USDA United States Department of Agriculture

Forest Service

2015 Science Accomplishments *of the* Pacific Northwest Research Station

Our 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.

Emily Jane Davis, Oregon State University

◀ Forest collaborative members, national forest staff, and researchers tour sites of potential collaborative projects in the Willamette National Forest.

Contents

Johnny H. Carson

A Forest Inventory and Analysis field-crew member hikes into a plot on the flanks of Mount Jefferson, Oregon. ▶

A Message From the Station Director

Greetings!

Tim LeBarge

Robert Mangold

Last year was marked by anniversaries. Forest Service Research and Development celebrated 100 years as a distinct branch within the agency. The Pacific Northwest Research Station turned 90, although the first forest research in the region traces back to 1909 with a study near Wind River, Washington, to determine growth rates of Douglas-fir.

Last year also marked the 75th anniversary of the Starkey Experimental Forest and Range in eastern Oregon, and the 25-year partnership of the Blue Mountains Elk Initiative. This is the longest-running wildlife partnership in the Forest Service and includes more than 25 state, federal, private, and tribal partners. The findings from research done at Starkey through the Blue Mountains Elk Initiative are now used across western North America for effective elk management.

And 2015 was also the 35th anniversary of the 1980 eruption of Mount St. Helens. This milestone was marked by the 5th science pulse, an international gathering of scientists to collect the latest set of post-eruption measurements on the ecological response of a severely disturbed landscape. It was also a time of knowledge exchange as the original cohort of post-eruption scientists begin to pass the care of long-term study plots onto the next generation.

Like a tree laying down growth rings each year, at the station we grow and learn with each passing season. This learning is a key to our resilience. Just as a resilient landscape is one that is able to adapt to change and accommodate disturbance, the strength of an organization also lies in its resilience. We practice resilience while staying true to our values of producing high-quality, unbiased science and thinking creatively about the work we do and the way we do it. We are driven by unbridled curiosity and bound by our service to society. A recent example is a study that examined if moss is an effective bio-indicator of air quality in an urban area. Findings from the study have had an immediate impact toward improving air quality in the Portland area when state agencies and local companies took action to reduce air pollution.

Another milestone of note in 2015 is our new virtual Center for Advanced Forest Ecosystem Research. My thought was to gather many of the station's most accomplished scientists from various disciplines and give them an opportunity to work together. I asked them to focus on developing pioneering concepts of forest ecosystem research, with an emphasis on climate resilience. Their research will provide a scientific foundation for decisionmaking in a changing climate.

I like to think of this as the research advantage. Well-crafted, timely research that helps others—from land managers to public health agencies—to anticipate, understand, and solve the problems of the day. By talking about our research from the perspective of those who have need for high-quality, relevant information, our science will be more readily adopted by the world of practitioners. To that end, in 2016, the station looks forward to building on its many partnerships with the National Forest System, tribes, universities, nongovernmental organizations, private industry, and state and other federal agencies.

Let's stay in touch,

Station Director Robert Mangold

◀ Okanogan-Wenatchee National Forest. The station has a strong partnership with this national forest and others in the region. Photo by Tom Iraci.

PNW Research Station: The Setting

Laboratories and Centers

- Alaska Wood Utilization and Development Center (Sitka, Alaska)
- Anchorage Forestry Sciences Laboratory
- Boreal Ecology Cooperative Research Unit (Fairbanks, Alaska)
- 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, Washington)
- Portland Forestry Sciences Laboratory
- Wenatchee Forestry Sciences Laboratory
- Western Wildland Environmental Threat Assessment Center (Prineville, Oregon)

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 research centers in Alaska, Washington, and Oregon.
- 12 active experimental areas (forests, ranges, and watersheds).
- Research is conducted in more than 98 research natural areas.
- 300 employees (272 permanent, 28 temporary).

Experimental Areas

1. Bonanza Creek Experimental Forest
2. Caribou-Poker Creeks Research Watershed
3. Héen 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 88 percent of the funds in fiscal year 2015, and direct client support, which comes from organizations in need of scientific information.

The numbers below are for the fiscal year October 1, 2014, to September 30, 2015.

Incoming funding

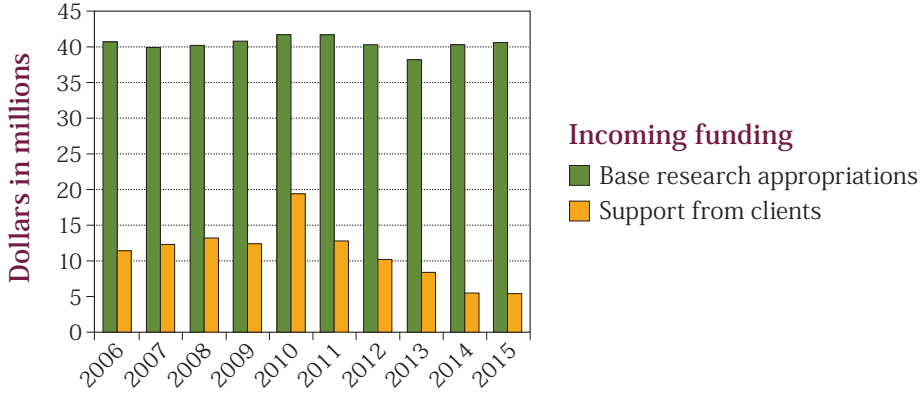
- Base research appropriations: $40.5 million (88%)
- Client support: $5.4 million (12%)
- Total funding: $45.9 million
- Discretionary funding: 34%
- Nondiscretionary funding: 66%

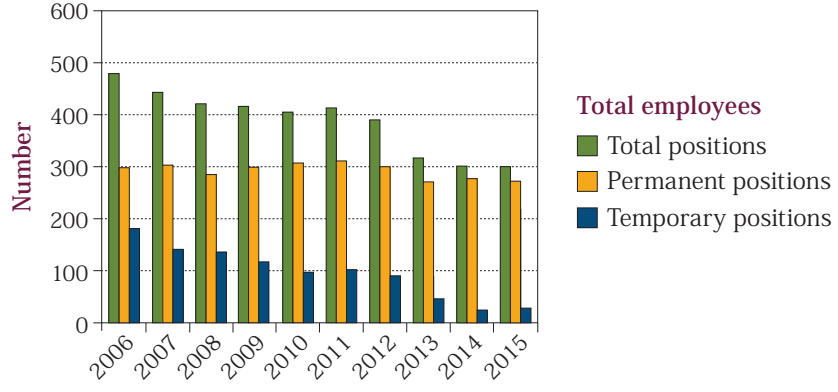
Distribution of funds

- Permanent employee cost: $28.9 million (63%)
- Support and operations: $8.7 million (19%)
- Distributed to cooperators: $8.3 million (18%)
- Of the $8.3 million to cooperators, 77% went to educational institutions

Workforce statistics

- Total station workforce: 300 employees
- Permanent workforce: 272 employees
- Of the permanent workforce, 79 employees (29%) are scientists
- Temporary workforce: 28 employees





Funding Partners in 2015

Partners Who Received Funding From the PNW Research Station for Studies

Educational Institutions

- Boston University
- Colorado State University
- Cornell University
- Desert Research Institute
- Loyola University
- Michigan Tech University
- Mississippi State University
- Oregon State University
- Portland State University
- Regents of the University of California
- Regents of the University of Idaho
- Regents of the University of Michigan
- San Jose State University Foundation
- State University of New York
- University of Alaska
- University of Alaska Anchorage
- University of Alaska Southeast
- University of British Columbia
- University of Hawaii at Manoa
- University of Maryland
- University of Montana
- University of Oregon
- University of Washington
- Utah State University
- West Virginia University
- Willamette University

Foreign Institutions

- New Zealand Forest Research Institute Limited (Scion)

Municipal Governments

- Cascadia Conservation District
- Woodland Park Zoo, Seattle

Nonprofit Organizations

- American Fisheries Society
- Association for Fire Ecology
- Conservation Biology Institute
- Duwamish River Cleanup Coalition
- Earth Systems Institute
- Ecohealth Alliance
- Mount St. Helens Institute
- Sitka Conservation Society
- Southern Oregon Small Diameter Collaborative
- Student Conservation Association
- Terrainworks
- Willamette Partnership

Other Federal Agencies

- Department of Energy
- Department of the Interior, Bureau of Land Management
- Department of the Interior, National Business Center Aviation Management
- Department of the Interior, National Park Service

Private Industry

- Street Sounds Ecology, Washington

State Agencies

- Alaska Department of Natural Resources
- Alaska Energy Authority
- Oregon Department of Fish and Wildlife
- Oregon Department of Forestry
- Oregon Office of Energy

Tribes

- Confederated Tribes of the Umatilla Indian Reservation

Partners Who Provided Funding to the PNW Research Station for Studies

Educational Institutions

- Colorado State University
- Cornell University
- Mississippi State University
- Oregon State University
- Portland State University
- Regents of the University of Idaho
- Regents of the University of Michigan
- State University of New York
- University of Alaska Anchorage
- University of Alaska Southeast
- University of British Columbia
- University of Hawaii at Manoa
- University of Maryland
- University of Montana
- University of Oregon
- University of Washington
- Utah State University
- West Virginia University
- Willamette University

Nonprofit Organization

- Duwamish River Cleanup Coalition
- National Council for Air and Stream Improvement

Other Federal Agencies

- Environmental Protection Agency
- Department of Agriculture, Office of the Chief Economist, Climate Change Program Office
- Department of the Interior, Bureau of Land Management
- Department of the Interior, Fish and Wildlife Service
- Department of Interior, Office of Surface Water
- National Aeronautics and Space Administration, Goddard Space Flight Center
- Department of Defense, Army Corps of Engineers
- Department of Defense, U.S. Army Corps of Engineers, Environmental Resources Branch
- Department of the Interior, Geological Survey, Office of Acquisitions and Grants
- Department of the Interior, Geological Survey, Northeast Climate Science Center

Private Industry

- Eco Logical Research, Inc.
- Portland General Electric, Oregon

State Agencies

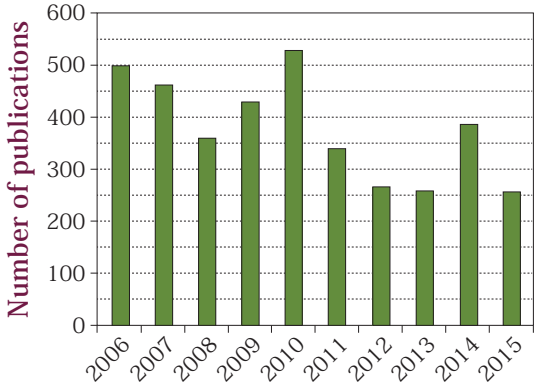
- Oregon Department of Forestry
- Oregon State Marine Board
- Hawaii Division of Forestry and Wildlife

Metolius River, Oregon.
Photo by Glenn Christensen. ▶

Sharing What We've Learned

The station produced 255 publications in fiscal year 2015. This includes station series publications, journal articles, books or book chapters, theses and dissertations, and other publications.

- **94,700** hard copies of station publications distributed.
- **4,810** station publications available online through Treesearch
- **340** hardcopies of historical publications (1947—2010) on tree genetics scanned and placed online, now readily available to students, natural resource professionals, and scientists
- **12** issues of *PNW Science Findings* published, about 8,000 copies of each issue distributed or downloaded.



Web Visitors

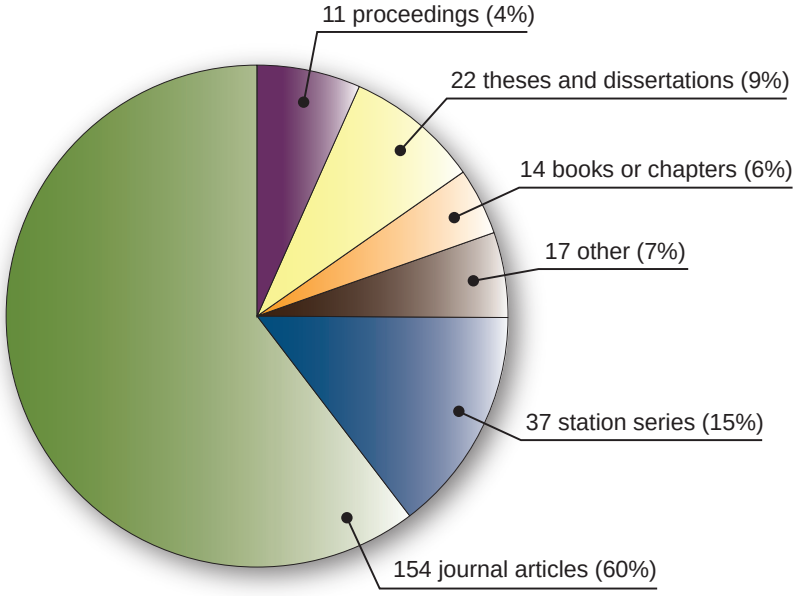
- Total number of visits: **110,407**
- Total number of page views: **290,909**
- Percentage of new visitors: **77%**

Twitter

The station's Twitter account has 1,523 followers—up from 1,162 in 2014. Reporters, natural resource professionals, and nonprofit groups comprise the majority of subscribers, who receive instant electronic alerts (tweets) about 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.



How Is PNW Research Used?

Knowledge and tools for applying this knowledge are the products of research. At the Pacific Northwest Research Station, some of our studies address the immediate needs of our clients. Other studies develop foundational knowledge that provides a launchpad for answering pressing questions of the future. Some years may pass before new knowledge and tools are fully adopted. At some point, the knowledge becomes "common" and the tools "standard." These are the marks of our greatest achievements. Following are a few examples of station research that is on its way to becoming common knowledge and tools that are the current standard.

BlueSky used across the country to support air quality forecasting: In 2015, the BlueSky Smoke Modeling Framework was used across the country during one of the worst fire seasons on record. BlueSky daily model runs were used by air resource advisors, regional forest and air quality offices, and public health departments as well as directly by the public. The BlueSky model viewer was accessed more than 20,000 times a day during particularly bad smoke events in Washington and Oregon.

Responding to climate change in national forests: a guidebook for developing adaptation options: Written to provide guidance for the National Forest System when developing climate change vulnerability assessments and adaptation strategies, this publication (PNW-GTR-855) has been used in more than 50 national forests throughout the United States. Nearly all regions of the Forest Service (Regions 1, 2, 4, 5, 6, and 9) have used it, resulting in a consistent, science-based approach to assessments and adaptations.

Output from the BlueSky modeling framework shows the day's projected smoke dispersal from the 2015 Okanagan Complex fire in eastern Washington.

Mary Rowland

Federal, state, and tribal representatives celebrate a 25-year partnership through the Blue Mountains Elk Initiative with a tour of the Starkey Experimental Forest and Range.

Consume used to estimate carbon emissions during wildfires: The Washington Department of Natural Resources used Consume, fire decision-support software developed by the station, to prepare an estimate of carbon emissions from wildland fires in 2014 for Washington's governor's office. This is an example of an operational planning tool being applied to inform policy decisionmaking.

Fire history study used to craft Teanaway Conservation Forest Management plan: The Washington Department of Natural Resources used the fire history study of the Teanaway River drainage, (Wright and Agee. 2004. *Ecological Applications*. 14: 443–459) when developing the forest management plan for the newly created Teanaway Community Forest in central Washington.

Elk nutrition and habitat use models and methods adopted for use in Idaho and Montana: Originally developed for Oregon and Washington, landscape tools to evaluate elk nutrition and habitat have now been adapted for use in Idaho and Montana. The Clearwater Basin Collaborative used them in the Clearwater Basin of north-central Idaho. Results will be used for early-seral forest restoration planning by the Nez Perce-Clearwater National Forest.

The types of data collection needed to build or validate these elk landscape evaluation tools are now being adopted by the Idaho Department of Fish and Game. Similarly, the Oregon-Washington elk models have been applied to elk habitats across Montana, and are undergoing validation tests by the Montana Department of Fish, Wildlife, and Parks with field data on animal condition, reproductive status, and habitat use. These adaptations of the Oregon-Washington elk models will provide a consistent and effective means of evaluating environmental conditions across a large set of ecoregions in the northwestern United States for land use planning and elk population management.

Applying the science of decisionmaking: In a study led by a station scientist, managers and analysts with the National Forest System were surveyed about their familiarity and use of decision science methods and tools. The findings are being used by the U.S. Forest Service Washington Office to guide training in, and development of, decision-science methods and tools.

Decision support for integrated resource restoration in east-side forests of the Pacific Northwest: Okanogan-Wenatchee National Forest managers and station scientists pooled their resources to create a core set of foundational research studies, a peer-reviewed, state-of-knowledge restoration strategy, and an advanced, customizable spatial decision-support system for landscape evaluation and restoration planning. The system, based on the Ecosystem Management Decision Support framework, is used to evaluate key changes and restoration needs of modern-day terrestrial landscapes, resulting in more efficient planning related to the National Environmental Policy Act, improved project design. It is also used to facilitate a focus on ecological outcomes and landscape conditions, and an increased restoration footprint. Since FY 2012, the Colville National Forest has used the tool on two districts, and the Umatilla National Forest began its first project in early 2016.

Evaluating tradeoffs among ecosystem services in the management of public lands (2013, PNW-GTR-865): The National Forest System used this research to develop technical guidance for national forest staff regarding how to address ecosystem services in the assessment phase of national forest planning, as required under the new forest planning rule.

Integrated Landscape Assessment Project used in support of several forest plan revision efforts: Originally funded by the American Recovery and Reinvestment Act, models from the Integrated Landscape Assessment Project (ILAP) are being used in the Blue Mountains (Umatilla, Wallowa-Whitman, and Malheur National Forests) in the Pacific Northwest; by the Rio Grande National Forest in the Rocky Mountain Region; and Coronado, Cibola, Carson, and Santa Fe National Forests in the Southwestern Region. In most cases, ILAP models are being run with multiple management scenarios to help conduct the ecological assessments required under the new planning rule.

Science Delivery Highlights

Delivering science in accessible formats to the people who need it to make informed decisions is a key part of the station's mission. In 2015, station scientists engaged with our stakeholders, using a variety of formats to share information. A few of the events are highlighted below. In summary, station scientists gave:

- **250** presentations
- **70** consultations
- **50** workshops
- **20** webinars

Some webinar topics:

- BlueSky modeling framework updates
- Climate change
- Coldwater fish, wildfire, and climate change
- Development and use of seed zones
- Genetic adaption in forest trees
- National Emissions Inventory for wildland fire
- National Environmental Policy Act (NEPA)
- Smoke column and plume dynamics
- Postfire ecology of the East Cascades

Major Events

Air Resource Advisor Training Workshop: Fifteen students received training from station scientists on the current state of wildland fire air quality tools and how to fill the role of air resource advisor during a wildland fire incident. Training topics included computer models, interpretation of smoke monitor data, communication and messaging tools, and an opportunity to establish relationships with other air resource advisors.

Blue Mountains Stakeholder and Science Forums: Two forums with 65 stakeholders were held to address socioecological research needs in the Blue Mountains, Oregon. These were followed by a science forum with 35 researchers to discuss potential socioecological research for the region.

Climate Change Adaptation: A station scientist reached 535 people with multiple presentations about climate change to resource specialists in the Intermountain Region, Northern Region, and Pacific Northwest Region of the Forest Service. This includes students at the University of Washington, and the nongovernmental organization Alliance for Clean Jobs and Energy.

Ecosystem Services Champions Forum: About 70 Forest Service employees from the National Forest System, Research and Development, and State and Private Forestry attended a policy forum in Washington, D.C., organized by a station scientist. The forum was titled, "Integrating ecosystem services into Forest Service programs and operations."

Hugh Luce

Writers tour the Pumice Plain with scientists during the Mount St. Helens Science Pulse, marking the 35th anniversary of the 1980 eruption.

Four Focal Years of Herpetofauna: 2011—2014 were the years of the turtle, lizard, snake, and salamander, respectively. Working with Partners in Amphibian and Reptile Conservation, a station technician edited and designed monthly newsletters, outreach posters, and synthesis documents, which have been viewed online by more than 20,000 readers.

International Union of Forest Research Organization's 24th World Congress: More than 25 station scientists gave presentations and organized sessions at this event held in Salt Lake City, Utah, in October 2014. Topics included climate change, community forestry, ecosystem services, forest health, remote sensing, science communications, and ungulate herbivory. More than 3,500 people attended, including 2,500 scientists from more than 100 countries and 1,200 professional foresters from North America. A PNW research forester helped organize the conference program for the Society of American Foresters, which was held in conjunction with the congress. Another station employee co-chaired the Congress Communications Committee and conducted a science communications workshop for about 40 scientists from Africa, Asia, and Latin America in a pre-congress training as part of the IUFRO Program for Developing Capacities.

Mount St. Helens Science Pulse: About 120 scientists, land managers, writers, and students convened on Mount St. Helens in August. Held every 5 years, the Pulse gatherings have facilitated long-term research within the national volcanic monument since the 1980 eruption. Hundreds of long-term plots are sampled for mammals, birds, amphibians, fish, insects, plants, lichens, fungi, and soil. Collectively, these 5-year measurements chronicle the reassembly of life at the volcano and give land managers information about landscape restoration. The writers and poets create science-inspired works that provide a further narrative about the natural world and our place in it. Students from five high schools across Washington state participated as part of the Science, Technology, Engineering, and Math (STEM) program with the aim of providing them with life-changing experiences and opportunities for career development.

Native Seed Field Day: Fifty attendees—seed producers, scientists, land managers, nursery owners, and nonprofit organizations—learned about seed transfer zones for bluebunch wheatgrass, an important native grass used in restoration efforts. The field day was held at Oregon State University's Malheur Experimental Station.

Holly Prendeville

At Oregon State University's Malheur Experimental Station, seed producers, land managers, and others learn about research on bluebunch wheatgrass, a species often used to restore burned areas.

NEPA Knowledge Café Webinars: Eleven webinars in this series were hosted in 2015 on a variety of topics including public-private partnerships that conserve working forest and agriculture lands, integrating climate change with forest management, and a new electronic, searchable archive of forest plans. Webinar attendance ranged from 78 to 122 per session.

NEPA Line Officer Team Inaugural Workshop: A station scientist organized this workshop to establish a NEPA Line Officer Team to better facilitate environmental planning within the agency. The initial workshop for forest supervisors and district rangers (line officers), held in Washington, D.C., was followed by three different webinars with line officers from across the agency to address issues related to environmental planning. The first webinar had 260 attendees.

Science Teacher Workshop: Ten Washington high school teachers participated in a full-day workshop titled, "Mentoring students to create high quality science fair projects." The workshop emphasized experimental design and statistical inference while also providing participants with information on tree physiology and examples of Forest Service research.

SEEDS: The station participated in the Oregon State University College of Forestry's Strengthening Education and Employment for Diverse Students Program (SEEDS) by providing paid mentored work experiences to underrepresented students preparing to enter professional forestry and natural resource management. Forty-five college students participated.

Ashley Steel

Station scientists led a workshop for science teachers, offering tips on experimental design and statistical inference by using station research on tree physiology as an example.

Wildland Fire National Emissions Inventory Training Sessions: About 130 students were introduced to the process that will be used to create the 2014 EPA National Emissions Inventory for wildland fire. Students learned what data are being requested from the states, how that data will be used, and modeling methods that will be used to estimate emissions for each wildland fire.

Wood Scaling and Moisture Sample Collection Training Course: The Gwitchyaa Zhee Utility Company in Fort Yukon, Alaska, requested training from a station scientist. The 12 participants learned how to estimate harvest volume of cordwood and how to collect moisture samples. The utility company is in the process of installing a biomass boiler to heat tribal buildings and potentially generate electricity.

Conservation Education

It's vital that young people discover and maintain their connection to nature. They are the next generation of land stewards, scientists, and decisionmakers. Recognizing this, the station contributes to a variety of conservation education activities for students from elementary to high school and their teachers.

Biodiversity Conservation Research Panel: About 40 eighth graders conducted environmental research projects at Jane Goodall Environmental Middle School in Salem, Oregon. A station scientist provided guidance on these projects.

Cascade Head Ecosystem Charrette: Five high school students sampled small mammal populations with a station scientist at the Cascade Head Experimental Forest to learn how the mosaic of private and public lands affects coastal ecosystem management. Students will use this knowledge to propose a meadow restoration plan.

Duwamish Valley Youth Corps: The Duwamish Valley Youth Corps in Seattle, Washington, is a new youth conservation education and stewardship group composed of local youth living in low-income, ethnically diverse neighborhoods in the Duwamish River Valley. The station sponsors this group and provides scientific expertise. Thirty high-school-age youth participated in 6-week classes where they did trail maintenance, participated in river and trail cleanup activities, and planted trees, shrubs, and rain gardens in the Duwamish River Riparian Zone.

Duwamish Valley Cleanup Coalition

Washington high school students with the Duwamish Valley Youth Corps learn about stewardship of their local watershed.

Ecological Restoration and Monitoring in Garfield Gulch: A station scientist led a field trip for 40 students from Mason Middle School in Tacoma, Washington, at an event sponsored by Tacoma Public Schools and Metro Parks.

Field-Based Studies of Pond-Breeding Amphibians: In its ninth consecutive year, 60 high school students at the Battle Ground School District's Center for Agriculture, Science, and Environmental Education (CASEE) learned about the biology and general ecology of resident amphibians in classroom, laboratory, and field settings. Each year, students spend 4 to 6 weeks developing research questions, gathering and analyzing data, and presenting their research results.

Forests Inside Out! In its seventh year, the station and the nonprofit World Forestry Center provided a series of 2-day immersive indoor and outdoor experiences for 300 children ages 6 to 10 and their family members from diverse and underserved communities in the Portland

metropolitan area. The program promotes active, healthy outdoor lifestyles for young children and their families and fosters positive associations with urban forests, natural areas, and national forests. Eight high school and college-age students from the Portland area were mentors for the program, two of them from the Inner City Youth Institute, another youth program sponsored by the station.

H.J. Andrews Experimental Forest: More than 270 students, kindergarten through twelfth grade, participated in tours and structured field activities throughout the year at this experimental forest in Blue River, Oregon. Participating schools included: Fern Ridge Middle School, King's Valley Charter School, McKenzie Middle School, Prairie Mountain Middle School, Presbyterian Coming of Age Program, Ridgeline Montessori Public Charter School. The Youth Conservation Corps also participated.

Inner City Youth Institute: The station reached about 100 students from Portland inner-city high schools through the Inner City Youth Institute (ICYI). The program connects underrepresented youth with careers and experiences in natural resources and is a partnership among the Forest Service, Oregon State University's 4-H program, and the Bureau of Land Management. During the school year, students with ICYI planted trees and participated in a beach cleanup and invasive plant removal. During the summer, students went on day-hikes and attended a weeklong camp at Oregon State University. They traveled to the Oregon coast where they worked alongside Siuslaw National Forest field rangers and trail crew members. The camp concluded with student presentations to parents and sponsoring agency representatives. The ICYI program has reached 2,600 students since 1995.

Inter-Tribal Youth Climate Leaders Congress: A Tlingit high school student from Juneau, Alaska, and a Haida Culture Bearer from Kasaan, Alaska, were sponsored by the station and Forest Service Alaska Region to attend the Inter-Tribal Youth Climate Leaders Congress in Shepherdstown, West Virginia. They shared

Becky Bittner

An Inner City Youth Institute field trip to the Oregon Coast.

Heather Crow, Riverdale Grade School

Children from a Portland area school collect moss samples and learn how moss serves as a living record of local air pollution.

their experiences with the Alaska Tribal Leaders Committee and Forest Service employees.

Measuring Levels of Air Pollution: Fifty third- and fifth-graders collected moss samples with a station scientist and learned how moss can be used to measure air pollution and how trees can help clean the air.

Salmon Watch Program: About 65 students from Linus Pauling Middle School in Corvallis, Oregon, learned about macroinvertebrates from a station scientist during a salmon watch program.

Science Fairs: The station sponsored "Outstanding Natural Resource Science" awards for middle and high school students at the Northwest Science Expo, a science fair for young scientists, engineers, and mathematicians held at Portland State University. Station statisticians were judges at the Seattle School District Middle School Science sFair held at the Museum of Flight in Seattle, Washington. Three station scientists served as judges at the Washington State Science and Engineering Fair in Bremerton, Washington. They provided feedback to a diverse group of students working on many types of projects. There were 600 projects, and more than 3,000 people attended.

Scholastic Math: A station scientist collaborated on an article about changing habitats in Alaska for moose for a classroom print magazine about math for grades 6 through 9. This information was also used to develop a teaching module about the effects of climate change on Alaska's ecosystems.

STEM Field Ecology Program: Focused on Mount St. Helens, this program for 10-grade biology students engage them in ecological projects that include all aspects of field-based studies and subsequent analyses, interpretation and presentation. Over 700 students and nine teachers have conducted relevant field research at Mount St. Helens with natural resource professionals from a variety of public and private entities. In addition to the multi-day field experience, this program includes a summer teacher training workshop, pre- and postfield trip curriculum which included data entry and analysis, and an end-of-year research summit at Washington State University in Vancouver, Washington.

Trout Release Day: A station scientist organized this event for 70 third- and fourth-grade students from Chapman Hill Elementary in Salem, Oregon, and Timber Hill Elementary in Albany, Oregon. It was part of Trout International, an environmental education program. As part of the program, the classes hatched native rainbow trout in classroom tanks and later released them.

Climate Change

Climate change is expected to profoundly alter vegetation structure and composition, ecosystem processes, and the delivery of important ecosystem services over the next century. Science from the Pacific Northwest Research Station is helping land managers and decisionmakers prepare for these changes. Actions taken now may help mitigate the effects of climate change so that our forests, streams, and grasslands can continue providing life-sustaining benefits.

Janelle Cossey

What lies ahead? Josephine County, Oregon.

Highlights in 2015

- Tree seedlings of most species in California, Oregon, and Washington are germinating in areas cooler than those occupied by mature trees. The mean annual temperature of the range of seedlings is 0.12 ° C colder than that of the range of mature trees across all forest lands in the region.
- In southeast Alaska, forest area is increasing. Gains are concentrated on the northern sides of slopes and at higher elevations, while loss in forest area is skewed toward southern aspects and lower elevations.
- Modeling vegetation response to climate change in the western United States reveals that precipitation is a stronger driver than temperature. In a scenario assuming increasing greenhouse emissions, (Representative Climate Pathway 8.5), most of the U.S. West will be a carbon sink because of increases in live vegetation.
- National forests in Oregon use analyses on projected future stream flows in the western Cascades to incorporate climate change in their forest plans.

Seedlings seek cooler temperatures

Seedlings of most tree species in California, Oregon, and Washington have shifted toward areas colder than those occupied by mature trees.

Global warming is predicted to cause systematic changes in the distribution of tree species. Changes in tree distribution begin with seedling colonization of newly favorable areas. Determining if and where these changes are occurring and estimating their magnitude is crucial for large-scale policy and management decisions.

Scientists compared the distribution of seedlings and mature trees for most tree species in California, Oregon, and Washington. The mean annual temperature of the range of seedlings is 0.12 ° C colder than that of the range of mature trees across all forest lands in the region. Individual species followed the same pattern, except for some species common in California's mixed-conifer forest. For most species, the estimated shift is less than the increase in temperature during the past decades. This suggests that tree migration may be lagging temperature increases.

The broad scale of analysis, exhaustive sampling of tree species, variety of disturbance regimes examined, and direct relationship between temperature response and a warming climate provide strong evidence for attributing the observed shifts to climate change.

Contact: Vicente Monleon, vjmonleon@fs.fed.us

Partner: Oregon State University

Rhonda Mazza

Along the West Coast, seedlings are becoming established in areas with cooler mean annual temperatures compared to the areas occupied by mature trees of the same species.

A sedge species extends its range into interior Alaska

Associated with drying lake margins, a sedge species is found in Yukon Flats in interior Alaska. Previously, Yukon, Canada, was as far northwest as this species had been documented.

During fieldwork documenting a climate-change-induced lake drying in the Yukon Flats area of interior Alaska, scientists found the sedge species *Carex sartwellii*. This species has a very specific habitat associated with drying lake margins. Owing to the vast terrain and limited access to the region, this species likely has occurred in the Yukon Flats for some time. However, as a component of plant communities

Rick Edwards

Temperate rain forest in southeast Alaska.

associated with drying lake margins, its local presence may be a good indicator species of climate-induced changes in the lake area.

Eight specimens of this species are now cataloged in the University of Alaska Herbarium for use by botanists. The Yukon Flats National Wildlife Refuge was very interested in the discovery of this species within its borders and has added the sedge to its regional species list.

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

Partners: University of Alaska Fairbanks, U.S. Geological Survey

Spatial patterns found in disturbance and regrowth within southeast Alaska forests

Southeast Alaska is gaining forest area on the northern side of slopes, at higher latitudes, and at higher elevations while losing forest area on southern aspects and at lower latitudes. Gains in forest area and biomass exceed the losses.

Natural forest growth is important to carbon sequestration patterns, and climate is likely to alter both disturbances and regrowth. Scientists used remote sensing and inventory data to examine recent trends in biomass and forest area in southeast Alaska. They found that although rain forest dynamics occur at a very small spatial scale (<1000 m2), the net result of thousands of individual events is regionally patterned change. Forest area gains were concentrated on northerly aspects and at lower elevations and higher latitudes, whereas loss was skewed toward southerly aspects and lower latitudes. Repeated measures on inventory plots also showed biomass increases on gentler slopes and at higher latitudes. Early detection of changes can help land managers anticipate how the temperate rain forests of Alaska may continue to change in the future.

Contact: Tara Barrett, tbarrett@fs.fed.us

Partner: University of Alaska Southeast

Tool

Climate Change Adaptation Library for the Western United States

Description:
The Climate Change Adaptation Library provides menus of options for adapting to climate change, summarized by vegetation, water resources, fisheries, wetlands-riparian habitat, wildlife, and recreation.

Use:
This library was developed for federal land managers, other land managers, tribes, and other stakeholders throughout the United States.

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

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

Climate change, fire, and alpine treeline

High-elevation forests are expected to be especially sensitive to a warming climate. Treelines may advance upslope as temperatures warm, displacing alpine meadows and changing hydrology. Or, increased fire could reduce tree cover, thereby lowering treelines.

Scientists used satellite data to examine the area burned by fires at the alpine-treeline ecotone from 1984 to 2012 and compared it to total area burned by fire in the region. Intensive field data from two fires in Washington and two fires in Montana were used to quantify both the spatial patterns of fire severity and the relative success of seedling establishment after fire.

The scientists found that area burned near treeline was significantly correlated with regional area burned. In some regions of the Pacific Northwest and northern Rocky Mountains, subalpine parkland—characterized by alpine meadow and dispersed trees—is burning proportionally more than the region as a whole. Although no clear predictions can be made about treelines moving either up or down en masse, it is very likely that given the varying severity of fire and varying success of seedling establishment, the alpine treeline ecotones will be wider and have more complex spatial patterns in the future.

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Partners: Joint Fire Science Program, University of Washington, UDSA Forest Service Rocky Mountain Research Station

Considering effects of climate change and air pollution on forest pathogens

A favorable environment, a susceptible host, and a virulent pathogen create a "disease triangle." How will physical and chemical changes in the environment influence forest pathogens?

Climate change is triggering physical changes in the environment through warming, temperature extremes, and type, amount, and pattern of precipitation. Chemical changes in the environment are also occurring: carbon dioxide and ozone levels are increasing as is the deposition of air pollutants such as nitrogen oxides. The chemical and physical environments affect plant health and alter plant susceptibility to insect and pathogen attack. For the first time, scientists reviewed the combined effects that these physical and chemical changes may have on forest pathogens. They propose a generalized modelling approach to incorporate the complexities of these effects on host and virulent pathogen into dynamic vegetation models. This will increase efficiency in model vegetation response to climate change.

Contact: Nancy Grulke, ngrulke@fs.fed.us

Partner: Auburn University

C. Alina Cansler

Fire may become more frequent in high-elevation forest. Above, evidence of a burn at treeline in the Selway-Bitterroot Wilderness, Idaho.

Projections indicate likely changes in vegetation and disturbance in the Blue Mountains of Oregon over next century

Scientists assessed potential climate-change effects on upland vegetation in the Blue Mountains of Oregon. The Pacific Northwest Region is using this information in climate-change-vulnerability assessments and other forest planning efforts.

Climate-induced changes will affect wildlife habitat, biodiversity, hydrology, future disturbance regimes, ecosystem services, and the ability of ecosystems to absorb and sequester carbon from the atmosphere. Working with the three national forests in the Blue Mountains as they assess their climate-change vulnerability, scientists reviewed the literature and projected vegetation change by using the MC2 dynamic vegetation model with downscaled CMIP5 climate projections.

The projections indicate that:

- Subalpine and alpine systems are potentially vulnerable.
- Juniper woodlands may be reduced if longer and drier summers lead to more wildfire.
- Grasslands and shrublands at lower elevations may increase across the landscape
- Nonnative species, including annual grasses, may increase in abundance and extent.

Tom Iraci

A changing climate is expected to trigger changes in vegetation in the Blue Mountains of Oregon. Above, the Malheur National Forest, with a view of the Strawberry Mountain Wilderness.

Ecological disturbances are expected to increase and will be extremely important in affecting species distribution, tree age, and forest structure, facilitating transitions to new combinations of species and vegetation patterns. Mountain pine beetle may be particularly important in lodgepole pine and ponderosa pine forests, and western spruce budworm and Douglas-fir tussock moth may also increase periodically. Annual area burned by wildfire is expected to increase substantially, and fire seasons will likely lengthen. The interaction of multiple disturbances and stressors will create or exacerbate stress complexes.

Contact: Becky Kerns, bkerns@fs.fed.us; John Kim, jbkim@fs.fed.us

Partners: Oregon State University; University of Washington; USDA Forest Service Malheur National Forest, Umatilla National Forest, and Wallowa-Whitman National Forest

Tool

MC2

Description:
MC2 is used for visualizing vegetation change. The model produces maps showing the distribution of current and future vegetation and above- and belowground carbon under appropriate assemblages of global circulation models as drivers of climate input.

Use:
This model has many Forest Service and non-Forest Service users. It can be used by climate change coordinators at the regional and forest level, by forest plan revision teams, state and other land managers, tribes, collaboratives, and other nongovernmental organizations.

How to get it:
http://www.fs.fed.us/wwetac/threat_map/index.html

Contact:
John B. Kim, jbkim@fs.fed.us

Simulating vegetation response to climate change in the western United States

Projections under a no-climate-policy scenario indicate most of the western United States will be a strong carbon sink because of increases in live vegetation. The Forest Service is using this information in forest planning, and its Pacific Northwest and Pacific Southwest Regions are also using it in biophysical and socioeconomic vulnerability assessments.

Climate change is expected to profoundly alter vegetation structure and composition, terrestrial ecosystem processes, and the delivery of important ecosystem services in the western United States over the next century. These changes will affect wildlife habitat, biodiversity, hydrology, future disturbance regimes, and the ability of ecosystems to absorb and sequester carbon from the atmosphere.

Scientists assessed potential climate change effects on the vegetation of the western United States. They used MC2, a dynamic vegetation model, and standard experimental protocol established by the World Climate Research Project as part of the Coupled Model Intercomparison Project. The projections were downscaled to about 4 km resolution. They found that future climate projections vary widely across the western United States. Generally, precipitation is a stronger driver of live-vegetation carbon than temperature, but there is greater uncertainty with projections of change in precipitation. Under the scenario that assumes increasing greenhouse emissions (2014 Intergovernmental Panel on Climate Change, Representative Climate Pathway 8.5), most of the western United States will be a strong carbon sink because of increases in live vegetation.

Contact: John B. Kim, jbkim@fs.fed.us

Partners: USDA Forest Service Regions 1-6, 10

Continent-wide simulations of a dynamic global vegetation model

A newly assembled dataset for the United States and Canada can be used to address continent-scale questions regarding climate change and ecosystem responses to it. The data are available for download and are suitable for both researchers and land managers.

Finer grid projections of climate change under different greenhouse gas emissions are needed for research purposes and land management. To address this, station scientists produced downscaled relatively fine-grid climates (5 arc-minutes), and soil variables, as well as ecosystem responses to the future climates across the United States and Canada. Ecosystem responses come from the MC1 Dynamic Global Vegetation

Kelly Kerr

A portable photosynthesis system measures the rate of photosynthesis occurring in ponderosa pine seedlings from different populations.

model and include vegetation types, carbon cycle variables (e.g., total vegetation carbon and net primary production), water cycle variables (e.g., actual evapotranspiration and streamflow), and fire variables (e.g., biomass consumed by fire). Monthly climate data included minimum and maximum temperature, precipitation, and vapor pressure. Soil data include mineral depth and percent sand, rock, and clay for three depths.

Contact: John B. Kim, jbkim@fs.fed.us

Reduced growth is traded off for increased resistance to drought and extreme temperatures

The successful establishment of tree seedlings is crucial for future forest and stand regeneration. Understanding the physiological mechanisms and functional traits that drive successful seedling establishment may improve our ability to predict future species distributions, especially as climate change is predicted to alter the dynamics, composition, and diversity of many plant ecosystems.

Seeds from two populations of ponderosa pine from sites with contrasting precipitation and temperature regimes east and west of the Oregon Cascade Range were sown in a common garden experiment. First-year shoot growth was lower in the drier-site seedlings largely because they became dormant by early October, whereas the western population continued to grow throughout the fall. Water-use efficiency was greater in the drier-site seedlings and they also showed greater ability to maintain cell turgor during soil drying. Overall, the eastern, drier-site population exhibited more conservative behavior, suggesting that reduced growth is traded off for increased resistance to drought and extreme temperatures.

These findings provide insights concerning functional adaptations contributing to successful seedling establishment in different types of environments and may have implications for understanding the adaptability of individual populations to future climate change.

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Partners: Oregon State University, University of Wisconsin

New mapping of landscape sensitivities to changes in peak and low streamflow helps national forests plan ahead

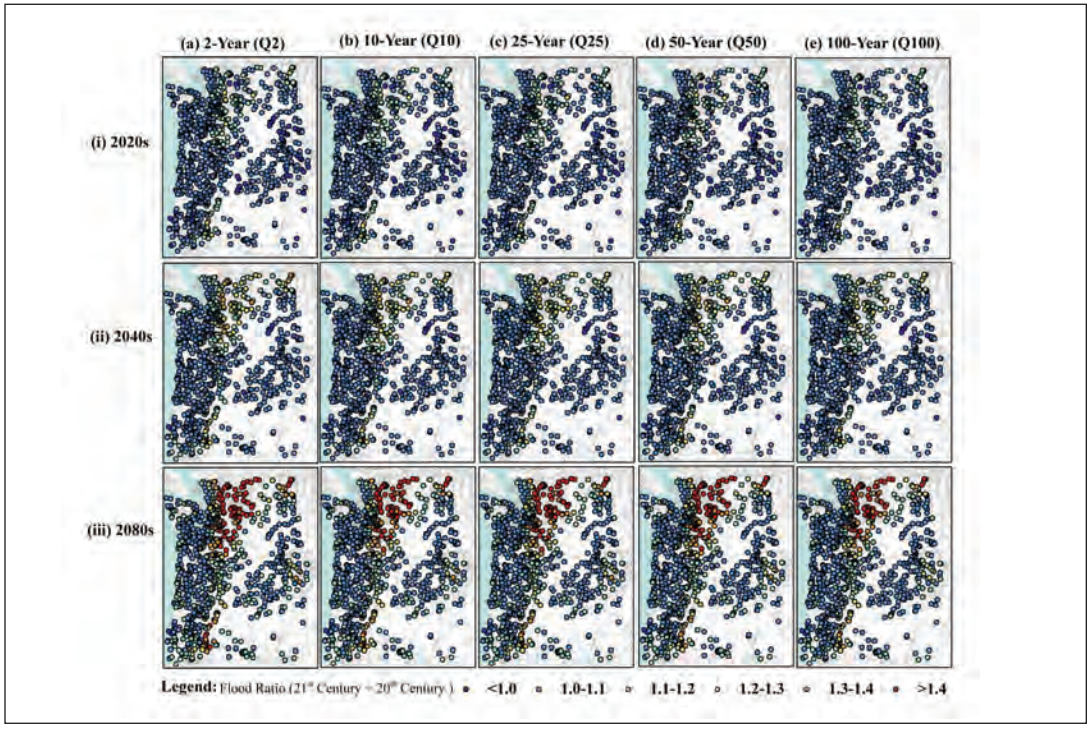
Forest planning efforts throughout the Pacific Northwest are using this research to develop adaptation strategies that address changes to streamflows. This information is vital for watershed restoration and management decisions, including where to build or remove roads, invest in restoration, and anticipate water stress.

A changing climate over the coming decades poses serious challenges to the Pacific Northwest's streamflow. How can predictions of future flows be used to guide intelligent choices about current infrastructure and restoration investments? New analyses demonstrate that impacts of climate change on streamflows will not be uniformly distributed across the landscape but are strongly controlled by both hydrologic regimes (i.e., rain versus snow) and the underlying geological setting (deep groundwater versus shallow runoff-dominated landscapes. Watersheds that provide much of Oregon and Washington's summertime flow, such as the Cascade Range, may continue to have water as the climate warms, but paradoxically, also are most sensitive to reduced stream flows under climate change.

The information in these analyses is being incorporated into forest planning efforts around the region. The Blue Mountain Adaptation Partnership used this analysis as a cornerstone of its hydrologic assessment that incorporates climate change into the forest plans for the Malheur, Umatilla, and Wallowa-Whitman National Forests. These analyses are also being used to provide the fundamental hydrologic assessment in the ongoing South Central Oregon Adaptation Partnership. This effort involves a collaborative assessment of climate change vulnerabilities for a consortium that includes the Deschutes, Ochoco, and Fremont-Winema National Forests, the Crooked River Grasslands, and Crater Lake National Park. Results from these analyses were also featured prominently in the Climate Change Toolkit developed by the Pacific Northwest Region to provide state-of-science tools for resource managers to address climate change vulnerabilities.

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

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



As precipitation changes from snow to rain, more flooding is projected for streams in much of the Cascade Range and Olympic Mountains by 2080. Above, the projected changing risk of increased peak flows in Oregon and Washington for 2020, 2040, and 2080 for 2-year, 10-year, 25-year, 50-year, and 100-year floods. Warmer colors indicate greater relative increase over current peak flows.

Fire and Other Natural Disturbances

From fires to floods, insect outbreaks, and volcanic eruptions, natural disturbance is instrumental in shaping the landscape. Station research seeks to learn about these disturbances so that risk to human life, property, and uses of the land and its resources are minimized.

Tom Spies

A sunset through heavy smoke from wildfires on the east side of Oregon's Cascade Range.

Highlights in 2015

- Initial maps were produced for the National Forest System's Terrestrial Condition Assessment. The assessment sets the stage for the Forest Service's integrated restoration program.
- An assessment approach was developed to identify gaps in local planning and prioritizing by state and federal agencies in mitigating wildfire risk to nearby communities. It will be piloted in more than 120 communities in the western United States.
- Station scientists worked with Wallowa-Whitman National Forest to quantify tradeoff among restoration goals and prioritize areas in need of restoration.
- Three LiDAR datasets were produced for pre- and post-fire conditions within the area of the Rim and King Fires. This will facilitate study of these unusually large fires that burned in California in 2013 and 2014.

Charlie Crisafulli

Field crew sample willow shrubs on the Pumice Plain of Mount St. Helens as part of a study on the role of herbivory on nutrient cycling, species turnover, and assembly of small mammal and bird communities during early primary succession. Pyroclastic flows during the 1980 eruption removed all traces of the old-growth forest here, about 4 miles north of the volcano.

Mount St. Helens has a central role in field of volcano ecology

Ecological lessons and methods developed during studies on Mount St. Helens are now used to shape research and monitoring at other volcanic sites in Alaska, Argentina, Chile, Costa Rica, Indonesia, Japan, Papua New Guinea, and Russia.

Volcanoes are broadly distributed around the earth, with more than 1,500 currently active and dozens erupting at any point in time. After eruptions, natural, agricultural, and social systems are often profoundly disrupted and may remain so for centuries. The formal study of volcano ecology began in 1883 with the eruption of Krakatau (Indonesia). Since then, 404 volcanoes have erupted, but only 76 of these have been the focus of ecological inquiry, and most investigations have been limited in scope.

The breadth and duration of research (35 years and counting) on Mount St. Helens following the 1980 eruption puts this body of integrated research at the fore of volcano ecology. The methods and monitoring protocols developed there are now being adopted at volcanic sites around the world.

To further the field of volcano ecology, scientists conducted a massive literature search to determine what is known about ecological

responses to volcanism. The extensive bibliographic database, currently for research use only, will provide information on eruption impacts and responses. The identified gaps in knowledge about volcano-ecology interactions are a starting point for developing a research strategy that will lead to new insights and understanding about volcano ecology.

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Partners: Universidad Austral de Chile, USDA Agricultural Research Station, U.S. Geological Survey Cascades Volcano Observatory

Assessment of disturbance agents provides foundation for nationally integrated restoration program

Initial map products, for use in national strategic planning, were developed for the agency's Sustainable Landscape Management Board of Directors, to be followed by customized regional map products for regional Forest Service planning staffs.

The Terrestrial Condition Assessment is an effort to assess terrestrial ecosystem conditions through a process that is objective and consistent for all national forests. To support this, a station scientist led the design and implementation of a logic model in a spatial decision support system that can be used to assess effects of disturbance agents and other stressors on terrestrial conditions within the National Forest System of the conterminous 48 states. Some of the major stressors addressed include insect and disease incidence and risk, road densities (as they pertain to impacts on habitat fragmentation, for example), soil acidification, uncharacteristic wildfire, wildland-fire potential, and departure of fire regimes and vegetation departure from their historical range.

The Terrestrial Condition Assessment provides foundational information that sets the stage for further decision support of strategic planning for the integrated resource restoration program of the agency.

Contact: Keith Reynolds, kreynolds@fs.fed.us

Partners: USDA Forest Service National Forest System, Remote Sensing Applications Center, and Washington Office

Janelle Cossey

Standing dead trees and regeneration 12 years after the Biscuit Fire in southern Oregon.

Tool

FIDAR

Description:
Quickly assesses forest stand types and tree age classes that have experienced the greatest disturbance.

Use:
FIDAR is used to prioritize field work. It helps users determine which areas are most disturbed by a particular agent. The Medicine Bow-Routt National Forest (Colorado and Wyoming) has used this tool.

Contact:
Nancy Grulke, ngrulke@fs.fed.us

Tool

Fuel and Fire Tools v. 2.0

Description:
Fuel and Fire Tools (FFT) is a platform-independent software application that integrates the Fuel Characteristics Classification System (FCCS), Consume, Fire Emissions Production Simulator (FEPS), Pile Calculator, and Digital Photo Series into a single user interface. FFT is used for characterizing fuels and estimating fire behavior, fuel consumption, emissions production, heat release rate, and emissions rate during wildland and prescribed fires in different fuelbed types using measured fuel characteristics. This version adds the ability to estimate heat release and emissions rates through the inclusion of FEPS.

Use:
FFT is routinely used by fire and fuels planners, prescribed fire practitioners, and air quality regulators to characterize fuels and estimate fire behavior and effects for use in prescribed fire planning, implementation, and regulation; ecological and wildfire risk assessment; and evaluations of fuel treatment effectiveness.

How to get it:
http://www.fs.fed.us/pnw/fera/fft/

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

Paige Fischer

A property line may be all that separates an area that has been treated to reduce fuels from an area that has not been treated.

National forests and communities test new approach for wildfire risk mitigation

A new assessment approach that couples biophysical and social dimensions of risk can potentially improve wildfire protection within the wildland-urban interface.

Scientists developed an assessment approach and planning framework to address gaps in local planning and broad-scale prioritization of federal and state assistance to mitigate wildfire risk on federal lands near high-risk communities. This work explicitly incorporates social-science information pertaining to mitigation potential among private landowners and information on risk transmission to identify the sources of wildfire exposure to communities.

The Forest Service's State and Private Forestry, Washington Office, and Pacific Northwest Region have funded pilot studies to apply this approach in more than 120 communities in the western United States. Results from these pilot studies can potentially help funding allocation that targets specific communities for risk-reduc-

tion activities, and improve community wildfire protection planning process as case studies are implemented. The outputs from this study are being distributed through a new interactive geospatial Web portal that allows communities to interact with social and biophysical assessment data and strategize potential mitigation activities.

This work contributes a landscape-science foundation for an "all lands-all hands" risk management approach consistent with the broad goals of the new federal wildland fire cohesive strategy. The work also has led to new science to analyze and understand wildfire risk transmission between federal, state, and private lands.

Contact: Alan Ager, aager@fs.fed.us, Jeff Kline, jkline@fs.fed.us

Partners: Portland State University, Oregon State University, USDA Forest Service Washington Office, State and Private Forestry, Rocky Mountain Research Station

Learning to coexist with wildfire

The impacts of escalating wildfire in many regions necessitate a more sustainable coexistence with wildfire. Homeowners and local government can take action through risk management and land-use planning informed by measures of local and regional fire hazard.

Viewing fire-related problems in the context of coupled socioecological systems provides insights into achieving a more sustainable coexistence with wildfire. Station scientists and collaborators summarized research on fire-prone ecosystems and fire effects on human communities through this lens, identified linkages in these coupled systems, and discussed recommendations for greater resilience in three fire-prone regions in the Mediterranean basin, the western United States, and Australia.

This research can help managers integrate current science into land use management and policy decisions that have broad implications for the future. Regardless of the surrounding ecosystem conditions, all communities can better coexist with fire by retrofitting homes against ember attack, managing fuels around homes, developing household and community plans for evacuation, and participating in risk-awareness education. For existing high-hazard wildland-interface areas, landowners have primary responsibility for pursuing the optimal combinations of adaptation measures, based on their local vulnerabilities and wildfire exposure. For development of new communities in high-hazard wildland-interface areas, governments will need to take a leadership role in planning. All these efforts can be guided by better mapping the local and regional fire hazard.

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

Partners: Australian National University, Canberra, Australia; Conservation Biology Institute, Corvallis, Oregon; CSIRO, Victoria, Australia; RMIT University, Melbourne, Australia; University of California Berkeley; University of California, Santa Barbara; University of Colorado, Boulder; University of Wollongong, New South Wales, Australia

Tool

BlueSky Playground prototype for the U.S. Army Corps of Engineers

Description:
This prototype tool was developed to meet the specific needs of military bases across the southeastern United States that do significant prescribed burning. The tool allows for a fast assessment of smoke impacts under a variety of burn prescription conditions, allowing the user to determine what prescription window will minimize the likelihood of adverse smoke impacts to populations or sensitive equipment.

Use:
The Army Corps of Engineers is currently testing this tool. Changes based on user feedback for this prototype have been extended to the regularly used BlueSky Playground web tool available to land managers across the country.

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

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

Tool

LiDAR data products for the Rim and King fires in California

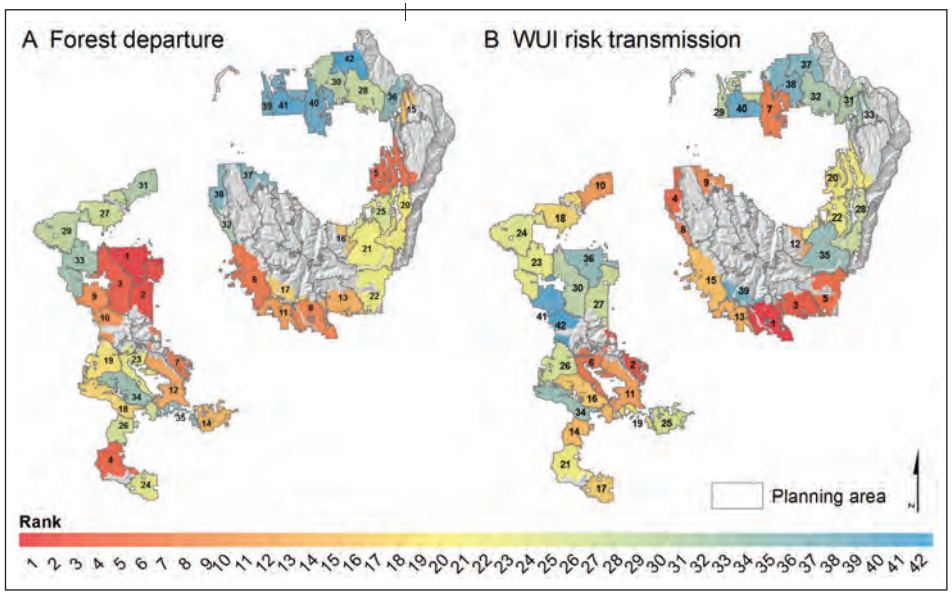
Description:
In August 2013, the Rim Fire burned over 257,000 acres in Yosemite National Park and the Stanislaus National Forest. In September and October 2014, the King Fire burned over 96,000 acres on the Eldorado National Forest. Three datasets are available for pre- and postfire conditions: (1) hyperspectral Airborne Visible/Infrared Imaging Spectrometer (AVIRIS), (2) MODIS/ASTER Airborne Simulator (MASTER), and (3) high resolution (~1m) LiDAR. Coverage for the prefire conditions varies but postfire data products cover the entire burned area for both fires.

Use:
In the past 5 years, unusually large fires have become more frequent across the western United States. Because of their historically rare nature and different behavior from other, more typical fires, information regarding drivers and their relationship to forest management practices has been limited. This project compiled prefire LiDAR data and postfire LiDAR data. An organized dataset is useful to ensure that any studies of pre- and postfire conditions and their relationships to fire behavior and severity are comparable.

How to get it:
http://wildfire.jpl.nasa.gov/

Contact:
Bob McGaughey, bmcgaughey@fs.fed.us

Partners:
California Institute of Technology Jet Propulsion Laboratory; University of California, Irvine; University of Washington; USDA Forest Service Pacific Southwest Research Station; Utah State University



Output from the Landscape Treatment Designer showing planning area priorities for treating ecological departure (A) versus wildfire transmission to the urban interface (B) for the Wallowa-Whitman National Forest in northeastern Oregon. The program can quickly prioritize planning areas and perform tradeoff analysis between alternative restoration scenarios.

Coupled biophysical and social dimensions planning framework used to mitigate wildfire risk mitigation in Wallowa-Whitman National Forest

Scientists demonstrated a new approach to prioritize planning areas and identify tradeoffs with respect to ecological restoration, forest health, fire protection in the wild-land-urban interface, and wood production on the Wallowa-Whitman National Forest in eastern Oregon.

The backlog of active restoration needs on national forests in Oregon and Washington has stimulated interest in new ways to prioritize projects and improve the efficiency of restoration and fuel management programs. The Landscape Treatment Designer, a spatial optimization program, can be used at a

range of scales to prioritize management activities and understand policy tradeoffs associated with specific restoration goals. The work quantifies tradeoffs and conflicts associated with multifaceted restoration programs on national forests. Understanding these tradeoffs as part of the collaborative planning process can facilitate the development of optimal restoration scenarios to meet the socio-ecological goals of accelerated restoration programs.

Scientists used the Landscape Treatment Designer to quantify tradeoffs among restoration goals and prioritize planning areas on the Wallowa-Whitman National Forest. The demonstration yielded several outcomes: (1) The Wallowa-Whitman National Forest incorporated the results into its 5-year program of work; (2) The analysis was presented to the local collaborative group to illustrate specific tradeoffs in their restoration program and explain the rationale for prioritizing future restoration projects; (3) The forest developed a comprehensive understanding of the variation among and within its 42 planning areas in need of restoration and the potential to address socioeconomic issues.

Contact: Alan Ager, aager@fs.fed.us

Partners: USDA Forest Service Pacific Northwest Region, Washington Office State and Private Forestry

Seven core principles for restoring fire-prone landscapes of the Inland Pacific Region

The Nature Conservancy is applying these principles to land in central Washington.

More than a century of forest and fire management of Inland Pacific landscapes has transformed their successional and disturbance dynamics. Current efforts to address these impacts yield a small footprint in comparison to wildfires and insect outbreaks. Many current projects emphasize thinning and fuels reduction within individual forest stands while overlooking large-scale habitat connectivity and disturbance-flow issues.

Station scientists and collaborators focused on landscape-level prescriptions as foundational to restoration planning and execution. They offer seven core principles, which provide a solid framework for landscape restoration throughout the Inland Pacific. To restore key resilience characteristics to current landscapes, planning and management are needed at ecoregion, local-landscape, successional-patch, and tree-neighborhood scales. Restoration that works effectively across ownerships and allocations will require active thinking about landscapes as socioecological systems that provide services to people within the finite capacities of ecosystems. This research can help managers

Tool

Wildland Fire Emissions Information System v. 0.5

Description: The Wildland Fire Emissions Information System (WFEIS) is an online application that allows users to compute wildland fire emissions in any location across the continental United States and Alaska for the time period 1984-2013. WFEIS uses Fuel Characteristic Classification System (FCCS) fuelbeds and Consume in its computations. This version of WFEIS was updated to use Consume v. 4.2.

Use:
WFEIS is used by landscape, carbon, and air quality modelers to estimate large-scale carbon fluxes to the atmosphere associated with wildland fire.

How to get it:
http://wfeis.mtri.org/

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

Tool

Air Quality Monitoring Reporting Web Tool

Description:
This new Web-based tool makes it simple to see the real-time updated conditions measured from both permanent and temporary air quality monitors across a wide array of monitoring networks. The tool allows the user to quickly generate a report for monitors of concern (e.g., near a fire) and easily obtain updates to this report throughout the day.

Use:
This tool is now a standard part of the Air Resource Advisor toolkit, used in incident support nationwide.

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

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

U.S. Forest Service

The 2015 Okanogan Complex Fire in eastern Washington was the largest in the state's history. BlueSky was used to project smoke dispersal from that fire.

and decisionmakers integrate current science into land use management and policy decisions that have broad implications for the future.

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

Partners: Aldo Leopold Wilderness Research Institute, The Nature Conservancy, The Wilderness Society, University of Montana, University of Washington, Washington Conservation Science Institute, USDA Forest Service Pacific Southwest Research Station and Rocky Mountain Research Station

Fish and Wildlife

What makes habitat a home? Our scientists work to answer this question for the many different species of fish and wildlife that live, hunt, breed, spawn, or otherwise spend time in national forests and waterways. Information about the specific needs and interactions among species and their environment helps land managers plan treatments with minimal impact, and where possible, enhance the habitat for fish and wildlife.

Katie Moriarty

A Pacific marten in Lassen National Forest. California.

Highlights in 2015

- Streams in Tongass National Forest were classified based on their likely suitability for salmon spawning habitat with predicted higher stream flows. This information can be used to focus mitigation and restoration efforts.
- Cold-water refuges for fish will benefit from management that enhances riparian habitat and decreases wildfire intensity under projected future climates.
- Radio-tagged barred owls yield better understanding regarding the degree of similarity in habitat preferences between barred owls and threatened northern spotted owls.
- Expanded habitat models for key prey of northern spotted owls help Siuslaw National Forest plan forest thinning projects while ensuring adequate prey near areas with known spotted owl pairs.

Don MacDougall

Station scientists found that salmon spawn in areas where the energy of high streamflows can dissipate across the floodplain like this one in southeast Alaska. This reduces potential for high streamflows to wash the eggs downstream.

Increased winter stream flows: effects on salmon egg and embryo survival

Will higher flows scour salmon eggs from their nests (redds)? Scientists identified streams within the Tongass National Forest where higher stream flows could reduce the suitability of spawning habitat for pink and Coho salmon.

Warmer winters resulting from climate change will lead to higher streamflows in southeast Alaska. Some studies suggest that the higher flows will result in more salmon egg mortality as the eggs are scoured from the streambed. However, the geomorphic features of a stream largely determine the response of the streambed to high flows. Salmon spawn in low-gradient, wide-valley portions of the stream

network where the energy of high flows is dissipated laterally onto the floodplain, reducing the potential for scour.

Scientists classified the suitability of streams in every watershed in the Tongass National Forest for spawning by pink and Coho salmon (*Oncorhynchus gorbuscha* and *O. kisutch*). They determined potential changes in winter flows that could occur in the future with climate change and they modeled the likelihood of increased scour of developing eggs and embryos. These findings will inform management decisions relative to road restoration, mitigation efforts such as placing instream down wood, and other stream restoration activities.

Contact: Gordon Reeves, greeves@fs.fed.us

Partner: Oregon State University

Instream habitat restoration benefits Chinook salmon and steelhead trout

Study finds positive response by fish to instream restoration projects in the Entiat River watershed in Washington. These results are being used by restoration planners and by a larger monitoring program to help design and implement additional restoration structures in this watershed and others throughout the Upper Columbia River basin.

Engineered log jams and rock barbs extending from streambanks were installed to enhance instream habitat for Chinook salmon and steelhead in the Entiat River watershed, Washington. Scientists found more Chinook salmon using pools and the microhabitats created by the restoration structures compared to sites without restoration structures. Increased water depth at restoration structures appears to be the mechanism leading to increased Chinook abundance. The scientists also found that increased abundance of Chinook in pools with restoration structure was a result of increased habitat capacity for the fish, rather than the fish relocating from the untreated, poorer habitats. Steelhead trout were much more variable in their use of restored vs. unrestored microhabitats and were inconsistent in their numerical response to physical habitat variation.

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

Partners: Cascadia Conservation District, Integrated Status and Effectiveness Monitoring Program (ISEMP), NOAA-Fisheries, U.S. Bureau of Reclamation

Karl Polivka

Researchers prepare to conduct fish surveys along the Entiat River, Washington, to assess the effect of instream habitat restoration, a practice based on science published by the PNW Research Station decades ago.

Management can help keep cold-water refuges cool in the face of climate change and wildfire

How vulnerable are cold-water fish to changes in climate and wildfire? Is it possible for management to mitigate for either of these potential hazards?

Along with altering fire regimes, climate change has the potential to increase stream temperatures in many freshwater systems in the western United States. Cold-water fish, such as bull trout (*Salvelinus confluentus*), are not physiologically adapted to survive in warm environments and may become isolated in cool upriver areas, particularly during the summer. This isolation coincides with wildfire season, making these fish particularly vulnerable to the potential for local extirpation events.

Scientists modeled the potential effect of climate change and wildfire on the resilience of bull trout populations throughout the Wenatchee River watershed, Washington. They found that management actions that enhance riparian habitat and decrease predicted wildfire intensity may keep streams cooler and thus help bull trout. This research contributes to the body of work that allows managers and scientists to integrate current science into land-use management decisions that have broad implications for the future.

Contact: Rebecca Flitcroft, rflitcroft@fs.fed.us

Partners: Earth Systems Institute, Environmental Protection Agency, Joint Fire Sciences Program, University of Alaska in Fairbanks, USDA Forest Service Okanagan-Wenatchee National Forest

Joel Sartore, U.S. Fish and Wildlife Service

Bull trout (*Salvelinus confluentus*) are cold-water fish that are particularly vulnerable to warming stream temperatures.

Understanding the complexity of natural stream thermal regimes

Water temperature is a key element of aquatic habitats. New findings suggest that year-round monitoring of water temperature patterns can add value beyond summer-only data.

Stream temperatures can affect the metabolic rates of fish and other organisms, interactions between aquatic species, and timing of life history transitions such as egg hatching or migra-

Colin Sowder

A station scientist measures water temperature in the Snoqualmie River, Washington.

tion between habitats. Natural stream thermal regimes fluctuate over days and years as well as across the stream network. Relatively new spatial stream network models, which account for the branching nature of stream networks and the directionality of flow, can be used to harness water temperature monitoring data, providing predictions of biologically important aspects of stream thermal regimes across entire networks and understandings about how human actions may affect aquatic thermal regimes.

Scientists found that no single metric of stream temperature was sufficient to predict all biologically relevant aspects of stream thermal regimes. They found that insights from models of mean temperatures or summer-only data are not necessarily sufficient to predict other facets of the thermal regime, such as daily fluctuations in water temperature when salmonid eggs are incubating in gravels. Conclusions based on data collected in the summer may differ from those based on winter data.

Contact: Ashley Steel, asteel@fs.fed.us

Partners: NOAA Northwest Fisheries Science Center; University of Washington

Local stream conditions may protect trout populations from effects of timber harvest and climate change

Local habitat variability in northwest streams can help shield coastal cutthroat trout from the effects of forest harvest and climate change. In some cases, increased summer stream flows, a byproduct of timber harvests that left fewer trees to store and use groundwater, countered the effects of climate change.

Scientists designed a study to better understand habitat changes at the local scale. Considering both land use and climate change, they modeled local variability for trout habitat in Pacific Northwest streams. Their findings provide critical insights into the processes behind potential changes in species distribution and abundance. This study illustrates the importance of integrating local characteristics of watersheds into land-management decisions. The findings are relevant to resource managers developing plans that accommodate climate change, habitat needs of trout, and timber harvests.

Contact: Brooke Penaluna, bepenaluna@fs.fed.us

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

Tool

Global Ranavirus Reporting System (GRRS)

Description:
The Global Ranavirus Reporting System (GRRS) is an open-source Web platform designed for storing, sharing, and visualizing surveillance data on ranavirus. It is designed to meet the needs of a wide variety of users, including natural resource managers and researchers. Ranavirus is an emerging infectious disease associated with amphibian losses; it also affects fish and reptiles. Ranavirus is relatively poorly understood, and there is a need to enhance communication among researchers and managers.

Use:
Ranavirus scientists in the field or the lab will be able to upload datasets in multiple formats to the system, where they will be stored for easy download and analysis. GRRS users are able protect and share their uploaded datasets and examine datasets in views appropriate to their content (e.g., tables, maps, and charts). The GRRS will rapidly advance the scientific community's understanding of ranavirus epidemiology and help natural resource agencies and other organizations respond intelligently to new outbreaks.

How to get it:
https://mantle.io/grrs

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

Barred owl and northern spotted owls share some habitat preferences

Competitive interactions with barred owls are contributing to the population decline of the threatened northern spotted owl. Prior to the turn of the 20th century, barred owls were only found east of the Mississippi River. They have since expanded their range into the forests of western Canada and the Pacific Northwest and are now common throughout the range of the northern spotted owl.

Understanding the degree of similarity in fine-scale habitat associations for the two species will help land managers identify strategies for effective spotted owl conservation despite competition from barred owls. Station scientists sampled forest structure within home ranges of 14 radio-tagged barred owls in the Okanogan-Wenatchee National Forest. Three major forest types were found within the barred owl home ranges: (1) open ponderosa pine,(2) simple-structure Douglas-fir, and (3) complex-structure mixed grand fir. During the breeding season (spring and summer), barred owls used the complex-structure mixed grand fir more than the other forest types, but all three forest types were used equally the rest of the year. The vegetation conditions used by barred owls were similar to those used by spotted owls.

This research can help managers and scientists understand and plan for the effects of competitive interactions between barred owls and spotted owl populations and will contribute information for review of the listing status of the northern spotted owl under the Endangered Species Act.

Peter Singleton

The barred owl (above) is contributing to the decline of the federally threatened northern spotted owl.

Contact: Peter Singleton, psingleton@fs.fed.us

Partners: University of Washington, U.S. Fish and Wildlife Service

Where are the flying squirrels and woodrats?

Flying squirrels and woodrats are the primary prey of the northern spotted owl, a threatened species protected by the Endangered Species Act. An expanded model projects their abundance across the Pacific Northwest. The Siuslaw National Forest is using information from this study to determine where to conduct forest thinning to help ensure adequate prey near areas with known spotted owl pairs.

There is limited information for quantifying and predicting high-quality habitat for the key prey species of the northern spotted owl in some regions of the Pacific Northwest. This makes it difficult to know how timber harvest activities actually affect northern spotted owls and their prey.

To help close this knowledge gap, scientists are working on models that can predict prey habitat at the stand level to ensure that efforts to improve owl habitat over the long term have minimal effects on owls during the short term. They expanded on a model originally built for flying squirrel populations in western Washington to include woodrats, and extended it to Oregon. All land managers operating under the Northwest Forest Plan in Oregon and Washington will be able to use this information to help refine timber harvest prescriptions as well as the timing and location of those prescriptions to better support spotted owls.

Dave Roelof, Bureau of Land Management

A scientist coaxes a bushy tailed woodrat out of a trap. This field work is informing efforts to develop models that predict where quality habitat for key prey of the northern spotted owl is likely to be found.

Contact: Todd Wilson, twilson@fs.fed.us

Partners: Oregon State University; USDA Forest Service Pacific Northwest Region, Rogue-Siskiyou National Forest, Siuslaw National Forest, Umpqua National Forest; USDI Bureau of Land Management

Tool

Revised west-side elk-nutrition and elk-habitat-use models

Description:
The west-side elk-nutrition and habitat-use models for western Oregon and Washington were reformulated for easier application by users in ArcGIS® python script. The streamlined models will allow biologists and planners to more easily run the models in a GIS environment.

Use:
The elk-nutrition and elk-habitat-use models help managers evaluate the nutritional and habitat conditions of west-side landscapes and predict how likely elk are to use these landscapes. The models also project the effects of land management activities, like road closures and thinning, on elk nutritional resources and habitat use. Managers are using these models in forest planning and management projects.

How to get it:
http://www.fs.fed.us/pnw/research/elk/westside/index.shtml

Contact:
Jen Hafer, jhafer@fs.fed.us

Woodpeckers are picky about the wood hardness of snags excavated for nest sites

Only 4 to 14 percent of snags on the landscape can be used for nesting by six species of woodpeckers, finds a study on the east side of the Cascade Range. Current snag management guidelines may not provide enough suitable snags to sustain populations of woodpeckers and other cavity excavators.

Woodpeckers and other excavators are widely regarded as ecological keystone species for excavating cavities in trees. The cavities created by woodpeckers may be used by up to 25 percent of all forest wildlife. Land managers are often tasked with providing snags to meet conservation objectives, but many snags are never used and several species of woodpecker are at risk.

To learn more, station scientists conducted the first study to examine the role of wood hardness in limiting nesting opportunities. They measured wood hardness in more than 800 snags in different forest types on the east side of the Cascades. They found that all woodpecker species in the study were limited by wood hardness, even in burns where snag density was high. Most snags were too hard to be used for nesting during the study period. Lack of suitable snags for cavity excavation not only affects woodpecker populations; it limits populations of other wildlife that also use the cavities. Current guidelines may not provide enough snags for sustaining populations. These findings may also explain the rarity or declines in some snag-dependent wildlife.

Teresa Lorenz

Woodpeckers often use snags—standing dead trees—for nesting and to forage for insects. Above, a female white-headed woodpecker.

Contact: Teresa Lorenz, tlorenz@fs.fed.us

Partners: Okanogan-Wenatchee National Forest, University of Idaho, Washington Department of Fish and Wildlife, Oak Creek Wildlife Area

U.S. Forest Service

A marten fitted with a GPS collar to collect information on its movements in Lassen National Forest.

Forest thinning and fuels treatments that simplify forest structure hamper marten movements

The Lassen National Forest incorporates this information about marten movement in fuel treatment planning to minimize impact on species.

Habitat connectivity at landscape and regional scales is essential for gene flow among wildlife populations. Large, high-severity wildfires remove and separate habitat, as can fuel reduction treatments that simplify forest structure by removing downed logs, low branches, and small-diameter trees. Pacific martens (*Martes caurina*) live at high elevation (5,000 feet) and are associated with forests with older characteristics (e.g., trees with cavities). Martens are considered an indicator species for that ecosystem. It is unknown how martens will respond to changes in habitat resulting from fuel reduction treatments across large portions of the landscape. To gain a better understanding, scientists examined how marten movements in Lassen National Forest reflect the animals' perceptions of stand types that represent a gradient in forest complexity. The scientists found that forest management that simplified forest structure negatively affects connectivity of marten habitat and movement. Lassen National Forest is using the data on marten movements and rest sites in its planning efforts to minimize negative effects of fuel treatments on martens. The forest is also considering ways to strategically increase structural complexity within managed stands at higher elevations.

Contact: Katie Moriarty, kmoriarty02@fs.fed.us

Partners: California Department of Fish and Wildlife, Oregon State University, USDA Forest Service Lassen National Forest

Small mammals and riparian restoration efforts in the Blue Mountains, Oregon

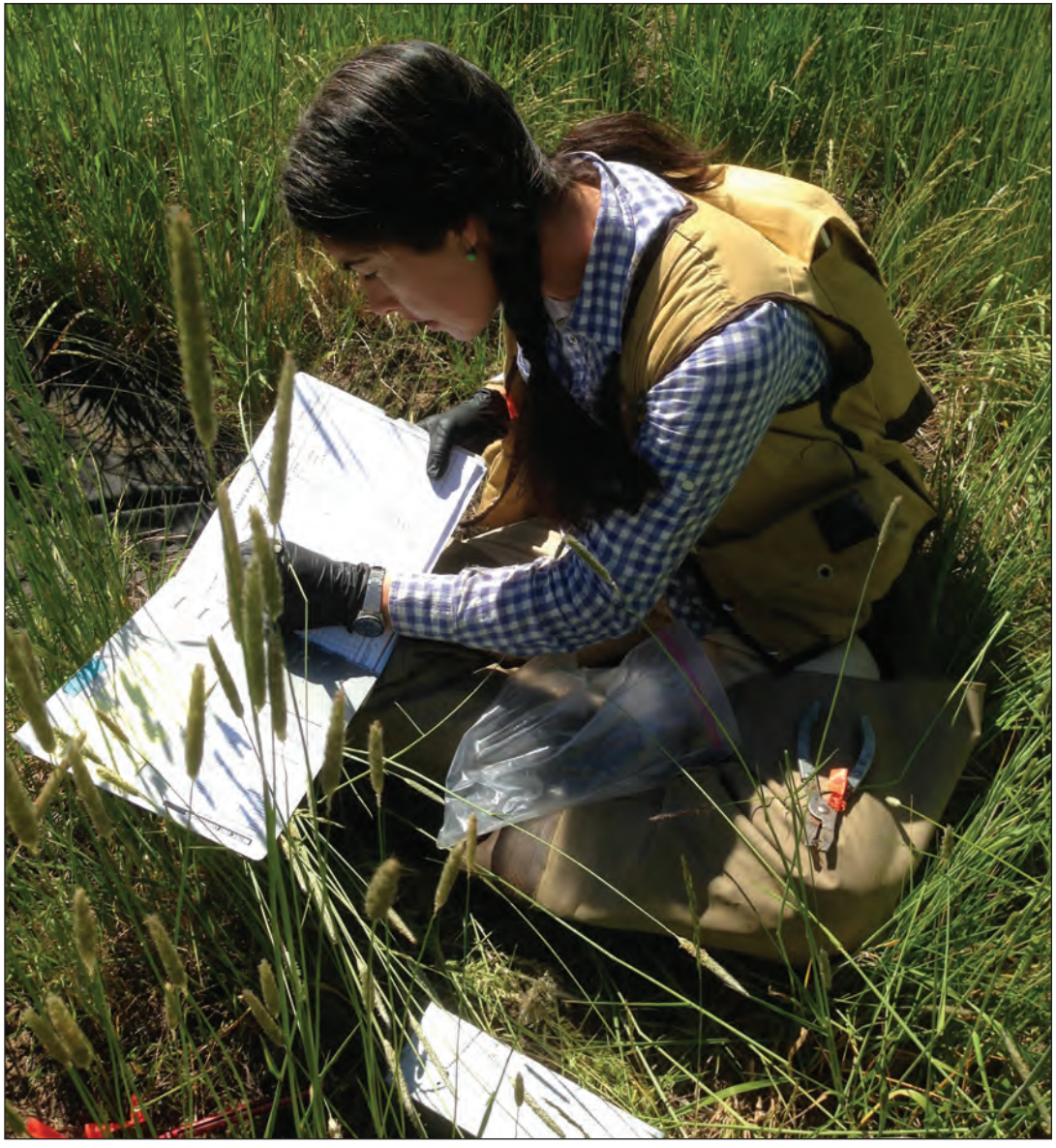
A multi-year study is underway to learn what small mammals are present in riparian ecosystems in the Upper Grande Ronde river system targeted for restoration (tree and shrub plantings, adding woody debris, installing fencing to exclude cattle and elk).

Small mammals play important roles for healthy riparian systems—they serve as prey for hawks, owls, reptiles, and other top-level predators. They also disperse seeds, pollen, and spores, including fungi needed by many trees and shrubs for nutrient and water uptake. Species of interest include mice, voles, shrews, squirrels, chipmunks, and woodrats.

This study fills a critical gap in our knowledge about how riparian restoration efforts affect the broad suite of wildlife species that depend on these ecosystems. The information could be used in the future to modify restoration prescriptions to improve the overall health and function of these ecosystems.

Contact: Todd M. Wilson, twilson@fs.fed.us

Partners: Oregon State University, USDA Forest Service Wallowa-Whitman National Forest



Todd Wilson

An employee of Oregon State University (a station partner) records data for a small mammal study at a site along Meadow Creek in the Starkey Experimental Forest and Range.

Inventory and Monitoring

Knowing what species are growing, thriving, or in peril in our national forests and waterways is essential for informed decisionmaking. Station research develops new tools and methods to efficiently and economically conduct inventory and monitoring that is fundamental to many of the land management activities in the region.

D.R. Irvine

Forest Inventory and Analysis in southeast Alaska.

Highlights in 2015

- The Forest Inventory and Analysis program implemented a new method for estimating the amount of carbon stored in moss and lichen in boreal and temperate forests.
- Software updates to FUSION/LDV—used worldwide for processing and modeling LiDAR data—include a tool for computing topographic metrics. This is useful when looking at factors influencing vegetation patterns across a landscape, for example, or local topographic features used by wildlife.
- A tablet-based system for collecting field data was developed and tested on 300 Forest Inventory and Analysis plots throughout the country. Data are uploaded daily to a server, allowing for near-real-time checks to data quality and prompt feedback to field crew.

Sarah Jovan

The tundra of interior Alaska hosts an incredible diversity of moss and lichen species that sequester carbon and regulate the water table, among other ecosystem services.

New method for estimating carbon storage in moss and lichen layers in boreal and temperate forests

Mat-forming ground layers of mosses and lichens are responsible for sequestering one-third of the world's terrestrial carbon. They also regulate water tables, cool soils, and inhibit microbial decomposition.

Mat-forming mosses and lichens have important functional roles in the ecosystem. Without reliable assessment tools, the potential effects of climate and land use changes on these important functions remain unclear. To fill this need, station scientists developed a nondestructive, repeatable, and efficient method for gauging these functions and evaluating responses to ecosystem changes. They used this method to estimate biomass, and carbon and nitrogen content for nine moss and lichen functional groups among eight contrasted habitat types in the Pacific Northwest and boreal Alaska.

Ground-layer cover, volume, standing biomass, carbon content, and functional group richness were greater in boreal forest and tundra habitats of Alaska compared to moss and lichen ground layers in Oregon forests and steppes.

Biomass of up to 22,769 kg/ha in upland black spruce forests was nearly double other reports, likely because this method included viable, nonphotosynthetic tissues. Functional group richness was greatest in lowland black spruce forests. High biomass and functional distinctiveness in Alaska ground layers highlight the need for increased attention to boreal and Arctic regions, which are projected to be among the most affected by climate change.

Contact: Sarah Jovan, sjovan@fs.fed.us
Partners: Oregon State University, USDA Forest Service Forest Health Monitoring

H.M. Johnson

A field technition sets a transect across a study plot. Accurate biomass measurements are essential for quantifying carbon stocks, locating bioenergy processing plants, and mapping fuel treatments.

Improving estimations of regional tree biomass and carbon

Developing nationally consistent methods for defining, measuring, and calculating biomass components will improve the reliability and application of biomass and carbon estimation.

Accurate biomass measurements and analyses are critical components in quantifying carbon stocks and sequestration rates, assessing the potential effects due to climate change, locating bioenergy processing plants, and mapping and planning fuel treatments. To this end, biomass equations will remain a key component of future carbon measurements and estimation. Researchers reviewed the present scenario of aboveground biomass estimation, focusing particularly on estimation using tree-level models. They identified opportunities to improve the accuracy of biomass and carbon estimates. For example, integrating taper and other attributes and combining different data sources would improve the accuracy of the estimates. Making use of already available resources such as wood density and forest inventory databases is one option. Sampling trees across the full range of forest conditions is also important. Researchers recommend a focus on collecting new data that merges tree taper and biomass sampling and includes estimates of belowground (root) biomass.

Contact: Andrew Gray, agray01@fs.fed.us
Partners: Oregon State University, University of Montana

Tool

Tablet-based field data collection system for carbon monitoring

Description:
To increase the efficiency of data collection and management, station scientists developed an iPad®-based field data collection system and are testing it on 300 plots distributed throughout the United States. The data collected on field plots is uploaded (wirelessly) to a server and the main plot database is updated on a daily basis, allowing for data quality checking and feedback to crews on a near-real-time basis.

Use:
The products developed from this study could help to inform and improve the efficiency of larger field data collection programs, such as Forest Inventory and Analysis, in the future. Although there will be challenges to implementing this system on a large scale, the benefits of managing data "in the cloud" (including near-real-time quality assessment) could increase the quality and timeliness of inventory database delivery in the future. This system is currently used only in a research setting, but it may provide insights into how tablet devices and cloud storage can be used to increase the efficiency of both research and production inventory applications.

Contact:
Hans-Erik Andersen, handersen@fs.fed.us

Partners:
Cirrus North, Inc., University of Washington

Tool

Updated user tools for PNW-FIA database

Description:
This tool integrates the public Forest Inventory and Analysis (FIA) database with a simple interface, allowing users to begin working with complex FIA data to answer meaningful questions about forest resources. This updated set of user-friendly tools now includes data from Alaska, California, Oregon, Washington, and U.S.-affiliated Pacific Island groups. Additional features include re-measurement data from FIA plots sampled from 2001–2014, an expanded set of summary tables, and greater customization for specific users.

Distribution:
The annually updated PNW-FIA database user tools (PNW-FIADB) are publicly available. Existing clients and known users receive email alerts when website updates are posted. Workshops are available for those interested in learning more about the database and FIA data in general.

How to get it:
http://www.fs.fed.us/pnw/rma/fia-topics/inventory-data/index.php.

Contact:
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Jason Hollinger

This lichen (*Evernia mesomorpha*), common in the northeastern United States, is a strong indicator of air quality and climate. It is sensitive to pollution and is associated with cooler habitats.

New indices using lichens are developed to monitor changes in air pollution and climate for the northeastern United States

Even the cleanest areas in the Northeast may have air pollution that exceeds the critical threshold to fully protect lichen communities.

Lichens have a long history as strong indicators of air quality. They have also been used as indicators for forest response to other environmental factors such as climate. Scientists developed two lichen-based indices to efficiently monitor changes in air pollution and climate in forests across the northeastern United States. The Pollution Index was correlated with modeled deposition of acidifying sulfur and oxidized nitrogen and with lichen community ordination pollution axes. The Climate Index was correlated with minimum January and annual maximum temperatures. The two indices are statistically independent. Repeat sample variability for each index was 7 to 14.5 percent, supporting detection of consistent trends of 16- to 20-percent change over time or variation across space. The continuous gradient of Pollution Index values suggests that even the cleanest areas in the Northeast may have air pollution that exceeds levels above the critical threshold to fully protect lichen communities.

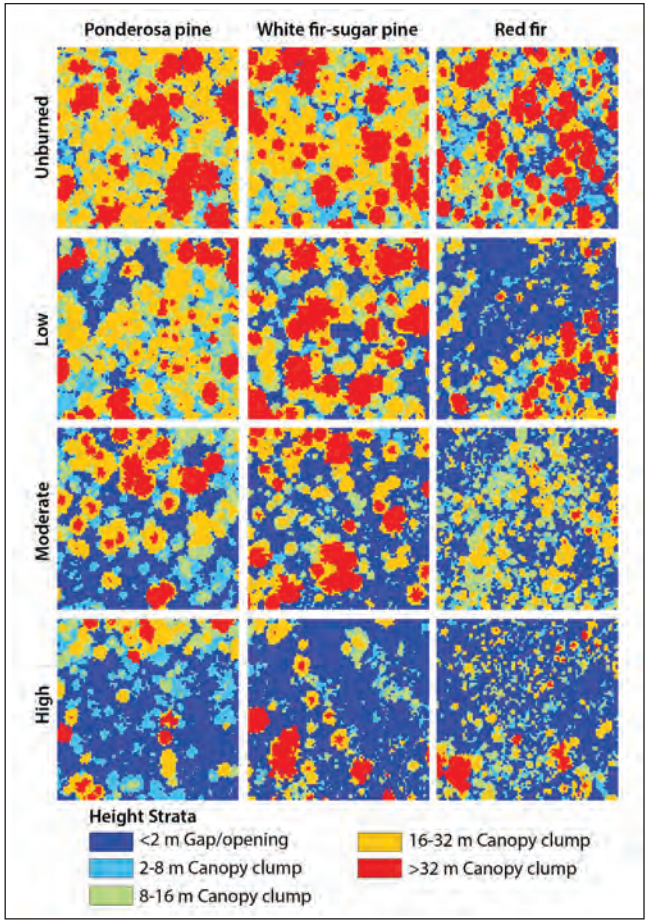
Contact: Sarah Jovan, sjovan@fs.fed.us

Partners: Pennsylvania State University, University of Wisconsin, USDA Forest Service Northern Research Station, USDI National Park Service

Landsat and airborne LiDAR data used to assess fire effects on forest spatial structure in Yosemite National Park

Low-to moderate-severity fires best replicated the historical clump-opening patterns that were common in forests with frequent fire regimes.

Mosaics of tree clumps and openings are characteristic of forests dominated by frequent low- and moderate-severity fires. When restoring these fire-suppressed forests, managers often try to reproduce these structures to increase ecosystem resilience. Scientists examined unburned and burned forest structures for 1,937 two-acre sample areas in Yosemite National Park. They estimated severity for fires from 1984 to 2010 using the Landsat-derived relative differenced Normalized Burn Ratio (RdNBR) and measured openings and canopy clumps in five height strata using airborne LiDAR data. They found three spatial structures—canopy-gap, clump-open, and open—that differed in spatial arrangement and proportion of canopy and openings. As fire severity increased, the total area in canopy decreased while the number of clumps increased, creating a patchwork of openings and multistory tree clumps.



An example sample areas (2 acres) for each forest-type, fire-severity combination from study in Yosemite National Park. Analysis on the influence of past fire activity on the spatial structure of a forest can help guide current forest restoration efforts.

Tool

Update to FUSION/LDV LiDAR processing and visualization software (version 3.50)

Description:
FUSION/LDV is free software developed by station scientists that is used worldwide in research, academia, and industry to process LiDAR data and then use the data to model vegetation structure over large areas. The newly released version 3.50 includes a tool to compute topographic metrics using bare-earth surface models. It computes basic metrics describing the terrain shape and orientation along with a topographic position index that compares local and surrounding topography. When computed using large window sizes, this index informs analyses of landform shape and position and has proven useful when looking at factors influencing overall vegetation patterns across a landscape and assessing variables such as moisture-related stress or solar input into riparian areas. When small window sizes are considered, the index helps identify local topographic features that influence vegetation patterns or serve as resting sites for animals.

How to get it:
http://forsys.cfr.washington.edu/fusion/fusionlatest.html

Contact:
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Tools

Updated DecAID (Decayed Wood Advisor)

Description:
DecAID is a publicly-available online tool that can be used by land managers to evaluate the effects of forest conditions and proposed management activities on wildlife species that use snags, down wood, or other wood-decay elements. DecAID is a statistical summary of published research data on wildlife and forest inventory data, and of professional knowledge on fungi, insects, and pathogens. The tool was updated to include field data through 2014, and additional functionality is being added.

Use:
Users can incorporate this information into stand growth and harvest simulators, such as the Forest Vegetation Simulator (FVS), to predict snag and down wood numbers or to determine what numbers would be provided under management scenarios, and relate those outcomes to levels of wildlife use.

How to get it:
http://www.fs.fed.us/r6/nr/wildlife/decaid/

Contact:
Sharon Stanton,
sharonmstanton@fs.fed.us

These results suggest the following objectives when designing forest restoration activities: (1) reduce total canopy cover by breaking up large contiguous areas into clumps and large trees; (2) create a range of opening sizes and shapes, (3) create multistory clumps in addition to single-story clumps; (4) retain historical densities of large trees; and (5) vary treatments to include canopy-gap, clump-open, and open mosaics across project areas to mimic the range of patterns found for each forest type in this study.

Contact: Bob McGaughey, bmcgaughey@fs.fed.us

Partners: University of Washington; USDA Forest Service Pacific Southwest Research Station, Utah State University, U.S. Geological Survey, Yosemite National Park

Janelle Cossey

The Decayed Wood Advisor (DecAID)—an online tool used to evaluate the likely effects of proposed manage actions on wildlife that use snags and other decaying wood—has been updated with 2014 field data.

Resource Management and Landscape Resilience

The Pacific Northwest Research Station

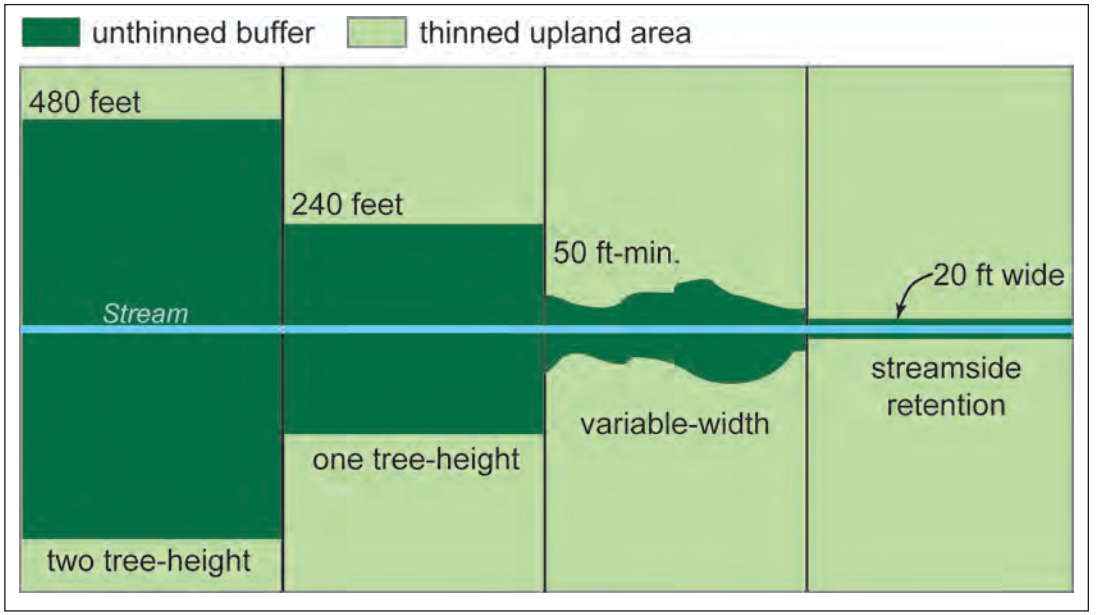
provides big-picture science, often working in partnership with national forests. We provide tools and information that can be used to assess tradeoffs and improve understanding of how restoration and management activities affect ecosystem resilience.

Connie Harrington

An Oregon State University student examines a Douglas-fir for needle cast diseases at a study site near Menlo, Washington, that is part of Douglas-fir Seed-Source Movement Trial.

Highlights in 2015

- Several lines of evidence indicate that 50-foot minimum variable-width buffers along headwater streams in western Oregon sufficiently mitigate effects to the riparian and aquatic environment from upland forest thinning.
- A science-management partnership yields information about smoke transport during prescribed burns. Better understanding of the meteorological conditions near Bend, Oregon, will help fire managers initiate prescribed burns on the Deschutes National Forest at times when smoke is least likely to intrude on the nearby city.
- Logging burned stands after severe wildfire resulted in less surface fuel 10 to 39 years after the fire, compared to unlogged burned stands. The amount of the reduction depended on logging methods, post-logging fuel treatments, and amount and size of wood left onsite to support wildlife habitat and other management objectives.
- A climate adaptation strategy for the conservation and management of yellow-cedar was developed for Alaska.



The Density Management and Riparian Buffer Study in western Oregon tested the effects of various buffer widths on headwater habitat and organisms.

50-foot minimum variable-width buffers along headwater streams sustain aquatic and riparian resources

How wide does a riparian buffer need to be to maintain aquatic and riparian habitat in and along forested headwater streams when upland forest thinning occurs? This is a controversial topic in the Pacific Northwest, where riparian buffers in western Oregon and Washington vary tremendously with land ownership and stream size.

Long-term experiments as part of the Density Management and Riparian Buffer Study of western Oregon investigate the interaction between upland forest thinning and various riparian buffer widths, ranging from 20 to 480 feet, on aquatic and riparian resources in headwater systems. Several lines of evidence indicate that 50-foot minimum variable-width buffers effectively retain sensitive salamander species, accelerate growth of streamside riparian trees, and provide down wood for instream habitat, as well as protect other resource conditions and processes along headwater streams in western Oregon. These findings have bearing on management decisions relative to streamside riparian reserve widths along headwater streams in the Oregon Coast Range and western Cascades.

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

Partners: Environmental Protection Agency, Oregon State University, U.S. Geological Survey, USDI Bureau of Land Management

Shannon Claeson

Trout Creek, Washington, 2 years after removal of the Hemlock Dam.

River conditions are improved with a modified dam removal strategy in Washington state

A modified dam-removal strategy used on the Hemlock Dam successfully minimized downstream sedimentation while restoring migratory steelhead access and improving conditions for other aquatic life. This study compared with other dam-removal strategies and their ecological effects. The findings can help watershed managers determine the best method of dam removal given specific restoration objectives, while establishing benchmarks for future comparisons.

Throughout the nation, dams have dramatically altered many rivers and ecosystems. Now many of these dams are aging and becoming unsafe, have reservoirs that are filled with sediment, or are simply no longer needed. Dam removal is increasingly considered for river restoration. Environmental responses to dam removals differ because of differences in the type of dam and the hydrologic and geomorphic context of the river. The size of a dam and river limit the range of feasible dam removal and restoration strategies. Removal of moderate-sized dams may significantly affect water quality and aquatic habitat, yet mitigation of effects may be possible with a modified removal strategy.

The Hemlock Dam on Trout Creek in southwest Washington (26 feet tall, 184 feet wide) impeded migration of an important run of threatened steelhead. However, standard removal operations were anticipated to release high volumes of fine sediment, which could harm juvenile fish downstream and lead to habitat degradation. Therefore, a modified removal strategy was designed to limit channel erosion and improve aquatic habitat by excavating stored sediment and reconstructing a channel in the former reservoir, in addition to removing the dam.

The modified dam-removal strategy successfully minimized downstream sedimentation while restoring water temperatures and other aquatic conditions. Currently, watershed managers have few dam-removal case studies on which to base expected results for river systems and even fewer where modified removal strategies are required. This study's comparison of ecological effects with other dam-removal strategies may help watershed managers plan future dam removals by informing expectations of response time of the river system to the new conditions.

Contact: Shannon Claeson, sclaeson@fs.fed.us

Partners: USDA Forest Service Gifford Pinchot National Forest

Tool

Ecosystem Management Decision Support (EMDS) System, version 5

Description:
EMDS is a spatial decision-support framework for environmental analysis and planning that brings logic processing and multi-criteria decision analysis to integrated, multiscale spatial decision support. The new version of EMDS has been completely re-engineered and optimized, resulting in 10- to 100-fold improvements in processing speed and database handling capacity.

It has improved interfaces for viewing and customizing map products, and producing and comparing multiple alternative scenarios that let users explore changes to data and models. EMDS 5.0 lays essential groundwork for integrating extremely powerful new tools to the framework over the next few years, including support for designing and implementing workflows so that users can extend the functionality of the system or automate complex geoprocessing sequences, and introduction of provenance tracking, which will provide comprehensive documentation of project development as well as support backtracking and branching in complex analytical sequences.

Use:
The Forest Service uses EMDS as the primary system to support implementation of the agency's national Terrestrial Condition Assessment. The system has been used by universities, natural resource agencies, and research organizations around the world for environmental analysis and planning since 1997.

How to get it:
http://emds.mountain-viewgroup.com/

Contact:
Keith Reynolds, kreynolds@fs.fed.us

Eli Brownell, King County Parks

Restoration plantings in the Three Forks Natural Area in King County, Washington.

Forest Landscape Assessment Tool for urban settings

Washington's King County used this tool to collect and map data on 24,700 acres of county lands; information was used to develop and implement the county's forest stewardship plan and target restoration efforts of its volunteer program.

The Forest Landscape Assessment Tool (FLAT) is designed for use by municipal, park, recreation, and forest land managers and agencies. It is a set of procedures and tools used to rapidly determine forest ecological conditions and potential threats in urban settings. FLAT enables planners and managers to understand baseline conditions, determine and prioritize restoration needs across a landscape system, and conduct ongoing monitoring to achieve land management goals. The rapid assessment process presents a cost-effective opportunity to use ecological data to guide decisionmaking and improve environmental outcomes on their lands. FLAT also can be used as a monitoring tool to evaluate changing conditions and inform adjustments in management strategies and priorities.

The Department of Natural Resources and Parks for King County, which encompasses Seattle, used FLAT to collect and map data on the county's parklands. The Green Everett Partnership also used FLAT when developing a 20-year forest management plan for the city of Everett, Washington.

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

Carbon dynamics in the hyporheic zone of a headwater stream

How do hydrology and biogeochemistry interact to control stream respiration and processing of carbon in forested headwater streams of the Pacific Northwest? Respiration of terrestrially derived organic carbon from the vast network of headwater streams could be a significant flux in global carbon budgets.

Pacific Northwest forests have high rates of primary production, absorbing significant quantities of carbon dioxide (CO_2) from the atmosphere. Absorbed CO_2 is transformed into organic carbon, the bulk of which is respired directly back to the atmosphere or stored as biomass or in soils. However, as much as 25 percent of the organic carbon may be transported to streams.

A study at H.J. Andrews Experimental Forest revealed that hydrologic interactions between the stream and the shallow aquifer underneath the riparian zone were critical in controlling the stream carbon budget. The stream water was always supersaturated with CO_2 with the greatest concentrations in late summer.

Concentrations of CO_2 in the saturated streambed sediment reached as much as four times that of the CO_2-saturated stream water. These high CO_2 concentrations in the hyporheic zone can't be explained solely by respiration of stream-source dissolved organic carbon. Rather, organic carbon in riparian soils appears to be an additional, critical source of carbon to stream ecosystems. Full accounting of carbon fluxes is critical for understanding the global carbon budget with respect to global change impacts. Accurate accounting will be critical for market-based approaches to control CO_2 emissions.

Contact: Steve Wondzell, swondzell@fs.fed.us
Partner: Oregon State University

Rick Edwards

Integrated terrestrial and aquatic research is revealing how water flux drives nutrient movement through the temperate rain forest, wetlands, peatlands, and streams of southeast Alaska.

Nutrient cycling through wetlands in southeast Alaska affects stream carbon

To better understand the role that the region's extensive wetlands play in nutrient cycling, station scientists and partners designed and implemented a regional watershed evaluation in southeast Alaska.

The coastal temperate rain forest of southeast Alaska can be characterized by the constant flow of water between terrestrial and aquatic systems. As the water drains from steep slopes into wetlands, streams, rivers, and estuaries of the Gulf of Alaska, it carries nutrients that influence the productivity of the watershed.

A regional watershed evaluation in southeast Alaska revealed that wetlands affect stream carbon concentrations. The research team's findings were integrated to create a model for the production and export of abundant organic material from wetland soils that is closely associated with the flux of water in the coastal temperate rain forest. Nutrient cycling and export of carbon, nitrogen, and phosphorus in peatlands and the cumulative impact of these cycles across several spatial scales is now better understood because of this collaborative terrestrial and aquatic research program.

These combined studies have established a fundamental understanding of the movement of carbon from terrestrial to aquatic zones in watersheds with significant wetland acreage. The information has established values for dissolved carbon, nitrogen, and phosphorus export from watersheds that can be used to develop methods for evaluating watershed conditions by forest managers.

Contact: Dave D'Amore, ddamore@fs.fed.us
Partners: Colorado State University, University of Alaska Fairbanks, University of Alaska Southeast, University of Washington, USDA Forest Service Alaska Region

Tool

Yellow-cedar website

Description:
Yellow-cedar can found from northern California to the Kenai Peninsula in Alaska. It is an ecologically and economically important species with special cultural value for Native Americans, yet relatively little information has been available about yellow-cedar. This website features more than 1,000 pictures of yellow-cedar. Pictures include shots of tree boles, tops of trees, and groups or stands of trees as well as specific features such burls, bark, or foliage. The site includes links to other sources of information on the species.

Outcome:
The website has been viewed by many natural resource professionals and others with a general interest in the species. Several national forests in Washington and Oregon have used it to add the tree to their list of species. To minimize vandalism, specific site locations are not posted online.

How to get it:
http://www.fs.fed.us/pnw/olympia/silv/YellowCedar/ycedarCover.html

Contact:
Connie Harrington, charrington@fs.fed.us

Partner:
USDI Bureau of Land Management

Connie Harrington

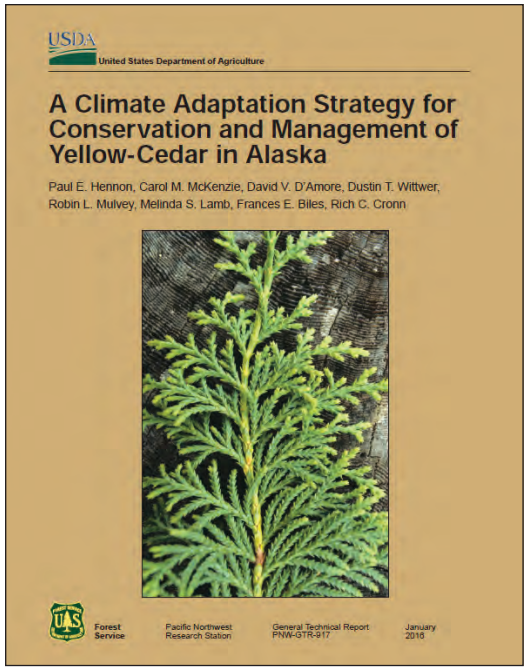
Giant yellow-cedar growing in the Olympic National Forest, Washington.

A climate adaptation strategy for conservation and management of yellow-cedar in Alaska

A new report assesses past, current, and expected future conditions of yellow-cedar in Alaska. The report reveals specific areas of yellow-cedar forest that are expected to remain healthy in the future and gives related options for monitoring these populations.

Yellow-cedar is an extremely valuable tree species along the northern Pacific coast but has been experiencing widespread mortality over the last century. Research by a team of Forest Service scientists and colleagues identified the cause of tree death as freezing injury to shallow fine roots during cold-winter and early-spring weather that occurs when snow is not present. A summary research paper published several years ago outlined a conceptual framework to develop a climate adaption strategy for yellow-cedar. This year, station scientists worked with a team of Forest Service Alaska Region experts to a write a comprehensive report that summarizes current knowledge on yellow-cedar, assesses its health status throughout Alaska, and offers opportunities to adapt conservation and management of yellow-cedar in Alaska.

The report has four sections: a review of the silvics, ecology, genetics, and many other aspects of yellow-cedar; a summary of the cause of forest decline and involvement of climate; considerations for conservation and management of yellow-cedar on suitable and unsuitable habitats; and new models that predict the health status of yellow-cedar forests now and in the future. An appendix gives detailed tables and maps for yellow-cedar occurrence, ongoing forest decline, and future risk to decline for 34 subregions in Alaska.



This publication is set to provide the foundation for management of yellow-cedar in Alaska.

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Partners: Stanford University; USDA Forest Service Alaska Region, State and Private Forestry

For more info: Hennon, P.E.; McKenzie, C.; D'Amore, D.V., et al. 2016. A climate adaptation strategy for conservation and management of yellow-cedar in Alaska. Gen. Tech. Rep. PNW-GTR-917. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 382 p. http://www.treesearch.fs.fed.us/pubs/50115

Timber and habitat tradeoffs associated with managing west Cascades forests to increase carbon storage

A new analysis describes potential timber and wildlife habitat outcomes that could result from national forest policies and management intended to store carbon. It characterizes joint production possibilities for multiple ecosystem services that are likely to result from specific management scenarios.

Policies for increasing carbon storage on federal lands are being proposed to address climate change. Although the effects of forest management on carbon dynamics generally are known, few studies have examined how carbon dynamics are influenced by different forest management regimes within specific ecosystems.

Scientists analyzed how different management regimes would affect carbon storage, habitat, and timber production in the Pacific Northwest. They found that the tradeoffs among these ecosystem services depend on the management regime. For example, managing Pacific Northwest forests to store forest carbon can be roughly complementary with the production of habitat for the olive-sided flycatcher, northern spotted owl, and red tree vole. However, managing forests to increase carbon storage potentially can be competitive with timber production and habitat for pacific marten, pileated woodpecker, and western bluebird, depending on the disturbance interval and harvest intensity.

Rhonda Mazza

The tradeoffs among carbon storage, wildlife habitat, and timber production depend on the management scenario that is used. H.J. Andrews Experimental Forest, Oregon.

Tools

Within-year prediction of tree mortality from bark beetles and wood borers

Description:
Provides a quick statistical assessment of the probability of tree mortality by using Aerial Detection Survey data from prior years, simulated weather data (PRISM), and elevation, slope, and aspect for the state of California.

Use:
The Pacific Southwest Region and CalFire are using this tool to prioritize high-risk stands in need of thinning.

Contact:
Nancy Grulke, ngrulke@fs.fed.us

Janelle Cossey

Wood borer insect damage.

Scientists found that forest management regimes typical of industrial forest lands (e.g., 40- to 80-year rotations with some tree retention for wildlife) represent only a small fraction of joint production outcomes possible in the region. Although some of the production possibilities sets developed in this study may be unachievable in the current management environment, they can be used to define the long-term potential of managing forests to produce multiple goods and values within and across multiple forest ownerships.

Contact: Jeff Kline, jkline@fs.fed.us; Tom Spies, tspies@fs.fed.us

Partners: H.J. Andrews Long-term Ecological Research program, NASA, Oregon State University

Weighing tradeoffs: reducing fire hazard, preserving water quality, protecting owl habitat

Scientists work with the Deschutes National Forest to apply an ecosystem services framework in a management context.

A science-management collaboration helped to identify the ecosystem services provided by the Deschutes National Forest and incorporate them into the design of management goals and restoration activities. Building on this work, a station scientist led a team in using optimization to weigh the tradeoffs inherent in reducing fire hazard in forested areas that also yield drinking water for residents in and around Bend, Oregon. The team also included the habitat of northern spotted owls as a consideration, allowing managers to understand the multifaceted effects of reducing fire hazard on water quality and owls. This is one of the first examples to quantitatively assess tradeoffs among ecosystem services that are important to managers when using an ecosystem services framework. This collaboration has reaped multiple benefits, and the Deschutes National Forest has achieved impressive restoration work that could not have happened otherwise.

Contact: Robert Deal, rdeal@fs.fed.us

Partners: Deschutes National Forest, University of Washington

Svetlana Schroder, University of Washington

A thinning treatment in the Deschutes National Forest. The fuel is piled for burning or transporting off site.

Tools

FP_DECK: Forest Plan Database and Exchange of Current Knowledge

Description:
This Web-based tool electronically archives completed forest plans in a searchable database.

Use:
Forest planners and managers will be able to examine similar forest-based activities, explore specific forest issues, and develop consistent templates that incorporate knowledge and expertise from several levels. National Environmental Policy Act coordinators will be able to efficiently evaluate the consistency of proposed actions and guide land managers through in-depth plan building. The public will be able to easily find information about specific topics.

How to get it:
http://fpdeck.taccimo.info/phpv_plan_list.php

Contact:
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Study models smoke intrusion during prescribed burn, yields better knowledge about smoke transport

This information is crucial for land managers wanting to use prescribed burning as a management tool while protecting air quality in nearby communities. Understanding the meteorological and fuel conditions that cause smoke to move in a certain direction will inform decisions about when to start and stop ignitions.

Smoke from prescribed fires in the Deschutes National Forest has negatively affected the city of Bend, Oregon, nine times over the past 2 years. These smoke events threaten the ability of land managers to use prescribed burning as a tool to mitigate hazardous fuels in the wildland-urban interface around Bend. Further complicating the situation is the narrow window that managers have to safely conduct prescribed burns. Meteorological and fuel conditions only meet burn requirements about 9 days per year.

The station and Pacific Northwest Region partnered the Deschutes National Forest to better understand meteorological conditions near Bend. This was part of an effort to increase the pace and scale of forest restoration while protecting air quality in nearby communities. To better understand when and how smoke intrusions from prescribed burns occur, scientists deployed up to 12 meteorological and smoke monitors during fall 2014 and spring 2015 in a 40-mile north-to-south transect from Sisters to Sunriver, Oregon.

U.S. Forest Service

Scientists set up a meteorological monitor prior to a prescribed fire in the Deschutes National Forest. The data from this and 12 other monitors were used to model smoke movement and intrusion into Bend, Oregon.

Station scientists successfully modeled smoke intrusion in Bend using a high-resolution smoke model. They are now analyzing the data to determine how the predominant wind directions vary diurnally and seasonally. A better understanding of the conditions that cause smoke to drain into Bend will allow for more targeted burn windows. Specifically, will smoke from a prescribed burn be transported up-drainage during the day of the burn, only to reverse flow and be transported down-drainage (toward Bend) over night and in early morning hours? Or is the problem smoldering on the burn unit overnight that continues to generate smoke close to the ground, which is then transported into Bend? Answering these questions will inform decisions about when to start and stop ignitions.

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Partners: USFS Region 6; Deschutes National Forest; National Weather Service

Postfire logging reduces future surface woody fuels in dry coniferous forests

Reductions in surface fuels were evident 10 to 39 years after wildfire in stands that were logged. Unlogged burned stands had less surface fuel 5 to 7 years after fire.

Severe wildfires create pulses of dead trees that affect future fuel loads, fire behavior, and fire effects as they decay and fall to the ground. A regional survey of surface woody fuels in dry coniferous forest stands that burned with high severity between 1970 and 2007 showed that, in unlogged stands, surface woody fuel levels were low shortly after wildfire, peaked 10 to 20 years after wildfire, and then declined gradually out to 39 years after wildfire. Stands that were logged shortly after wildfire had higher levels of surface woody fuels than unlogged stands for the first 5 to 7 years after fire, but then had lower levels of surface woody fuels from 10 to 39 years after fire.

This study shows that postfire logging can significantly reduce future surface woody fuels in forests regenerating following wildfires. The amount of fuel reduction depends on the volume and sizes of wood removed, logging methods, post-logging fuel treatments, and amounts of coarse woody debris left onsite to support wildlife habitat, erosion control, and other competing management objectives. This study provides a sound scientific basis for forest managers to consider fuel management goals along with recovery of economic value and wildlife habitat concerns when deciding when and where to propose postfire logging.

Nicole Vaillant

Nicole Vaillant

Photo points 1 year (left) and 8 years (right) after prescribed fire on the Modoc National Forest, California.

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Partners: Joint Fire Science Program, Oregon State University, USDA Forest Service Okanogan-Wenatchee National Forest

Scientists assess effectiveness of fuels reduction treatments in California

Fuel treatments are used to abate undesirable fire behavior and effects. Short-term effectiveness of fuel treatments to alter fire behavior and effects is well documented; however, long-term effectiveness is not well known.

Scientists evaluated surface fuel load, vegetation cover, and forest structure before and after mechanical and fire-only treatments over 8 years across 11 national forests in California: the Inyo, Klamath, Lassen, Modoc, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Stanislaus, and Tahoe National Forests and the Lake Tahoe Basin Management Unit. Eight years after treatment, total surface fuel load neared or exceeded pretreatment levels and herbaceous or shrub cover exceeded pretreatment levels two-thirds of the time.

Fire-only treatments warranted re-entry at 8 years to reduce accumulating fuel, understory vegetation and small-diameter trees. This would maintain and extend the intended effectiveness of fuels reduction treatments. In general, mechanical treatments were more effective. However, elevated surface fuel loads, canopy base height reductions in later years, and lack of restoration of fire as an ecological process suggest that adding prescribed fire to this treatment would be beneficial.

This information can be used in land management planning.

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Partners: USDA Forest Service Adaptive Management Services Enterprise Team, Pacific Southwest Region, Southern Research Station; Wildland Fire Management Research and Development

New seed zones for bluebunch wheatgrass are being field tested

The results will help local, state, and federal land managers in the Interior Northwest determine sources of bluebunch wheatgrass populations for postfire restoration

Bluebunch wheatgrass (*Pseudoroegneria spicata*) is an ecologically important species. It is found throughout the western United States and is often used to re-seed burned areas. Bluebunch wheatgrass populations differ in traits important for adaptation to precipitation and temperature. Scientists developed seed zones for bluebunch wheatgrass for the Interior Northwest. Now, a new transplant experiment is underway to investigate the efficacy of these seed zones. The study will explore how different populations of bluebunch wheatgrass will adapt to changing climate. The results will help land managers determine the best sources of bluebunch wheatgrass populations for postfire restoration for a particular area. This research will inform the Native Seed Strategy by enhancing our understanding of methods that yield locally-adapted plant materials in an economical fashion.

Holly Prendeville

Researchers plant bluebunch wheatgrass to test the efficacy of seed transfer zones at a study site in the Bureau of Land Management's Burns District, Oregon. Their findings will help postfire restoration efforts.

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Partners: USDA Forest Service Rocky Mountain Research Station, USDI Bureau of Land Management

Socioeconomic Dimensions

Forest Service research exists because society values forests—for many different reasons. At the Pacific Northwest Research Station, our challenge is to generate understanding about the many different values citizens hold for natural resources. With this information, decisionmakers and land managers can work to sustain the quality of life that natural resources provide.

Susan Charnley

Resource managers, scientists, and members of several local forest collaboratives discuss forest restoration during a field trip in the Umatilla National Forest, Oregon.

Highlights in 2015

- Alaska-specific Community Biomass Handbook is published. The companion calculator helps users quickly assess wood-energy options so they can make informed investment decisions.
- Timber demand projections through 2030 for the Tongass National Forest are completed. The Alaska Region of the Forest Service is using these to set allowable cut targets for the forest.
- Inexpensive method developed that uses moss to measure air pollution around schools in Portland, Oregon. The Oregon Department of Environmental Quality used these results to guide placement of air quality monitors.
- Research on the capacity of forest collaboratives in Oregon and the similarities and differences among them sets groundwork for understanding their potential to achieve goals and which characteristics may be linked to their successes.

Wood and coal cofiring tests demonstrate feasibility at interior Alaska power plant

Plant operations were not adversely affected, and cofiring woody biomass resulted in no appreciable changes in fuel storage, fuel handling, fuel mixing, combustion, or other measures of plant performance. These tests included using a wood-coal mix where the wood yielded 15 percent of the energy produced.

Burning a wood-coal mix to fuel power plants, rather than 100-percent coal, is one way to use woody residues and reduce fire risk if the woody residues come from fuel-reduction activities. This process, known as cofiring, also lowers carbon dioxide emissions from power plants because renewable energy feedstocks are generally regarded as carbon-neutral.

In Alaska, nearly 600,000 tons of coal are burned each year for electricity production, and interior Alaska can experience air quality problems year round owing to motor vehicle emissions and smoke from wildfires. Reducing the amount of coal burned can help improve air quality by reducing emissions from power plants, including sulfur and nitrogen compounds, as well as lowering ash levels. Woody biomass is plentiful in interior Alaska and can easily be cofired with coal using existing technologies. Although several test burns have been conducted in the past, cofiring wood and coal has not been conducted on an ongoing basis in Alaska. This work, led by station scientists, is helping to demonstrate the feasibility of using low-value waste woods for energy, including residues from a wood pellet production facility in interior Alaska.

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Partners: Aurora Power, Superior Pellet Fuels, University of Alaska Fairbanks

Dave Nicholls

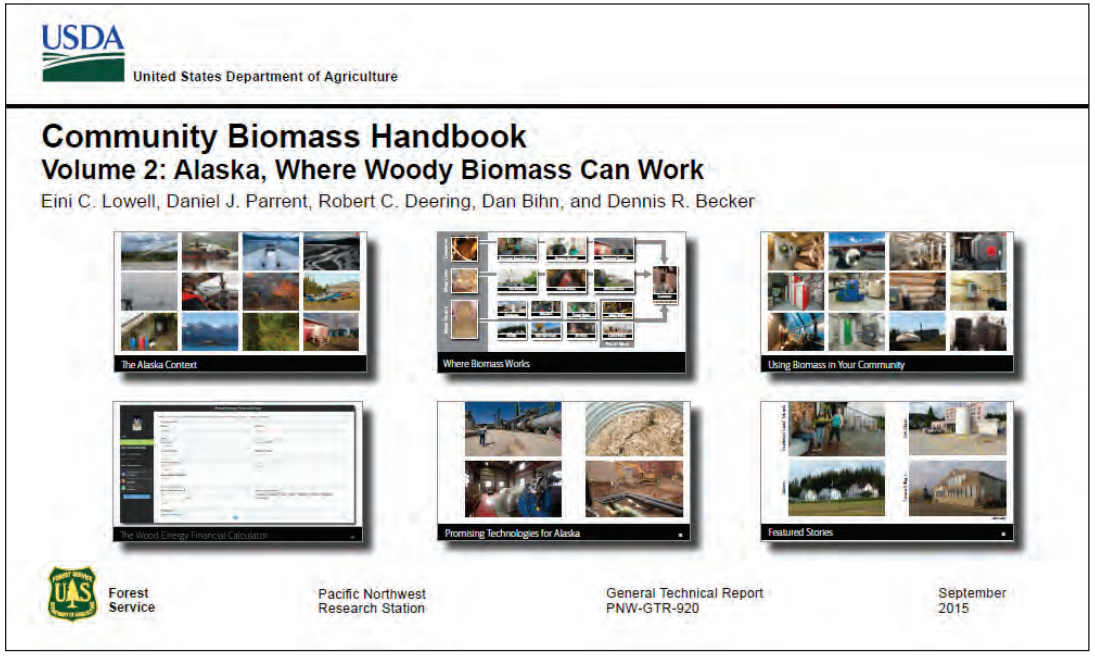
A wood-coal cofiring test burn at Aurora Power in Fairbanks, Alaska.

Community Biomass Handbook Volume 2: Alaska, Where Woody Biomass Can Work

This handbook is the first stop for individuals, businesses, and communities considering biomass heating in Alaska. It is designed to empower Alaska communities by helping them determine the best choices for their energy needs.

With little access to natural gas, many rural Alaskans depend on fuel oil to meet their heating needs. Alaska is the highest per-capita consumer of petroleum in the country, which makes Alaskans particularly vulnerable to high oil prices, price spikes, and delivery interruptions.

Using forest biomass for heating is a proven way to meet the thermal energy demands of communities and businesses, while also creating jobs, building infrastructure, and retaining wealth in rural Alaska communities. It also provides a financial means to use the byproducts of forest health restoration and wildfire risk reduction treatments throughout the state. This has national significance. It directly responds to goals of reducing reliance on nonrenewable fossil fuel, promotes diversification of energy portfolios, and addresses the USDA goal of advancing installation of commercially viable wood-energy systems.



Community Biomass Handbook Volume 2 and the companion interactive Wood Energy Financial Calculator, provide Alaska communities with the opportunity to quickly assess energy options that can help them save time and resources and allow them to make investments in appropriate technologies.

The Biomass Thermal Energy Council is now hosting the site where the financial calculator resides. The U.S. General Services Administration has also used the calculator to assess biomass heating options in federal buildings.

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

Partners: Alaska Energy Authority; Bihn Systems LLC; University of Alaska Extension; University of Minnesota; USDA Forest Service Alaska Region, State and Private Forestry

For more info: http://www.treesearch.fs.fed.us/pubs/49700.

Local production of wood pellets in southeast Alaska could yield environmental and financial benefits

Findings will benefit the Sealaska Corporation and Tlingit-Haida Regional Housing Authority as they attempt to develop a regional demand for wood pellets, while more efficiently using their pellet resources.

Wood pellets are an emerging renewable energy source in Alaska, yet currently pellets must be imported from Washington. A local production facility could greatly facilitate the use of pellets, while using resources from southeast Alaska.

Potential pellet producers need information on local system operations and project economics, including return on investment. Station scientists conducted a case study that examined two pellet burners at different scales of operation and different energy needs. They found that two Alaska Native organizations in Juneau that use wood pellets realized financial and environmental benefits. Favorable economic conditions were realized over a range of operating conditions, despite having to import pellets from Washington. Locally produced wood pellets would likely provide greater energy cost savings while creating local jobs. Because the wood pellets (a carbon-neutral fuel) were used instead of heating oil, additional environmental benefits have been realized. Within the past year, a third wood pellet burner has been installed in Juneau, helping to create infrastructure needed to use pellets more effectively. This research is helping guide the next generation of wood-energy systems in southeast Alaska.

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Partners: Sealaska Corporation, Tlingit-Haida Regional Housing Authority, USDA Forest Service, Alaska Region, State and Private Forestry

Linda Kruger

A Tlingit high school student and a station hydrologist conduct a beach survey in Yakutat, Alaska.

Interweaving science and traditional knowledge about shoreline changes in southeast Alaska

The southeast Alaska shoreline supports many fish and wildlife used for subsistence by Native Alaskans. Oral histories are being gathered from six villages to document observed physical changes to this environment and their effect on shoreline resources.

Southeast Alaska's coastlines extend nearly 19,000 miles, exhibiting a diversity of habitats from rocky cliffs to estuaries. Many stretches of beach are bounded closely by steep mountains, which limit settlement and wildlife habitat to the strip of coastline. These narrow bands at the boundary between land and sea support numerous fish and wildlife species and are critically important to the communities living there. The shoreline habitat is threatened by oil spills and toxic shellfish poisoning and is subject to tectonic shift and sea level rise.

Information about shoreline resources adjacent to southeast Alaska Native villages has been hard to find. A station scientist is gathering oral histories from Alaska Natives about the changes they are seeing. For example, some Alaska Natives say storms are more intense and beaches are starting to erode. Others says they have to go farther and farther out on the beach for clams. The scientist is studying sites at six Alaska Native villages and working with colleagues to summarize the relationship between physical features such as slope, nearshore ocean depth, substrate type, and length of open water, and biological features such as algae, blue mussels, eelgrass (important salmon and mussel habitat), and giant kelp.

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Partners: National Oceanic and Atmospheric Administration, Forest Service Region 10, Central Council Tlingit and Haida Indian Tribes of Alaska, Sitka Conservation Society, University of Alaska Juneau

Emily Jane Davis, Oregon State University

A field tour of potential collaborative projects in the Willamette National Forest.

Oregon forest collaboratives: what are the similarities and differences among them?

Collaboration is a currently a popular approach to resolving conflict around national forest management in Oregon, particularly in regards to forest health and wildfire-risk reduction. Are expectations about the influence forest collaboratives may have on management transferable to other regions? Or are group characteristics and processes uniquely place-dependent?

Oregon has at least 24 collaborative groups engaged with all 11 national forests in the state. As efforts increase to expand policies that encourage collaborative activities statewide, there is a need to better understand them. Scientists conducted a rapid census assessment of all Oregon collaboratives to better understand their composition and organizational capacity. For example, does the collaborative have a dedicated facilitator, active committees, and established policies and procedures? The scientists found many differences among the groups in terms of age, land-ownership focus, and dominant activities. This suggests that the groups' management interests and outcomes are likely to differ across the state. However, the assessment found a common set of organizational capacities across most the groups, indicating that a particular "model" of formal governance structure may have become the norm. This research is the first in a multiphased project to study Oregon's forest collaboratives, rate their efficacy at achieving their stated goals, and identify which characteristics may be linked to their successes.

Contact: Lee Cerveny, lcerveny@fs.fed.us

Partners: Oregon State University, Sustainable Northwest

Study of Blue Mountains forest collaboratives reveals trends in participation

Groups participating in multiple collaboratives might be candidates for outreach for landscape-scale engagement. A significant portion of groups involved in litigation or who have filed objections or appeals do not participate in collaboratives.

This study supports efforts by Blue Mountains forest collaboratives and the U.S. Forest Service to strengthen public engagement and outreach capacity for forest restoration efforts designed to address forest health and fire risk in dry, fire-prone forests in eastern Oregon and southeastern Washington. The scientists used social network diagrams to explore the composition of five different collaborative groups. This revealed trends in participation related to the diversity of groups included the balance of different types of groups, and the makeup of the "core" group of participants. The scientists also examined the groups that filed legal cases against Blue Mountains national forests, as well as groups that objected to or appealed national forest decisions between 2007 and 2014. They found that balance among different group categories within a collaborative is important. Most organizations focus their efforts on smaller geographic regions, such as one or more national forest.

Contact: Lee Cerveny, lcerveny@fs.fed.us

Partner: Portland State University

Tools

Human Ecology Mapping Tool

Description:
The Human Ecology Mapping (HEM) tool is a set of protocols and procedures used to engage the public around critical forest management issues using maps and other geospatial applications. HEM enables planners and managers to understand public values and uses of forest and rangeland landscapes. The tool captures public preferences for ecosystem services as well as desired future conditions for forest management. HEM also can be adapted for many types of planning processes, including travel management planning, forest plan revisions, and sustainable recreation planning, among others.

Use:
The tool can be used in many settings and in a variety of applications including with paper maps, electronic tablets and online applications. HEM is designed for use by forest planners and public affairs staff to bring together a diverse array of citizens, partners, stakeholders, landowners, and agencies together to provide systematic input to a planning process. The Olympic National Forest, Mount Baker-Snoqualmie National Forest, Deschutes National Forest, and Ochoco National Forest have used HEM to gather public input.

How to get it:
http://pdxscholar.library.pdx.edu/geog_occasionalpaper/7/

Contact:
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Outdoor recreation study maps the places people love

Shoppers at farmers' markets in King County, Washington, shared information about their favorite places for outdoor recreation. This kind of citizen mapping could play a valuable role in helping agencies enhance public access and recreation opportunities.

Many Oregon and Washington residents report participating in outdoor recreation. Through a novel study using citizen mapping exercises, a station scientist studied trends in recreation and other ways that humans value the natural landscape. She set up booths at more than a dozen farmers' markets in the greater Seattle region, including rural communities, and displayed a large map of King County. People put dots on the map to show places they favored in their free time for outdoor recreation, and such questions as, "Where do you go most often? What do you do there? How much time do you spend there?" More than 500 people participated, yielding thousands of data points that can be used to reveal patterns. Capturing this information at farmers' markets was a good opportunity to reach a cross-section of people

Mount Baker-Snoqualmie National Forest

The Human Ecology Mapping Tool is applied to better understand how people use and value the forest. National forests in Oregon and Washington have used it to gather public input. Above, a child picks huckleberries in the Mount Baker-Snoqualmie National Forest.

Lee Cerveny

At a farmers market in Carnation, Washington, members of the public identify some of their favorite places for outdoor recreation.

whose views might not otherwise be heard by federal land management agencies. This research could play a valuable role in helping these agencies enhance public access and recreation opportunities.

Contact: Lee Cerveny, lcerveny@fs.fed.us

Partner: Oregon State University

Cultural ecosystem services from forest land include sense of place

People living near the Deschutes National Forest value it for diverse reasons. Understanding the local context may help forest managers manage for these cultural ecosystem services.

Station scientists monitored recreation permits and held focus groups with forest staff and local stakeholders to find out what people consider to be the benefits of living near the Deschutes National Forest. The answers differed from the ecosystem services categories defined by the Millennium Ecosystem Assessment, a report called for by the United Nations that assessed the consequences of ecosystem change to human well-being.

The researchers found that some of the provisional services (for example, symbolic uses, hunting, fishing) had strong cultural meanings. Sense of place was hugely important. They also captured new categories that were not included in the Millennium Ecosystem Assessment list such as homes for the homeless and boundaries for growth and development. Their results suggest that forest managers will be more successful if they understand the local context for ecosystem services instead of following a standardized list.

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Partner: University of Washington

Tools

Forest Restoration and Utilization Calculator v 1.0

Description:
The calculator estimates the jobs and income supported in local communities by restoration projects on federal forests in Oregon. The calculator has a simple spreadsheet interface and requires users to input basic information about the forest restoration work performed, timber volume generated, and where the project took place.

Use:
In 2015, the calculator was used to analyze forest collaborative projects on the Fremont-Winema, Malheur, and Rogue-Siskiyou National Forests. Output from the calculator was used in a report on the outcomes of Oregon's 2013-2015 Federal Forest Health Program that was funded by the Oregon Legislature.

How to get it:
http://ewp.uoregon.edu/calculate

Contact:
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Partner:
University of Oregon

New report analyzes change in California's forest-products industry and timber harvest, 2006–2012

Timber harvest declined 18 percent; 83 percent of the 2012 harvest came from private lands; and more than half of the wood fiber harvested was used to generate energy either as heat for steam or electricity.

The Forest Inventory and Analysis program includes regular production of statewide assessments of timber-products outputs. These studies trace the flow of a state's timber harvest through the primary wood-products industry and provide a description of the structure, condition, and economic impacts of the forest products sector. Historical trends also are discussed.

This report covers changes in California's forest-product industry between 2006 and 2012. It summarizes the most recent information on California's timber utilization and the conditions, structure, and operations of the state's primary forest-products industry. This research can help land managers, policymakers, and the forest-products industry make informed decisions that have broad implications for the future. This report is the third such study of California's timber harvest and forest-products industry since 2000, providing important historical context for future policy decisions.

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Partner: University of Montana

Tongass National Forest Timber Demand, Projections for 2015 to 2030

The Forest Service Alaska Regional Office is using these latest projections to set annual allowable cut targets for the Tongass National Forest. The projections are also informing the environmental impact statement under development for amending the Tongass Land Management Plan.

Proposed changes in forest policy regarding the harvest of timber on the Tongass National Forest in southeast Alaska have resulted in a need to amend the most recent Tongass Land Management Plan. Efforts were set into motion by evolving USDA policy that limits old-growth harvesting and encourages the harvest of younger, second-growth forest. At the request of the Forest Service Alaska Region, station scientists developed three potential future scenarios affecting Tongass timber demand: (1) response to the young-growth transition, (2) expansion of bioenergy markets, and (3) recovery of the U.S. housing market. Initial demand projections suggest that developing markets for dimensional lumber and low-quality and utility logs will be crucial for the wood products industry in southeast Alaska to remain viable following the transition to young-growth harvest. The model developed by the scientists accounts for all material harvested in southeast Alaska by landowner, final product, and destination. This is the fifth such economic analysis performed for the Tongass National Forest by the station.

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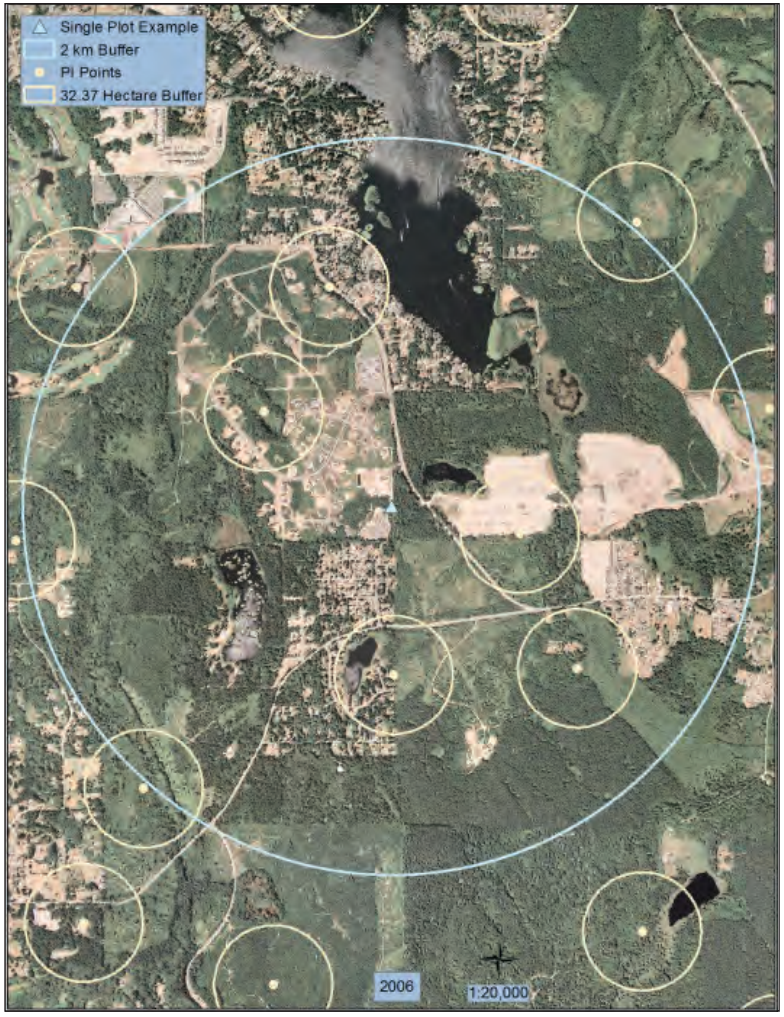
Houses near the forest

Rural residential development in forests of Oregon and Washington continues to be a key driver of land use change. Proximity and amount of development affects forest structure, invasive plant abundance, and probability of management of remaining forested lands.

With greater housing density and shorter distances between housing, there tends to be less standing and dead down wood, lower abundance of conifer trees, and fewer large trees. Invasive plants and forest fragmentation increase with greater housing density and shorter distances between housing.

Summary: Rural residential development can have various effects on the goods and services that forests provide to the region. Scientists used structure density from photo-interpreted points around Forest Inventory and Analysis plots to examine differences in forest attributes with respect to varying development metrics. Their results demonstrate that forest ownership (public vs. private), structure density, and proximity of development are critical factors in explaining variation in forest attributes. Small-scale fragmentation, standing dead tree volume, coarse woody debris, and the propensity for introduced species are all affected by development close to the borders of public land.

Differences in coarse woody debris, small-scale fragmentation, and propensity for introduced species are also affected by the density and proximity of development on private ownership. The likelihood of forest management decreased with proximity to development on private lands, while on public lands, forest management increased when private development was nearby.



Forest management on private land tends to decrease as proximity to residential development increases. Above, points on an aerial photo used to examine differences in forest attributes.

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

Partner: Oregon State University

Julie Johnson

A station scientist collects moss samples that will be analyzed for the presence of airborne toxins.

An innovative study uses moss to measure air toxin levels at Portland schools

Air pollution has been linked to major health problems including cancer, cardiovascular disease, and adverse birth outcomes. Children can be particularly vulnerable to certain airborne toxins like heavy metals.

Mosses and lichens are like sponges, absorbing moisture and nutrients from the air and from rain. In doing so, they also pick up contaminants that they store in their tissue, making them a living record of pollution levels in the nearby environment. Because they are so widespread, they provide a handy and inexpensive method for sampling air pollutants and mapping pollution sources.

An innovative study by station scientists used moss samples to measure the levels of air pollution throughout Portland, Oregon. The scientists also collected moss from 110 K-12 schools across the Portland metropolitan area to analyze for a variety of air pollutants identified as priorities by the Environmental Protection Agency. One school took the opportunity to engage several third- and fifth-grade science classes in their study.

The Oregon Department of Environmental Quality (DEQ) has been following the results of this intensive sampling. The detailed deposition maps, based on the collected data, show the location and concentration levels of airborne toxins across the Portland area. Based on these findings, Oregon DEQ placed new permanent air quality monitors and several temporary mobile monitors in "trouble spots" that were previously unknown sources of heavy metals.

Contact: Geof Donovan, gdonovan@fs.fed.us; Sarah Jovan, sjovan@fs.fed.us

Visual access to nature has positive psychological effects

Viewing scenes of nature might improve student enthusiasm and even boost their grades.

Scientists explored the experiences and academic performance of 567 students randomly assigned to different sections of a composition class in the spring semester. Some classes were held in a room with a view of the Rocky Mountains, and other sections of the same class were held in an interior room with a view of a concrete wall. Students completed a questionnaire about their experience of the course, and their grades and attendance records were tracked.

Overall, students with a view of the mountains rated the course higher than students with a view of the concrete wall. Although attendance rates were no different between the two classrooms, students in the room with the natural view achieved higher final grades. These findings raise interesting possibilities for classroom design and challenge the notion that students perform best in windowless settings with no "distractions."

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

Experimental Forests and Ranges

The experimental forests and ranges of the U.S. Forest Service were established to provide opportunities for research and experimentation to develop new knowledge and practices to guide management of the nation's forest resources. The mission has evolved beyond a biophysical-sciences focus to more fully encompass contemporary perspectives of forest ecosystems as complex coupled human-natural systems.

The Pacific Northwest Research Station maintains 12 active experimental forests and ranges. The H.J. Andrews Experimental Forest in western Oregon and Starkey Experimental Forest and Range in eastern Oregon regularly host field tours, making them perhaps the most well known in the regional network. But each experimental forest, selected as representative of a particular ecosystem, attracts researchers from near and far. Researchers seek out these special settings that foster discovery about natural processes. These are living laboratories to test ideas that may become the best management practices of tomorrow. Following are a few highlights from some of the experimental forests.

Todd Wilson

Oregon State University students place small mammal traps at a study site in the Cascade Head Experimental Forest. They are contributing to a study that examines the role of small mammals in maintaining coastal meadow habitat that is used by the threatened Oregon silverspot butterfly.

Peter Pearsall, U.S. Fish and Wildlife Service

The threatened Oregon silverspot butterfly.

Cascade Head

Just a few miles inland from the Oregon coast, a new study at Cascade Head is examining the role that small mammal communities play in maintaining butterfly habitat. Small mammals serve as prey for top-level predators, disperse seeds and fungi, dig burrows used by reptiles and pollinating insects, and create soil disturbance that could promote the species of violet needed by the endangered Oregon silverspot butterfly. Considerable efforts and resources have been put into restoring habitat for the silverspot butterfly over the past 30 years, yet populations continue to decline and are nearing local extinction.

Findings from this study will contribute to restoration strategies for coastal meadows on Forest Service lands as part of a collaborative project with local landowners and nonprofit organizations.

Contact: Todd Wilson, twilson@fs.fed.us

Partners: Oregon State University; Salmon Drift Creek Watershed Council; USDA Forest Service Siuslaw National Forest; U.S. Fish and Wildlife Service, Nestucca National Wildlife Refuge

H.J. Andrews

Established in 1948, H.J. Andrews is representative of west-side Cascade forests. It is managed cooperatively by the station, Willamette National Forest, and Oregon State University. Early research included examining the effects of clearcutting with and without burning as well as various partial cutting practices on nutrients, streamflow, and sediment yield from small watersheds. Since then, its scope has broadened considerably. Today, H.J. Andrews is a nexus of interactions for science, education, arts, and management related to forest ecosystems.

Highlights in 2015

- The National Science Foundation renewed its support for the Long-Term Ecological Research project at H.J. Andrews. This 6-year LTER program increases the emphasis on human dimensions of forest ecosystems. This new emphasis is reflected in the breadth of research, education and experiential programs.
- H.J. Andrews hosted more than 160 researchers from throughout the United States and nine other countries; provided educational opportunities for more than 50 K-12 teachers and 570 university students; facilitated meetings for groups from agencies, universities, and the local and international community; and provided tours to more than 1,200 people.
- The experimental forest continues to lead the integration of science and the humanities through the ground-breaking Artists in Residence program, this year hosting 15 writers, scholars, and artists.

On the horizon

- Efforts are underway to define new research experiments at H.J. Andrews that explicitly study the relationships of public perception and human values to the processes of planning, implementing, and monitoring resource management activities. Such efforts will contribute strongly to future policy formulation and acceptance.

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

Partners: National Science Foundation, Oregon State University, USDA Forest Service Willamette National Forest, and many other universities and institutions

Theresa Valentine

Researchers use a backpack electroshocker in Lookout Creek in the H.J. Andrews Experimental Forest to document the presence and absence of fish species as part of a larger study examining factors that influence fish distributions.

U.S. Forest Service

Participants in the Strengthening Education and Employment for Diverse Students Program (SEEDS), sponsored by the station and Oregon State University's College of Forestry, receive training at H.J. Andrews.

Rick Edwards

Héen Latinee Experimental Forest, southeast Alaska.

Héen Latinee

Established in 2009, Héen Latinee is in the Tongass National Forest in southeast Alaska. It spans glacial to marine environments with coastal temperate rain forests in between. The site provides opportunities to learn how temperate rain forests function, particularly amid a changing climate.

Researchers constructed two weather monitoring stations at different elevations within the Experimental Forest. A third will be installed in 2016. This network of weather stations will monitor rain, total precipitation, and snow depth along with other weather measurements. The data will allow for improved hydrologic models and forecasts of changes in aquatic habitats as the experimental forest's three glaciers recede and the annual discharge and thermal regimes change. Local helicopter skiing charter operators will also use snow cover measures to better manage their heli-skiing operations within the experimental forest, a popular destination in the area.

One of two new weather monitoring stations in Héen Latinee Experimental Forest. The data will be used for research and by the National Weather Service to improve weather forecasting.

Temperate rain forests have very high carbon densities compared to other forest types. The Tongass National Forest alone contains about 7 percent of the carbon in forests in the United States. Because of the importance of forest sequestration on regional and global carbon cycles, and the potential mobilization of accumulated carbon caused by climate change, it is important to understand the factors that control forest productivity and the spatial distribution of aboveground biomass. To address this need, scientists examined how hydrology controls distribution of forest biomass in Héen Latinee.

Elevation and hydrology control biomass accumulation in the Héen Latinee Experimental Forest. There is little evidence that blowdown of trees (windthrow), the primary stand-replacing disturbance in southeast Alaska, influences current distribution of biomass and carbon.

Using ground surveys and a high-resolution LiDAR data set generated for the Héen Latinee Experimental Forest, scientists modelled the influence of nine different physical and topographic variables influencing the distribution of aboveground vegetation biomass. The significance of both elevation and water accumulation on biomass distributions supports the contention that better models of rain, snow, evapotranspiration, and water runoff are critical to predicting the effects of a warming climate and adapting forest management to this changing environment.

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

Partner: University of Alaska Southeast USDA Natural Resource Conservation Service

Olympic Experimental State Forest

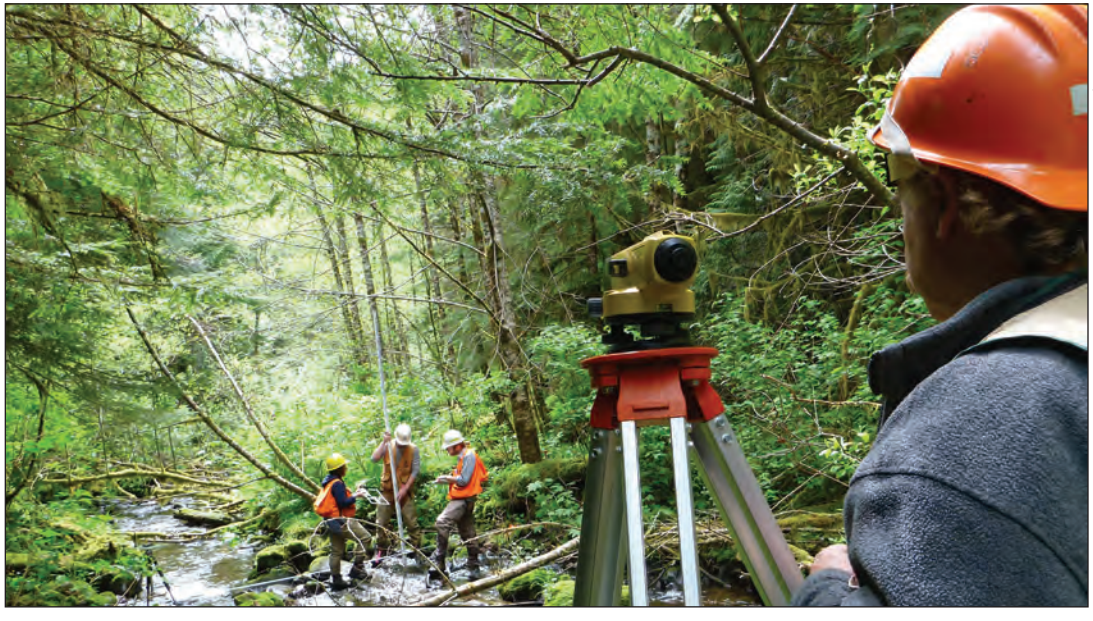
Located on Washington's Olympic Peninsula, this experimental forest was established in 2009 through a memorandum of understanding with the Washington Department of Natural Resources. The station is collaborating with the Washington Department of Natural Resources on a variety of studies, including status and trends monitoring of riparian and aquatic habitats.

This project provides the groundwork for examining alternative riparian management strategies. Findings will inform management decisions by the Washington Department of Natural Resources, their stakeholders, and federal land managers. It has bearing on rural communities whose economies are tightly linked to natural resource commodity production.

The Washington Department of Natural Resources wants to chart the recovery of these habitats by applying innovated forest management strategies that are being tested at the Olympic Experimental State Forest. The primary goal of the station is to establish an aquatic and riparian monitoring program suitable for cross-site and regional comparisons with other experimental forests and ranges and Long-Term Ecological Research sites. In its third year, the program has been implemented in 54 watersheds. The first focused research study includes the assessment of stream temperature regimes across the Olympic Experimental State Forest and relationships to forest management and climatic influences affecting the distribution and life histories of Pacific salmon.

Teodora Minkova, Washington Dept. of Natural Resources

View from Olympic Experimental State Forest toward the Strait of Juan de Fuca, Washington.



Jacqueline Winter

Field crew collect stream data from the Olympic Experimental State Forest. The study findings will benefit management of state and federal lands.

Contact: Alex Foster, afoster@fs.fed.us

Partner: Washington Department of Natural Resources

Pringle Falls

Located on the dry side of the Cascade Range in central Oregon, Pringle Falls lies within the Deschutes National Forest. It was established in 1931. Early research developed a rating system for ponderosa pine susceptibility to western pine beetle and growth studies involving ponderosa pine—a species valued for its timber.

Eventually this work may inform policy about restoration treatments and their impact on a diverse array of ecosystem services, and tradeoffs between ecosystem resilience, adaptive capacity, species conservation, and economic benefits.

Current studies involve experimental landscape thinning and fuels reduction treatments. Landscape applications of thinning and understory fuels reduction treatments are commonly advocated for dry forests of the western United States. However, the effects of these treatments across the spectrum of ecosystem processes have not been fully tested.

In the past 5 years, thinning to different densities, followed by combinations of understory mastication and broadcast burning treatments, have been implemented over 2,400 acres of the Lookout Mountain Unit of Pringle Falls.

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

Partners: Oregon State University; USDA Forest Service Deschutes National Forest, Pacific Southwest Research Station, Rocky Mountain Research Station

Paul Anderson

A gap created in 160-year-old ponderosa pine stand thinned and subsequently masticated and broadcast burned.

Paul Anderson

Contrasting conditions of a 160-year-old ponderosa pine stand without treatment (left portion of image) and following thinning and fuels mastication treatment (right portion of image).

A member of the research elk herd.

U.S. Forest Service

Chief Tom Tidwell and former Chiefs Jack Ward Thomas and Dale Bosworth toured the Starkey Experimental Forest and Range as part the 75th anniversary celebration to discuss past and current research.

Michael Wisdom

Hunters check in as part of ongoing, long-term hunting research at Starkey that evaluates how hunters use landscapes, as well as how all-terrain vehicles and hunters affect the movements of deer and elk.

Starkey Experimental Forest and Range

Starkey is the only experimental forest *and* range in the Forest Service network. Established in 1940 in the Blue Mountains of eastern Oregon, it is well known for research involving interactions among elk, cattle, mule deer, and rangeland management. Hunting research at Starkey has shaped the design of elk hunting seasons, while motorized traffic and off-road recreation research was used by the Forest Service to develop national roadless and off-highway vehicle policies and travel management plans across the country.

Important research continues. A new group, as part of the Mountain Social Ecological Observatory Network, formed in 2015 to investigate socioecological patterns and processes in the Blue Mountains. Long-term data from Starkey can be leveraged by placing them in a regional context to explore the interacting effects of changes in factors such as climate, vegetation, hydrology, grazing intensity, human disturbance, and insects.

The process outlined in this approach provides a template integrating social science and ecological research for Forest Service research.

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Partners: Confederated Tribes of the Umatilla Indian Reservation; Oregon State University; Portland State University; University of Idaho; University of Nevada, Reno; USDA Forest Service Pacific Northwest Region, Wallowa-Whitman National Forest

Fuels reduction, ungulate grazing, and exotic plants

Fire and grazing have been shown to facilitate the spread and establishment of exotic plant species in many grassland and shrubland ecosystems across the world. However, these relationships are not well-documented for forested ecosystems, especially dry forests of interior western North America, where fuels reduction treatments and ungulate grazing are common.

Exotic plant establishment was short-lived following fuels treatments, and was not strongly affected by either cattle or elk grazing.

To learn more, researchers conducted a 6-year landscape experiment at Starkey. Treatments included mechanical fuels reduction and prescribed fire in dry forest understories, versus untreated areas, combined with varying densities of cattle and elk grazing versus no grazing. They found that the different combinations of fuels reduction and ungulate grazing had only minor effects on the variety and spread of exotic plants. These results point to the need for ecosystem-specific research on disturbance effects of fire and other fuels reduction treatments and ungulates to understand these individual and combined effects on exotic plant dynamics.

Contact: Michael Wisdom, mwisdom@fs.fed.us; Bridgett Naylor, bnaylor@fs.fed.us

Partners: Oregon State University, San Diego Zoo Global Conservation Program

Immune defense responses of elk

Elk in poor condition invest more in immune defense responses than elk in better condition

All animal species have well-developed systems of immune defense to fight disease. However, these immune defense systems are not well understood in relation to different population densities and different levels of animal health.

Wild elk are subjected to a wide variety of diseases that can be fatal, affect productivity, and be transmitted to domestic ungulates or even humans. This research has direct bearing on wild and domestic animal health and the multimillion-dollar economies that depend on production of these ungulates.

At the Starkey Experimental Forest and Range, researchers experimentally evaluated the relationships among immune function, animal condition, and densities of elk. Animals from a high-density population had lower reproductive output and lower nutritional condition and invested more in immune defenses than animals from a low-density population with higher output and condition. These results indicate that higher density populations of elk in poorer condition invest more in disease-fighting responses than those at lower density and better health. Additional research is needed to fully understand how immune-defense systems of elk and other ungulates function under a variety of environmental conditions and population densities.

Contact: Brian Dick, bldick@fs.fed.us

Partner: University of Nevada, Reno

Michael Wisdom

A station scientist calibrates weather equipment at Meadow Creek, Starkey Experimental Forest and Range, as part of long-term climate change and stream temperature modeling for riparian restoration research.

Drought affects cattle habitat selection

By better understanding how cattle distributions may shift in response to more arid conditions, managers can monitor range conditions more efficiently by targeting areas strongly preferred by cattle and adjust seasonal grazing to balance stakeholder needs with conservation of grazing resources. Researchers developed resource selection models to predict seasonal distributions of cattle during summer at Starkey. The models showed that cattle selected similar conditions, such as gentle slopes and areas near water, despite marked differences in seasonal and interannual rainfall. These results demonstrate the importance of intensive monitoring in riparian areas, which may be increasingly vulnerable under more arid conditions.

Land managers with grazing allotments can use new models to inform decisions about pasture rotation and livestock management to better integrate cattle grazing with other resources.

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

Partner: Oregon State University Agriculture Program

Honors and Awards

2014 Chief's Excellence in Science Delivery Award

Keith Reynolds, a research forester, was recognized for his exceptional performance in sustained productivity, leadership, and science delivery, serving natural resource management in the United States with global applications.

2015 Abraham Lincoln Honor Award

The Secretary of Agriculture recognized the Pacific Northwest Research Station Engineering staff, **Steve Oravetz** and **Rob Avila**, for their personal and professional excellence.

Blue Mountains Elk Initiative Long-Term Research Awards:

These awards were presented by state, federal, private, and tribal partners in the Blue Mountains Elk Initiative to **Mary Rowland**, a research wildlife biologist, for long-term research on roads and road effects on elk, and for a variety of other wildlife research at the Starkey Experimental Forest and Range and replicate sites. Results of this work are used across western North America for effective elk management.

Brian Dick, a rangeland management specialist and Starkey Area Manager, was honored for implementing long-term research at Starkey Experimental Forest and Range, and capably managing the facility for research, resulting in management applications for elk from over 80 studies.

Michael Wisdom, a research wildlife biologist, was honored for leading and implementing long-term research on elk at Starkey Experimental Forest and Range and replicate sites, resulting in a wide variety of management applications from over 80 studies.

Boone and Crockett Club Conservation and Stewardship National Award

The PNW Starkey Ungulate Ecology Team was recognized for its exemplary long-term research that has substantially enhanced conservation and stewardship of big game and natural resources in North America.

◀ Beargrass, Mount Hood National Forest. Photo by Georgia Hart.

Elected to Ecological Applications Editorial Board

Research wildlife biologist **Bruce Marcot** was named to the editorial board of the prestigious journal *Ecological Applications*, a publication of the Ecological Society of America. He will be serving as an editor of papers exploring structured decisionmaking and use of Bayesian statistical tools, as well as general wildlife and habitat modeling approaches.

Elected to Society of Wood Science and Technology Board

Research forest products technologist **Eini Lowell** was elected to a two-year term on the Board of Directors for the Society of Wood Science and Technology. The society advances the profession of wood science around the world and advocates the socially responsible production and use of wood.

President-elect of the Cooper Ornithological Society

Martin Raphael, a research wildlife biologist, was elected to serve a two-year term as president of this renowned society dedicated to avian science and conservation.

Rise to the Future Award for Professional Excellence

Bruce Hansen, an ecologist, was recognized by the Forest Service For excellence in research liaison and partnerships between the PNW Research Station and Pacific Northwest Region for dive safety and aquatic-riparian projects, including topics of aquatic organism passage through culverts and aquatic invasive species.

Society for Northwestern Vertebrate Biology: Lifetime Achievement Award

Kathryn Ronnenberg, an information specialist, was honored for her tireless volunteer contributions as copyeditor of the society's journal, Northwestern Naturalist, as newsletter editor, for production of the annual meeting programs, and for her graphic design expertise.

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◀ Olympic National Forest. Photo by Connie Harrington.

United States Department of Agriculture

Forest Service

Online Supplements

2015 Science Accomplishments of the Pacific Northwest Research Station is available online, along with all 2015 publications by Pacific Northwest Research Station scientists, at http://www.fs.fed.us/pnw/sa/2015/.

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The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the national forests and national grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

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