



Forest
Service

2014 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.



Barb Lachenbruch

Researchers examine new growth on Douglas-fir as part of a study to better understand how Swiss needle cast—a fungal disease—affects its host.

Contents

A Message From the Station Director	5
PNW Research Station: The Setting	7
Finances and Workforce	8
Funding Partners in 2014	9
Sharing What We've Learned	11
Featured Research	17
Climate Change.....	17
Inventory and Monitoring	25
Fish and Wildlife	33
Natural Disturbances.....	45
Resource Management and Landscape Resilience	53
Socioeconomic Dimensions	63
Honors and Awards	71
PNW Research Station Organization.....	72

Field crew collect data for the Meadow
Creek Restoration Project at Starkey
Experimental Forest and Range, Oregon.
Photo by Rhonda Mazza.





A Message From the Station Director

Greetings!

The past year was a busy one for the Pacific Northwest Research Station. From our laboratories to the field, we worked with our collaborators to uncover new information and produce tools that land managers and decisionmakers can use in the stewardship of forests, riparian, and grassland habitats in our region.



Robert Mangold

An effort from 2014 that I'm proud to highlight involves our work to develop a framework for guiding strategic decisions within the station. We will be using this strategic framework over the next 10 years to move the station forward in meeting stakeholder needs while keeping our science on the cutting edge. We took an inclusive, multistep approach in crafting the framework. We asked stakeholders from many organizations that use our research to review a draft of our framework and participate in interviews and discussion groups. We wanted to know: Have we identified key areas of research that meet your needs? How can we improve communication? We also posed the same questions to employees.

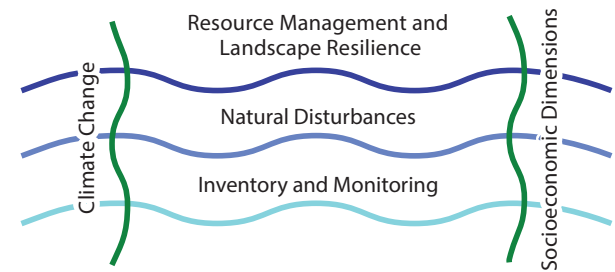
Through a facilitated process, we worked with employees and stakeholders to reaffirm and

update the core values of the Pacific Northwest Research Station. While our research emphasis areas define the work we do, our core values define the way we do that work. These values are to:

- Reflect the highest standards and quality in our work.
- Provide unbiased scientific expertise and technology that make a difference for people and the natural resources on which they depend.
- Be responsive to urgent science information needs identified by society.
- Be accountable and deliver peer-reviewed science.
- Care deeply about the systems we live in, and work for their betterment.
- Collaborate and communicate frequently with others to conduct, share, and apply research.
- Focus on the long term while serving today's needs.
- Foster a supportive, inclusive, engaging, and safe workplace for a skilled and diverse workforce.
- Nurture the next generation of employees.

We have five emphasis areas of research at the station. Climate change and the socioeconomic emphasis permeate the other three:

resource management and landscape resilience, natural disturbances, and inventory and monitoring. This approach continues the station's journey of integrating research across disciplines.



I'm excited about the upcoming year. We are committed to elevating the visibility and recognition of our science. We will continue to build a case for the benefits of our research by positioning ourselves to deliver the science land managers need and strengthening relationships with our diverse set of partners and stakeholders. With the new strategic framework in place, we are aligned to do high-quality relevant work that benefits society and maintains the integrity and restores the health of ecosystems throughout Alaska, Oregon, Washington, and elsewhere.

Let's be in touch,

A handwritten signature in black ink, reading 'Rob'.

Station Director Robert Mangold



Climbing up into the forest canopy in Oregon.

Ken Winterberger



A Forest Inventory and Analysis field crew in interior Alaska.

Connie Harrington



Measuring photosynthesis in the lath house at the Forestry Sciences Laboratory in Olympia, Washington.

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 seven research units in the U.S. Department of Agriculture, Forest Service.

- ▶ Headquarters are in Portland, Oregon.
- ▶ 11 laboratories and research centers in Alaska, Oregon, and Washington.
- ▶ 12 active experimental areas (forests, ranges, and watersheds).
- ▶ Research is conducted in more than 98 research natural areas.
- ▶ 301 employees (277 permanent and 24 temporary).



● Experimental Areas

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



Finances and Workforce

Two sources of funding support the workforce of the Pacific Northwest (PNW) Research Station: federal appropriations, which contributed 88 percent of the funds in fiscal year 2014, and direct client support, which comes from organizations in need of scientific information.

The numbers below are for the fiscal year **October 1, 2013, to September 30, 2014.**

Incoming funding

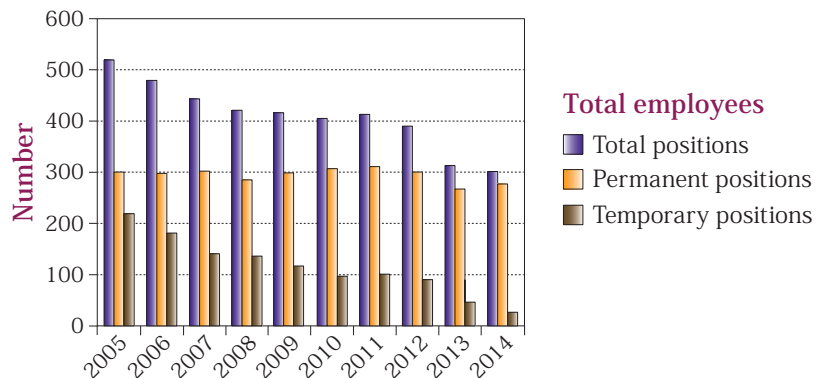
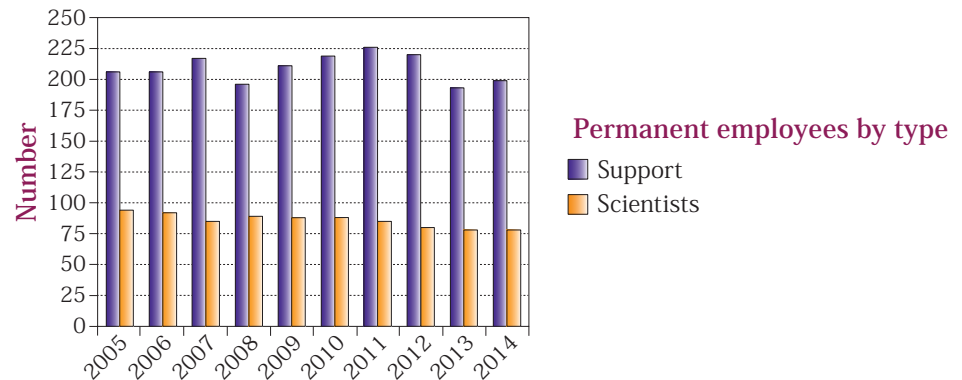
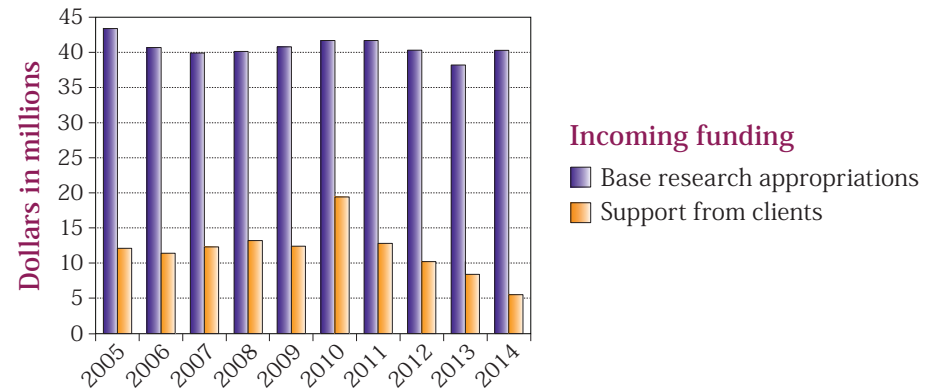
- ▶ Base research appropriations: \$40.3 million (88%)
- ▶ Client support: \$5.5 million (12%)
- ▶ Total funding: \$45.8 million

Distribution of funds

- ▶ Permanent employee cost: \$28.8 million (63%)
- ▶ Support and operations: \$3.9 million (9%)
- ▶ Distributed to cooperators: \$13.1 million (29%)
- ▶ Of the \$13.1 million to cooperators, 92% went to educational institutions

Workforce statistics

- ▶ Total station workforce: 301 employees
- ▶ Permanent workforce: 277 employees
- ▶ Of the permanent workforce, 78 employees (26%) are scientists
- ▶ Temporary workforce: 24 employees



Funding Partners in 2014

Cooperators Who Received Funding From the PNW Research Station for Studies

Educational Institutions

Boston University
Colorado State University
Humboldt State University
Loyola University
Oregon State University
Portland State University
State University of New York
University of Alaska, Anchorage
University of Alaska, Southeast
University of British Columbia
University of California
University of Georgia
University of Guam
University of Hawaii, Hilo
University of Idaho
University of Maryland
University of Michigan
University of Minnesota
University of Montana
University of Nevada, Reno

University of New England
University of Oregon
University of Washington
Western Carolina University

Foreign Institutions

New Zealand Forest Research Institute
Limited, Scion

Municipal Governments

Cascadia Conservation District
Woodland Park Zoo

Nonprofit Organizations

Duwamish River Cleanup Coalition
Mount St. Helens Institute
Sustainable Northwest
Willamette Partnership
World Forestry Center

Other Federal Agencies

Department of Agriculture, Office of
Advocacy and Outreach

Department of Health and Human Services,
Federal Occupational Health
Department of the Interior, Bureau of
Land Management
Department of the Interior, Geological Survey

Private Industry

Ecohealth Alliance, Inc., Data Science and
Research Technology

State Agencies

Alaska Department of Natural Resources
Oregon Department of Fish and Wildlife
Oregon Department of Forestry
Oregon Office of Energy
State Board of Higher Education on
Behalf of Oregon State

Tribes

Confederated Tribes of the Umatilla
Indian Reservation

Clients Who Provided Funding to the PNW Research Station for Studies

Educational Institutions

Oregon State University
Wake Forest University
Washington State University

Nonprofit Organization

National Fish and Wildlife Federation

Other Federal Agencies

Environmental Protection Agency
Department of Agriculture, Office of
the Chief Economist

Department of Commerce, National Marine
Fisheries Service

Department of Defense, U.S. Army Corps
of Engineers

Department of Defense, U.S. Army Corps of
Engineers, Environmental Resources Branch

Department of the Interior, Bureau of
Land Management

Department of the Interior, Fish and
Wildlife Service

Department of the Interior, Geological Survey

Department of the Interior, National Park Service

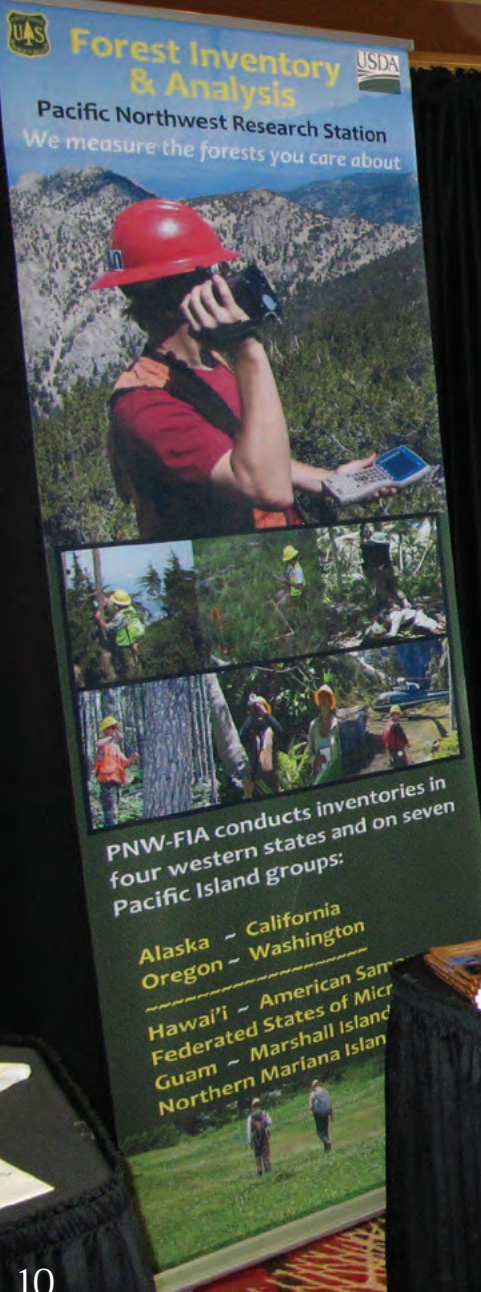
Department of the Interior, Office of Surface Water
National Aeronautics and Space Administration,
Goddard Space Flight Center

Private Industry

Eco Logical Research
ESSA Technologies Ltd.
Green Diamond Resource Company

State Agencies

Alaska Department of Fish and Game



Forest Inventory & Analysis
 Pacific Northwest Research Station
 We measure the forests you care about

PNW-FIA conducts inventories in four western states and on seven Pacific Island groups:

- Alaska - California
- Oregon - Washington
- Hawai'i - American Samoa
- Federated States of Micronesia
- Guam - Marshall Islands
- Northern Mariana Islands



Forest Inventory & Analysis
 Pacific Northwest Research Station

PNW - FIA provides unbiased estimates on status and trends of western forests

- Forest land area
- Tree species diversity
- Biomass, Carbon, Volatiles
- Deadwood components
- Understorey vegetation



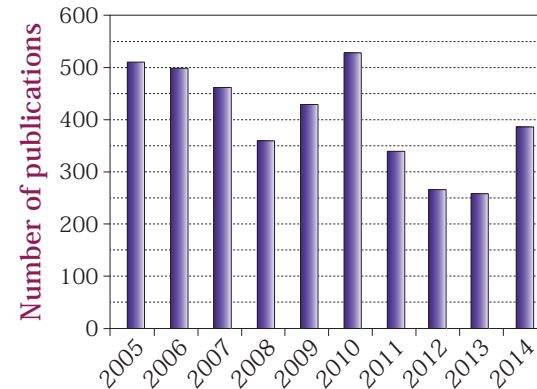
Three people are standing near the table, looking at the materials. A woman in a patterned top is gesturing towards the table. A man in a white shirt and light-colored pants is looking at a brochure. Another man in a plaid shirt is standing nearby.

Sharing What We've Learned

The station produced 386 publications in fiscal year 2014.

This includes station series reports, journal articles, books or book chapters, theses and dissertations, and other publications.

- ▶ **100,448** hard copies of station publications were distributed.
- ▶ **4,504** station publications were made available online through Treesearch.
- ▶ **10** issues of *PNW Science Findings* were published and about 8,000 copies of each issue were distributed or downloaded.



Web Visitors

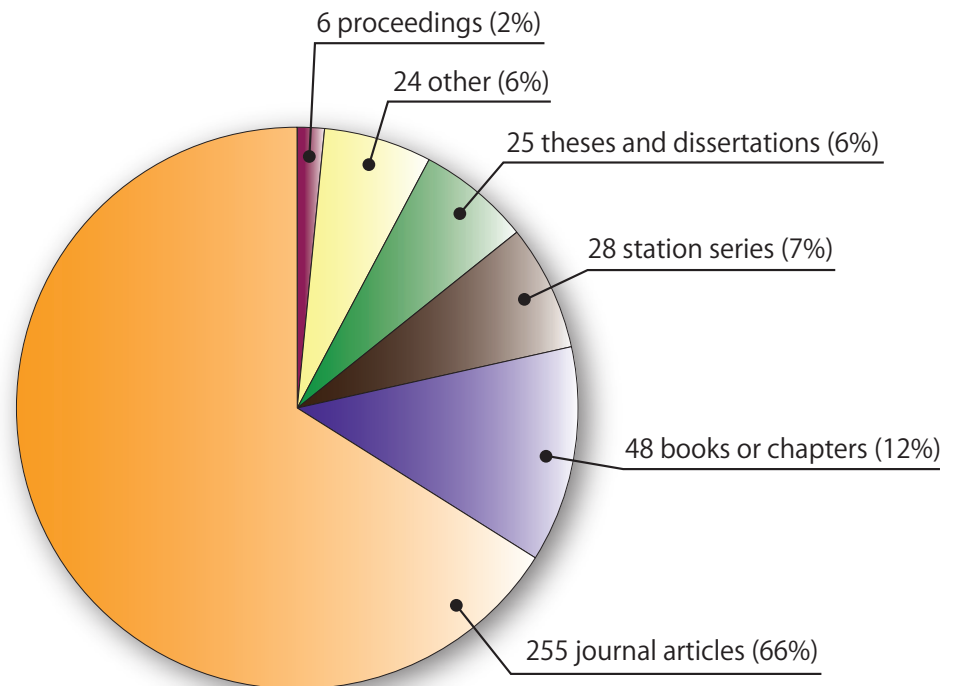
- ▶ Total number of visits: **106,368**
- ▶ Total number of page views: **214,465**
- ▶ Percentage of new visitors: **72%**

Twitter

The station's Twitter account has 1,162 followers—up from 928 in 2013. Reporters, natural resource professionals, and non-profit groups comprise the majority of subscribers, who receive instant electronic alerts (tweets) to station news releases, new publications, and other information.

RSS Feeds

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



Symposia, Workshops, and Tours

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

IN 2014:

- ~920 people participated in symposia, workshops, and webinars sponsored by the station.
- ~1,510 people went on field trips led by station researchers.
- ~1,040 people participated in conservation education activities sponsored by the station.

EXPERIMENTAL FORESTS

Bonanza Creek Long-Term Ecological Research Symposium: Thirty senior investigators and graduate students affiliated with the Bonanza

Creek Long-Term Ecological Research site met in Fairbanks, Alaska, to discuss research and results from the past year.

Héen Latinee Experimental Forest Tour:

Station researchers led a field tour of the Héen Latinee Experimental Forest and yellow-cedar experimental planting areas in Alaska on Goldbelt, Inc., lands with the Board of Directors and Chief Executive Officer of Goldbelt, Inc. The seven participants learned about plans for infrastructure development on the forest.

H.J. Andrew's Day: This annual event brought 130 participants to the H.J. Andrews Experimental Forest. The audience included scientists; students; federal, state, and utility managers; and the general public who spent the day learning about current and past research conducted on the forest.

H.J. Andrew's Safety Training Day: This annual event co-hosted by the PNW Research Station and Oregon State University (OSU) provided 30 new researchers and students with training in the basic safety procedures and best practices needed to conduct field work at the Andrews Forest and similar environments. In 2014, the OSU College of Forestry cited this as a positive example of safety training.

H.J. Andrew's Long-Term Ecological Reflections: This writers' program, hosted at H.J. Andrews Experimental Forest, celebrated its 10th anniversary with high-profile collaboration among the arts, sciences, and humanities. About 30 scientists, philosophers, artists, and writers met to envision the next 10 years for this program.

Meadow Creek Workshop and Tours: More than 100 partners in the Meadow Creek restoration project on the Starkey Experimental Forest and Range participated in a workshop held at Eastern Oregon University. Participants, who attended either onsite or virtually via a real-time webinar stream, discussed project goals; restoration work; grazing treatments; and monitoring responses of vegetation, ungulates, fish, and other biota. Station scientists also led several tours of the Meadow Creek restoration project site. Sixty-eight participants from the National Riparian Service Team, a leader in cooperative riparian restoration; Evergreen

A field tour through a site planted with yellow-cedar adjacent to Héen Latinee Experimental Forest, Alaska.



Judy Mason

A field tour of the Meadow Creek restoration project at the Starkey Experimental Forest and Range, Oregon. Photo by Rhonda Mazza. ►



State College; Washington State University; and the Australian National University learned about the long-term interdisciplinary project, ungulate research, and grazing issues.

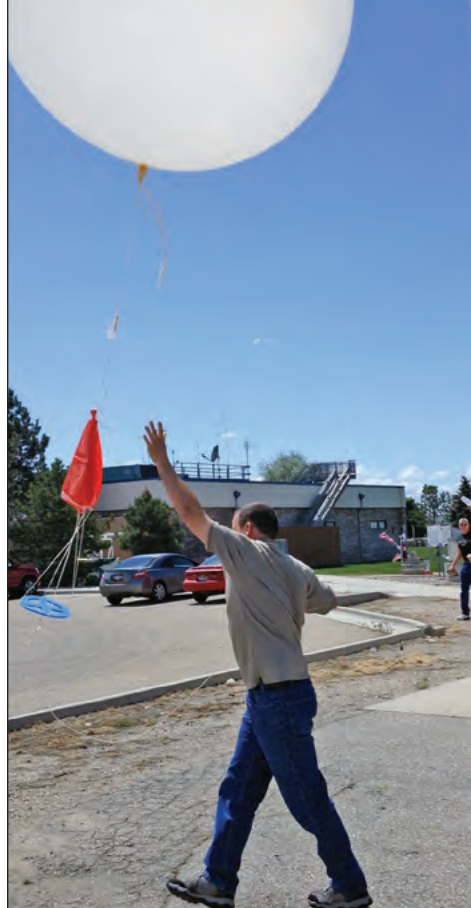
Syrup Creek Study Area Silvicultural Tour:

Station researchers led 25 silviculturists and fire managers from the Forest Service's Pacific Northwest Region on a tour of the Syrup Creek Study Area on the Starkey Experimental Forest and Range in Oregon. Participants learned about proposed forest restoration research.

FIRE AND SMOKE

BlueSky Workshop: Station researchers taught 50 attendees about the BlueSky modeling framework at the International Smoke Symposium in College Park, Maryland. Attendees engaged in hands-on training and learned about the latest improvements to the framework—which simulates the impacts of smoke on air quality—as well as how to interpret results, and more.

Second-Annual Air Resource Advisor Training Workshop: Twenty individuals were trained as air resource advisors at the second annual Air Resource Advisor training workshop in Boise, Idaho. Station scientists worked closely with an interagency and interdisciplinary group to develop the course. Air Resource Advisors are technical specialists deployed to wildfires to address smoke impacts to air quality and risk to public health and safety, transportation safety, and fire personnel.



An instructor demonstrates a weather balloon launch at the 2014 Air Resource Advisor Training Workshop in Boise, Idaho.

Susan O'Neill

FOREST INVENTORY AND ANALYSIS (FIA)

FIA Outreach: Researchers with the FIA program conducted outreach at the Oregon and California Chapters of the Society of American Foresters meetings in Canyonville, Oregon, and Tuolumne, California. They distributed copies of a regional database application (PNW-FIADB 2001–2012), and more than 200 station

publications and journal articles. Researchers also attended the annual meetings of Calforests in Napa, California, and the National Indian Timber Symposium in Worley, Idaho, which drew 250 participants, and distributed materials there.

PNW-FIA Strategy Committee Meeting:

Sixteen members of the PNW-FIA Strategy Committee—a group of industry, nongovernmental organization, state, National Forest System, and tribal stakeholders—met in Portland, Oregon, to advise FIA about regional and national needs. Committee members annually help to coordinate the implementation and operation of FIA, guide enhancements, and help devise a strategy for PNW-FIA.

Inventorying Alaska's Forests Workshop:

Sixty-seven participants convened at a workshop in Anchorage, Alaska, to explore how interagency needs could be met by the FIA program and to discuss plans for a pilot inventory of interior Alaska.

FIA Client Meeting and Workshops: PNW-FIA organized a forum with 60 regional stakeholders in Sacramento, California, to share current research activities using FIA data, provide information and updates, and obtain feedback from partners to improve the program. PNW-FIA also led hands-on workshops in Sacramento and Pago Pago, American Samoa, teaching 28 clients how to analyze and summarize inventory

data to answer their own questions concerning resource management. The training focused on “PNW-FIADB,” a user-friendly application that simplifies the process of working with a large, complex dataset.

OTHER NOTABLE EVENTS

Douglas-Fir Seed Source Movement Trial

Field Tours: In all, 85 participants with the Swiss Needle Cast Cooperative and Washington State Department of Natural Resources toured sites of the Douglas-Fir Seed Source Movement Trial. They learned how Douglas-fir trees from a range of geographic locations have been growing and surviving since being planted in common gardens at various locations.

Joint Aquatic Sciences Symposium: A station statistician co-organized a full-day water temperature symposium as part of the Joint Aquatic Sciences Meeting in Portland, Oregon. The session included 23 oral presentations given by invited speakers from across the country and abroad, including several station researchers. About 200 people attended.

Moist Mixed-Conifer Synthesis Workshop:

Authors of *The Ecology and Management of Mixed-Moist Conifer Forests in Oregon and Washington*, published by the station in 2014, led a 2-day workshop in Pendleton, Oregon. Sixty natural resource managers toured an area of the Blue Mountains on the Umatilla National Forest to learn about large landscapes and likely climatic impacts.

Conservation Education

Station scientists make time to share their expertise with students and teachers. Classroom activities, science fairs, and week-long outdoor camps are some of the ways we interact with the next generation of scientists. A few of these activities from 2014 are highlighted below.

Canopy Connections: This learning program for Oregon middle school classes was developed by the University of Oregon Environmental Leadership Program, The Pacific Tree Climbing Institute, and the PNW Research Station. Hosted at H.J. Andrews Experimental Forest, it gives students an opportunity to climb and explore the canopy of an old-growth forest. The curriculum integrates science, art, and creative writing. In 2014, two hundred fifty students and 25 teachers participated.

Conservation Biology Panel: Forty eighth-grade students from Jane Goodall Environmental Middle School, a multicultural magnet school in Salem, Oregon, collected and analyzed data, then presented results to expert panelists, including a station researcher. Topics ranged from long-term trends of amphibian habitat use to leaf-out patterns in a nearby park and implications for climate change.

Conservation Education Tour: Nine people with the Tacoma Public School Re-Engagement Center visited the Olympia Forestry Sciences Laboratory in Washington to learn about forest management and tree growth. Two station

Lina DiGregorio



A middle-school student explores the forest canopy as part of the Canopy Connections program at H.J. Andrews Experimental Forest.

scientists organized the tour for the project, which is designed to help students who have dropped out of school return and obtain a high school diploma.

Ellie's Log Field Day: The book *Ellie's Log*, written about research at H.J. Andrews Experimental Forest, inspired a teacher at Fern Ridge Middle School in Elmira, Oregon, to devote a portion of his spring curriculum to the topics covered in the book. This unit culminated with a tour of H.J. Andrews, attended by 100 students and teachers.

Forest Camp 2014: About 120 sixth-grade students learned about basic ecology and fungi during a presentation at Camp Tadmor in Lebanon, Oregon, given by station employees in partnership with the Siuslaw National Forest.

Forests Inside Out! In its sixth year, the station and the nonprofit World Forestry Center provided a series of 2-day immersive indoor and outdoor experiences for 400 children ages 6 to 10 and 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 to create positive and direct associations with urban forests, natural areas, and national forests. Eight high school and college-aged 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.



Students with the Inner City Youth Institute worked with forest staff to remove tansy ragwort, an invasive weed, on the Siuslaw National Forest.

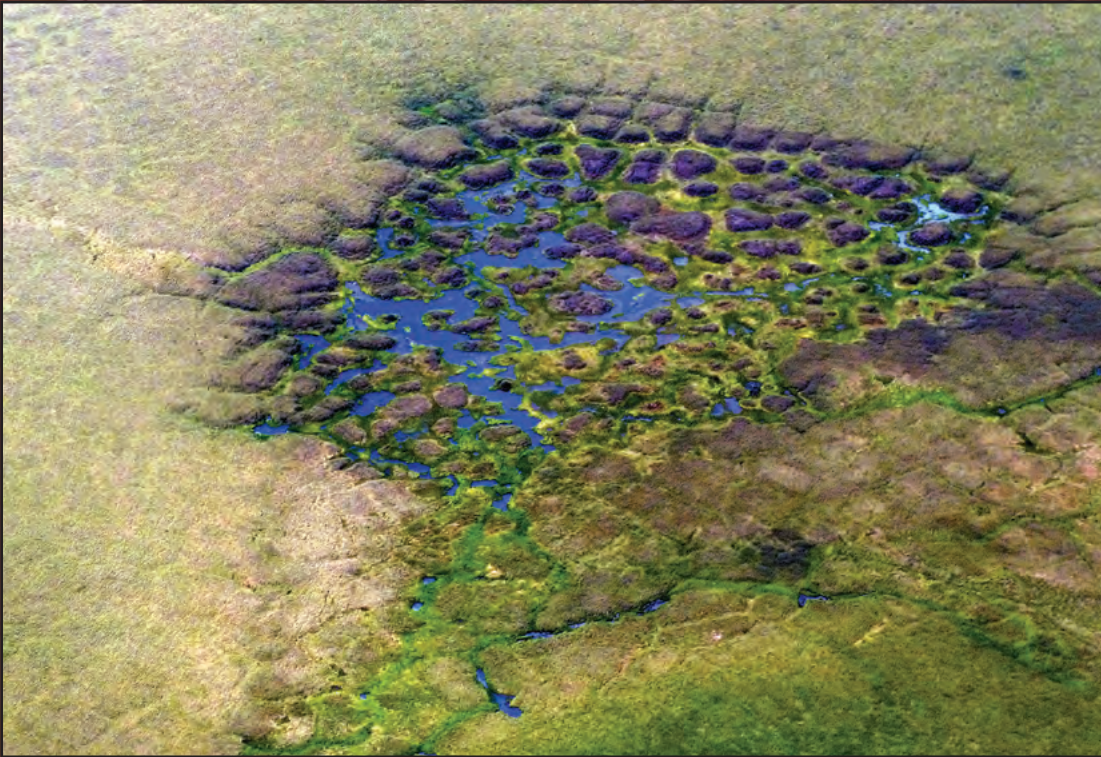
Inner City Youth Institute: The station reached about 100 students from Portland inner-city high schools through the Inner City Youth Institute (ICYI). The program connects underrepresented youth with careers and experiences in natural resources and is a partnership between the Forest Service, Oregon State University's 4-H program, and the Bureau of Land Management. Students with ICYI attended a natural resources career fair held at Mount Hood Community College to learn about professional opportunities and participated in hiking and backpacking trips in central Oregon. Their experience culminated with a week-long immersive camp at Oregon State University, where they experienced campus life, and 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.

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 researchers also participated as judges at the event. At the Washington State Science and Engineering Fair, for grades 1 through 12, in Bremerton, Washington, the station sponsored a high school, middle school, and elementary school "Outstanding Natural Resource Science Award" and an "Outstanding Statistical Thinking Award." A station scientist also participated as a judge and taught a teacher workshop.

Trout International: More than 100 students in Oregon and 25 in Northern Ireland participated in "Trout International," an environmental education, conservation, and cross-cultural connection program for school children. As part of the project, a third-grade class at Chapman Hill Elementary in Salem, Oregon, a fourth-grade class at Timber Hill Elementary in Albany, Oregon, and one school in Northern Ireland hatched native trout species in classroom tanks. Oregon classrooms hatched rainbow trout, while Irish classrooms hatched native dollaghan trout. Educational elements presented in both countries focused on the similarities and differences between these species of trout and included introductory instruction on climate change, invasive species, culture, art, and landscape change.

Climate Change

A changing climate will trigger change throughout the natural world and ripple into human environments. 🌀 Our research aims to improve understanding of the effects of projected changes in temperature and in timing and volume of precipitation in the Pacific Northwest. 🌀 From there, our goal is to provide land managers with information they can use to manage forests to facilitate adaptation and resiliency into the future.



Bruce Marcot

A draining lake on the Alaska tundra.

Highlights in 2014

- ▶ Huge partnership effort in Washington state completes largest climate-change adaption project in country. The assessment and strategies are being used by the Mount Baker-Snoqualmie and Okanogan-Wenatchee National Forests and North Cascades and Mount Rainier National Parks.
- ▶ Some vegetative species are more vulnerable to drought than others. Scientists identified why piñon pine, a common species in the Southwest, dies more quickly than juniper in drought conditions.
- ▶ The climate-based projections indicate some California eco-regions may see widespread shifts in vegetation types. The Pacific Southwest Region will be using this information in forest planning.
- ▶ In Douglas-fir and true-fir-dominated dry mixed-conifer forests of the Northwest, implementing selective harvest and surface fuel treatments generates greater climate benefits than no treatment, when accounting for in-and out-of-forest effects on greenhouse gases.

Tom Iraci



Flooding and subsequent damage to roads and infrastructure, like this may become more common as winter precipitation shifts from snow to rain. Above, a washout on the Gifford Pinchot National Forest.

Largest climate change adaptation project in the United States completed in Washington State

The northern Cascade Range of Washington contains diverse ecosystems with thousands of plant and animal species. Station scientists helped evaluate the projected effects of climate change

**Assessment used
by national forests
to meet 2012
Planning Rule.**

in this region by using an all-lands approach that included two national forests (Mount Baker-Snoqualmie, Okanogan-Wenatchee) and two national parks (North Cascades, Mount Rainier).

An additional 30 agencies and stakeholders participated in a science-management partnership that provided climate science education, compiled a climate change vulnerability assessment (vegetation, wildlife, water resources, and fisheries), and developed an adaptation strategy for the region.

The climate change vulnerability assessment found that water may be the most sensitive

resource. Less snow and more rain may lead to greater flooding and damage to roads and infrastructure. Fisheries are also expected to be very sensitive to low peak flows and high stream temperatures in summer.

The assessment and adaptation strategy are being used by national forests to meet requirements of the 2012 Planning Rule, so that climate change is addressed in planning and management. This will encourage management actions that reduce negative outcomes of climate change, ease the transition of systems to a warmer climate, and ensure long-term sustainability of resources.

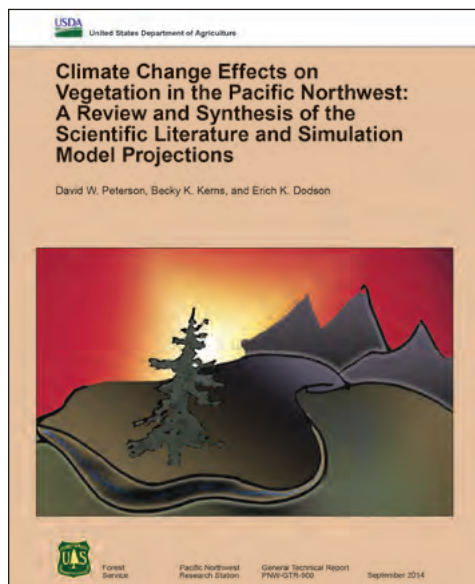
Contact: David L. Peterson, peterson@fs.fed.us

Partners: University of Washington, USDA Forest Service Pacific Northwest Region, USDI National Park Service

Citation: Raymond, C.L.; Peterson, D.L.; Rochefort, R.M., eds. 2014. Climate change vulnerability and adaptation in the North Cascades region. Gen. Tech. Rep. PNW-GTR-892. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Understanding vegetation vulnerability to climate change

Scientists have learned much about historical rates and patterns of vegetation change during glacial and interglacial epochs; forest growth responses to past climatic variability; plant physiological responses to higher temperature and carbon dioxide levels; and how phenotypic plasticity, local adaptation, and migration can help individual plants, plant populations, and species adapt to changing environments. However, this information had not been adequately reviewed, synthesized, and compiled into a form



This report reviews potential climate change impacts on Pacific Northwest vegetation and provides a scientific basis for developing vulnerability assessments and adaptation strategies.

that managers can use to establish short- and long-term management objectives and adopt appropriate management strategies.

A new synthesis reviews potential climate change impacts on Pacific Northwest vegetation and provides a scientific basis for developing vulnerability assessments and adaptation strategies. It focuses on five major vegetation types: subalpine forests and alpine meadows, maritime coniferous forests, dry coniferous forests, juniper savannas and woodlands, and interior shrub-steppe. Forest managers and scientists can use this information for developing science-based plans for managing forests and rangelands under changing environmental conditions.

Contact: David W. Peterson, davepeterson@fs.fed.us

Partners: USDA Forest Service Pacific Northwest Region, USDI Bureau of Land Management Oregon and Washington

Citation: Peterson, D.W.; Kerns, B.K.; Dodson, E.K. 2014. Climate change effects on vegetation in the Pacific Northwest: a review and synthesis of the scientific literature and simulation model projections. Gen. Tech. Rep. PNW-GTR-900. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 183 p.



Jane E. Smith

Researchers collect soil samples to learn what mycorrhizal fungi are present in this stand of lodgepole pine on the Deschutes National Forest.

Multihost fungi may facilitate migrations of pine species with climate change

Tree species migration is a complex process involving ecological linkages between ecosystems above- and belowground. Trees rely on symbiotic relationships with mycorrhizal fungi for optimal survival and growth. Mycorrhizal networks provide conduits for nutrient exchange between tree species. Successful migration of tree species may be constrained by the distribution or co-migration of belowground fungi.

Working in the Deschutes National Forest, scientists found remarkable overlap in mycorrhizal fungi species colonizing ponderosa and lodgepole pines, which bodes well for the

Tool

TimeSync Landsat time series visualization and data collection tool

Description:

TimeSync allows users to accurately characterize forest change at the plot level on an annual basis. It can be used across a range of spatial extents, from regional to continental.

Users:

TimeSync is used by researchers to characterize change, map accuracy, and provide independent estimates of forest change by disturbance agent. Within the North American Carbon Program, TimeSync has been used to assess the quality of a national-level disturbance map and to provide independent estimates of forest disturbance. These estimates have provided characterizations of regional differences in disturbance regimes and direct linkages of forest stress to climate change. TimeSync is also a central component of the nascent Landscape Change Monitoring System under development by the U.S. Forest Service and U.S. Geological Survey.

Distribution:

The TimeSync user community has grown via word of mouth. A webinar tutorial attracted 35 participants in November 2014. Standalone training modules are also available on the TimeSync website.

How to get it:

<http://timesync.forestry.oregonstate.edu/>

Contact:

Warren B. Cohen, wcohen@fs.fed.us

migration of ponderosa pine into the historical lodgepole pine range.

Planning for tree species migration with climate change is an immediate challenge for land managers. Climate change models suggest that lodgepole pine will decline in the Pacific Northwest by the end of the 21st century. As climate change transforms the lodgepole pine zone into a warmer, drier environment, drought-tolerant ponderosa pine may establish within the historical lodgepole pine range. In an assisted migration management approach, mycorrhizal fungal networks may enhance seedling survivorship and growth.

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

Partners: Deschutes National Forest, Oregon State University, University of British Columbia, National Science Foundation

Forest stress linked to climate change

Climate change, including increased temperature and decreased precipitation, is expected to have profound effects on forest stress, a key indicator of forest health. Forest stress can be

Forest stress increased dramatically between the late 1980s and the early 2000s.

measured in terms of lost vigor and leaf area and increased mortality from drought, insects, and disease. Individual

studies for specific geographical regions and key affected species have already demonstrated the link between changes in temperature and precipitation, but until now there had not been a study that systematically examines these links across regions and species using a single set of methods.



Andrew J. Boone, Bugwood.org

Nationally, forest stress dramatically increased between the late 1980s and the early 2000s, corresponding to increasing temperatures and lower precipitation.

Station scientists provided evidence about direct connections between forest health and climate change that highlights the need to monitor forest to (1) determine where and when remedial silvicultural prescriptions should be prioritized, and (2) help set realistic expectations of climate change effects on forest health and adapt forest policy accordingly. Modeling the effects of climate change on forest structure and function, in the context of national efforts such as the North American Carbon Program, can now be better grounded in national-level observations.

The scientists used Landsat satellite annual time series data from 1984 through 2012 to characterize forest change by disturbance agent type, including forest stress. The data were visually interpreted using a newly developed tool, TimeSync, across 7,200 plots distributed throughout the conterminous United States.

Regional differences were evident, but nationally, forest stress dramatically increased between the late 1980s and the early 2000s, declining somewhat in the mid to late 2000s. Seeking a link to climate, the scientists plotted annual average summer temperatures and precipitation amounts against estimated annual forest stress. Results indicate exceptionally high correlation between stress and both increased temperatures and decreasing precipitation.

Contact: Warren B. Cohen, wcohen@fs.fed.us

Partners: NASA, USDA Forest Service
Rocky Mountain Research Station,
University of Maryland

Dave Powell, USDA Forest Service, Bugwood.org



Simulations indicate that greater climate benefits are realized by treating stands of Douglas-fir and true-fir to reduce fire hazard compared to not treating them.

Simulations reveal climate benefits of forest management

What effects do forest restoration efforts have on forest carbon levels? To find out, scientists used the Forest Vegetation Simulator to simulate the silvicultural prescriptions typically used by foresters seeking to restore forest health. Thirteen different prescriptions were applied to several hundred forest inventory and analysis plots that comprise a statistically representative sample of current conditions in Douglas-fir and true-fir forests in the northwestern United States. The resulting forest stands were

projected forward for 32 years under four scenarios: no wildfires, and one wildfire at one of three times since treatment: 1, 16, or 32 years.

Over this short period, in the absence of wildfire, treatments did not produce net climate benefits. However, with fire return intervals of 20 or 50 years, implementing the most effective treatments generated considerable climate benefits when considering carbon stored in the forest, carbon in forest products and landfills, and substitution benefits from the use of energy generated from wood and woody biomass. For about half of the forest area where treatment



Bruce Marcot

Climate change is increasing the incidence of fire in Alaska's boreal forests.

would be effective, sales of merchantable lumber and wood-based fuels could more than offset the costs of implementing treatments, provided that prescriptions were not restricted by arbitrary limits on the size of trees that can be harvested in the course of implementing effective treatments.

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

Partners: Humboldt State University, University of Montana, USDA Forest Service Rocky Mountain Research Station

Scientists integrate multidiscipline models to estimate impacts of climate change and mitigation policies on global forestry economics sector

In a Climate Change Impacts and Risk Analysis project sponsored by the Environmental Protection Agency, global-scale socioeconomic, climate and climate-impacts models are integrated to estimate the effects of policy scenarios crafted to mitigate greenhouse gases. Forest Service scientists and colleagues worked on one thread of this project by estimating the effects of mitigation policies on the global forestry economic sector for the 21st century.

By using an integrated assessment model, an atmosphere model, and MC2—a dynamic global vegetation model developed the PNW Research Station—the scientists simulated a range of climate change impacts on global forest conditions, including shifts in the rate of forest growth and carbon sequestration, and shifts in

species distribution and disturbance regimes. Further analysis suggests climate change impacts on forest productivity and disturbance will vary significantly among global timber production regions, which may drive complex market dynamics.

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

Partners: Environmental Protection Agency, Massachusetts Institute of Technology, Ohio State University

New insights on determinants of drought vulnerability in piñon-juniper ecosystems

Episodes of drought-induced tree mortality are on the increase worldwide, but some species are more vulnerable than others. Information about

Piñon pine is more susceptible to drought than juniper.

the plant functional traits that determine species-specific vulnerability to drought is needed before vegetation

models can generate realistic predictions of the fate of woody vegetation under episodic drought.

In the southwestern United States, drought-induced mortality events have been particularly severe in ecosystems dominated by ponderosa pine, piñon pine, and juniper in the last several decades. This study focused on leaf osmotic and turgor regulation in juniper and piñon pine in a multiyear drought mortality field experiment at Los Alamos Laboratory in New Mexico.



Piñon pine, currently a dominant species in parts of the Southwest, is less able to regulate leaf turgor in response to fluctuations in available soil water. This makes piñon pine (dead tree in foreground) more vulnerable to drought compared to juniper (alive in background).

Juniper was able to rapidly regulate its leaf osmotic properties and turgor to track fluctuations in soil water availability, whereas piñon pine exhibited static behavior in this regard. This contrasting behavior resulted in leaves of piñon pine losing turgor when the soil was dry. The findings were consistent with the greater drought resistance of juniper. Because plants cannot grow or take up carbon dioxide when

their cells lose turgor, the inability of piñon pine to regulate its turgor may set it on a trajectory to drought-induced mortality sooner than juniper. The findings should contribute to more accurate estimates of thresholds for drought-induced mortality in the two species.

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

Partner: Los Alamos National Laboratory

Projections indicate that some California ecoregions may see widespread shifts in vegetation types

Climate change is expected to profoundly affect California's diverse vegetation. Until recently, vegetation simulation results were too coarse or incomplete to assess climate change impacts at the subregional scale. In an effort coordinated by the California Public Interest Energy Research Program, scientists worked with four climate projections developed by the Intergovernmental Panel on Climate Change. The scientists used the MC1 dynamic general vegetation model to simulate climate change impacts on vegetation at 800-meter resolution, suitable for planning at the national forest and watershed levels.

The simulation results show that exposure to climate change and sensitivity to this change differ greatly by ecoregions in California. Ecoregions projected to have high exposure do not necessarily have high sensitivity, and vice versa. In many ecoregions, simulation results from all four climate projections agree that 60 to 70 percent of the ecoregion will change vegetation types. Fire is projected to decrease in the coastal ecoregions while mediating type-shifts in interior forested or shrubland ecoregions. The Pacific Southwest Region of the Forest Service will be using this information in forest planning.

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

Partners: University of California Davis, USDA Forest Service Pacific Southwest Region



Some California ecoregions may see a 60- to 70-percent change in vegetation type as the climate changes. Above, a dry winter day and an empty spillway in Annadel State Park, California.

How does drought affect tree physiology?

Phloem is living tissue, part of a plant's complex vascular system. Phloem transports carbohydrates produced by photosynthesis to all parts of the plant to fuel growth and respiration. Measuring phloem function in trees is difficult, and the specific mechanisms involved in phloem transport, and how environmental parameters influence these processes, are still unknown. Improving our fundamental understanding of this central component of the plant's vascular system may provide insight into ways that trees will be affected by changing climatic conditions.

This study examined how sieve cell radius, sap sugar concentration, phloem relative water content, and sap viscosity vary across a range of water stress using tree height as a proxy for

increasing soil moisture stress. Accounting for sugar concentration and water content, the sap viscosity and molar concentration of sucrose did not vary with tree height, but the viscosity and molar concentration of total sugars increased with sample height. Combining the decreased sieve lumen diameter and increased viscosity resulted in a 60-percent reduction in conductivity with increased tree height/water stress.

The development and application of models that effectively incorporate the response of phloem content and phloem cell anatomy to drought as described in this study will represent a substantial advancement in our ability to more accurately predict plant responses to environmental and competitive stressors.

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

Inventory and Monitoring



Rhonda Mazza

Sampling a site at Pringle Falls Experimental Forest in Oregon.

We keep a pulse on forest ecosystems through regular inventories and monitoring to identify trends in growth, habitat, carbon flux, and much more. 🌀 This information is critical for making sound decisions and policy about natural resources. 🌀 It shapes our understanding of change over time in terrestrial, aquatic, and human environments as they respond to climate, disturbance, insects and pathogens, and management policies. 🌀 With this information, tools and models are developed for projecting likely scenarios to help prepare for the future.

Highlights in 2014

- ▶ Lichens can be used to detect low level nitrogen inputs from oil and gas operations. This information can be used to protect air quality near wilderness areas.
- ▶ Scientists find the fungus-to-plant ratio in boreal black spruce forest soils is at least 17:1 and is regionally stable. These fungi are important to seedling establishment, and play a role in how trees regenerate after fire.
- ▶ Scientists find that some Oregon estuaries had increased potential for complex edge habitat for rearing juvenile salmonids, whereas others showed a marked decrease in potential habitat if sea level rises and mean high tides increase 1 to 2 meters.
- ▶ A small net gain in forest carbon was seen in Pacific Northwest forests even as effects of tree growth and afforestation were offset by fire, insects, logging, and deforestation. Tracking changes in forest carbon by using repeated inventory measurements identifies the magnitude of influence land use change, management, and disturbances have on aboveground forest carbon flux.
- ▶ The number of structures on private lands near almost all types of public forest in Oregon and Washington has more than doubled between the 1970s and 2000s. Consequences include increased road density with more human-caused ignition of wildfire, higher probability for invasive species, greater demand for local recreation, higher fire suppression costs, and increased complexity for managers trying to reduce wildfire hazard through fuel treatments.



Jason Hollinger

Wolf lichen (*Letharia vulpine*) can be used to monitor levels of atmospheric nitrogen near oil and gas wells.

Lichen serve as indicators of air quality near natural gas wells

Using lichens to assess air quality on public lands is increasingly common, serving as a budget-friendly supplement to other monitoring networks. Lichens accumulate nutrients, such

Study validates use of lichens as air quality indicators for dry interior forests.

as nitrogen (N), making their tissue levels a reflection of atmospheric N levels.

Scientists collected two common lichen species, *Letharia vulpina* and *Usnea lapponica*, from the Bridger Wilderness less than 20 miles from a concentration of active oil and gas wells in Sublette County, Wyoming. They wanted to calibrate N levels in lichen with N measurements collected by nearby monitoring instruments to determine

the extent of N dispersal into the wilderness. They found that N levels were relatively low, although visual signs of damage to lichens were evident at sites with the most N deposition. These results mirrored those yielded by the monitoring equipment. This is the first study to validate use of lichen tissue indicators for dry interior forests.

The Clean Air Act mandates that federal land managers protect air-quality-related values for national parks and wilderness areas. This study demonstrates that lichen tissue indicators are a simple, accurate tool for N monitoring.

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

Partners: Montana State University; USDA Forest Service Forest Inventory and Analysis—Interior West Region, Pacific Northwest Region, Pacific Southwest Research Station

Fungus-to-plant ratio in boreal black spruce forest soils is at least 17 to 1

Molecular techniques have increased our ability to study the diversity of fungi in the soil and to better understand the key roles that fungi play in ecosystems. Knowledge about the

Used as input for simulations of treeline dynamics in boreal and arctic forests.

distribution of species, community composition, and ecological niche of fungi is critical in light of global climate change. In

Alaska's boreal forests, for example, wildfires are increasingly prevalent in tundra and at treeline. A critical but often overlooked factor to seedling establishment at treeline is the symbiosis with belowground, ectomycorrhizal fungi. Ectomycorrhizal fungi provide soil nutrients and water to seedlings and protect seedlings

against pathogens, enhancing their growth and reducing drought stress.

Researchers found that the fungus-to-plant ratio in boreal black spruce forest soils is at least 17:1 and is regionally stable. The global extrapolation of this suggests 6 million species of fungi, a sixfold increase in diversity from previous estimates. Results also illustrate the important role ectomycorrhizal fungi-tree interactions play in seedling performance after fire.

This information is being used to improve simulation models of treeline dynamics and in particular the most current ALFRESCO landscape model with the Scenarios Network for Alaska and Arctic Planning.

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

Partners: University of Alaska–Fairbanks, University of New Mexico



Ken Winterberger

Black spruce forests in Interior Alaska host a rich network of belowground fungi.

Tool

New soil respirometer for calculating CO₂ fluxes

Description:

This field instrument is used for extensive soil respiration sampling in the challenging forest environment. Soil respiration is the flux of carbon dioxide (CO₂) from the soil to the atmosphere, and is the largest carbon flux from the terrestrial ecosystem. Soil respiration is nearly tenfold greater than fossil-fuel emissions on a global basis.

The instrument utilizes infrared gas analysis technology to calculate CO₂ fluxes. It was designed to optimally sample the highly variable forest ecosystem.

Use:

This instrument is for those interested in estimating and monitoring carbon stocks and greenhouse gas fluxes.

How to get it:

Seven devices have been built for the PNW Research Station. Several of these are being used for carbon monitoring in southeast Alaska. Contact Mark Nay to obtain a loaner for a trial or a demonstration. Plans and parts lists for building additional instruments are available through the USDA Forest Service Missoula Technology and Development Center. <http://www.fs.fed.us/eng/techdev/mtdc.htm>

Contact:

Mark Nay, mnay@fs.fed.us

Tool

MHW_Composite: mean high-water composite shoreline for southeast Alaska

Description:

MHW_Composite is a digital geospatial dataset depicting a mean high-water shoreline across the entire mainland and island extent of southeast Alaska. This dataset compiles maps from the National Oceanic and Atmospheric Administration (NOAA) that previously existed as 79 separate projects. NOAA maps represent the most accurate depiction of mean high-water in Alaska; however, only about two-thirds of southeast Alaska has been mapped. To map areas of shoreline not covered by NOAA maps, and to update areas where existing shoreline data were inaccurate, researchers used the next-best source of available data, which included digitizing new lines from high-resolution digital orthophotography. Because the non-NOAA source data are not directly tied to a tidal station, these lines are a “best guess” approximation of mean high-water, hence the name MHW_Composite. MHW_Composite is the most accurate and precise continuous shoreline available for southeast Alaska.

Use:

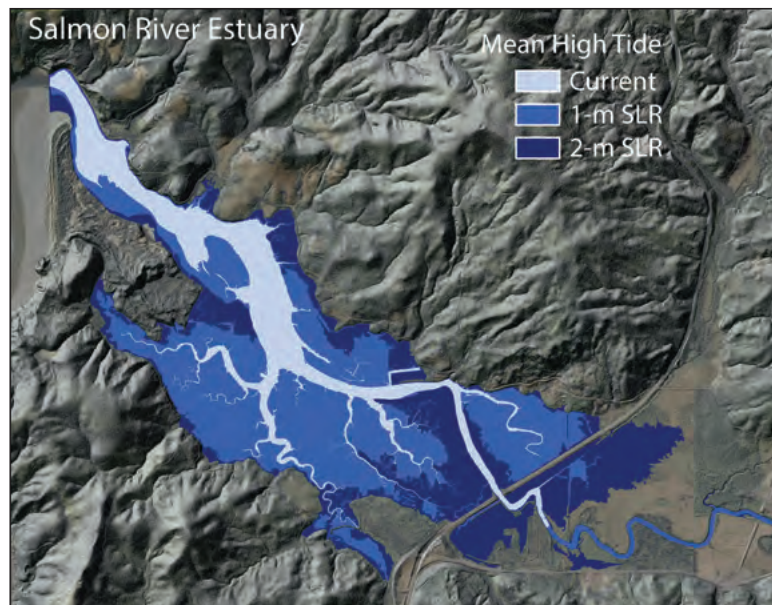
Shorelines are an essential base layer needed for geospatial analyses. MHW_Composite will be used by researchers, managers, planners, and students, and will be valuable for anyone who needs a digital shoreline dataset. The Tongass National Forest is using MHW_Composite to model high and low tide lines. MHW_Composite will also be integrated into the U.S. Geological Survey (USGS) National Hydrography Dataset, which is the surface water component of The National Map. MHW_Composite is a dynamic product that will be updated annually in conjunction with updates to the National Hydrography Dataset. MHW_Composite has already been used by the Tongass National Forest for producing environmental impact statements, and by research analysts with the Alaska Department of Fish and Game. MHW_Composite has been used by the Pacific Northwest Research Station for developing regional hydrologic models that predict freshwater discharge and nutrient flux, and in cooperative projects with the USGS and University of Alaska Fairbanks as an input layer for LandCarbon, a national carbon assessment.

How to get it:

The geographic information system (GIS) dataset will be available in spring 2015 for download from the Southeast Alaska GIS Library: <http://seakgis.alaska.edu/>.

Contact:

Frances Biles, fbiles@fs.fed.us



Kelly Christiansen

Scientists mapped the current mean high tide and projected mean high tide if sea level increases 1 to 2 meters. These changes would affect estuarine habitat for salmonids and other species in the Salmon River Estuary, Oregon.

Keeping pace with sea-level rise: insights for Oregon estuaries

Coastal areas are among the most dynamic, productive environments in the world, but they have been extensively developed for human uses. Current climate projections predict sea-level rise; alterations in type, timing, and intensity of precipitation; and increases in water temperature. Diverse

Habitat for
juvenile salmon
may increase in
some estuaries,
decrease in others.

estuarine habitats are used for varying lengths of time by juvenile salmonids. Sea-level rise may flood currently productive salt-marsh habitats, with limited potential for these habitats to shift upstream or into adjacent floodplains because of human development.

Land managers and citizens lack the spatially explicit data needed to incorporate effects of climate change and sea-level rise into planning for habitat improvement projects in estuarine areas.

Scientists developed simple models using LiDAR data collected by airborne laser scanners to characterize the geomorphology of multiple Oregon estuaries. They mapped the margin of current mean high tide and contour intervals associated with different potential increases. They found that some estuaries had increased potential for complex edge habitat for rearing juvenile salmonids, whereas others showed a marked decrease.

This research can help managers and scientists integrate current science into land use management decisions that have broad implications for the future. The scientists plan to work with local watershed groups and the state of Oregon to expand the use of mapping tools to enhance planning for estuarine habitat restoration, recovery, and protection.

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

Partners: Coos Watershed Association, Oregon Department of Fish and Wildlife, Oregon State University, South Slough National Estuarine Research Reserve

Using cover-based definition of forest land increases estimates of forest land

A key function of forest inventory is to detect changes in the area of forest land over time, yet different definitions of forest land are used in different regions of the world. The Forest Inventory and Analysis program has proposed changing its definition of forest land, which is based on relative stocking, to better match



Rebecca Flitcroft

Researchers set a seine net to sample the fish communities that use Palouse Slough, Oregon, as part of ongoing work to investigate the potential effect of sea-level rise on aquatic communities in estuaries.

the international definition, which is based on canopy cover. This would improve international consistency but could affect the ability to quantify true changes in the United States over time.

This study evaluated the anticipated effects of a definitional change on the area classified as forest land and its relationship to species and forest density in California, Oregon, and Washington. Scientists found that western juniper and ponderosa pine forest types will have higher estimates of forest land area if using a canopy-cover definition, compared to the

stocking-based definition. The difference will be pronounced where land is marginally forested.

The change in definition may result in an additional 360,000 acres of forest land being reported on the west coast. Measuring marginal forest lands with both metrics for the first cycle after implementation should make it possible to distinguish real change from definitional change, but will require reclassifying older plot measurements using the new definition.

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

Tool

An enhanced fuels map uses Fuel Characteristic Classification System (FCCS) and satellite imagery

Description:

This new product for the continental United States links mapped FCCS fuelbeds to estimates of dominant vegetation cover from satellite imagery (MODIS) to refine fuel-loading estimates at each point (pixel) on the map. By including observed vegetation cover, mapped output more accurately describes the actual fuels on the ground. This is critical for estimating fire effects, such as smoke exposure in local airsheds and air quality downwind, as well as carbon emissions that contribute to greenhouse gases. Regular updates using updated MODIS products (e.g., Vegetation Continuous Fields) will keep the dataset current with ongoing application to fire, smoke, and carbon management.

Users:

This will be a key product for modelers of air quality and the carbon cycle. It will be useful for regulators creating emissions inventories (e.g., Environmental Protection Agency and the Western Regional Air Partnership) that can also provide inputs for Earth-system models (e.g., NASA and the National Center for Atmospheric Research).

Contact:

Don McKenzie, donaldmckenzie@fs.fed.us

Partners:

Michigan Technological University,
NASA, University of Washington

Choice of equations affects estimates of tree biomass

People need accurate biomass equations to improve carbon accounting in forests. Station scientists developed equations for aboveground biomass components of Douglas-fir growing in the Siskiyou Mountains of southwestern Oregon. These site-specific equations were compared with nationally generalized equations, other published and widely used Pacific Northwest equations, recent site-specific equations from southwest Washington, and the USDA Forest Service Forest Inventory and Analysis program approaches.

This work shows how using different available biomass equations can affect estimates of tree biomass, and specifically, how similar-sized trees generate different equations depending on site characteristics. The Douglas-fir/Siskiyou equations were generated from data on older trees and a lower-productivity site, compared to the equations created from younger trees and a higher-productivity site in southwest Washington. This work illustrates how site-specific approaches will fine tune future carbon assessments and be particularly useful for long-term productivity studies, carbon accounting, and modeling.

Contact: Mark Nay, mnay@fs.fed.us

Partners: Joint Fire Science Program,
U.S. Environmental Protection Agency
Western Environmental Research Laboratory,
USDA Forest Service Siskiyou-Rogue River
National Forest

Net forest carbon in Oregon increased slightly during the last decade

A substantial portion of the carbon (C) emitted by human activity is apparently being stored in forest ecosystems in the Northern Hemisphere, but the magnitude and cause are not precisely

Decreases in east-side forests offset by increase in forest growth on west side.

understood. Studies have tracked these changes in forest C using repeated inventory measurements of nonfederal lands in Oregon, and of national

forests in Oregon and Washington. Although the net area of forest land increased in Oregon, the net effect of land-use change on C was a decrease because forest gains in low-C juniper forests were offset by losses in high-C Douglas-fir forests.

On nonfederal lands, C decreased significantly in eastern Oregon owing to the effect of western spruce budworm, but increased significantly in western Oregon owing to growth on nonfederal public lands. On national forest lands, C increases were higher on the west side of the Cascade Range, and primarily stayed in the live tree pool, compared to lower increases on the east side, where most of the increase was seen in the down wood pool. Fire led to decreased C stores in wilderness areas east of the Cascade Range.

The small impact of recent fires on C storage in national forests suggests that fires may not be a cause for concern, although investigation

of longer term effects is warranted. Better understanding of the magnitude of effects of land-use change, management, and disturbance on C storage from repeated inventory measurements will improve our ability to predict the effects of future changes in those drivers.

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

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

Development bordering public forest land in Washington and Oregon doubles in 30 years

Development stemming from population increases over the last 30 years has greatly affected forested lands in the United States. To assess and compare increases in development, station scientists counted changes in the number of structures on a systematic grid of photo-interpreted points around public forest land in Washington and Oregon.

Areas bordering public forest land show substantial increases in development. The number of structures on private lands near almost all types of public forest more than doubled between the 1970s and 2000s. Lands bordering Washington's Department of Natural Resources lands have more than twice as many new structures along their edges compared to other public owners. In Oregon, the greatest amount of development occurred along the



Rhonda Mazza

New housing near the Gifford Pinchot National Forest boundary in Washington.

edges of forests managed by the Bureau of Land Management. The greatest increases in structure density along the borders of public forests occurred in Pierce, King, Snohomish, and Clark Counties in Washington, and Deschutes County in Oregon.

The continuing development pressure along the edges of public forests in Washington and Oregon has numerous consequences, including

increased road density with more human-caused ignition of wildfire, higher probability of invasive species, greater demand for local recreation, higher fire suppression costs, and increased complexity for managers trying to reduce wildfire hazard through fuel treatments.

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

Partner: Oregon Department of Forestry

Tool

Database of low-altitude photographs and videos of northwestern Alaska

Description:

A database has been produced with 19,167 high-resolution photographs and 80 minutes of high-resolution videos (290,580 frames) taken along three aerial transect in arctic and subarctic northwestern Alaska, along with a database of the specific global positioning system (GPS) location (latitude-longitude) and content (land and water cover categories) in each image, and GPS locations of each flight transect. The small-plane flight transects occurred over 3 days time in July 2013 over 1,609 miles, totaling 17 hours 46 minutes of flight time, and covered five administrative units of the National Park Service and one of the U.S. Fish and Wildlife Service. Project collaborators include the USDA Forest Service, U.S. Geological Survey, National Park Service, and Alaska Ecoscience.

Use:

This product serves as a massive, detailed baseline from which future (and, in some locations, past) changes in terrestrial conditions can be measured, particularly from climate change effects. It is expected to provide a legacy for many such studies to come. The work was initiated to track effects of climate change on arctic and subarctic tundra. Worldwide, these are the most rapidly affected areas and can serve as an early warning of impending ecosystem changes in lower latitudes.

Distribution:

The full information set of photographs, videos, and associated maps and databases are being made available on a U.S. Geological Survey website, and have been provided also to the National Park Service for their posting.

How to get it:

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

Bruce Marcot



A new database of aerial photos establishes a baseline from which researchers can measure changes in terrestrial conditions in northwestern Alaska. Left, a shrunken lake in a white spruce forest.

Fish and Wildlife

As a steward of public lands, the Forest Service works to enhance and restore habitat for the wildlife and fish that live in national forests and grasslands and the waterways that flow through these lands. 🌀 Station scientists provide tools and knowledge that land managers and decisionmakers can use to minimize the effects of fire, urbanization, disease, and climate change on habitat.



Foothill yellow-legged frog (*Rana boylii*).

Ryan Peek

Highlights in 2014

- ▶ New technical guide offers comprehensive guidance for wildlife habitat monitoring on public lands in the United States. It has been endorsed in the science review of bioregional monitoring for national forests in the Sierra Nevada and by the Association of Fish and Wildlife Agencies for state wildlife action plans.
- ▶ Scientists project the effects of climate change on ecosystems and wildlife habitats in northwest Alaska. Projections indicate increases in some ecosystems and decreases in others and associated changes in dependent birds and mammals. Declines will occur in half of the 50 bird and mammal species currently used for subsistence hunting and trapping.
- ▶ Offshore abundance of marbled murrelets is most strongly associated with amount and pattern of adjacent suitable forest nesting habitat. Prior to this study, it was unclear if abundance of this threatened species was more heavily influenced by nesting habitat or by availability of forage in nearshore marine waters.
- ▶ The salmonid species *Oncorhynchus mykiss* can become sea-going steelhead or freshwater rainbow trout. Lipid accumulation and metabolic rate appear to influence which life history young *O. mykiss* will assume.



Michael Mengak

A new technical guide provides standardized protocols for habitat monitoring. The American marten (above) is one of the species featured as a case example for habitat monitoring.

National technical guide provides a foundation for monitoring wildlife habitat on national forests

Information about the status and trends of wildlife habitat is fundamental for meeting the mission and legal and policy requirements of the Forest Service. Many techniques have been used to monitor wildlife

**Endorsed by
Association of
Fish and Wildlife
Agencies for use in
state wildlife
action plans.**

habitat in the Forest Service, but no comprehensive guide existed to provide standardized protocols for habitat monitoring.

To that end, working with partners, Forest Service scientists and managers from three

research stations, eight regions, and the Washington office published a national, multichaptered book. This technical guide provides current, scientifically credible, and practical protocols to inventory and monitor terrestrial wildlife habitat. It is written for

resource professionals (e.g., ecologists, silviculturists, and planners) charged with forest planning, project impacts analysis, and habitat monitoring at ranger district, national forest or grassland, and regional levels. The book also offers guidance to other agencies and organizations in the use of standardized, contemporary approaches for wildlife habitat monitoring.

Contact: Mary Rowland, mrowland@fs.fed.us

Partners: USDA Forest Service, Northern Research Station, Rocky Mountain Research Station; Washington office, Terrestrial Wildlife Ecology Unit and Ecosystem Management Coordination; Forest Service Regions 1, 2, 3, 4, 6, 8, 9, and 10; Forest Inventory and Analysis; Remote Sensing Applications Center; University of Massachusetts; and Western Ecosystems Technology, Inc.

Citation: Rowland, M.M.; Vojta, C.D. tech. eds. 2013. A technical guide for monitoring wildlife habitat. Gen. Tech. Rep. WO-GTR-89. Washington, DC: U.S. Department of Agriculture, Forest Service. 400 p. <http://www.treeseearch.fs.fed.us/pubs/45213>.

Projecting the effects of climate change on ecosystems and wildlife habitats in northwest Alaska

Climate change is affecting terrestrial and aquatic ecosystems and associated wildlife habitats in the arctic and subarctic more rapidly than anywhere else. Such changes are likely

Declines projected for 25 bird and mammal species currently used for subsistence.

to reduce snow-based access to areas used for hunting and trapping and alter the abundance and availability of wild-

life, including species used for subsistence by native Alaskans and local communities.

To project the effects of such changes over the 21st century in northwest Alaska, scientists developed a set of state-transition models and wildlife-habitat relationship models that summarize knowledge on the extent and transitions of ecosystems and wildlife habitats and their biophysical drivers.

Projections indicate habitat increases in some ecosystems and decreases in others, with associated changes in dependent birds and mammals. Expansion of tall shrubs and trees, increase in fire, vegetation succession, and melting of permafrost are some of the major disturbances that will drive the transitions. Of the 201 bird and mammal species currently occurring in the area, the model projects that 52 percent will experience habitat expansion, 45 percent will see habitat contractions, and only 3 percent will have no change. Declines will occur in half of the 50 bird and mammal species currently used for subsistence hunting and trapping.

These results were shared with federal agencies in the region and presented at public conferences and information sessions for local communities.

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

Partners: USDI Geological Survey and National Park Service



Nick Hatch

Nesting habitat for the sea-going marbled murrelet is critical to its conservation.

Offshore abundance of marbled murrelets is most strongly associated with amount and pattern of adjacent suitable forest nesting habitat

The marbled murrelet is a threatened species of seabird that forages on small fish and invertebrates in nearshore marine waters, and nests inland on limbs of large coniferous trees. A major objective of the Northwest Forest Plan is to conserve the bird's nesting habitat. However, because the bird forages in ocean waters, managers have not been certain if conservation of nesting habitat is key to the species conservation or if marine factors that influence the bird's prey are more important.

Scientists developed a model that evaluates the relative contributions of a set of marine variables and nesting habitat variables. They found that the nesting habitat variables were the strongest contributor to predictions of murrelet

Bruce Marcot



Climate-induced habitat changes will affect birds and other wildlife in northwest Alaska. Melting permafrost, for example, can cause tundra lakes to drain. Some species will likely benefit from these changes, while others will not.

abundance, which means that conservation of nesting habitat appears essential to conservation of murrelet populations.

This work has been immediately applied by U.S. Fish and Wildlife Service managers who are tasked with consulting on projects that may harm marbled murrelets. It has also been applied by Forest Service and U.S. Fish and Wildlife Service managers in setting policy for management of nesting habitat within the range of the murrelet. The work also has informed the marbled murrelet effectiveness monitoring group about the relevance of habitat monitoring in assessing effectiveness of the Northwest Forest Plan.

Contact: Martin G. Raphael, mraphael@fs.fed.us

Partners: California Department of Fish and Wildlife, Oregon Department of Forestry, U.S. Fish and Wildlife Service, USDI Bureau of Land Management, Washington Department of Natural Resources

Lipid accumulation and metabolic rate influence steelhead vs. rainbow trout life history

Protecting and restoring freshwater habitats for steelhead in the face of potential climate change impacts is a major challenge. Many populations

Lipid levels decrease at higher temperatures; fish with lower lipid levels tended to be female steelhead.

of steelhead are protected by the Endangered Species Act. Steelhead are the sea-going form of *Oncorhynchus mykiss*, whereas

rainbow trout (also *O. mykiss*), reside lifelong in freshwater. The offspring of either form may opt for the opposite life history, but the mechanisms for this are not well understood.

Five coordinated, independent studies addressed aspects of how life-history expression relates to habitat, water temperature, sex, metabolic rates, and lipid levels. To conduct this research, the scientists used a novel, nonlethal method for genetically determining the sex of salmon smolts.

Scientists found that steelhead spawn in areas that contain both suitable spawning gravels and nearby juvenile rearing habitat. Lipid accumulation was related to metabolic rate and life history: fish with lower metabolic rates and higher lipid levels tended to be rainbows. Lipid

levels decreased at higher temperatures, and fish with lower lipid levels tended to be steelhead and female. In fact, 70 percent of steelhead were female. This was true for 65 to 70 percent of steelhead smolts from northern California to southeast Alaska to central Idaho.

This work makes a major contribution to understanding the life-history expression in *O. mykiss* and other species that exhibit similar variation in life histories. It provides insight for the variation in life-history expression between sexes and challenges the notion that faster growing fish tend to be sea-going steelhead.

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

Partners: National Oceanic and Atmospheric Administration—Fisheries, Oregon State University, U.S. Geological Survey

Mark Lisac, U.S. Fish and Wildlife Service



Rainbow trout or steelhead? A novel study begins to unravel how the life-history expression of *Oncorhynchus mykiss* relates to habitat, water temperature, sex, metabolic rates, and lipid levels.

In-stream habitat restoration benefits Chinook salmon and steelhead trout

Station scientists and cooperators evaluated the effectiveness of in-stream habitat restoration structures to enhance rearing habitat for juvenile salmonids for a fifth study year (2009–2013). Habitat restoration structures consisted of engineered logjams and rock barbs extending from banks of streams in the Entiat River watershed of the upper Columbia River basin. More Chinook salmon continue to be found in microhabitats with restoration structures compared to those without restoration structures early in the season. Deeper water around restoration structures appears to be the mechanism leading to increased Chinook salmon abundance. Steelhead trout were much more variable in their use of restored vs. unrestored microhabitats.

These results are being used by restoration planners and by a larger monitoring program to further inform the design and implementation of additional restoration structures in the same watershed and in other watersheds throughout the upper Columbia River basin.

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

Partners: Cascadia Conservation District, Integrated Status and Effectiveness Monitoring Program, National Oceanic and Atmospheric Administration—Fisheries, U.S. Bureau of Reclamation



Adding down wood to riparian areas following timber harvest helps create moist microhabitats favored by red-backed salamanders.

Salamander benefits from large amounts of wood debris along headwater streams following clearcutting

Woodland salamanders may be used to monitor biodiversity and ecosystem integrity following forest disturbance. As part of a study of alternative riparian buffer treatments along headwater streams, scientists trapped western red-backed salamanders (*Plethodon vehiculum*) before and after treatments to determine treatment effects. Their goal was to learn how alternative buffering strategies could be used to conserve and protect headwater streams during timber harvest.

They found that the reduced forest canopy caused by clearcut harvest and partial clearcut harvest (forest islands on fragile sites in a clearcut landscape) had detrimental effects on moist micro-environments used by salamanders.

Retaining dead downwood plus adding three to six times more dead downwood than occurred before harvest to create moist micro-environments seemed to lessen the expected adverse treatment effects on salamanders in clearcut areas.

Contact: Martin G. Raphael, mraphael@fs.fed.us

Partner: Washington Department of Natural Resources



Rhonda Mazza

An innovative, multidisciplinary riparian restoration project

Federal agencies have spent millions of dollars restoring streams and riparian habitats to recover endangered salmonids, including placement of woody debris and planting native shrubs and trees to stabilize banks and mediate stream temperatures. Small mammals, birds, and native pollinators may also benefit from stream restoration. However, browsing by native and domestic ungulates such as cattle, elk, and mule deer can dramatically affect riparian vegetation, even eliminating key species such as willows.

Knowledge about effects of cattle versus deer/elk herbivory on shrub recovery is limited, posing major obstacles in designing best ungulate management practices to improve riparian systems for salmonids. Moreover, knowledge is limited about effects of climate change on stream temperature, and how these effects may be ameliorated by restoration plantings. To address these complex and important issues, the PNW Research Station initiated a long-term research project at Meadow Creek within the Starkey Experimental Forest and Range.

This project offers novel opportunities for cross-cutting research to understand links between abiotic and biotic systems in arid environments. The integrative approach addresses holistic management of complex riparian ecosystems and their multiple stressors. The Meadow Creek restoration project will

result in a comprehensive set of best management practices for recovery of riparian systems that include effective ungulate management in the intermountain West.

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

Partners: Bonneville Power Administration; Columbia River Intertribal Fish Commission; Grande Ronde Model Watershed; Oregon Department of Fish and Wildlife; Oregon State University; USDA Forest Service Pacific Northwest Region, Wallowa-Whitman National Forest

Terrestrial salamanders in managed forest headwater basins move nearer to streams

Station scientists examined terrestrial salamanders in managed headwater forest stands in western Oregon from 1998 to 2009. They found that headwater riparian areas may act as habitat “funnels” for these animals, where movements are concentrated within and along narrow streamside zones.



Matt Kluber

Artificial covers, such as boards, facilitate the study of salamander movements at this study site in the Oregon Coast Range.

The scientists provide options for where and how to enhance ground surface habitat connectivity for sensitive salamander species in forests in the west Cascades. Positioning upland down wood in “chains” extending out from riparian area funnels may facilitate overland habitat connectivity for salamander dispersal. At larger spatial scales, landscape chains of connectivity may be designed with log links connecting riparian and upland areas. This work may inform riparian forest management and riparian-upland management decisions.

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

Partner: Oregon State University

Terrestrial mollusks respond to logging in riparian areas

Little is known about the biology and response to environmental change of native, terrestrial mollusks in the Pacific Northwest. Most people simply regard slugs and snails as garden pests, but most often the actual culprits are introduced nonnative species. Because of mollusk affinities to moist environments, the effect of human-caused habitat alteration from logging is assumed to be detrimental but is largely unknown. This uncertainty is problematic because federal agencies are required to account for impacts to sensitive, native mollusks as part of their project environmental analyses. Several mollusk species are being considered for protection under the Endangered Species Act.



Robin Shoal

The Malone jumping-slug (*Hemphillia malonei*) is one of seven species of jumping-slugs found in the Pacific Northwest.

Station scientists evaluated the response of terrestrial mollusks within three different buffer configurations along small streams in western Washington. The buffers consisted of 30-meter-wide fixed-width corridors, clearcuts with no buffers, and unlogged controls. Mollusks were sampled both before and after logging.

The scientists found that mollusk communities varied among sites relative to vegetative composition, the amount of understory cover, and the presence of seeps or small wetland features in the riparian areas. After logging,

Tool

FrogLog— Global Bd mapping project

Description:

This publication provides a comprehensive summary of the known occurrence of the amphibian chytrid fungus, *Batrachochytrium dendrobatitis* (Bd), as of June 2014.

Use:

Global natural resource managers, scientists, and conservationists use locality maps of Bd sites for amphibian species threat assessments, to make local decisions for Bd inventory and monitoring, and to develop study plans for new investigations of Bd ecology and epidemiology and Bd-host interactions. The synthesis is used by biologists and naturalists to gain knowledge of the pathogen and infected amphibian species. The U.S. watershed-scale maps are used to make informed decisions about water draws and use of pathogen disinfection protocols for firefighting and other land management practices.

Distribution:

Froglog is internationally distributed via the Internet and email listservers. U.S. watershed maps were distributed to all Forest Service regions in the Western United States and Bureau of Land Management/Oregon upon request from the agencies.

How to get it:

<http://www.fs.fed.us/pnw/lwm/aem/people/olson.html>

Contact:

Dede Olson, dedeolson@fs.fed.us

Tool

Salamander News— monthly newsletter reaches worldwide audience

Description:

This newsletter provides science, management, and educational information about salamanders as part of an annual campaign “2014 Year of the Salamander” to raise awareness for salamander conservation. Monthly newsletter issues have reported on educational and citizen science programs, conservation challenges, the Appalachian salamander biodiversity hotspot, various taxonomic groups, diseases, threats to habitats, state and federal programs, interviews with leaders working with salamanders, and many other topics.



Matt Kluber

Upland salamander species such as this ensatina (*Ensatina eschscholtzii*) use riparian corridors to move about the landscape.

Use:

Sixty groups across the world have become partners in the Year of the Salamander, and link to the Web page from their own websites. The monthly news issues get about 5,000 views from a wide international audience. Newsletter articles are used by biologists, naturalists, and the public to gain knowledge of the taxon, and are used for educational purposes by various organizations.

How to get it:

<http://www.yearofthesalamander.org>

Contact:

Dede Olson, dedeolson@fs.fed.us

slug and snail abundance were significantly different between streams with no buffers and control streams. Mollusk abundance differed significantly between fixed-width buffers and streams with no buffers. The effect was relatively small, however, suggesting that site variability may override the effects of logging. These findings illustrate that site differences can affect mollusk community structure and influence resiliency to disturbances such as logging. This research contributes to our understanding of a little-studied but important component of Pacific Northwest forest biodiversity.

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

Partners: University of Washington, USDA Forest Service Olympic National Forest, Washington Department of Natural Resources

Conservation assessments and maps for regionally sensitive species

Scientists compiled comprehensive summaries of the biology and ecology of two regionally sensitive salamanders: Cope's giant salamander and Van Dyke's salamander. Natural resource managers use species conservation assessments to develop science-based management alternatives when they have a proposed land-use action within the range of a state or federally listed species. The Interagency Special Status and Sensitive Species Program for the Forest Service and Bureau of Land Management notifies regional agency biologists about the availability of these conversation assessments.

Scientists also mapped two sensitive turtle species in the region: the western pond turtle and painted turtle. This is the first publication to compile locations across the United States and Canada. It included maps of known locations by date, demonstrating accrual of knowledge and showing where re-surveys may be needed to learn if the species are still present at historical sites. Natural resource managers use these types of locality maps of species sites for status assessments. Gaps in locations may be used to target geographic areas for new surveys, whereas known locations may be useful for development of monitoring programs.

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

Pygmy rabbits, an endangered species in Washington state, selectively browse on sagebrush plants with higher levels of crude protein.



Boise State University

Pygmy rabbits use nutritional and chemical cues while making foraging decisions

Pygmy rabbits are dietary specialists that feed on sagebrush and forage on specific plants more than others within a foraging patch. These small rabbits are endangered in Washington state and considered a sensitive species throughout the Great Basin.

For herbivores, nutrient intake is limited by the relatively low nutritional quality of plants and their high concentrations of potentially toxic defensive compounds, referred to as plant secondary metabolites. Scientists hypothesized that plants with evidence of heavy browsing by pygmy rabbits would have higher dietary quality than plants that were not browsed.

They found that sagebrush plants containing higher crude protein had greater odds of

being browsed by pygmy rabbits than plants with lower protein, whereas the opposite was observed for certain secondary metabolites. The scientists concluded that pygmy rabbits use nutritional and chemical cues while making foraging decisions. These rabbits can occupy foraging patches near their burrows for multiple years, and their constant browsing may influence the nutritional and secondary metabolite constituents of these plants. This indicates that dietary quality of the landscape is an important parameter to consider when planning and implementing conservation and restoration strategies for pygmy rabbit habitat.

Contact: Rick Kelsey, rkelsey@fs.fed.us

Partners: Boise State University, University of Alaska, University of Idaho, Washington State University

Panel evaluates techniques to control raptors preying on western snowy plovers

Raptors, particularly northern harriers and great horned owls, prey on western snowy plovers—a federally threatened seabird that lives along the Pacific coast. A seven-member

Plover monitoring refined based on panel's suggestions.

expert panel reviewed the feasibility and efficacy of 26 humane raptor-control tech-

niques. The panel also identified information and monitoring methods to help inform raptor control management as well as extenuating considerations for policy application such as cost consideration, training personnel, workloads, and information management.

The raptor control techniques identified with the highest potential feasibility and effectiveness included lethal removal, and use of various trapping methods, including a cube trap, a



Michael L. Baird, flickr.bairdphotos.com

Western snowy plover (*Charadrius nivosus nivosus*).

Swedish style goshawk trap, and a dho-gaza net trap. The panel also identified a need for monitoring plover nest sites with cameras and observers.

The U.S. Fish and Wildlife Service is applying these findings at designated western snowy plover recovery sites along the Oregon coast. The findings have also been shared with the U.S. Forest Service and Bureau of Land Management for use at their sites. To date, several instances of potential raptor predation have been thwarted by using the identified techniques, and plover monitoring is being refined based on the panel's suggestions.

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

Partner: U.S. Fish and Wildlife Service

Using LiDAR to evaluate habitat characteristics for the red-cockaded woodpecker

The red-cockaded woodpecker is a federally endangered forest-dwelling bird that occupies a narrow ecological niche in southern pine forests. The recovery plan for the woodpecker describes specific habitat requirements to sustain existing populations and facilitate population expansion.

Current efforts to characterize habitats involve labor-intensive installation and measurement of field plots. This research showed that LiDAR data collected by an airborne laser scanner can be used to describe vegetation structure, specific size classes of trees, and

spatial arrangement across large land areas while maintaining high spatial resolution. Scientists combined the LiDAR data with data measured on forest inventory plots to develop layers describing specific attributes for softwood and hardwood vegetation. This allowed them to evaluate habitat conditions for the red-cockaded woodpecker using the guidelines specified in the recovery plan.

Jon Dickey



Pink salmon in the Tye River, Washington.

This method provides an alternative to the plot-based methods currently used to assess and report habitat conditions. The method also allows spatially explicit mapping of forest conditions over large land areas, allowing managers to identify areas where vegetation management could transform existing conditions into those more suitable for the woodpecker.

Contact: Robert J. McGaughey, bmcgaughey@fs.fed.us

Partners: Department of Energy Savannah River Site, North Carolina State University, USDA Forest Service Southern Research Station

New tool: A self-adjusting, expandable telemetry collar for elk

Forest Service scientists at the Starkey Experimental Forest and Range in eastern Oregon collaborated with the Oregon Department of Fish and Wildlife to successfully develop and deploy a novel expandable telemetry collar for male elk. The collar is safe, humane, and effective in collecting location and survival data for research and management of wild male cervids (deer and elk).

Successful placement of telemetry collars on male deer and elk has been extremely challenging because their neck size can increase substantially during the rut, and their bodies grow substantially as they mature. The new expandable collar is used on yearling or adult male elk for telemetry tracking of animal locations and survival estimation. The majority of collars were



Brian Dick

An expandable elk collar, invented at Starkey Experimental Forest and Range, allows researchers to more easily monitor individual elk.

successfully worn by elk over a 1- to 3-year period. No deaths or injuries were attributed to the collars, and recaptured animals were in excellent health after wearing the collars for long periods.

This new technology represents a breakthrough opportunity to gain desired knowledge on ecology of male cervids throughout the world, which has been difficult in the past. Use of the expandable collar technology will allow implementation of important new lines of research needed to address long-standing knowledge voids of keen interest regarding ecology and management of male deer and elk.

Contact: Brian Dick, bldick@fs.fed.us, or Michael Wisdom, mwisdom@fs.fed.us

Behavior and nutritional condition buffer elk against direct and indirect effects of climate

Changes in net energy balance strongly influence animal fitness; thus natural selection should favor behaviors that buffer individual animals against negative effects of environmental variation. However, little is known about how energy balances in animals are affected by climate, animal condition, and behavior.

Scientists studied elk in two contrasting ecosystems—montane forest at the Starkey Experimental Forest and Range in eastern Oregon and an arid high desert in Idaho—to test the hypothesis that elk behavior from spring to autumn

varies as a function of contrasting climates and by the nutritional condition of individual elk. In the high desert, elk selected sites that required less energy for them to maintain body temperature rather than areas with the highest quality forage. By contrast, elk at Starkey selected sites that provided high-quality forage even if they had to expend more energy in thermoregulation. At the Starkey sites, the nutritional condition of an individual elk did not affect its foraging-site selection. In the desert, however, elk in poorest condition at winter's end strongly selected areas that reduced thermoregulatory costs during summer.

This study highlights the importance of understanding the roles of animal behavior and nutritional condition in buffering individuals against effects of climate. As climate warms in areas occupied by elk, managers can use this information to balance habitat management for sites that reduce thermoregulatory costs vs. those that provide high-quality forage.

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

Partners: Idaho State University, Princeton University, University of Idaho, University of Wisconsin–Madison, Wyoming Cooperative Fish and Wildlife Research Unit



Rhonda Mazza

Although their meetings are infrequent, range cattle and elk do co-mingle for periods long enough to possibly transmit disease from one species to the other.

Co-mingling of cattle and elk may facilitate disease transmission between the two species

The potential for disease transmission between wild and domestic ungulates is increasing throughout the world, with substantial economic and ecological ramifications. Estimating the probability of disease transmission on ranges co-occupied by wild and domestic ungulates, however, is notoriously difficult.

The first step for estimating the potential for between-species disease transmission is to quantify the proximity between individuals of different species in space and time.

Station scientists and partners assessed the likelihood of disease transmission between domestic and wild ungulates by using long-term location data on cattle, elk, and mule deer collected at the PNW Research Station's Starkey Experimental Forest and Range. They used novel

statistical methods to estimate the frequency at which domestic and wild ungulates, tracked with global positioning system collars, would occur in proximity sufficiently close for disease transmission to potentially occur.

The scientists found that elk and cattle had rare co-mingling events, but when the two species did meet, they were closer to each other than expected, based on general space use by these species. This pattern also held for deer and elk, but not for deer and cattle. Understanding the causes for such events is important for designing grazing practices that minimize wild ungulate–livestock contacts. Co-mingling between domestic and wild ungulates, although rare, may facilitate disease transmission. This is a critical issue across the world where co-occupied ranges are common.

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

Partners: Oregon Department of Fish and Wildlife, University of Calgary, University of California, University of Wyoming

Natural Disturbances

Fire, insects, disease: these events disrupt forest succession and nudge the stand along a different developmental trajectory. 🌀 As the climate changes, forests and rangelands will be more vulnerable to these disturbances, which may be uncharacteristically severe. 🌀 We provide information and tools that allow land managers to anticipate these disturbances and take action to reduce or ameliorate the effects of these stressors. 🌀 This includes developing and improving models of fire dynamics and smoke behaviors, and understanding disturbance interactions between terrestrial and aquatic ecosystems.



Kari Greer

PNW scientists provided smoke modeling support for the 2014 Carlton Complex Fire in north-central Washington.

Highlights in 2014

The **BlueSky** smoke modeling framework received major improvements in 2014:

- ▶ A new Google™ map display of BlueSky shows near-surface particulate matter concentrations calculated for various resolutions and domains by the BlueSky smoke modeling framework. This allows users to easily navigate the daily suite of BlueSky forecast simulations.
- ▶ A new trajectory tool provides an interface to the HYSPLIT model to calculate trajectories with results displayed in a Google map interface and available in Google Earth™. Specifying a trajectory initiation height is a means of simulating plume rise from a wildland fire.
- ▶ The air quality monitoring data viewer links into the Environmental Protection Agency's AirNow Tech database of air quality monitoring data. A Google map interface allows a user to easily select a desired location by either clicking or entering latitude/longitude values.

Fuel and Fire Tools now integrates stand-alone versions of the Fuel Characteristic Classification System Consume, Fire Emission Production Simulator, and Pile Calculator. The system allows users to develop fuelbeds and predict fire behavior, fuel consumption, and rate of heat release during wildland fires.

Safe Separation Distance was developed to provide recommended fire-safe separation distance between a person and a fire in the presence of a given terrain slope and a range of windspeeds. This preliminary safety zone rule was released in July 2014 for the upcoming fire season.

Delivering smoke science to incident operations

Summer 2014 saw significant fires occur across the Pacific Northwest, with accompanying large smoke impacts. Station scientists, working with Washington Office Fire and Aviation Management to support the Wildland Fire Air Quality Response Program, responded to these fires. They

provided smoke projections and updated smoke science tools that were used by incident operations to inform communities about anticipated smoke conditions. A record number (25) of air resource advisors were dispatched to wildfire incidents to deliver smoke modeling,



Output from the BlueSky smoke modeling framework showing projected smoke dispersal for the day from the 2014 King Fire in the Eldorado National Forest.

monitoring, and messaging information to the incident operators and other state, local, and tribal agencies.

The centerpiece of this science is the BlueSky smoke modeling framework, which received major scientific improvements in 2014. It now generates particle simulations, parallelized computer modeling, multiple model domains (CONUS and regional) and high-resolution (as fine as 1 km) domains. Results now provide information about how smoke interacts with terrain in complex valleys and flows.

This work was recognized by the Pacific Southwest Region with a Regional Forester Honor Award in 2013. Further appreciation came in August 2014: Praising the system, an air resource advisor deployed on the Klamath National Forest in northern California stated, "Model outputs are accurate." For a modeling system, higher praise cannot be achieved! The area is very remote with complex terrain and meteorological interactions, and the modeling products helped the air resource advisors provide timely and detailed air quality forecasts to communities affected by smoke.

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

Partners: Desert Research Institute; National Weather Service; University of Washington; USDA Forest Service Air Program, and Fire and Aviation Management

Tools

The BlueSky Smoke Modeling Framework v3.5.1

Description:

The BlueSky Smoke Modeling Framework links together fire information, mapped fuels information, fuel consumption models, fire emission models, plume rise algorithms, and atmospheric dispersion models to calculate emissions and downwind smoke dispersion from wildland fires. Version 3.5.1 represents significant improvements to the framework such as particle mode simulations with the HYSPLIT dispersion model, parallelized computing, and integration with high-resolution meteorology from partners such as the Desert Research Institute, National Weather Service, and University of Washington.

Use:

BlueSky is used by Air Resource Advisors; state, local and tribal air quality and health agencies; and prescribed burn planners. It helps inform agencies about potential smoke impacts to the public and wildland firefighters as well as transportation safety issues on wildland fire operations. It aids in go/no-go decisions on prescription burns.

Distribution:

Use of BlueSky is taught in National Wildland Fire Training classes and Air Resource Advisor Training Workshops. Scientific developments are shared at conferences and symposia such as the International Smoke Symposium, American Meteorological Fire and Forest Meteorology, American Geophysical Union, and Fire and Fuels Conference.

How to get it:

Daily forecasts for a variety of domains are available at <http://www.fs.fed.us/pnw/airfire>.

Contact:

Sim Larkin, larkin@fs.fed.us

Google Map display of the BlueSky output products

Description:

A new Google Map™ display of BlueSky output products became available in 2014. The display shows near-surface particulate matter concentrations calculated for various resolutions and domains by the BlueSky Smoke Modeling Framework. This allows users to easily navigate the daily suite of BlueSky forecast simulations and makes the model outputs easily accessible to computers that do not have the capacity to show Google Earth™ output.

Use:

This tool is used by anyone accessing the daily BlueSky forecasts such as Air Resource Advisors and state, local, and tribal air quality and health agencies. It has been widely adopted.

Distribution:

This tool was first unveiled at the 2014 Air Resource Advisor Training Workshop and will be taught in upcoming classes offered through National Wildland Fire Training.

How to get it:

<http://www.fs.fed.us/pnw/airfire>

Contact:

Sim Larkin, larkin@fs.fed.us



Rob Elleman

A helium-filled, tethered aerostat with monitoring equipment records smoke emissions data during a field burn near Walla Walla, Washington.

Wildland Fires, Carbon, and Climate: The U.S. Forest Service Greenhouse Gas–Black Carbon Report

In response to questions from Congress, a working group of scientific experts from across the Forest Service and partnering universities convened to summarize the current state-of-the-science on wildland fires, carbon, climate, and their linkages. The Pacific Northwest Research Station contributed its expertise to this effort. In 2014, the group's final report was published as a collection of connected peer-reviewed journal articles in a special edition of the journal *Forest Ecology and Management*.

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

Partners: George Mason University, University of Montana, USDA Forest Service Research Stations (all)

Smoke measurements from field burning first step in modeling smoke concentrations from agricultural burns

A comprehensive field campaign was undertaken to measure smoke from crop residue burns of Kentucky bluegrass in northern Idaho and wheat fields in eastern Washington. The

Information is
being used to
build models that
project the
amount and
behavior of smoke.

project goal was to help smoke management agencies predict the amount of smoke from agricultural burns as well as the behavior of the plumes.

Researchers developed a comprehensive sampling strategy, unprecedented for studying agricultural smoke. They characterize the preburned field, and measured the ground, near-ground, and downwind smoke

density and chemical composition. They also collected remotely sensed measurements of the smoke plume. Measurements were made of carbon monoxide, carbon dioxide, methane, black carbon, elemental carbon, total carbon, aerosol absorption and scattering properties, volatile organic compounds, and particulates (PM_{2.5}) from instruments deployed aboard an aircraft, a tethered balloon sampling system, and at the ground. Modeling studies are underway.

Contact: Susan O'Neill, smoneill@fs.fed.us

Partners: U.S. Environmental Protection Agency, National Weather Service, Nez Perce Tribe, USDA Forest Service Rocky Mountain Research Station, Washington State Department of Ecology, Washington State University

Regional fire professionals use new field guide to learn about conducting fuel inventories

Some of California's most destructive and costly wildfires have occurred in wildlands near San Francisco and surrounding cities. The 1991 East Bay Hills Fire in Oakland and Berkeley, for example, killed 25 people and destroyed more than 3,000 structures.

Scientists photographed and inventoried sites characteristic of fuel types found throughout the East Bay area of California. This information was published as a field guide to assist regional fire management staff with fuel planning and fire hazard assessment in the wildlands and adjoining urban interface areas.



The latest volume of the National Fuel Photo Series documents fuel types common to East San Francisco Bay. These guides are useful to fire managers planning treatments, and the photos have proven useful in discussions of proposed treatment options with citizens and public officials.

Following the publication of the field guide, fire management staff from the East Bay Regional Park District and the Hills Emergency Forum conducted two training sessions for 35 regional fire professionals from local fire departments, the East Bay Municipal Utility District, Lawrence Livermore National Laboratory, the City of Oakland, and CalFire. Training included basic fuels concepts, then moved on to how the field guide was constructed, and finally how to conduct a fuels inventory using the field guide.

Contact: Clint Wright, cwright@fs.fed.us

Partners: East Bay Regional Park District, Hills Emergency Forum

Citation: Wright, C.S.; Vihnanek, R.E. 2014. Stereo photo series for quantifying natural fuels. Volume XIII: grasslands, shrublands, oak-bay woodlands, and eucalyptus forests in the East Bay of California. Gen. Tech. Rep. PNW-GTR-893. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 39 p.

Tools

Trajectory Tool

Description:

Trajectories are a computationally fast and easy means of tracking where a parcel of air will travel in a 3-dimensional meteorological field given a starting location and height in the atmosphere. The AirFire trajectory tool provides an interface to the HYSPLIT model to calculate trajectories with results displayed in a Google Map™ interface and available in Google Earth™. Specifying a trajectory initiation height is a means of simulating plume rise from a wildland fire.

Use:

The trajectory tool is part of the suite of tools available to Air Resource Advisors.

Distribution:

The trajectory tool was first unveiled at the 2014 Air Resource Advisor Training Workshop and will be taught in upcoming classes offered through National Wildland Fire Training.

How to get it:

<http://www.fs.fed.us/pnw/airfire>

Contact:

Sim Larkin, larkin@fs.fed.us

Air Quality Monitoring Data Viewer

Description:

The air quality monitoring data viewer links into the Environmental Protection Agency's AirNow Tech database of air quality monitoring data and displays the data in terms of raw hourly data, 3-hour rolling means, 24-hour rolling means, and box plots against a background color-coded to the Air Quality Index if the user chooses. A Google Map™ interface allows a user to easily select a desired location by either clicking or entering latitude/longitude values.

Use:

The air quality monitoring data viewer tool is part of the suite of tools available to Air Resource Advisors.

Distribution:

The air quality monitoring data viewer tool was first unveiled at the 2014 Air Resource Advisor Training Workshop and will be taught in upcoming classes offered through National Wildland Fire Training.

How to get it:

<http://www.fs.fed.us/pnw/airfire>

Contact:

Sim Larkin, larkin@fs.fed.us

Tool

Fuel and Fire Tools (FFT) Version 2.2

Description:

FFT integrates stand-alone versions of the Fuel Characteristic Classification System, Consume, Fire Emission Production Simulator, and the Pile Calculator. No specific operating system is required. The system allows users to develop fuelbeds and predict fire behavior, fuel consumption, and rate of heat release during wildland fires.

Use:

FFT is routinely used by land managers and fire planners, air quality regulators, and researchers for fire and fuels planning and ecological assessments.

Distribution:

FFT is distributed via the Web. It has been demonstrated at several informal and formal workshops and training venues for land managers and regulators throughout the United States in 2014 with additional demonstrations expected in 2015.

How to get it:

<http://www.fs.fed.us/pnw/fera/fft>

Contact:

Roger Ottmar, rottmar@fs.fed.us



Robert Vihnanek

Researchers measure vegetation coverage prior to a pile burning experiment on the Okanogan-Wenatchee National Forest, Washington.

Fuel Characteristic Classification System fuel map for South America

The characteristics and spatial distribution of fuels are critical for assessing how wildland fire will affect the globe with regards to fire hazard, fuel

Maps help fuel managers plan for wildland fire.

consumption, greenhouse gas emissions, and other fire effects.

This is especially true

in South America, where vast areas of tropical forests and savannas burn every year. However, fuel maps are difficult to generate and do not exist for many countries throughout the world, including many in South America.

To remedy this, researchers used the Fuel Characteristic Classification System to quantitatively describe 98 fuelbeds. They then generated a fuelbed map for South America. The map can be used to assess areas of South America for potential fire hazard, fire behavior, fuel consumption, and greenhouse gas emission under a variety of environmental conditions, enabling managers to better plan for wildland fire events and assess their potential impacts.

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

Partners: Michigan Tech Research Institute, Spanish Ministry for Science and Innovation, University of Alcalá

Gaining understanding of bark beetle effects on fire behavior by using physics-based models

Bark beetle outbreaks are a major disturbance in forests throughout western North America, affecting ecological processes and social and economic values.

There is scientific disagreement regarding how the beetle-killed trees affect wildfire behavior. To that end, scientists addressed the question using physics-based models, rather than the more established empirically based fire models. Physics-based models directly capture the processes involved (e.g., altered winds) and account for complex fuel characteristics (e.g., the state, amount, and distribution of vegetation).

Results from physics-based model simulations suggest that bark-beetle-caused tree mortality alters wildfire behavior through a number of interacting physical processes. These include the influence of the spatial pattern of the dead trees on the windflow, heat transfer, and crown-fuel loading relative to surface-fire intensity. A judicious use of physics-based models can lead to a more complete understanding of how bark

beetle mortality can influence fire behavior. These findings provide a focus for more complete studies that combine field measurements and computer modeling.

Contact: William Mell, wemell@fs.fed.us

Partners: Colorado Forest Restoration Institute, Colorado State University, Los Alamos National Laboratory, University of Idaho, USDA Forest Service Rocky Mountain Research Station

Ethanol accumulation during severe drought may signal tree vulnerability to bark beetles

Tree mortality from temperature-driven drought is occurring in forests around the world, often in conjunction with bark beetle outbreaks. Measurable parameters that can predict which water-stressed trees are most vulnerable to bark beetles prior to being attacked remain elusive.

Working in Spain, scientists examined levels of ethanol, water, and monoterpenes in the stem tissues from two groups of drought-stressed Aleppo pine (*Pinus halepensis*): those freshly attacked by mature Mediterranean pine shoot beetles (*Tomicus destruens*), and neighboring trees that were not attacked. The attacked trees were more water-stressed and contained over twice the amount of ethanol than the neighboring attack-free trees. Concentrations of monoterpenes, the volatile compounds in pine resin, were higher in the phloem of attacked trees, but probably not a strong influence on



D. Gallego

In Spain, Aleppo pines that were attacked by the Mediterranean pine shoot beetle had a greater drought stress and subsequently produced more than twice the amount of ethanol compared to neighboring pines that were not attacked.

host tree selection. This beetle's preference for trees with higher ethanol is consistent with their known attraction to ethanol in traps.

This is the first report of elevated ethanol concentrations in tissues of trees experiencing natural drought stress. It suggests that ethanol measurements may allow early detection of trees most vulnerable to attack by some bark beetles.

Contact: Rick Kelsey, rkelsey@fs.fed.us

Partners: Universidad De Murcia, Spain; University of Valladolid, Palencia, Spain

Stand-level factors influence sensitivity of aspen mortality to climate in Western United States

Recent incidence of sudden aspen decline has increased interest in understanding and predicting aspen mortality in the western United States. Previous research has highlighted drought as a major contributing factor to sudden aspen decline. However aspen sensitivity to drought is likely to differ between forest stands and individual trees. Factors such as competition,

Tool

Safe Separation Distance

Description:

Safe Separation Distance provides recommended fire-safe separation distance between a person and a fire in the presence of a given terrain slope and a range of windspeeds. It is rule based but was developed from physics-based computer simulations. This preliminary safety zone rule was released in July 2014 for the upcoming fire season. An update is expected next year. This effort was funded by the Joint Fire Science Program.

Use:

Provides an extra margin of safety for all wildland fire personnel.

Distribution:

<http://www.firescience.gov/>

Contact:

William Mell, wmell@fs.fed.us



Dave Powell, USDA Forest Service, Bugwood.org

Researchers found that aspen mortality rates increased with summer temperatures and were influenced by the structure, productivity, and age of the stand, as well as individual tree size and incidence of disease.

tree size, and disease are likely to mediate the trees' responses to climate.

A team of scientists from the U.S. Forest Service, U.S. Geological Survey, and University of Wyoming examined patterns of aspen mortality across the western United States. They found that although mortality rates increased with summer temperatures, mortality rates also were influenced by the structure, productivity, and age of the stand, as well as by individual tree size and incidence of disease.

These results highlight the importance of local forest dynamics and biotic interactions (e.g., disease) in shaping geographic patterns in tree mortality.

The scientists are developing aspen mortality risk maps for the southwestern United States to be distributed to forest managers in the region.

Contact: David M. Bell, dmbell@fs.fed.us

Partners: University of Wyoming,
U.S. Geological Survey

Resource Management and Landscape Resilience

Unprecedented stresses on forest ecosystems, including wildland fire, climate change, and land use change complicate the ability of land managers and policy-makers to provide sustainable forests, rangelands, and watersheds. 🌀 Our research provides information and tools for assessing tradeoffs associated with improving and restoring natural resources. 🌀 It is leading to improved understanding of the effects of restoration and management activities on ecosystem resilience.



Dede Olson

Station leadership met with the district ranger and staff from the Siuslaw National Forest to discuss research needs and opportunities at Cascade Head Research Natural Area, Oregon.

Highlights in 2014

- ▶ Genetic analysis of yellow-cedar trees in Alaska rules out the likelihood of finding local sources for genetic solutions to yellow-cedar decline. Findings suggest looking for climate tolerance in yellow-cedar growing outside Alaska.
- ▶ A landscape approach is needed to restore mixed-conifer forests in eastern Oregon and Washington. A new publication synthesizes the best available science about these forests; it will be used to guide restoration projects in the region.
- ▶ Scientists assessed how fuel treatments influenced fire behavior during the 2011 Wallow Fire in Arizona and New Mexico. Their findings suggest that an effective fuel treatment is highly site-specific. These results can be used to estimate the distance from the treatment edge that fire severity can be expected to be reduced under a specific set of landscape, fuel, and environmental conditions.
- ▶ Variable-retention timber harvests call for retaining live trees, snags, and logs in the harvest unit. Retention abundance and pattern can influence rates of overstory tree mortality following harvest. This information is useful to forest managers of Douglas-fir/western hemlock forests in western Oregon, Washington, and British Columbia and to any management community considering implementation of variable-retention harvest systems.

Genetic analysis shows the scale and pattern of spatial genetic variation in yellow-cedar

Yellow-cedar trees (*Callitropsis nootkatensis*) in Alaska are suffering from a decline induced by climate change. A lack of genetic information about the species limits deliberate gene

Findings suggest looking for climate-tolerance in yellow-cedar growing outside Alaska.

conservation efforts to mitigate declines in population fitness. Improvements in DNA sequencing

technology have made it possible to develop genetic markers inexpensively, and these are being applied to yellow-cedar management in Alaska.

Genetic analysis shows that yellow-cedar is a diverse and highly mobile species. Pollen records indicate that the species appeared about 2,000 years ago in southeast Alaska. Yellow-cedar can live up to 2,000 years, so this recent expansion—in evolutionary terms—means there is not much molecular variation for traits such as cold hardiness and growth rate within the populations growing in southeast Alaska.

These results point to limited potential for finding genetic solutions for cedar decline within Alaska and point to greater potential for identifying climate tolerance in geographically distant sources such as yellow-cedar growing in British Columbia, Washington, or Oregon.



Marshall Murray

A yellow-cedar tree in the Olympic National Forest, Washington.

This information may inform the U.S. Fish and Wildlife Service's consideration of a petition to list Alaska yellow-cedar under the Endangered Species Act.

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

Partners: USDA Forest Service Alaska Region, Forest Health and Protection

Synthesis on mixed-conifer forest science provides scientific and practical guidance to landscape restoration

Millions of acres of mixed-conifer forest across the western United States have been adversely affected by drought and insect outbreaks. The forests are overloaded with fuels, priming them

Findings will be applied to restoration projects on national forests in eastern Oregon and Washington.

for unusually severe and extensive wildfires. Public support for forest restoration has grown, but natural resource managers and policy-makers are awash in information, with little time to assimilate and interpret the science.

To that end, Forest Service and university scientists developed a comprehensive synthesis of the best available science about these forests in eastern Oregon and Washington. It calls for a significant change in the culture and emphasis of vegetation management projects in the region. The findings in this synthesis will be applied to forest- and project-level planning and to restoration projects on national forests throughout eastern Oregon and Washington. To date, this is the first synthesis and review that has provided scientific guidance on landscape restoration and practical guidance for diagnosing and designing landscape restoration projects.

Contacts: Paul Hessburg, phessburg@fs.fed.us; Tom Spies, tspies@fs.fed.us

Partners: Oregon State University; University of California-Berkeley; University of Florida; University of Montana; USDA Forest Service Pacific Northwest Region, Pacific Northwest Research Station, Pacific Southwest Research Station

Citation: Stine, P.; Hessburg, P.F.; Spies, T.A. (et al.). 2014. The ecology and management of moist mixed-conifer forests in eastern Oregon and Washington: a synthesis of the relevant biophysical science and implications for future land management. Gen. Tech. Rep. PNW-GTR-897. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 254 p.

Making model results useful for vulnerability assessments

It is still uncommon for national forests to use output from fine-scale, dynamic global vegetation models in vulnerability assessments. Technical, administrative, and social barriers exist.

As part of a science-management partnership, Forest Service scientists performed simulations of vegetation response to climate change for four national forests in the Blue Mountains, Oregon, for use in vulnerability assessments. The simulation results under business-as-usual scenarios suggest starkly different future forest conditions for three of the four national forests in the study area. This may cause some forest managers to be more reluctant to adopt them. However, output from dynamic global vegetation models can be used to structure discussion of the dynamic nature of vegetation change in relation to more commonly available model output.



Dave Powell, USDA Forest Service, Bigwood.org

Ready for restoration: a forest stand on the Malheur National Forest, Oregon.



Okanogan-Wenatchee National Forest

An interdisciplinary team on the Okanogan-Wenatchee National Forest used the Ecosystem Management Decision Support system to identify priority areas for restoration treatments within the forest's Naches Ranger District.

Key lessons from this coordinated work with the national forests include (1) strategically selecting a small number of climate change scenarios that capture the range of variability in future conditions simplified results; (2) collecting and integrating data from managers for use in simulations increased support and interest in applying output; (3) a structured, regionally focused, and hierarchical calibration of the dynamic global vegetation models produced well-validated results; (4) simple approaches to quantifying uncertainty in simulation results facilitated communication; and (5) interpretation

of model results in a holistic context in relation to multiple lines of evidence produced balanced guidance. This demonstrates the importance of using model output as a forum for discussion along with other information, rather than using model outputs in an inappropriately predictive sense.

These lessons are being applied to other national forests in the Pacific Northwest to contribute in vulnerability assessments.

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

Partners: USDA Forest Service Malheur, Umatilla, and Wallowa-Whitman National Forests

Transparent environmental management decisions

The Ecosystem Management Decision Support (EMDS) system is a spatially enabled decision support framework for environmental analysis and planning. The system has steadily evolved since it was first released by the Pacific Northwest Research Station in 1997. It remains one of the state-of-the-art decision support solutions for environmental analysis and planning.

The longstanding success of EMDS can be attributed to its rational approach to spatial decision support that is transparent and repeatable. A newly published book documents diverse applications of EMDS spanning many different problem areas, spatial scales, and geographic contexts. Many of the applications described in the book have contributed to formulating environmental management policy.

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

Partners: InfoHarvest, Inc.; National Oceanic and Atmospheric Administration; Rules of Thumb, Inc.; The Nature Conservancy; University of California–Santa Barbara; University of Cantabria (Spain); University of Colorado; University of Redlands; USDA Forest Service Okanogan-Wenatchee National Forest, Northern Region, Pacific Northwest Region, and Rocky Mountain Research Station; Washington Department of Natural Resources

Citation: Reynolds, K.M.; Hessburg, P.F.; Bourgeron, P.S., eds. 2014. Making transparent environmental management decisions: applications of the Ecosystem Management Decision Support system. Berlin: Springer. 337 p.



Tim Sexton

During the 2011 Wallow Fire, conservative fuel treatments designed to reduce fire severity while still providing forest cover and wildlife habitat were just as effective at protecting homes, compared to more intensive fuel treatment.

Fuel treatments moderated fire behavior and effects at Arizona's Wallow Fire

The Wallow Fire was the largest in Arizona state history; it burned more than 539,000 acres between May and June 2011. Portions of the area that burned during the fire had undergone fuel reduction treatments as part of the White Mountain Stewardship Contract following the massive Rodeo-Chediski Fire, which destroyed 465 homes in 2002. This management history gave station scientists and their colleagues an unexpected opportunity to study how effective two alternative fuel treatments were in reducing the severity of the Wallow Fire,

particularly in the wildland-urban interface, a critical area on the landscape where a forest or wildland intersects with development.

They found that, during the 2011 Wallow Fire, homes were as protected by conservative fuel treatments designed to reduce fire severity while still providing forest cover and wildlife habitat as they were by the more intensive fuel treatments. As the fire moved from untreated to treated areas, it became less severe as it transitioned from a crown fire to a ground fire. The distance into the treated area where fire severity was reduced differed depending on the intensity of the fuel reduction treatment.

The findings suggest that there may be multiple paths to fuel treatment design around the wildland-urban interface.

Contact: Morris Johnson, mcjohnson@fs.fed.us

Partners: University of Washington, USDA Forest Service Apache-Sitgreaves National Forest

Seeding in disturbed areas after fuel reduction helps establish native plants but may not mitigate spread of exotic grasses

Western juniper has spread across the interior Pacific Northwest since the late 1800s. Management goals for many juniper woodlands now focus on reducing tree densities. After thinning, the disturbed areas are frequently seeded to help restore vegetation quickly and combat exotic plant invasion.

To assess the efficacy of this practice, scientists seeded plots using two seed mixes in postburned slash piles and skid trails after juniper cutting on the Crooked River National Grassland, Oregon. Two years later, some seeded areas had higher total species richness, higher native species richness, higher cover of seeded species, and higher overall cover compared to areas that were not seeded. But seeding effectiveness in mitigating exotic species spread varied. Neither seed mix lowered exotic grass cover. Areas cut and burned by slash, areas cut and used for skid trails, and even uncut and undisturbed plots were invaded by exotic annual grasses.



Michelle Day

Crooked River National Grassland, Oregon, with Mount Jefferson in the background. The area in the foreground was reseeded with native species, such as yarrow, following juniper removal.

In the short term, the fuel reduction activities further facilitated conversion of this woodland to an exotic grassland, but longer term evaluation is needed. In low-elevation juniper woodlands that have been invaded by exotic species, extensive exotic species control may be needed to limit invasion and promote native vegetation after fuel-reduction activities.

Contact: Becky Kerns, bkerns@fs.fed.us

Partners: Oregon State University, USDA Forest Service Malheur National Forest and Crooked River National Grassland

Provisional seed zones developed to guide restoration of native species

The use of well-adapted and ecologically appropriate plant materials is core to a successful restoration program. Knowledge of local adaptation and population differentiation in adaptive traits,

Forest Service and BLM use these seed zones in restoration plans for areas of Pacific Northwest.

however, is lacking for many species, especially for shrubs, grasses, and forbs used in restoration.

Station scientists developed generalized provisional seed zones that can be applied to any plant species in the United States to help guide seed movement. Because plants are, in general, largely adapted to differences in climate as determined by cold temperatures and aridity, the scientists mapped seed zones by using the intersection of discrete bands of high-resolution climate data for minimum winter temperature and aridity as measured by the annual heat:moisture index. Ecoregions can be used to further refine seed improvement within provisional seed zones, dependent upon local knowledge and acceptable risk.

The proposed provisional seed zones delineate areas of climatic similarity, which when combined with areas of general ecological similarity may be an effective starting point for guiding seed transfer of species used in restoration.

The provisional seed zones developed from this research are being incorporated into the restoration plans of the national forests in the Pacific Northwest and of the Bureau of Land Management.

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

Partners: USDA Forest Service Pacific Northwest Region and Rocky Mountain Research Station

Citation: Bower, A.D.; St. Clair, J.B.; Erickson, V. 2014. Generalized provisional seed zones for native plants. *Ecological Applications*. 24: 913–919.



Brad St. Clair

A forestry technician collects seeds from blue-bunch wheatgrass in the Blue Mountains, Washington. This work contributed to research that identified seed zones for this native grass that is often used to reseed burned areas and minimize erosion.

Former prairies transitioned to Douglas-fir forests over 60 years following infrequent and low-intensity fires

Scientists analyzed the growth rings on 242 Douglas-fir stumps in six recently harvested sites at Joint Base Lewis-McChord, Washington, to identify year of tree establishment, timing of natural disturbances, and periods of growth release and suppression. They compared these data to historical records from the General Land Office Survey to identify how forest colonization of the former prairies occurred following suspension of burning by Native Americans in the 1850s.

They learned that current stands established via three or more waves of regeneration unique to each site. Each wave was associated with low-intensity disturbances—probably fire. Although highly variable, such disturbances occurred on average every 37 years. Growth rates and crown characteristics of the dominant trees indicated that the rate of site occupancy occurred faster on sites of better quality. The rate of tree establishment peaked and abruptly declined beginning around 1940, after which few natural disturbances were detected.

This information will be useful for developing prescriptions for natural regeneration of Douglas-fir and for planning savanna and prairie restoration. It will be used to identify the appropriate size of forest canopy openings and conifer planting density and points to the need for reducing competing understory vegetation.

Contact: David H. Peter, dpeter@fs.fed.us

Partner: U.S. Department of Defense Joint Base Lewis-McChord



Dave Peter

A researcher analyzes the growth rings of a Douglas-fir to piece together the history of the stand as the land transitioned from prairie to forest.

New tools developed to accurately assess sunlight in forested landscapes

Sunlight controls major ecological processes, but it is difficult to accurately assess how much sunlight reaches the ground or a stream. Its ephemeral nature, affected by daily and sea-

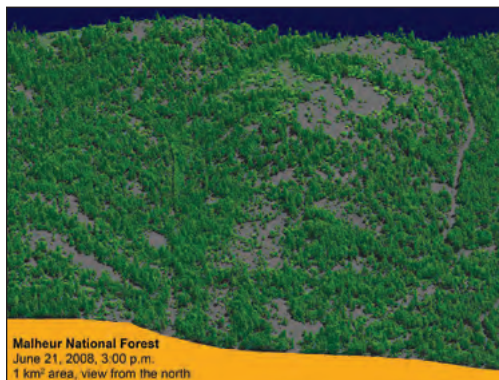
Information can be used to determine a variable-width buffer around fish-bearing streams.

sonal cycles, topography, and shading from vegetation, contributes to this challenge.

By using innovative analyses, specially developed software, and high-density airborne LiDAR data, scientists

have found a way to generate an unbiased, precise assessment of solar illumination.

Scientists have computed mean growth season illumination indices for several stream reaches in Deschutes, Ochoco, and Malheur National Forests. Shading regimes in riparian areas influence stream temperature and fisheries habitat. Because of this research, it is now possible to quantify change in shading conditions. It's also possible to identify the landscape elements responsible for providing shade to specific locations of interest and generate summaries over periods.



Accurate assessments of the amount of sunlight reaching the ground can contribute to forest growth and yield models, assessment of regeneration potential, and support tactical decision-making.

Hydrologists and ecologists with the Pacific Northwest Region will be using these tools to determine a variable-width buffer around fish-bearing streams where forest thinning of prespecified intensity will not reduce shading below a certain threshold.

Contact: Demetrios Gatzliolis, dgatzliolis@fs.fed.us

Partners: USDA Forest Service Pacific Northwest Region, Willamette, Ochoco, Malheur, and Siuslaw National Forests; USDI Bureau of Land Management Oregon and Washington

New herbicides tested for efficacy against Scotch broom

Three recently developed herbicides provided excellent preemergent control of Scotch broom from simulated seed banks, killing up to 89 percent of germinating seedlings. Differences in cost effectiveness among the three products give vegetation managers clear choices in selecting a suitable treatment.

Scotch broom is a large, nonnative shrub that has invaded forest sites throughout the Pacific Northwest. Because it develops a long-lived seed bank, the species can persist on a given site for decades. In a series of growth chamber studies, scientists compared three of the newer synthetic auxin herbicides (aminocyclopyrachlor, aminopyralid, and clopyralid) for their ability

to control germinating Scotch broom seedlings from simulated seed banks. Low rates of each herbicide (<50 percent of the maximum labeled rate) killed 60 to 80 percent of seedlings, whereas maximum rates controlled up to 89 percent of seedlings. Cost per unit seedling mortality for aminopyralid was 57 percent of that for clopyralid and 42 percent of that for aminocyclopyrachlor. With half-lives of 30 to 50 days, the herbicides retained much of their efficacy throughout the 90-day duration of the studies, making them suitable for controlling germinating broom seedlings under field conditions.

Contact: Timothy B. Harrington, tharrington@fs.fed.us

Partners: Dow AgroSciences, LLC; DuPont Corporation

Dave Powell, USDA Forest Service, Bigwood.org



Scotch broom, a large, nonnative shrub, readily invades recently harvested sites throughout the Pacific Northwest.

Tom Iraci



Remaining trees are more likely to survive when retained in groups.

Mortality of retained trees can compromise the ecological objectives of variable-retention harvest

Variable-retention timber harvests call for retaining live trees, snags, and logs in the harvest unit. These remnant elements can be a seed source for the regenerating stand, mitigate

Tree mortality decreased when trees were retained in groups 1-hectare or larger.

harsh microclimates, and provide structure, which promotes persistence of plant and animal species through the disturbance period.

Harvest regulations on federal lands in western Oregon and Washington stipulate leaving at least 15 percent of the overstory, with 70 percent of that in aggregates 0.2 hectare or larger. However, there is much latitude with respect to the proportion of overstory trees retained and

their distribution as aggregates or dispersed individuals. Ten-year monitoring of the Demonstration of Ecosystem Management Options (DEMO) study shows that retention abundance and pattern can influence rates of overstory tree mortality occurring following harvest.

Scientists found that low levels of dispersed retention led to greater mortality among the retained trees. This suggests that minimum standards may result in greater risk of mortality and

compromise the intended ecological functioning of the retention harvest. Conversely, decreased rates of mortality in larger 1-hectare retention aggregates suggest that edge creation may benefit the functioning of trees retained within aggregates.

Although variable-retention harvest practices have been increasingly used worldwide over the past two decades, the DEMO project provides the most direct evidence for assessing the efficacy of varying abundance and pattern of overstory retention. It provides a proof-of-concept for “ecological silviculture” as a management strategy that is being discussed regionally by federal agencies and legislators.

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

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

Alaska spruce forests yield lessons that can help forest managers across the globe

Forests with structural complexity provided by trees and plants of many shapes and sizes often have more biodiversity than forests with uniform structure. Forest managers often are interested in encouraging this variety and all the ecological processes and functions it supports.

In Sitka spruce forests in southeast Alaska, forest management practices using clearcutting beginning in the early 1950s have resulted in forests with uniformly sized trees and little understory vegetation or wildlife habitat. Scientists synthesized management options that improve biodiversity and structural complexity in Sitka spruce forests in Alaska and applied them to Sitka spruce forests and plantations elsewhere in the world, with particular emphasis on Great Britain and Ireland. For example, including broadleaved species such as alder or birch can provide more complexity. Researchers also explored the role of fungi in increasing both biological and structural diversity in Sitka spruce forests

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

Partner: Ireland Department of Agriculture

Ungulate herbivory maintains shrub diversity in forests in the absence of disturbance

Herbivory by elk, cattle, and other ungulates can dramatically affect vegetation in forest understories. However, little is known about how ungulate herbivory interacts with episodic disturbances such as fire and fuels removal. This knowledge is important because ungulates can potentially alter shrub and conifer composition in ways that increase fuel loading and fire risk.

Over 6 years, scientists evaluated shrub responses to grazing pressure by cattle and elk in forested areas where fuel had been reduced by mechanical means, followed by prescribed burning, and in untreated forested sites at Starkey Experimental Forest and Range. Their findings suggest that without fuels reduction and ungulate herbivory, shrub diversity is reduced. Increased dominance was observed in species that would have been suppressed by ungulates and fuels removal. Ungulate herbivory, even at low intensities, can be used to suppress dominant shrub species and maintain diversity in the absence of episodic disturbances.

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

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



Rhonda Mazza

Elk, deer, and cattle herbivory can help maintain vegetation diversity. Above, a study site at the Starkey Experimental Forest and Range that was thinned and fenced to exclude ungulate herbivory.

Managing forests to retain water

As the climate warms, drought and associated water stress on vegetation are emerging as critical issues underlying a host of forest disturbances, including fire, insect and disease attacks, and forest dieback. Forest landscapes have historically been seen as sources of water for downstream uses. Given the changing risks to forests, a new paradigm suggests managing forests to provide sufficient water to maintain healthy vegetation. Although management actions cannot stop droughts from occurring,

many strategies potentially could be used to increase water availability for vegetation in forests. For example, modeling studies suggest that specific strategies, including thinning or mulching, can be sufficient to keep forests below water stress levels at which tree mortality occurs. These kinds of strategies could be used to offset, mitigate, or potentially forestall water stress, thereby increasing forest health and resilience.

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

Socioeconomic Dimensions

Patterns of land use, recreation, and economic development are changing. ∞ Quality of life increasingly depends on understanding the human values and choices that sustain the environment, promote public health, support rural economies, and reduce conflict. ∞ Our research improves understanding of the interactions between socioeconomic and biophysical systems at the landscape scale. It identifies and evaluates the goods, services, and benefits produced by ecosystems and management. ∞ We also develop tools for land managers to use when evaluating local economic and social conditions.



Jenna Tilt

A housing development in Snoqualmie, Washington, 25 miles east of Seattle, with the Mount Baker-Snoqualmie National Forest as its backyard.

Highlights in 2014

- ▶ The eBook, *Community Biomass Handbook*, and related application help users set objectives, define project scopes, and conduct a preliminary financial appraisal for a range of options. It features in-text financial calculators and links to video case studies. With just a few inputs, users can estimate capital investment and operations costs, biomass requirements, and return on investment.
- ▶ *Stitching the West Back Together: Conservation of Working Landscapes*—This new book highlights ways for individual landowners to join together to protect open spaces and working landscapes. Featuring the perspectives of farmers, ranchers, scholars, foresters, and conservationists, the book encourages a vision of collaboration and argues for a new public policy of interdependence between public and private landowners.
- ▶ Tree planting campaign in Portland, Oregon, more effectively reaches better educated residents, inadvertently exacerbating environmental inequality.
- ▶ Considering the impact to local quality of life when attempting to build a sustainable tourism industry promotes more positive interactions between local people and visitors.



USDA Forest Service

The Community Biomass Handbook is interactive, allowing users to easily assess the feasibility of prospective projects.

Community Biomass Handbook guides businesses seeking to replace fossil fuels with wood energy

The Forest Service is promoting the development of wood energy projects that create new jobs and help save energy while improving forest health. With the increasing interest in alter-

An included app lets users quickly assess if wood energy is financially feasible for them.

natives to fossil fuels and the availability of grants and loans for wood energy projects, small businesses, nonprofit organizations, tribes, and state and local

agencies are trying to assess whether they could bring wood energy to their community.

In line with this effort, the station released an eBook containing a wood energy financial application that allows users to quickly assess whether wood energy is a feasible option for their community or small business. Accompanying the app is a Community Biomass Handbook that provides background information and case studies, answers to project development questions, and a checklist of possible products and investment considerations. For iPad and Mac users, this interactive handbook is available

for free download at the iTunes bookstore. A PDF version of the handbook and a Web-based version of the financial application are also available.

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

Partners: Bihn Systems, The Beck Group, University of Minnesota

Citation: Becker, D.; Lowell, E.; Bihn, D.; Anderson, R.; Taff, S. 2014. Community biomass handbook. Volume I: Thermal wood energy. Gen. Tech. Rep. PNW-GTR-899. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 93 p.

Integrating tribal stewardship practices, traditional knowledge, and science to address climate change

Tribes have been adapting to change for thousands of years. Environmental disturbances such as land use change, wildfire, and climate change can threaten many values for American Indians and Alaska Natives. With climate causing potential shifts in the distribution and composition of some plant and animal species, tribes could lose their cultural traditions and in turn their identities. Some tribes are leading the way in innovative thinking and planning for management of threats to natural resources. Many tribes use traditional practices such as controlled burning to manage forests and make them more resilient to climate change impacts.

A new synthesis examines the challenges associated with bringing traditional knowledge and scientific research together, and reviews

how federal policies and administrative practices help or hinder the incorporation of traditional knowledge into climate change adaptation strategies.

Contact: Linda Kruger, lkruger@fs.fed.us

Partner: Oregon State University

Citation: Vinyeta, K.; Lynn, K. 2013. Exploring the role of traditional ecological knowledge in climate change initiatives. Gen. Tech. Rep. PNW-GTR-879. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 37 p.

Economic feasibility of biomass energy depends on biomass prices

The use of forest treatment byproducts, like treetops and limbs or small trees, holds promise as an alternative energy source that could help reduce reliance on fossil fuels, create less pollution, and increase opportunities for rural employment. But removing this material from forests remains an expensive, labor-intensive hurdle. Collecting, grinding, and transporting forest biomass requires the use of diesel fuel, which has seen price fluctuations in recent years.

Scientists examined the effects of increases in diesel fuel costs on delivery of biomass in western Montana, as well as the financial impact of changes in delivered biomass price. Their study found that the financial feasibility of using forest biomass for energy production is much more sensitive to changes



Prices for forest biomass, rather than the cost of diesel fuel, appear to be the key determinant in the feasibility of using forest biomass for energy production.

in biomass prices than to the cost of diesel fuel used to process and transport the biomass.

Contact: Susan Hummel, shummel@fs.fed.us

Partners: University of Montana, USDA Forest Service Rocky Mountain Research Station

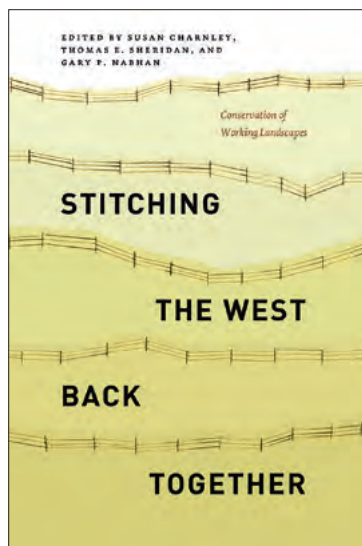
Sustainable working landscapes are critical to biodiversity conservation in the West

Conflict among different interest groups in the West over how land should be managed often makes the news. A new book, *Stitching the West Back Together*, turns the focus toward

Authors call for a new public policy of interdependence between public and private landowners.

more positive examples of ranchers, forest managers, and conservation groups working to find common ground.

The authors highlight ways for individual landowners to join together to protect open spaces and working landscapes,



This new publication highlights ways to collectively protect open spaces and working landscapes.

and to “stitch” pieces of the landscape back together into functional, ecologically and economically healthy wholes. They provide examples of conservation efforts that cross ownership and management boundaries, provide case studies of sustainable working rangelands, and discuss management and policy strategies such as conservation easements, renewable energy incentives, and payments for ecosystem services. Featuring the perspectives of farmers, ranchers, scholars, foresters, and conservationists, the book encourages a vision of collaboration and argues for a new public policy of interdependence between public and private landowners.

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

Partner: University of Arizona

Citation: Charnley, S.; Sheridan, T.E.; Nabhan, G.P., eds. 2014. *Stitching the West back together: conservation of working landscapes*. Chicago, IL: University of Chicago Press. 352 p.

Advances in biomass-derived fuels yield limited commercial production

For decades, researchers and entrepreneurs have tried to produce liquid fuels from lignocellulosic biomass for transportation vehicles with little commercial success. Although successful feedstocks and processes have been identified, inherent disadvantages such as transportation logistics that biofuels face vs. petroleum fuels remain a significant barrier. Scientists summarized recent progress in commercializing

biomass-derived fuels, offering a discussion of national and international trends in implementing biofuels, and the status of commercial biofuels facilities. They also examined the current status of lignocellulosic transportation fuel production as well as near-term prospects for commercialization.

Contact: Dave Nicholls, dnicholls@fs.fed.us

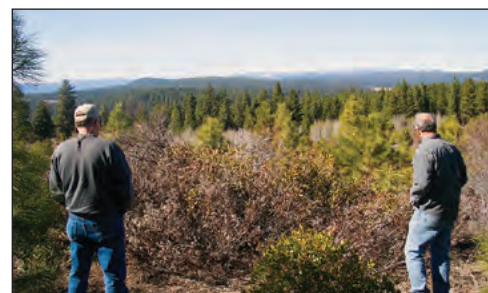
Partner: USDA Forest Service Forest Products Laboratory

Private forest landowners consider fuel conditions and past wildfires in their risk-mitigation decisions

Policy makers seek ways to encourage fuels reduction by private forest landowners to augment similar efforts on federal and state lands. Because private forest lands influence

Study leads to landscape model to be used by Pacific Northwest Region in forest planning.

the connectivity of hazardous fuel and potential movement of fire across the landscape, these



Private forest landowners assess their wildfire risk.

A. Paige Fischer

lands offer significant potential for reducing wildfire risk if managed appropriately. Motivating landowners to contribute to landscape-level wildfire protection requires an understanding of factors that underlie landowner behavior regarding wildfire. Researchers examined which factors influence wildfire risk perceptions and mitigation behavior among private nonindustrial forestland owners in central Oregon.

The conceptual framework behind this study formed the basis for further investigation of homeowners' "defensible space" activities in fire-prone forests as part the Forests, People, Fire study funded by the National Science Foundation. The study also has resulted in the development of a landscape simulation model that the national forests in the region plan to use as input in their upcoming forest planning processes.

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

Partner: Oregon State University

Tree planting and environmental justice

Many cities have ambitious tree-planting goals but do not have the resources to reach these goals alone. Therefore, cities often create policies that encourage private citizens to plant

Homeowners with existing trees are more likely to plant more.

trees. By studying factors that influence people's tendency to follow up on incentive programs

and plant trees on their property in Portland, Oregon, scientists identified some trends in who



Rhonda Mazza

A "Plant it Portland" sign from the nonprofit organization, Friends of Trees, encourages Portland residence to plant trees.

is most likely to plant and also barriers that appear to deter people from planting.

People who live in census blocks with lower high school graduation rates, for example, were less likely to plant trees, whereas homeowners with existing street trees or who had lived in an older house were more likely to plant additional trees. With many studies showing the health and well-being benefits of urban trees, the success or failure of a tree-planting program takes on environmental justice implications. Results from this study suggest that tree-planting programs may inadvertently exacerbate environmental inequality.

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

Seattle homeowners show increased interest in fruit trees

For urban planning and urban forestry to be effective, it is important to understand the social context of a city, including the attitudes of residents toward trees and other natural settings. Scientists developed a Web-based survey for single-family homeowners across the city and asked people what plans they had for future tree planting and care. Homeowners reported they will plant fewer trees in the future than they did in the past, with the exception of fruit trees: 19 percent of surveyed homeowners had planted a fruit tree in the past, yet 42 percent say they will do so in the future, perhaps revealing interest in urban agriculture, food security, and local food production.

Contact: Kathleen Wolf, kwolf@fs.fed.us

Partners: City of Seattle, University of Washington

Considering the impacts of ex-urban housing developments in advance could reduce community conflicts later

Housing developments are likely to remain a common approach for supporting rising population in the United States. Scientists examined the impacts these communities have on their physical and social environment. Looking specifically at the Snoqualmie Valley outside of Seattle, Washington, they found that large planned communities can substantially change an area. Social perceptions of these changes

sometimes led to conflict. For example, the large influx of residents and the creation of a new city center within a few miles of the historic downtown drove a wedge between new and existing residents, leading to relocation of critical city services and a cultural rift. Community leaders and planners could work closely with developers of future planned communities to consider the impacts of a development before people move in to help mitigate competition for services, overloading of city infrastructure, and access to public lands and open spaces.

Contact: Lee Cervený, lcervený@fs.fed.us

Partner: Oregon State University

Citizen participation benefits community decisions in Sitka, Alaska

Some tourism proponents in Sitka, Alaska, have worked hard to expand its tourism base within the past two decades. This process has led to tension at times among residents, local government, the local Alaska Native tribe, the chamber of commerce, and the tourism bureau. Scientists organized a community forum, reviewed planning documents, and identified differences in government-led approaches versus citizen-led approaches.

They found that planning exercises that considered the impacts of tourism on local quality of life and sense of community are more likely to create a sustainable tourism environment that promotes positive interactions between



Chris Schnepf, University of Idaho, Bugwood.org

Beargrass is a culturally important plant to tribes in the Northwest. It is also extensively harvested by the commercial floral industry.

local people and visitors. This case study will be useful to practitioners interested in collaborative decisionmaking.

Contact: Linda Kruger, lkruger@fs.fed.us

Partner: Michigan State University

Beargrass faces pressure from the commercial floral industry

Many hikers in the West are familiar with beargrass, a member of the lily family. It decorates mountain meadows with its showy white flowers clustered on a single stalk. Beargrass provides food and habitat for many kinds of wildlife and has long been used by Native Americans for basketry, medicines, and regalia. Scientists studied the natural and

cultural history of this plant, including its importance to pollinators, traditional harvest practices of tribes, and how it is affected by natural disturbances such as fire. They also examined the impact of the commercial floral industry, which generates more than \$200 million a year in the Pacific Northwest. Although disturbance by fire has been declining, the impact of leaf harvest by the floral industry is causing shifts in disturbance within beargrass habitat. This study helps clarify the ecological importance of beargrass and identifies knowledge gaps and potential conflicts in human use.

Contact: Susan Hummel, shummel@fs.fed.us

Partner: USDA Forest Service Northern Research Station

Demonstrating value of national forest management by shifting focus to ecosystem services

The new forest planning rule requires forest planners to address ecosystem services in national forest plans. By extension, although not required, forest managers may consider

**Forest Service,
Environmental
Defense Fund
using this research.**

ecosystem service outcomes in project-level assessments. The Forest Service hopes that the ecosystem services concept will enable planners

and managers to tell a richer story to Congress and the public about the benefits and tradeoffs associated with managing national forests; support decisions that promote sustainability; and facilitate collaborative partnerships with local communities, cities, and other entities that benefit from forest ecosystem services.

The Forest Service has already made a considerable effort to develop methods for measuring public uses and values and incorporate them into national forest planning documents and project-level assessments. Yet, these efforts have not led to their widespread use in national forest management. In light of this history, this research examined the challenges and opportunities involved in applying ecosystem services to national forest management.

This research is being used by the USDA Forest Service Washington Office, Ecosystem Services Valuation Framework Working Group, to develop directives outlining a nationally consistent framework for addressing ecosystem services in national forest planning and project implementation. The group Environmental Defense Fund also is drawing on the research to identify challenges in evaluating ecosystem services and to develop a set of guiding principles and best practices that they will propose to state and federal agencies.

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

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

Experimental forests have untapped potential for social science research

Experimental forests and rangelands offer an unparalleled opportunity for long-term research and monitoring across a wide range of forest types. The research in these areas has traditionally focused on biophysical science. Thirty-five percent of experimental forests and ranges are within 50 miles of an urban center and offer recreation and education opportunities. These research areas can be used to better understand the dynamics of human interactions with nature through social science.



Lina DiGregorio

H.J. Andrews Experimental Forest, Oregon.

Scientists explored human interactions with experimental forests and ranges through surveys and a literature review to identify patterns of visitor use. They found that these research areas are widely used, and that the most common activities are hiking, hunting, and wildlife viewing.

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

Virtual community encourages open and creative knowledge sharing among NEPA practitioners

The National Environmental Policy Act (NEPA) requires transparency in federal decisionmaking processes, and allows for public participation in government. Many Forest Service activities depend on the successful completion of NEPA processes.

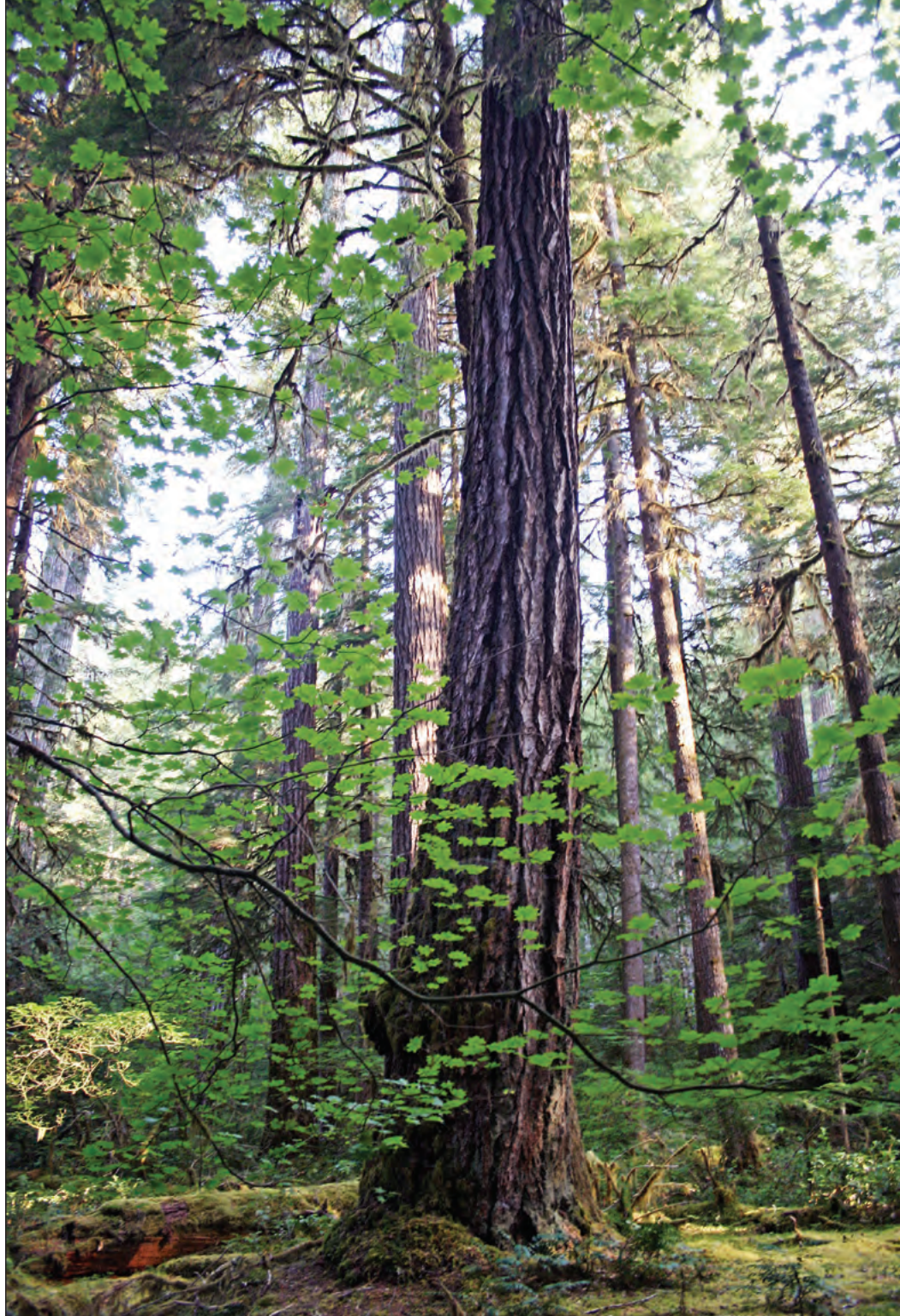
Monthly
webinars
attract 100
attendees,
on average.

Yet inefficiencies and fragmentation in the current system have made it difficult for practitioners to implement NEPA processes and work together.

Scientists helped NEPA practitioners connect with each other by establishing a virtual community of practice (eForest) and hosting a monthly webinar series (NEPA Knowledge Café). They hosted 12 NEPA Knowledge Café webinars in 2014 with an average attendance of 100 people a month. Membership in eForest has hit 575, and it serves as a venue for exchanging knowledge among NEPA practitioners and scientists. Users can initiate exchange by asking questions or raising issues with the community as a whole or within smaller “neighborhood” groups.

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

H.J. Andrews Experimental Forest.
Photo by Theresa Valentine.



Honors and Awards

Chief's Excellence in Science and Technology Award

Research biologist **David L. Peterson** was recognized by the U.S. Forest Service Chief for his work to develop and deliver scientific principles, partnerships, and actions for adaptation to climate change in national forests.

Chief's Sustaining Forests and Grasslands Award

Nancy Grulke, Western Wildland Environmental Threat Assessment Center Director, was recognized by the U.S. Forest Service Chief for her work as part of the Inter-Agency ForWarn Team.

Deputy Chief Distinguished Science Award

Paul Hennon, research plant pathologist, received a Distinguished Science Award from the U.S. Forest Service Research and Development Deputy Chief for his research on forest diseases and the health and sustainability of Alaska yellow-cedar forests.

Deputy Chief Science Delivery Award

Deanna Olson, a research ecologist, received a Science Delivery Award from the U.S. Forest Service's Deputy Chief for Research and Development for excellence in sustained science productivity and technology transfer. She was recognized for serving biodiversity and natural resource management in the United States with global applications.

ESRI—Best Data Integration

Starkey Experimental Forest and Range researchers were recognized by ESRI, the world's leading geographic information systems company, with third place in the "Best Data Integration" category in the company's national poster contest. The researchers' poster highlighted applications of new landscape models for elk.

Journal of Mammalogy Associate Editor

Keith Aubry, a research wildlife biologist, is a new associate editor of the *Journal of Mammalogy*. During the 3-year term, he will be helping to direct the peer-review process for manuscripts submitted to the journal.

President-Elect of the Cooper Ornithological Society

Martin Raphael, a research wildlife biologist, is president-elect of the Cooper Ornithological Society. He was elected because of his long history of leadership in the society and outstanding record of ornithological accomplishments.

Regional Forester Honor Award

Research meteorologists **Sim Larkin** and **Miriam Rorig** and research air quality engineer **Susan O'Neill** received this award for "Leading in a Natural Resource Environment" from the U.S. Forest Service Pacific Southwest Region in 2013. The researchers were part of an interagency team that was recognized for its response to the 2013 wildfires in California, which included the 250,000-acre Rim Fire.

Rise to the Future Lifetime Achievement Award

Research fisheries biologist **Gordon Reeves** received the Forest Service's "Rise to the Future Lifetime Achievement Award." He was recognized for his research on the impacts of climate change on aquatic and riparian ecosystems in the Pacific Northwest and Alaska and for his holistic, field-based research perspective. He also was honored for his long-standing commitment to communicating research with decisionmakers and for mentoring the next generation of fisheries scientists.

USDA Protecting Natural Resources Award

Eric Forsman, a research wildlife biologist, was recognized by the U.S. Department of Agriculture for his sustained contributions to understanding the ecology and management of the northern spotted owl in the Pacific Northwest. Forsman began conducting research on the spotted owl in the 1970s as a graduate student and today, as a world-renowned expert on the raptor, is frequently consulted for his expertise.

USDA Honor Award

Catherine Parks, a research ecologist, was honored for her international work in Afghanistan. Parks assisted with the evacuation and recovery of wounded personnel in Afghanistan, helped to create the Afghan Agricultural Tool Kit, and managed agricultural operations in the country.

Worthy Coelacanth Award

Pete Bisson, an emeritus scientist, was honored by the Washington-British Columbia Chapter of the American Fisheries Society. The Worthy Coelacanth award is presented to an individual who has made an outstanding contribution to fisheries management and science over the course of their career.



PNW Research Station Organization

Station Director

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

Assistant Station Director for Administration

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

Assistant Station Director for Communications and Applications

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

Assistant Station Director for Program Development

Katherine Smith
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2104
E-mail: klsmith@fs.fed.us

Assistant Station Director for Research

Borys Tkacz
P.O. Box 3890
Portland, OR 97208-3890
Phone: 503-808-2115
E-mail: btkacz@fs.fed.us

Programs

Ecological Process and Function

Paul Anderson
Forestry Sciences Laboratory
3200 SW Jefferson Way
Corvallis, OR 97331
Phone: 541-758-7786
E-mail: pdanderson@fs.fed.us

Goods, Services, and Values

Simon Kihia
Pacific Wildland Fire Sciences Laboratory
400 N. 34th Street, Suite 201
Seattle, WA 98103
Phone: 206-732-7846
E-mail: smkihia@fs.fed.us

Land and Watershed Management

Susan Alexander
Forestry Sciences Laboratory
11175 Auke Lake Way
Juneau, AK 99801
Phone: 907-586-7801
E-mail: salexander@fs.fed.us

Resource Monitoring and Assessment

Gretchen Nicholas
Forestry Sciences Laboratory
620 SW Main St., Suite 400
Portland, OR 97205
Phone: 503-808-2034
E-mail: gnicholas@fs.fed.us

Threat Characterization and Management

Maureen Hyzer
Forestry Sciences Laboratory
1133 N. Western Ave.
Wenatchee, WA 98801
Phone: 509-664-1712
E-mail: mhyzer@fs.fed.us

Western Wildland Environmental Threat Assessment Center

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

Online Supplements

2014 Science Accomplishments of the Pacific Northwest Research Station is available online, along with all 2014 publications by Pacific Northwest Research Station scientists, at <http://www.fs.fed.us/pnw/sa/2014/>.

Credits

Assistant Director for Communications and Applications—Cynthia L. Miner

Managing Editor—Rhonda Mazza

Writer—Rhonda Mazza

Publishing Director—Frank Vanni

Graphic design—Keith Routman and Rhonda Mazza

Cover photograph by Tom Iraci, with graphic treatment by Frank Vanni

All uncredited photographs—U.S. Forest Service staff

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, sexual orientation, marital status, family status, status as a parent (in education and training programs and activities), because all or part of an individual's income is derived from any public assistance program, or retaliation. (Not all prohibited bases apply to all programs or activities.)

If you require this information in alternative format (Braille, large print, audiotope, etc.), contact the USDA's TARGET Center at (202) 720-2600 (Voice or TDD).

If you require information about this program, activity, or facility in a language other than English, contact the agency office responsible for the program or activity, or any USDA office.

To file a complaint alleging discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call toll free, (866) 632-9992 (Voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice users). You may use USDA Program Discrimination Complaint Forms AD-3027 or AD-3027s (Spanish) which can be found at: http://www.ascr.usda.gov/complaint_filing_cust.html or upon request from a local Forest Service office. USDA is an equal opportunity provider and employer.





Federal Recycling Program
Printed on Recycled Paper

February 2015

Pacific Northwest Research Station
1220 SW Third Ave., Suite 1400
P.O. Box 3890
Portland, OR 97208-3890
www.fs.fed.us/pnw/

