists to reflect on the natural world. One such gathering at Mount St. Helens led to the publication of *In the Blast Zone: Catastrophe and Renewal on Mount St. Helens*. This anthology of essays and poems addresses ecological, geological, and human dimensions of the 1980 eruption of the volcano. Writers offer their interpretations of the volcanic landscapes—the resilience of life, the changing character of a severely altered landscape, and the value of personal relationships in interdisciplinary inquiry in such a place. Writings from *In the Blast Zone* are now used in the interpretive program in the National Volcanic Monument, adding a humanities dimension to the interpretive program dominated by geology and ecology lessons.



Contact: Fred Swanson, fswanson@fs.fed.us, Ecosystem Processes Program

Partners: Oregon State University

More information: Goodrich, C.; Moore, K.D.; Swanson, F.J. 2008. In the Blast Zone: Catastrophe and Renewal on Mount St. Helens. Corvallis, OR: Oregon State University Press. 128 p.

Integrated Restoration of Forested Ecosystems to Achieve Multiresource Benefits

Integrated Restoration of Forested Ecosystems to Achieve Multiresource Benefits is the byproduct of the 2007 National Silviculture Workshop. These proceedings present new ideas in silviculture and forest management for producing multiple resource benefits. Topics include ecosystem services, forest restoration and climate change, increasing biodiversity, fuel reduction, improving wildlife habitat, and forest insect, disease, and health issues.

Contact: Robert Deal, rdeal@fs.fed.us, Focused Science Delivery

More information: PNW-GTR-733. Integrated Restoration of Forested Ecosystems to Achieve Multiresource Benefits. http://www.treesearch.fs.fed.us/pubs/29399

Forest Community Connections

The past two decades have seen a dramatic shift in the social forces that shape natural resource policy. A new book, *Forest Community Connections*, examines the complex relationships that have emerged among individuals, organizations, communities, and forest ecosystems. Bringing together perspectives from sociology, anthropology, political science, and forestry, the authors confront a range of management issues, including wildfire risk, forest restoration, labor force capacity, and the growing demand for a variety of forest goods and services.

The book reveals that the connections that communities have to forests are not simple or static; they are complex and evolving. Understanding these connections is important because it is through these connections that the goals of sustainable forest management will be realized. Through diverse and detailed approaches, this book takes stock of the ways communities interact with forest ecosystems and the opportunities and challenges of community-based forest management and collaborative forest management.

Contact: Ellen Donoghue, edonoghue@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Colorado State University, Institute for Culture and Ecology, Northern Arizona University, North Carolina State University, Oregon State University, Southern Oregon University, University of Minnesota, University of Montana, University of Oregon, University of Vermont, USDA Forest Service Pacific Southwest Research Station

More information: Donoghue, E.M.; Sturtevant, V.E. 2008. Forest Community Connections. Washington, DC: Resources for the Future. 280 p.

Pete Bisson

Log bridge on the Olympic National Forest.

Continue to Part 3

Field trip to Ghost Lake, Mount St. Helens National Volcanic Monument, by Keith Routman

LEARNING EVENTS

Symposia, Workshops, and Tours

- 1,167 people participated in symposia and workshops
- 1,373 people went on field trips
- 3,268 people participated in conservation education activities

The PNW Research Station sponsors scientific and technical events each year, many with the help of partners including nongovernmental organizations, state and federal agencies, and universities. Below is a description of some of these events.

Adapting to Climate Change: At this 2-day short-course, about 30 scientists and land managers gathered at H.J. Andrews Experimental Forest to develop a climate change educational package. On day 1, scientists presented different aspects of climate change relating to natural resource management, and land managers suggested ways to present the information in a more accessible manner and address specific needs. On day 2, scientists delivered modified presentations which were filmed. These will be available as an electronic short-course at http://www.fs.fed.us/ccrc.

Airborne Laser Mapping for Forest Measurement: At this half-day workshop in Colville, Washington, station scientists presented the basics of airborne laser mapping (LIDAR) and its use for forest terrain and vegetation mapping to 40 attendees, including managers and specialists from the Colville National Forest, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, Homeland Security, county commissioners, Confederated Tribes of the Colville Reservation, Spokane Tribe, and several private forest owners and forestry consultants.

Audubon Society: Forty-five members of the Vancouver, Washington, chapter toured Mount St. Helens National Volcanic Monument and learned about ecosystem recovery after the Mount St. Helens eruptions. Another 35 members of the Kittitas chapter attended a "Nature of Night" presentation by a station scientist, and about 50 members of the Portland chapter learned about the nocturnal behavior of red tree voles from another station scientist.

BlueSky Stakeholders' Meeting: About 50 people attended the annual meeting held this year in Boise, Idaho. New developments to the smoke modeling framework were presented, and users provided feedback about their experiences using the BlueSky framework.

BlueSky Training: At the request of the National Weather Service and the Pacific Northwest Coordination Center, station scientists conducted a special training session for eight incident meteorologists. Participants learned how to use and interpret output from the BlueSky framework at this training held at the Pacific Wildland Fire Science Laboratory in Seattle, Washington.

John Laurence

Brown Bag Seminars: The Olympia Forestry Sciences Lab hosted a bimonthly brown bag seminar series for 120 natural resource professionals in the Puget Sound area.

Climate Change Short Course for Forest Service Managers: Station scientists presented an overview of climate change, climate models, and focused on vegetation models that might be useful for predicting the effects of climate change on ecosystems. In Denver, Colorado, 40 participants attended 2 days of informal lectures, group exercises, and open discussions aimed at identifying practical solutions to the agency mandate to include climate change in forest planning.

Michael Furniss

Fiber Optic Workshops: The H.J. Andrews Experimental Forests hosted two workshops where 80 scientists and technical specialists learned about distributed temperature sensing—a process that uses fiber optics to measure water temperature, airflow and the dynamics of snowmelt.

Fish and Fire Practitioner Workshop: Fifteen land managers and fire practitioners identified their information needs for managing for fish in fire-prone areas and managing for fire in areas with important fish habitat at this 2-day workshop in Portland, Oregon.

Fish and Fire Scientist Workshop: During this 2-day workshop in Portland, Oregon, 15 scientists explored the management questions posed by land managers and fire practitioners. Scientists shared their perspectives and suggested topics for synthesis and new research. The workshop yielded a summary of the eight main management issues and outlined a research program that will help policymakers, managers, and practitioners make more informed choices when critical decisions are needed.

Forest Inventory and Analysis (FIA) Client Meeting: FIA updated 30 clients in Anchorage, Alaska, and 50 clients in Sacramento, California, on its activities over the past year and shared research findings. Clients also shared results from their research based on FIA data.

GIS Day 2007 Seminar: About 50 adults attended a seminar and poster session at Oregon State University about uses of geographic information systems (GIS). GIS Day is a global event with the goal of educating millions of children and adults about how geography and GIS make a difference in our lives.

Landscape Workshop: Eight scientists toured the Starkey Experimental Forest and Range to discuss climate change and how it might impact the deeply carved mountainous areas of the interior Pacific Northwest such as the Blue Mountains.

Large-Scale Management Experiments in Western Oregon: As part of the Society of American Foresters 2007 national convention, 35 resource managers, academics, and scientists visited the Green Peak Study Site in Benton County, Oregon, to observe various silvicultural approaches to managing young, second-growth Douglas-fir stands for development of late-successional forest habitat attributes.

Managing Fire With Fire in Alaskan Black Spruce Ecosystems: About 30 scientists and fire and resource managers attended this conference at the University of Alaska,

Fairbanks, to discuss findings from the Joint Fire Science Program on fire in black spruce ecosystems.

Meeting Complex Silvicultural Objectives Through Uneven-Age Management in the Douglas-Fir Region: There were 91 attendees at this workshop in Vancouver, Washington, which reviewed the latest concepts and applications for managing Douglas-fir west of the Cascades in uneven-aged stands for wildlife habitat, diverse forest products, and ecosystem services.

Molalla Forest Productivity Study Tour: Scientists from the station and Oregon State University met with the Silviculture Instructors Group of the Society of American Foresters and forest managers from Port Blakely Tree Farms LP to discuss strategies for managing logging debris and competing vegetation to enhance Douglas-fir productivity and soil resource sustainability. There were 66 participants.

Olympic Habitat Development Study Tour: Station scientists hosted a tour of the study area near Forks, Washington, for 20 natural resource professionals.

Prince of Wales Island Tour: Five members of a watershed restoration working group toured restoration sites on the island in southeast Alaska and discussed opportunities to coordinate restoration activities with scientific studies designed to develop new effectiveness monitoring tools. A second tour on the island involved 15 people who discussed restoration effectiveness monitoring and ways to include nongovernmental environmental agencies and a broader range of Forest Service managers and research scientists in the working group.

John Laurence

RapidSpot Workshops: The workshops demonstrated a new training approach to fuel treatment planning. Teams worked on real data from home units rather than data prepared for a standardized training session. Teams also worked in a collective atmosphere to identify and solve analysis problems within a larger community of planners. Thirty participants attended the workshop in Portland, Oregon, 27 attended in Missoula, Montana, 25 attended in Berkeley, California, and 15 attended the workshop on the Fremont-Winema National Forest.

Riparian Recreation Management Workshop and Field Trip: Sixteen researchers and managers from Washington, Oregon, and Alaska met in Cle Elum, Washington, to discuss the challenges of managing for recreation and biophysical objectives in riparian and coastal environments. They also discussed policy, research, and case-study examples that highlight appropriate and defensible decisions regarding multiple riparian values.

Spotted Owl Field Tour and Bird Walks: As part of their annual meeting, 22 members of the American Ornithologist's Union viewed northern spotted owls in the Oregon Coast Range and discussed ecology and management of owls and old forests in western Oregon. Seven other bird walks were conducted with 88 people participating.

Water Resources Training for Line Officers: About 40 forest supervisors and district rangers attended this course in Sedona, Arizona. The session led by a station scientist addressed adaptation strategies for managing water resources in a changing climate.

Marty Vavra

The Rocky Mountain Elk Foundation Habitat Council tours the Starkey Experimental Forest and Range.

Conservation Education

Experimental Forests and Ranges: Lands for Learning

The 11 experimental areas within the Pacific Northwest Research Station provide a wide range of learning opportunities for everyone from the scientist emeritus to the kindergartner. A few of the fieldtrips and learning events held at these unique areas for long-term research are mentioned below.

- **The Caribou-Poker Creek Research Watershed** near Fairbanks, Alaska, hosted four classes of kindergartners who learned about the landscape of interior Alaska and invasive species.
- **The H.J. Andrews Experimental Forest** in Oregon hosted field trips and outdoor school for more than 400 elementary school children, middle schoolers, and university students. A common theme of these outings was teaching participants how to conduct research and write about their findings. An additional 840 visitors from around the world toured the forest in 2008 to learn about ongoing research. Five writers spent a week in the forest and 40 more participated in writing workshops.
- **At the Starkey Experimental Forest and Range** a variety of groups toured the elk handling facilities and learned about past and ongoing research projects. Fifteen people with the Oregon Parks and Recreation Commission Advisory Group toured the experimental area to learn about the all-terrain-vehicle and hunting study. Sixteen students from the Union High School science club also toured the facilities, as did 8 people with La Grande Ranger District, 40 people with the Oregon Fish and Wildlife Commission and Oregon Department of Fish and Wildlife, 51 people with the Rocky Mountain Elk Foundation Habitat Council, and 3 congressional staffers.
- **The Wind River Experimental Forest** also hosted several activities include a pre-meeting tour associated with the Society of American Foresters National Convention, where station scientists provided an overview of the experimental forest and several silvicultural trials for 57 participants.

2008 Canon Envirothon: At this event, high school students learned about the connections between quality of life and the quality of the environment. Activities

Ken Winterberger

2008 Canon Envirothon near Fairbanks, Alaska.

Glen Ahrens

Forest Camp near Lebanon, Oregon.

were geared to help them develop an understanding of forestry, soils, aquatic ecology, and wildlife. The event for 75 students was held at Chena Hot Springs Resort, near Fairbanks, Alaska.

Amphibians of Clark County: About 65 high school students learned about the life history and ecology of amphibians native to Clark County, Washington.

Bark Beetle Short Course: A PNW scientist presented a course titled "Bark beetles: how they communicate and why it's important" to 20 students participating in Tree School East. This event, sponsored by Oregon State University and the station, was held at Eastern Oregon University in La Grande, Oregon.

Cool Careers in Science: Station scientists talked with elementary and high school students and their families about science careers with the Forest Service, particularly for women and minorities, at an event hosted by University of Washington-Bothell. Approximately 150 people attended.

Forest Camp: This outdoor learning event hosted by the Siuslaw National Forest in Lebanon, Oregon, taught 250 sixth graders about the web of life. This camp also featured an added segment on the role fungi play in forest ecosystems.

Forest Camp—Project Learning Tree: Fifth and sixth graders near Sweet Home, Oregon, learned about the ecology of forests and the web of life, a concept illustrating the links among biotic and abiotic elements of forest ecosystems. Several station scientists contributed a day of instruction to 120 students.

Fungi in Our Forests: On this tour of a tree farm in Astoria, Oregon, 300 sixth graders from Clatsop County learned about the role fungi play in healthy forest ecosystems.

GIS Day 2007 Hike: About 450 students, teachers, and parents from schools in Corvallis and Portland, Oregon, participated in a global positioning systems hike around Oregon State University and attended a lecture about using GIS technology for climate mapping.

Diane Rainsford

GIS Day.

Keith Routman

Cedar Flats Research Natural Area, Washington.

Live Science Video Conference: About 450 high school students throughout Washington watched this live video conference and learned about the recovery of animal populations after the 1980 eruption of Mount St. Helens.

Natural History of Prairies: As part of a cooperative arrangement with New Market Skills Center, a vocational high school in Washington's Thurston County School District, 18 students visited the Olympia Forestry Sciences Laboratory five times and learned about the natural history of prairies and forests. The students helped maintain a prairie garden, an oak savanna, and a forest trail.

Natural Resource Management: A PNW scientist presented two lectures to 40 high school students at New Market Skills Center in Washington. He talked about forest science, forest management, and the spotted owl.

Northwest Science Expo: The station sponsored "Outstanding Forest Science" awards that are given to a high school and middle school student at the Northwest Science Expo. This science fair for young scientists, engineers, and mathematicians, was held at Portland State University in March, and station scientists served as judges.

Oregon State University Extension Outdoor School: In Astoria, Oregon, 150 middle school students learned about the ecology of riparian zones through field and classroom sessions.

Petri Dish Experiment: By participating in an activity called "Growing fungi and bacteria from the dirt on our hands," 70 third graders from Liberty Elementary School District in Albany, Oregon, learned about the scientific method. The children rubbed dirty hands on an agar petri plate and then clean hands on another to see what sort of fungus and bacteria would grow.

Poster distribution: The station distributed approximately 2,200 posters related to Mount St. Helens, invasive species, fish, oak communities, old-growth forests, and sequoias. Most of these posters went to teachers in the Pacific Northwest, but teachers throughout the United States and overseas have also requested them.

Society and Natural Resources: A PNW scientist was invited to lecture on "One hundred years of landscape change: inland Northwest forests in transition." Ten students attend this event at Wenatchee Valley Community College in Wenatchee, Washington.

Streams to Sea: In Juneau, Alaska, 40 first and second graders from Harborview Elementary learned about the hydrology of southeast Alaska. On the field trip they saw the flow paths of water from point of origin to streams and to the ocean.

Tour of Mount St. Helens National Volcanic Monument: Forty-five youth with the National Association for the Advancement of Colored People toured the monument and through hands-on lessons learned about the aquatic ecology at Mount St. Helens.

Training for Mount St. Helens National Volcanic Monument Interpreters and Staff: A PNW scientist led a training workshop for 30 interpreters and staff with the national volcanic monument, focusing on key messages to share with public.

Washington State Science and Engineering Fair: The station gave an "Outstanding Forest Science Project Award" to a 10th-grade student at the Washington State Science and Engineering Fair at Olympic College, Bremerton, Washington, in April. Station scientists also served as judges.

Students on a field trip near Mount St. Helens.

Wolftree: Station employees participated in ecology programs with Portland and Vancouver area middle and high schools. About 100 students were involved. The station also contributed funds for supplies and equipment.

Rowena State Park, Oregon; © Miles Hemstrom

HONORS AND AWARDS

Alaska Region Excellence in Science and Technology Award

Gordon Reeves, a research fish biologist with the Aquatic and Land Interactions Program, was honored by the USDA Forest Service Alaska Region for his spirit of partnership, which has fostered collaboration between research and management to develop projects and products that are critical to effectively managing natural resources throughout southeast and south-central Alaska.

Excellence of Service

Bruce Marcot, a research wildlife biologist with the Ecosystem Processes Program, received a Unit Award for Excellence of Service from the Secretary of the Interior for his work as a member of the International Polar Bear Science Team. He was honored for his outstanding contribution in providing timely information to the U.S. Fish and Wildlife Service for use in its decision to list the polar bear as a threatened species.

Honorary Doctorate

Roger D. Ottmar, a research forester with the Managing Disturbance Regimes Program, received an honorary Ph.D. in natural resources from University of Idaho. Ottmar was honored for pioneering work on the physical properties of wildland fuels and how they contribute to fire behavior, smoke production, and atmospheric pollution. Ottmar's data collection in fires and fuel treatments provided the empirical basis for developing tools such as the Natural Fuels Photo Series and CONSUME software. He also created the Fuel Characteristic Classification System, which greatly advanced the understanding and management of wildland fuels in the United States.

Letter of Recognition

Martin G. Raphael, a research wildlife biologist with the Ecosystem Processes Program, received a letter of recognition from the Director of the USDI Fish and Wildlife Service Pacific Region for his advice and service to the northern spotted owl recovery team as it developed a final spotted owl recovery plan.

Society for Technical Communications Awards

The Communications and Applications Group received top honors from the Puget Sound Chapter of the Society for Technical Communication for its second edition of the station's media guide, *Sources and Science: A Guide to Experts at the Pacific Northwest Research Station*.

Two Chiefs' Partnership Award

Nathan Poage, a research forester with the Resource Management and Productivity Program, shared this award with other members of the Clackamas Stewardship Partners—a collaborative group connecting managers from the Mount Hood National Forest with conservation groups, environmental groups, and a local watershed council. The group received this award from Natural Resources Conservation Service Chief Arlen Lancaster and Forest Service Chief Gail Kimball.

USDA Secretary's Honor Award

Ralph Alig and **Eric White** were honored for their contributions toward development of the Forest Service's open space conservation strategy. They share this award with 22 other members of the Open Space Conservation Team.

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PRINT AND WEB PUBLICATIONS

Print Publications

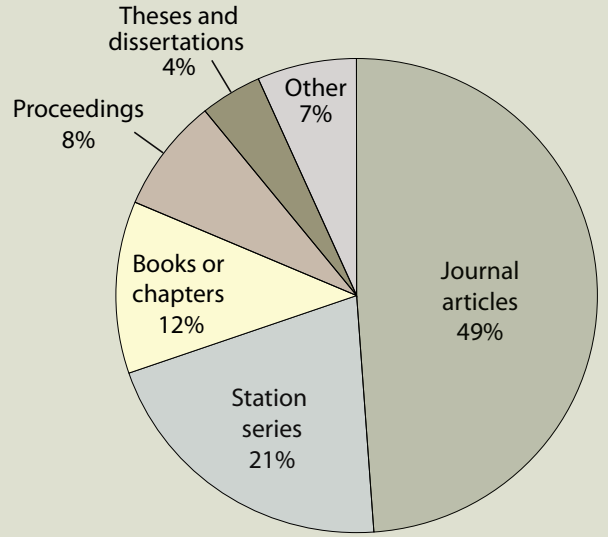
- 360 total publications. (Includes station series publications, journal articles, proceedings, books or book chapters, theses and dissertations, and other publications.)
- 195,007 hardcopies of station series publications distributed.
- 1,734 station publications available online via the station's Web site and Treesearch (http://www.treesearch.fs.fed.us).
- 9 issues of *PNW Science Findings*; about 9,800 copies distributed each issue.
- 3 issues of *PNW Science Update*; about 9,800 distributed each issue.

Number of Publications

Journal articles	176
Station series	75
Books or chapters	42
Proceedings	28
Theses and dissertations	15
Other	24

Types of Publications

360 total publications for FY2008



Web Presence

Beyond Print—The Pacific Northwest Research Station uses multiple media to disseminate research findings to diverse audiences around the world. All publications published by the station are available online. The interested reader can sign up for electronic subscriptions, either for specific publications or by a particular topic area, and receive the publication electronically as soon as it is available.

Receive notification or an electronic edition of new publications by signing up for a Really Simple Syndication (RSS) feed at http://www.fs.fed.us/pnw/RSS/index.shtml

Additionally, the station's Web sites offer multimedia presentations, such as tutorials about climate change or culvert installation to name a few. Acknowledging the increasing number of people who turn to the Web for information, the station's Web pages feature research syntheses and case studies, as well as other tools developed for and in partnership with land managers.

New Multimedia Presentations

The station published 27 multimedia presentations online. Links to these are available on the supplemental CD-ROM found inside the back cover of this report. A sampling of these presentations include the following:

- Eighteen videos related to climate change, including the 11-part *Climate 101 Short Course* series:
  http://www.fs.fed.us/ccrc/video/
- An interactive tutorial for procedures for inventory and assessment of road-stream crossings for aquatic organism passage:
  http://www.fs.fed.us/pnw/pep/PEP_inventory.html
- Two videos on identifying the bankfull stage in a stream or river in which water begins to flow over the flood plain:
  http://www.stream.fs.fed.us/publications/videos.html

New PNW Web sites

The Climate Change Resource Center—This joint effort by the Pacific Northwest, Southwest, and Rocky Mountain Research Stations is a reference Web site for resource managers and decision-makers who need information and tools to address climate change in planning and project implementation on forest lands in the West.

http://www.fs.fed.us/ccrc/

Pacific Northwest Global Change Research—This site provides links to ongoing climate-related research by station scientists.

http://www.fs.fed.us/pnw/research/climate-change/index.shtml

Western Wildland Environmental Threat Assessment Center—The mission of the Western Wildland Environmental Threat Assessment Center is to generate and integrate knowledge and information to provide credible prediction, early detection, and quantitative assessment of environmental threats in the Western United States.

http://www.fs.fed.us/wwetac/index.html

Updated Web sites

Biology and Culture of Forest Plants Team:

http://www.fs.fed.us/pnw/rmp/bcfp/

Demonstration of Ecosystem Management Options Study:

http://www.fs.fed.us/pnw/rmp/demo/

Experimental Forests in Oregon, Washington, and Alaska:

http://www.fs.fed.us/pnw/exforests/index.shtml

FishXing:

http://www.stream.fs.fed.us/fishxing/case.html

Forest Inventory and Analysis:

http://www.fs.fed.us/pnw/fia/

Long-Term Ecosystem Productivity:

http://www.fs.fed.us/pnw/ecop/ltep/

Land Use and Land Cover Dynamics:

http://www.fs.fed.us/pnw/hnri/lulcd/

MAPSS (Mapped Atmosphere-Plant-Soil System):

http://www.fs.fed.us/pnw/mdr/mapss/

Web Statistics

People from 160 countries visited the station's main Web site during fiscal year 2008. Of the 70,268 visits, the majority—84 percent—came from the United States, followed by Canada with 4 percent.

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FINANCES AND WORKFORCE

Finances and Workforce

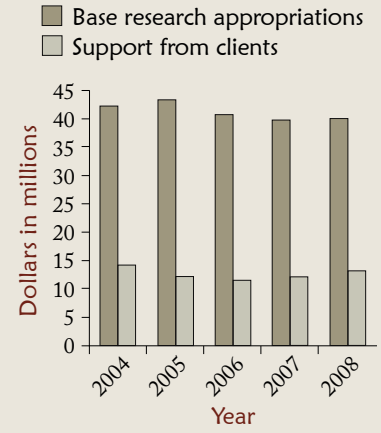
Two sources of funding support the work of the Pacific Northwest Research Station: federal appropriations, which contribute the greatest percentage of funds; and direct client support, which comes from organizations in need of scientific information.

2008 PNW Research Station finances and workforce, by the numbers:

Fiscal year 2008: October 1, 2007, to September 30, 2008

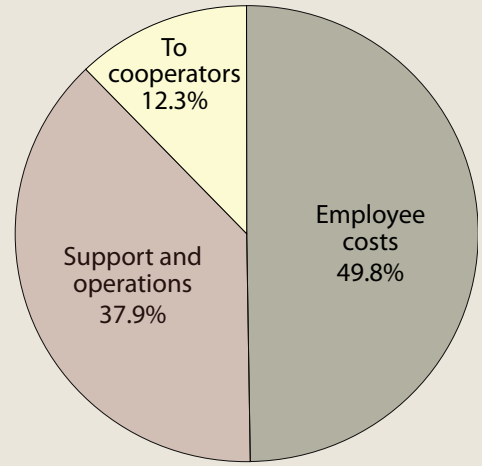
Incoming funding

- Base research appropriations: $40.2 million
- Client support: $13.2 million
- Total funding: $53.4 million



Distribution of funds

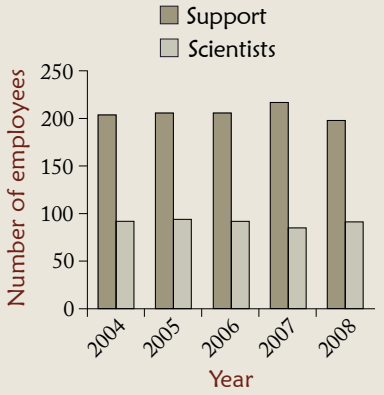
- Permanent employee costs: ($26.6 million)—49.8%
- Support and operations: ($20.3 million)—37.9%
- Distributed to cooperators: ($6.6 million)—12.3%
  - Of $6.6 million to cooperators, 89.7% went to educational institutions



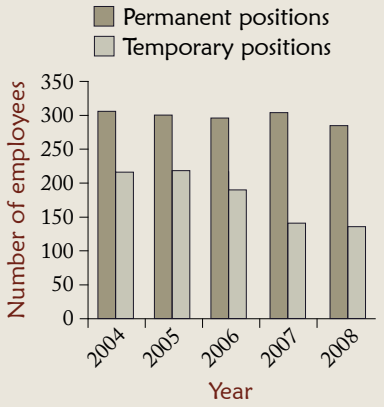
Workforce statistics:

- Permanent workforce: 285 employees
  - Of the permanent workforce, 31 percent, or 89 employees, are scientists
- Temporary workforce: 136 employees
- Total station workforce: 421 employees

Permanent employees by type



Total number of employees



Funding Partners for 2008

Cooperators Who Received Funding for Studies From the PNW Research Station

Educational Institutions

Board of Trustees of the University of Illinois
Desert Research Institute
Loyola University
Michigan State University
Oregon State University
Southern Illinois University
Trustees of Indiana University
University of Alaska Fairbanks
University of Idaho
University of Maine
University of Montana (Missoula)
University of Oregon
University of Redlands
University of Washington
University of Wisconsin
Virginia Polytechnic Institute and State College
Virginia Tech University
Western Washington University

Other Federal Agencies

Department of Commerce, National Institute of Standards and Technology
Department of Commerce, National Oceanic and Atmospheric Administration, Storm Prediction Center
Department of Defense, Navy Systems Management Activity
Department of the Interior, Bureau of Land Management
Department of the Interior, Geological Survey, Forest and Rangeland Ecosystem Science Center

State Agencies

Oregon Department of Agriculture

Nongovernmental Organizations

Defenders of Wildlife
Earth Systems Institute
Society of American Foresters

Clients Who Provided Funding for Studies to the PNW Research Station

Educational Institutions

Idaho State University
Oregon State University
Regents of the University of California

Other Federal Agencies

Department of Agriculture, Agricultural Research Service
Department of Defense, U.S. Army, Fort Lewis
Department of Defense, U.S. Army, Corps of Engineers
Department of Energy
Department of the Interior, Bureau of Land Management
Department of the Interior, Fish and Wildlife Service
Department of the Interior, Geological Survey, Forest and Rangeland Ecosystem Science Center
Department of the Interior, National Park Service, Mount Rainier National Park
Environmental Protection Agency
National Aeronautics and Space Administration, Goddard Space Flight Center (University of Maryland)

State Agencies

Hawaii Division of Forestry and Wildlife
Oregon Watershed Enhancement Board
Washington Department of Fish and Wildlife
Washington Department of Natural Resources

Nongovernmental Organizations

National Fish and Wildlife Foundation
Northwest Power and Conservation Council
The Nature Conservancy

Karen Waddell

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