2007 SCIENCE ACCOMPLISHMENTS of the Pacific Northwest Research Station

United States Department of Agriculture
Forest Service

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.

Vision and Mission

Contents

On the cover: Turnagain Pass, Alaska. This page: Mack Creek, H.J. Andrews Experimental Forest, Oregon. Both photos by Tom Iraci.

A Message From the Station Director

Station Director Bov Eav

As I look back at 2007 for the Pacific Northwest (PNW) Research Station, I am very gratified at the contributions of our scientists and support staff in producing scientific knowledge and tools. This year has brought unprecedented recognition of the contributions of our scientists. Ralph Alig (research forester), Ron Neilson (bioclimatologist), and David L. Peterson (research biologist) were recognized with the Nobel Peace Prize for their contributions to the International Panel on Climate Change. Their participation in this rigorous endeavor is truly remarkable. They and those who have supported their efforts bring great pride to the Station and the Forest Service.

Also, two scientists at the Station were promoted to super grade scientists, representing the highest graded positions in Forest Service Research and Development. The Chief of the Forest Service recognized Richard Haynes with the Distinguished Science Award, Bruce Marcot with the Global Stewardship Award, and Gail Hodgson with the Excellence in Budget and Financial Accountability Award. And there are more. Please turn to page 84 for a description of these and other awards the Station received in 2007.

The PNW Research Station is extremely fortunate to have many retired scientists work with us as emeritus scientists. Their continued work with the Station is very valuable. This year, Jim Trappe, Walt Thies, and Nan Vance became PNW emeritus scientists.

Our partnerships are very important to the work we do, and I want to acknowledge that nearly all accomplishments reported here are possible because of those who work side-by-side with us in generating and delivering new knowledge and developing tools that will help inform land management. This past year we reached out to many of our partners and clients as we developed a strategic business plan that will help guide our work for the next 3 to 5 years. We also had several field visits with Congressional staffers as we presented information on climate change, fire, and urban development.

I look forward in 2008 to new efforts we have started related to climate change. We are working hard to find new ways to generate and deliver science to meet an incredible demand for information as people adapt and mitigate the changes we have begun to experience. We also are reaching out to partners in new endeavors. For example, to better understand urban areas as forested environments, we are working with the University of Washington, Northern Research Station, and others.

I invite you to read this report at whatever pace you might choose: glance through the photos and captions. You might pause at the key findings and tools. And we hope there are headings that will draw you. Following are findings related to climate change, an area that the Station has been studying for about 20 years.

- A vegetation model, developed by one of our Nobel Peace Prize winners, indicates that climate change likely will affect many forest types and increase fire frequency on one-third of the global land surface. Federal, state, and private land management agencies, and The Nature Conservancy have inquired about these MD1 Dynamic General Vegetation Model climate change projections.
- Models are predicting warmer temperatures will lead to less snow accumulation and less runoff during longer dry seasons. This information about snowmelt helps managers anticipate effects of climate change on snow regime.
- Different landscapes have widely different responses to warming climate with ground water becoming the primary source of summer streamflow in parts of Oregon and California with a warming climate. Public water and energy utilities are incorporating information about sources of summer water supply in western Oregon into long-range management plans.
- Land-use changes affect carbon storage and ecosystem goods and services. Scientists found that Oregon's land-use planning program resulted in substantial carbon storage over the past decade, sufficient to offset more than twice the increase in carbon emissions over the same period. The Oregon Department of Forestry and Environmental Protection Agency are using this and other land-use studies to develop climate change strategies.

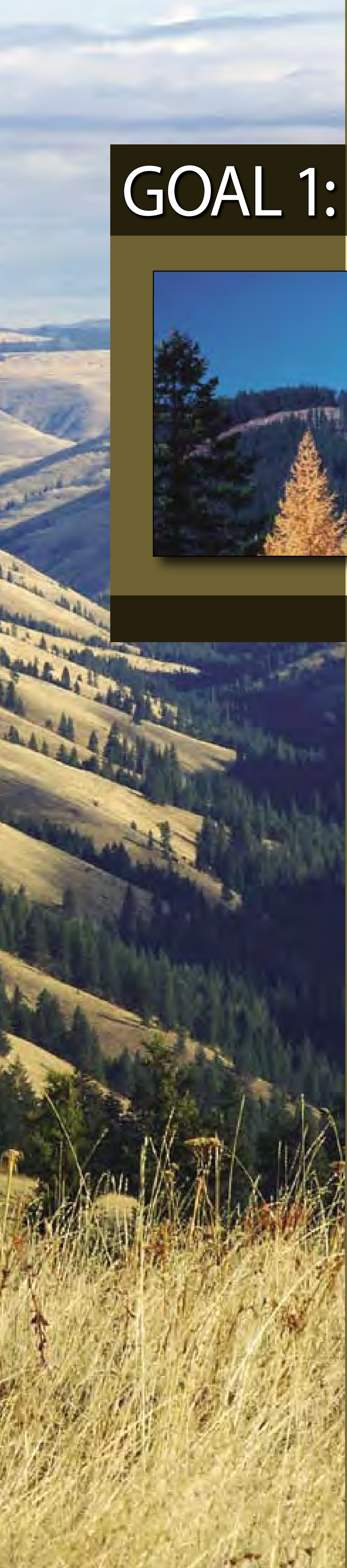
The coming year promises to be one marked by further change and accomplishment. I wish you the best in all your 2008 endeavors.

Pacific Northwest Research Station: The Setting

- 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
- 443 employees (302 permanent, 141 temporary)

Left: Research ecologist samples pond near Mount St. Helens for presence of amphibians. Photo by Tom Iraci.


Goal Accomplishments



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

KEY FINDINGS

- *Models predict warmer temperatures will lead to less snow accumulation and less runoff during longer dry seasons.*
- *Significance of groundwater will increase in parts of the Cascade Range as the climate warms.*
- *Vegetation model indicates climate change likely will affect many forest types and increase fire frequency on one-third of global land surface.*
- *Nutrient chemistry of streams changes seasonally and differs among stream types in southeast Alaska.*
- *Scientists summarize historical climate data and create climate maps to forecast atmospheric conditions contributing to large wildfires.*
- *During the Biscuit Fire in southern Oregon, areas that had been salvage-logged and replanted after an earlier fire appeared to burn more severely than comparable unmanaged areas.*
- *First field study of Washington's wolverine population finds the species may be particularly vulnerable to local extinction.*
- *Two distinct lineages in the chloroplast genome of modern-day sugar pine reveal genetic difference among populations with measurable resistance to white pine blister rust and those with no resistance.*

Left: Blue Mountains, Oregon. Photo by Miles Hemstrom.
Above: Mount Hood, Oregon. Photo by Tom Iraci.

Richard Woodsmith

Climate change models project less snow accumulation. Here graduate students measure snow depth on the Entiat Experimental Forest.

Models predict future snowpack and rate of melt

In the Cascade Range of the Pacific Northwest, snowpacks store winter precipitation for release later in the year. In the semiarid environment east of the Cascade crest, this melted snow is critical for recharging groundwater aquifers and streams. The warmer temperatures predicted with a changing climate likely will mean less snow and less spring and summer recharge and runoff. These effects will reduce water supply during longer dry seasons in the summer and fall for this environment. This will affect the water supply for society at large as well as federally protected salmon species and other aquatic life.

In this study, scientists applied the SNOBAL and ISNOBAL models to two different climate regimes in the Cascade Range to determine rate of snowmelt. They found that solar radiation, both direct and indirect, was the principal factor in snowmelt in the western and eastern Cascade environments, and the rate at which wind and temperature affected snowmelt depended on the topography and vegetation. Simulating snowmelt processes helps managers anticipate effects of environmental change on the snow regime in the Pacific Northwest.

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

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

Different landscapes have widely different responses to warming climate

Station scientists have found that where large groundwater systems are present, these aquifers are the primary source for rivers in western and central Oregon and northern California during the dry summer months. Scientists traced the source of late summer water in this region to groundwater stored in permeable lava flows in the Cascade Range. These immense groundwater reserves help explain why many large rivers in this region continue to have relatively high flow volumes in the summer when high-elevation snowpacks have receded and when many other rivers throughout the West are quite low.

Using these findings, scientists modeled how regional streamflow will be affected by climate change. They found that different landscapes will have widely different responses to a warming climate because of differences in their groundwater dynamics. Regions of the West fed by groundwater will continue to have streamflow under climate warming, in contrast to areas fed exclusively by snowpack, such as the southern Sierras in California. These same groundwater regions, however, will be most sensitive to a warming climate and will lose a greater proportion of their flow volumes because the annual recession or multimonth decrease in flow will start earlier in the year and last longer for these slow-draining systems.

These findings have significant implications for how rivers, dams, and water supplies are managed in the future throughout the West. They are being incorporated into long-range management plans and strategies developed by public water and energy utilities, and also are helping scientists develop better models for predicting late summer streamflows.

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

Partners: Eugene Water and Electric Board; Oregon State University; University of California, Santa Barbara

Outcome: Public water and energy utilities are incorporating information about sources of summer water supply in western Oregon into long-range management plans.

Climate change likely will affect many forest types and increase fire frequency

A changing climate means trees and other plant species may become suited to different areas than where they are currently located. This has profound implications for biodiversity and economic concerns. To help anticipate this change, scientists developed the MC1 Dynamic General Vegetation Model, which projects what might grow where under different temperature and precipitation regimes. The model also projects fire frequency under different climate scenarios. These climate scenarios are linked to high, moderate, and low trajectories for future greenhouse emissions. Simulations showed that areas of tropical woodland, temperate mixed forest, and tundra and alpine vegetation are potentially the most vulnerable to impacts of future climate change, and that approximately one-third of the global land surface could experience increased fire frequency.

Numerous federal, state, and private land management entities have asked Station scientists about these findings. The Nature Conservancy is considering these research results as it incorporates climate change into conservation action plans.

Contacts: James Lenihan, jlenihan@fs.fed.us; Ronald Neilson, rneilson@fs.fed.us, Managing Disturbance Regimes Program

Partners: Oregon State University, The Nature Conservancy

Outcome: **The Nature Conservancy along with federal, state, and other private land management agencies have inquired about MD1 Dynamic General Vegetation Model climate change projections.**

A warmer climate is projected to shrink range of lodgepole pine in Alberta

Lodgepole pine, the dominant tree in Alberta, Canada, is prevalent throughout western North America and is a commercially valuable timber species. Through a series of studies using the province's extensive permanent study plot network, a Station scientist and his colleagues estimated the effects of global climate change on lodgepole pine over the next century.

Warren Olney

Mount Hood, Oregon.

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John Laurence

Pine seedling growing in ashes.

Model simulations indicate that in areas where enough moisture is present, lodgepole pine will actually thrive with warmer temperature, with dominant trees growing about 3 additional feet per decade of the 90-year simulation. Because the warmer climate is also projected to be drier, however, the future range of the lodgepole pine is projected to be much smaller than it is currently. In Alberta, the species would be confined to the foothills of the Canadian Rockies under this climate scenario.

This information enables land managers to begin planning ahead for a climate that is projected to change faster than the slow-growing species can adapt.

Contact: Robert A. Monserud, rmonserud@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Alberta Sustainable Development; Russian Academy of Science, Siberian Branch

Modest increases in global temperatures could significantly alter ecosystems in northwestern Yunnan, China

Potential impacts of climate change on global, regional, and local biodiversity are a significant environmental concern. The Hengduan Mountains of northwestern Yunnan Province, China, support many rare and endemic species as well as alpine and coniferous forest ecosystems of critical value to the local human population. Simulation runs of the MC1 Dynamic General Vegetation Model under three climate-forcing scenarios projected that even modest increases in temperature could cause significant alteration of these ecosystems. For example, simulated increases of 6.8 °F in average annual temperature in the latter part of the 21st century were projected to cause coniferous forests to shift to more temperate forest types and loss of alpine meadows–with attendant loss of habitat for many rare and endemic species that depend on the coniferous forest and alpine ecosystems as well as socioeconomic values.

This project and its outcomes contribute to the larger goals of the Forest Service to help conserve forests worldwide and are part of The Nature Conservancy's ongoing work in northwestern Yunnan. Outcomes will be used to help identify how future climate change will affect conservation targets in China, primarily in alpine, subalpine, and coniferous forest ecosystems.

Contacts: James Lenihan, jlenihan@fs.fed.us, Managing Disturbance Regimes Program

Partners: Colorado State University, The Nature Conservancy

Outcome: The Nature Conservancy is using climate change work in Yunnan, China, to help conserve various forest types.

Land-use changes affect carbon storage and ecosystem goods and services

The ability of trees to store carbon makes conserving forest land an effective way to offset increases in carbon emissions and consequently mitigate greenhouse gas production and resulting climate change. As a result, land-use laws can play a key role in determining the amount of carbon that is stored. Scientists found that Oregon's land-use planning program resulted in substantial carbon storage over the past decade, sufficient to offset more than twice the increase in carbon emissions in Oregon over the same period. Nationally, forest land conservation can contribute significantly to carbon storage as well as enhance other ecosystem goods and services associated with forests. For example, additional research linking land-use projections with forest fragmentation analyses quantifies how land-use changes affect biodiversity in Western States. Forest land conversion and fragmentation are shown to not only reduce carbon storage but also to reduce forest biodiversity.

These findings were used by the Oregon Department of Forestry and the Environmental Protection Agency to develop strategies for addressing global climate change within a multisector economy. More broadly, the research lends support to current interests within the Forest Service in taking a greater leadership role in the conservation of forest land and other open space nationally.

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

Partners: Oregon Department of Forestry, Oregon State University, Texas A&M University, U.S. Environmental Protection Agency

Outcome: **Oregon Department of Forestry and Environmental Protection Agency use land-use studies to develop climate change strategies.**

Stream chemistry changes seasonally in southeast Alaska

The productivity and quality of stream habitats is determined by the input of organic material produced outside the stream, such as branches and leaf litter, and production of organic matter from within the stream, which is largely controlled by the availability of nitrogen and phosphorous. Recent research in southeast Alaska indicates that the chemistry of different stream types changes seasonally in predictable ways.

Understanding differences among glacial, clearwater, and brownwater streams, as well as current conditions and the natural range of variation among these stream types is critical for predicting future change related to climate warming. This information will help land managers categorize watersheds into functionally distinct groups, which will allow them to tailor activities specifically to a watershed, reducing the need for onsite surveys.

Contact: Rick Edwards, rtedwards@fs.fed.us, Aquatic and Land Interactions Program

Partners: University of Alaska Southeast

Forested wetlands and bogs have lower rates of mineralization than previously believed for southeastern Alaska

A detailed study of field and laboratory experiments conducted by scientists showed that nitrogen and phosphorus mineralization rates are very low in southeastern Alaskan wetlands. In contrast, the high internal nutrient recycling rates in open bogs indicates that these ecosystems retain nitrogen and phosphorus. Forested wetlands do not have as great a potential for internal nutrient cycling as bogs and are sites for exchange between vegetation and surface waters.

Nitrogen and phosphorus can influence the ability of terrestrial ecosystems to sequester carbon, so understanding the magnitude of nitrogen and phosphorus cycles is necessary for estimating carbon cycling and sequestration.

David D'Amore

Nitrogen and phosphorus levels in soil indicate the ability of this southeast Alaska bog to sequester carbon.

Knowledge of mineralization rates also is important to developing models of carbon sequestration that determine future scenarios of vegetation succession under changing climate conditions.

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

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

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NEW TOOL

Regional Wetland Delineation Manual for Alaska

Description: A guide for delineating wetlands in Alaska that uses indicators that are specific to Alaska's ecosystems to determine wetland boundaries based on soils, plants and hydrology.

How to get it: The guidebook is available online from the U.S. Army Corps of Engineers at http://www.usace.army.mil/cw/cecwo/reg/erdc-el_tr-07-24.pdf

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

Historical climate data and new maps aid predictions of large fires

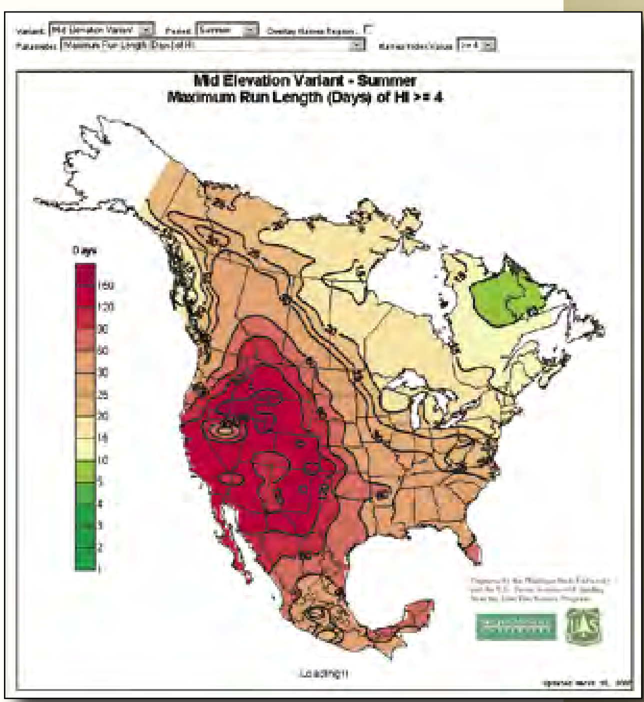
"Blowup" fires are situations where fuel conditions and the weather at the ground fail to foretell sudden increases in fire intensity or spread. These blowups create extremely dangerous situations for wildland firefighters. Since 1988, fire weather forecasters have used the Haines Index to evaluate the potential for large fires, based on the stability and moisture content of the lower atmosphere. But until now, there has been no information available about what "normal" atmospheric conditions are for a given location. To address this need, Station scientists developed a North American climatology for the Haines Index that summarizes atmospheric information from 1961 to 2000. They produced 7,600 maps (now available at http://www.airfire.org/haines) to provide context for evaluating existing conditions and context for forecast conditions.

Fire behavior analysts, long-term analysts, and the National Predictive Service Group are using the Haines Index Web climatology information. The historical climatology is also an integral part of a recently completed Joint Fire Science Program study to evaluate how climate models predict the Haines Index will change over the next 100 years. This information will help guide long-term resource management and policy decisions.

Contact: Brian Potter, bpotter@fs.fed.us, Managing Disturbance Regimes Program

Partners: USDA Forest Service Northern Research Station, Joint Fire Sciences Program; Michigan State University; National Predictive Services Group

Outcome: Fire analysts use climatology maps to predict large fires.



This fire climatology map, based on historical data, shows the number of consecutive days when weather in the lower atmosphere creates dangerous and erratic fire conditions. Users can select from over a thousand maps such as this one for various regions, seasons, and other predictors from http://www.airfire.org/haines.

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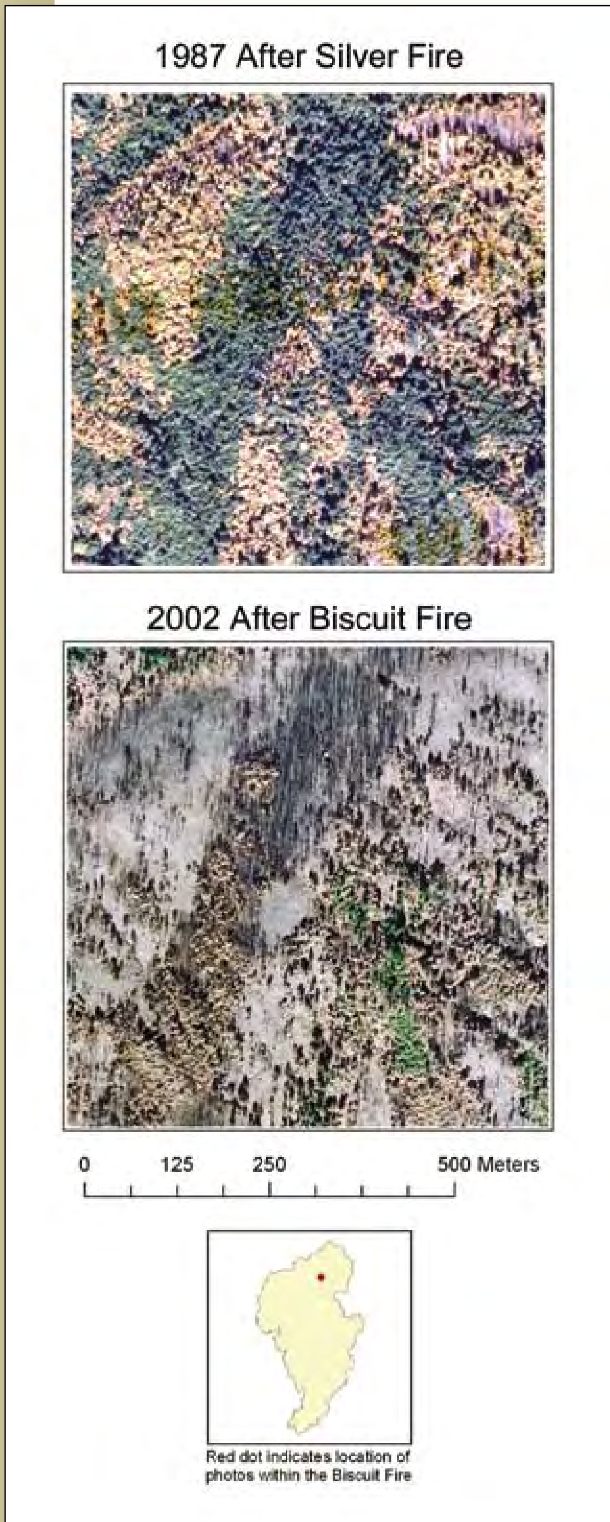

Areas that burned severely in the 1987 Silver Fire tended to burn again at high severity in the 2002 Biscuit Fire, regardless of management treatment.

Reburn severity differs depending on management history of forest vegetation

Following the massive Biscuit Fire in southern Oregon in 2002, Station scientists had the unique opportunity to study the effects a past fire and subsequent management can have on future fire severity. Parts of the area that burned in 2002 also were burned in 1987 by the Silver Fire and then either salvage-logged, planted, and managed to establish Douglas-fir plantations or left to naturally regenerate.

Using satellite and aerial imagery and management records, scientists found that areas burned severely in the Silver Fire tended to burn again at high severity in the 2002 Biscuit Fire, regardless of management treatment. Areas that were salvaged-logged and planted after the initial fire, however, burned more severely than comparable unmanaged areas, suggesting that slash left over from logging and fuel conditions in conifer plantations can increase fire severity for some time despite removal of large woody fuels.

The work also reveals that in mixed fire regimes such as southwest Oregon, the occurrence of one wildfire does not necessarily reduce the severity of a second wildfire burning within a decade or two. This is contrary to what has been found in drier forest types.

This study is the first to look at how postfire management can affect vegetation burn severity in a subsequent fire. Continued research is needed to further understand the causes of these results and to better understand the tradeoffs associated with postfire forest management.

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

Partner: Oregon State University

Matthew Horning

Postfire resprouting is one of the many traits being analyzed in the bitterbrush common gardens in Madras, Oregon.

High level of genetic diversity found in antelope bitterbrush, an important postfire species

Antelope bitterbrush is a dry-land shrub that occupies an important ecological niche in many fire-prone communities across the Western United States. Because it is an important food source for wildlife species, bitterbrush is frequently planted by federal agencies in postfire revegetation and landscape restoration activities.

Station scientists have begun to analyze the genetic diversity of bitterbrush as part of a larger effort to develop seed movement guidelines. Analyses to date reveal high levels of genetic diversity in the species. Markers developed in this study are now being applied to assess the genetic diversity in bitterbrush cultivars that are widely planted on public lands. These results will be combined with quantitative genetic data to identify adaptive traits in this key restoration shrub.

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

Partners: USDA Forest Service, Pacific Northwest and Pacific Southwest Regions; USDA National Research Initiative

Washington's wolverine population may be vulnerable to local extinction

Relatively little is known about the distribution and ecology of the wolverine, one of the rarest mammals in North America. Wolverines once lived in the Sierra Nevada of California, but now the northern Cascade Range in Washington represents the southern extent of their current range along the Pacific Coast, making the species a candidate for listing under the Endangered Species Act.

During the winters of 2005–06 and 2006–07, scientists captured and radio-collared four wolverines in the North Cascades—a pregnant female, a juvenile female, and two subadult males. Using satellite technology, scientists monitored the wolverines' movements and documented areas of use ranging from 900 to

The first field study of Washington's wolverines indicated that the species population is small and isolated.

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1,200 square miles. Early results from the field study—the first to study the species in the Pacific Northwest—suggest that Washington's wolverine population is small and isolated and may be particularly vulnerable to local extinction.

The study's findings have provided the first empirical evidence of a resident wolverine population in the Pacific Northwest and have helped characterize the species' use of boreal forest habitats in the North Cascades. This work contributes new information critical to the conservation of wolverines in the contiguous United States and to the numerous land management agencies charged with the species' management.

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

Partners: USDA Forest Service Okanogan-Wenatchee National Forest, Washington Department of Fish and Wildlife

Rare salamander lives in areas prone to catastrophic disturbance

Van Dyke's salamander is likely the rarest small vertebrate in the Cascade Range. It lives in small, steep streams and seeps within the volcanic regions of Mount St. Helens and Mount Rainier. The salamander is sedentary; most of the animals monitored in this study moved less than 6 feet during a 4-month period. Its scarce and patchily distributed habitat in an active volcanic region, combined with its low mobility and reproductive rates are presumably factors that have resulted in the small, highly fragmented population that exists today. The salamander is likely a relic from the Pleistocene 10,000 to 14,000 years ago and is undergoing a slow decline that may be accelerated if predicted global warming trends occur. The U.S. Forest Service, National Park Service, and Washington Department of Fish and Wildlife are using results from this study to develop conservation plans and to meet survey protocols of the Northwest Forest Plan.

Charlie Crisafulli

Van Dykes's salamander is likely the rarest small vertebrate in the Cascade Range.

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

Partners: Oregon State University, Central Washington University

Charlie Crisafulli

Small, steep streams in the volcanic regions of Mount Rainier and Mount St. Helens are home to the rare Van Dyke's salamander.

John Lehmkuhl

This riparian area along Devil's Gulch in the Okanogan-Wenatchee National Forest contributes to the forest's biodiversity.

Midelevation riparian zones contribute to bird diversity in dry forests

Riparian areas are critical to biodiversity, but that importance varies greatly across regions, landscapes, and elevations. Station scientists quantified breeding bird abundance, diversity, and indicator species in riparian and upland dry forests along large streams in the eastern Cascade Range, Washington. Riparian areas did not have more species than upland forests, but riparian bird community composition was different from that of upland forests and contributed to landscape-scale avian diversity. Results from this study indicate that current riparian buffers could be effective avian refuges and movement corridors. Scientists also identified indicator species for predicting and monitoring changes in bird species composition after management practices or environmental changes.

Forest managers may use findings and models from this work to predict the biodiversity value of specific riparian areas and could use the indicator species identified in this study to predict and monitor shifts in bird species composition from fuel reduction and other management practices.

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

Partners: USDA Forest Service, Okanogan-Wenatchee National Forest

Douglas-fir needles protect trees against disruptions in water transport

Xylem is an extremely important tissue in plants that is responsible for transporting water from roots to leaves. Because it relies on constant tension to transport water upwards, xylem is extremely sensitive. The entry of gas bubbles—known as emboli—can break the cohesion of the water column and disrupt water transport. In the branches of Douglas-fir, for example, embolism is not readily reversed and must be limited if the xylem is to remain conductive for many years.

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Scientists found that, in contrast to stems, the xylem of Douglas-fir needles undergoes daily cycles of embolism and refilling. The stomata, which are small openings on the leaf surface where water vapor is released during transpiration, respond to this variable hydraulic signal by limiting their release of vapor, which prevents tension in stems from reaching levels where embolism-induced loss of transport capacity increases rapidly. Scientists found that both the hydraulic architecture of leaves and stomatal control of transpiration are finely tuned to height-related increases in xylem tension. This allows taller trees to keep their stomata open for photosynthesis while maintaining the tension necessary for successful water transport.

These findings are fundamental to understanding how trees cope physiologically with increases in water stress that are associated with increasing height.

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

Partner: Oregon State University

Scientists are unraveling the mystery of how tall trees transport water to their tops.

High-tech method works well to measure soil depth in the Sierra Nevada

Soil depth can influence where trees and shrubs grow, particularly in forests that experience summer drought. Visual surface conditions and low-tech methods for estimating soil depth may overlook thick layers of weathered bedrock that can serve as a potential rooting medium for deep-rooted trees and shrubs. This study evaluated different methods for measuring soil depth in the mixed-conifer forests of the Sierra Nevada. Only the refraction seismic method was able to measure various soil profiles with different levels of rock content. This method involves geophones connected to a computer, which calculates soil depth based on the intensity of sound vibrations and the length of time it takes for these vibrations to hit bedrock. Understanding subterranean influences on the spatial distribution of vegetation is another component to understanding where and how forests grow.

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

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

New model predicts seasonal variation in soil water redistribution

In earlier studies, Station scientists found that deep roots play an important role in ensuring conifer survival during the Pacific Northwest's dry summer months. Conifer roots take up water from deep soil layers and then hydraulically redistribute it near the surface, slowing the drying of upper soil layers and reducing seasonal dieback of shallow roots.

Scientists have now constructed a simple model that predicts how water will be hydraulically redistributed by roots in the region's ponderosa pine and Douglas-fir forests. Using parameters such as rooting density, driving force for water movement, and root conductivity, the

Left: Lookout Creek, H.J. Andrews Experimental Forest, Oregon. Photo by Tom Iraci.

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model enhances scientists' ability to predict seasonal variation in hydraulic redistribution of soil water. More broadly, the model improves understanding of the relationship between vegetation and water availability, which can inform management strategies.

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

Partners: Oregon State University, U.S. Environmental Protection Agency

Douglas-fir, western hemlock differ in their ability to extract soil water

Douglas-fir and western hemlock are two of the most abundant and widely distributed conifers in western North America. Although both species can—and often do— co-occur in forests, their distributions typically extend to different extremes along a moisture gradient: Douglas-fir occurs in drier, interior sites, whereas western hemlock is found in wet coastal areas.

To better understand the basis for the species' ecological distributions, scientists studied patterns of soil water extraction and root distribution around old-growth Douglas-fir and western hemlock trees. They found that, although western hemlock tended to have greater root areas, Douglas-fir were better able to seasonally extract water from the soil. This apparent greater efficiency of Douglas-fir roots helps explain why the species grows better on dry sites than does western hemlock.

These findings contribute to the fundamental understanding of these species' distributions and are of interest to silviculturists, forest ecologists, tree physiologists, and others charged with developing management strategies.

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

Partner: U.S. Environmental Protection Agency

Diversity in chloroplast genomes tracks the prevalence of blister rust resistance in sugar pine

Like all North American five-needle pines, sugar pine is susceptible to white pine blister rust, a serious fungal infection that is one of the most destructive diseases of the *Pinus* genus. In sugar pine, rust resistance is genetically conferred, and this resistance is more prevalent in the southern latitudes of the sugar pine's range.

To understand the historical forces responsible for this gradient in resistance, scientists conducted a chloroplast DNA survey of sugar pine and its near relatives from North America and Asia. Results revealed two distinct chloroplast lineages, indicating a major historical break in the ancestral gene pool of modern-day sugar pine. Scientists found that the published frequencies of the gene that confers blister rust resistance differs significantly, depending on the chloroplast lineage.

Although chloroplasts, the microscopic components responsible for photosynthesis within plant cells, are not directly linked to resistance, the partitioning of chloroplast diversity between populations showing no resistance and measurable resistance indicates that these genetically distinct groups have only recently come into contact.

These data are being used to develop models that quantify the historical prevalence of blister rust resistance in sugar pine and to understand the molecular genetic basis of blister rust resistance in white pines.

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

Partners: Oregon State University; USDA Forest Service, Pacific Northwest and Southwest Regions

Traditional and local ecological knowledge tapped to conserve biodiversity

Maintaining and restoring native biodiversity is a common goal of forest management in the Pacific Northwest. Station scientists asked about 100 natural resource managers from various institutions what kind of research information would help them reach this goal. They learned managers were interested in knowing how traditional ecological knowledge could be incorporated into efforts to conserve biodiversity in the region.

By synthesizing existing literature on traditional and local ecological knowledge related to forest management among American Indians, family forest owners, and commercial nontimber forest products harvesters, several key points emerged: (1) integrating this knowledge into forest biodiversity conservation is most likely to be successful if the knowledge holders are engaged as active participants in conservation efforts, (2) more information is needed about how different groups are currently implementing their ecological knowledge through forest use and management actions and about the ecological effects of these actions on biodiversity, and (3) several promising models exist for integrating traditional and local ecological knowledge into forest management, but the social, economic, and policy constraints that prevent this knowledge from flourishing should be addressed alongside any strategy for knowledge integration.

Contact: Susan Charnley, scharnley@fs.fed.us, Human and Natural Resources Interactions Program

Partners: Oregon State University, Institute for Culture and Ecology.

Jerry Bednarczyk

Buckbean (Menyanthes trifoliata).

Continue to Part 2

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