2009 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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Umpqua National Forest, by Tom Iraci

THE SETTING

Derby Canyon, Washington, by Tom Iraci

Pacific Northwest Research Station: The Setting

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- Headquarters in Portland, Oregon
- 11 laboratories and centers in Alaska, Oregon, and Washington
- 12 active experimental areas (watershed, range, and experimental forests)
- Research also conducted in more than 20 research natural areas
- Pacific Northwest Research Station is one of five research stations in the U.S. Department of Agriculture, Forest Service
- 416 employees (299 permanent, 117 temporary)

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)

A MESSAGE FROM THE STATION DIRECTOR

Rooster Rock State Park, Oregon
© Miles Hemstrom

Looking back, I see that 2009 was a year of hard work and celebration at the Pacific Northwest Research Station. The hard work by our scientists, technicians, administrative support staff, partners, and volunteers allowed us to continue generating information that is used by land managers and policymakers to address pressing questions about climate change, carbon accounting, fuel treatments, and more. For example, station scientists and collaborators developed a GIS-based system for downscaling commonly available gridded climate data to 100 meters. The Olympic National Forest used this new method to simulate effects of climate change across its complex, mountainous terrain.

The station celebrated the 100th anniversary of the Forest Service experimental forest network. Experimental forests provide unique opportunities for long-term research, and the experiments conducted at these sites over the decades have yielded invaluable information about forest management and ecosystem processes. The station welcomed two new sites into the experimental forest network and decommissioned the inactive Young's Bay Experimental Forest on Admiralty Island in southeast Alaska. It was replaced by Héen Latinee near Juneau, which is more accessible and has a higher potential for research among our own scientists and our university partners in Juneau. The second new site is the Olympic Experimental State Forest on Washington's Olympic Peninsula, a result of a new partnership between the station and the Washington Department of Natural Resources.

We also celebrated the new Alaska Coastal Rainforest Center, a collaborative venture of the University of Alaska Southeast, University of Alaska Fairbanks, the station, the Forest Service's Alaska Region, the U.S. Fish and Wildlife Service's Alaska Region, and the City and Borough of Juneau. The center, located in the Juneau Forestry Science Laboratory, will provide formal and informal education at the university and community school levels as well as professional training relating to coastal rain forest ecosystems.

This year, the station received $13.4 million under the American Recovery and Reinvestment Act (ARRA). This stimulus money is being used to fund nine projects, including the installation of energy-efficient windows at the Olympia Forestry Sciences Laboratory and new stream gauging equipment at the South Umpqua Experimental forest in Oregon. Another project will restore community ecosystems while promoting green jobs in the Puget Sound area. Other projects will yield valuable information about fish and aquatic habitat, fire and fuels, and how the forests of Alaska, California, Hawaii, Oregon, and Washington are adapting to and mitigating the effects of climate changes. All these projects were selected based on their ability to create jobs and promote economic recovery, especially in those areas most impacted by the recession. These projects also will help the Forest Service achieve management practices that promote and provide clean air, clean water, wildlife habitat, and recreational opportunities.

Tim LeBarge

Station Director Bov B. Eav

In 2009, the station completed a realignment process that began with an evaluation of the station's ability to implement the strategic business plan, which, among other things, outlines our future research priorities and areas of emphasis. The net effect is six new research programs that optimize the station's capacity to produce relevant, quality science and attract stakeholder support. With this new groundwork in place, I'm confident in our ability to do timely research with long-term value.

Bov B. Eav
Station Director

Canopy crane at Wind River Experimental Forest, Washington, by Frank Vanni

100 YEARS OF EXPERIMENTAL FORESTS

A 1932 stand density study at Wind River Experimental Forest.

Celebrating the First 100 Years of Experimental Forests

Research has been occurring on the Forest Service's experimental forests and ranges for 100 years. This national network consists of 81 sites for long-term science and management studies across the country. Nearly every forest and ecosystem type in the United States and Puerto Rico is represented in the network.

Dubbed "lands for learning," experimental forests and ranges are set aside specifically for short- and long-term research. Researchers can establish experiments on these lands that may require decades or even centuries to run their course. These living laboratories become prime sites for collaboration, facilitating research-management

Frank Vanni

Visitors learn about past and current research at Wind River Experimental Forest.

partnerships among the national and state forests that host them, state agencies, universities, and other research institutions. These partners are central to the success of experimental forests and ranges, contributing staff and funding for studies and research facilities and sponsoring many important outreach activities, like field tours and workshops.

The Pacific Northwest Research Station celebrated the centennial with a day-long event at Wind River Experimental Forest, the station's oldest experimental forest. It was home to the region's first tree nursery, established in 1909, and site of the first permanent tree growth plots west of the Mississippi River. Today, Wind River is known as the "cradle of forestry research in the Pacific Northwest." Wind River's scientists pioneered many silvicultural practices still used today.

Two New Experimental Forests Join Network

The station also marked the centennial by bringing two new experimental forests into the national network.

Rick Edwards

Héen Latinee Experimental Forest.

Héen Latinee Experimental Forest

Héen Latinee Experimental Forest, 25,000 acres within the Tongass National Forest in southeast Alaska, spans glacial to marine environments over a short distance, allowing for studies crossing many different landscape types. The site provides opportunities for research on how coastal temperate rain forests function, particularly amid a changing climate.

The name "Héen Latinee" is a Tlingit phrase meaning "River Watcher." It was given to the experimental forest by a group of Tlingit elders whose traditional territory encompassed the area. The name honors and acknowledges the Tlingit as the traditional custodians of the land and also reflects the purpose of this experimental forest—a place for watching natural processes unfold and for learning through experiments.

Partnerships with the University of Alaska Southeast, the University of Alaska at Fairbanks, local schools, native tribes, other federal agencies, and the City of Juneau will lead to a variety of learning opportunities.

Olympic Experimental State Forest

A memorandum of understanding between the station and Washington Department of Natural Resources added a second new experimental forest to the Forest Service's national network. About 20 people attended the signing, including landowners, tribal and local government representatives, and congressional staff. The Olympic Experimental State Forest comprises 260,000 acres on Washington's Olympic Peninsula. It is now the largest site in the national network and the only representative of the Olympic Peninsula temperate rain forest ecosystem type, which is known for its extreme rainfall and growth rates. The state trust land will continue to be managed by the Washington Department of Natural Resources as a working forest, and the station will coordinate the research opportunities.

Pete Bisson

Olympic Experimental State Forest.

GOAL ACCOMPLISHMENTS

Middle Fork John Day River, Oregon; © Miles Hemstrom

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

Key Findings

- Properly placed shade trees reduce electricity use and thus reduce carbon emissions from electricity generation.
- Changes in forest conversion rates and land transfers between forestry and agriculture substantially impact forest carbon sequestration.
- Improved methods for estimating down woody biomass yield more accurate estimates of carbon stocks and fuel levels in forests.
- Climate is a principal environmental control on wildfire.
- Invasive plants may be less competitive than native plants in more severely burned sites where organic matter, plant nutrients, and soil microbes are lost to intense heat.
- Relying on streams in old-growth forests to provide the best habitat for fish may not produce expected conservation benefits.
- Hydrologic connection to hillslope explains seasonal patterns of runoff and streamflow.
- Scientists develop site- to landscape-scale criteria for linking headwater habitat across ridgelines to help retain habitat connectivity for amphibians, arthropods, and other biota in Pacific Northwest forests.
- Cross-site analysis of long-term data from experimental forests reveals similarities and differences in stream chemistry responses to harvest and other disturbances.
- An analysis of historical data on old-growth Douglas-fir trees suggests structural differences in young and old trees of similar large diameter. This is valuable information when designing management strategies that attempt to accelerate development of conditions associated with older forest.
- New method for genome sequencing provides a detailed, accurate picture of population and evolutionary history. This information can be used in conservation efforts.
- Enormous variability exists within Forest Service and among federal land management agencies regarding processes associated with the National Environmental Policy Act.

Follow the for more information about these key findings.

Sacramento Tree Foundation

A well-placed shade tree can reduce home energy use.

Properly placed shade trees reduce electricity use and thus carbon emissions

Researchers examined the effects of shade trees on summer electricity use in 460 homes in Sacramento, California. This is the first study to analyze electricity bills to determine the actual impact shade trees have on energy use. Researchers found that a tree's location influences the magnitude of the effect of shade trees on summertime electricity use. Trees on the west and south side of a dwelling reduced electricity use in the summer, whereas trees on the east side had no effect. Thus, while directly sequestering carbon through photosynthesis, shade trees also help reduce a home's carbon footprint by reducing emissions from electricity generation. The London plane tree, the most common tree in Sacramento, illustrates these carbon benefits: over 100 years, the tree reduces net carbon dioxide emissions from summer electricity use by 31 percent, provided that it is on the west side of the house.

Use:
Sacramento Municipal Utility District uses findings to help homeowners reduce energy use.

This study has given city planners and local environmental groups a scientific basis for articulating the benefits of urban trees. As a result, this study has generated a large and positive response. The Salt River Project in Arizona consulted with the lead scientist on the possibility of setting up a shade tree program in Phoenix, and the vice president of U.S. Geothermal Inc. consulted with the lead scientist about applying these findings in Idaho. This information has been used by the Sacramento Municipal Utility District, the Sacramento Tree Foundation, the City of Portland's Urban Forestry Program, Portland Friends of Trees, and ECONorthwest.

Contact: Geoffrey Donovan, gdonovan@fs.fed.us, Goods, Services, and Values Program

Partners: National Institute of Standards and Technology, Sacramento Municipal Utility District

Land use policies affect levels of carbon sequestration

Researchers used the Forest and Agriculture Sector Optimization Model—Greenhouse Gases Model to analyze alternative policy scenarios and compare their potential influence on land use and related effects on carbon sequestration and other environmental and economic benefits. The "business as usual" scenario suggests that the amount of forest land converted to more developed uses will be substantial, causing significant net release of greenhouse gases currently stored in those forests. Scenarios involving carbon-related payments to U.S. private forest-land owners led to increase in carbon sequestration. Modeling results do suggest that carbon-related payments to

Use:
EPA, USDA, and Congress use findings on carbon sequestration to analyze proposed energy and land use policies.

Ralph Alig

Land use competition among forestry, agriculture, and development influences the amount of terrestrial carbon storage.

landowners engaged in forestry or agriculture can substantially affect future land use patterns, levels of terrestrial carbon sequestration, forest resource conditions, agricultural production trends, and bioenergy production.

The Environmental Protection Agency (EPA), USDA's Global Change Program Office, and U.S. Congressional staff have used the models and findings from this work to analyze legislative proposals that address climate change and new policies that impact land use, such as the 2007 Energy Independence and Security Act and the Conservation Reserve provisions of the 2008 farm bill. The research is also being used to inform decisionmaking under the Forest Service's Forest Legacy Program, and it has attracted international recognition. Australia consulted with the scientists for advice on addressing climate change, and spinoff modeling systems have been developed in Europe and elsewhere.

Contact: Ralph Alig, ralig@fs.fed.us, Goods, Services, and Values Program

Partners: Oregon State University, Duke University, Texas A&M University

Improved methods yield better estimates of forest carbon stocks

Interest in woody debris—the downed logs and other smaller wood on the forest floor—used to center around wildlife habitat. It now focuses on carbon stocks and fuel levels. In Oregon, for example, it is estimated that the volume of down logs is about 45 percent of the volume of live forest trees. Scientifically defensible estimates of these quantities are essential for estimating stocks of biomass and stored carbon. This information is also important to those describing forest structure and wildlife habitat and to the fire community because fire behavior is largely determined by the amount and type of fuel present.

Current sampling protocols and statistical methods for estimating the volume of woody debris involve several assumptions. Given the increasing interest nationwide for accurate estimates of forest biomass, researchers evaluated and quantified the bias that results from two of the key assumptions. Based on their findings, they suggested changes in protocol and other improvements that may result in more accurate estimates of volume, biomass, and carbon stocks.

Contact: Vicente Monleon, vjmonleon@fs.fed.us, Resource Monitoring and Assessment Program

Partners: USDA Forest Service Northern and Rocky Mountain Research Stations

© Miles Hemstrom

Down wood and other woody debris stores carbon but also can fuel a wildfire.

Tool: Carbon Offset Analysis with ArcFuels

Description:
ArcFuels is a library of command functions (macros) within ArcMap® GIS software developed to streamline fire behavior modeling and spatial analyses for fuel treatment planning. ArcFuels now includes new analytical functions that allow users to analyze expected carbon offsets from fuel treatments and other management activities.

Use:
Land managers can examine detailed carbon budgets for stands and landscapes and examine the effects of proposed management on carbon stocks.

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

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

New method quantifies potential effects of fuel treatments on carbon stocks

Do FUEL REDUCTION treatments result in a net gain or loss of carbon stored in forests? If fuel treatments reduce future fire severity, then less carbon dioxide is released to the atmosphere, and the treatments could result in carbon gains. When considered individually, however, thinning and underburning treatments result in a net loss of carbon, but what is their effect on carbon storage outside the treatment units?

To begin answering these questions, scientists developed a risk-based approach to determine expected offsets from landscape-scale fuel management activities. The approach is being tested on the 198,000-acre Drews Watershed of the Fremont-Winema National Forest. Preliminary results suggest that in this particular forest ecosystem, there were extensive carbon benefits outside the treatment area in terms of reduced likelihood of wildfire, but the carbon loss specifically from treatment activities resulted in an overall loss of carbon on the entire landscape. Over time,

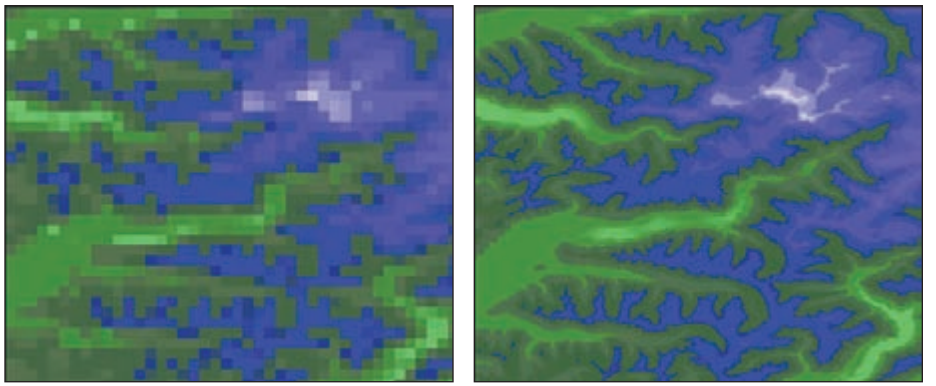
Tom Iraci

A new risk-based approach may help managers determine expected carbon offsets from landscape-scale fuel management activities.

depending on decomposition rates in the dead trees and rates of regeneration, the carbon loss within the treated area could be reversed. These methods will help forest managers balance demands for reduced fire risk and increasing carbon storage as a climate change mitigation strategy.

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

Partners: Oregon Department of Forestry; USDA Forest Service Fremont-Winema National Forest, Rocky Mountain Research Station, and Forest Health Enterprise Technology Team; West Coast Regional Sequestration Partnership (WESTCARB)



Climate mapping at ultra-fine resolutions better captures the microclimates found in mountainous areas. Here, climate data from the Olympic Mountains were downscaled from 800 meters (left) to 80 meters (right).

New system yields climate-change simulations at 100-meter resolution

Use: *Olympic National Forest simulates effects of climate change across complex terrain.*

Increasing requirements for climate-change simulations at ultra-fine resolution has created the need for methods to downscale existing gridded climate data sets with resolution of about 1 kilometer to about 100 meters. This ultra-fine scale is needed to simulate the effects of climate change on ecosystems in regions with complex topography where the slope of the terrain and direction it faces creates microclimates based on differences in exposure to sunlight.

To meet this need, station scientists and collaborators developed a GIS-based system for downscaling commonly available gridded climate data. The system was tested on existing grids of climate data for the Olympic Peninsula and other regions within the Western United States with complex terrain. The complete downscaling system was delivered to Forest Service users and training was provided.

Contact: Ron Neilson, rneilson@fs.fed.us, Ecological Process and Function Program

Partner: Oregon State University

Soils in Douglas-fir plantations in the Oregon Coast Range have high rates of methane uptake

Methane is a particularly potent greenhouse gas. Since the 1750s, the increase in methane in the atmosphere has contributed to about 20 percent of the enhanced greenhouse effect. Forest soils are both a source and a sink for the gas. Methane is a by-product of chemical reactions occurring in very wet, anaerobic soil, but it is absorbed during different chemical reactions occurring in drier soils. Despite its potential to affect the Earth's climate, limited sampling has been done to determine the rates of exchange for soil uptake and production for several major ecosystems.

Station scientists conducted the first study to report methane uptake rates by forest soil in the Pacific Northwest. Methane uptake was measured five times over a 13-month period from three Douglas-fir stands in the Coast Range of Oregon. Uptake was similar across the sites, and was high compared with most other coniferous forests globally. This is most likely due to the well-drained, highly porous, volcanic soils at the sites. The overall high rates suggest these forests offset methane emissions more than coniferous forests outside the region. This information on rates of methane uptake can be used in greenhouse gas accounting efforts.

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

Partner: U.S. Geological Survey

Tool: Framework for Predicting Postfire Forest Change in Interior Alaska

Description:
This set of tools provides forest managers with a rule-based framework for predicting what type of forest will regenerate after fire in interior Alaska. The forests of interior Alaska are currently dominated by black spruce, and stand-replacing wildfires are the main form of disturbance. The fire regime in the region is changing, however, and further changes are expected with climate warming. These changes may lead to more deciduous tree cover in areas previously dominated by black spruce. These forest types differ dramatically in their potential fire behavior and provision of wildlife habitat and other forest resources. Postfire successional trajectories in black spruce forests of interior Alaska can be predicted based on prefire species composition, fire severity, and site moisture.

J. Johnstone

The fire regime in interior Alaska is changing and may lead to different forest types. Above is a stand, 1 year after fire, that was previously dominated by black spruce.

The framework includes four tools: (1) a key to classifying potential site moisture, (2) a summary of conditions that favor black spruce self-replacement, (3) a key to predicting postfire forest recovery in recently burned stands, and (4) a set of photos that serve as a visual reference tool.

Use:
Managers from the Alaska Fire Service, Alaska Division of Forestry, U.S. Fish and Wildlife Service, and National Park Service are using these tools to help design fire management actions and to predict the effects of recent and future fires on postfire forest cover.

Contact:
Teresa Hollingsworth, thollingsworth@fs.fed.us, Ecological Process and Function Program

Partners:
University of Alaska Fairbanks; University of Saskatchewan Saskatoon

For more information:
Johnstone, J.F.; Hollingsworth, T.N.; Chapin, F.S., III. 2008. A key for predicting postfire successional trajectories in black spruce stands of interior Alaska. Gen. Tech. Rep. PNW-GTR-767. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 37 p.

Climate is a principal environmental control on wildfire

Station scientists, working with university collaborators, demonstrated that the area of wildfire burned in the American West was significantly controlled by climate (combinations of precipitation, temperature, and drought) during most of the 20th century (1916–2003). Climate-fire relationships differed by vegetation type, represented by 16 ecoprovinces (broad geographic regions with similar ecological properties) across the West. Fire in most mountainous ecoprovinces, except in the arid Southwest, is driven by low precipitation, dry conditions, and high temperatures in the summer fire season. Fire in arid ecoprovinces, or those dominated by grasses or shrubs, is strongly associated with precipitation or drought in the previous year, which affects the amount of fuel for the current year. Despite the influences of fire exclusion, other land use changes, or both, the amount of burned area is still substantially controlled by climate. In the future, this will likely depend on ecosystem-specific seasonal variation in climate

and its effects on fuel conditions in northern mountainous ecosystems and fuel availability in arid ecosystems.

Understanding fire-climate relationships, which differ for different ecosystems, will help land managers anticipate changing fire regimes in response to global warming and predict fire patterns associated with multiannual and interdecadal climatic variability. Despite the overarching influence of climate, it will be important to link this understanding of climate drivers to land use changes and broad-scale management strategies.

Contact: Don McKenzie, donaldmckenzie @fs.fed.us, Threat Characterization and Management Program

Partners: University of Washington; University of California, Merced

Effects of severe wildfire on watershed processes may last for decades

Rare, high-quality historical data are being used for model formulation, calibration, and testing to evaluate effects of a severe 1970 wildfire on flow regime and maintenance of water quantity and quality from streams draining forested headwaters. Following more than 25 years of inactivity at the Entiat Experimental Forest in eastern Washington, study watersheds were reinstrumented in 2004 with stream gauging, water quality, and meteorological stations to assess rate of recovery toward prefire conditions.

Rick Woodsmith

A newly installed weather station on the Entiat Experimental Forest provides data for ongoing studies.

Preliminary results indicate that the wildfire resulted in initial peak flow increases in runoff of 100 percent or more from the burned area, and that these increases resulted from decreased evapotranspiration—the process through which plants draw up water—increased snow accumulation, and more rapid snowmelt. The effects of wildfire on watershed processes may be long lived and depend, in part, on rehabilitation actions.

This ongoing research is providing predictive capability regarding effects of severe wildfire and hydrologic recovery processes after a major disturbance. These findings are informing management decisions regarding the need and strategies for postfire rehabilitation. They lay the foundation for future investigation of hydrologic effects of fuel-reduction treatments.

Contact: Richard D. Woodsmith, rwoodsmith@fs.fed.us, Threat Characterization and Management Program

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

Topography controlled historical fire patterns in eastern Washington

Station scientists and collaborators have analyzed historical data for fires that burned between 1700 and 1900 in eastern Washington. These fires predate the fire suppression efforts of the 20th century and, therefore, provide valuable information about the historical fire regime in this mountainous region that experienced frequent, low-severity fires. By using these data, scientists developed computer simulation models that replicate complicated patterns of historical fire over space and time by tuning a few key parameters. They discovered mathematical relationships that reveal (1) the topographic complexity of fire-prone landscapes and (2) the relative influences of climate, topography, and fuels across multiple spatial and temporal scales.

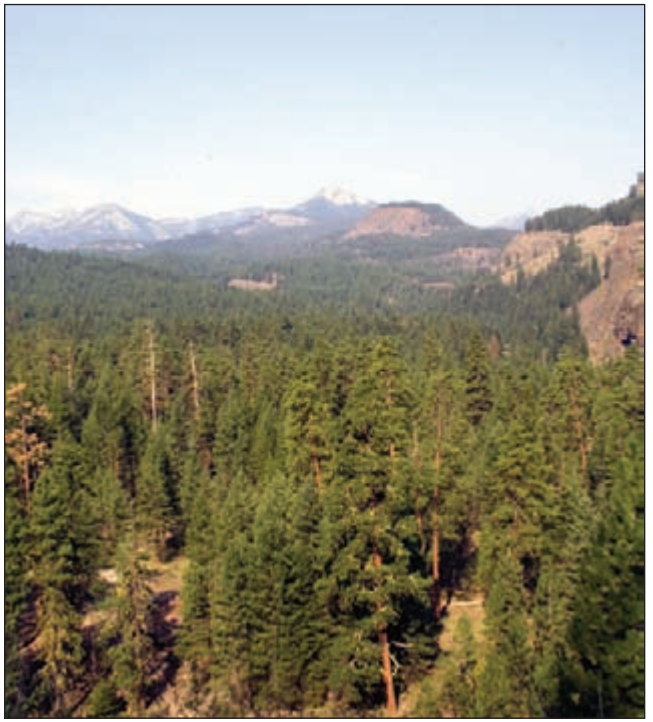
This analysis yielded two pieces of information that are unprecedented in fire-history research: (1) statistical properties of topographic controls (such as ridges or canyons) on fire spread and (2) estimates of historical fire-size distributions. The 200-year data set, precise information on fire locations, spatial statistics, and these simulations are enabling researchers to glean more information about historical fire regimes than would be possible from reconstructing individual fires.

This work makes it possible to identify landscapes where small changes in environmental drivers, such as climate, might lead to significant changes in fire regimes by overriding the topographic controls on fire spread.

Contact: Don McKenzie, donaldmckenzie@fs.fed.us, Threat Characterization and Management Program

Partner: University of Washington

Miles Hemstrom



The varied topography in eastern Washington historically helped contain wildfire. Climate change may override this control.

Invasive plants appear less competitive than native plants in more severely burned sites

Reestablishing native vegetation after severe fire is an ongoing challenge for land managers. Postfire landscapes have been shown to facilitate establishment of invasive, nonnative plants, yet the role of fire severity on their establishment and growth is unclear. Exposure of soil to intense fire that completely burns large pieces of decaying wood during wildfire greatly reduces soil microbes and nutrients, potentially facilitating invasion by nonnative plant species. Such severely burned soils show a distinctive color change where the top layer of mineral soil changes to various shades of red owing to oxidation of soil nutrients.

Scientists found that nonnative plants grew more rapidly than native plants in both the severely burned red and less severely burned black soil. Despite this rapid growth, nonnative plant biomass was significantly lower in red soil, whereas native plant biomass did not differ between red and black soils. These findings suggest that some native species may outperform invasive species in severely burned areas. Knowledge of the impact of severe surface burning on soil nutrients, soil microbial communities, and postfire plant recolonization is critical to forest recovery projects.

These findings provide a scientific basis for developing rehabilitation plans, particularly to support the use of native plants

Doni McKay

Researchers measure soil respiration as part of postfire study on the Deschutes National Forest.

and to take advantage of postfire conditions where native plants may out-compete non-native species.

Contact: Jane E. Smith, jsmith01@fs.fed.us, Land and Watershed Management Program

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

Plant-microbe associations release key nutrients from rocks

It has long been observed that chemical elements in soil such as potassium, calcium, and nitrogen, essential to plant growth, are lost at different rates after disturbance, and similarly, build back in the soil at different rates. Some of the drivers behind the reacquisition processes, however, are not well known.

Through a series of laboratory and field experiments, researchers determined that pioneer plant-microbe associations play a key role in acquiring nutrients directly from rock particles rather than simply through free-moving soil water. Interactions between photosynthesizing green plants and fungi and bacteria associated with plant roots produce organic acids that dissolve the rock surface, making the minerals trapped inside accessible. The so-called "biofilms" and other structures create spaces where microbes and plant roots are in intimate contact with mineral surfaces, and released elements are not lost through the soil water. This process likely increases plant productivity and carbon sequestration in plants and soils.

Researchers found that fungi and bacteria alone also can chemically weather rocks, but experiments using pine seedlings suggest that plants and microbes work together to speed the weathering process. Managing a disturbed landscape to assure the presence of important plant-microbe associations may lead to a more rapid recovery of critical ecosystem processes, soil productivity, and enhanced carbon sequestration.

Contact: Bernard Bormann, bbormann@fs.fed.us, Land and Watershed Management Program

Partner: Washington State University

Managing for single condition may not be best fit for dynamic aquatic ecosystems

High-quality fish habitat and strong, diverse populations of wild salmon and trout are often considered synonymous with old-growth forests (forests dominated by trees more than 200 years old) in the Pacific Northwest. The attributes of streams that run through these forests are used as standards to assess the impact of management actions and for

Tool: NetMap

Description:
NetMap is a community-based watershed science system comprising a digital watershed database for the Pacific Northwest, analysis tools, and user forums. This state-of-the-art, desktop GIS analysis tool contains about 50 functions and 60 parameters that address watershed attributes and processes such as fluvial geomorphology, fish habitat, erosion, watershed disturbance, road networks, wildfire, hydrology, and large woody debris, among other issues. NetMap is designed to integrate with ESRI ArcMap® 9.2.

Use:
NetMap allows watershed analyses to be done at a fraction of the cost of current methods. The Willamette National Forest is using NetMap to prioritize road restoration and removal projects, and the Oregon Department of Forestry is using it to plan timber management.

How to get it:
http://www.netmaptools.org/

Contact:
Gordon Reeves, greeves@fs.fed.us, Land and Watershed Management Program

setting restoration goals, such as those of the Northwest Forest Plan. Streams in old-growth forests, however, represent a limited set of conditions. A synthesis of studies done since 1995 questions the efficacy of this approach.

The scientists conclude that efforts to restore aquatic ecosystems to old-growth conditions will not produce the complexity of habitats needed to maintain strong populations of salmon and other resident fish. A landscape containing a mixture of successional stages may be a more appropriate setting for robust salmon populations. The shift in perspective may require managers, regulators, and policymakers to consider tradeoffs between old-growth-dependent species, such as the northern spotted owl, and those that require a mixture of successional types.

Contact: Gordon Reeves, greeves@fs.fed.us, Land and Watershed Management Program

Topography determines streamflow sources and seasonal runoff

Where does the water in a stream come from? The answers to this fundamental question are critical for society's well-being. Understanding the connections between streamflow and the surrounding

Steve Wondzell

Researchers hike to study sites in the Tenderfoot Creek Experimental Forest in Montana.

landscape is necessary for forecasting flood behavior and for understanding how land use affects water quality and quantity. Most research on streamflow generation and routing focuses on storms and peak flow responses. This study, however, focused on connections between hillslopes and streams across the full range of hydrological conditions. Researchers found that in most locations, hillslopes are only hydrologically connected to the stream during major storms or during spring snowmelt. In the few locations where hillslope drainage converges from large hillslope hollows, hillslopes remain hydrologically connected to the stream over most of the year. These patterns of connectivity explain the seasonal patterns of runoff observed across watersheds of different shapes and sizes.

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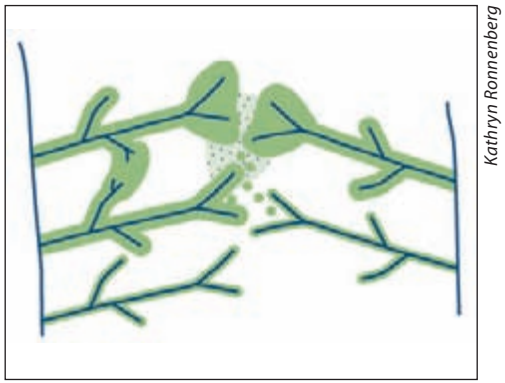
Partners: Montana State University, Pennsylvania State University, U.S. Geological Survey

Providing habitat links across ridgelines lets headwater species traverse watersheds

Fragmented habitat prevents species from moving across the landscape. In managed forest landscapes, riparian buffers provide key habitat for aquatic and terrestrial species. These buffers are generally limited to the streamside and thus do not meet the habitat needs of amphibians and other species that tend to also use the upland forest. To remedy this, station scientists developed criteria for linking headwater habitat to provide overland connectivity for headwater amphibians and other biota that benefit from intact forest habitat conditions that allow terrestrial dispersal among watersheds.



Kathryn Ronnenberg

Linked buffers, as diagrammed here, provide dispersal corridors for salamanders and other species.

Habitat links can take into account target species locations, existing protections, land ownership patterns, climate change predictions (e.g., retaining habitats along north-south or altitudinal gradients), and the natural disturbance regime such as landslide-prone areas. Creating habitat links may be especially critical among watersheds with no aquatic connections. At the stand scale, forest management activities that extend and connect stream buffers can create habitat links.

This design creates a web of connectivity across a forest landscape, reducing forest fragmentation and providing dispersal corridors for a host of species. It is a tool for consideration in forest management planning at the stand to landscape scale.

Contact: Deanna H. Olson, dedeolson@fs.fed.us, Land and Watershed Management Program

Partner: USDI Bureau of Land Management

Local conditions influence salmon demographics

Climate, geology, and regional species pools define ecoregions. In the Wenatchee subbasin of the Columbia River, association with a relatively dry ecoregion led to higher abundance of salmon and trout compared to a relatively wet ecoregion of the subbasin. Demographic parameters such as growth and emigration also were locally influenced. Population density of fish in headwaters was correlated with fish density in corresponding main tributaries of individual watersheds. By contrast, temporal variation of density in headwaters and main tributaries did not correspond beyond the timescale of a single season. Thus, large-scale influence (ecoregions, watersheds) was limited to overall density differences, whereas population dynamics are under local control with limited input from ecoregions. The observed difference in emigration rates between ecoregions could be due to different physical habitat characteristics or behavioral differences between the dominant salmonid species in each ecoregion.

Salmon are critical to the ecology of the Pacific Northwest and have high economic

and cultural values. These findings support efforts to enhance fish habitat and production. Strategies to manage for salmon production may benefit from an ecoregional context because local conditions appear to control salmon population dynamics, and ecoregions appear to define the range of variation in metrics related to population dynamics.

Contact: Karl M. Polivka, kpolivka@fs.fed.us, Land and Watershed Management Program

Partners: Bonneville Power Administration, National Oceanic and Atmospheric Administration

Wetlands are sources of downstream productivity

Dissolved organic matter, including carbon and associated nutrients, is a critical component in stream ecosystems. As a food source for stream micro-organisms, it supports the productivity of the entire food web. In southeast Alaska, the downstream transfer of dissolved organic matter from wetlands to estuaries and the Gulf of Alaska stimulates food webs that support important sport and commercial fisheries.

In ongoing research on the biogeochemistry of wetlands and streams, researchers found that soil type and hydrologic pathways control the amount and biodegradability of dissolved organic matter exported by rain-forest streams. They also found that the quantity and quality of the organic matter transferred downstream to estuaries was greatest during storms, and that the amount and form of carbon in the organic matter changes seasonally.

Understanding the controls on organic matter transfers to marine ecosystems is a first step in predicting the impact of climate-induced changes in stream hydrology and soil processes.

Contact: Rick Edwards, rtedwards@fs.fed.us, Land and Watershed Management Program

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

Tom Iraci

Jack Creek, Deschutes National Forest, Oregon.

Nationwide study finds similarities, differences in stream chemistry responses to harvest and other disturbances

Forests provide high-quality water for downstream and instream uses. Stream chemistry is a major water quality parameter and responds to forest harvest and other disturbances to forest cover. Forest managers need to be able to predict how forest harvest and other disturbances

Sherri Johnson

Researchers process water samples as part of a nationwide study on the effects of disturbance on ecosystem processes such as nutrient cycling.

will affect water quality to meet federal and state Clean Water Act guidelines. To help provide this information, station scientists are reexamining long-term stream biogeochemistry data collected before and after forest harvest and thinning from gauged basins at the H.J. Andrews Experimental Forest to quantify relationships between amount and type of harvest and instream responses. Thus far, they have observed short-term increases of instream nitrate concentrations and export after clearcutting but little change with thinning.

Through collaborations with researchers at 10 other experimental forests across the country, the scientists are comparing the magnitude of responses among forest type and with differing nutrient limitations to harvest as well as to natural disturbances, including fire, hurricane, and insect infestations. Understanding the effects of disturbance, including forest management, on critical ecosystem processes facilitates the design of management options that minimize disruption of normal nutrient cycling. It also provides a foundation to predict responses in water quality and recovery time in forested watersheds following disturbances such as fire and insect infestation.

Contact: Sherri L. Johnson, sherrijohnson@fs.fed.us, Ecological Process and Function Program

Partners: National Council for Air and Stream Improvement; Oregon State University; University of Alaska-Fairbanks; University of New Hampshire; USDA Forest Service Northern Research Station, Pacific Southwest Research Station, Rocky Mountain Research Station, and Southern Research Station

New hypothesis for yellow-cedar decline links calcium accumulation to nitrogen cycles and rooting depth

Yellow-cedar and western redcedar are two valuable tree species of Pacific Northwest forests. They grow well in wet soils with limited nitrogen—areas where many other species don't. Station scientists formulated a new hypothesis that explains how cedar trees survive in marginal conditions, yet have roots that are susceptible to freezing injury—an occurrence that has killed more than 500,000 acres of yellow-cedar in southeast Alaska. The hypothesis proposes a mechanism whereby cedar trees assimilate nitrogen as nitrate, but must accumulate a counter-ion to nitrate, such as calcium, to control their internal cell pH and provide electrochemical balance. The simultaneous acquisition of calcium and nitrate requires the trees to maintain shallow roots to acquire nitrate, as nitrification does not occur in the deeper, acidic soils.

This may lead to a greater predominance of superficial fine roots of yellow-cedar relative to redcedar, which makes yellow-cedar more susceptible to freezing injury.

The cedar-nitrate hypothesis provides a means to design focused experiments to test this hypothesis and understand the possible successional pathways of cedars related to soil nutrient cycles. The interaction of cedars with soil nutrient cycles expands the potential interactions that must be considered in understanding yellow-cedar decline, as well as the ecology of cedars in general.

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

Partners: USDA Forest Service Forest Health Protection, Northern Research Station, and State and Private Forestry; University of Vermont

New analysis of historical data on old-growth Douglas-fir yields valuable insights

In the 1960s, as part of a wood quality study, thousands of Douglas-fir trees were harvested from old-growth forests in the Pacific Northwest. A station scientist recently analyzed some of these original measurements. Because destructive sampling of old trees is no longer tenable, these data offer a unique opportunity to understand relationships between tree size, branch and crown dimensions, and forest density. Results suggest that the branch structure of large-diameter, young Douglas-fir trees is not the same as that of older ones with comparable girth. This is valuable information for forest managers designing management strategies that attempt to accelerate the growth of younger forests to create habitat for organisms associated with old forests. The variability in tree crowns documented in the historical data set also underscores the importance of avoiding small samples from a few locations when attempting to draw inferences about the crown architecture of Douglas-fir trees. The new analysis offers evidence that investment in research can pay dividends over decades, and that old studies can shed light on contemporary questions.

Contact: Susan Hummel, shummel@fs.fed.us, Goods, Services, and Values Program

Branch architecture and wood density determine leaf functional traits in tropical trees

Rates of photosynthesis, transpiration, and efficiency of water movement through leaves differ by tree species. These functional traits provide valuable information about how a species might respond to different environmental conditions, and when examined collectively, how the entire ecosystem may respond. In tropical forests, however, the sheer number of different tree species presents daunting challenges for interpreting and predicting the functional traits of the forest canopy based on a small subset of species.

U.S. Forest Service

Data collected in the 1960s have lasting value.

David Woodruff

The Smithsonian Tropical Research Institute canopy crane in a seasonally dry forest in Panama is being used to gather data on tree functional traits.

Therefore, researchers looked for common denominators that would be relatively easy to measure, yet would still provide the needed information. Working along a rainfall gradient across the Isthmus of Panama, researchers found that wood density and simple architectural features such as leaf area to sapwood area ratio accounted for a large fraction of the variation in leaf and stem functional traits among tree species. This information will help tree physiologists, plant ecologists, and vegetation modelers who are interested in developing common rules to better describe the behavior of trees and complex, multispecies ecosystems under a variety of environmental conditions.

Contact: Rick Meinzer, fmeinzer@fs.fed.us, Ecological Process and Function Program

Partners: North Carolina State University; Universidad de Buenos Aires, Argentina; University of Miami

Trees rely on two principal mechanisms for avoiding hydraulic failure

As water is pulled from the roots to the leaves under negative pressure, or tension, air bubbles known as emboli may enter and block the water-conducting xylem tissue. Previous studies on the ways in which plants avoid embolism have focused primarily on the role of xylem structure in avoiding catastrophic hydraulic failure. A new analysis of more than 100 woody species suggests that there is actually a continuum of relative reliance on two main mechanisms that confer hydraulic safety. Species with low water storage capacity and denser wood experience greater daily maximum xylem tension and appear to rely primarily on xylem structural features to avoid embolism. Species with high water storage capacity and low wood density appear to avoid embolism by relying on transient release of stored water to constrain transpiration-induced fluctuations in xylem tension.

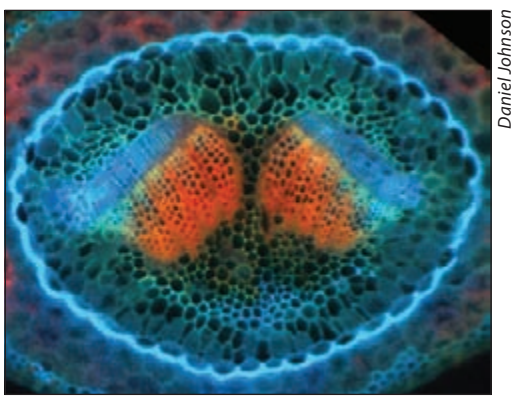
The findings are fundamental to understanding how trees maintain safety margins in the face of environmental stress. Findings will result in more realistic modeling of tree species distribution and performance under different climate regimes.

Contact: Rick Meinzer, fmeinzer@fs.fed.us, Ecological Process and Function Program

Partner: Oregon State University

Leaves are the first line of hydraulic defense in conifers and other woody species

The hydraulic efficiency of leaves decreases as drought stress increases, eventually resulting in reduced photosynthesis. By using various techniques, including detection of ultrasonic acoustic emissions and imaging of dehydrated leaves flash-frozen in liquid nitrogen, researchers determined that water-stress-induced loss of leaf hydraulic efficiency in two pine species and two shrubs was directly related to emboli—or air bubbles—in the leaf xylem. They also found that emboli formed daily in field-grown plants and that the process was reversed in the afternoon and overnight. Rapidly reversible embolism in leaves may constitute part of an essential hydraulic signal that triggers stomatal closure, ensuring the integrity of water transport in the stems upstream from the leaves.



Daniel Johnson

Microscopy of a fully hydrated Douglas-fir needle flash frozen in nitrogen. The xylem tissue is stained red and the phloem tissue is stained blue.

The findings provide insights into the mechanisms by which plants respond to and cope with environmental stresses such as drought.

Contact: Daniel Johnson, danieljohnson @fs.fed.us, or Rick Meinzer, fmeinzer@fs.fed.us, Ecological Process and Function Program

Partner: Oregon State University

Genetics regulate concentrations of potential defense compounds in ponderosa pine

Research clearly demonstrated that genetics regulate the concentrations of foliar piperidine alkaloids in ponderosa pine. These alkaloids are potential tree defense compounds against insects or pathogens. The highest quantities were found in seedlings originating along the western margin of ponderosa pine's range in California, Oregon, and Washington. The lowest quantities were observed in seedlings from regions either in, or east of, the Cascades and Sierra Nevada mountains. No latitudinal gradient was detected among regions. The contribution of various seedling growth parameters and climatic conditions at the sites of parental seed sources were evaluated for their influence on the variability of alkaloid levels but were found to be only marginally important.

Measurements of alkaloid concentrations have the potential to function as an independent physiological indicator of tree or stand vigor and overall health for ponderosa pine. Future research will examine if trees with higher alkaloid levels are more resistant to attack from insects or pathogens.

Contact: Rick Kelsey, rkelsey@fs.fed.us, Threat Characterization and Management Program or Brad St. Clair, bstclair@fs.fed.us, Land and Watershed Management Program

Brad St. Clair

A genetics study on ponderosa pine reveals differences among seed sources.

New genome sequencing method reveals a species' evolutionary history

Organelle genomes from plants, animals, and fungi are used as genetic markers to track maternal diversity, historical migration, and maternally inherited fitness traits in wild populations. These genomes, which range in size from 15,000 to 1,000,000 base pairs, can now be efficiently sequenced in large numbers using "multiplexed massively parallel sequencing" (MMPS), a technique developed at the PNW Research Station. Analyses of complete organelle genomes from conifers (pine chloroplast genomes) and carnivores (fisher mitochondrial genomes) obtained using MMPS show that genetic parameters estimated from complete genomes are not accurately predicted by single organelle genes (a common sampling unit in conservation genetics). This finding highlights the importance of using whole organelle genome sequences when conservation decisions are based on molecular information.

Use:
New genome sequencing method aids fisher and wolverine conservation efforts.

John Rohrer

Wolverine.

The new method for genome sequencing is being used by geneticists at the Pacific Northwest and Rocky Mountain Research Stations to re-address estimates of population distinctiveness for fisher and wolverine in the Pacific Northwest. Results will help guide proposed reintroduction efforts by the U.S. Fish and Wildlife Service.

Contact: Richard Cronn, rcronn@fs.fed.us, Land and Watershed Management Program

Partners: Linfield College, Oregon State University, Rocky Mountain Research Station, Santa Clara University

Montane red foxes are ecologically and evolutionarily distinct

Based on analyses of ecological, historical, archeological, fossil, and other data, scientists hypothesized that populations of red fox that occupy high-elevation boreal forests in the Cascade Range, Sierra Nevada, and Rocky Mountains were derived from populations that were isolated south of the ice margin during the last glaciation, and that they are ecologically and evolutionarily distinct from red foxes living elsewhere. The scientists used genetic analyses to test this hypothesis. They found that the montane red foxes were derived from populations that had colonized North America from Asia during the penultimate glaciation and became isolated in ice-free refugia in the contiguous United States during the last glaciation. These results indicate that the montane red foxes are specialized to subalpine and alpine habitat conditions and do not cross intervening habitat areas.

Given their long-term isolation and the extreme climatic conditions they occupy, montane red foxes may possess physiological adaptations that other populations lack. These findings support treating the montane red foxes as evolutionarily distinct. In California, the Sierra Nevada red fox is a state-listed threatened species, and their decline in the Sierra Nevada has been documented over several decades. The status of montane red fox populations in the Cascade Range and Rocky Mountains is unknown, but given the likely impacts of climate change on suitable habitat, this study may provide information for their future conservation.

Contact: Keith B. Aubry, kaubry@fs.fed.us, Ecological Process and Function Program

Partners: California Polytechnic State University, Kansas State University, University of California at Davis

Dan and Cindy Hartman

Rocky Mountain fox.

Gene Paul

A researcher removes bark from an infested Douglas-fir tree to collect Douglas-fir beetles north of La Grande, Oregon.

Scientists identify genetic differences between populations of Douglas-fir beetle

The Douglas-fir bark beetle occurs in Douglas-fir forests in northern Mexico, western United States, and southwestern Canada. The beetle is a significant source of mortality for Douglas-fir. It is a particular problem in Mexico where Douglas-fir is considered a threatened species.

Scientists identified a new subspecies of Douglas-fir beetles from a population in northern Mexico, based primarily on differences in physical characteristics. Variation within bark beetle species is important because it can mean different control tactics could be effective against different populations. Scientists tested multiple populations throughout the distribution of this beetle for genetic differences and found that Douglas-fir beetle has high intra- and inter-population genetic variation compared with several other bark beetles. These analyses also suggest that the genetic structure of this bark beetle species is strongly influenced by isolation resulting from geographic distance between populations. The observed genetic differences between northern (Canada-United States) and southern (Mexico) populations confirm that these two sets of populations correspond to previously assigned subspecies. Because of these differences between subspecies, beetle management tools that have been used successfully in Canada and the United States may need to be modified to be effective against populations in Mexico.

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Partners: Eastern Oregon University, Instituto Politecnico Nacional de Mexico

Population density of North American elk significantly influences vegetation diversity

Large herbivores, such as elk and deer, are common across western North America. Their impacts generally have been ignored in most management documents because their effects vary across landscapes. However, what herbivores eat and the resulting changes this brings to the diversity in understory plant species

Elk herd.

and plant productivity may have cascading effects on other organisms, overall biodiversity, and on forest productivity.

In a study conducted on the Starkey Experimental Forest in eastern Oregon, scientists observed significant indirect relationships between the number of herbivores in an area and plant productivity and plant diversity. Those subtle effects of herbivory may have strong effects on ecosystem functioning, even in plant communities that are relatively resilient to herbivory. This information may help land managers develop sustainable management practices for forest and range land including stocking levels of herbivores.

Contact: Brian Dick, bldick@fs.fed.us, Ecological Process and Function Program

Partners: Idaho State University, University of Nevada, Reno

Agency approaches to NEPA differ widely

The National Environmental Policy Act (NEPA) influences all aspects of federal land management. It requires federal agencies to consider the environmental impacts of proposed actions and to offer reasonable alternatives to those actions. Planning related to NEPA can be expensive. It is the Forest Service's second largest area of expenditure after firefighting.

Use: *Forest Service uses findings to update NEPA training course for line officers.*

Researchers conducted two NEPA-related studies. One examined the different approaches district rangers adopt when managing environmental assessment and disclosure processes under NEPA requirements. They found that district rangers differed greatly in their decisionmaking processes and how they adapt their management style to particular circumstances. Some view NEPA activities as risk factors in the management of other unit processes. They tend to avoid initiating projects where environmental assessments will be needed, or conversely, will commit significant resources to it. Others view NEPA activities as a negotiation process that creates an opportunity to meet the needs and values of a variety of stakeholders. Results from this study are being used to update training for Forest Service line officers.

Rolando Mendez

Line officers on the Deschutes National Forest shared insights to their decisionmaking processes under the National Environmental Policy Act.

The second study compared the approaches used by the Army Corps of Engineers, Bureau of Land Management, Forest Service, and National Park Service. Researchers found little consensus regarding best practices for navigating NEPA processes. Some of the most positively viewed practices included using a dedicated staff writer to orchestrate the completion of NEPA documents, more direct inclusion of U.S. Fish and Wildlife staff on interdisciplinary teams, and early and informal public involvement. The breadth of conflicting ideas about NEPA revealed within this small sample of agency personnel suggests that an even wider range of interpretations of the act and its processes exists. This study highlights pathways of inquiry that could be highly relevant in charting a course for future implementations of NEPA requirements.

Contact: David Seesholtz, dseesholtz@fs.fed.us, Focused Science Delivery Program

Partners: MacGregor-Bates Consultants, Virginia Polytechnic Institute and State University

Keith Routman

Hoh River Trail, Olympic National Park, Washington.

Study reveals trends in NEPA assessments regarding recreation planning

Researchers surveyed 106 interdisciplinary team leaders involved in recreation-related environmental assessment required by the National Environmental Policy Act (NEPA) to find out how they conceive of success in those processes. The online survey also explored common trends in these processes with regard to team makeup, project goals, analytical techniques, and process outcomes. Few team leaders felt that limiting recreation use was an important goal, nor were they in favor of maximizing recreation use. This suggests team leaders sought a balance between meeting recreation use and resource protection goals. The study also found that social science and recreation specialists were underrepresented on travel management interdisciplinary teams. Interdisciplinary team leaders were much more likely to have academic training in forestry or biological sciences than in recreation or social science disciplines.

Contact: Dale Blahna, dblahna@fs.fed.us, Goods, Services, and Values Program

Partner: Virginia Polytechnic and State University

Communities in north-central Colorado and eastern Oregon are concerned about invasive plants

In Colorado, natural and human-caused disturbances, such as bark beetle outbreaks, housing development, and recreation exacerbate plant invasions. This study assessed public awareness and concern about invasive plants in a forested region. About 88 percent of those surveyed reported having heard about invasive plants. However, respondents were unlikely to have heard about specific, locally problematic plants targeted for control. Most respondents had checked plants for invasive potential before purchase or planting, and a small minority had attempted to remove or reduce established invasive plant species. Another study in eastern Oregon found that family forest owners in the ponderosa pine ecosystem are most concerned about Canada thistle, leafy spurge, and knapweed, but are not very concerned about exotic weeds as a fire hazard. Building awareness about invasive plants is key to encouraging helpful public behaviors.

Contact: Susan Charnley, scharnley@fs.fed.us, Goods, Services, and Values Program

Partners: University of Illinois

Tom Iraci

Pulling knapweed, an invasive species in eastern Oregon.

Tool: Current and future habitat suitability maps for invasive tamarisk species

Description:

Tamarisk species are shrubs or small trees considered by some to be among the most aggressively invasive and potentially detrimental exotic plants in the United States. Climate change has the potential to significantly affect the species habitat and distribution. These maps illustrate where tamarisk currently grows in Idaho, Oregon, and Washington, and where future habitat conditions may facilitate its spread.

Use:

Public land managers and private landowners will find these maps useful. Understanding invasive species distribution and habitat is critical for early detection and to coordinate management responses and eradicate species before they become widely established.

How to get it:

Kerns, B.K.; Naylor, B.J.; Buonopane, M.; Parks, C.G.; Rogers, B. 2009. Modeling tamarisk (*Tamarix* spp.) habitat and climate change effects in the Northwestern United States. Invasive Plant Science and Management. 2: 200–215.

Contact:

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

Near Black Butte, Oregon © Miles Hemstrom

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

Key Findings

- Deep groundwater mediates streamflow response to climate warming and will provide a major source of summer streamflow for the Western United States in the future.
- Projected changes in temperature and moisture over the next 80 years could dramatically increase the release of carbon currently stored in soil to streams. Station scientists developed new methods for quantifying fluxes of carbon from terrestrial and aquatic ecosystems in southeast Alaska.
- Statistical analyses that combine forest inventory data with remotely sensed data provide better estimates of forest conditions in Oregon and Washington than methods using only forest inventory data.
- New maps detail changes in Pacific Northwest forest lands from 1984 through 2007.
- Southern rural areas are projected to experience the greatest increases in U.S. development through 2030.

Forest Inventory and Analysis summer management team meeting near Black Butte, Oregon.

Groundwater will be major source of summer streamflow in Western U.S.

Prior efforts to model streamflow trends, and hence the availability of water, under future climate scenarios in the Western United States focused on snowpack dynamics. But snowpack is only one source of water. Station scientists found that groundwater dynamics exert a comparable, or even larger, control on future streamflow regimes than does snowpack. Different landscapes will have widely different responses to the same climate warming. Regions of the West with primarily groundwater sources will continue to have streamflow under climate warming, in contrast to areas served exclusively by snowpack, such as the southern Sierras in California. However, these same groundwater regions display maximum sensitivity to warming climate and will lose a significant proportion of their flow volumes, perhaps leading to unanticipated consequences for water quantity and aquatic habitat.

Use: *Eugene Water and Electric Board uses findings to plan for the future.*

Public water and energy utilities, such as the Eugene Water and Electric Board, are incorporating these findings with long-range management plans and strategies being developed by public water and energy utilities.

Contact: Gordon E. Grant, ggrant@fs.fed.us, Ecological Process and Function Program

Partner: University of California at Santa Barbara

Sherri Johnson

Blue River outside H.J. Andrews Experimental Forest.

New methods quantify fluxes of carbon from terrestrial and aquatic ecosystems in southeast Alaska

Mitigating increases in atmospheric carbon dioxide by increasing forest sequestration of carbon is a high priority for forest managers. Assessing management impacts on carbon in aboveground vegetation is straightforward, but accounting for fluxes from belowground storage pools is challenging. Projected changes in temperature and moisture over the next 80 years could dramatically increase the release of carbon currently stored in soil. In a rain forest like the Tongass National Forest where terrestrial and aquatic systems are closely linked, increases in the amount of carbon and associated nutrients exported to coastal estuaries could have far-reaching impacts on estuarine productivity and fish habitat. Changes in freshwater fish habitat quality stemming from increased mobilization of dissolved organic matter, increased water

temperature, and higher stream respiration could affect survival of salmon during egg development and early juvenile stages.

Scientists in southeast Alaska have established methods for quantifying fluxes of carbon from terrestrial and aquatic ecosystems across a gradient of forest structures. This research, coupled with adaptive management, will provide information on the magnitude of the carbon sink or source on the Tongass National Forest. It provides a powerful approach to understanding short- and long-term aspects of carbon sequestration on the forest, which can then be applied to regional and national carbon sequestration goals.

Contact: Rick Edwards, rtedwards@fs.fed.us, Land and Watershed Management Program

Partners: University of Alaska Southeast; USDA Cooperative State Research, Education, and Extension Service Program

Marbled murrelet populations are declining in the Northwest Forest Plan area

Use: *U.S. Fish and Wildlife Service uses findings to inform decision to keep murrelet listed as a threatened species.*

The marbled murrelet, a seabird, is a threatened species under the Endangered Species Act. The 1996 Northwest Forest Plan is the guiding plan for managing the bird's terrestrial habitat that runs along the coast of Washington, Oregon, and northern California. To determine if the plan is working, researchers have monitored murrelet population since 2000. By using at-sea transects in coastal waters adjacent to the plan area, scientists have estimated the size of the murrelet population, and it appears that from 2000 to 2009, murrelets have declined by 2 to 4 percent per year, depending on how the data are analyzed. Habitat losses have been minimal on federally managed lands; however, losses on private lands, and nest predation associated with urban encroachment have increased and may be responsible for some of the decline in population.

The U.S. Fish and Wildlife Service used this information in their status assessment of the marbled murrelet. Based in part on these results, the service determined that the species should continue to be listed as threatened. Resource managers are using these findings to evaluate the role of forest conditions in contributing to the observed decline.

Contact: Martin G. Raphael, mraphael@fs.fed.us, Ecological Process and Function Program

Partners: USDA Forest Service, National Forest System, USDI Bureau of Land Management and Fish and Wildlife Service; Washington Department of Fish and Wildlife

Marty Raphael

Marbled murrelet on Puget Sound.

James Swingle

A researcher installs a video camera near a red tree vole's nest.

Nightlife of red tree voles caught on camera

Red tree voles live high in the tops of coniferous trees in western Oregon and northwestern California. They are an important food for the threatened northern spotted owl, and there is concern that they may be declining as old forests are removed and replaced by intensively managed young forests. This has led to extensive attempts to survey them by searching for nests from the ground and then climbing trees to confirm that the nests were built by tree voles. But because the voles are nocturnal and so far from the ground, not much was known about their basic habits. To learn more, researchers used radio transmitters and video cameras to document the movements and behavior of red tree voles, from 2002 to 2007. These studies are the first to describe the movements and foraging behavior of tree voles at night, when they are active in the forest canopy.

Researchers found that 62 percent of the observed voles occupied home ranges that included multiple nests in different trees, and that voles sometimes came to the ground to move between nests if there were no interconnecting limb pathways between trees. Researchers also found that many tree vole nests could not be detected by ground-based visual surveys, especially in old forests, where nests were often located inside cavities in the broken tops of large trees. These findings will help land managers and ecologists design management plans for red tree voles and improve survey methods for tree voles.

Contact: Eric Forsman, eforsman @fs.fed.us, Ecological Process and Function Program

Partners: Oregon State University, USDI Bureau of Land Management

New methods yield improved estimates of current forest conditions

The Forest Service's Forest Inventory and Analysis Program has been collecting and analyzing data on our Nation's forests since the 1930s. This information is used by decisionmakers to decide policy, law, and regulation of forests at the state and federal level; by forest managers to understand the status and changes in the forest; and by the general public and researchers to understand how forests are affected by broad socioeconomic and ecological change.

In the Western United States, established forest plots are remeasured every 10 years. Forest managers, state and federal agencies, and other groups that need information about the current status of forests would

Rhonda Mazza

Field crew measures tree diameter.

prefer more current information. To help meet this need, station and university scientists explored using current remote-sensing data and previous measurements from national forests in Oregon and Washington to update plot information. By comparing the modeled outcomes with known conditions, they were able to identify a more accurate statistical method for updating plot information. They also identified ways to improve commonly used "nearest neighbor" methods for updating or filling in missing data. These findings could be used to support the Resource Planning Act, which requires the Forest Service to assess the Nation's forest lands every 10 years.

Contact: Tara Barrett, tbarrett@fs.fed.us, Threat Characterization and Management Program

Partner: Oregon State University

Maps illustrate 23 years of change on Northwest forests

Use: *Regulatory agencies use maps to assess land management and status of threatened and endangered species.*

By using historical remote-sensing data, researchers developed maps of annual forest change between 1984 and 2007. These maps, with a resolution of 98 feet (30 meters), of western Oregon, western Washington, and northern California show changes from timber harvests (thinnings to clearcuts), fires (low to high severity), insects and pathogens, and forest increase associated with recovery after disturbance. As a series, the maps contain an unprecedented level of spatial and temporal detail. The ability to illustrate forest change over time was made possible by publicly available satellite data and new algorithms developed by the station and its partners.

Land managers and regulatory agencies are using these maps to assess current land management, the status and trends of populations of threatened and endangered species, and develop innovative approaches. For example, the Northwest Forest Plan Effectiveness Monitoring Program is using them to assess the effects of forest management and natural disturbance on wildlife habitat for the spotted owl, marbled murrelet, and other old-growth-related species; watershed condition; and socioeconomic factors of forest-product-dependent communities. The National Marine Fisheries Service is using these data to assess effects of forest change on the threatened and endangered runs of the coho salmon in Oregon.

Contact: Warren B. Cohen, wcohen@fs.fed.us, Resource Monitoring and Assessment Program

Partners: Oregon State University, USDA Forest Service Pacific Northwest Region

Keith Routman

Mount Hood, Oregon.

Tom Iraci

Map resolution can affect interpretation of stream length, which then leads to discrepancies in estimates of quality and quantity of riparian and aquatic habitat. Above: a creek on the Siuslaw National Forest.

Map resolution influences analysis

Digital maps of rivers and lakes are often used in research, planning, and monitoring for freshwater conservation across large areas. Such maps are publicly available, for example from the U.S. Geological Survey, or can be produced at different spatial accuracies and resolutions. Before this study, the influence of differences in map accuracy and resolution on broad-scale assessments of the quality and quantity of freshwater resources had not been well quantified. Researchers compared maps from the Oregon Coast Range and determined that differences in accuracy among examined maps were not large enough to appreciably affect landscape characterizations, such as the amount of old-growth forest estimated in streamside buffers. However, differences in resolution among maps caused the length of represented streams to differ by as much as 1,250 percent, yielding substantial discrepancies in the estimated quality and quantity of riparian and salmon habitats. These differences affected interpretation about small, intermittently flowing headwater streams and larger, perennially flowing streams.

These findings are helping researchers and managers understand the advantages and disadvantages of different stream maps in specific applications. This knowledge also facilitates comparison among studies and better communication.

Contact: Kelly M. Burnett, kmburnett@fs.fed.us, Land and Watershed Management Program

Partners: Oregon State University, USDA Forest Service Natural Resources Inventory System

Scientist quantifies incidence and effects of insects and diseases in Oregon forests

The native insects, diseases, parasites, and animals that damage and kill trees in Oregon's forests are natural parts of their ecosystems. They are as responsible for creating current forests as they are for destroying them. By weakening and killing trees, these damaging agents promote the natural succession that allows new trees and forests to establish and grow. When forest conditions are outside their normal range of variation, however, the behavior of damaging agents may also depart from normal ranges.

To provide a baseline that can be used to assess future changes, a station scientist quantified the incidence and effects of insects, diseases, and other damaging agents in Oregon forests between the mid-1980s and the late 1990s. He found that 36 percent of live trees had some damage, with more trees damaged on the east side of the Cascades than on the west side. The most

common damages were physical injuries or defects such as dead tops, basal scars, and forks. Average annual mortality was just under 1 percent. Of that, bark beetles were the most common cause of mortality, followed by root disease. Conifers were found to have higher mortality rates from bark beetles when root disease was present than when it was not.

Contact: Sally Campbell, scampbell01@fs.fed.us, Resource Monitoring and Assessment Program

Partner: USDA Forest Service Pacific Northwest Region

For more information: Dunham, Paul A. 2008. Incidence of insects, diseases, and other damaging agents in Oregon forests. Resour. Bull. PNW-RB-257. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 89 p.

Southern rural areas projected to experience greatest increases in development

Rapid development of rural land is projected to continue as the U.S. population grows. This may reduce the capacity of these lands to produce the goods, services, and functions critical to society. Combining population projections and trends in people per housing unit with development indices, researchers projected that developed area in the United States will increase by 54 million acres between 2003 and 2030. The greatest absolute increases are projected to occur in the Southeast and South Central regions of the country. Continued declines in the number of people per housing unit also will contribute to the rate of rural development because more housing units will be needed to accommodate the population. As the area of rural land decreases, greater demands will be placed on remaining open space. More emphasis on open-space conservation through regulatory, incentive, or other programs may decrease the rates of rural land conversion in the coming decades.

Contact: Ralph Alig, ralig@fs.fed.us, Goods, Services, and Values Program

Partner: U.S. Environmental Protection Agency

Mark Godfrey © 2004 The Nature Conservancy

Atlanta, Georgia, suburb.

Cold Springs Fire, Mount Adams, Washington, by Rhonda Mazza

GOAL 3: Develop science-based options for informed management

Key Findings and Products

- Pacific salmon may be better served by freshwater habitat recovery strategies that focus on natural processes and variability rather than those that attempt to maintain or engineer a desired set of conditions through time.
- MAPSS Fire Forecasting System accurately calculates total area burned and total firefighting expenditures in the conterminous United States during the 2008 fire season. Scientists present 2009 seasonal forecast to fire managers throughout the West.
- Decision-support system advances evaluation of wildland fire danger and prioritization of forest fuels treatments in the Pacific Northwest region.
- National study compares outcomes of commonly used fuel reduction treatments, providing needed information for land managers who must choose which treatments to use.
- Assessments of treatments to reduce fire hazard in part of Oregon and northern California indicate that removing only small trees is not an economical or effective way to reduce fire hazard; large, merchantable trees need to be removed as well.
- *First Approximation of Fire Hazard and Fire Risk* establishes protocol for estimating hazard and risk of wildland fire on a national scale.
- New model projects number of potential jobs and cost of reducing fire hazard on national forests in the Western United States.
- Wildfire risk assessments on the Deschutes National Forest highlight priority areas for fuel treatments to protect specific human and ecological values.
- Spring budburst in Douglas-fir can be modeled using a range of temperature combinations that meet chilling and forcing requirements. This allows budburst to be predicted for a wide range of future climate scenarios.
- Landscape models indicate that maintaining working forests in central Oregon rather than converting them to residential use results in lower fuel levels, more winter range for mule deer, and sustainable production of timber and other forest products.
- Scientists develop a method rural forest communities can use to assess their transition from a timber-based economy to one based on amenities that attract tourists, second homes, and retirees. The method can help communities identify their current transition phase and possible policies that may mitigate foreseeable conflicts.
- Published airborne laser scanning (LIDAR) specifications make technology more useable.
- Combining aggregated and dispersed retention of live trees in harvest units provides substantial ecological and social benefits.

Doni McKay

Researchers plant trees as part of a study on the Deschutes National Forest to learn about recolonization of ectomycorrhizal fungi on tree roots.

Pete Bisson

Salmon have different habitat needs during different phases of life. The Olympic Experimental State Forest (above) supports many salmon runs.

Scientists propose new focus for salmon habitat recovery strategies

A common tactic for restoring freshwater habitat for Pacific salmon has been to maintain or engineer a desired set of habitat conditions through time. Station scientists proposed a new approach for habitat recovery that focuses on the importance of natural variability in habitat resilience. They identified three factors that support the productivity of salmon in freshwater ecosystems: (1) capacity of habitat to recover after disturbance, (2) diversity of habitats necessary to meet the salmon needs during different phases of life, and (3) ecological connectivity.

They identified three steps to developing such management strategies: (1) Establish environmental targets that are compatible with natural disturbance and recovery processes. (2) Assess the current and potential threats to reestablishing complex natural habitats. (3) Determine if the planning area is sufficiently large to achieve the three criteria for habitat resilience and when and where it will be necessary to apply restoration techniques to help promote them.

Contact: Pete Bisson, pbisson@fs.fed.us, Land and Watershed Management Program

Partner: U.S. Geological Survey Forest and Rangeland Ecosystem Science Center

Fire forecasting system accurately calculates area burned and costs for 2008

The station produces continuously updated 7-month forecasts of fire danger and drought for the conterminous United States using the MC1 Dynamic General Vegetation Model. In 2009, scientists worked to increase the spatial resolution of the fire forecasting system by more than two orders of magnitude, bringing the focus down from grid cells of 50 square kilometers (km) to 4 square km. A "hindcast" of acreage burned in 2008 at the increased resolution was just 2 percent below actual burned area reported by the National Interagency Fire Center.

Use: *Forecasts help fire managers plan for 2009 fire season.*

Scientists also began providing output from their fire forecasting system to researchers at the Rocky Mountain Research Station for use in predicting total annual firefighting expenditures. Preliminary results show these forecast-based regression models are significantly better at predicting total seasonal expenditures than the professional judgment approach currently used at the National Interagency Fire Center. Actual total firefighting expenditures for the 2008 fire season were about $1.25 billion. The predicted expenditure based on the 50-km hindcast for 2008 was about $1.21 billion, or just 3 percent below observed.

Nearly 200 land managers from various resource agencies receive monthly alerts

about new fire forecasts posted on the Mapped Atmosphere-Plant-Soil System (MAPSS) Web site. In April, the 2009 seasonal forecast was presented to fire managers throughout the West.

Contact: James M. Lenihan; jlenihan@fs.fed.us, Ecological Process and Function Program

Partners: National Interagency Coordination Center, Oregon State University

For more information: http://www.fs.fed.us/pnw/mdr/mapss/fireforecasts/index.shtml

New prototypes provide advanced evaluations of wildfire danger

Federal land-management agencies responsible for managing forest fuels have been strongly criticized in recent years by Congress and oversight agencies for lacking a rational process for allocating funds for fuel treatment. To remedy this, since 2006, scientists have been using the Ecosystem Management Decision Support system to develop national level decision-support applications for fuel analysis and fuel-treatment planning for the Forest Service and U.S. Department of the Interior.

This year, the project undertook advanced and comprehensive fuel evaluations at fine spatial scales. Separate prototypes were developed for the Pacific Northwest and western Montana. Both prototypes provide advanced evaluations of wildfire danger at the subwatershed scale (roughly 25,000 to 30,000 acres), drawing on data from the LANDFIRE Program, NASA, and other reliable agency sources.

The new prototypes provide "wall-to-wall" evaluations of fire danger for all subwatersheds in a geographic region. These units can be correlated with a wide range of administrative units such as ranger districts, national forests, Bureau of Land Management districts, and national parks.

Contact: Keith M. Reynolds, kreynolds@fs.fed.us, Paul Hessburg, phessburg@fs.fed.us, Ecological Process and Function Program

Partners: USDA Forest Service Fire and Aviation Management, Intermountain Research Station, Northern Region, and Pacific Northwest Region; USDI Bureau of Land Management, Oregon State Office

Commonly used fuel-reduction treatments yield different outcomes

Scientists synthesized outcomes from the national Fire and Fire Surrogates project, evaluating the consequences of commonly used fuel-reduction treatments. They found that the mechanical treatments to reduce fuel and prescribed fires produced different outcomes. In the short term, mechanical treatments were effective at reducing overstory tree density and basal area and at increasing tree diameter. Prescribed fire treatments were more effective at creating

Use:
Forest managers receive requested side-by-side comparison of fuel treatments.

Tom Iraci

Prescribed burn on the Okanogan-Wenatchee National Forest.

Tool: New metric for measuring the fuel available for crown fires

Description:

Crown bulk density (CBD), the metric commonly used to quantify canopy fuel available for combustion in the event of a crown fire, is difficult to consistently measure. It is a three-dimensional metric based on the mass of foliage, twigs, and an approximation of canopy volume of a stand of trees. Scientists developed an alternative, one-dimensional metric that only uses the amount of foliar biomass per unit area in a stand. This metric is a novel solution because foliar biomass can be reliably estimated and is easily related to stand conditions including leaf area index, basal area, and transpiration. This new metric was found to be statistically equivalent to CBD when comparing the modeled minimum rate of spread necessary for active crown fire across a broad range of stand conditions. The new metric is the first potential alternative to the existing CBD metric since its introduction in 1977.

Use:

State and federal wildland fire and fuel treatment planners now have a more easily obtainable, consistent metric for assessing crown fire potential.

Contact:

James D. Dickinson, jddickinson@fs.fed.us, Ecological Process and Function Program

Shawnita Nelson

Mechanical thinning followed by prescribed burning reduces crown fire potential.

snags, killing seedlings, elevating the height to live crown ratio, and reducing surface woody fuels. Mechanical treatments followed by prescribed fire were the most effective treatment for reducing crown fire potential and predicted tree mortality. Findings indicated that if the management goal is to quickly shift stands toward conditions with fewer and larger diameter trees, less surface fuel mass, and more herbaceous species, the mechanical plus burn treatment is a reasonable alternative.

Forest managers throughout the United States had asked for side-by-side comparisons of treatments to better understand the ecological and economic considerations for applying fuel-reduction and forest restoration treatments. Managers who are confronted with uncertainties in selecting from a set of fuel-reduction treatments in fire-prone ecosystems now have quantified and documented results upon which to base their decisions.

Contact: Andrew Youngblood, ayoungblood@fs.fed.us, Land and Watershed Management Program

Partners: Oregon State University; Texas Tech University; University of California-Berkeley; University of Montana; USDA Forest Service Northern Research Station, Pacific Southwest Research Station, Rocky Mountain Research Station, Southern Research Station, and Wallowa-Whitman National Forest; U.S. Geological Survey

Model simulations quantify differences among fuel-reduction treatments

Scientists evaluated the effects of simulated thinning and surface fuel treatments on 45,000 stands in low- to mid-elevation dry forests in the Western United States using the Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS). They found that thinning treatments that left 50 or 100 trees per acre were more effective at reducing crown fire hazard than thinning treatments that left 200 or 300 trees per acre. Prescribed fire was the most effective surface fuel treatment.

This is the first study to statistically test treatment effects with FFE-FVS. These results support inferences from recent empirical studies about stand density and fuel structures on crown fire hazard. The concurrence of results from modeling and empirical studies provides quantitative support for "fire-safe" principles of forest fuel reduction.

This study quantified what would constitute significant differences among a variety of thinning treatments. These findings will help forest and fire managers develop effective treatment options for reducing potential fire behavior in dry forests of the Western United States.

Contact: Morris C. Johnson, mcjohnson@fs.fed.us, Threat Characterization and Management Program

Partners: USDA Forest Service Forest Management Service Center and Forest Vegetation Simulator Group

Focusing only on small trees is not an economical or effective way to reduce fire hazard

Increasingly large and severe wildfires threaten millions of forested acres throughout the West. Under certain conditions, mechanical thinning can address these hazardous conditions while providing opportunities to both obtain wood products and create renewable energy from the removed biomass.

Jeremy Fried

Fuel treatments that included removal of trees 10 inches or larger in diameter more effectively reduced fire hazard and were more economical than treatments focused on smaller trees.

Station scientists created an analysis framework called FIA BioSum that uses the nationwide Forest Inventory and Analysis (FIA) database and allows forest managers to simultaneously assess the effectiveness of fuel treatments, the location and capacity of processing facilities, and project returns on investments. Using FIA BioSum to analyze the Klamath region in southern Oregon, scientists determined that under current harvest systems, product prices, and harvest and haul costs, only a tiny fraction of the region could be treated via operations that generate positive net revenue under prescriptions that focus on removing trees smaller than 10 inches in diameter. To expand the economically treatable area, logging or hauling costs would need to be substantially subsidized, or more merchantable timber (larger trees) would need to be removed.

Another analysis simulated the outcomes of implementing three alternative policies with different overarching objectives in northern California, southwestern Oregon, and the east slopes of the Cascade Range in Oregon. This analysis suggests that a considerable number of commercial-size trees need to be removed to accomplish fire-hazard-reduction goals when objectives center on either maximizing net revenue or maximizing treatment effectiveness. Most of the softwood biomass that would be chipped and used to generate electricity came from the tops and limbs of the larger trees. Trees smaller than 7 inches in diameter were a relatively minor component of the chipped material.

Contact: Jeremy Fried, jsfried@fs.fed.us, Resource Monitoring and Assessment Program

Scientists develop national-scale protocol for estimating fire hazard and risk

At the request of the national Wildland Fire Leadership Council, station scientists and partners developed a risk assessment protocol: *First Approximation of Fire Hazard and Fire Risk*. This formal risk framework uses spatially defined estimates of the annual likelihood of fire, the expected intensity, and the fire effects—positive and negative—on values such as wildlife habitat, energy infrastructure, recreation, and human population density. This protocol will be used to establish a baseline from which national trends in wildland fire hazard can be monitored. Results from the project will also be used to strategically plan fuel-reduction treatments over time to mitigate ecological and human loss from wildfire.

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

Partner: USDA Forest Service Rocky Mountain Research Station

Station leads effort to evaluate thinning treatment to reduce fire hazard

Millions of acres of public forest in the United States have accumulated excess biomass after a century of fire exclusion, making them susceptible to uncharacteristically severe wildfire. Research by station scientists was used by the Southern Research Station to develop the Economics of Biomass Removal 3 (EBR-3) Model. This model answers questions about the costs and benefits of fuel-reduction treatments. The PNW Research Station also coordinated an effort to use this model to evaluate thinning treatments on nonreserved forest land in the Western United States. Researchers found that five Forest Service jobs and six additional jobs would result from every 5,000 acres treated. They also determined it would cost $1.9 billion per year to reduce the number of national forest timberland acres with high fire hazard by 20 percent. A portion of this cost, however, could be recovered through the sale of wood products removed. Over 10 years, these fuel-reduction treatments on western national forests would remove up to 0.15 billion cubic feet of biomass suitable for bioenergy use. The station also contributed to an effort led by the Forest Products Laboratory to develop county-level estimates of biomass removal.

Use: *Findings inform national discussion on climate change, renewable energy, and wildfire suppression costs.*

The Forest Service is using these findings to contribute to ongoing discussions about the agency's role in addressing climate change, promoting renewable energy sources, and combating increases in wildfire suppression expenditures.

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

Partners: USDA Forest Service Southern Research Station and Forest Products Laboratory

Tom Iraci

Hand thinning project, Siuslaw National Forest, Oregon.

Risk assessment helps prioritize fuel treatments

Where will fuel-reduction treatments be most effective? This is a key question for land managers challenged by a finite budget and public expectations to protect specific highly valued resources while meeting goals to restore fire resilience to large forested landscapes. Focusing treatments in

Use: *Deschutes National Forest uses risk assessment to develop a management plan for northern spotted owls.*

Tom Iraci

Firefighters note ways that homeowners in the wildland-urban interface could reduce fire hazards.

and around the wildland-urban interface to protect human property, for example, is less efficient and perhaps not compatible with landscape restoration goals to change the behavior of large fires.

Work by station scientists and managers on the Deschutes National Forest demonstrated how risk assessment tools can be used to measure the relative wildfire risk to the wide array of human and ecological values found on federal lands. These analyses can guide management activities to protect specific resources including habitat conservation efforts for threatened and endangered species, such as the northern spotted owl, in fire-prone areas. Scientists also analyzed fuel-reduction strategies on a wildland-urban area, typical of eastern Oregon, abutting the Wallowa-Whitman National Forest. Both studies revealed spatial variation in burn probability and intensity that is useful for prioritizing fuel-reduction treatments.

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

Partners: USDA Forest Service Deschutes National Forest and Rocky Mountain Research Station

Web Page: Daily updates on new fire weather indicator

Description:

A new Web page was developed to assist the Northwest Coordination Center (NWCC) evaluate fire danger from ongoing wildland fires. The NWCC coordinates logistics support, aviation support, and predictive services for all state and federal agencies involved in wildland fire management and suppression in Oregon and Washington.

The Web page provides daily updates on the "downdraft convective available potential energy" in the region, a quantitative meteorological measure that appears to track severe fire weather. This information helps fire managers plan for safety and resource deployment.

Use:

Predictive Service Meteorologists at the Northwest Coordination Center access the page almost daily.

How to get it:

http://airfire.org/firewx/dcape/

Contact:

Brian Potter, bpotter@fs.fed.us, Threat Characterization and Management Program

Tool: Customized models based on BlueSky modeling framework

Description:
Users can now create custom consumption, emissions, and smoke dispersion model runs based on their specific model choices by using the new BlueSky Web-service functionality similar to that found in other online tools. This means users do not need to install any additional software. This new feature has led to the addition of new models, increasing the capabilities for the BlueSky framework, and to research studies aimed at using BlueSky's functionality to understand model-to-model variations, which can help focus model development.

Use:
Through the National Fire Consortia for Advanced Modeling of Meteorology and Smoke partnership, air quality managers, land managers, and fire managers now have access to a national smoke prediction system that creates tailored smoke model predictions. Custom smoke model predictions are also helping managers at the Northwest Coordination Center understand model prediction uncertainties through an ensemble of daily customized smoke prediction runs that are produced.

How to get it:
To view current model predictions go to http://today.airfire.org; to learn about BlueSky's capabilities go to http://blueskyframework.org.

Contact:
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Postfire seeding does not reduce soil erosion following wildfire

Slope stabilization treatments are applied after severe wildfires to increase soil cover, reduce soil erosion, protect water quality, and reduce risks to human life and property. The effectiveness of many common slope stabilization treatments, such as reseeding, remains in question, however.

Station scientists assessed different reseeding treatments after several recent fires on the Okanogan-Wenatchee National Forest. They found that seeding winter wheat over portions of the burned area produced little or no additional soil cover following high-severity wildfires in the dry coniferous forest. They also tried seeding yarrow, a perennial native forb, and found this often increased cover of yarrow significantly, particularly when applied in combination with nitrogen fertilizer. In general they found the increased cover of seeded species was often offset by reduced cover of native, nonseeded vegetation. These findings suggest that seeded species compete with recovering native vegetation for limited soil resources after wildfire in dry coniferous forests, and that efforts to monitor the effectiveness of slope stabilization treatments by measuring seeded species cover alone are likely to overestimate treatment effects on soil cover, runoff, and erosion.

Contact: Dave W. Peterson, davepeterson@fs.fed.us, Threat Characterization and Management Program

Partners: USDA Forest Service Okanogan-Wenatchee National Forest, USDA-USDI Joint Fire Science Program

Dave W. Peterson

Reseeding studies on the Okanogan-Wenatchee National Forest suggest that seeded species compete with recovering native vegetation for nutrients and water.

New method predicts spring budburst under different climate scenarios

Most tree species have a chilling requirement (exposure to a certain amount of cold weather) and a forcing requirement (enough warm weather to trigger budburst) before the buds will burst in the spring. The chilling requirement is a protective mechanism that prevents budburst during warm spells midwinter. Results from a recent study indicate that the temperature range that will satisfy the chilling requirement for Douglas-fir is wider than previously appreciated. A new approach to modeling spring budburst calculates the temperature combinations that meet both chilling and forcing requirements and predicts the timing of spring budburst for historical and possible future climate scenarios. It predicts budburst will occur earlier in the spring with moderate winter warming; however, if substantial winter warming occurs, the model predicts budburst will be delayed because reduced winter chilling would increase the requirement for forcing temperatures. The modeling approach is consistent with reports from the literature for multiple species; thus, it may apply quite broadly.

Partners: Oregon State University, Washington Department of Natural Resources, Webster Nursery

Contact: Constance Harrington, charrington@fs.fed.us, Threat Characterization and Management Program

Brad St. Clair

Field crew planting a Douglas-fir seedling from a nonlocal seed source near Winlock, Washington, as part of a study on assisted migration.

Study tests viability of assisted migration in response to climate change

Successful reforestation and subsequent productivity of Douglas-fir forests require that trees are adapted to their planting site. Seed zones and breeding zones are used to ensure adapted planting stock by specifying relatively local seed sources. Local seed sources, however, may not be adapted to future climates given climate change projections. A possible solution is assisted migration, where seed sources are moved north or up in elevation in response to predicted climate warming.

To test the viability of assisted migration, researchers planted seedlings from locations throughout western Oregon and Washington and northern California at nine sites in western Oregon and Washington. Responses of the different seed sources will be evaluated relative to test site environments and the environments of the seed sources.

Brad St. Clair

A technician checks the weather station installed 25 miles east of Sweet Home, Oregon, as part of a study on assisted migration of Douglas-fir.

These tests will contribute significantly to our understanding of the responses of different Douglas-fir seed sources to climate, and provide guidelines for choosing seed sources that will be adapted to current and future climates.

Contacts: Brad St. Clair, bstclair@fs.fed.us, Land and Watershed Management Program

Partners: Agenda 2020 Program; Cascade Timber Consulting; Giustina Land and Timber; Hancock Forest Resources; Lone Rock Timber Co.; Port Blakely Tree Farms; Puget Sound Tree Improvement Cooperative; Roseburg Resources; Starker Forests; USDA Forest Service, J. Herbert Stone Nursery; Washington Cascade Tree Improvement Cooperative; Washington Department of Natural Resources

Landscape models connect natural resource impacts and potential development objectives

In terms of housing construction, central Oregon has been the fastest growing region in the state for more than a decade. This change in land use has many implications including reduced wildlife habitat and increased fire risk to property. Scientists modeled potential scenarios for two tracts of private forests in Deschutes County depending on if they were developed for residential use or maintained as working forest. They compared the effects these two uses might have on mule deer wintering habitat, changes in vegetation composition, and wildfire conditions.

Use: *Study informs decision by Oregon legislature to buy forest land.*

They found that maintaining these lands as working forests would likely result in relatively low levels of landscape fuels, provide suitable winter range for mule deer, and generate forest products from sustainable forest management. Researchers also projected housing development in the upper Deschutes area out to 2050, showing the most pressure around existing developed areas such as Bend. The landscape analysis tools used in this study were developed as part of the Interagency Mapping and Assessment Project (IMAP).

Miles Hemstrom

A stand of ponderosa pine treated to reduce fuel levels and increase wildlife habitat.

The Oregon legislature consulted the maps and analyses stemming from this project and authorized the sale of bonds to buy one of the tracts, which could make it a state forest. It also approved a plan to develop part of the other tract and offer the remainder for sale to the Deschutes Land Trust. The Deschutes Land Trust also referred to the study results when applying for funding under the Forest Legacy Program, a voluntary federal program in partnership with states that supports state efforts to protect working forests.

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

Partner: Oregon Department of Forestry

New techniques help rural forest communities plan for future

Thousands of rural communities across the West have experienced significant changes in the last 30 years as management policies on neighboring national forests shifted from resource production to biodiversity conservation. Towns that once centered on timber or mining may now be hubs for recreation and tourism on the neighboring forest. Many have also become retirement destinations, a place for city dwellers to build a second home, or perhaps even telecommute while enjoying the natural amenities of the rural setting. The economic activity that follows these changes may benefit some communities and residents, but not all.

Station scientists are studying the relation between public land management policy, amenity migration, and socioeconomic well-being in the Pacific Northwest. They show that managing for multiple forest uses may influence a community's ability to adapt to these socioeconomic changes. They have developed a method for estimating a community's socioeconomic resilience by evaluating the transition stages from an extractive, commodity-based economy to an amenity-based economy. This information can help a community identify its current transition stage, what to expect in the next stage, and possible policy actions to mitigate foreseeable conflicts. Another study developed a method of manual indexing that allows a flexible and replicable way of assessing and ranking the amenity levels for communities at various geographic scales.

Managing for multiple forest uses may help rural communities adapt to socioeconomic changes.

Contact: Dale Blahna, dblahna@fs.fed.us, and Susan Charnley, scharnley@fs.fed.us, Goods, Services, and Values Program

Partners: Institute for Culture and Ecology, University of Illinois, Utah State University

Ecosystem services markets are not a cure-all to environmental woes

"Ecosystem services markets" are among the latest buzzwords used by environmental policymakers and conservationists. But what is the real promise in ecosystem services markets and what can realistically be achieved by their implementation? To begin answering these questions, scientists published an article that outlines how environmental markets work in theory and discusses several issues that influence their effectiveness. They point out that the success of traditional approaches to ecosystem protection such as conservation easements and land trusts should not be overlooked amid enthusiasm for market approaches. Voluntary markets, in particular, are only one part of a larger solution at best and, at worst, are a serious distraction from addressing the difficult task of achieving an optimal level of ecosystem protection. Ultimately, ecosystem protection depends on public support. Educational campaigns that emphasize the societal value of functioning ecosystems may help garner the support necessary to enact and fund conservation efforts.

Use:
EPA uses research to explore ways markets might be used to help protect ecosystems.

State and Private Forestry staff are using these findings as an educational tool for partners and collaborators. The

Environmental Protection Agency also has consulted the lead scientist about ways to conceptually frame ecosystem services and how to measure them.

Contact: Jeffrey Kline, jkline@fs.fed.us, Goods, Services, and Values Program

Partner: M.J. Mazzota, Ltd.

For more information: Kline, J.D.; Mazzotta, M.J.; Patterson, T.M. 2009. Toward a rational exuberance for ecosystem services markets. Journal of Forestry. 107(4): 204–212.

Scale matters when integrating social and ecological systems

The scale of analysis used when examining social systems determines many of the processes that will be identified. This is true in ecological systems as well. Therefore, integrating social and ecological systems requires special attention to scale because system processes may change across scales. Researchers found that people interact with and value natural areas at multiple scales. For example, a person's attachment to an individual campsite many differ compared to his or her attachment to an entire wilderness area. To identify potential conflicts between recreation and other resource uses and to ensure equal consideration of recreation requires a framework that considers management across multiple scales. Without multiscale and spatially explicit analysis of recreation along with other natural resources, important tradeoffs among different social and ecological uses and values could be neglected. By incorporating ecological criteria and scale concepts into recreation-planning frameworks, land managers can improve the foundation for decisionmaking by resolving issues of incongruent boundaries and mismatched scales.

Contact: Linda Kruger, lkruger@fs.fed.us, Goods, Services, and Values Program

Partner: University of Idaho

Linda Kruger

A riparian recreation interface on the Cle Elum River, Wenatchee National Forest. What may appear to be a big ecological impact at the small scale may be insignificant at larger scales, especially when recreational benefits are considered.

Habitat networks foster efficient broad-scale conservation planning

One management challenge for wildlife species of conservation concern is determining how the requirements of multiple species can be reduced to a workable number and yet sufficiently represent the ecological needs of the comprehensive set of species. Habitat networks offer one promising approach.

Mary Rowland

Cheatgrass, an exotic invasive grass, has invaded thousands of acres of native shrubland altering the fire regime and the ecosystem's ability to support native fauna. Above: the Worland Basin in Montana.

Scientists developed a habitat network for five groups of terrestrial vertebrates in the interior Columbia basin and a similar network for sagebrush-associated vertebrates in the Great Basin. This process revealed spatial patterns of habitat abundance, quality, and threats to habitat from invasive species. Watersheds in which all or most habitat had been lost were widely distributed across the ranges of old forest and sagebrush-associated species of the interior Columbia basin, indicating substantial declines in amount, quality, and resiliency of habitats. In the Great Basin, watersheds with abundant habitat at low risk were rare for key species groups.

This study demonstrated that mapping habitat networks can foster efficient conservation planning at regional levels by identifying areas where efforts to protect or restore habitat will be most effective. This process can be augmented with spatial models that incorporate characteristics such as population connectivity and land protection status.

Contact: Mary Rowland mrowland@fs.fed.us, Ecological Process and Function Program

Partners: USDA Forest Service National Wildlife Ecology Program, USDI Bureau of Land Management, USGS Biological Resources Discipline

Tool: Wildland Threat Mapper

Description:
This virtual Earth viewer integrated with a search engine facilitates analysis of distribution and co-occurrence of various wildland threats and the values they affect. The search engine searches more than 30,000 global Internet map servers for spatial data sets. Query results connect to the map server, and map data are loaded directly into ArcGIS Explorer® where potential interactions can be identified. The search engine can also be used to locate a wide range of other natural resource data on a global scale.

Use:
Geospatial analysts are using Wildland Threat Mapper to conduct a systematic assessment of Internet data relevant to wildland threat assessments.

Partner:
USDA Forest Service Remote Sensing Application Center

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

Published LIDAR specifications make technology more usable

Use:
National forests, state, and federal agencies use new specifications for collecting airborne laser scanning data.

Airborne laser scanning (LIDAR) is a relatively new remote-sensing technology that has become widely used by federal, state, and local agencies for generating bare-earth surface models. It can also be used to measure forests, but agencies generally have lacked information on how to use it for this purpose. To fill this need, station scientists and the Remote Sensing Applications Center developed specifications for LIDAR missions where generation of high-resolution, bare-earth terrain models and forest structure measurement are the main project objectives. These sensor and flight specifications are based on a decade's worth of knowledge from 15 LIDAR projects. They provide land managers with an up-to-date reference for planning LIDAR missions. The specifications ensure that resulting data will be of sufficient quality to produce high-resolution bare-earth surface models and forest canopy characteristics. The publication also includes specifications for typical LIDAR-derived products such as ground and canopy surface models, images, and data formats.

The Colville, Coronado, and Rogue-Siskiyou National Forests, Washington Department of Natural Resources, and the U.S. Department of Energy are using the LIDAR mission specifications. The resulting LIDAR data are facilitating more accurate, timely, and cost-effective planning and design of forest management activities such as watershed analysis, fuel reduction and forest health treatments, and road system inventory.

Contact: Steve Reutebuch, sreutebuch@fs.fed.us, Resource Monitoring and Assessment Program

Partners: USDA Forest Service Remote Sensing Applications Center and Coronado National Forest

For more information: Laes, D.; Reutebuch, S.; McGaughey, B. [et al.]. 2008. Practical LIDAR acquisition considerations for forestry applications. RSAC-0111-BRIEF1. Salt Lake City, UT: U.S. Department of Agriculture, Forest Service, Remote Sensing Applications Center. 7 p.

Adrian Ares

Selective harvest and thinning treatments in this stand increased vegetative diversity.

Large-scale, operational experiments link scientists with managers to inform decisions

In the past 15 years, the station has established numerous large-scale operational silviculture experiments on U.S. federal and state lands by using interdisciplinary approaches that address a broad range of ecological and social objectives. A number of findings have emerged from these studies.

- Silviculture operations such as selective harvest and thinning can increase variation in stand structure, moving stands from uniform, even-age conditions toward the development of more complex structural characteristics associated with older, mixed-age stands.
- Retaining 15 percent or more of live trees in a stand may be needed to protect residual trees, retain sensitive species, and gain public acceptance.
- Retaining and recruiting down wood in managed stands benefits ground-dwelling organisms.
- Buffers on headwater streams provide amphibian habitat, mitigate upslope harvest effects on microclimate, and provide connectivity across the landscape.
- New technology for characterizing and mapping forest structure and the underlying terrain has been validated.

Contact: Paul Anderson, pdanderson@fs.fed.us, Land and Watershed Management Program

Partners: USDA Forest Service Pacific Northwest Region, and Gifford Pinchot, Umpqua, Olympia, Siuslaw, and Willamette National Forests; USDI Bureau of Land Management; Washington Department of Natural Resources

Harvest pattern influences survival of forest-dependent species

Use: *Land managers in Pacific Northwest, British Columbia, and Tasmania apply DEMO findings to forest management.*

The Demonstration of Ecosystem Management Options (DEMO) study was established in 1994 to evaluate the benefits of leaving some live trees standing as part of harvest treatments. The percentage of trees retained ranged from 15 to 100, and the retention pattern also differed among study sites in mature Douglas-fir forests.

Short-term results suggest that both dispersed and aggregated retention are needed to retain sensitive plants and animals, ameliorate harsh microclimatic conditions, and gain public acceptance of retention harvests. Although retention level had a greater influence on most ecological responses than did its pattern, retaining trees in aggregates of 2.5 acres provided several benefits over dispersed retention. Aggregates greatly reduced damage to and mortality of residual trees (particularly at lower retention levels) and provided short-term refugia for forest species sensitive to disturbance or environmental stress.

Tom Iraci

Foresters examine the Blue Ridge study site in Washington's Capitol State Forest as part of the Demonstration of Ecosystem Management Options study.

Tool: New deer model for the Tongass National Forest

Description:
The values for this new model are derived from field data analyzed with the station's Forage Resource Evaluation System for Habitat–Deer (FRESH-Deer), which is entirely transparent in its theory and calculations and is based on strong biological science. The model replaces a controversial expert-opinion model that led to legal challenges because of its hidden assumptions and relative lack of data-based analysis.

The new Tongass model also includes a process for immediately incorporating new results from the young-growth silviculture adaptive management program Tongass-Wide Young-Growth Studies (TWYGS). The TWYGS results are original field data, statistically strong, and updated annually. The combination of FRESH-Deer and TWYGS provides the Tongass National Forest with an always current tool for quantitatively evaluating habitat and potential forest management alternatives.

Use:
The Tongass National Forest is using this model in routine land management planning and analysis. It is expected to greatly reduce contention around deer habitat analysis and related legal appeals to Tongass National Forest management decisions.

How to get it:
The FRESH-Deer habitat evaluation system is available at http://cervid.uaa.alaska.edu/deer/. The new Tongass National Forest deer model is available through Jim Brainard (jbrainard@fs.fed.us) or Patricia O'Connor (poconnor@fs.fed.us) of the Tongass National Forest.

Contact:
Thomas A. Hanley, thanley@fs.fed.us,
Ecological Process and Function Program

Based on these findings, a combination of aggregates larger than 2.5 acres and dispersed retention at levels considerably greater than current minimum standard of 15 percent appears a general strategy for ensuring the short-term persistence (and, presumably, the long-term recovery) of most forest-dependent species. It also appears to be an effective treatment for gaining public acceptance of green-tree retention that sustains the ecological and commodity values of managed forests. These studies have garnered international interest—both in the findings and in the safety and operational aspects of green-tree-retention harvests.

Contact: Charley Peterson, cepeterson@fs.fed.us, Resource Monitoring and Assessment 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

Understory plants respond dramatically to thinning treatments in Tongass young growth

Dense young stands of naturally regenerated trees have filled in the clearcuts of the 1970s and 1980s on the Tongass National Forest. Lacking light, little understory vegetation is present in these stands, leading to concerns about the quantity and quality of forage for deer. To improve the management of young-growth stands for multiple values, including deer, the station and Tongass National Forest established four operational-scale, widely replicated, adaptive management experiments known as the Tongass-Wide Young-Growth Studies (TWYGS). The fifth-year measurements of two of the experiments have yielded valuable information about responses to thinning in 15- to 25-year-old stands and to pruning combined with thinning in 25- to 35-year-old stands. Researchers found dramatic improvements in abundance and diversity of understory vegetation in the treated stands when compared with untreated controls. Further analysis indicated a demonstrable increase in deer forage owing to active management.

Use: *Tongass National Forest uses vegetation data in new deer habitat model.*

The TWYGS experiments are the primary means for monitoring the effects

Black-tailed deer.

of young-growth management under the Tongass land and resource management plan. The vegetation response data and outputs from the FRESH-Deer forage model are being used by the Tongass National Forest to develop a new deer habitat model for southeast Alaska. This new model will be used for project- and landscape-level planning.

Contact: Michael McClellan, mmcclellan@fs.fed.us, Focused Science Delivery Program

Partner: USDA Forest Service Tongass National Forest

10-foot spacing is optimal for longer term management of Douglas-fir

Growth and mortality responses of Douglas-fir spaced 3 to 20 feet apart were compared among three sites of contrasting quality in Washington and British Columbia. During 25 years of stand development, stands planted at a 10-foot spacing maintained a high level of tree vigor and stability. They also experienced little or no competition-induced mortality. The relationship between stem diameter and stand volumes suggests that the 10-foot spacing enabled growth to be allocated equitably to development of tree size and stand yield. Each of these results provides supporting evidence that, independent of site quality, planting stands at a 10-foot spacing results in a desirable starting point for subsequent management of Douglas-fir plantations.

Keith Routman

Olympic National Forest, Washington.

The research provides a biological basis for selecting appropriate planting spacings for Douglas-fir. Foresters will be able to compare effects of initial spacing on tree vigor, stability, and mortality and on stand growth and yield for sites that differ substantially in quality.

Contact: Timothy B. Harrington, tharrington @fs.fed.us, Threat Characterization and Management Program

Partner: USDA Forest Service Gifford Pinchot National Forest

Level of hardwood control leads to distinct stand structures in Douglas-fir plantations

A vegetation management study initiated in 1983 continues to yield important results about longer term management of Douglas-fir. At age 1 to 2 years, sprouts of tanoak and other evergreen hardwoods were treated with herbicides to reduce their abundance in two Douglas-fir plantations. The conifers were thinned at age 16 to 17 years to leave

Tim Harrington

Different treatments as part of a vegetation management study in southwest Oregon led to distinct stand structures.

densities of 120 to 190 dominant trees per acre. Depending on initial density of hardwoods, three distinct stand structures emerged 8 years later. (1) Highly productive, pure stands of Douglas-fir (39 to 52 feet tall) occurred where hardwoods were completely removed. (2) Where 25 percent of the original hardwood density was retained, moderately productive stands of conifers (39 feet tall) overtopped the hardwoods (23 feet tall). (3) Where the original hardwood density was retained, conifers and hardwoods occupied the same canopy layer in a mixed stand of low productivity (26 to 30 feet tall).

In southwestern Oregon, initial hardwood density in Douglas-fir plantations affects how the stands will respond to a subsequent precommercial thinning. The three stand structures that developed by age 24 to 25 years represent different opportunities for managing stands to produce habitat for wildlife and wood products for future harvest.

Contact: Timothy B. Harrington, tharrington @fs.fed.us, Threat Characterization and Management Program

Partners: USDA Forest Service Siskiyou National Forest, USDI Bureau of Land Management, Medford District

Bear-damaged logs often can still be used as lumber

Washington's Capitol State Forest is an important timber-producing area. The forest is also home to black bear, which use the trees as a food source in the spring and early summer, stripping away bark to consume sapwood that is rich in sugars. A high incidence of bear-damaged trees led forest managers to ask how the value and volume of lumber attainable from these trees was affected. Common practice when harvesting bear-damaged trees has been to cut the butt section of the bottom log (as bear damage is generally limited to this lower section) and leave it in the woods. Researchers compared harvested logs and found that the difference in log volume recovery between undamaged and bear-damaged logs was about 6 percent. They found that the butt 16-foot logs from bear-damaged trees were worth about 5 percent less than the butt logs from undamaged trees. This suggests that an optimal harvesting policy would be to haul the entire butt log to the mill rather than cutting off the damaged portion and leaving it in the woods. Although the value of the damaged portion is lower, most of the lumber recovered from that section can be used, with only a modest reduction in grade and value.

Contact: Eini Lowell, elowell@fs.fed.us, Goods, Services, and Values Program

Partner: USDI Bureau of Land Management Oregon State Office

Freshly harvested Sitka spruce logs lose most moisture in first 8 months of air drying

The moisture content of freshly harvested logs affects many aspects of log home construction, including log processing, the durability of the resulting house, and transportation costs to the construction site–logs with high moisture content are heavier and thus cost more to transport. In southeast Alaska, large acreages of second-growth timber are now reaching commercial size, and log home construction is one potentially important use of the logs from these stands. Interest in adding value to Alaska wood products led station scientists to evaluate the feasibility of air-drying young-growth Sitka spruce and western hemlock in southeast Alaska.

They discovered that the fastest drying rates for both species occurred for peeled logs that were stored inside. Sitka spruce lost considerable moisture during the first 8 months. In most cases, western hemlock needed additional drying beyond the 12-month study period to produce satisfactory house logs. Nonetheless, peeling logs, then air-drying them indoors for 8 to 12 months should allow sufficient reductions in shipping weight, and thus reduce shipping costs. These findings will help entrepreneurs determine appropriate levels of capital investment in the region's wood processing infrastructure.

Contact: David Nicholls, dlnicholls@fs.fed.us, Goods, Services, and Values Program

Partner: Ketchikan Wood Technology Center

David Nicholls

Logs are air dried at the Ketchikan Wood Technology Center as part of a value-added study.

H.J. Andrews Experimental Forest, Oregon, by John Laurence

GOAL 4: Communicate science findings and enhance their application

Key Communications

- Scientists shared findings from 29 years of research at Mount St. Helens with researchers in other volcanic areas, including Alaska and Chile. They also hosted photographers, writers, and filmmakers who communicate insights about ecosystem response to volcanic eruption to diverse audiences.
- The Alaska Coastal Rainforest Center is established in Juneau to foster temperate rain-forest education and research.
- Scientists contributed expertise to a pilot project involving payment to rural residents in Vietnam for the provision of ecosystem services.
- New book contends progress on old-growth forest conservation can only be made by understanding how it fits in a dynamic social and ecological world defined by complexities, ambiguities, and the certainty of change.
- Field trips connect Portland children with the natural world in town and in national forest.

John Laurence

Annual open house at H.J. Andrews Experimental Forest, Oregon.

Tom Iraci

Mount St. Helens, Washington.

Lessons from Mount St. Helens applied to other volcanic regions

Mount St. Helens, a rich natural outdoor laboratory for 29 years, has yielded numerous lessons and insights that can be carried and applied to other volcanic landscapes throughout the world. Station scientists are sharing these insights with foreign governments and scientists to help develop studies in Chile and Alaska—sites of intense volcanic disturbance in 2008 and 2009. They are also facilitating related learning opportunities for graduate students. In preparation for the 30th anniversary of the May 18, 1980, eruption, station scientists hosted photographers, writers, and filmmakers from numerous media outlets, including the National Geographic Society, *New York Times*, and NOVA. These articles and film will share findings about ecosystem response after volcanic eruption with the general public.

Contacts: Charlie Crisafulli, ccrisafulli @fs.fed.us, Land and Watershed Management Program; Fred Swanson, fswanson@fs.fed.us, Ecological Process and Function Program

Partners: Parque Pumalin; University of Alaska (Anchorage and Fairbanks); University Austral de Chile; University of Nevada-Las Vegas; U.S. Fish and Wildlife Service; U.S. Geological Survey (Cascades and Alaska Volcano Observatories)

Station lends expertise to payment for ecosystem services project in Vietnam

A station hydrologist and an economist traveled to Vietnam to assist with a pilot program involving payment to rural residents for protecting the forest-based ecosystem services. The project is part of the USAID Asia Regional Biodiversity Conservation Program. The program centers around the water quality of Da Nhim reservoir in Lam Dong Province in southern Vietnam, in the Dong Nai River basin. The hydroelectric powerplant in this central highlands region is paying upstream residents to not cut trees and to patrol the forest to prevent others from cutting them. Maintaining the upstream forest reduces erosion, which prevents sediments from filling in the reservoir, and thus maintains the powerplant's capacity to generate electricity. About $3.5 million has been paid to residents since the project's initiation in 2007.

Michael Furniss

A hydroelectric company in Lam Dong Province, Vietnam, is paying residents to maintain and protect the forest.

The economist analyzed the payment system and contributed to a planning effort for tourism and development where the objective was to increase the percentage of benefits retained in the local economy. The hydrologist helped establish a monitoring system for water quality and provided training on mitigating the environmental effects of a road that traverses the watershed. This project is being closely watched by the Asian Development Bank, the United Nations, and other southeast Asian countries who have expressed interest in replicating it.

Contact: Michael Furniss, mfurniss@fs.fed.us, Communications and Applications Group, Trista Patterson, tmpatterson@fs.fed.us, Goods, Services, and Values Program

Partners: Colorado State University, USAID, Winrock International, World Conservation Union (IUCN)

Old growth in a new world

Old-growth forests have been an icon of the Pacific Northwest for more than 100 years. Despite their prominence in ecological science and policy debates, few studies have examined them in terms of a linked social-ecological system. The book *Old Growth in a New World: A Pacific Northwest Icon Reexamined*, published in 2009 by Island Press, examines the old-growth issue from the perspective of ecologists, social scientists, and stakeholders. The history of old growth in the Pacific Northwest is a history of social change. The science of old growth is maturing to incorporate ecosystem dynamics and complexity and the recognition that conservation of old growth sometimes means undertaking active management to achieve ecological goals.

The collection of essays, and the conference from which they arose, have elevated the discussion of old-growth forests, leading to a productive discourse among a wide range of people and the groups they represent.

Contact: Thomas A. Spies, tspies@fs.fed.us, Ecological Process and Function Program

Partners: National Commission on Science for Sustainable Forestry, Oregon State University, University of Washington

Keith Routman

Students participating in Forests Inside Out! at Oregon's Sandy River Delta learn how to use GPS devices.

Field trips connect Portland children with natural world

The station was a major sponsor of Forests Inside Out!, a series of 2-day indoor and outdoor experiences for 300 children ages 6 to 10 and family members from diverse and underserved communities in the greater Portland metropolitan area. The World Forestry Center in Portland launched this program to promote active, healthy outdoor lifestyles for young children and their families, and creates positive and direct associations with urban forests, natural areas, and national forests.

Forests Inside Out! centered around two day trips through the heart of the city's urban forest to the wild waterfalls of the Columbia River gorge. On the first day, students experienced outdoor activities close to the city. Participants had unique access to interactive exhibits, live animals,

Keith Routman

Forests Inside Out! students at Horsetail Falls.

a world-class arboretum collection, and child-friendly educational resources at the World Forestry Center, Oregon Zoo, and City of Portland's Hoyt Arboretum. The second day began with stewardship activities at the Sandy River Delta and ended with a hike from Horsetail Falls to Ponytail Falls in the Columbia River Gorge. Throughout the session, children were engaged in age-appropriate, hands-on learning activities from the award-winning Project Learning Tree program.

Mentors and guides for the youngsters included older children who are graduates of the Inner City Youth Institute, another outdoor program made possible through a partnership among the Forest Service, Bureau of Land Management, Oregon State University, and Portland Public Schools.

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

Partners: Americorp; Boys and Girls Clubs of Portland; Inner City Youth Institute; National Forest Foundation; Oregon Zoo; Portland Public Schools; USDA Forest Service, More Kids in the Woods and Pacific Northwest Region; World Forestry Center; YMCA

Learning opportunities abound at H.J. Andrews

Every year, the H.J. Andrews Experimental Forest in Oregon hosts numerous events for people of all ages—from elementary school children to visiting scientists. In 2009, more than 1,300 people attended tours, workshops, and symposia at H.J. Andrews, with more than 60 of these attendees hailing from China, Japan, Israel, Tasmania, and Vietnam. Over 400 visitors were affiliates of colleges and universities, and more than 200 represented primary and secondary schools. In addition to attracting 273 scientists, 65 managers, and 52 teachers, events at H.J. Andrews also attracted 41 writers and 80 members of the general public.

Contact: John Laurence, jalaurence@fs.fed.us, Ecological Process and Function

Learning about forest processes deepens cultural knowledge

At a 4-day culture camp organized by the Tlingit and Haida Central Council, Alaska youth and elders connected through cultural activities that provided the youth with an opportunity to learn about the traditional way of life and gain a deeper understanding

Paul Hennon

Students learn about wetland plants at the Tlingit and Haida Central Council Culture Camp in southeast Alaska.

of how culture plays a role in daily life. The cultural learning piece focused on invasive species, plants, and the environment. Station scientists talked with participants about forest processes and climate change. The station also hosted a world-renowned

Richard Cartensen

Culture camp students learned how to make a basket from a thimbleberry leaf and identify edible, native berries.

ethnobotanist who taught participants how different cultures use plants as foods, medicines, textiles, and in rituals.

Contact: Paul Hennon, phennon@fs.fed.us, Threat Characterization and Management Program

Partners: Administration for American Indians, Central Council of Tlingit and Haida Indian Tribes of Alaska, Environmental Protection Agency

New center for research and education in southeast Alaska

The Alaska Coastal Rainforest Center was established in August to stimulate and develop temperate rain-forest education and research. It will provide a framework for synthesizing ecological, geophysical, social, traditional, and economic knowledge. The center will improve the environment and economic health of southeast Alaska communities, and will enhance cooperative research at the newly established Héen Latinee Experimental Forest with the University of Alaska Fairbanks and University of Alaska Southeast faculty, graduate students, and visiting scholars.

The center will provide education opportunities and conduct research about temperate rain forests as well as facilitate public policy dialogue and foster a greater understanding of the interactions among rain-forest ecosystems, communities, and social and economic systems. It will make facts, methods, literature, and new findings about temperate rain forests available and will disseminate this information through suitable types of media (reports, bulletins, circulars, films, journal and magazine articles, and Internet).

Contact: Sue Willits, swillits@fs.fed.us, Station Director's Office

Partners: City and Borough of Juneau; University of Alaska, Fairbanks, and Southeast; USDA Forest Service Alaska Region; U.S. Fish and Wildlife Service

Web Site: Pacific Northwest Global Change Research

Description:
Station scientists are studying a variety of climate-change issues from many different disciplinary angles. From this expanded Web site, viewers can read summaries of these studies, download related briefing sheets and journal articles, and access other Web resources about global change research by Forest Service scientists.

How to get it:
http://www.fs.fed.us/pnw/research/climate-change/index.shtml

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

Tom Iraci

Regional warming may be a dominant contributor to increases in tree mortality in many undisturbed stands more than 200 years old in the Western United States and southwestern British Columbia.

Climate Change Strategy Group promotes sustainable operations

The Climate Change Strategy Group, a partnership between the Pacific Northwest Region and research station, continues working to implement the Forest Service Climate Change framework.

This year the group undertook several projects. It worked to make hydrologic information available for the region's national forests, surveyed regional employees on climate change awareness and information needs, enhanced the group's intranet site, and participated in national climate change task groups. The group also partnered with the Alaska Region to plan the fiscal year 2010 Sustainable Operations Summit, which is a national meeting that is focused on sharing information relating to reducing our environmental footprint and promoting sustainable practices. This session, hosted in Portland with up to 100 attendees, was also deployed virtually to field units across the Nation using video teleconferencing and the Internet.

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

Partners: USDA Forest Service Pacific Northwest Region and Alaska Region

Reporters, fire professionals, and others follow station's Twitter account

The station now has more than 100 people following its "tweets"—instant, electronic alerts to press releases, new publications, and information. Only about 5 percent of Twitter users have more than 100 followers. Reporters from major news outlets, fire professionals, and outdoor groups make up the majority of the followers. Metrics show that Twitter is increasingly becoming a source of traffic to the station's Web pages. To view the station's Twitter profile, visit http://www.twitter.com/ysands_pnwrs.

Contact: Yasmeen Sands, ysands@fs.fed.us, Communications and Applications Group

Media highlights, 2008–2009

The invasion of Mount Rainier's high-elevation meadows by conifers prompted several news stories in Washington State's regional and local newspapers. Research biologist David L. Peterson was interviewed for the story about the influence a changing climate likely has on the incursion. He was quoted in stories run by the *Seattle Post-Intelligencer*, the *News Tribune* (Tacoma), the *Olympian*, and the *Wenatchee World*.

In early 2009, research forester Geoffrey Donovan was quoted in stories describing the results of one of his studies, which quantified the summertime energy savings homeowners receive from their shade trees. His research was featured by Discovery News, United Press International, Science Daily, and the *Sacramento Bee*.

A PNW Station-supported study that found tree death rates had doubled in some old-growth forests, particularly in the Pacific Northwest, generated a great deal

Tom Iraci

The new culvert on the left was designed to improve passage for aquatic organisms. The old culvert is on the right.

of media interest. Stories were run by CNN, MSNBC, the *Christian Science Monitor*, *U.S. News & World Report*, *USA Today*, the *Washington Post*, the *Seattle Times*, and the *Oregonian*.

Also generating a tremendous response from the media were bioclimatologist Ron Neilson's summer fire danger forecasts for the Western United States. His work—which projected that California's fire danger would be increased in 2009, while the Pacific Northwest's would be decreased—was featured in numerous outlets, including the *New York Times*, the *Oregonian*, the *Seattle Post-Intelligencer*, *Reno Gazette-Journal*, *Press-Enterprise* (Riverside, Calif.), and the *San Francisco Chronicle*. A few weeks later, Neilson was again interviewed, this time by NBC Nightly News, which sought his expertise to help explain the then-raging Station Fire, the largest ever on California's Angeles National Forest.

Research ecologist Deanna Olson garnered national attention for her amphibian research. She was consulted as an expert source for stories run by *National Geographic* and PBS' "Nature" on the threats facing frog species around the world, particularly the devastating and deadly chytrid fungus.

In late summer, ecologist Charlie Crisafulli was interviewed by the *New York Times* about the ecological lessons learned from decades of research at Mount St. Helens in a story that discussed the future of the volcanic monument. The article appeared on the front page of the newspaper's "Science Times" section.

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

Tool: Improving passage for aquatic organisms at road-stream crossings

Description:

This guide helps users design stream crossings that present no greater challenge to the movement of stream and riparian organisms than the natural stream. It establishes an important new paradigm for crossing design called "stream simulation." The objective is to maintain the width, gradient, and substrate of the stream despite the installation of a bridge, culvert, or other stream crossing.

Users:

Engineers, fish biologists, and hydrologists worldwide.

Contact:

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

For more information:

Forest Service Stream-Simulation Working Group. 2008. Stream simulation: an ecological approach to providing passage for aquatic organisms at road-stream crossings. U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center.

"HJA Days" at H.J. Andrews Experimental Forest, Oregon, by John Laurence

LEARNING EVENTS

Symposia, Workshops, and Tours

- 604 people participated in symposia and workshops
- 838 people went on field trips
- 1,813 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.

Applications of Mount St. Helens Science: At the request of the University Austral de Chile, two station scientists traveled to Valdivia, Chile, to present their research on the ecological responses to Mount St. Helens' 1980 eruption to 45 participants. The university sought the expertise of the scientists, who have been studying volcanic disturbance at Mount St. Helens for the past 30 years, to help with initial assessments of the ecological impacts at Chaiten volcano, which erupted in Chile in 2008. Sixty people were involved in the ecological assessment. Several months later, the U.S. Fish and Wildlife Service and the U.S. Geological Survey's Alaska Science Center hosted a presentation in which one of the station scientists discussed aspects of Mount St. Helens' 1980 eruption that were relevant to the August 2008 eruption of Alaska's Kasatochi volcano. Twenty people attended the session.

ArcFuels and Risk Analysis Workshops: At these workshops, station scientists taught land managers how to use ArcFuels, a new tool for modeling fuel-reduction treatments, and discussed how formal risk analyses can benefit planning. About 15 managers from the Deschutes and Ochoco National Forests attended a workshop in Bend, Oregon, and 35 from the Northern Region attended a workshop in Missoula, Montana.

Climate Change Risk Workshop: More than 80 resource managers, academics, and scientists from across the Pacific Northwest attended a workshop on the management of climate change risk in forests. The event explored silvicultural and genetic approaches to developing forests adapted to climate changes.

Constructing Low-Impact Roads: A station hydrologist led this 1-day course on constructing roads to minimize their impact on the environment. The course was held in the town of Dalat in Lam Dong Province of Vietnam. About 20 people attended, representing various Vietnamese government agencies, nongovernmental organizations, and universities.

Dead Yellow-Cedar Utilization Demonstration: Station scientists held a 2-day workshop in Thorne Bay, Alaska, that discussed utilization options for dead yellow-cedar. As part of the workshop, the group of 30 participants traveled to a demonstration site to examine dead trees, evaluate their wood quality, and estimate recoverable wood volume.

Fire Tool Virtual Training Session: A station scientist held a virtual training session on the use of a key tool for predicting postfire successional trajectories in interior Alaska's black spruce stands. The session was offered to about 40 fire ecologists and managers in Fairbanks and Anchorage using video conferencing technology and was held in conjunction with the Alaska Interagency Fire Effects Task Group's fall and spring reviews.

Forest Inventory and Analysis (FIA) Client Meeting: FIA shared the status of its activities for the last year as well as the results of its research efforts with 60 of its Washington, Oregon, and California clients. The program also invited its clients to present results from their research based on FIA's inventory data.

International Workshop on Ungulate, Forest, and Landscape Management: Thirteen people from the United States, United Kingdom, Denmark, Sweden, and Estonia attended a week-long workshop that focused on the joint management of ungulates, forests, and landscapes. During

the event, attendees worked on research synthesis papers and a prospectus for future research collaboration.

LIDAR for Forest Planning: Station scientists conducted a 1-day workshop on the use of LIDAR data from the Sherman Pass Scenic Byway pilot LIDAR project. The 25 participants who attended learned about the available data and how to use it in planning forestry activities.

Mapping Vegetation Structure in the Pinaleño Mountains Using LIDAR: A station scientist collaborated with the Forest Service's Remote Sensing Applications Center to conduct a 3-day workshop on the use of LIDAR data collected in Arizona's Pinaleño Mountains for planning forestry activities. The workshop was attended by 40 participants, including specialists from the National Forest System, state agencies, and universities.

Mount St. Helens Interpretation Training: The station's lead scientist at the Mount St. Helens National Volcanic Monument presented key science from his studies at the volcano to 30 interpreters and visitor center staff members at a day-long training workshop.

Participatory Action Research Workshop: During this 2-day workshop, 12 participants learned about participatory action research (PAR)—a collaborative nonsurvey approach to gathering information and creating conversation with people in a place-based community. Attendees also worked to identify and develop resources to support PAR practitioners.

Silvicultural Research at Capitol Forest: A station scientist led a day-long field tour for 14 employees of the Bureau of Land Management at Capitol Forest outside of Olympia, Washington. Participants visited study sites and discussed recent findings.

Sixth International Integrated Pest Management Symposium: During a 3-day symposium, 12 attendees learned about the challenges of developing and implementing an integrated pest management program for bark beetles in the Western United States. The event featured six invited speakers from the United States, Canada, and Mexico.

Tara Jennings

Scientists lead a field trip to examine the effects of forest fires on soils.

Soil Recovery Workshop and Tour: Seventy participants—including federal and industry resource managers, university faculty, and nongovernmental organization members—participated in a B&B Fire workshop and field tour in the spring. The event explored soil responses to and recovery after wildfire and postfire forest management.

Variable-Density Thinning Study: Thirty-two members of land management and natural resource organizations toured installations of the Olympic Habitat Development Study. During the day-long tour, participants viewed sites and discussed variable-density thinning and the creation of artificial log structures.

Variable-Retention Silviculture Tour: A station scientist led 27 district foresters, regional managers, and regional timber sale administrators from the Washington State Department of Natural Resources in a field tour of Capitol Forest outside of Olympia. The tour was designed to improve reforestation planning and further understanding of the growth and yield trends of different treatments and society's perceptions of these treatments.

Western Pine Beetle Workshop: About 12 people attended a workshop on the Upper Imnaha Western Pine Beetle Management Project. The 1-day event took stock of what has been learned about pine beetle management and how it might be applied by participants.

Kathy Keable

Students learn about the forest canopy at H.J. Andrews Experimental Forest.

Conservation Education

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 field trips and learning events held at these unique areas for long-term research are highlighted below.

- **H.J. Andrews Experimental Forest** in Blue River, Oregon, hosted "Canopy Connections." About 110 high school and middle school students from primarily underserved schools in Eugene-Springfield learned about old-growth canopy, nutrient cycling, microclimates, and wilderness survival. The experimental forest also hosted the 2009 McKenzie Outdoor School for 20 local fifth graders who climbed into the forest canopy. They also learned about the salmon life cycle, local Native American culture, and stream ecology. On their last night, they presented a program about what they had learned to their families.
- **The Starkey Experimental Forest and Range** in eastern Oregon hosted four field tours throughout the summer reaching a total of 79 people. The tours were designed to teach people about ongoing ecological research projects based at the site. Starkey also hosted a field day where 43 livestock permitees learned about sustainable livestock grazing practices on national forest lands.
- **The Wind River Experimental Forest**, located in south-central Washington, hosted 10 staff members of the Washington and Oregon congressional delegations and 15 members of the Western Coordinating Committee for Extension Foresters. These visitors were briefed on research activities occurring at the forest and given an interpretive lift in the gondola of the Wind River Canopy Crane, one of only 10 such structures in the world.

Amphibians of Clark County, Washington: About 65 high school students learned about amphibians native to Clark County, Washington, as part of their science class.

Camp Tadmor Outdoor School: Several station employees teamed up with the Siuslaw National Forest to host Camp Tadmor, an outdoor school for more than

Mary Rowland

Rangeland scientist and visitors at the Starkey Experimental Forest and Range.

a half dozen Oregon school districts. The scientists taught 250 sixth graders about the importance and functionally diverse roles of fungi in forest ecosystems.

Cascade Range Field Class: Station scientists accompanied 25 University of Washington students to the Cascade Mountains outside of Wenatchee, Washington, where they participated in a 2-day forest ecology field class.

Dry Ice—Discovering the Properties of CO_2: Third graders from Liberty Elementary School District in Albany, Oregon, experienced science first-hand while witnessing CO_2 change from a solid to a gas. The 61 students also learned about the role of CO_2 in respiration and photosynthesis.

Endangered Species Panel: Sixty students at Jane Goodall Middle School in Salem, Oregon, watched a presentation and panel discussion on endangered species in which a station scientist participated as an amphibian expert.

Entomology Course: A station scientist was invited to teach a quarter-long entomology course to six students at Eastern Oregon University.

Forest Camp—Project Learning Tree: Station scientists taught more than 100 students attending "Forest Camp," an outdoor learning event for fifth and sixth graders, about the "web of life" concept. Their full day of instruction illustrated the interactive linkages between living and nonliving elements of forest ecosystems.

Green Team Outreach: Members of the station's Green Team visited Estacada Junior High School in Estacada, Oregon, to challenge the seventh- and eighth-grade graphic arts students to create posters with sustainability themes for use in station offices. Students learned about green teams and discussed ways to reduce their environmental footprint. These posters are being used in a 2010 Reduce, Reuse, Recycle Planner for the station.

Inner City Youth Institute: The station continued to support the Inner City Youth Institute (ICYI). The ICYI encourages underrepresented youths to pursue higher education and careers in the natural resource and environmental fields. This year, ICYI sponsored an ecology program in a Portland inner city high school and a summer camp program for high school students from Portland, Oregon, and Vancouver, Washington. This summer's camp was held at H.J. Andrews Experimental Forest. Participants spent a week at the experimental forest, learning from scientists about forest ecosystems. The ICYI is a partnership between the Forest Service, Oregon State University, Bureau of Land

Management, Portland Public Schools, and the Urban League of Portland. About 200 students participated in ICYI programs.

Invasive Aquatic Species Class: Thirty people learned about invasive aquatic species, including the devastating amphibian chytrid fungus, at Oregon State University's Central Oregon campus in Bend.

Invasive Species Workshop: The station partnered with Oregon State University's Natural Resources Education Program to host a workshop for 15 high school teachers that offered classroom exercises for students on identifying and tracking invasive species.

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. Two station employees volunteered as judges.

Olympia Lab Interpretive Trail: A station scientist worked with 15 junior and senior high school students from the Tumwater, Washington, New Market Skills Center to develop an interpretive nature trail at the Olympia Forestry Sciences Laboratory. The scientist also was "shadowed" for 2 days by a science teacher interested in learning more about plant surveys and tree growth.

Petri Dish Experiment: Sixty-one third graders from Albany, Oregon, learned scientific methods and how to use a microscope while attempting to grow fungi and bacteria from samples taken from their hands. The students rubbed both dirty and washed hands on agar Petri dishes and counted the different-colored fungi and bacteria that grew on each.

Plant Ecology Lecture and Tour: A station scientist gave a lecture on plant ecology and led a field tour for eight students at Grays Harbor College in Aberdeen, Washington.

Poster distribution: The station distributed about 200 posters related to Mount St. Helens, invasive species, fish, oak communities, old-growth forests, and sequoias. Most of these posters are requested by teachers in the Pacific Northwest, but many posters have been sent to teachers throughout the United States and overseas.

Salmon Watch: Fifty middle school students in Alsea, Oregon, participated in field and classroom sessions on the ecology of riparian zones.

Society and Natural Resources Class: A station scientist was invited to give a lecture and host a question-and-answer section on landscape patterns and forest transition. Ten students from Wenatchee Valley Community College took part.

Washington State Science and Engineering Fair: The station sponsored an "Outstanding Forest Science Project Award" to a 10th-grade high school student at the Washington State Science and Engineering Fair at Olympic College, Bremerton, Washington, in April.

What Lives in a Forest? Before visiting the World Forestry Center in Portland, 65 fifth-grade students from Albany, Oregon, learned about the interconnections among animals, mushrooms, and fire as well as career opportunities in forest science.

Wolftree: Station employees participated in ecology programs that reached about 100 students from Portland, Oregon, and Vancouver, Washington, middle and high schools. The station also contributed funds for supplies and equipment.

Columbia Gorge , Oregon © Miles Hemstrom

HONORS AND AWARDS

Experimental Forests and Ranges Centennial Award

Fred Swanson, a research geologist with the Ecological Process and Function Program was recognized by the station for his outstanding leadership in facilitating research within experimental forests and ranges.

Invitation to Provide Expertise

Pete Bisson, a research fisheries biologist, and **Nate Mantua**, a research climate scientist with the Land and Watershed Management Program, were among eight scientists invited to Washington, DC, to provide a scientific assessment of the Federal Columbia River Power System Biological Opinion—a management strategy litigated since 2000 that guides a salmon restoration program for the Columbia River. The closed workshop included the administrator of National Oceanic and Atmospheric Administration (NOAA), head of the U.S. Army Corps of Engineers, and high-level managers from the Bonneville Power Administration, Bureau of Land Management, Bureau of Reclamation, and Department of Justice. The contributions of Bisson and Mantua were personally acknowledged by Dr. Jane Lubchenco, NOAA Administrator, and Dr. Usha Varanasi, director of Northwest Fisheries Science Laboratory.

Outstanding Technical Assistance Volunteer

Rebecca Flitcroft, an ecologist with the Land and Watershed Management Program, was honored by the Long Tom Watershed Council of Eugene, Oregon, for her work developing sampling protocols for a fish barrier assessment.

Service to America Medal finalist

Bruce Marcot, a research wildlife ecologist with the Ecological Process and Function Program was a finalist in the environmental category for Service to America Medal. He was recognized for making significant contributions to the Nation for his work on the U.S. Geological Survey International Polar Bear Science Team. He also received a letter of congratulations from Kim Elton, Senior Advisor to the Secretary for Alaska Affairs, U.S. Department of the Interior, Office of the Secretary.

Wings Across the Americas

Martin Raphael, a research wildlife biologist, **Beth Galleher**, a program analyst, and **Thomas Bloxton**, a wildlife biologist, all with the Ecological Process and Function Program, received the Wings Across the Americas Research and Partnership award. Raphael and Bloxton, along with other partners, were cited for leading a research and management partnership across agencies to help make fundamental contributions to understanding the ecology and behavior of the marbled murrelet.

Eric Forsman, **Brian Bissell**, and **Janice Reid**, all wildlife biologists with the Ecological Process and Function Program, also received a Wings Across the Americas Research and Partnership award, along with partners, for their work fostering a research and management partnership that produced a substantial understanding of the northern spotted owl and its ecology.

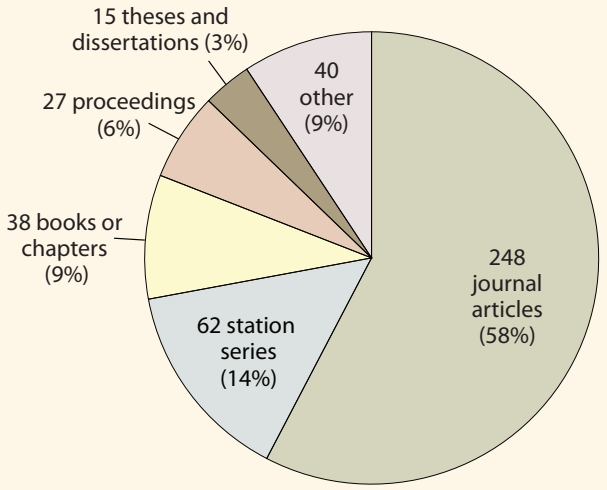
Deschutes River, Oregon © Miles Hemstrom

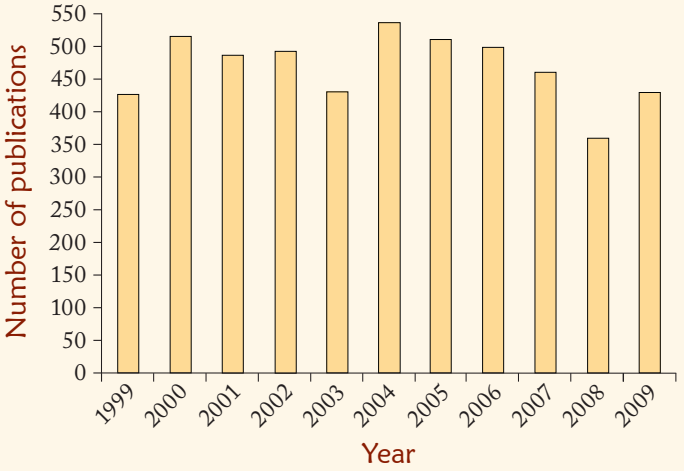
PUBLICATIONS

Publications

- 430 total publications. (Includes station series publications, journal articles, proceedings, books or book chapters, theses and dissertations, and other publications.)
- 127,408 hardcopies of station series publications distributed.
- 1,836 station publications available online via the station's Web site and Treesearch (http://www.treesearch.fs.fed.us).
- 10 issues of *PNW Science Findings*, about 9,800 copies of each issue distributed.

Number and Type of Publication





Finances and Workforce

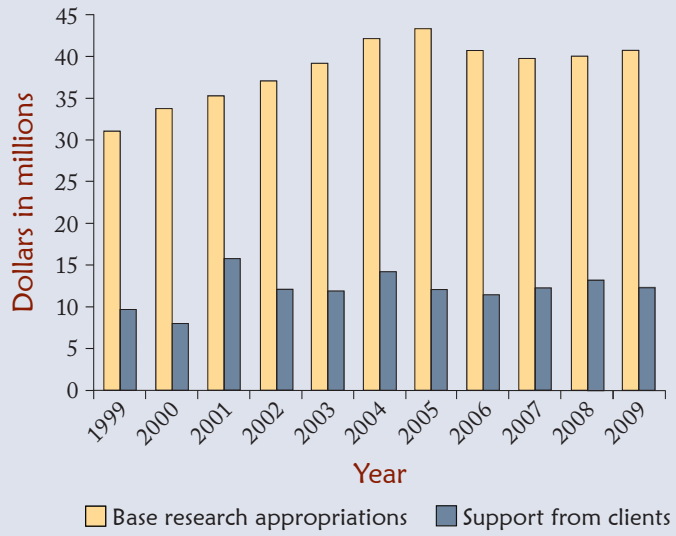
Two sources of funding support the work of the Pacific Northwest Research Station (PNW): federal appropriations, which contribute the greatest percentage of funds; and direct client support, which comes from organizations in need of scientific information.

2009 PNW Research Station finances and workforce, by the numbers:

- Fiscal year 2009: October 1, 2008, to September 30, 2009

Incoming funding*

- Base research appropriations: $40.8 million
- Client support: $12.4 million
- Total funding: $53.2 million



Distribution of funds*

- Permanent employee costs: ($28.3 million)—53.1%
- Support and operations: ($13.0 million)—24.5%
- Distributed to cooperators: ($11.9 million)—22.4%
  - Of $11.9 million to cooperators, 84.1% went to educational institutions

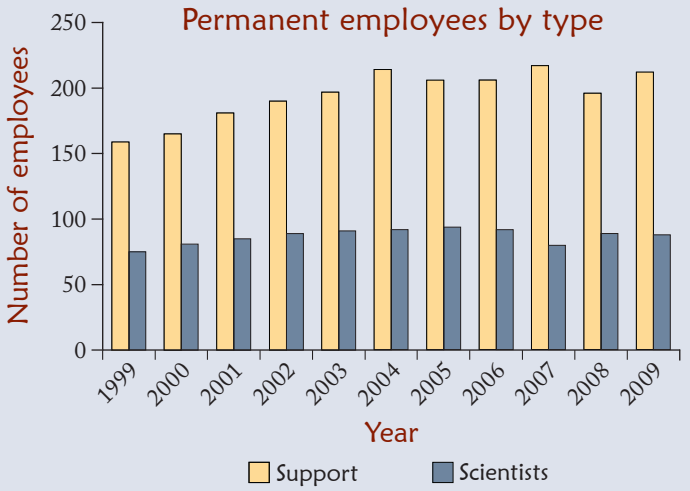
* Does not include funds from the American Recovery and Reinvestment Act. See page 78 for details on these funds.

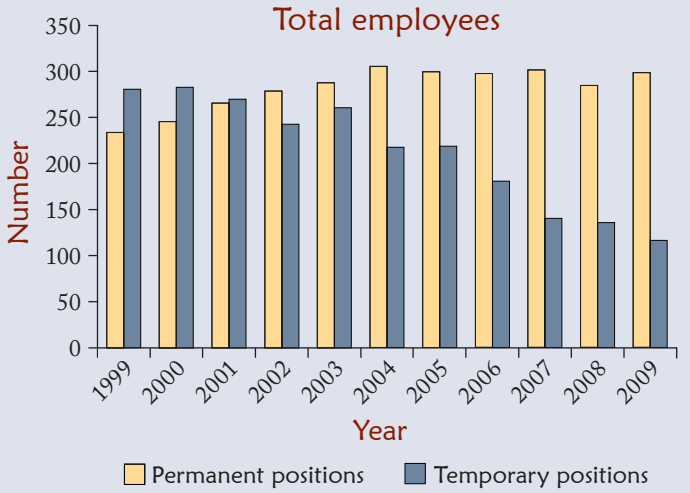
Photo by Rhonda Mazza

FINANCES AND WORKFORCE

Workforce statistics:

- Permanent workforce: 299 employees
  - Of the permanent workforce, 29 percent, or 88 employees, are scientists
- Temporary workforce: 117 employees
- Total station workforce: 416 employees





American Recovery and Reinvestment Act

The Pacific Northwest Research Station received $13,396,000 from Congress through the American Recovery and Reinvestment Act (ARRA) of 2009. The nine projects that received funding are listed below. All ARRA projects were selected based on their ability to create jobs and promote economic recovery, especially in those areas most impacted by the recession. These projects will help the Forest Service achieve management practices that promote and provide clean air, clean water, wildlife habitat, and recreational opportunities.

Yasmeen Sands

Contractor installs energy-efficient windows at Olympia Lab.

The Olympia Forestry Sciences Laboratory was the first facility in the station to receive ARRA funding. With that money, 150 single-pane, low-thermal-rated windows were replaced with new energy-efficient windows. The new windows provide better insulation than the old ones, which were installed in the 1960s. This is expected to lower the heating and cooling cost of the building while conserving energy. Contractors from Longview, Washington, completed the work.

The station is working with partners to complete the other eight projects and create jobs as quickly as possible.

Station projects funded by the American Recovery and Reinvestment Act

Project	Funding
Prioritize fuel-reduction treatments by estimating restoration potential and understanding their effects on forest conditions	$5,940,000
Research on restoring critical habitat for listed Pacific salmon in Alaska, Oregon, Washington	$2,240,000
Research how western forests are adapting to and mitigating climate change	$1,795,000
Restore community ecosystems while promoting green jobs in the Puget Sound area, Washington	$1,346,000
Improve health and safety of communities and firefighters by forecasting and managing smoke from fires	$735,000
Assess the socioeconomic impact of ARRA investments through the Forest Service in communities around the country	$530,000
Reconstruct Coyote Creek gauging stations on the South Umpqua Experimental Forest, Oregon	$350,000
Install energy-efficient windows at the Olympia Forestry Sciences Laboratory, Washington	$260,000
Road maintenance at PNW Research Station facilities and experimental forests in Oregon and Washington	$200,000

Funding Partners for 2009

Cooperators Who Received Funding for Studies From the PNW Research Station

Educational Institutions

Auburn University
Colorado State University
Humboldt State University
Loyola University
Michigan State University
Montana State University
Ohio State University
Oregon State University
San Jose State University
Southern Illinois University
University of Alaska
University of Arizona
University of California
University of Idaho
University of Maine
University of Montana
University of Notre Dame
University of Oregon
University of Puget Sound
University of Redlands
University of Rhode Island
University of Washington
University of Wisconsin
University of Wyoming
Utah State University
Virginia Polytechnic Institute and State University
Washington State University

Other Federal Agencies

Department of Agriculture, Agricultural Research Service
Department of Agriculture, Foreign Agriculture Service
Department of Agriculture, Cooperative State Research Education and Extension Service
Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Department of Commerce, National Institute of Standards and Technology
Department of the Interior, Bureau of Land Management
Department of the Interior, Fish and Wildlife Service
Department of the Interior, Geological Survey

State Agencies

Alaska Department of Fish and Game
Oregon Cultural Heritage Commission
Oregon Department of Forestry
Oregon Economic and Community Development Department
Oregon Watershed Enhancement Board
Texas Agricultural Experiment Station
Washington Department of Agriculture
Washington Department of Natural Resources

Nongovernmental Organizations

Desert Research Institute
Earth Systems Institute
Essa Technologies Ltd
Institute for Culture and Ecology
MacGregor-Bates, Inc.
National Council for Air and Stream Improvement
Sustainable Northwest
Western Forestry and Conservation Association
World Forestry Center

Foreign Institutes

Canadian Wood Fibre Centre, Natural Resources Canada

Clients Who Provided Funding for Studies to the PNW Research Station

Educational Institutions

University of Oregon
University of California

Other Federal Agencies

Department of Agriculture, Agricultural Research Service
Department of Commerce, National Oceanic and Atmospheric Administration, Fisheries Science Center
Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Department of Defense, U.S. Army, Fort Lewis
Department of Energy, Bonneville Power Administration
Department of the Interior, Bureau of Land Management
Department of the Interior, Fish and Wildlife Service
Department of the Interior, Geological Survey
Environmental Protection Agency
National Aeronautics and Space Administration, Goddard Space Flight Center

State Agencies

Alaska Department of Fish and Game
Oregon Department of Forestry
Oregon Economic and Community Development Department
Oregon Watershed Enhancement Board
Washington Department of Natural Resources

Municipal Agencies

Seattle City Light

Nongovernmental Organizations

Ecotrust
Northwest Power and Conservation Council
Trout Unlimited

Miles Hemstrom

Sprague River, Fremont-Winema National Forest, Oregon, by Tom Iraci

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The attached CD-ROM contains the following:

- 2009 Science Accomplishments
- PNW Research Program Reports
- 2009 PNW Research Station Publications

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United States Department of Agriculture

Forest Service

Pacific Northwest Research Station

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