

2012 Science Accomplishments



PACIFIC NORTHWEST RESEARCH STATION

Vision and Mission

The Pacific Northwest Research Station is a leader in the scientific study of natural resources. We generate and communicate impartial knowledge to help people understand and make informed choices about natural resource management and sustainability.



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A researcher installs a piezometer to measure water pressure and temperature in spawning gravels of the Little Martin River, Alaska.

A Message From the Station Director

With a mix of both sadness and excitement, I've embarked on a new chapter in my life—retirement. After more than 27 years with the Forest Service, I retired in December 2012. My tenure with this agency has been rewarding beyond my imagination—and the last 6 years, which I spent here at the Pacific Northwest Research Station, were especially memorable.

As Station Director, I commissioned the newest addition to the Nation's experimental forest and range network, Héén Latínee, in 2009. The station manages Héén Latínee, a Tlingit name that means "River Watcher," in partnership with the Alaska Region. Its outstanding setting—which reaches from ridge to reef, from glacier to marine environment—helps the station conduct nationally significant research on how coastal temperate rainforests function.

That same year, I was one of the signatories of a memorandum of understanding that paved the way for the Alaska Coastal Rainforest Center. The center now has 18 partners committed to making it a hub for temperate rainforest education and research in Juneau.

The station's commitment to research in Alaska will be further demonstrated in 2013 when employees move into the new Juneau Forestry Sciences Laboratory, adjacent to the University



Bov B. Eav

Tim LeBarge

of Alaska Southeast. It, too, will be primed for collaboration and will eventually house station scientists along with colleagues from State and Private Forestry, the Forest Service's Alaska Region, the University of Alaska Southeast, and the Alaska Coastal Rainforest Center. Through these

partnerships, science will support adaptation to climate change and help develop sustainable management practices for the Forest Service in Alaska.

In 2012, the renovation of the Corvallis Forestry Sciences Laboratory was completed and the station welcomed the Siuslaw National Forest headquarters and U.S. Geological Survey to share the new space. This new proximity is creating synergy among scientists and land managers.

In 2012, we met with stakeholders interested in the research at the Starkey Experimental Forest and Range over the years. Agreement on the value and need for continued research was readily apparent. This is how the station makes a lasting contribution: steady systematic learning.

The climate change adaptation guidebook is another good example of systematic learning. Forest Service scientists started with one

case study forest, then a second and a third. The guidebook has been adopted by the entire National Forest System and other land management agencies across the country as they develop adaptation options for responding to climate change.

Similarly, fire and smoke modeling is becoming indispensable to fire suppression activities around the country, contributing to the public's health and well-being.

Consistency is key when it comes to data collection. The forest inventory and analysis presence in Alaska, Washington, Oregon, California, Hawaii, and the Pacific Islands yields invaluable information about the status and trends of forests year after year.

There is so much good work occurring at the station and with its partners; I am confident that the station is well positioned to continue providing timely, high-quality information to clients in the years to come.

Sincerely,

A handwritten signature in black ink, appearing to read "Bov B. Eav". The signature is stylized with a large, sweeping initial "B" and a horizontal line at the end.

Station Director Bov B. Eav

Why Conduct Research?

Research Benefits Society. Forest Service research helps society make choices about water, wildlife, and natural resources. 🌀 Scientific understanding gained from research transforms the way land managers rise to challenges. For example, the tools and information used daily by managers and policymakers to make cost-effective and environmentally sound fire management decisions are based on research about fire behavior, fire ecology, fuels, and smoke in ecosystems. 🌀 As a result, citizens are provided ways to secure their homes from fire, are warned when smoke requires them to take precautions, and informed how forests can be managed to reduce fire risk in their communities.

Science-based knowledge and tools are being used to restore our Nations' forests and protect their ability to provide clean water and air. 🌀 In doing so, jobs are created, forest products—from lumber for homes to Native American basketry materials—are provided, cities become greener and healthier, wildlife and fish prosper, and humans increase the quality of life for themselves, their children, and grandchildren. 🌀 Our Nation's forests provide a bounty of oxygen, water, foods, and wood. Research gives society the means to understand this, appreciate the complexity inherent in forests, and ensure that the values from forests and grasslands are realized today and tomorrow.



Pete Bisson

Copper River Delta field work, Cordova, Alaska.



Sherri Johnson

Decomposition study.



James Dollins

Buckhorn Wilderness, Washington.



Rhonda Mazza

H.J. Andrews Experimental Forest, Oregon.



Jon Williams

Forest Inventory and Analysis crew in southeast Alaska.



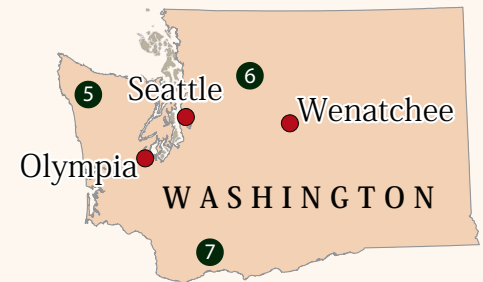
View of Mount Adams from Mount Rainier, Washington.

PNW Research Station: The Setting

● Laboratories and Centers

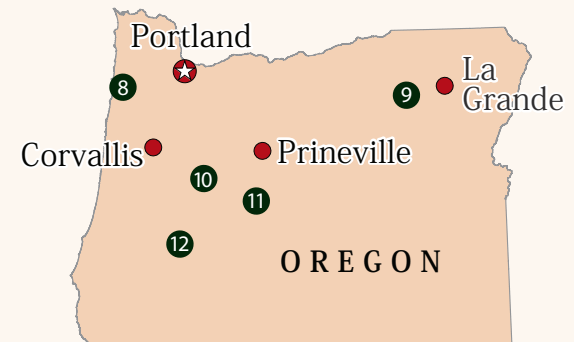
- Alaska Wood Utilization and Development Center (Sitka)
- Anchorage Forestry Sciences Laboratory
- Boreal Ecology Cooperative Research Unit (Fairbanks)
- Corvallis Forestry Sciences Laboratory
- Juneau Forestry Sciences Laboratory
- La Grande Forestry and Range Sciences Laboratory
- Olympia Forestry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

- ▶ The Pacific Northwest Research Station is one of five research stations in the U.S. Department of Agriculture, Forest Service
- ▶ Headquarters are in Portland, Oregon
- ▶ 11 laboratories and centers in Alaska, Oregon, and Washington
- ▶ 12 active experimental areas (forests, ranges, and watersheds)
- ▶ Research is conducted in more than 20 research natural areas
- ▶ 390 employees (300 permanent and 90 temporary)



● Experimental Areas

1. Bonanza Creek Experimental Forest
2. Caribou-Poker Creeks Research Watershed
3. Héén Latinee Experimental Forest
4. Maybeso Experimental Forest
5. Olympic Experimental State Forest
6. Entiat Experimental Forest
7. Wind River Experimental Forest
8. Cascade Head Experimental Forest
9. Starkey Experimental Forest and Range
10. H.J. Andrews Experimental Forest
11. Pringle Falls Experimental Forest
12. South Umpqua Experimental Forest



Finances and Workforce

Two sources of funding support the workforce of the Pacific Northwest (PNW) Research Station: federal appropriations, which contributed 80 percent of the funds in fiscal year 2012, and direct client support, which comes from organizations in need of scientific information.

The numbers below are for the fiscal year **October 1, 2011, to September 30, 2012**:

Incoming funding

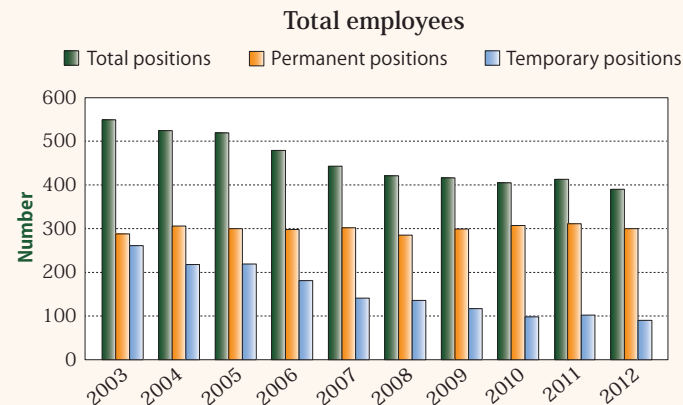
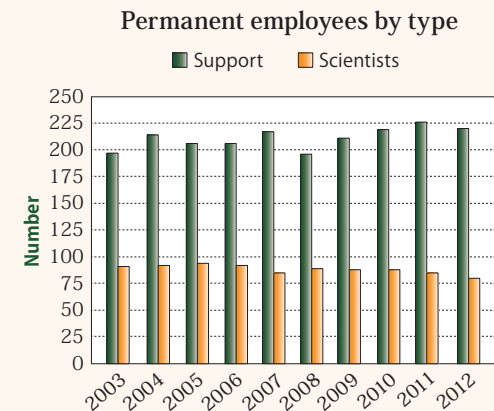
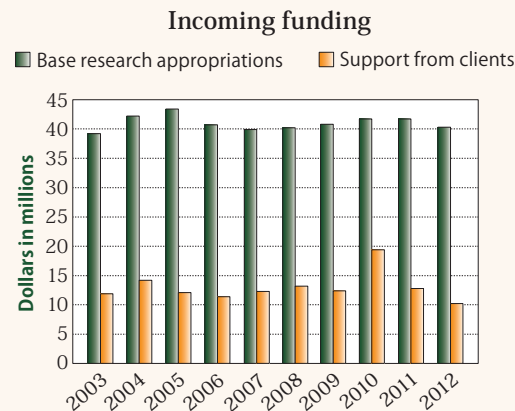
- ▶ Base research appropriations: \$40.3 million (80%)
- ▶ Client support: \$10.2 million (20%)
- ▶ Total funding: \$50.5 million

Distribution of funds

- ▶ Permanent employee cost: \$30.7 million (61%)
- ▶ Support and operations: \$10.6 million (21%)
- ▶ Distributed to cooperators: \$9.2 million (18%)
- ▶ Of the \$9.2 million to cooperators, 84% went to educational institutions

Workforce statistics

- ▶ Total station workforce: 390 employees
- ▶ Permanent workforce: 300 employees
- ▶ Of the permanent workforce, 80 employees (27%) are scientists
- ▶ Temporary workforce: 90 employees



Funding Partners in 2012

Cooperators Who Received Funding From the PNW Research Station for Studies

Educational Institutions

Colorado State University
Cornell University
Loyola University
Michigan State University
Ohio State University
Oregon State University
Portland State University
University of Minnesota
University of Alaska
University of Hawaii
University of Montana
University of Nevada
University of New England
University of Oregon
University of Redlands
University of Vermont
University of Washington
Virginia Polytechnic Institute

Washington State University
Western Carolina University
Western Washington University
Worcester Polytechnic Institute

Other Federal Agencies

Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Department of Defense, Army Corps of Engineers
Department of the Interior, Bureau of Land Management
Department of the Interior, Geological Survey, Western Region

Foreign Institutes

New Zealand Crown Research Institute (Scion)

Nonprofit Organizations

Association for Fire Ecology
Cascadia Conservation District

Earth Economics
Earth Incorporated
Earth Systems Institute
Forterra
Mount St. Helens Institute
National Council for Air and Stream Improvement, Inc.
Resources for the Future, Inc.
Society of Wood Science and Technology
Student Conservation Association, Inc.
Sustainable Northwest
The Institute for Culture and Ecology
The Research Foundation for the State University of New York
World Forestry Center
Zoological Society of San Diego

Private Industry and Associations

Carlson Small Power Consultants
Paoag's Black, Inc.

Clients Who Provided Funding to the PNW Research Station for Studies

Educational Institutions

Oregon State University
University of Oregon
Washington State University

Other Federal Agencies

Department of Defense, Army Corps of Engineers
Department of Defense, United States Army, Joint Base Lewis-McChord
Department of Energy, Bonneville Power Administration
Department of the Interior, Bureau of Land Management
Department of the Interior, Bureau of Ocean Energy 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

Nonprofit Organizations

Ecological Research, Inc.
Ecotrust
National Fish and Wildlife Federation
Northwest Power and Conservation Council
The Wolverine Foundation, Inc.

Municipal or Township Governments

Seattle City Light

State Agencies

Alaska Department of Fish and Game
Oregon Department of Forestry
Washington Department of Natural Resources

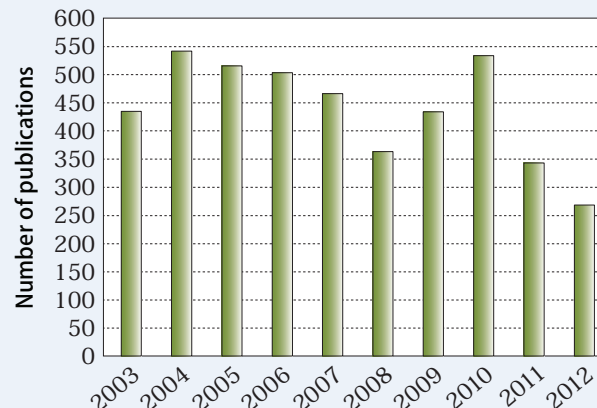
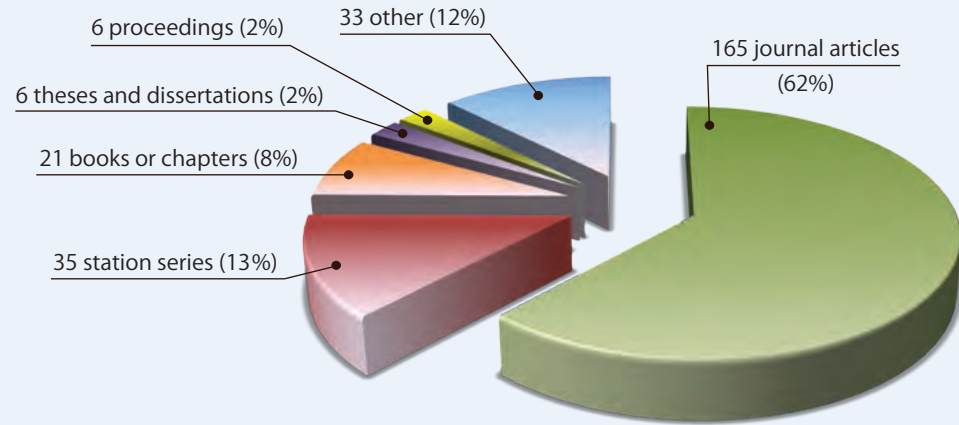
Sharing What We've Learned

The station produced 266 publications in fiscal year 2012. This includes station series publications, journal articles, books or book chapters, theses and dissertations, and other publications.

- ▶ 158,202 hard copies of station publications distributed
- ▶ 37,336 electronic publication downloads for the station's Web site and Treesearch (www.treesearch.fs.fed.us)
- ▶ 4,106 station publications available online via the station's Web site and Treesearch
- ▶ 11 issues of *PNW Science Findings* published, about 8,000 copies of each issue distributed or downloaded

Web Visitors

- ▶ Total number of visits: **90,862** from 161 countries and territories
- ▶ Total number of unique visitors: **53,166**
- ▶ Total number of page views: **222,205**
- ▶ Percentage of new visitors: **55.73%**



Our Most Popular Publications

All of the station's publications are available online. The station's top 10 most frequently downloaded publications are listed below. Some of these publications are decades old but still relevant today.

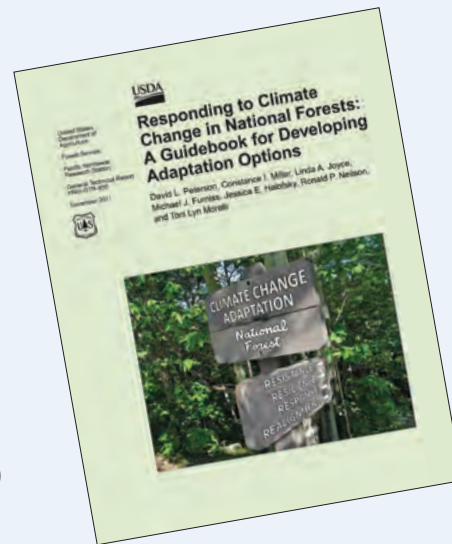
1. Responding to Climate Change in National Forests: A Guidebook for Developing Adaptation Options (2011; PNW-GTR-855)
2. Production, Prices, Employment, and Trade in Northwest Forest Industries, All Quarters 2010 (2011; PNW-RB-260)
3. Natural Vegetation of Oregon and Washington (1973; PNW-GTR-008)
4. Synthesis of Knowledge of Extreme Fire Behavior: Volume I for Fire Managers (2011; PNW-GTR-854)
5. Adaptive Management of Natural Resources: Theory, Concepts, and Management Institutions (2005; PNW-GTR-654)
6. Adapting to Climate Change at Olympic National Forest and Olympic National Park (2011; PNW-GTR-844)
7. FRAGSTATS: Spatial Pattern Analysis Program for Quantifying Landscape Structure (1995; PNW-GTR-351)
8. The Formula Scribner Log Rule (1952; OSN-PNW-078)
9. Engineering a Future for Amphibians Under a Changing Climate (2011; Science Findings 136)
10. Ecological Characteristics of Old-Growth Douglas-Fir Forests (1981; PNW-GTR-118)

Twitter

The station's Twitter account has 766 followers—up from 560 in 2011. Reporters, natural resource professionals, and nonprofit groups comprise the majority of subscribers, who receive instant electronic alerts (tweets) to station news releases, new publications, and other information.

RSS Feeds

Readers can receive alerts about new publications by subscribing to a Really Simple Syndication (RSS) feed at www.fs.fed.us/pnw/RSS/index.shtml.



Symposia, Workshops, and Tours

The station sponsors learning events each year, often in partnership with other agencies, organizations, and universities. A few events are highlighted below.

In 2012:

- ▶ ~**920** people participated in symposia, workshops, and webinars sponsored by the station.
- ▶ ~**1,630** people went on field trips led by station researchers.
- ▶ ~**1,510** people participated in conservation education activities sponsored by the station.

Assessing the Impact of Climate Change in Alaska's Forests: The station hosted workshops in Fairbanks, Juneau, Sitka, Kenai, Haines, Anchorage, and Palmer with 22 key clients and research partners. Participants developed a conceptual framework to describe the impacts of climate change across Alaska forests.

Blue Mountains Elk Habitat Modeling

Workshop: Station scientists and partners presented ground-breaking models depicting elk nutritional resources and habitat selection in the Blue Mountains of eastern Oregon and Washington. The models can benefit land management plan revisions and habitat restoration for elk in this region. The workshop was held in Pendleton, Oregon, where 140 people participated.

BlueSky Training: Station scientists led two training sessions for National Forest System staff using the BlueSky framework to model fire information, fuel loading, smoke dispersal, and more. About 50 people attended the training in Redmond, Oregon, and 45 attended the training in Missoula, Montana.

Forest and Fire Scenarios Workshops: Station scientists organized workshops in Klamath Falls and Bend, Oregon, with 24 representatives from forest management and nongovernmental organizations. Attendees shared information about factors affecting forests and fire; scientists provided a tutorial on how to use scenario planning to address uncertainties and connections in ecological and social systems.

Density Management in the 21st Century: At this 3-day conference, 120 natural resource professionals reviewed 20 years of thinning research in young forests of western Oregon and Washington. Forty-five people participated in a related 1-day field trip.

Density Management Study Tours: Station scientists led two tours through the Green Peak and Delph Creek study sites for 85 natural resource professionals and explained the ongoing Density Management and Riparian Buffer study designs and research findings. The tours were cosponsored by Bureau of Land Management, Oregon State Office.

Forest Inventory and Analysis (FIA) 2012

Client Meetings: PNW-FIA held symposiums in Portland and Honolulu to discuss current research activities in the respective regions. The second day featured training workshops where clients received help with analyzing FIA data to answer challenging resource questions. Seventy clients attended.

National Emissions Inventory Workshop:

Station scientists taught 40 people how to use local data to improve the National Emissions Inventory for Wildland Fire at the International Emissions Conference in Tampa, Florida.

Next Generation Genetic Sequencing Workshop:

This workshop introduced 54 participants to the essentials of next-generation sequencing. The workshop was part of the Botanical Society of America's 2012 annual meeting in Columbus, Ohio.

Sudden Oak Death Science Symposium:

National and international leaders in the discipline of forest pathology and ecology came together to discuss and present their research findings on *Phytophthora ramorum*, the pathogen that causes sudden oak death. About 150 people attended the event in Petaluma, California.

Conservation Education

Station scientists make time to share their expert knowledge with students and their teachers through programs ranging from classroom activities to week-long field camps. A few activities from 2012 are highlighted below.

Forest Camp 2012: Station and Siuslaw National Forest staff taught roughly 200 sixth graders about ecology and the role of fungi in forest ecosystems at Camp Tadmore, Lebanon, Oregon.

Forests Inside Out! The station continued its partnership with the nonprofit World Forestry Center in Portland to support Forests Inside Out!, a successful summer conservation education program. This program is a series of 2-day immersive and unforgettable indoor and outdoor experiences for 400+ children ages 6 to 10 and family members from diverse and underserved communities in the greater Portland metropolitan area. The program promotes active, healthy outdoor lifestyles for young children and their families and introduces participants to urban forests, natural areas, and national forests. Eight high school and college-age students from the Portland area were hired as mentors for the program.



Children examine animal skulls during the summer program Forests Inside Out!

Héen Latinee Outdoor Classroom Project:

This collaboration between the Central Council of Tlingit and Haida Indian Tribes of Alaska and the station introduced nine Alaska Native high school students to natural resource management.

Inner City Youth Institute: The station continued its support of the Inner City Youth Institute (ICYI), which encourages underrepresented youth to pursue higher education and careers in the natural resource and environmental fields. ICYI sponsored forest ecology programs in Portland inner city high schools and a summer camp program for high school students from Portland and southwest Washington. About 200 students participated in ICYI programs.



Roy Yurkewycz, Mount St. Helens Institute

High school students learn about ecology on Mount St. Helens.

Learning on Mount St. Helens: The station and partners are using the Mount St. Helens landscape as a living laboratory for teaching middle school teachers and their students about disturbance ecology and natural history. Twelve middle school teachers and 40 middle school students attended this workshop at the

Mount St. Helens National Volcanic Monument. Another 60 students from the Battle Ground School District, Washington, learned about the life history, reproductive biology, and general ecology of amphibians of Clark County in classroom, laboratory, and field settings.

Minorities in Agriculture and Natural Resources Research: About 25 high school students from Roosevelt High School, Portland, Oregon, attended presentations about aquatic ecology research and natural resource management.

Climate Change

Station scientists conduct research to provide land managers and decisionmakers with information and tools to prepare for environmental change triggered by a changing climate. 🌀 This research ranges from landscape management to the genetics of a plant's ability to cope with drought. 🌀 It addresses the physical repercussions of warmer temperatures, such as changes in the amount of snow versus rain, frequency of drought, timing of snow melt, and severity of storms. 🌀 Station research also addresses the social and economic implications of changes in forests and rangelands.



Bruce Marcot

Mount St. Helens, Washington.



Rhonda Mazza

A precipitation collector at H.J. Andrews Experimental Forest.

Highlights in 2012

- ▶ Social vulnerability to climate change varies depending on geographic location and unique cultural and economic relationships with the land.
- ▶ Prescribed burns can be timed so that wind currents do not transport sooty black carbon to the Arctic. The Environmental Protection Agency included this information in its May 2012 report to Congress.
- ▶ The guidebook *Responding to Climate Change in National Forests* is being used throughout the National Forest System and by other federal agencies and institutions to develop options for adapting to climate change.
- ▶ Scientists synthesize what is known about U.S. forest carbon dynamics and prospects for forest-based carbon mitigation.
- ▶ Station scientists developed methods to identify genes responsible for climate sensing and adaptation in Douglas-fir, evaluate conservation units in salmon and carnivores of management concern, and identify geographic provenance of illegally collected timber.
- ▶ Snowpack and soil drainage determine where yellow-cedar will survive.



Illustration by Keith Routman

Researchers Document Social Vulnerability and Climate Change

The effects of climate change are expected to be more severe for some segments of society than for others. American Indian and Alaska Native tribes, for example, have unique cultures and economies that are vulnerable to climate change. Resulting environmental changes could threaten ways of life, subsistence, and access to natural resources. Because some populations may have less capacity to prepare for, respond to, and recover from climate-related

hazards, they may be particularly vulnerable to the effects of climate change.

This new synthesis documents the socioeconomic effects of climate change on indigenous, low-income, and rural resource-based communities.

Contact: Susan Charnley, scharnley@fs.fed.us

Partner: University of Oregon

For more information: Lynn, K.; MacKendrick, K.; Donoghue, E.M. 2011. Social vulnerability and climate change: synthesis of literature. Gen. Tech. Rep. PNW-GTR-838. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 70 p.

Guidebook Adopted as Foundation for Climate Change Adaptation on National Forests

Station scientists and collaborators developed this climate change guidebook using a science-management partnership approach. The guidebook provides information on climate change education and explains how to conduct vulnerability assessments and adaptation planning. It describes various tools and processes that have been tested in national forests and provides scientific documentation.

The guidebook is the basis for adaptation principles and applications cited in the forest sector technical report for the 2013 U.S. Global Change Research Program National Climate Assessment.

Contact: David L. Peterson, peterson@fs.fed.us

Partners: USDA Forest Service Pacific Southwest Research Station and Rocky Mountain Research Station, University of Washington

For more information: Peterson, D.L.; Millar, C.I.; Joyce, L.A.; Furniss, M.J.; Halofsky, J.E.; Neilson, R.P.; Morelli, T.L. 2011. Responding to climate change in national forests: a guidebook for developing adaptation options. Gen. Tech. Rep. PNW-GTR-855. Portland, OR: U.S., Department of Agriculture, Forest Service, Pacific Northwest Research Station. 109 p.

Stored Carbon Potential in Western Cascades Forests Projected to Change

During the 21st century, climate-driven changes in fire regimes will be a key agent of change in Pacific Northwest forests. Understanding the response of forest carbon

Information helps manage fire to minimize carbon loss.

dynamics to increases in fire will help quantify limits on the contribution of forest carbon storage to climate change mitigation.

Scientists examined these implications for the state of Washington, moving beyond a previous focus on stand-level carbon dynamics models of fire behavior and fire effects. Forests of the western Cascades are projected to be more sensitive to climate-driven increases in fire, and thus projected changes in carbon dynamics, than forests of the eastern Cascades. This landscape approach helps facilitate fire management planning at a broader scale than any other currently available study.

Contact: Don McKenzie, donaladmckenzie@fs.fed.us

Partners: National Oceanographic and Atmospheric Administration, University of Washington



The Science Behind Forest-Based Carbon Mitigation

A station scientist participated in a task force brought together by the Society of American Foresters to synthesize current science on forest carbon dynamics, carbon and climate change policy, and bioenergy. The task force synthesized information from more than 200 publications and published forest inventory statistics to highlight what is known about forest carbon dynamics and prospects for forest-based carbon mitigation in the United States.

The report was submitted to the Environmental Protection Agency's Science Advisory Board Biogenic Carbon Emissions Panel for consideration during policy development. The report also has been used in briefings with congressional staffs and as assigned reading in university courses. Its key findings were featured in the magazines *Biomass* and *Wood Bioenergy*.

Contact: Jeremy Fried, jsfried@fs.fed.us

Partners: Dovetail Partners, Mississippi State University, National Council for Air and Stream Improvement, Society of American Foresters, State University of New York Syracuse, University of California, University of Georgia, University of Washington, USDA Forest Service Washington Office

For more information: Malmshimer, R.W.; Bowyer, J.L.; Fried, J.S. [et al.] 2011. Managing forests because carbon matters: integrating energy, products, and land management policy. *Journal of Forestry*. 109(7S): S7–S50.

New Genome Analysis Methods Are Cost-Effective for Understanding Changes in Trees, Fish, and Wildlife

Next-generation sequencing of DNA is revolutionizing all aspects of biology, making it possible to identify the genes that control adaptive traits like disease resistance, growth

Methods that identify genes responsible for climate sensing and adaptation help conserve salmon and carnivores and identify illegally collected timber.

rate, and reproductive output. Despite modern instruments, forest plants and animals remain a challenge to analyze genetically. For example, conifer tree genomes are large, show extensive redundancy in genes, and comprise numerous repeated sequences. This complexity makes it difficult to sequence the large number of individuals needed to identify adaptive variation in population- or landscape-level analyses.

Geneticists at the PNW Research Station evaluated existing methods for genome analysis and identified two approaches—genome reduction and genome skimming—that show the greatest promise for adaptation for genetic analysis of forest and range species. These methods extend a previous innovation developed at the station and combine to make cost-effective approaches for genome analysis forest species.

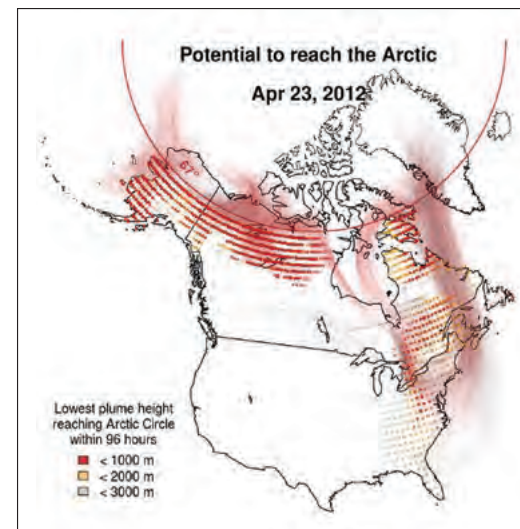
Contact: Richard Cronn, rcronn@fs.fed.us

Partners: Brigham Young University, Linfield College, Oklahoma State University, Oregon State University

Mitigating Airborne Soot That Hastens Arctic Warming

A new study of the ability of emissions to be transported to the Arctic is providing managers and policymakers with information relevant to mitigating Arctic black carbon deposition from the United States.

Black carbon is the sooty particulate matter produced by incomplete combustion of fossil fuels, biofuels, and biomass. It readily absorbs sunlight and warms the atmosphere. When



By predicting which plume injection heights have the capability to reach the Arctic, timing of prescribed burns and other fire operations may be shifted to mitigate negative impacts on the Arctic. The map shows a prediction for April 23, 2012, done two days in advance. It shows little transport potential over much of the country except along the eastern seaboard.

deposited on snow, it absorbs light and heat and accelerates melting. This study used a 30-year climatology of atmospheric transport patterns along with a real-time forecasting system. Scientists found that even in locations and seasons where emissions can be transported to the Arctic quickly during most days, there are still a number of windows when Arctic transport does not occur. By conducting prescribed burning and other emissions activities during these windows when transport does not occur, mitigation of Arctic black carbon deposition is possible.

This work was used in the Environmental Protection Agency's Report to Congress on Arctic Black Carbon, finalized in May 2012. Specifically the work identified ways to mitigate Arctic black carbon deposition and yet avoid seasonal bans on prescribed burning. This work also was presented to U.S. Forest Service Fire and Aviation Management in Washington, D.C., and at a meeting in Moscow with the Russian Engineering Academy of Management and Agrobusiness.

Contact: Sim Larkin, larkin@fs.fed.us

Partners: Joint Fire Science Program, Sonoma Technology, Inc., USDA Foreign Agricultural Service, U.S. State Department



Innovative modeling that incorporates information about topography, drainage, and predicted snowpack in a warmer climate is being used in a conservation effort to identify suitable habitat for yellow-cedar in the future.

From Cause to Conservation: Understanding Yellow-Cedar Decline

Yellow-cedar decline has affected about 60 to 70 percent of trees in forests covering 600,000 acres in Alaska and British Columbia. Yellow-cedar's shallow rooting, early spring growth, and unique vulnerability to freezing injury contribute to its decline in Alaska's coastal forests. The tree thrives in wet soils, but its tendency to produce shallow roots to access nitrogen on these sites makes it more vulnerable to fine root freezing in late winter and early spring in years with little snow to insulate the tree's roots. To be effective, conservation and management activities need to follow the shifting snow patterns on the landscape.

Current and future yellow-cedar health can be predicted across landscapes based on patterns of snow and soil drainage. Coastal Alaska is expected to experience less snow but a persistence of periodic cold weather events in the future. Station scientists are working with federal land managers in Alaska to use this information as the framework for a comprehensive yellow-cedar conservation strategy that factors in climate change.

Contact: Paul Hennon, phennon@fs.fed.us, and David D'Amore, ddamore@fs.fed.us

Partners: Stanford University; USDA Forest Service Alaska Region, Northern Research Station; University of Vermont

Estimating Carbon Loss From Tundra Fire

Arctic tundra soils store large amounts of carbon in organic soil layers. Fire has been largely absent from most of this biome for thousands of years, but its frequency and extent are

Fire managers use innovative method to estimate carbon loss in tundra.

increasing. The effect of fires on the carbon balance of tundra landscapes, however, remains largely unknown. In

2007, the Anaktuvuk River fire burned 1000 square kilometers of Alaska tundra and was the largest tundra fire on record. Estimating carbon loss, particularly in the organic soils, was a critical step to understanding the effects of fire in the tundra. Researchers developed a method for estimating carbon loss based on the size of remaining tussocks and the depth of organic layer versus tussock meristems. This method allowed them to quantify carbon loss of the Anaktuvuk River fire at approximately 2000 grams of carbon per square meter.

These results indicate that the magnitude of ecosystem carbon lost by fire in tundra ecosystems could represent a positive climate feedback potentially offsetting Arctic greening and influencing the net carbon balance of the tundra biome.

Contact: Teresa Hollingsworth, thollingsworth@fs.fed.us

Partners: Marine Biological Laboratory; University of Alaska Fairbanks; University of Florida; USDI Bureau of Land Management, Alaska Fire Service



Trees invading subalpine meadow on the Priest River Experimental Forest, Idaho.

Trees Advance Into Subalpine Meadows

Tree invasions have been documented throughout subalpine meadows in the Northern Hemisphere. This study in the Oregon Cascade Range helps scientists and managers to better understand how topography, snow, climate, and seed source affect the shift from meadow to forest, and how these ecotones may respond to future climate conditions.

Scientists used an innovative approach to combine airborne Light Detection and Ranging (LiDAR) characterizations of landforms, topography, and overstory vegetation with historical climate, field measurements of snow depth, tree abundance, and tree ages to reconstruct spatial and temporal patterns of tree invasion over five decades in a subalpine meadow complex in the Oregon Cascade Range. They found

that the proportion of meadow occupied by trees increased from 8 percent in 1950 to 35 percent in 2007.

They also found that the larger landforms such as debris flows, topography, and tree canopies interactively mediated regional climatic controls of tree invasion by modifying depth and persistence of snowpack, while tree canopies also influenced seed source availability. These findings were shared with recreation and resource personnel on the Willamette National Forest. The Siuslaw National Forest is using related meadow research to help establish reference conditions guiding meadow restoration treatments on Marys Peak.

Contact: Demetrios Gatzolis, dgatzolis@fs.fed.us, and Tom Spies, tspies@fs.fed.us

Partners: Oregon State University, U.S. Geological Survey

Fire and Smoke

Fire-related research at the station provides science-based knowledge and tools that enable land managers and fire professionals to reduce fuels and wildfire risk at the landscape level and minimize overall risk to property and human life. 🌀 During large wildfires, for example, station scientists provide customized smoke modeling that is used by local air quality agencies to alert the public about hazardous air conditions. 🌀 Weather variability, declining snowpacks, insect infestations, and fuel accumulations are all components of environmental change that is expected to lead to increased costs and risks associated with fire and fire suppression. 🌀 Station scientists are working with public land managers, private landowners, and federal and state agencies to find ecologically sound and economically feasible methods for mitigating these conditions.



Field technician measures remaining fuel after a prescribed burn on Nenana Ridge, Alaska.



2002 Biscuit Fire in southwestern Oregon.

Highlights in 2012

- ▶ Customized smoke projections and analyses were developed to guide public health outreach during major wildfires in California, Colorado, Utah, Washington, and Wyoming in 2012.
- ▶ A study linked mortality from smoke to 2003 southern California fires.
- ▶ The Environmental Protection Agency is using new techniques developed by station scientists and collaborators to create the next national emissions inventory for wildland fire.
- ▶ A new National Fuels Database is publicly available and can be used to model real-time carbon emission of individual fires and continental-scale simulations of air quality.
- ▶ *Principal Findings of the National Fire and Fire Surrogate Study* is published, summarizing 206 technical articles stemming from the 12-site network of this national study initiated in 1996 in response to stated management needs.
- ▶ The National Wildfire Coordinating Group uses a new knowledge synthesis about extreme fire behavior and the way science is shared with the fire management community to inform revisions to training curriculum.
- ▶ The Bureau of Land Management Alaska Fire Service and Alaska State Division of Forestry are using findings from a study on fuel treatments in boreal forests to develop policy that will apply the most effective and least costly fuel treatment to the landscape for community protection from wildfire.



2012 High Park Fire, Colorado.

Smoke Modeling Helps Protect Public Health

Customized smoke projections and analyses guide public health outreach during major wildfires in California, Colorado, Wyoming, and Utah.

Station scientists provided customized smoke modeling for the High Park Fire west of Fort Collins, Colorado. As new fires started, they adopted a regional focus and provided smoke dispersion projections for fires burning in Colorado, Wyoming, and Utah. They provided similar support for the Halstead Fire in Idaho, wildfires in eastern Washington, and all the wildfires burning in northern California in 2012.

The smoke from these fires created a significant public health challenge because of unhealthy air quality conditions and reduced visibility in transportation corridors. The Environmental Protection Agency used these data and expert analyses provided by station scientists in their Exceptional Events assessments. The information also was shared with state and local air quality agencies in the areas affected by the fires.

Contact: Miriam Rorig, mrorig@fs.fed.us

Partners: Desert Research Institute; Mazama Science; National Weather Service; Sonoma Technology, Inc.; USDA Forest Service Pacific Southwest Region, Rocky Mountain Region, Fire and Aviation Management, and Wildland Fire Management Research, Development, and Application

Research Estimates Cost of Smoke-Related Deaths

Wildfire raises concerns about the human health effects of smoke exposure. Very little is known about the mortality impacts and the resulting social costs of wildfire smoke. The

Smoke from the 2003 wildfires in southern California associated with 133 human deaths from cardiorespiratory illness.

wildfires in southern California in late October 2003, some of the largest ever to burn near a major

U.S. urban area, provided an opportunity to assess the impacts of smoke. These fires burned 750,043 acres, cost \$123 million to suppress, and were linked to the deaths of 133 people, predominantly elderly. The mean estimated total mortality-related cost associated with these wildfires is approximately \$1 billion. The relationship between smoke and human health allows for a better understanding of the tradeoffs between fire risk reduction treatments and fire suppression.

Contact: Geoffrey Donovan, gdonovan@fs.fed.us

Partners: Colorado State University, University de Ciudad Juárez, USDA Forest Service Rocky Mountain Research Station

New Techniques Improve National Emissions Inventory for Wildland Fire

Created every 3 years, the Environmental Protection Agency's (EPA's) National Emissions Inventory forms the basis of regulatory modeling and numerous other studies including global climate change greenhouse gas reports, regulatory policy decisions, and state and federal implementation plans.

Station scientists worked with numerous stakeholders including federal agencies, regional planning organizations, state

EPA uses techniques to create the next national emissions inventory for wildland fire.

agencies, air quality regulators, and the EPA to significantly improve the national emissions inventory for wildland fire.

The inventory now significantly improves overall estimates of fire size, fuel loading, fuel consumption, and emissions by utilizing additional data sets and a new methodology for combining and reconciling disparate data sets into a unified data stream.

The Forest Service's Fire and Aviation Management unit has expanded this effort to create a 10-year climatology of

wildland fire (both prescribed fire and wild-fire). Development of additional techniques is being funded by a research grant from the Joint Fire Sciences Program.

Contact: Sim Larkin, larkin@fs.fed.us

Partners: Joint Fire Science Program, Michigan Technology Research Institute, National Wildfire Coordinating Group Smoke Committee, Sonoma Technology, Inc., U.S. Environmental Protection Agency, USDA Forest Service Fire and Aviation Management, U.S. Department of the Interior

Tom Iraci



2006 Bluegrass Fire, Oregon.

Researchers Build a National Fuels Database for Multi-Scale Applications

Local air quality and fire managers use fine-scale data and models to estimate smoke pollution and schedule prescribed fires. However, few resources are currently available for estimating emissions from wildfires in real time, at subcontinental scales, in a spatially consistent manner. To remedy this, station researchers created fuel maps at both 30-meter and 1-kilometer resolution, using vegetation types generated by the LANDFIRE project. Geographically specific rules were developed for associating each of these vegetation types with a Fuel Characteristic Classification System fuelbed. The database is publicly available and can be used in diverse modeling efforts from real-time carbon emission calculations for individual fires to continental-scale simulations of air quality.

Contact: Don McKenzie, donaldmckenzie@fs.fed.us

Partners: Michigan Tech Research Institute, National Aeronautics and Space Administration

To access database: www.fs.fed.us/pnw/fera/fccs/maps.shtml



Rhonda Mazza

As part of a fuel reduction study at the Pringle Falls Experimental Forest in central Oregon, a masticator shreds small trees and shrubs after selective harvest of larger trees.

12-Site National Study Informs Choices About Fuel Reduction

The national Fire and Fire Surrogate study was designed to evaluate how alternative fuel reduction treatments influence a multitude of ecological effects in seasonally dry forests.

This report summarizes results from 206 technical articles stemming from the 12-site network of this national study. Some general conclusions: for most sites, treatments modified stand structures and fuels to the point where posttreatment stands would be expected to be much more resilient to moderate wildfire. Although ecological effects tend to dampen with time, fire risk appears to increase due to treatment-induced collapse of burned portions

of stands. Mechanical treatments do not serve as surrogates for fire for most ecosystem components, suggesting that fire could be introduced and maintained as a process in these systems whenever possible. The critical components of these ecosystems are strongly linked, thus fuel reduction work may be most effective when designed with the entire ecosystem in mind.

Contact: Andrew Youngblood, ayoungblood@fs.fed.us

Partner: Oregon State University

For more information: McIver, J.; Erickson, K.; Youngblood, A. 2012. Principal short-term findings of the national Fire and Fire Surrogate study. Gen. Tech. Rep. PNW-GTR-860. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 210 p.

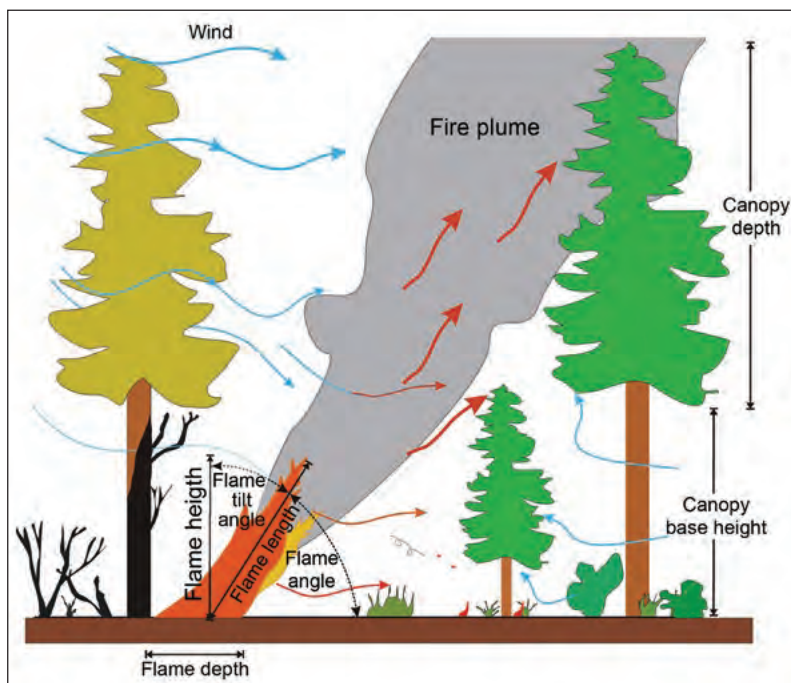
What Contributes to Extreme Fire Behavior That Fire Managers See Today?

Experts synthesized the latest science on weather patterns, fuel, and topographic factors that contribute to extreme fire behavior. This project stems from fire managers' expressed need to have a comprehensive understanding of the latest science related to extreme fire behavior. Volume 1 of this Joint Fire Science Program project also examines how science is presented to the fire management community, including incident commanders, fire behavior analysts, incident meteorologists, National

Weather Service office forecasters, and firefighters. The authors found that current training does not include the full extent of scientific understanding, particularly newer research related to the influence of wind profiles on fire behavior. This synthesis has been distributed to land management offices across the country.

Contact: Brian Potter, bpotter@fs.fed.us

Partners: Canadian Forest Service; CSIRO, Australia; Joint Fire Science Program; San Jose State University; Southern Research Station; USDA Forest Service Rocky Mountain Research Station; Weather Research and Consulting, LLC



An explanation of fire dynamics in conifer forests is one of many aspects of extreme fire behavior explained in a new knowledge synthesis for fire managers.

For more information: Werth, P.A.; Potter, B.E.; Clements, C.B.; Finney, M.A. [et al.] 2011. Synthesis of knowledge of extreme fire behavior: volume I for fire managers. Gen. Tech. Rep. GTR-PNW-854. Portland, OR: U.S., Department of Agriculture, Forest Service, Pacific Northwest Research Station. 144 p.



Odell Butte Fire Lookout, Oregon.



A First-of-Its-Kind Study Tests the Efficacy of Fuel Treatment in Alaska's Boreal Forest

Mechanical and manual fuel treatments have become the preferred strategy for reducing fire hazard in the boreal forest. Prior to this study, however, the actual effect

Alaska agencies use findings for cost-effective wildfire protection policies.

of these fuel treatments on fire behavior and fuel consumption in boreal forests had not been measured.

To fill this gap, scientists assessed two major fuel treatments, thinning trees and mechanical shearing of trees and shrubs, by measuring fire behavior and consumption of fuels on the forest floor following a stand-replacement, prescribed fire. They found that both treatments decreased fire behavior, although the thinning treatments were more effective.

The USDI Bureau of Land Management Alaska Fire Service and Alaska State Division of Forestry are using the findings to develop policy that will apply the most effective and least costly fuel treatment to the landscape for community protection from wildfire.

Contact: Roger D. Ottmar, rottmar@fs.fed.us

Partners: Alaska Department of Fish and Game, Alaska Department of Natural Resources Division of Forestry, University of Alaska, USDA Forest Service Rocky Mountain Research Station, USDI Bureau of Land Management Alaska Fire Service

Field technicians place devices for measuring forest floor consumption prior to a prescribed burn in this boreal forest south of Fairbanks, Alaska.

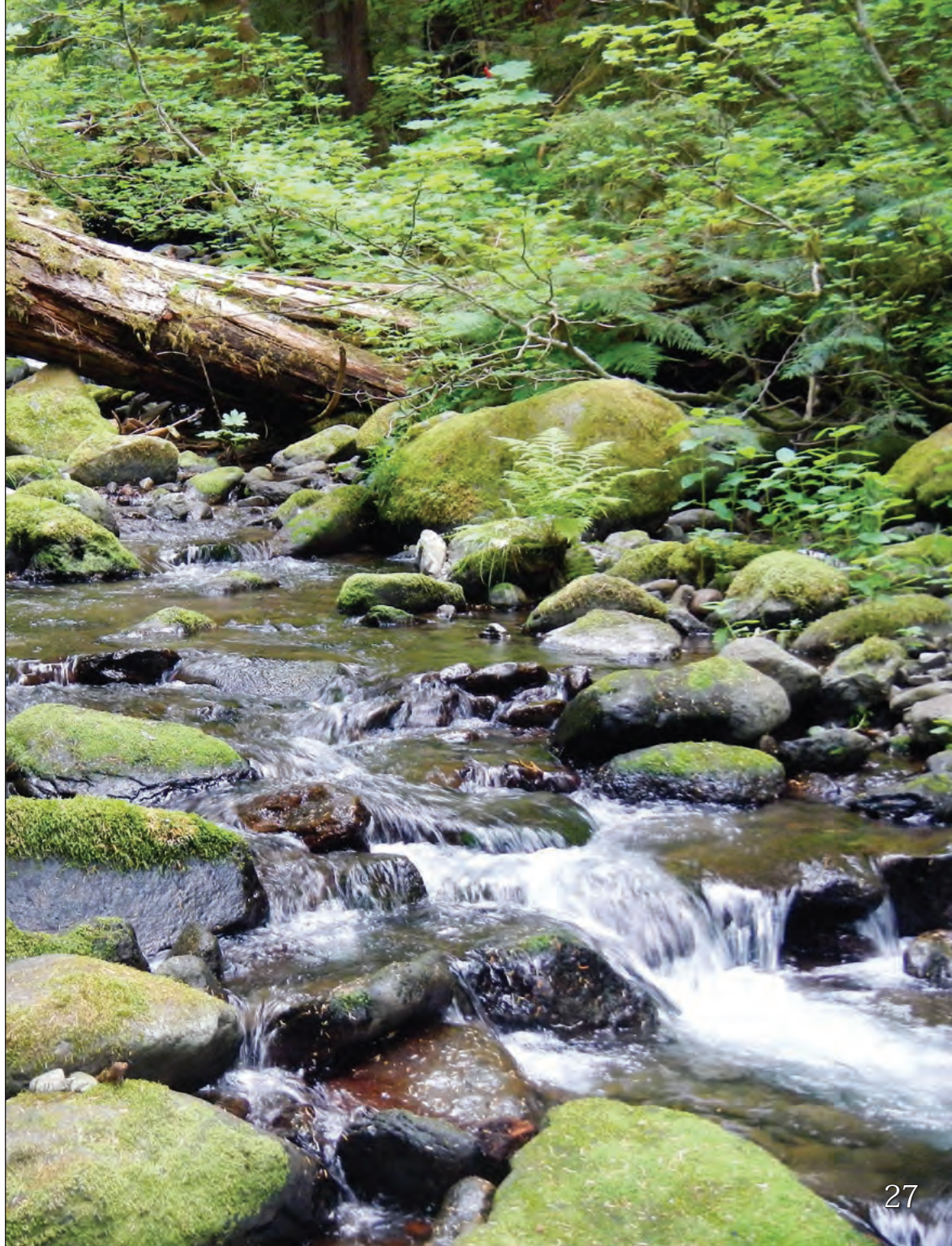
Strengths and Vulnerabilities Better Understood in Fish and Fire Communications

Communication between scientists and natural resource managers is essential to effectively address pressing issues related to natural resource management. Station scientists used a social network analysis to map, analyze, and facilitate improvements in communication and collaboration networks among managers and scientists concerned with the effects of wildland fire, fuels treatments, and postfire restoration on riparian and aquatic ecosystems.

They found that the Fish and Fire Communication and Collaboration Network contains many relationships among scientists linked by a few senior individuals but far fewer relationships between scientists and managers. Unless federal agencies can foster new relationships among scientists, impending retirements are likely to fragment the scientist subnetwork, impeding knowledge generation and communication. Institutional initiatives that encourage scientists and managers to collaborate can enhance information exchange, innovation, and problemsolving related to fish and fire issues.

Contacts: Kelly Burnett, kellyburnett@fs.fed.us,
or Paige Fischer, paigefischer@fs.fed.us

Partners: Oregon State University; National Oceanic and Atmospheric Administration, Fisheries Service; USDA Forest Service national forests in Oregon, Washington, and Idaho; USDI Bureau of Land Management, Fish and Wildlife Service, and Geological Survey



Soil Microbes Undaunted, Soil Nutrients Reduced by Postfire Logging

Better understanding about the impacts to soil following the harvest of fire-killed trees contributes to the success of recovery projects on fire sites in dry, mixed-conifer forests with volcanic soils.

Large areas of fire-killed trees are ready fuel when another fire occurs. Postfire logging removes some of this large dead wood and may reduce this future fire risk. However, the harvesting equipment used in postfire logging disturbs forest soils, and frequently results in soil compaction, reducing soil pore size and decreasing oxygen availability, water, and nutrient movement to tree roots. The effects of this mechanical disturbance on soil productivity and forest recovery differs in terms of severity, time since disturbance, and site factors. To alleviate compaction, the practice of subsoiling or deep tillage is used to fracture the lower soil strata. But there's a tradeoff: tillage may degrade soil structure, adversely affecting microbial biomass and diversity.



Jane Smith

Fungi and soil bacteria essential to mediating decomposition and nutrient cycling appeared resilient to disturbance from salvage logging.

This short-term study was developed to fine tune postfire treatments that help speed the forest recovery process. Scientists found that soil bacteria and fungi essential to mediating decomposition and nutrient cycling appeared resilient to timber harvesting applications, but nutrients critical to soil productivity were reduced.

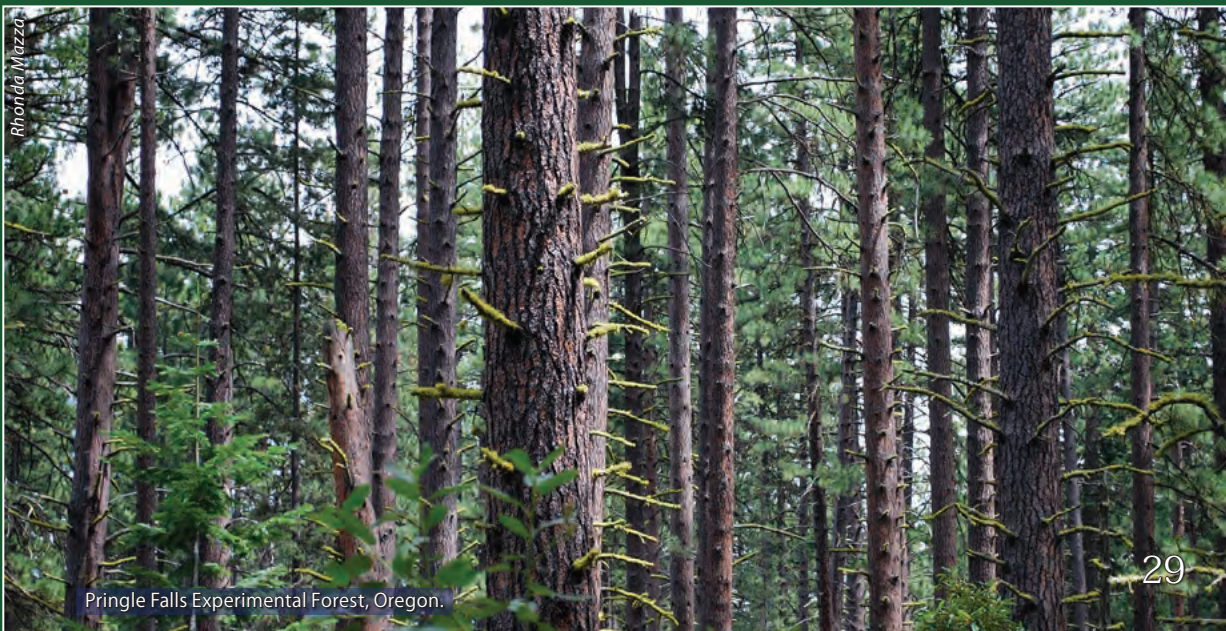
Contact: Jane E. Smith, jsmith01@fs.fed.us

Partners: Joint Fire Science Program, Oregon State University, Pacific Northwest Fire Consortium, USDA Forest Service Deschutes National Forest

Citation: Jennings, T.N.; Smith, J.E.; Cromack, K., Jr.; Sulzman, E.W.; McKay, D.; Caldwell, B.A.; Beldin, S.I. 2012. Impact of postfire logging on soil bacterial and fungal communities and biogeochemistry in a mixed-conifer forest in central Oregon. *Plant and Soil*. 350: 393-411. DOI: 10.1007/s11104-011-0925-5. www.treeseearch.fs.fed.us/pubs/40807

Forest Management Across Landscapes

Since 1908, when Thornton Munger laid out the first study plots in what would become the Wind River Experimental Forest, the station has been at the forefront of forestry research in the Pacific Northwest. This research has provided the scientific basis for forest management in the region. 🌀 Forests and rangelands of the Pacific Northwest and Alaska are experiencing unprecedented levels of biological and environmental disturbances. 🌀 Scientists with the station are developing tools and techniques to identify and prioritize at-risk ecosystems, including mapping forest structure and composition, an essential first step in most landscape-scale endeavors, and modeling and assessing trends in disturbance across public and private land. 🌀 Land managers are using this information to develop management options that promote a forest's resilience to environmental stressors. 🌀 In this way, the flow of benefits from forests will be sustained.



Forest inventory technician near Eugene, Oregon.

Pringle Falls Experimental Forest, Oregon.

Highlights in 2012

- ▶ Improvements identified for stewardship contracting and processes associated with the National Environmental Policy Act.
- ▶ The Forest Service Ecosystem Services Valuation Working Group is using information from a new report, *Evaluating Tradeoffs Among Ecosystem Services in the Management of Public Lands*, to develop a technical advice bulletin for Forest Service staff.
- ▶ Renters will pay more for rental housing with a tree in the yard. The city of Portland is using this finding to help promote its goal of increasing the city's tree canopy.
- ▶ The projected spread of amber-marked birch leaf miner in Anchorage, Alaska, provides the city with needed information to address the infestation.
- ▶ Tree breeders are using genetic information about the growth performance of Douglas-fir to improve productivity.
- ▶ Improvements to the small-tree components of the Forest Vegetation Simulator, a popular tool among forest managers, enables users to more accurately predict how different management actions will affect small trees.
- ▶ The Bureau of Land Management is modifying national and regional policies on management of sagebrush ecosystems and the associated species of conservation concern, based on work by station scientists and partners.
- ▶ Novel techniques enable mapping of old-growth forest and disturbance over time. This information will be used to help evaluate the efficacy of the Northwest Forest Plan throughout the region.



Tom Iraci

The term "ecosystem services" is used to describe the ways in which people benefit from nature. Clean water and air, wildlife habitat, and scenic beauty are examples of services provided by a healthy ecosystem. Above, Klamath National Wildlife Refuge, Oregon.

Managing for Ecosystem Services on Public Land

With the new forest planning rule, the U.S. Forest Service has formally adopted the concept and language of ecosystem services to describe the beneficial outcomes of forest management. A new report reviews the economic theory of ecosystem services as it applies to public lands management under the new planning rule and considers what it implies about the types of biophysical and other data needed for characterizing management outcomes as changes in ecosystem services. The report serves as a guide to policymakers, managers, researchers, and others for evaluating and describing the tradeoffs involved in the management of public lands.

The Ecosystem Services Valuation Working Group within the Forest Service is using the report to develop a technical advice bulletin for Forest Service staff. The technical advice bulletin will guide national forest staff in their efforts to consider the relative contributions and values of ecosystem services in forest planning and other decisionmaking situations.

Contact: Jeff Kline, jkline@fs.fed.us

Partners: Environmental Protection Agency, University of Rhode Island

For more information: Kline, J.D.; Mazzotta, M.J. 2012. Evaluating tradeoffs among ecosystem services in the management of public lands. Gen. Tech. Rep. PNW-GTR-865. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 48 p. www.treeseearch.fs.fed.us/pubs/40875

Improvements Identified for Stewardship Contracting

In 2003, Congress granted stewardship contracting authority to the Forest Service in an effort to support disposal of low-value material, such as woody biomass, through the removal of higher-value products. This mechanism for trading goods for services has great potential to help the Forest Service accomplish its hazardous fuel reduction goals and increase community benefits. Yet adoption of this authority has been inconsistent and slow. Station scientists conducted case studies of four fire-prone national forests, two in California and two in Oregon, to determine what factors are influencing the use of this management tool.

They found that an education campaign for local management units about stewardship contracting could be helpful, but is not likely to be enough. Ensuring adoption of new policy tools such as stewardship contracting across the Forest Service will require a broad set of strategies to support early adopters as well as those hesitant to try new approaches.

Contact: Susan Charnley, scharnley@fs.fed.us

Partner: University of Oregon

Housing Density on Forest and Farm Land Increasing in Oregon

Scientists found that land use change in Oregon slowed between 2005 and 2009 as the economy entered recession in 2007. Conversion to urban uses fell to the lowest level in the 35-year study period. The number of housing units per square mile, however, has continued to increase on private land remaining in forest, agricultural, and range uses since 1984. This set of studies, started in 1973, has been used by the Oregon legislature to inform land use policy over the past decade.

Contact: David Azuma, dazuma@fs.fed.us

Partner: Oregon Department of Forestry

Renters in Portland Will Pay More for Trees

Understanding how people respond to environmental characteristics, such as trees, can be good for business. On average, rental houses with trees in Portland, Oregon, commanded higher rents. Specifically, a tree in the yard increased monthly rent by over \$5.00. A tree in the public right-of-way increased rent by \$21 a month. These results are consistent with a previous study in Portland showing that a street tree adds \$7,130 to the sale price of a house.

Urban planners, policymakers, local governments, and the volunteer group Friends of

Trees have been using this information to make the case for urban forestry. For example, the city of Portland is using these studies to help promote its goal of increasing the city's tree canopy to 33 percent; the city's tree canopy coverage is currently 26 percent.

Contact: Geoffrey Donovan, gdonovan@fs.fed.us

Partner: National Institute of Standards and Technology



Geoffrey Donovan

Consumer appreciation for trees is an indication of broader, intangible benefits people receive from the natural environment. Above, a rental house in Portland, Oregon.

Retain Staff During NEPA Processes to Help Reduce Administrative Appeals

The National Environmental Policy Act (NEPA) requires the assessment and public disclosure of the likely impacts of any major land management activity. During this process, any public entity can challenge the resulting decision through an administrative appeal, which can cost the agency considerable additional time and effort. Appeals also delay and sometimes prevent proposed project implementation.

The Forest Service may be able to mitigate the risk of administrative appeals by using public involvement to achieve buy-in, creating consensus between the interdisciplinary team and the decisionmaker, and limiting turnover of agency staff during the process.

Improved direct supervision for those performing complex NEPA-related tasks is another area for agency improvement.

Contact: David Seesholtz, dseesholtz@fs.fed.us

Partners: Auburn University, University of Illinois-Springfield, Virginia Tech

Scientists Model Future Infestations of Amber-Marked Birch Leaf Miner in Anchorage

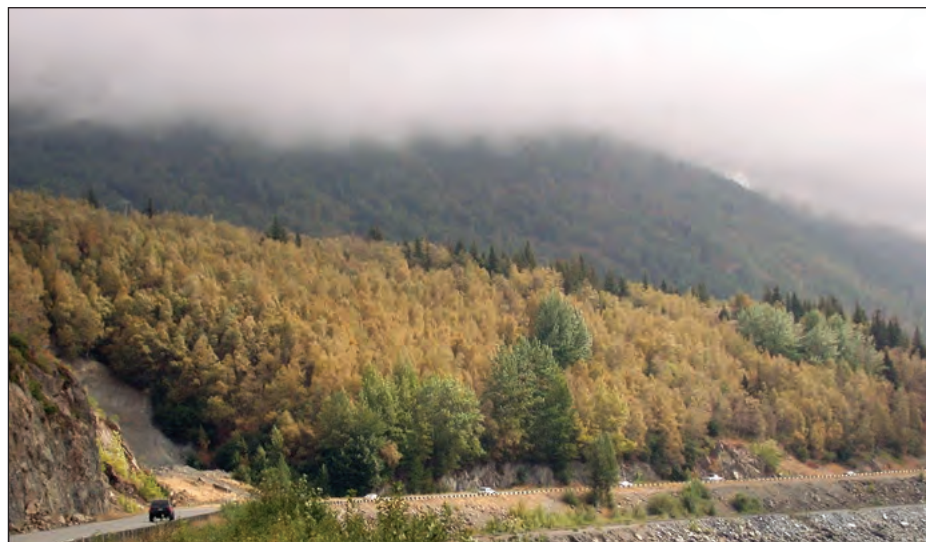
The amber-marked birch leaf miner (*Profenusa thomsoni*) is a leaf-eating insect that has infested trees in Anchorage since 1996. The infestations create distinct, patchy landscape-scale patterns involving multiple trees synchronized across multiple urban neighborhoods. These patches appear to migrate across neighborhoods from year to year. Areas of relatively high intensity one year experience relatively low intensity the following year. This study generated spatial distribution models of the leaf miner in the Anchorage area and compared and contrasted spatial distributions across years.

The infestations have received much attention by homeowners, extension agents, and researchers. Thousands of dollars have been spent trying to reduce the insect's impacts. Effective management techniques to mitigate its impacts over landscape scales remain elusive.

The modeling methods developed here enable the numerical analysis of invasive insect populations across large spatial and long temporal scales. The model also projects future insect infestation levels and distributions.

Contact: John Lundquist, jlundquist@fs.fed.us

Partners: Colorado State University; Municipality of Anchorage; University of Alaska-Fairbanks, Cooperative Extension Service



Birch leaf miner infestation.

Chris MacQuarrie, University of Alberta, Bugwood.org



Mountains to Sound Greenway Trust

A volunteer plants a greenway in the Seattle area.

Volunteers Come for Camaraderie, Stay for Ecological Benefits

Thousands of volunteers participate in environmental stewardship projects each year in the Puget Sound region of Washington. These efforts include working in parks, planting

To better attract and retain citizen stewards, it's important to understand the values that motivate participation.

street trees, and restoring riparian areas. Yet little is known about who volunteers and why. This information is important as agencies and organizations increasingly turn to stewardship as an approach to improving landscape health.

Station scientists and collaborators worked with representatives from nine Seattle envi-

ronmental organizations and surveyed volunteers at several environmental stewardship events to explore their experiences with stewardship and generate a big-picture perspective on the rationale behind participating in these activities. They found that people who participate in urban stewardship activities vary in their motivations: personal, social, and community reasons are likely to be as important as their concern for the environment. The work people contribute on behalf of urban natural resources is also an act of social stewardship in caring for one's neighborhood and community.

Contact: Dale Blahna, dblahna@fs.fed.us

Partners: EarthCorps, Forterra, King County, University of Vermont, University of Washington

Tool

Making the Little Things Count: Improvements to the Small-Tree Components of the Forest Vegetation Simulator

Description:

Forest managers have become more focused on the growth of small trees in recent years owing to an increasing interest in developing more complex stands. Scientists revised the model components that predict the growth and survival of small trees in the Forest Vegetation Simulator (FVS) to make model projections more accurate and to better account for management actions such as variable-density thinning. These changes have been incorporated into the variants of FVS that are used for west-side forests in Oregon and Washington.

Use:

The FVS is widely used by forest managers within federal, state, and private organizations. The improved variants allow forest managers to more accurately predict how different actions will affect small trees. The FVS can be used to compare how well small trees fare following treatments such as uniform thinning or treatments that include thinning with "skips" (unthinned areas) and "gaps" (areas where all overstory trees are removed). Managers can also use FVS to evaluate the growth and survival of different species when they are planted in the understory to help promote the development of complex, multiaged stands.

How to get it:

www.fs.fed.us/fmssc/fvs

Contact:

Peter Gould, pgould@fs.fed.us

Partners:

Oregon State University, USDA Forest Service Forest Management Service and Pacific Northwest Region, USDI Bureau of Land Management



Brad St. Clair

Tree breeders are using new information about the influence of neighboring trees and interactions among genotypes on tree growth to further Douglas-fir improvement programs. Above, a study site on Weyerhaeuser land near Mill City, Oregon.

Growth Performance in Tree Improvement Program Depends on Neighbors

Tree improvement programs identify genotypes that are expected to perform well in operational plantings, yet relatively little is known about how the relative performance of genotypes is influenced by the proximity and genotype of neighboring trees. Scientists measured the growth of trees that were a sample of genotypes in a Douglas-fir tree improvement program. The findings indicate that the relative performance of families in Douglas-fir tree improvement programs depends on competition from neighbors as determined by stand density and the specific mixture of genotypes. Diameter growth is affected to a greater degree than height and

crown morphology traits such as crown width and leaf area relative to branch length are important for explaining differences in performance.

Tree breeders are using this information to decide which traits may be important to consider for improving genetic gains in productivity in tree improvement programs. Results are also being incorporated into decisions on traits to include in new growth models for Douglas-fir.

Contact: Brad St. Clair, bstclair@fs.fed.us

Partners: Northwest Tree Improvement Cooperative, Weyerhaeuser NR Company

Citation: Gould, P.J.; St. Clair, J.B.; Anderson, P.D. 2011. Performance of full-sib families of Douglas-fir in pure-family and mixed-family deployments. *Forest Ecology and Management*. 262: 1417–1425.

Landscape Restoration Strategy for Okanogan-Wenatchee National Forest Based on Planning Tool Developed by the PNW Research Station

Okanogan-Wenatchee National Forest managers and station scientists have pooled their resources over the past 15 years to create a restoration strategy and an advanced, customizable landscape evaluation and restoration planning tool. The tool is used to evaluate key changes and restoration needs of modern-day terrestrial landscapes. Analogous aquatic, fish, and road system modules are under development.

The strategy has been implemented across the forest; every ranger district has at least one project underway using these tools, and some have several. Tool development is ongoing and the restoration strategy is under revision to incorporate new science. By evaluating large landscapes, project design and planning related to the National Environmental Policy Act can be done more efficiently and better focus on ecological outcomes and landscape conditions. Work is underway to initiate a new multiownership, multistakeholder project with the Tapash Collaborative Forest Landscape Restoration Program.

Contact: Paul Hessburg, phessburg@fs.fed.us

Partners: USDA Forest Service Fire and Aviation



Sagebrush habitat, home to sage-grouse and many birds and small mammals, is sensitive to disturbances such as oil and gas extraction, communication towers, agricultural uses, and invasive cheatgrass.

Assessment of Wyoming Basins Ecoregion Provides Basis for Managing Sagebrush Ecosystems

Station scientists collaborated with the U.S. Geological Survey and Bureau of Land Management (BLM) in conducting a multiyear ecoregional assessment of habitat threats across

BLM uses information to modify policies on the management of sagebrush ecosystems. the Wyoming Basins Ecoregion. The team relied on protocols previously developed by PNW researchers for the Great Basin ecoregional assessment. The assessment provides new information on distribution, abundance, and habitat relations of many species of concern in the sagebrush ecosystem, focusing on impacts of human disturbance.

The BLM requested this ecoregional assessment for use in managing sagebrush habitats under their jurisdiction within the Wyoming Basins Ecoregion. This area is a stronghold of the sagebrush ecosystem, but threats in this ecosystem are many. Human land uses are associated with declines in habitat quality and quantity for many sagebrush-associated species. Energy development has increased rapidly in this region. The greater sage-grouse, American pronghorn, and sage sparrow are some of the many wildlife species that depend on sagebrush habitats in the Wyoming Basins.

Contact: Mary Rowland, mrowland@fs.fed.us, and Michael Wisdom, mwisdom@fs.fed.us

Partners: USDI Bureau of Land Management and Geological Survey

For more information: sagemap.wr.usgs.gov/wbea.aspx

New Synthesis Examines Role of Carbon and Carbohydrates in Tree Growth During Drought

Models predicting growth of woody vegetation may overestimate growth rates if some of the chemical compounds resulting from photosynthesis are unavailable for growth, especially when plants are water-stressed.

Research on the degree to which carbon availability limits tree growth, as well as recent climate trends and concurrent increases in drought-related tree mortality, have led to a renewed focus on the mechanisms underlying tree growth responses to current and future climates. The synthesis discusses key issues such as the extent to which carbohydrate storage in trees is passive versus active, the extent to which growth is carbon limited, and why trees as long-lived organisms may need large stored carbohydrate pools to cope with environmental stresses. Its publication in *Tree Physiology*, an international scientific journal, is expected to influence and inform future research on environmental impacts on carbon partitioning in trees.

Contacts: Rick Meinzer, rmeinzer@fs.fed.us, and David Woodruff, dwoodruff@fs.fed.us

Partner: University of Montana

Analysis of Ancient Tree Rings Allows Scientists to Reconstruct Past Climate Conditions

Paleoclimate proxies based on the measurement of wood anatomy have rarely been developed across the temperature range of a species or applied to wood predating the most recent millennium. Scientists recently did this, however, by examining variation in xylem vessel anatomy in tree rings of extant and subfossil bur oaks (about 10,000 to 15,000 years old). They used this information as a proxy to reconstruct spring climate conditions. They found that xylem vessel characteristics provided consistent proxies for spring temperature conditions across the current range of bur oak. When these proxies were applied to vessel characteristics in rings of subfossil bur oak, inferences about late Quaternary climate in central North America were consistent with those derived from other climate proxies such as ice cores and pollen records.

These findings are a significant addition to the toolbox of approaches for reconstructing past climates by using tree rings and other proxies. The ability to use variation in characteristics of tree rings to reconstruct past climatic conditions strengthens our ability to predict responses of trees to anticipated future climate regimes.

Contact: Rick Meinzer, fmeinzer@fs.fed.us

Partners: Oregon State University, Southern Oregon University, University of Missouri

A field technician navigates a blowdown.

Novel Techniques Enable Mapping of Old-Growth Forest and Disturbance Over Time

This effort produced estimates of late-successional old-growth forest on all ownerships within the boundaries of the Northwest Forest Plan from a regionally consistent inventory design. Novel statistical mapping techniques were used to map and assess the distribution and trends of late-successional old-growth forest over the monitoring periods 1994 to 2007 in California and 1996 to 2006 in Washington and Oregon.

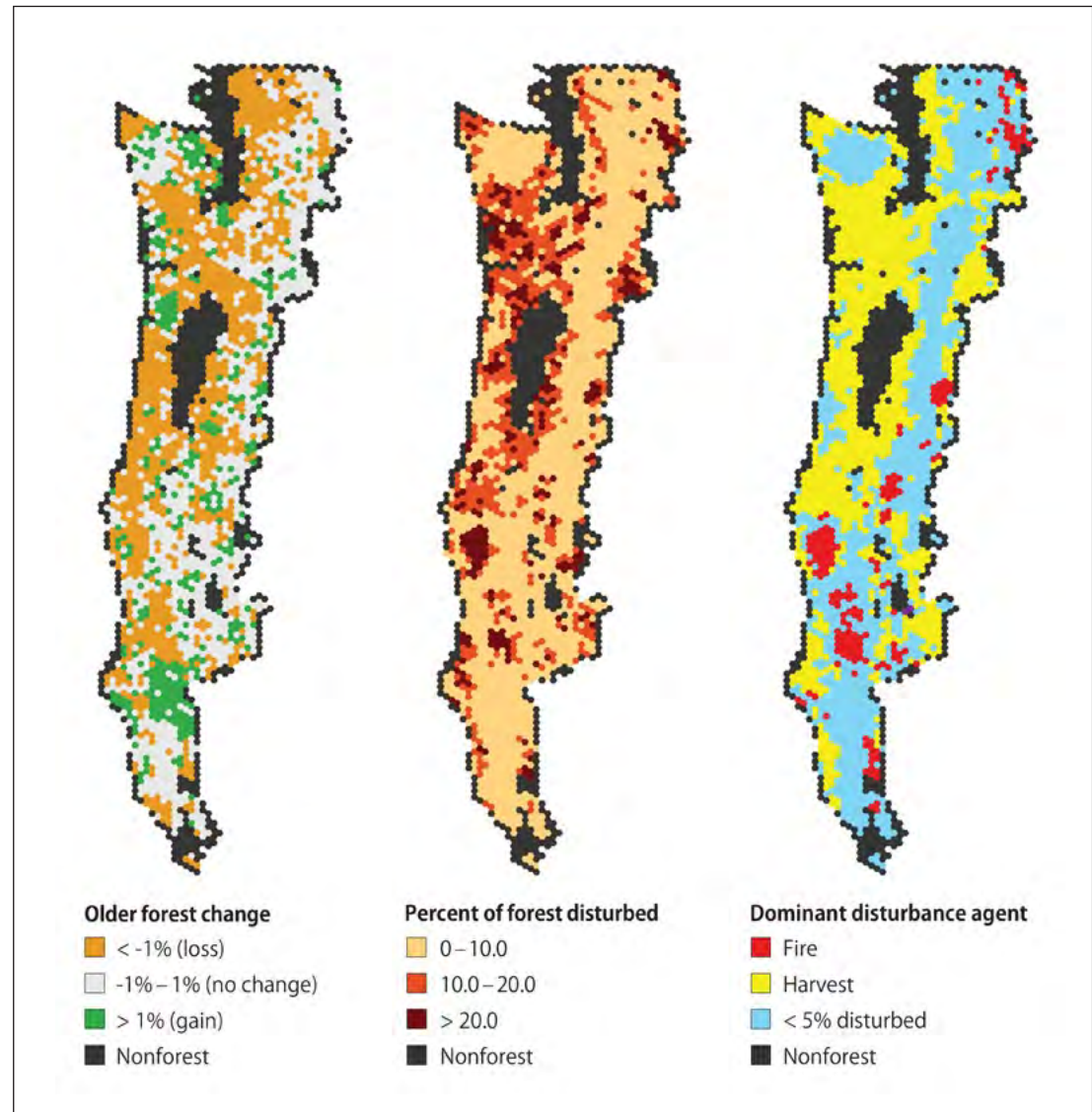
Work helps evaluate the efficacy of the Northwest Forest Plan throughout the region.

consistent inventory design. Novel statistical mapping techniques were used to map

The results support the assumption made in the Northwest Forest Plan that the primary responsibility for maintaining or restoring old-growth forest in the Pacific Northwest would fall to public lands. Federal lands contained less than half of the total forest land, but the federal share of total late-successional old-growth forest increased from 65 to 67 percent over the monitoring period.

Contact: Janet Ohmann, johmann@fs.fed.us

Partner: Oregon State University



The Northwest Forest Plan covers 57 million acres in Washington, Oregon, and California. This map sequence shows change in area of older forest (left) over the 15-year monitoring period, the proportion of forest disturbed (middle), and the predominant cause of disturbance (right).

Encouraging Understory Diversity in Pine Plantations

A management regime that includes pine thinning every 8 to 10 years can be used to sustain a vigorous community of herbaceous species in stands of longleaf pines less than 30 years old. Where dense understories of hardwoods and shrubs have formed, woody control with herbicides will sustain increases in abundance and diversity of herbaceous species for 14 years or more.

This work was conducted on the Savannah River Site, a National Environmental Research Park in the Coastal Plain of South Carolina. Combinations of pine thinning and control of understory hardwoods and shrubs were applied to 8- to 11-year-old plantations of longleaf pine. Both the thinning and woody control treatments were equally successful at promoting herbaceous species during the first 8 years after treatment. The woody control treatment, however, sustained the increases through year 14 because pine thinning stimulated increased abundance of hardwoods and shrubs, which competitively excluded herbaceous species.

Contact: Tim Harrington, tharrington@fs.fed.us

Partners: University of Georgia, USDA Forest Service Savannah River



Field crew on the Savannah River site in South Carolina.

Tim Harrington

Coniferous and Deciduous Tree Species Use Contrasting Strategies to Maintain Hydraulic Function Under Drought Stress

In much the same way that scuba divers can develop dangerous nitrogen bubbles in their bloodstreams, trees can develop air bubbles (called embolisms) in the water-transporting cells of their wood. These air bubbles inhibit water transport, which has several consequences including reduced growth, cell desiccation, and tree death. The likely reversal of embolism development is thought to occur through the conversion and transport of sugars and water from specialized cells (called

parenchyma) into the water-transporting cells (tracheids or vessels); deciduous trees appear to have more of these parenchyma cells than conifers. Conifers, however, can more effectively avoid developing embolisms by shutting down transpiration, which is a water-consuming process that allows trees to photosynthesize. In a sense, deciduous trees appear to be better at repairing embolisms, while conifers appear to be better at avoiding them in the first place.

The research represents a new understanding of the means by which plants cope with drought and the structural and functional tradeoffs that are involved in the different approaches that are used by plants to maximize assimilation while minimizing risk of hydraulic failure. As the future likely brings greater risk of drought, a more complete understanding of the tradeoffs associated with plants' responses to the stress will be crucial for our management of both wild and agricultural lands.

Contact: David Woodruff, dwoodruff@fs.fed.us

Partners: Duke University, Oregon State University

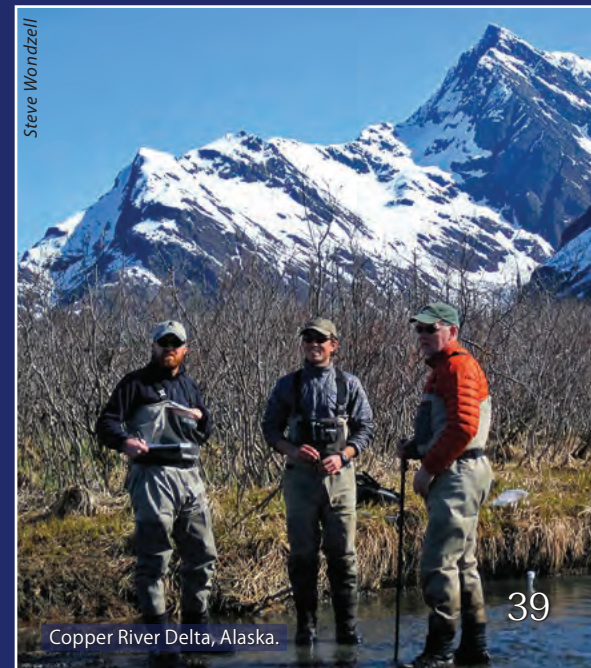
Watersheds, Fish, and Wildlife

Snow-topped mountain to headwater stream, river valley, and estuary: they all are connected by moving water. 🌀 A watershed approach to management requires understanding the connections between terrestrial and aquatic systems in the upper and lower reaches of a drainage. 🌀 Station research is leading to new knowledge about watershed processes. 🌀 Water is a key resource that will be affected by climate change. Droughts, floods, rain instead of snow, rain on top of snow: the effects of these events will ripple throughout the system. 🌀 Understanding how watersheds will respond to these changes is critical for managing habitat for fish and wildlife. 🌀 After a powerful storm led to large debris flows in streams in the Capitol State Forest, scientists began monitoring the recolonization of stream organisms. Their finding that species recover at different rates, coupled with models of hillslope stability, can inform management in areas with unstable soil.



Red fox.

U.S. Fish and Wildlife Service



Steve Wondzell

Copper River Delta, Alaska.

Highlights in 2012

- ▶ A new model demonstrates how nutrients flow from land to streams in coastal temperate rainforests.
- ▶ Streambed substrate in small head-water streams can moderate water temperature.
- ▶ U.S. Fish and Wildlife Service uses procedure for conducting expert panels in decision process to reintroduce threatened bull trout to Clackamas River.
- ▶ *Biology and Conservation of Martens, Sables, and Fishers: A New Synthesis* is published.
- ▶ First wolverine births documented in Washington state since the early 1900s.
- ▶ Red fox are native to eastern United States, not colonial transplants.
- ▶ Toads persist, despite drought, predators, and disease, in the central Oregon Cascades.



The flow of water and nutrients from mountain top to sea is vital to maintaining the rich biodiversity in coastal temperate rainforests. Above, a marsh in the Copper River Delta, Alaska.

Terrestrial Systems Provide Key Nutrients to Streams in Coastal Temperate Rainforests

Scientists developed a soil watershed model to demonstrate how terrestrial chemical export provides nutrient subsidies to streams in the Alaska coastal temperate rainforest. They quantified the flow of water and nutrients from terrestrial ecosystems and identified the associated chemical quality of the constituents in the water. The rich material produced and exported from soils was

rapidly transported from soils to streams along flowpaths that traverse the entire breadth of the landscape.

The flow of water and nutrients is a key component in maintaining the rich biodiversity of terrestrial and aquatic resources such as trees and salmon. This flow is now recognized as an important ecosystem function that varies across the hydrologic gradient of ecosystems in the Alaska coastal temperate rainforest.

Contact: David D'Amore, ddamore@fs.fed.us

Partner: University of Alaska Southeast

Delineating Riparian Zones in Alaska's Coastal Temperate Rainforest Requires Broader Perspective

Conventional ways of defining and delineating riparian areas and management do not incorporate the intense biogeochemical interactions between marine, freshwater, and terrestrial ecosystems present within the Alaska's coastal temperate rainforest. In these forests with extensive wetlands and saturated soils, the riparian zone functions as an interface between terrestrial and marine systems. Effective management of this area requires a perspective broader than that normally used. Potential climate change impacts on riparian function within the Tongass National Forest, for example, exceed the effects of active management.

This perspective has been used by the USGS Landscape Conservation Cooperative in setting the research agenda. This information is expected to be used by nongovernmental agencies, local and regional governments, and federal agencies to help set research and policy agendas to deal with changes in riparian function related to climate change in southeast Alaska.

Contact: Rick Edwards, rtedwards@fs.fed.us

Partners: Audubon Society, University of Washington





Steve Wondzell

Sensors in a streambed measure water temperature.

Streambed Influences Water Temperature in Small Headwater Streams

Very small headwater streams may be fundamentally different than many larger streams because factors other than shade from the overstory tree canopy can moderate stream temperatures, even following complete removal of the overstory canopy.

Researchers found that maximum daily temperatures of small headwater streams had variable sensitivity to forest harvest. Some streams warmed by several degrees after clearcut harvesting, both with and without riparian buffers. In other streams, the thermal regime did not change, regardless of the harvest treatment. Thermal sensitivity appeared to be broadly determined by substrate, with

coarser streambeds likely facilitating hyporheic exchange and thereby limiting thermal sensitivity. Among streams with finer textured streambeds, the exposed surface area of water appears to determine the magnitude of thermal response.

This study was designed to inform decisions on forest practices rules for small headwater streams in Washington state. It is also one of several recent studies contributing information to a joint science review of riparian forest management by the U.S. Forest Service and National Oceanographic and Atmospheric Administration Fisheries Service.

Contact: Steve Wondzell, swondzell@fs.fed.us

Partners: Washington Department of Ecology, Washington Department of Natural Resources

Stream Junctions Provide Cool Habitat for Fish

Cooler water temperatures at the junction of headwater streams and lakes benefit fish using near-shore habitats by decreasing need for foraging and lowering the risk of predation.

Station scientists examined small, fishless headwater streams to determine if transported macroinvertebrates augmented the food availability for sculpins (*Cottus asper*) of the near-shore lake habitats into which they flowed. Although streams did not appear to contribute to the composition or abundance of macroinvertebrates, the sculpin showed a slight preference for stream junctions. Juvenile sculpins responded to cooler temperatures at stream junctions and to predation risk from larger adults. These findings suggest that headwater streams can contribute to the downstream ecology indirectly by making it easier for foraging species to find food, thus reducing exposure to predation risk.

Contact: Karl Polivka, kpolivka@fs.fed.us

Partners: Cascadia Conservation District, University of Alaska-Fairbanks

Aquatic Organisms Recolonize Streams at Different Rates After Major Debris Flows in Western Washington

A powerful storm in December 2007 resulted in large debris flows in two streams in the Capitol State Forest in western Washington. These streams had several years of prestorm data, providing a rare opportunity to examine the recovery of aquatic habitats in headwater channels and their subsequent recolonization by trout and other aquatic species. Distinct patterns of recolonization among species were evident from 2008 to 2011. Cutthroat trout returned to all previously inhabited stream reaches, and their abundance in debris flow-affected channels after 4 years exceeded predisturbance levels. Tailed-frog tadpoles rebounded to predebris flow levels, but crayfish have been slow to recover.

Recolonization by sculpins varied among sites, and western brook lamprey present before the disturbance have not yet returned. The removal of migration barriers such as logjams and waterfalls by the debris flows may have increased the upstream extent of fish distribution from predisturbance locations.

These findings coupled with models of hillslope stability may help to explain species distribution patterns and influence management actions in areas with unstable soils. The findings can also be used to inform decision-makers about potential risks of land management decisions in areas with at-risk species.

Contact: Alex Foster, alexfofster@fs.fed.us, and Pete Bisson, pbisson@fs.fed.us

Partners: Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Wild Fish Conservancy

After the Dam: Lessons From the Sandy River, Oregon

Over the past decade, the number and size of dams removed on rivers across the United States have been increasing. Dam removal typically involves release of at least some of the sediment stored in the reservoir behind the former dam. As released sediment moves downstream, it has the potential to dramatically change the form and behavior of the downstream channel. Nowhere has this been more closely studied than on the Sandy River, outside Portland, Oregon, following the removal of Marmot Dam in 2007. At the time, its removal produced the largest intentional release of sediment from any dam removal in history.

A new report describes how the Sandy River responded to the release of sediment over the next 2 years. Key findings include (1) an energetic river can rapidly incise and remove large volumes of unconsolidated stored sediment, even under very modest flows; (2) channel



Alex Foster

Cutthroat trout returned to previous habitat and were more abundant than before a major debris flow 4 years prior in the Capitol State Forest, Washington.



Gordon Grant

Scientists have studied the fate of sediment released by the 2007 Marmot Dam removal on the Sandy River in Oregon. Allowing a river to naturally process the sediment is a viable option when it doesn't pose a flood risk downstream.

change is initially quite rapid but diminishes over time as sediment sources diminish; and (3) allowing rivers to naturally process stored sediment rather than manually removing it before dam removal may be a tractable option for coarse, clean sediment in cases where sediment deposition will not create a flood risk downstream.

Contact: Gordon Grant, ggrant@fs.fed.us

Partners: Graham Matthews and Associates, Johns Hopkins University, U.S. Geological Survey

For more information: Major, J.J.; O'Connor, J.E.; Podolak, C.J.; Keith, M.K.; Grant, G.E. [et al.]. 2012. Geomorphic response of the Sandy River, Oregon, to removal of Marmot Dam. Professional Paper 1792. Reston, VA: U.S. Department of the Interior, Geological Survey. 64 p. pubs.usgs.gov/pp/1792/pp1792_text.pdf.

A Rigorous Procedure for Holding Expert Panels

Over the years, dozens of expert panels have been held by the Forest Service and partners on a variety of local and regional environmental projects. Elicitation of expert knowledge in

Panel procedure used to help reintroduce bull trout to Oregon's Clackamas River.

panel settings is often used to fill in major data gaps and provide management recommendations. Prior

to this effort, no consistent procedure existed for ensuring scientific credibility and rigor. This project provides a general framework and specific methods usable for any such expert paneling task.

The U.S. Fish and Wildlife Service used this step-by-step procedure for eliciting knowledge and judgment from a panel of experts in the decisionmaking process to reintroduce the threatened bull trout to the Clackamas River, Oregon.

Contact: Bruce Marcot, bmarcot@fs.fed.us

Partners: U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office

For more information: Marcot, B.G.; Allen, C.; Morey, S.; Shively, D.; White, R. 2012. An expert panel approach to assessing potential effects of bull trout reintroduction on federally listed salmonids in the Clackamas River, Oregon. *North American Journal of Fisheries Management*. 32(3): 450–465.

Toads Tough it Out in Central Oregon Cascade Range

Toads persist at study sites in the Oregon Cascades despite documented episodic losses from water mold, raven predation, drought years, overexploitation by recreationists, and suspected infection with chytridiomycosis.

In 1990, a global alert reported unexplained declines of amphibian populations. This alert resulted in research that continues today on the effects on amphibians of habitat alteration, invasive species, UV-b radiation, chemical contaminants, climate change, and disease.

Research on amphibians in the Oregon Cascade Range began in 1982 and was continued in response to the 1990 alert. Few long-term amphibian monitoring efforts span three decades. Research on western toads (*Anaxyrus boreas*) and sympatric frogs and salamanders from sites monitored since 1982 has contributed to a better understanding of the roles of disease, UV-b radiation, climate change, and interspecies interactions in amphibian population dynamics, and has led to multiple research syntheses that continue to inform the science and management communities.

Contact: Dede Olson, dedeolson@fs.fed.us

Partner: Oregon State University



Dede Olson

2012 marked the 30th year of toad monitoring in the central Oregon Cascade Range.

Snag Sampling Method for Riparian Monitoring Tested

Many young Douglas-fir forests in western Oregon and Washington are being managed to restore riparian ecosystem function by increasing variability in species composition and spacing among trees, and providing standing dead trees, or “snags,” as habitat for a variety of organisms. Sampling is typically used to quantify forest structural characteristics, and the accuracy of any sampling method depends on the characteristic being quantified. Prior research identified sampling designs that were most effective in quantifying the dominant conifer component of riparian forest structure. However, when these same sampling designs were evaluated with respect to characterizing the infrequent hardwood tree or snag component, scientists found that the accuracy and precision of estimates generally decreased. The fundamental elements of the sampling design, however, were still the best option relative to other common sampling configurations.

These findings are being used in the design of monitoring schemes for research assessing alternative riparian forest management strategies and have a larger applicability to operational monitoring by a variety of entities engaged in riparian forest management.

Contact: Paul Anderson, pdanderson@fs.fed.us

Partners: Oregon State University, USDI Bureau of Land Management

Conserving Martens, Sables, and Fishers: A Synthesis of Knowledge

Throughout North America, Europe, and Asia, all nine species of martens, sables, and fishers face significant conservation and management challenges, many of which are growing increasingly urgent. These semi-arboreal forest carnivores contribute to the functioning of healthy ecosystems (especially as predators), serve as indicators of structurally complex habitats, and provide economic benefits as furbearers.

The conservation of their populations will depend largely on the application of scientifically sound and practical programs for habitat and population management and public education. To facilitate the development of such

programs, 62 biologists from around the world synthesized the current state of knowledge on the genus *Martes* to provide a reliable basis for organizing interdisciplinary knowledge and identifying key elements to communicate to wildlife biologists, resource managers, and policymakers. This book provides the first comprehensive synthesis of knowledge about these species in almost 20 years.

Contact: Keith Aubry, kaubry@fs.fed.us

Partners: Alpha Wildlife Research and Management Ltd., University of Wyoming, USDA Forest Service Pacific Southwest Research Station

For more information: Aubry, K.B.; Zielinski, W.J.; Raphael, M.G.; Proulx, G.; Buskirk, S.W., eds. 2012. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, NY: Cornell University Press. 580 p.



Pine marten.

Michael Mengak, University of Georgia. Bugwood.org



Keith Aubry

In spring 2012, researchers located a reproductive den where wolverine kits are born and raised. This was the first documented evidence of wolverine reproduction along the West Coast.

First Documentation of Wolverine Reproduction in Washington State

In April 2012, the North Cascades Wolverine Study located the reproductive dens (where young are born and raised until weaning) of two radio-collared female wolverines, one in North Cascades National Park and another in the Okanogan-Wenatchee National Forest in Washington state. This is the first documented evidence of wolverine reproduction anywhere in the contiguous United States.

Since the North Cascades Wolverine Study began in 2006, station researchers have documented movements and habitat use by 10

adult and subadult wolverines; confirmed the existence of a resident population in the North Cascades of Washington and southern British Columbia; and determined that Washington wolverines are genetically distinct from those in the U.S. Rocky Mountains and are likely connected to populations in the Coast Range of British Columbia.

The U.S. Fish and Wildlife Service is using these findings to inform the federal listing process for wolverine populations in the contiguous United States. The Okanogan-Wenatchee National Forest is using the findings to inform land management and

conservation decisions, including selection of high-elevation forest ecosystems for restoration under the National Forest Foundation's Treasured Landscapes campaign.

Contacts: Keith Aubry, kaubry@fs.fed.us, Cathy Raley, craley@fs.fed.us

Partners: British Columbia Ministry of Environment; Seattle City Light; Seattle Foundation/Tom and Sonya Campion Fund; The Wolverine Foundation; USDA Forest Service and USDI Bureau of Land Management Interagency Special Status/Sensitive Species Program; USDA Forest Service National Carnivore Program; Okanogan-Wenatchee National Forest; U.S. Fish and Wildlife Service; Washington Department of Fish and Wildlife

Red Fox Is Native to Eastern United States

The red fox of the eastern United States is native and did not result from the translocation of European red foxes to North America during the Colonial era. Researchers found no evidence of European genotypes anywhere in North America. This disproves long-standing assumptions that red foxes were introduced to the eastern United States from Europe during the early 1800s and subsequently expanded their range westward.

This finding indicates that management and conservation actions for the eastern red fox should be based on the assumption that it is a member of the native fauna and not an exotic species.

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

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

Citation: Statham, M.J.; Sacks, B.N.; Aubry, K.B.; Perrine, J.D.; Wisely, S.M. 2012. The origin of recently established red fox populations in the United States: translocations or natural range expansions? *Journal of Mammalogy*. 93: 52–65.



Red fox.

U.S. Fish and Wildlife Service



National Elk Refuge, Jackson Hole, Wyoming.

U.S. Fish and Wildlife Service

Nonnative Grass Found at Winter Feedground, But Effects Are Localized

Elk are fed hay in winter at about 37 locations in the western United States. The feeding compensates for losses in overwintering habitat and helps reduce damage to agricultural lands. Elk feeding can increase elk survival as well as viewing and hunting opportunities, and it can prevent vehicle-elk collisions by improving control of elk migrations.

Researchers studied a feedground in western Wyoming that was established in 1981–1982 and fed between 700 and 1,000 elk. Permanent vegetation transects were established and read in 1981 and read again in 2006. They found

that supplemental feeding reduced forbs and shrubs and fostered the invasion of a nonnative grass that was part of the hay fed to elk. These effects appeared to extend only short distances beyond the feedground.

These findings suggest it is good practice to avoid using feed with nonnative species capable of invasion. Researchers did not find naturalized populations of alfalfa and orchardgrass, the other hay species in the study, suggesting that these species are good options for feeding.

Contacts: Marty Vavra, martinvavra@fs.fed.us, and Catherine G. Parks, cparks01@fs.fed.us

Partners: Fort Keogh Range Livestock Research Center, USDA Agricultural Research Service; Wyoming Department of Game and Fish

Wood and Biomass

From the first campfire to electricity-generating biomass facilities, wood fires have warmed us and our homes for thousands of years. ♪ Because it is local, renewable, and plentiful, wood continues to be a valuable source of energy and income for many communities in Alaska and the rural West. ♪ Station scientists are identifying opportunities where wood is a feasible choice for energy or building materials. ♪ For example, they tested western hemlock, a plentiful species in southeast Alaska, and found that hemlock fuel pellets meet the national standard for home heating. This information was shared with three private-sector investor groups looking to purchase pelleting equipment or preparing business plans to build pellet facilities in southeast Alaska. ♪ Trees are valued as an inherent part of many cultures, such as the koa tree in Hawaii. Old-growth koa is now rare, but recent studies demonstrating the usability of young koa wood help extend the cultural legacy of the species.



Pringle Falls Experimental Forest, Oregon.



Koa wood projects, University of Hawaii.

Highlights in 2012

- ▶ About 1.3 to 1.7 million cords of wood per year would be needed if all residential and commercial buildings in Alaska converted from oil heating systems to renewable wood energy.
- ▶ Some of that renewable wood energy could come from fuel pellets made of western hemlock. Researchers determined that western hemlock pellets comply with national performance standards for residential wood heaters.
- ▶ A new screening tool helps Forest Service biomass coordinators assess the feasibility of proposed wood-to-energy projects.



USDA Forest Service

A residential woodpile.

Heating With Wood in Alaska

Finding new markets for bioenergy is an important component of the Forest Service's objectives to sustain healthy forests and address climate change. A recent study

Converting oil heating systems in residential and commercial buildings in Alaska to renewable wood energy would require 1.3 to 1.7 million cords of wood per year.

addressed the information needs of forest managers, entrepreneurs, and civic officials interested in using

various forms of local biomass as sources of energy. Given the high transportation costs of

importing products to Alaska, local markets are an important part of any business plan to produce energy products. The total volume required to convert oil or other liquid fuels used by the Alaska residential and commercial sectors to renewable wood energy is equivalent to the amount of wood needed to supply raw material to one large pulp mill annually. The economic incentive to convert to solid wood fuel exists at any heating oil price above \$3.00 a gallon.

Contact: Allen Brackley, abrackley@fs.fed.us

Partners: Fairbanks Economic Development Corporation, University of Alaska-Fairbanks

Western Hemlock Has Potential as Local Fuel Source

In southeast Alaska, the communities of Craig and Tok, native corporation Sealaska, the U.S. Coast Guard, and U.S. Forest Service successfully converted from heating with fuel oil to using renewable wood energy. Wood pellets are a preferred fuel type, and the demand for wood pellets is stimulating an interest among local business to use products from local materials. Western hemlock is the most common local softwood tree, but no information was available about using it in pellet production. To fill

this void, station scientists conducted a study and determined that western hemlock pellets meet the Pellet Fuel Institute standard for wood heaters used in residential construction.

Three private sector investor groups are purchasing pelleting equipment or preparing business plans to build facilities in southeast Alaska. These groups have been supplied with this information, which reduced their investment risk. It is a resource for firms throughout the geographic range of western hemlock.

Contact: Allen Brackley, abrackley@fs.fed.us

Partner: Juneau Economic Development Council

Updated Summary of Fuel Wood Values for Pacific Northwest Trees

Energy values for tree species that grow in the Pacific Northwest are essential to engineers designing any project involving the conversion to renewable energy systems. In particular, engineers need British thermal unit (BTU) values, the standard measure of energy used in the United States to evaluate the potential of fuel. Given the current interest in biofuels and wood-based heating systems, station scientists updated a report first published in 1987 by Oregon State University. The updated report provides fuel wood values, as well as formulas for converting and moisture content to BTU values. Thirty-four conifer and 20 hardwood species are included in the report, along with their fuel wood characteristics, such as specific gravity of wood and bark, percentage moisture content, and higher heating value of wood and bark.

Contact: Allen Brackley, abrackley@fs.fed.us

Partners: Juneau Economic Development Council, Oregon State University, Weyerhaeuser Company

For more information: Wilson, P.L.; Funck, J.W.; Avery, R.B. 2010. Fuelwood characteristics of northwestern conifers and hardwood (updated). In: Parrent, D.J.; Funck, J.W.; Reeb, J.; Brackley, A.M., eds. Gen. Tech. Rep. PNW-GTR-810. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.



Allen Brackley

Fuel pellets made from species native to Alaska.

New Tool Helps Evaluate Feasibility of Proposed Biomass Projects

Forest Service staff often are asked for information by biomass project developers interested in developing biomass utilization projects near national forests. Agency staff also are often asked to help the developer obtain grant or loan funding from federal agencies for the proposed development. Meeting these requests can require significant staff time and resources, and many of the requests for information and support are for projects that are unrealistic and ultimately fail. As a result, much effort and resources are wasted. This screening tool allows users to quickly assess the feasibility of proposed wood-to-energy projects and rank those that pass the initial screening.

Contact: Jamie Barbour, jbarbour01@fs.fed.us

Partner: Beck-Carlson Biomass Energy Consultants



A woody biomass power generating facility in northern California.

Fueling a 10-Megawatt Biomass Facility Would Require Coordinated Efforts in Central Washington

With thousands of forested acres in central Washington in need of treatment to reduce fire risk, landowners are looking for ways to offset treatment costs. One idea is to use the woody byproducts from thinning treatments to generate electricity. A study through the Integrated Landscape Assessment Project determined that no single ownership in the central Washington landscape could generate enough biomass to supply a hypothetical 10-megawatt biomass facility. A 10-megawatt biomass facility could meet the energy needs of 9,000 to 11,000 households.

By working together on restoration treatments, state, tribal, federal, and private landowners might be able to generate a sustainable biomass supply for at least the next 50 years.

Contact: Jamie Barbour, jbarbour01@fs.fed.us

Partners: Arizona Department of Game and Fish; Arizona Division of Forestry; Conservation Biology Institute; Ecosystem Management, Inc.; Firescape Group; Oregon Department of Forestry; Oregon State University; The Nature Conservancy; The Tapash Collaborative; University of New Mexico; University of Washington; USDA Forest Service Rocky Mountain Research Station, Pacific Northwest Region, and Southwestern Region; Washington Department of Natural Resources

Forty Minutes to the Mill

To offset fuel treatment costs, the Forest Service is considering using woody debris removed during the treatments to generate electricity at biomass facilities. Station scientists

Proximity to sawmills and biomass facilities influences the location and extent of wildfire risk reduction treatments that incorporate biomass utilization.

tists found that ranger districts relatively close to sawmills or biomass facilities treated more forest

land than ranger districts farther away. The threshold distance for this shift is 40 minutes of driving time.

This information supports policy strategies that support a network of wood-processing facilities distributed across forest-based communities, and confirm that transportation costs are a financial constraint on the ability to harness market forces in wildfire fuel reduction treatments.

Contact: Susan Charnley, scharnley@fs.fed.us

Value-Added Potential for Ponderosa Pine Chips

Hot water extraction converts ponderosa pine chips into components that can be processed into value-added biofuels or bioplastics.

Forests across the West are crowded with small trees, putting them at risk from fire, disease, and insect outbreaks. Small trees are expensive to remove, so land managers need ways to turn this woody biomass into products with economic value.

One potential method uses hot water extraction to chemically convert low-value woody biomass into commercially useful compounds.

In this study, small-diameter ponderosa pines removed during a fuel reduction treatment underwent hot water extraction and yielded components that can be

further processed into biofuels or bioplastics. These results establish the potential to maximize the benefits of woody biomass, a renewable resource, while also providing options for improving the feasibility of fuel reduction treatments.

Contact: Eini Lowell, elowell@fs.fed.us

Partners: State University of New York College of Environmental Science and Forestry, USDA Forest Service Deschutes National Forest, Washington State University



The dark chips have undergone hot water extraction; they are then ground and ready to be further processed into bioplastics.



Koa tree.

© Steven J. Baskauf

Finding Value in Young-Growth Koa Wood

Koa wood (*Acacia koa*) is a culturally important and economically valuable species in the Hawaiian Islands. It is used for a range of products from flooring to ukuleles. Old-growth koa, used for manufacture of

A demonstration project informs Hawaiian forest industry about quality characteristics and utilization opportunities for young-growth *Acacia koa*.

traditional Hawaiian wood products, is dwindling in supply, with limited amounts

available in the coming years. Thousands of acres of young (less than 30 years old) koa stands have naturally regenerated after logging and other disturbances. Little data is available for these second-growth koa stands. Active management in these stands will make available small-diameter young-growth trees within the next 5 years.

Two studies evaluated quality and attributes of both dead and dying old-growth koa and young-growth koa. Young-growth trees were sawn into lumber and the lumber is being used by woodworkers to demonstrate its quality characteristics in a number of different products. These studies extend the legacy of *Acacia*



Eni Lowell

The koa tree is valued in Hawaiian culture. Above, bowls made of young koa wood are displayed.

koa by demonstrating properties of this wood and promoting its utilization. The manufacture of traditional products for display and use in public institutions and cultural resource centers has allowed a broader public to register their opinions on the quality and value potential of wood from younger koa trees.

Contact: Eni Lowell, elowell@fs.fed.us

Partners: Hawaii Department of Hawaiian Home Lands, Hawaii Forest Industry Association, Kamehameha Schools, Parker Ranch, USDA Forest Service Northern Research Station and Pacific Southwest Research Station, University of Hawaii at Manoa

Experimental Forests and Ranges

Highlights From H.J. Andrews and Starkey

H.J. Andrews Experimental Forest

Established in 1948, the H.J. Andrews Experimental Forest near Blue River, Oregon, is home to extensive research on watershed processes, forest ecology and management, biological diversity, and carbon and nitrogen dynamics. 🌀 Studies here have led to new management approaches and informed policy decisions regarding northwest forests, riparian zones, road systems, dead wood, and species conservation. 🌀 For 60 years, continuous streamflow measurements have been collected in three watersheds within the forest. Stream gaging stations were initially established to study the effects of timber harvesting on water quantity. Since then, data have been used

for a wide variety of studies—most recently to learn how carbon and other nutrients cycle through the stream system. 🌀 In 2012, a wireless system was installed to stream real-time data and images from remote sites to the Web. This “cyber infrastructure” has facilitated the remote installation of acoustic profilers to study airflow and cold air drainage dynamics at unprecedented resolution, and development of a phenocam network to integrate satellite imagery with ground-based observations on the effects of climate on budding and flowering of trees and plants. 🌀 All major climate and stream monitoring stations will be connected to the new wireless network in 2013.



H.J. Andrews landscape.



Researchers prepare a hydrologic tracer as part of a whole-stream metabolism study.

Highlights in 2012

- ▶ H.J. Andrews becomes a “smart forest” with a wireless system that transmits real-time data and images from remote sites.
- ▶ Long-term data from H.J. Andrews are highlighted in five articles of *Bioscience*.
- ▶ Amount of carbon stored in old-growth forest varies across landscape.

Carbon Stores in Old-Growth Forest Influenced by Diversity of Vegetation, Structure, and Local Conditions

Forest ecosystems store vast amounts of carbon and mitigate human-caused climate change by acting as a large and persistent sink for atmospheric carbon dioxide. Yet forest carbon density varies greatly, globally, and at stand and landscape levels. Understanding the controls on carbon storage in forests will better enable forest managers to design effective mitigation strategies that both store more carbon and meet other management goals.

At the H.J. Andrews Experimental Forest in the western Cascade Range, Forest Service and university researchers used airborne light

A “Smart Forest.” The installation of a wireless system allows real-time data and images from remote forest and stream sites to be transmitted to the Web.

detection and ranging (LiDAR) and a novel high-resolution simulation model of landscape dynamics (iLand) to identify the drivers of variation in carbon density for an old-growth forest landscape. The scientists found that stand-level carbon was highly variable across the old-growth part of the landscape. About 55 percent of this variation in carbon was explained by environmental drivers such as radiation, soil, temperature, and precipitation. The remaining variation in carbon was largely attributable to diversity in species composition and structure, documenting a close link between biodiversity and ecosystem functioning. The findings suggest that maintaining species and structural diversity in stands will contribute to sustaining high levels of carbon in the forest.

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

Partners: Oregon State University; University of Natural Resources and Life Sciences (Austria)

Centuries-Old Trees Increase Growth Rate in Response to More Light and Moisture

Openings or gaps in the forest canopy created by tree mortality lead to the diverse structure and composition of species of mature forests. The change in light, available nutrients, and moisture influence the type of vegetation that becomes established and the rate of growth. The fate of surrounding trees determines

whether gaps increase in size, how much shading and root encroachment occurs, and how quickly gaps become occupied by recovering

Study yields clues about how forest growth and mortality might change in response to future disturbances and climate change.

vegetation.

Scientists designed a study to determine the effect of canopy gap size on mortal-

ity and growth on surrounding trees over a 16-year period in mature (90 and 145 years old) and old-growth (350 to 525 years old) Douglas-fir-dominated forests in the Cascade Mountains. The study sites were located in the H.J. Andrews Experimental Forest and Wind River Experimental Forest.

They found that diameter growth rates of trees were greater next to gaps than in controls. Growth patterns with respect to sun exposure suggested that trees in mature stands responded uniformly to increased soil moisture in gaps, while trees in old-growth stands had positive and negative responses to increased solar radiation depending on crown class and position around gaps. Results suggest that canopy gaps can create heterogeneity of ecosystem function through spatial variation in effects on growth and mortality across mature and old-growth stands. The results can be used to validate computer models that simulate forest growth and succession.

Contact: Andrew Gray, agray01@fs.fed.us

Partner: Oregon State University

Rhonda Mazza



A field technician measures tree diameter at H.J. Andrews.

Stream and Air Temperatures Aren't Necessarily Synchronized

Recent warming of terrestrial climate in most parts of the world has motivated concern about corresponding increases in water temperature. Researchers found that streams across western North America with high human impacts showed a mix in temperature trends over time, while reference sites included a significant number with cooling trends in the last two to three decades. This lack of coherence between air and stream temperature in recent decades may be related to microclimate dynamics under forest canopies as well as complex interactions among climatic variables.

Researchers also observed shifts in timing of summer stream temperature in relation to timing of low summer streamflow—both of which can be periods of stress for instream biota. Increased synchrony of these extreme events caused by climate change could magnify impacts over single stressors. These findings of trends and lack of trends are informing basic science and climate researchers as well as state and federal resource managers and the public.

Contact: Sherri Johnson, sherrijohnson@fs.fed.us

Partners: U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Oregon State University

Tours and Workshops

Experimental forests bring people together; they are hotspots for collaborative learning among researchers from different agencies and universities. The learning opportunities extend to students of all ages. In 2012, more than 1,500 people from 40 countries participated in tours, workshops, and symposia at H.J. Andrews Experimental Forest. A few of these events follow.



Visitors gather at H.J. Andrews Experimental Forest for an annual HJA Day.

Blue River Environmental Philosophers Gathering: This biannual gathering of philosophers and writers from the Pacific Northwest is an important event that helps build the humanities program at H.J. Andrews.

HJA Day: More than 140 scientists, students, federal, state, and utility managers, and general public attended this event to learn about current research activities

Long-Term Ecological Research (LTER)

Events: H.J. Andrews is also part of the national LTER network. It hosted several workshops and meetings that brought together scientists from around the country to discuss topics such as quantifying uncertainty in long-term climate and stream records.

Research Camp for Natural Resources

Students: This program through Lewis & Clark College provided mentorship for high school students interested in careers in natural resources. The 3-day research camp provided hands-on research training with H.J. Andrews graduate students and researchers.

Starkey Experimental Forest and Range

Established in 1940, the Starkey Experimental Forest and Range is a unique research facility in the Blue Mountains of eastern Oregon. It is the Nation's primary field location for scientific study of the effects of deer, elk, and cattle on ecosystems. 🌀 A game-proof fence surrounds most of the 28,000 acres of grasslands and rolling uplands forested with ponderosa pine, Douglas-fir, grand-fir, and western larch. For the past 23 years, the movements of resident elk, deer, and cattle have been tracked electronically. 🌀 The research at Starkey is designed to answer questions posed by state, federal, and tribal land managers. For example, findings from two decades of elk-related studies conducted at Starkey are being used by state wildlife agencies in the western United States to modify policies on elk hunting to better accomplish elk management objectives. 🌀 These policy changes have substantially altered the design and implementation of elk hunting seasons on both public and private lands in all states where elk are hunted.



Starkey landscape near La Grande, Oregon.

Frank Vanni



Rachel Cook

Elk cow and calf.

Highlights in 2012

- ▶ Rocky Mountain Elk Foundation honors station with national research award for long-term research.
- ▶ Key partners and clients pledge renewed support for Starkey research.
- ▶ The presence of archery hunters affects pregnancy rates and conception dates of female elk.
- ▶ Changing the point of entry to a pasture can help reduce overgrazing by cattle.
- ▶ Ungulate preference for deciduous vegetation may increase fire risk.

Move the Gate to Help Reduce Overgrazing

Livestock grazing is often highly uneven across a pasture. Some areas can be grazed to unsustainable levels while other areas are grazed very little. Researchers hypothesized that moving the entry point to a pasture would change livestock distributions and relieve areas of overgrazing. They identified the 10 most heavily used 4-hectare locations in a study pasture in the Starkey Experimental Forest and Range and fitted cattle with global positioning system collars. Over the next 18 years, cattle alternately entered the pasture from one side or the other.

Researchers found that altering the stocking location greatly reduced grazing of overused regions. Cattle spent 12 percent more time on the 10 locations when they entered from one side of the pasture compared to when they entered from the other side. This study identifies a relatively simple and inexpensive way to address a central challenge in grazing land management.

Contact: Marty Vavra, martinvavra@fs.fed.us

Partners: Eastern Oregon Agricultural Research Center, Fort Keogh Range Livestock Research Center, Oregon State University, USDA Agricultural Research Service



Changing the entry point can be an inexpensive way to reduce overgrazing in certain areas of a pasture.

Gary Kramer, Natural Resources Conservation Service

Presence of Archery Hunters Affects Pregnancy Rates and Conception Dates of Female Elk

Archery hunting in Oregon has increased dramatically over the past two decades. At the same time, the productivity of elk populations has been declining. This has raised concern that archery seasons may be disrupting elk breeding and contributing to the decline in population productivity.

Researchers varied the number of archery hunters at the Starkey Experimental Forest and Range over 13 years to evaluate effects of archer density on reproduction of elk. They found that pregnancy rates in female elk declined with increasing archer density. Conception dates in females also were 4 days later during hunts with high archer density compared to low archer density. Pregnancy rates for 28 percent of the lactating female elk were reduced by high archer density, whereas archer densities had no significant effect on pregnancy rates for nonlactating females. These results suggest that high archer density and its interaction with nutritional condition of elk can reduce pregnancy rates of lactating females with low kidney fat.

Contact: Michael Wisdom, mwisdom@fs.fed.us

Partner: Oregon Department of Fish and Wildlife

Citation: Davidson, G.A.; Johnson, B.K.; Noyes, J.H.; Dick, B.L.; Wisdom, M.J. 2012. Effect of archer density on elk pregnancy rates and conception dates. *Journal of Wildlife Management*. DOI: 10.1002/jwmg.411.



USDA Agricultural Research Service

Cattle and other ungulates prefer deciduous vegetation, passing over unpalatable conifers, which may then serve as ladder fuels.

Ungulate Preference for Deciduous Vegetation May Increase Fire Risk

The grazing and foraging preferences of free-ranging cattle, elk, mule deer, and other ungulates can dramatically affect vegetation dynamics. In forests of western North America, intensive herbivory by ungulates may substantially reduce or eliminate deciduous species such as aspen, cottonwood, and willow. This may lead to greater establishment of unpalatable conifers that serve as ladder fuels for stand-replacing fires. The resulting fuel loads often require fuel reduction treatments to mitigate fire risk. In turn, the fuel treatments may facilitate additional recruitment of deciduous species and additional herbivory pressure.

Working on the Starkey Experimental Forest and Range, researchers found that in study areas where ungulates were excluded after fuel reduction treatments—mechanical thinning followed by prescribed fire—densities of

aspen, cottonwood, and willow were more than four times greater compared to treated areas open to ungulates.

The amount of increase by deciduous species was surprising because aspen, cottonwood, and willow are not generally considered common understory species of dry inland coniferous forests. This study indicates that recruitment and long-term survival of aspen, cottonwood, and willow in coniferous forests of western North America requires a combination of episodic disturbances such as silviculture treatments and fire, followed by reductions in ungulate grazing pressure between these disturbances to facilitate plant establishment, growth, and survival.

Contact: Michael Wisdom, mwisdom@fs.fed.us

Partners: Global Conservation Program, Oregon State University Eastern Oregon Agricultural Research Center, National Council for Air and Stream Improvement, San Diego Zoo



Jeni Richardson

Members of the Rocky Mountain Elk Foundation tour Starkey Experimental Forest and Range.

Tours and Workshops

More than 400 people visited the Starkey Experimental Forest and Range in 2012. These educational events are effective ways to exchange information and ideas among interested parties.

Bonneville Power Association Riparian Tour: Fifteen people toured Meadow Creek, the site of a future riparian-restoration-grazing research project at Starkey.

Starkey Futuring Workshop: Hosted at Eastern Oregon University, La Grande, Oregon, 41 participants learned about past, present, and future research efforts at the Starkey Experimental Forest and Range, shared their opinions on the value of the research, and made recommendations on future research.

Starkey Tours for College Students: Twenty-one students from Central Oregon Community College and 23 students with the Oregon State University Range Program toured the experimental forest and range to learn about past and current research.

Starkey Tour for Natural Resource Professionals: In an event cosponsored by the Rocky Mountain Elk Foundation, 180 people took a day-long tour of the ungulate research facilities; more than 15 field presentations were given on results of long-term ungulate research.

Starkey Tour for Rocky Mountain Elk Foundation Habitat Partners: In an event cosponsored by the Rocky Mountain Elk Foundation, 125 people took a day-long tour of the ungulate research facilities; more than 10 field presentations were given on results of long-term ungulate research.

Honors and Awards

2011 Rise to the Future Award

Kelly Burnett, a research fisheries biologist, was recognized by the U.S. Forest Service for her professional excellence in research achievements.

2012 Forest Service/Bureau of Land Management Joint Conservation Project Award

Brad St. Clair and Francis Kilkenny, research geneticists, were honored for their contributions as members of the Great Basin Native Plant Selection and Increase Project.

Boone and Crockett Club

Bov Eav, PNW Station Director, the Starkey Ungulate Ecology Team, and their counterparts in the Oregon Department of Fish and Wildlife were honored for developing innovative elk nutrition and habitat models for elk management in western Oregon and Washington.

Excellence in Herpetofaunal Conservation

Deanna Olson, a supervisory research ecologist, earned the annual Alison Haskell Award from Partners in Amphibian and Reptile Conservation.

J. Frances Allen Scholarship

Brooke Penaluna, a SCEP research fisheries biologist, received the annual award from the American Fisheries Society.

Rocky Mountain Elk Foundation National Research Award

Bov Eav, PNW Station Director, the Starkey Ungulate Ecology Team, and their counterparts in the Oregon Department of Fish and Wildlife were recognized for their long-term elk research conducted at the Starkey Experimental Forest and Range.

Sjölin Award

William E. Mell, a research combustion engineer, was honored by the International FORUM of Fire Research Directors for his outstanding contributions over past years to the Fire Dynamics Simulator development team and the resulting impact of the team's work on the advancement of fire engineering around the world.

Sustained Lifetime Achievement

Marty Vavra, supervisory rangeland scientist, was honored by the Society for Range Management for his long-term professional contributions to the art and science of range management.

USDA Secretary's Honor Award

Brad St. Clair, research geneticist, was one of 30 members of the Conifer Translational Genomics Network Coordinated Agricultural Project honored for helping America promote sustainable agricultural production and biotechnology exports to increase food security.

Wildlife Society Outstanding Service Award 2012

The Oregon Chapter honored the station's Starkey Ungulate Ecology Team—Mary Rowland, wildlife biologist; Jennifer Boyd, biological technician; Bridgett Naylor, geographer; Michael Wisdom, research wildlife biologist; and Martin Vavra, supervisory rangeland scientist—for their accomplishments, which included developing, publishing, and providing training on new elk habitat use models for western Oregon and Washington.



Sarah Jovan



Keith Reutman

PNW Research Station Organization

Station Director

Robert Mangold (Acting)
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2100
E-mail: rmangold@fs.fed.us

Assistant Director for Administration

Lesley Kelly
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2102
E-mail: lakelly@fs.fed.us

Assistant Director for Communications and Applications

Cynthia L. Miner
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2135
E-mail: clminer@fs.fed.us

Assistant Director of Research

Bernard (Shiloh) Parresol
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2115
E-mail: bparresol@fs.fed.us

Program Managers

Ecological Process and Function

Beatrice Van Horne
Forestry Sciences Laboratory
3200 SW Jefferson Way
Corvallis, OR 97331
Phone: 541-750-7357
E-mail: bvhorne@fs.fed.us

Goods, Services, and Values

Robert Deal (Acting)
Forestry Sciences Laboratory
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2015
E-mail: rdeal@fs.fed.us

Focused Science Delivery

R. James Barbour (Acting)
Forestry Sciences Laboratory
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2542
E-mail: jbarbour01@fs.fed.us

Land and Watershed Management

Susan Alexander (Acting)
Forestry Sciences Laboratory
11305 Glacier Highway
Juneau, AK 99801-8545
Phone: 907-586-7801
E-mail: salexander@fs.fed.us

Resource Monitoring and Assessment

Gretchen Nicholas
Forestry Sciences Laboratory
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2034
E-mail: gnicholas@fs.fed.us

Threat Characterization and Management

Marcia Patton-Mallory
Forestry Sciences Laboratory
1133 N Western Ave.
Wenatchee, WA 98801
Phone: 206-732-7846
E-mail: mpattonmallory@fs.fed.us

Western Wildland Environmental Threat Assessment Center

Nancy Grulke
3160 NE 3rd St.
Prineville, OR 97754
Phone: 541-416-6583
E-mail: ngrulke@fs.fed.us



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Credits

Assistant Director for Communications
and Applications—Cynthia L. Miner

Managing Editor—Rhonda Mazza

Writer—Rhonda Mazza

Publishing Director—Frank Vanni

Graphic design—Keith Routman and Rhonda Mazza

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Back cover photographs—(left) *Pyrola asarifolia*, by Rhonda Mazza; (right) urban trees in Seattle, Washington, by Kathy Wolf.

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Hugh Luce

Fairy Falls, Oregon.

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Pacific Northwest Research Station
333 SW First Avenue
P.O. Box 3890
Portland, OR 97208-3890
www.fs.fed.us/pnw/



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