USDA United States Department of Agriculture

Forest Service

2017
Pacific Northwest Research Station Science Accomplishments

Glacier Lake, Eagle Cap Wilderness, Oregon. U.S. Forest Service

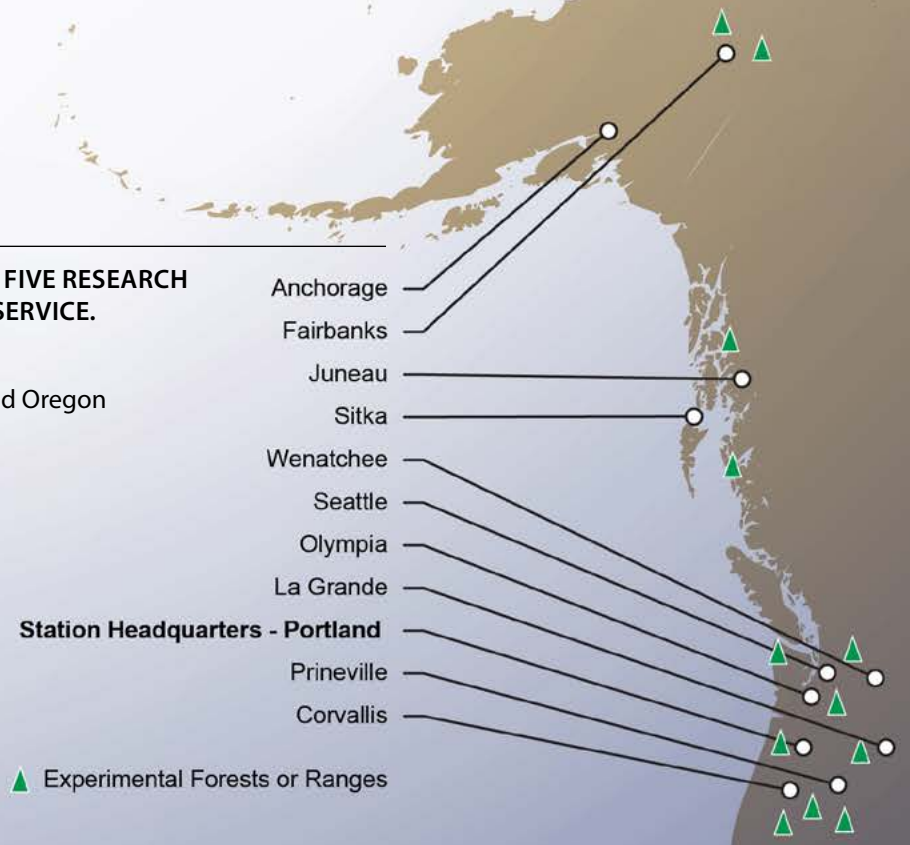
Our Mission

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.

WHERE WE WORK

THE PACIFIC NORTHWEST (PNW) RESEARCH STATION IS ONE OF FIVE RESEARCH STATIONS IN THE U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE.

- Headquartered in Portland, Oregon
- 11 laboratories and research centers in Alaska, Washington, and Oregon
- 12 active experimental areas (forests, ranges, and watersheds)
- Research is conducted in more than 98 research natural areas
- 317 employees



Forests Now and in the Future

Some things in life we want to be constant. We want our forests and grasslands to be productive now and sustained into the future. That said, it's easy to take these resources for granted. Sometimes it's only when they've been drastically changed—say, by fire or drought—that we realize how much we value them.

The National Forest System was established to protect and manage forests so they are sustainably productive over the long term. Forest Service research has been a key part of that vision. Early on, the agency's research branch was established as an independent unit dedicated to discovering new information that would answer pressing questions and take on challenges related to managing our nation's forests and grasslands.

The management questions have changed since the Pacific Northwest (PNW) Research Station was established in 1925. As questions are answered, new ones arise. Today's biggest challenges are intertwined: fire, drought, and climate. Scientists with the PNW Research Station tackle these challenges from multiple angles. Station research helps land managers take action now to build resilience across the landscape.

Forests are valued by many people for different reasons; interests, questions, and opinions regarding priorities are as diverse as society. By working closely with colleagues in the National Forest System, other public agencies, industry, nongovernmental organizations, and American Indian tribes, the station provides objective information that can be applied to the many challenges encountered in the management of our nation's forests.

The following pages showcase some highlights of our work in fiscal year 2017. This work, done collaboratively with nearly 80 partners, contributes to the stewardship of forests and grasslands.

For more information, click here.

Hood Canal, Washington

Connie Harrington

Finances and Workforce

Two sources of funding support the Pacific Northwest Research Station workforce: federal appropriations, which contributed 85 percent of incoming funds in fiscal year (FY) 2017, and direct client support, which comes from organizations in need of scientific information.

The numbers below are for the fiscal year October 1, 2016, to September 30, 2017.

FUNDING*

Base research appropriations: $39.2 million

Fire plan appropriations: $3.8 million

Client support: $3.3 million

Total funding: $46.3 million

* Other Forest Service units asked the station to conduct work totaling $9.4 million.

DISTRIBUTION OF FUNDS

Permanent employee cost: $30 million

Support and operations: $14.7 million

Distributed to cooperators: $14.2 million

Difference between funding and distribution of funds can be attributed to projects initially funded in prior years.

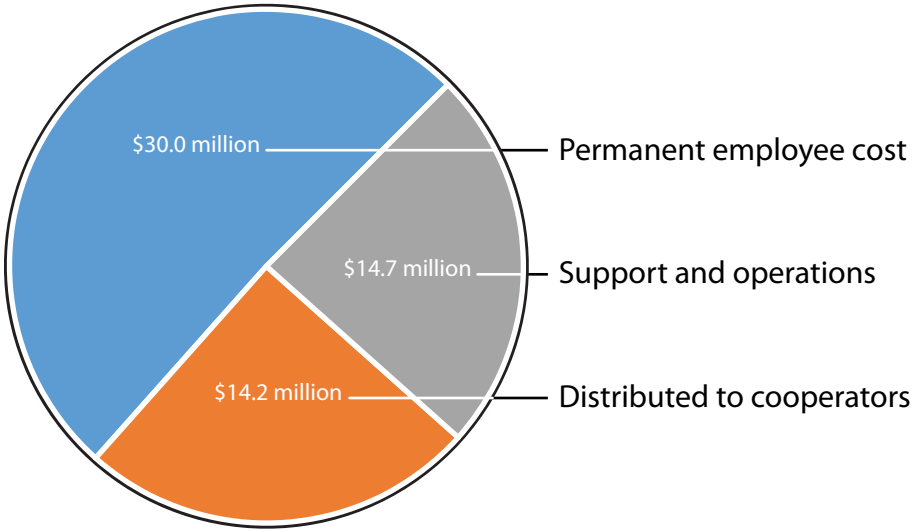
WORKFORCE STATISTICS

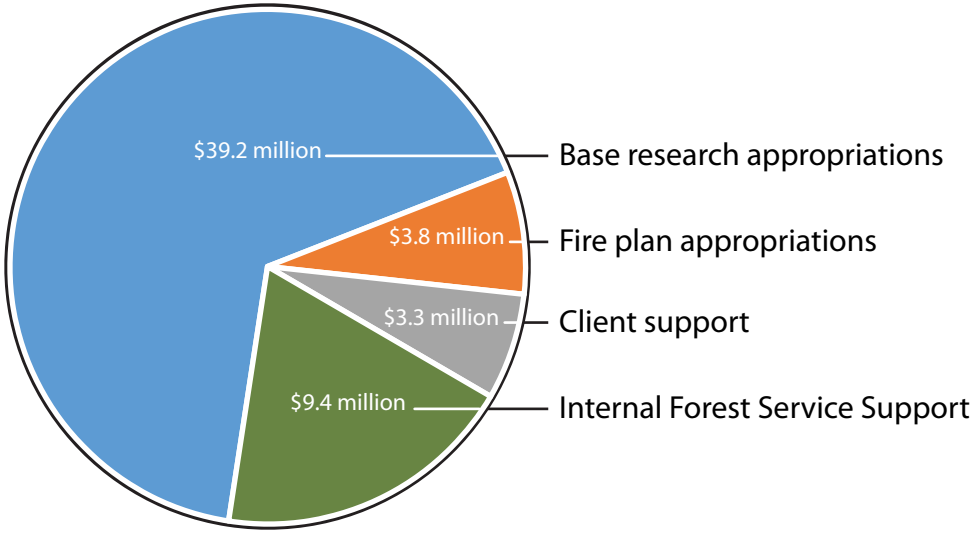
Total station workforce: 317

Permanent workforce: 263

Of the permanent workforce, 68 employees (21%) are scientists.

Temporary workforce: 54





Funding Partners in FY 2017

PARTNERS WHO RECEIVED FUNDS FROM THE PACIFIC NORTHWEST RESEARCH STATION

Alaska Department of Natural Resources
Alaska Pacific University
Bayesfusion, LLC
Cascadia Conservation District
Colorado State University
Conservation Biology Institute, Inc.
DHHS Federal Occupational Health
Humboldt State University Sponsored Programs Foundation
Idaho State University
Latah Soil & Water Conservation District
Massey University
Michigan State University
Michigan Technological University
Mississippi State University
Mount St. Helens Institute
National Academy of Sciences
Nevada System of Higher Education
North Forty Productions, LLC
Oregon Department of Fish and Wildlife
Oregon Department of Forestry
Oregon State University
Portland State University
Pyrologix, LLC
Regents of University of California
Regents of University of Idaho
Regents of University of Michigan
Regents of University of Minnesota
Sitka Conservation Society
Southern Illinois University
Student Conservation Association, Inc.
Tall Timbers Research, Inc.
TerrainWorks, Inc.
University of Alaska Anchorage
University of Alaska Fairbanks
University of Alaska Southeast
University of Arizona
University of California, Davis
University of Chicago
University of Guam
University of Montana
University of Oregon
University of Washington
University of Wisconsin System
Upper Snake River Tribes Foundation, Inc.
U.S. Department of Energy
USDA National Wildlife Research Center
USDI Geological Survey
Utah State University
Washington State University
West Virginia University Research Corporation
Wild Salmon Center
Willamette Partnership

PARTNERS WHO PROVIDED FUNDS TO THE PACIFIC NORTHWEST RESEARCH STATION

California Department of Forestry and Fire Protection
Canadian Wood Fibre Centre, Natural Resources Canada
City of San Diego
Confederated Tribes and Bands of the Yakima Nation
Earth Resources Observation and Science Center
Environmental Protection Agency
Green Diamond Resource Company
NASA, Goddard Space Flight Center
NASA, Marshall Space Flight Center
National Council for Air and Stream Improvement
National Fish and Wildlife Foundation
Oregon Department of Forestry
Oregon Department of State Parks and Recreation
Seattle City Light
U.S. Army Corps of Engineers
U.S. Department of Energy
USDA Office of the Chief Economist
USDC National Oceanic and Atmospheric Administration
USDI Bureau of Land Management
USDI Fish and Wildlife Service
USDI Geological Survey
USGS OAG Sacramento Acquisition
USGS DOI Northeast Climate Science Center
USGS Northwest Climate Science Center
Washington State Department of Natural Resources

Science Delivery Highlights

A key part of the station's mission is delivering science in accessible formats to people who need it to make informed decisions. In FY 2017, station scientists used a variety of formats to share information and engage with stakeholders. In summary, station scientists engaged in the following science delivery activities:

- 300 presentations
- 60 consultations
- 40 educational activities
- 30 workshops
- 28 webinars

WEB VISITORS

Total number of visits: 125,083

Total number of page views: 392,473

New visitors: 72%

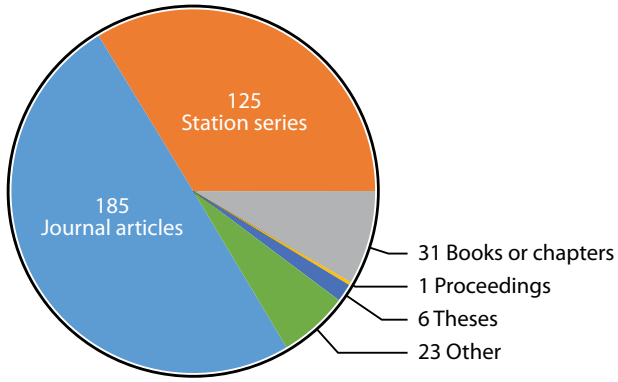
TWITTER

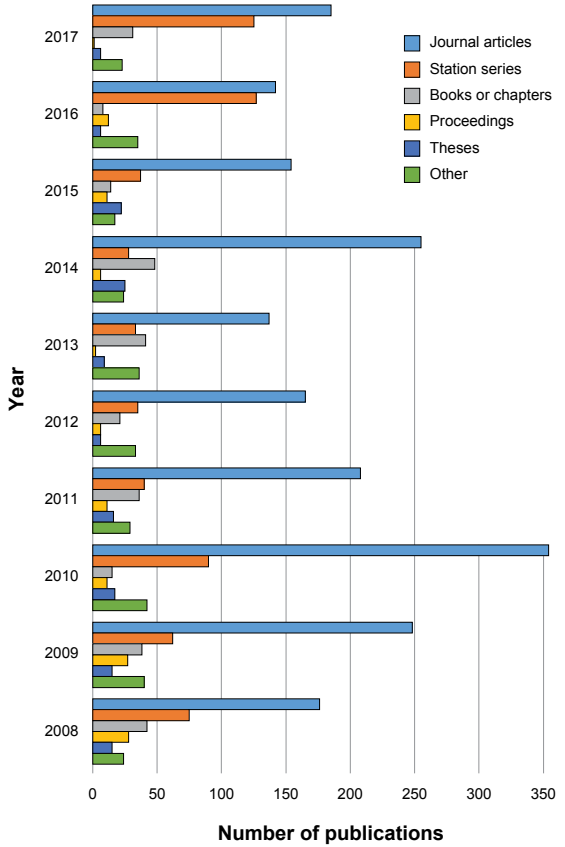
The station's Twitter account has 2,558 followers—up from 2,003 in 2016. Reporters, natural resource professionals, and nonprofit groups comprise the majority of subscribers who receive instant electronic alerts (tweets) about the station's news releases, new publications, and other information.

PUBLICATIONS

The station produced 371 publications in FY 2017. This includes station series publications, journal articles, books or book chapters, theses and dissertations, and other published works.

- 88,249 hardcopies of station publications distributed
- 76,657 views of station publications via Treesearch, the Forest Service's online library
- 11 issues of *PNW Science Findings* published; about 8,000 copies of each issue distributed or downloaded





Science for Fire, Smoke, and Fuels Management

Fire and fuels management have both ecological and social components. Station science is providing information and tools to land managers and the public so that fire can be used strategically to yield ecological benefits rather than become an uncontrollable force that destroys homes and lives.

Fire management personnel strip light an underburn unit at Shevlin Park, Bend, Oregon.

Sasha Salia

LINKING VEGETATION AND STRUCTURE-IGNITION MODELING

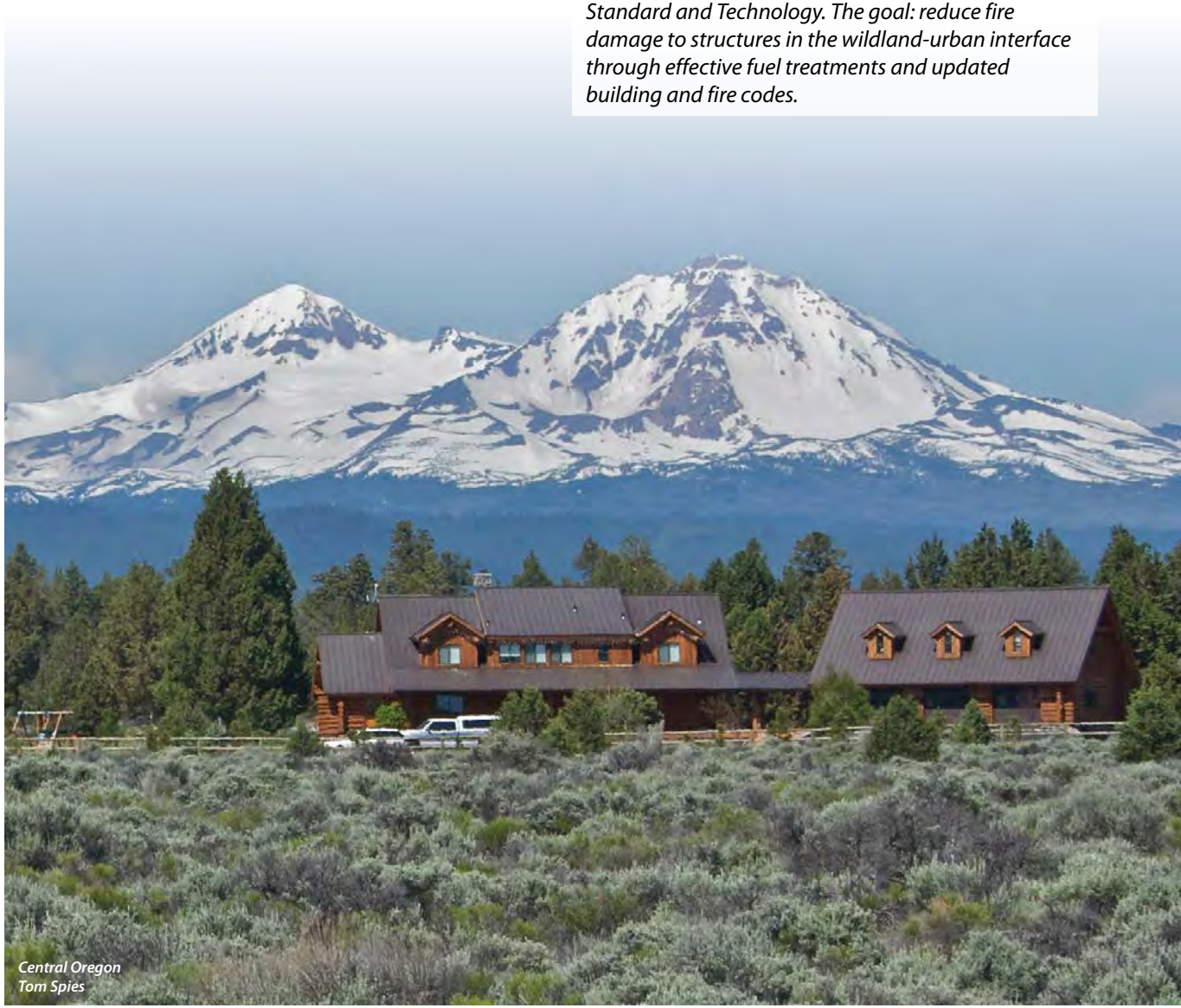
A collaborative effort is linking Forest Service modeling of fire in vegetation with the structure-ignition model used by the National Institute of Standard and Technology. The goal: reduce fire damage to structures in the wildland-urban interface through effective fuel treatments and updated building and fire codes.

Fire in the wildland-urban interface is a serious concern for the U.S. Forest Service because of the high risk that homes—and even lives—may be lost. Once a structure has ignited, it can contribute substantially to a fire's spread. The National Institute of Standards and Technology (NIST) provides the technical basis for building and fire codes, and thus both agencies have a vested interest in minimizing fire damage to homes and other buildings at the interface of forested and developed areas.

FY 2017 was the first of a multiyear effort by scientists from the NIST, University of Colorado, and U.S. Forest Service—including William Mell, a research engineer with the PNW Research Station—to extend the capabilities of NIST's Fire Dynamics Simulator computer model to include fire in vegetation. Once this effort is complete, NIST is planning to use the Fire Dynamics Simulator to support development of new standards and building codes to reduce the likelihood of structure ignition in the wildland-urban interface. The tool also will support the U.S. Forest Service's effort to design fuel treatments in ways that reduce community exposure to fire and smoke.

Partners: Colorado State University, National Fire Plan, National Institute of Standards and Technology

For more information, click here.



Central Oregon
Tom Spies

THE ERA OF MEGAFIRE

Station scientist Paul Hessburg initiated a ground-breaking effort to bring together researchers, land managers, and communities to discuss fire—and ways to coexist with this inevitable force of nature. Hessburg has taken his message on the road, working with local experts to present it in more than 80 communities to more than 20,000 people since June 2016. In November 2017, he presented the information as a TEDx talk, which was viewed more than 300,000 times within the first week of being posted online.

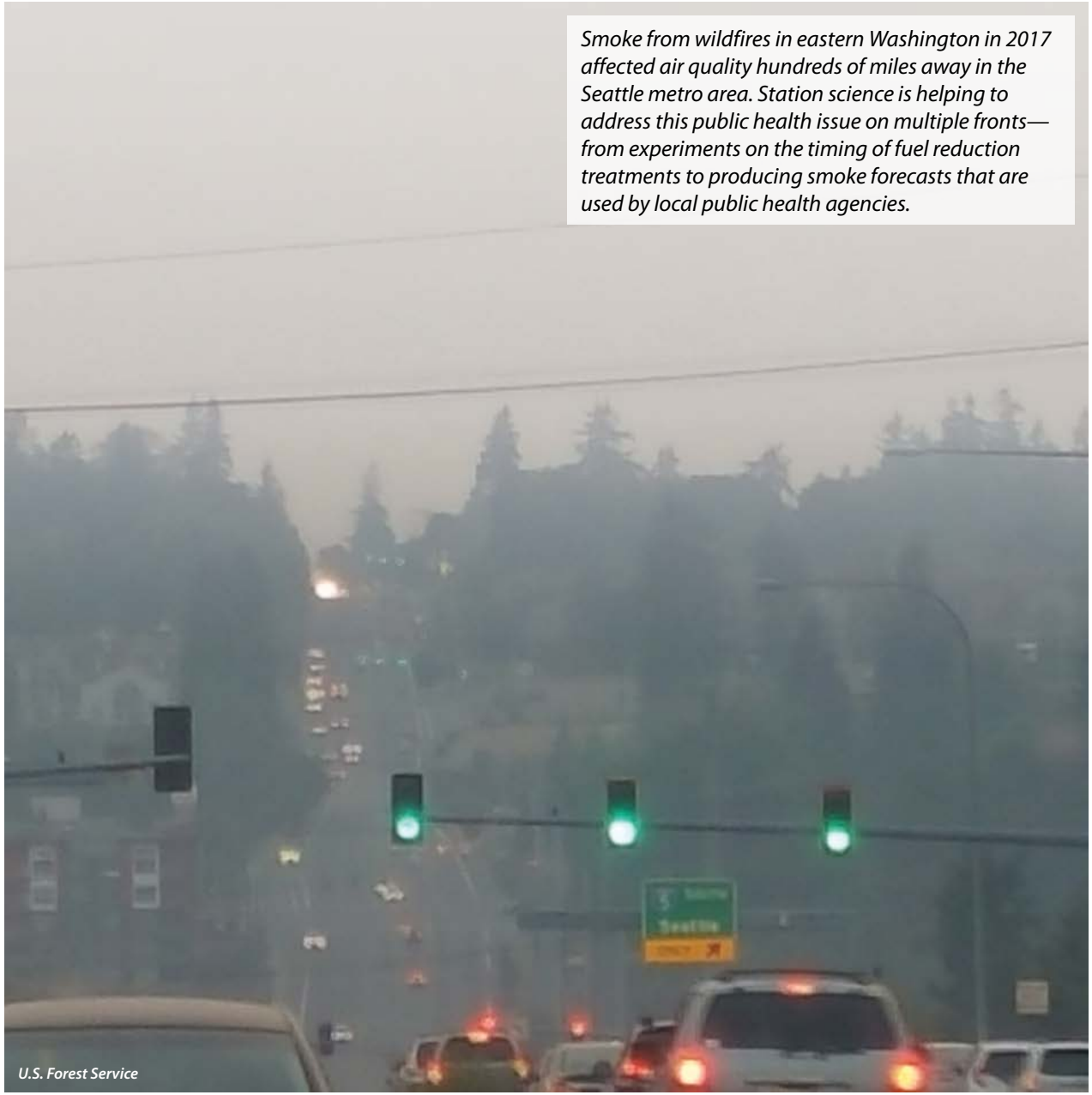
For more information, click here.

PROTECTING COMMUNITIES AND PUBLIC HEALTH

Smoke modeling by station scientists is now an integral part of the nation's wildfire fighting effort. The station's AirFire team supports incident command teams deployed across the country. The AirFire Research Team provides technical consultations and science-based tools that are helping fire professionals, public health agencies, and communities protect lives, structures, and natural resources from wildfire and smoke impacts.

In 2107, the AirFire Research Team directly supported more than 90 air resource advisors assigned to fire incidents with daily interactions and custom modeling to help local air quality agencies respond to smoke impacts. This included the following:

- Deploying more than 110 temporary air quality monitors.
- Conducting more than 3,000 smoke dispersion model runs and calculating nearly 1 million smoke trajectories.
- Producing about 1,100 "smoke outlook" forecasts.
- Providing after-action reviews and preseason training opportunities.



Smoke from wildfires in eastern Washington in 2017 affected air quality hundreds of miles away in the Seattle metro area. Station science is helping to address this public health issue on multiple fronts—from experiments on the timing of fuel reduction treatments to producing smoke forecasts that are used by local public health agencies.

U.S. Forest Service

NEW TOOLS FOR WILDFIRE INCIDENT OPERATIONS

The Experimental Hot-Dry-Windy Index improves forecasting by pulling from three different weather forecasts.

- Now used by National Weather Service meteorologists in the Pacific Northwest.

Outlook Editor Workflow Tool

- Automates segments of the process used by air resource advisors to produce a daily "smoke outlook" that estimates what smoke will do in specific areas over the next few days.
- The tool automatically gathers data from various systems, provides easy Web posting and social media links, and results in more consistent products from the Wildland Fire Air Quality Response Program.

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

Air resource advisor Wendy Wagner sets up air monitoring equipment.

FUEL TREATMENTS TO MITIGATE FIRE RISK

CHALLENGE: MAXIMIZING BURN DAYS

Prescribed fire and mechanical thinning are two common methods for reducing hazardous woody fuels and stand densities to limit the severity of future wildfire. Both have their own challenges when it comes to implementation. Prescribed burns are weather dependent, and the window of opportunity for conducting them safely is often quite small. Various efforts by station scientists are helping states and national forests to more accurately identify potential burn days.

Station scientists worked with Washington state to test a 24-hour, advance-notice burn approval system as compared to the standard day-of approval. This facilitates multiday burns. These pilot burns during fall 2016 and winter 2017 resulted in minimal impacts to air quality or impacts that were on par with non-pilot burns.

Station scientists used 31 years of fire weather data to reconstruct the available and unavailable burn days for the southeastern United States, a region where more than 70 percent of the nation's prescribed fire is burned annually. The results highlight the region's potential underused burn days that can be leveraged to achieve management objectives.

Partners: Joint Institute for the Study of the Atmosphere and Ocean, NOAA Pacific Marine Environmental Laboratory, University of Washington

TIMING PRESCRIBED BURNS FOR MAXIMUM BENEFITS

Working with managers on the Malheur National Forest, station scientists Doug Westlind and Becky Kerns conducted a prescribed burn/reburn experiment to learn how the timing of a burn affected subsequent fuel loads. The study sites were first burned in fall 1997 and spring 1998. Follow-up burns were conducted 5 and 15 years later during the same seasons as the initial burns.

KEY FINDINGS:

- The season of the prescribed burns affected subsequent fuels.
- Fall burning, regardless of frequency, generated larger pieces of fuel (1,000-hour fuel) primarily from overstory mortality resulting from the initial entry burns and subsequent snag and branch fall.
- Five-year fall reburning was most effective in reducing excessive conifer regeneration.
- Some burning near summer conditions may be needed to achieve and maintain the most desired fuel loads and regeneration densities in the long term.

This research provides forest managers and fire ecologists with new information on the limitations expected in managing fuels in dry fire-prone conifer forests using recurring burn cycles only in the spring or fall.

Partners: Joint Fire Sciences Program, Malheur National Forest, National Fire Plan, USDA Forest Health Protection

For more information, click here.

One hour after ignition on a fall reburn in 2002 at a study site in the Malheur National Forest, Oregon.

HOW HOT IS TOO HOT FOR TREES DURING A PRESCRIBED BURN?

A prescribed burn is generally intended to clear out accumulated ground fuels and reduce crowding by killing some of the smaller trees in a stand. Conventional wisdom is that larger trees with thicker bark will be able to survive the burn.

The lethal temperature limit for trees, and other plant tissue, is well established at 140 °F (60 °C). However, cells and tissues may die at lower temperatures if exposed long enough. During wild or prescribed fires, woody tissues in tree roots, stems, or crowns are exposed for variable times to temperatures below 140 °F (60 °C) that cause heat stress, but the physiological mechanisms are poorly understood. Heat stress from sublethal temperatures is important to understand because it can kill trees directly or make them more vulnerable to bark beetles and other stressors.

SUBLETHAL TEMPERATURE MAY TRIGGER ETHANOL PRODUCTION, WHICH ATTRACTS BARK BEETLES

To learn more, station scientists Rick Kelsey and Doug Westlind formulated a mechanistic model, proposing that when woody tree tissues reach 86 to 140 °F (30 to 60 °C) during a fire, three physiological mechanisms may be triggered that, individually or combined, impair aerobic respiration energy production and usually induce ethanol synthesis—a bark beetle attractant.

This new insight provides valuable information to land managers considering the use of prescribed fire to reduce fuel loads.

For more information, click here.

A prescribed burn on the Coconino National Forest, Arizona

QUANTIFYING FIRE EFFECTS ON SOIL

When large down wood burns, the soil beneath the log is exposed to prolonged intense heat. This alters soil properties and kills soil microbes. In areas with lots of large down wood from previous wildfires, the extent of severe soil burn can be a concern.

EXPERIMENT INDUCES INTENSE HEAT TO MEASURE RESPONSE OF KEY SOIL FUNGI

To better quantify the effects of soil heating, scientists conducted an experiment in the Pringle Falls Experimental Forest in central Oregon. The study team led by Jane E. Smith, a botanist with the PNW Research Station, found that the composition of soil microbial communities varied with burn severity.

- The greatest differences were apparent in the early time points following the fire and decreased over 4 years.
- Severely burned soils had a fewer nutrients, which slowed the recovery of vegetation for at least 4 years.
- These findings provide a foundation for ongoing studies investigating the effects of soil burn severity on tree seedling growth, soil fungi, and nutrients. Continuing this work, the scientists are investigating soil fungal community recovery and succession using next-generation DNA sequencing.

The Deschutes National Forest used these findings to address public comments on proposed forest plans.

Partners: Deschutes National Forest, Kansas State University, Oregon State University

For more information, click here.

Scientists designed an experiment involving a controlled burn in Pringle Falls Experimental Forest, Oregon, to learn more about the effects of intense heat on soil and subsequent tree regeneration.

Ariel Cowan

FIRE IN THE WAKE OF SUDDEN OAK DEATH

Sudden oak death, caused by the fungal pathogen *Phytophthora ramorum*, has killed many native oaks in California and southern Oregon. Forest managers are very interested about the interplay between fire and sudden oak death.

To learn more, station scientist J. Morgan Varner and colleagues used leaf litter from a variety of species in northern California to predict future flammability of the remaining vegetative community, once sudden oak death had basically eradicated native tanoak. They found that flammability was diverse across the native co-occurring species.

- Tanoak leaf litter is highly flammable, but Douglas-fir litter is less so.
- Leaf litter flammability may be reduced in forests where tanoak dies and is replaced by Douglas-fir.

Partners: Humboldt State University; National Fire Plan; University of California, Davis; University of California Cooperative Extension Service; USDA Forest Service Pacific Southwest Research Station

For more information, click here.

Sudden oak death has killed many native oaks in California and southern Oregon. Scientists are studying how the flammability of these stands may change as other species replace tanoak.

Steve Swain

MANAGING FIRE-PRONE FORESTS IN MULTI-OWNERSHIP LANDSCAPES

Some challenges are so big they really do require an all-hands-on-deck approach. Interest is growing among public and private land managers in using landscape-scale approaches across fire-prone forests to reduce the risk of uncontrollable wildfire near communities, commercial timberland, and other valued resources. Management actions—or nonaction—on one parcel of land can affect conditions on other lands in a watershed or region.

UNDERSTANDING MOTIVATIONS AND CONSTRAINTS

Identifying the need for collaboration is one thing; actually working together is another. An intermediary step is understanding the motivations and constraints faced by different landowners. To learn more, a team of scientists from the Pacific Northwest Research Station and Oregon State University co-led an interdisciplinary study to investigate how national forests, state forests, and private corporate forests were managed to reduce wildfire losses. They also looked at the underlying social and ecological drivers influencing management decisions, and modeled the outcomes of current management on different ownerships for increasing forest resilience to wildfire 50 years into the future.

Landowners in Oregon's eastern Cascade Range engage in diverse forest and fire management practices. Key drivers of forest and fire management decisionmaking, the scientists learned, are: (1) current forest conditions resulting from past management and fire, (2) market conditions for wood products and desired revenue streams, and (3) attitudes toward fire.

ADDRESSING PRACTICALITIES OF FOREST MANAGEMENT

Even with mutual goals in mind—more resilient forests and community safety—practicalities may inhibit implementation. The study team identified possible interventions that could help landowners lessen current constraints to managing for fire-resilient forests. These interventions include:

- Retaining and developing market infrastructure for wood products of all types.
- Incentivizing growth of big trees on private corporate lands that currently lack them.
- Making financial assistance available to private corporate owners for reducing fire hazard and recovery following wildfire.
- Developing policies and programs that support the use of prescribed fire on state and private corporate lands.
- Strengthening social networks for addressing wildfire.

The Deschutes National Forest and the Deschutes Collaborative Forest Project along with the Fremont-Winema National Forest and the Lakeview Stewardship group are using this information to explore possible futures that could result from collaboratively developed restoration strategies.

Partners: Deschutes Collaborative Forest Project, Deschutes National Forest, Fremont-Winema National Forest, Lakeview Forest Landscape Collaborative, Oregon State University, University of New England

A public field trip in the Deschutes National Forest.

Tom Spies

BURN A LITTLE, SAVE A LOT: USING CONTROLLED FIRES TO MITIGATE WILDFIRES

Large wildfires can be devastating for communities and forests. Beyond the immediate dangers to life and property, wildfire smoke can have far-reaching adverse effects on air quality and human health.

Setting small, controlled fires is an effective way to mitigate large, destructive wildfires. Not only do prescribed burns reduce forest fuel loads, thus reducing the risk of uncontrolled wildfires; they also offer unique opportunities to research fire and smoke patterns. Prescribed fires can act as test beds for existing models of smoke and tree mortality so researchers can continue to improve upon current predictive abilities related to forest fires and smoke impacts.

Up to 28.5 tons per acre: the amount of potentially hazardous fuel loads eliminated in each prescribed burn during this pilot study.

SUPPORTING WASHINGTON'S FOREST RESILIENCY BURNING PILOT STUDY

In Washington state, a large, interagency effort funded by the state legislature conducted 80 prescribed burns from fall 2016 to spring 2017, 15 of which were on state and national forest lands. Fire managers and teams were given 24-hour advance notice of burn approval instead of the standard day-of approval process, allowing them to complete more planned multiday burns.

Multiple researchers from the PNW Research Station were tasked with tracking and studying the fires. Roger Ottmar, a research forester, investigated the fuel load pre- and postfire to assess tree mortality. These results will contribute to future planning for a resilient burn program in Washington with the goal of promoting healthy forests.

The station's AirFire Research Team tracked air quality and smoke during the prescribed burns by deploying additional smoke measurement monitors to augment the permanent network. The scientists found no difference in the smoke impacts or air quality between prescribed burns approved the same day compared to those approved 24 hours in advance. This is useful information because burns approved 24 hours in advance are more likely to be completed than those approved the same day. The smoke and air quality data gathered by the AirFire team will be used to improve the predictive power of the current model being used to predict smoke impacts in Washington.

The data gathered during these prescribed burns will be presented to the Washington State Legislature in 2018 and used to develop a forest resiliency burning program.

For more information, click here.

A researcher collects fuel samples during a prescribed burn conducted as part of the Washington State Forest Resiliency Burning Pilot project.

Jim Cronan

LEGACIES OF PAST FIRES

In fire-prone ecosystems, the return of wildfire is inevitable. Legacies of past fires, or their absence, will often dictate the characteristics of subsequent fires. With the area of burns increasing across western U.S. forests, it will be essential to incorporate previously burned areas into fuel and fire management plans and real-time understanding of potential wildfire behavior.

For more information, click here.

EXAMINING PAST BURN MOSAICS TO LEARN HOW MANAGED WILDFIRE CAN BE USED FOR LARGE-SCALE FUEL TREATMENTS

Researchers, including station scientist Paul Hessburg, conducted a global synthesis of research on how pre-existing burns—originating as wildfires or prescribed burns—can modify the patterns and severity of subsequent fires. The lessons gleaned from this synthesis represent a significant advance in knowledge with important implications for landscape management planning. A clear understanding of how prior burn mosaics influence future fire spread and burn severity will also inform landscape-scale planning, and be useful when managing for fire-dependent wildlife habitat.

Partners: University of Idaho, University of Washington

An aerial view of the 2012 Pole Creek Fire in the Three Sisters Wilderness, Deschutes National Forest, Oregon. Past burns can influence the dynamics of future burns.

U.S. Forest Service

Human Dimensions

The reasons we care about forests are as diverse as society. National forests are valued for the jobs they sustain, as places to recreate, for their beauty, and for the many other ecosystem services they provide.

Human values and perspectives influence decisions about forest management. Social science and economic research by station scientists provides insights into how these values, and social systems in general, intersect with ecological systems. This is vital information because the health of many communities is linked to the health of the forests.

A field trip with members of the Lakeview Stewardship Group in the Fremont-Winema National Forest.

Tom Spies

ECONOMIC BENEFITS OF STEWARDSHIP CONTRACTING

Stewardship contracting has been embraced by some federal managers to achieve restoration goals while providing economic benefits to local communities. Little is known, however, about economic contributions from stewardship contracts, including how they compare against Secure Rural Schools program funding or the century-old payments to counties revenue-sharing systems.

A CASE STUDY ON THE MOUNT HOOD NATIONAL FOREST

To learn more, Jean Daniels, a research forester with the station, and colleagues conducted an economic analysis of two case study stewardship contracts located on the Mount Hood National Forest in western Oregon.

They found the following:

- The stewardship contracts all contributed to local economic activity.
- Expenditures for the two contracts generated $4 million of output and 36 jobs.
- Effects largely accrued to the private sector rather than county governments.

Partners: Clackamas Stewardship Partners, Portland State University, Mount Hood National Forest

For more information, click here.

Forest thinning conducted under a stewardship contract in Oregon.

Bureau of Land Management

AS CLIMATE CHANGES, SO DO SHORELINES IN SOUTHEAST ALASKA

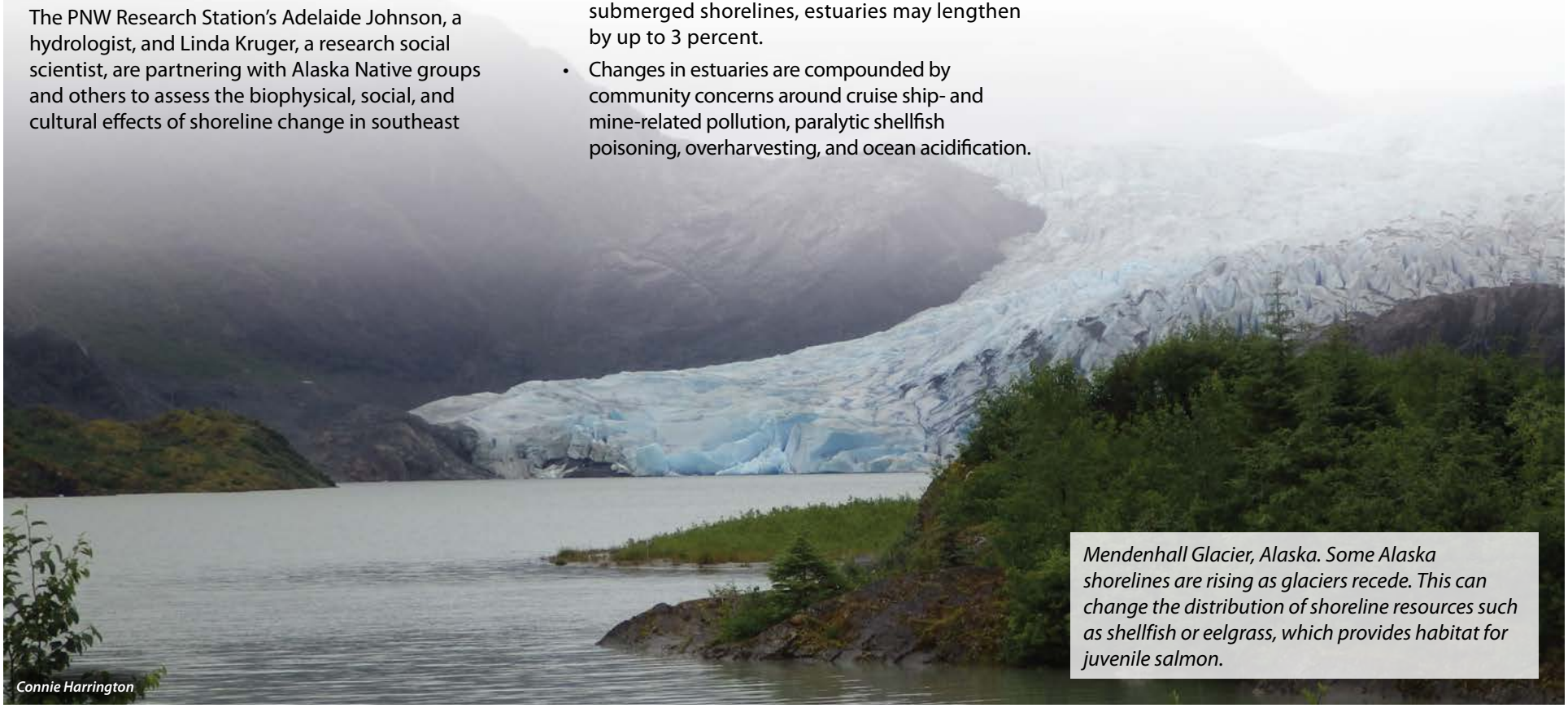
When landlocked glaciers melt, an immense weight is removed from the land previously under the glacier. The land "bounces" back and local sea levels drop in relation to the newly elevated shore. This geological process is known as isostatic rebound. Shoreline and estuaries provide habitat for many subsistence resources valued by nearby communities in southeast Alaska. Shoreline change means a change in the distribution of shoreline-associated food resources.

CHANGING SHORELINES HAVE BIOPHYSICAL, SOCIAL, AND CULTURAL IMPLICATIONS

The PNW Research Station's Adelaide Johnson, a hydrologist, and Linda Kruger, a research social scientist, are partnering with Alaska Native groups and others to assess the biophysical, social, and cultural effects of shoreline change in southeast Alaska. This research highlights the importance of using initial geomorphology-based assessments to improve biophysical, chemical, and social research along coastlines. This analysis provides information that can be used to design management strategies that are more attuned to social and cultural values.

- In the next 100 years, they predict up to a 30 percent reduction in total estuary length near some communities in southeast Alaska as the land rebounds in response to retreating glaciers.
- Where the rate of sea-level rise is faster than the isostatic rebound rate, resulting in submerged shorelines, estuaries may lengthen by up to 3 percent.
- Changes in estuaries are compounded by community concerns around cruise ship- and mine-related pollution, paralytic shellfish poisoning, overharvesting, and ocean acidification.

Partners: USDA Forest Service Alaska Region, Tongass and Chugach National Forests, University of Alaska Southeast, University of Alaska Fairbanks, Alaska Department of Fish and Game, National Oceanic and Atmospheric Administration, Central Council of Tlingit and Haida Indian Tribes of Alaska, Yakutat Tlingit Tribe, Hoonah Indian Association, Forest Service ANM/Angoon Liaison, Organized Village of Kake, Sitka Tribe of Alaska, Klawock Cooperative Association, Ketchikan Indian Community, Organized Village of Kasaan, Native Village of Eyak, Tatitlek Village IRA, Chenega IRA



Mendenhall Glacier, Alaska. Some Alaska shorelines are rising as glaciers recede. This can change the distribution of shoreline resources such as shellfish or eelgrass, which provides habitat for juvenile salmon.

Connie Harrington

PROJECTING THE EFFECTS OF GLOBAL CLIMATE CHANGE ON FORESTS AND MARKETS

Economic models that account for dynamic ecological and economic features can help us understand how climate change will likely affect forests and timber markets. But to measure the climate effects in particular regions, they must consider global impacts. A study led by station scientist John B. Kim modeled the global timber output under different climate scenarios. The results of their modeling suggest the following:

- Global timber output is projected to increase, driving prices down.
- Pulpwood prices will fall the most in relation to climate change, although prices for sawtimber also will fall.
- Output will increase throughout the century, with the strongest gains at the end of the century.
- Climate mitigation policies slow forest changes and reduce market impacts. The impact of climate mitigation on global timber outputs, however, are projected to be modest.

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

Researchers linked computer models with dynamic ecological and economic features to project the effects of climate change on the global forestry sector.

Logs are loaded onto a ship for export.

STAYING CURRENT: UNDERSTANDING RECENT TRENDS IN THE FOREST PRODUCTS INDUSTRY

Maximizing efficiency and minimizing waste are key to any successful business or industry, and the forest products industry in Oregon is no different. But to improve efficiency and ensure long-term sustainability in this important industry, managers and producers first need to know *current* production levels.

To gather this information, researchers conduct a census of forest products facilities every 5 years. This includes facilities that receive timber for processing into lumber, veneer, or export, and plants that use wood fiber residues for power and particleboard production. After analyzing data from 2008 to 2013, station scientist Glenn Christensen and his colleagues found that despite the number of forest products processing facilities decreasing from 251 to 188, timber harvest increased by 17 percent.

USE OF SMALL-DIAMETER LOGS INCREASES

Researchers found an increased use of small-diameter logs due to improved lumber markets, shorter harvest rotations, and more competition for large-log exports in 2013. Timber processing capacity at sawmills also increased because of mill upgrades and the construction of two high-capacity sawmills. These findings mirror broader trends in the forest products industry, which appears to be moving toward fewer, higher capacity sawmills.

CALCULATING LOGGING RESIDUES TO ESTIMATE FEEDSTOCK AVAILABLE FOR WOOD-BASED ENERGY

In a separate study, Christensen and colleagues also calculated the 2011–2015 logging utilization efficiencies in Oregon and Washington, numbers that had not been updated since the 1980s.

Comparing the amount of tree biomass removed from forests to the amount of timber and residues produced from that biomass, they found that statewide numbers were relatively constant despite differences in efficiencies across mills and processing facilities. This information will be used to associate logging residues with harvest volumes to meet national Forest Inventory and Analysis (FIA) parameters, develop estimates of available feedstock for wood-based bioenergy, and provide data on woody biomass lifecycles.

The knowledge gained from this research will help resource managers develop appropriate industry regulations to maintain the long-term health of the stocks on which the forest products industry relies.

For more information, click here.

RECENT INDUSTRY TRENDS

58,815: Oregon forest sector jobs in 2013

$3.18 billion: Total labor income from Oregon forest sector jobs in 2013

Despite 63 fewer forest products processing facilities, timber harvest increased 17 percent from 2008 to 2013 in Oregon.

A log truck in Douglas County, Oregon. ***Eric Simmons***

UNDERSTANDING NON-RECREATIONAL CAMPING ON NATIONAL FORESTS

Long-term occupancy by homeless visitors and other non-recreational campers in national forests and grasslands has become a persistent challenge for district rangers and law enforcement officers. Management challenges include maintaining sanitary conditions, public safety, vandalism, and conflict with other forest visitors. Biophysical challenges include soil compaction, damage to vegetation, trash, erosion, creation of fire rings, and dumping of household chemicals or pollutants.

SURVEY OF LAW ENFORCEMENT OFFICIALS REVEALS SCOPE OF PROBLEM

Lee Cerveny, a research social scientist with the station, surveyed law enforcement officers throughout the Forest Service to gauge the scope of problem. Nearly half of the surveyed law enforcement officers reported that interactions with homeless campers had increased during their tenure; weekly encounters with homeless campers were common for 38 percent of the officers. The most common type of homeless campers were "transient retirees." Homeless visitors were most often found in undeveloped areas close to major roads, and at rates that were higher in forests near urban areas.

OPPORTUNITIES FOR PARTNERSHIP WITH SOCIAL SERVICE ORGANIZATIONS

This research can help law enforcement officers and resource managers understand the implications of homelessness and non-recreational camping on the social environment. It can also help highlight areas for potential partnerships with other organizations to address the needs of homeless visitors to national forests and grasslands.

Partners: San Jose State University, USDA Forest Service Law Enforcement and Investigations

Non-recreational camping in the Mount Baker-Snoqualmie National Forest, Washington.

Lee Cerveny

DATA: LEVERAGING SOCIAL MEDIA TO MANAGE RECREATION IN NATIONAL FORESTS

In today's online world, scientists are exploring a new source of abundant data that will inform forest management: social media.

Outdoor recreation is a key use of our national forests. It is highly valued by the public, supports substantial public health benefits, and generates more economic activity nationally than all other uses of National Forest System land. In total across the United States, recreation on national forests generates about $9.3 billion in spending in local communities and supports 146,000 jobs.

RECREATION SPENDING

Working with the Forest Service Ecosystem Management and Coordination staff, station scientists determined that visitors recreating on Forest Service lands in Oregon spend about $448 million annually in communities located within 50 miles of national forest boundaries. This economic boost is also felt in Washington ($290 million in visitor spending annually) and Alaska ($197 million in visitor spending annually).

These numbers help policymakers and national forest managers understand the economic and social outcomes from investing in recreation planning, programs, and infrastructure. However, gathering on-site data on how many people are recreating and what they are doing requires significant time, staffing, and money. That's where social media comes in.

ONLINE POSTINGS PROVIDE METRICS ON RECREATION USE

Station social scientists Eric White, Dale Blahna, and colleagues at the University of Washington and Mount Baker-Snoqualmie National Forest are leveraging data available from social media posts to generate much needed information about recreational use across the entire network of individual sites and trails in national forests.

White and his colleagues have found strong correspondence between counts of recreation determined via social media platforms, such as Flickr photos and online trail reports, with traditional on-site counting methods, such as traffic counters and observations. This method has the potential to complement the current Forest Service recreation monitoring program by providing timely estimates of recreation use and visitor behavior in response to emerging management needs.

For more information, click here.

FOREST RECREATION AND SOCIAL MEDIA

15.3 million: Number of annual visits to national forests in Oregon and Washington

3,900: Year-round jobs supported in Oregon, many in rural communities, by revenue from visitors on trips to Forest Service lands

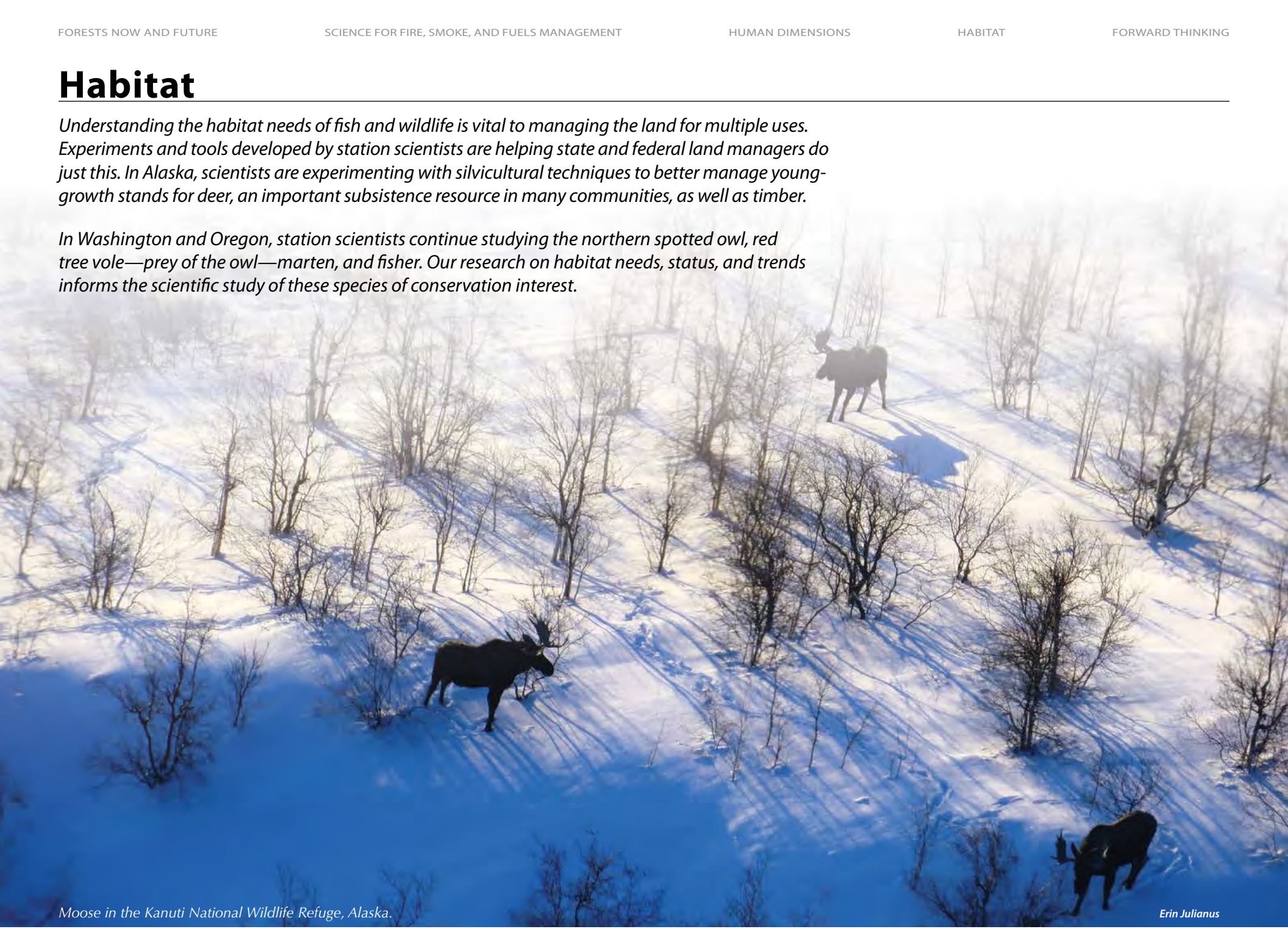
8,000: Average number of photographs taken from sites at Mount Baker-Snoqualmie National Forest and shared publicly on Flickr each year

Skiers in Mount Baker-Snoqualmie National Forest, Washington.

Habitat

Understanding the habitat needs of fish and wildlife is vital to managing the land for multiple uses. Experiments and tools developed by station scientists are helping state and federal land managers do just this. In Alaska, scientists are experimenting with silvicultural techniques to better manage young-growth stands for deer, an important subsistence resource in many communities, as well as timber.

In Washington and Oregon, station scientists continue studying the northern spotted owl, red tree vole—prey of the owl—marten, and fisher. Our research on habitat needs, status, and trends informs the scientific study of these species of conservation interest.



Moose in the Kanuti National Wildlife Refuge, Alaska.

Erin Julianus

MOOSE AND FIRE

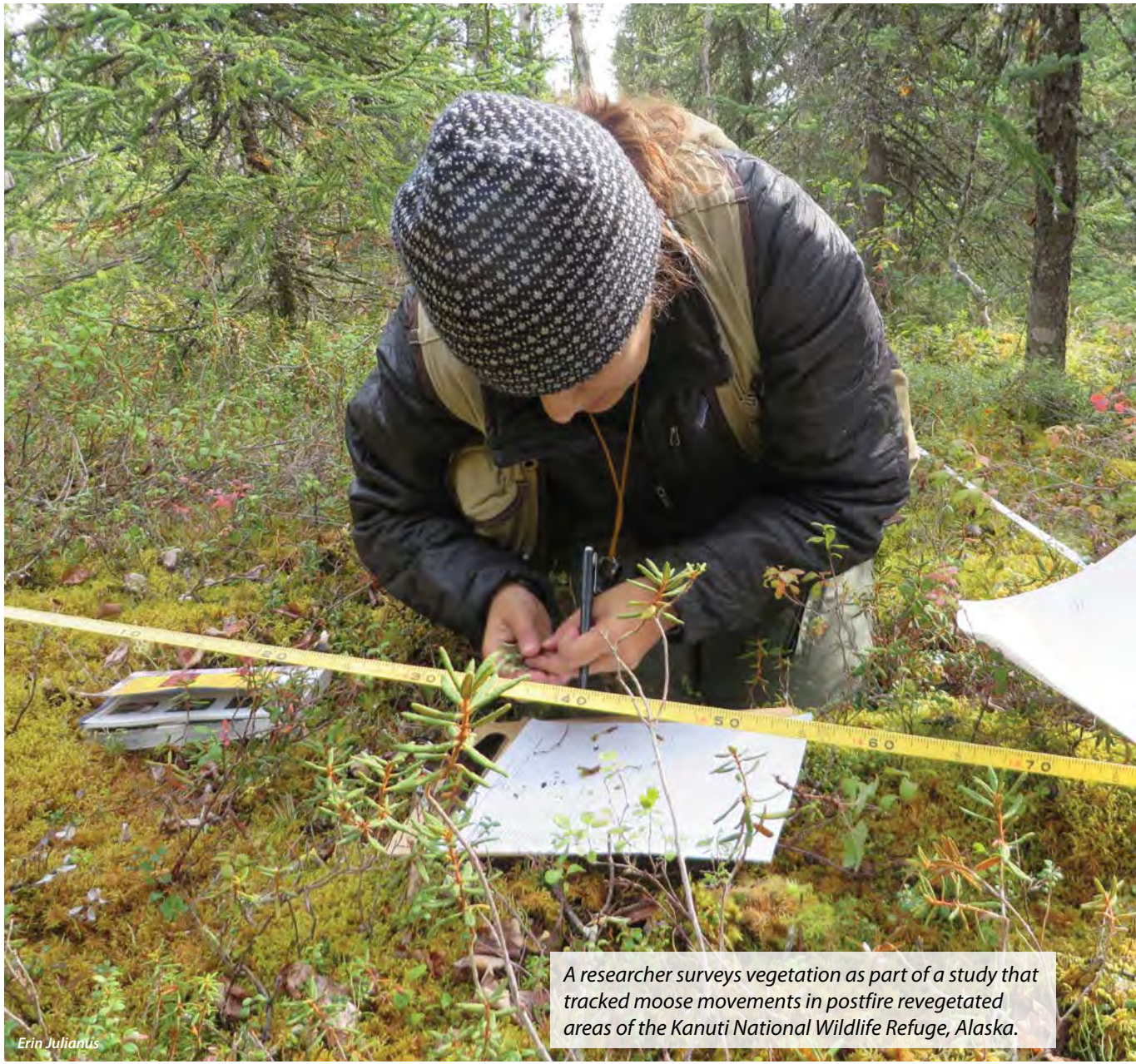
Wildfire is a prominent landscape-level disturbance in interior Alaska. After a fire, change in the availability and quality of vegetation affects wildlife habitat. Land managers responsible for managing habitat and wildlife managers responsible for ensuring sustained yield of game species, such as moose, are very interested in better understanding the postfire changes.

Managers of Kanuti National Wildlife Refuge are using findings to balance conflicting objectives of conserving vegetation while increasing the moose population.

A team of researchers, including Teresa Hollingsworth with the PNW Research Station, explored the dynamics of vegetation succession following fire and actual use by moose. Working in the Kanuti National Wildlife Refuge in interior Alaska, the researchers tracked moose movements throughout the refuge to learn how and when moose browse in certain burned areas.

Partners: University of Alaska Fairbanks; USDI Bureau of Land Management, Fish and Wildlife Service, Kanuti National Wildlife Refuge; USDI Geological Survey

For more information, click here.



A researcher surveys vegetation as part of a study that tracked moose movements in postfire revegetated areas of the Kanuti National Wildlife Refuge, Alaska.

Erin Julianus

ALASKA YOUNG GROWTH

The Tongass National Forest has more than 400,000 acres of young, even-aged stands that have regenerated after harvest in the 1900s. Without management, these stands can develop dense canopies in 15 to 20 years, and these dense canopies can persist for 100 years or more. With little light reaching the forest floor, understory plants are greatly reduced, and wildlife habitat—particularly deer forage, can be severely limited. Deer are an important subsistence resource in many communities in southeast Alaska, so there is interest in management that will enhance deer habitat while helping develop stands that are viable for commercial harvest to support the region's timber industry.

Two decades after treatment, deer continue to benefit from increased forage in artificial gaps in 81-year-old stands of southeast Alaska young growth.

The station and Tongass National Forest have several ongoing experiments related to the management of these young-growth stands. A study published by the station in 2017 compared treatment options and documented the habitat benefits from gaps created in stands of Alaska young growth on Chichagof Island. The study team found that 23 years following treatment, the areas where gaps had been created still had more understory plants, and thus were providing more foraging opportunities for deer than untreated areas.

Studies like this provide important insights as to how managed stands in southeast Alaska may affect wildlife habitat, particularly as forest management shifts from harvesting of old-growth stands to using managed second-growth stands as a source of timber and fiber.

For more information, click here.

An artificial canopy gap created in a 74-year-old stand at a study site in the Tongass National Forest, Alaska; untreated forest is in the background.

Mike McClellan

WATER, FISH, AND RIPARIAN AREAS

The temperature of water within a river network fluctuates in time and place, creating diverse thermal regimes. This variability has important biological and ecological consequences. Water temperature and changes in temperature trigger changes in the life stages of aquatic organisms. Spatial diversity in thermal landscapes provides river life with options—thermal niches—to maximize growth and survival. However, human activities and changes in air temperature and precipitation threaten to alter the dynamics of riverine thermal regimes. Station scientists are providing information and tools that can be used to manage aquatic and riparian habitats as environmental conditions change.

New techniques for modeling variability in temperature over time and place along a river network are setting the foundation for tools that could help pinpoint where restoration efforts to lower water temperature would be of most benefit to species of concern.

Aimee Fullerton

Ashley Steel downloads water temperature data in the Snoqualmie watershed, Washington.

UNDER WAY: PAIRED STREAM AND AIR MONITORING IN SOUTHEAST ALASKA

In summer 2017, researchers began installing a water and air temperature monitoring network in Héen Latinee Experimental Forest. Data and resulting model simulations will be used by fisheries managers to better adapt to changing patterns of fish production.

These data will be used to estimate the effects of temperature change on the productivity of the food web supported by the stream.

Warming trends in southeast Alaska will have a potentially significant impact on salmon habitat by altering thermal regimes in streams. In addition to general warming resulting from increased air temperatures, loss of glacial water inputs will have profound effects on the range and seasonality of water temperatures. These changes will likely affect river food webs with ripple effects to commercial fisheries. The station is providing foundational information on projecting changes in water temperature and flows across stream networks.

For more information, click here.

A researcher installs a water temperature gauge in Canyon Creek in the Héen Latinee Experimental Forest, Alaska.

Rick Edwards

SITE-SPECIFIC ACTIONS CAN BE TAKEN TO ADDRESS CHANGES IN WATER TEMPERATURE AND FLOW

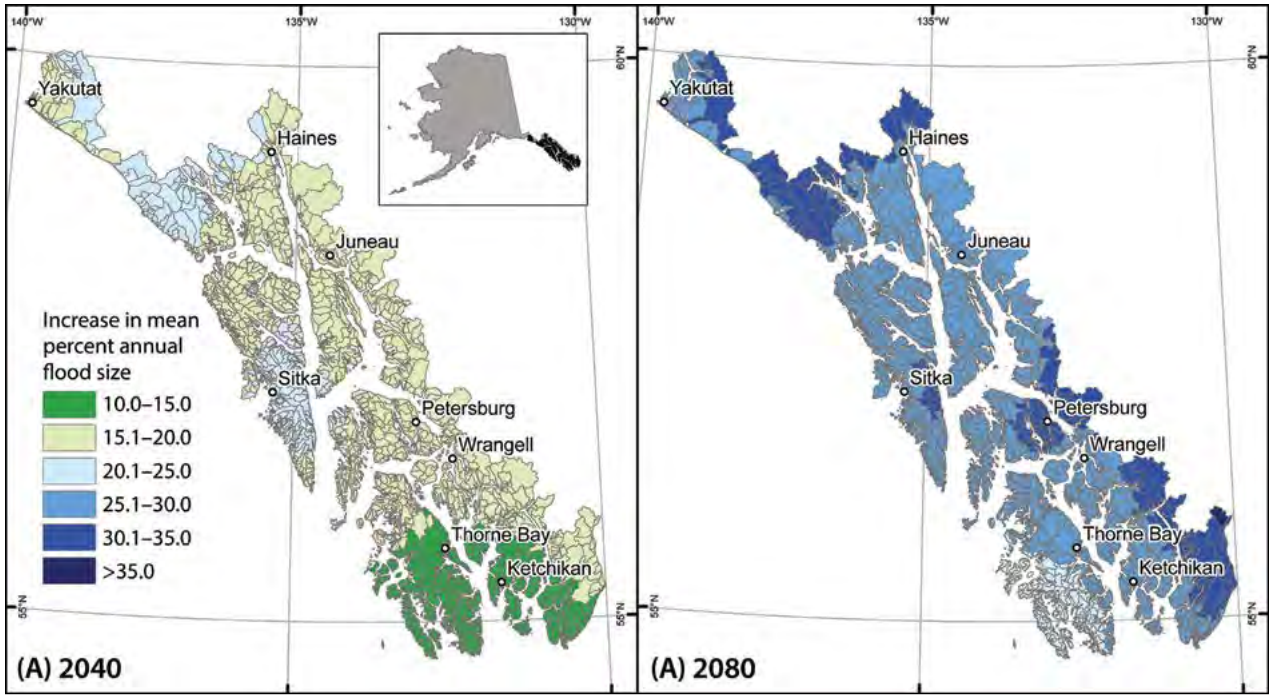
Natural resource managers and regulators have expressed their need for downscaled climate projections and tools for identifying the potential effects of changing environmental conditions before they can develop mitigation and adaptation practices and policies for climate change.

The Tongass National Forest is using this analysis in its vulnerability assessment and road management program. In Oregon, the Rogue-Siskiyou, Umpqua, and Siuslaw National Forests will be using this work for their climate change vulnerability analyses and development of forest plans.

Gordon Reeves, a research fish biologist with the PNW Research Station, and colleagues developed a process to display the effects of projected changes in water temperature and flows across a stream network in a watershed and to identify the variability in effects and potential mitigation actions across the stream network. Their work in three national forests in western Oregon and the Tongass National Forest in southeast Alaska shows that climate change effects will vary spatially within and among watersheds, and that site-specific actions can be taken to address these effects.

With this information, managers can develop more effective and targeted mitigation and adaptation actions.

Partners: TerrainWorks; USDA Forest Service Alaska Region, Pacific Northwest Region, Washington Office



Predicted increase in the magnitude of mean annual floods for the (A) 2040s and (B) 2080s in southeast Alaska relative to contemporary (1979–2000) flood magnitudes.

EVALUATING CONTEMPORARY FOREST ROAD PRACTICES

Early forest roads and their ditches delivered water and sediment directly into streams, degrading the aquatic ecosystem. Excess suspended sediment can clog fish gills and reduce visibility, making it harder to find food. If the sediment settles on the stream bottom, it can suffocate fish eggs. Even relatively small, sustained increases in suspended sediment concentrations can adversely affect aquatic biodiversity.

Over the decades, guidelines for building forest roads were developed to reduce their negative effects. But questions remained about the efficacy of the current standards.

WORKING IN THE OREGON COAST RANGE

As part of the Trask River Watershed Study, a multi-partner, long-term endeavor to evaluate Oregon's contemporary forest practices, station scientist Sherri Johnson and colleagues examined whether road building and road upgrades associated with forest harvest contributed to increased suspended sediment in streams. They also compared the suspended sediment and turbidity responses to multiple sediment thresholds that are used for regulatory purposes.

They observed very minor changes in downstream suspended sediment after road construction and road upgrades. A natural disturbance within the reference watershed, where a bankside tree tipped up and disturbed riparian soils, led to the largest increase in suspended sediment. This study indicates that, under current forest road guidelines for western Oregon, road upgrades and construction can occur with limited sediment inputs to streams.

Partners: National Council for Air and Stream Improvement, Oregon Department of Environmental Quality, Oregon Department of Forestry, Oregon Forest Industries Council, Oregon State University, USDI Geological Survey, Weyerhaeuser Company

For more information, click here.

Current practices effectively reduce delivery of fine sediment to streams within active timber sale sites in the Oregon Coast Range.

Kelly J. James

Timberland in the Oregon Coast Range.

QUANTIFYING THE EFFECTS OF DEER AND ELK ON RIPARIAN PLANTINGS INSTALLED TO IMPROVE SALMON HABITAT

Riparian restoration for threatened and endangered salmon is a billion-dollar endeavor in the Pacific Northwest. Restoration efforts often include planting streamside vegetation to shade and cool the streams and stabilize streambanks. However, these new plantings are often eaten by cattle, elk, and deer, and little is known about how this herbivory by wild ungulates affects riparian restoration in the absence of cattle.

ALONG MEADOW CREEK

The station's Starkey science team evaluated elk and mule deer impacts on deciduous woody riparian plantings along 7 miles of Meadow Creek, a steelhead- and Chinook salmon-bearing stream in the Starkey Experimental Forest and Range in northeastern Oregon. They found that herbivory by elk and deer can impede riparian restoration. Herbivory resulted in survival rates below regional agency criteria (50 percent) for restoration success after two growing seasons. This means that strategic management of wild ungulates to minimize impacts in riparian areas, and protection of riparian plantings from herbivory, are important considerations in riparian restoration for steelhead and salmon.

Protecting restoration plantings from herbivory may help fisheries biologists and land managers meet population recovery goals for threatened and endangered salmon.

Partners: Oregon State University, Wallowa-Whitman National Forest

For more information, click here.

Exclosures protect riparian plantings from browsing by deer and elk at the Starkey Experimental Forest and Range, Oregon.

Rhonda Mazza

INNOVATION: NEW TOOL FOR ENHANCING HABITAT FOR ENDANGERED SALMON

RESERVOIRS AND CHINOOK SALMON

Juvenile Chinook salmon normally rear in streams, but reservoirs now create novel habitats along stream networks. By spending just one summer in a reservoir, juvenile Chinook grow three to five times larger than they would if rearing in a stream or river. However, reservoirs create other challenges for juvenile Chinook salmon. Finding the outlet for continued downstream migration is a major problem. Reservoirs also contain introduced warm-water fish species that can compete with or prey on juvenile Chinook salmon. Managers are exploring new techniques to manage reservoirs, including draining reservoirs annually to help flush fish downstream.

GrowChinook estimates growth of juvenile Chinook salmon in reservoirs under differing water management and climate change scenarios

GrowChinook is a Web-based model that can help managers evaluate the effects of water drawdown, water temperature, changes in food resources, and drought on salmon growth and survival, and the carrying capacity of reservoirs. Developed by researchers with the station and Oregon State University, GrowChinook helps managers manage reservoir water levels to create as optimal as possible habitat for this endangered fish.

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

How to get it: http://cas-web0.biossys.oregonstate.edu/

For more information, click here.

Rick Swart, Oregon Department of Fish and Wildlife

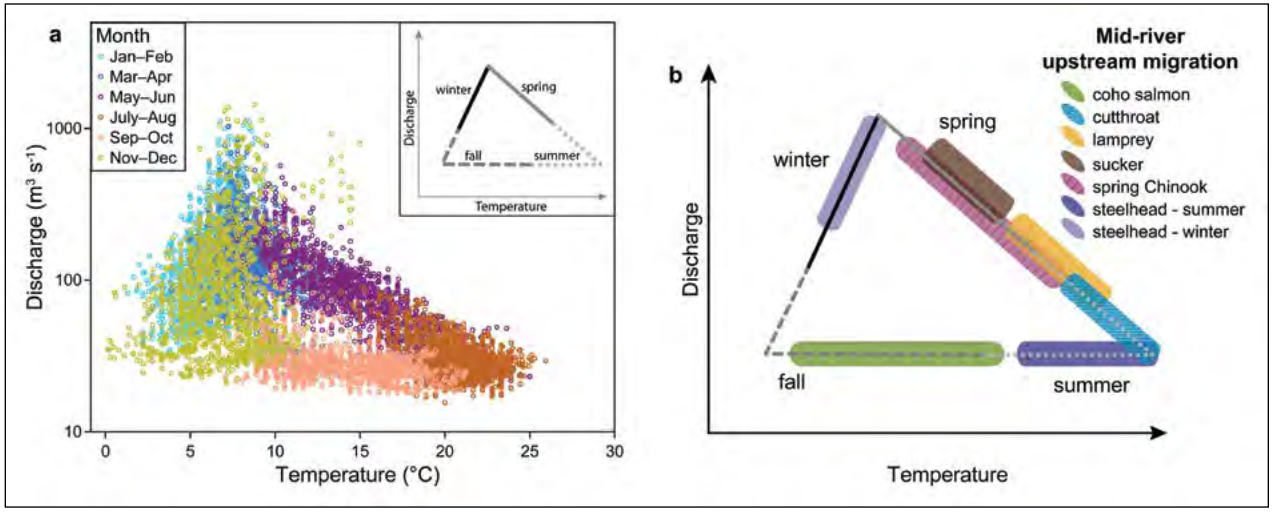
Applegate Reservoir, Oregon

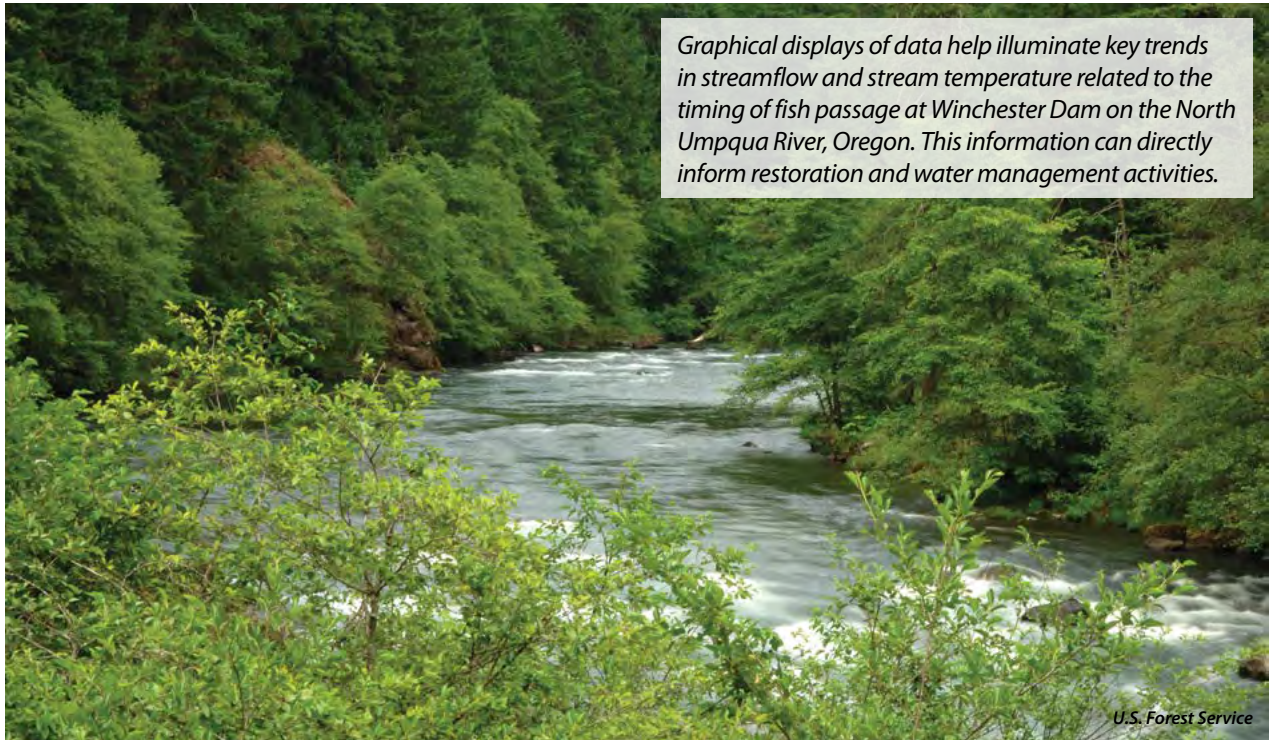
"SEEING" THE FISH AND THEIR HABITAT THROUGH VISUALIZATION OF BIG DATA

Rebecca Flitcroft, a research fish biologist with the PNW Research Station, and her colleagues used long-term daily temperature and discharge data to learn more about the relationship between hydroclimate and individual species, as well as communities of fish, near the Winchester Dam on Oregon's North Umpqua River. Fish behavior, streamflow, and water temperature can directly inform restoration and water management activities.

The researchers explored graphically creative ways to display the complex dataset, spanning 21 years, so that patterns would become visually apparent. Their techniques are being adopted by other agencies and scientists. The Environmental Protection Agency, for example, is using this technique to map hydroclimate and fish phenology in the Columbia River basin.

Partners: Oregon Department of Fish and Wildlife, Oregon State University





Graphical displays of data help illuminate key trends in streamflow and stream temperature related to the timing of fish passage at Winchester Dam on the North Umpqua River, Oregon. This information can directly inform restoration and water management activities.

Umpqua River, Oregon

TRACKING ELUSIVE WILDLIFE

It is difficult to measure movement patterns of small, elusive carnivores, such as the Pacific marten and fisher. Much of our understanding of how these species use the landscape is derived from radio telemetry, which requires large field crews or aircraft.

MARTEN

A study led by Katie Moriarty, a research wildlife biologist with the station, was the first to evaluate fine-scaled movements of martens in both summer and winter by using collars outfitted with miniature global positioning system (GPS) trackers. The ability to estimate annual home ranges within days could greatly improve the efficiency of addressing other research questions such as how home ranges vary with density, resource availability, and demography.

FISHER

Moriarty and her study team also amassed the largest movement dataset for the fisher and pioneered novel techniques to identify resting and denning structures. The fisher is a small carnivore listed as a sensitive species by the state of Oregon. The team is testing the first use of iridium collars to track fisher movements through a highly managed landscape. Location data will be sent via satellite, allowing teams, for the first time, to describe juvenile movement, which is a perceived limitation to population growth.

Partners: USDI Fish and Wildlife Service, USDI Bureau of Land Management, USDA Forest Service Pacific Northwest Region, Siuslaw National Forest, Rogue River–Siskiyou National Forest, Green Diamond Resource Company, Hancock Timber, Roseburg Timber, National Council for Air and Stream Improvement, Oregon Forestry Industries Council, Oregon Forest Resources Institute

For more information, click here.

Miniature radio collars enable researchers to track the movements of marten.

Caylen Cummings

Researchers are tracking fisher to learn how the small carnivores use highly managed landscapes.

Mark Linnell

DIFFERENCES IN FORAGING BEHAVIOR MINIMIZE COMPETITION BETWEEN BETWEEN ELK AND CATTLE

Cattle and elk co-occur throughout western North America, but research findings on competition between these species are often contradictory. Working at the Starkey Experimental Forest and Range, researchers used global positioning system tracking data to classify elk and cattle behavior, activity, and movement strategies to evaluate the potential for competition between the ungulates.

They found the following:

- Differences in foraging behavior between elk and cattle minimize competition between the two. Elk traveled farther per day and tended to select forbs.
- Cattle foraged more intensively within a smaller area and tended to select grasses.
- These observed differences in movement and energetic strategies suggest that when elk and cattle occupy the same general area during summer and fall, their different behaviors may moderate the potential for direct interspecific competition.

Demonstration of reduced dietary competition between cattle and elk should minimize debate and efforts to discourage elk use of private rangelands, and clarify support for coexistence of the two ungulates on public rangelands. Public and private land managers of forested rangelands can use these results to better allocate forage for cattle on grazing allotments under the assumption of minimal dietary competition with elk during most seasons.

Partners: National Council for Air and Stream Improvement, Oregon State University, USDA Agricultural Research Service

For more information, click here.

A researcher records the browsing habits of a tame, radio-collared elk in the Starkey Experimental Forest and Range, Oregon.

Mike Wisdom

CHALLENGE: MANAGING A HIGHLY FLAMMABLE INVASIVE GRASS

Cheatgrass (*Bromus tectorum)* is an invasive annual grass now found in most western states. It outcompetes native perennial grasses and plants that provide important biodiversity, wildlife habitat, and forage for cattle later in the season. Cheatgrass is also highly flammable; once it has completed its short growing season, the dry grass is ready fuel.

Multiple factors can lead to the colonization and persistence of invasive plants. The importance of disturbance by fire and other abiotic and biotic factors, such as competition, in driving cheatgrass invasion varies based on invasion stage. Understanding these dynamics may inform future restoration and conservation efforts in burned ponderosa pine forests.

WORKING IN THE MALHEUR NATIONAL FOREST

Becky Kerns, a station scientist, and her colleague at Oregon State University investigated how cheatgrass responded to both the frequency and season of prescribed burning over a 10-year period in stands of ponderosa pine in the Malheur National Forest.

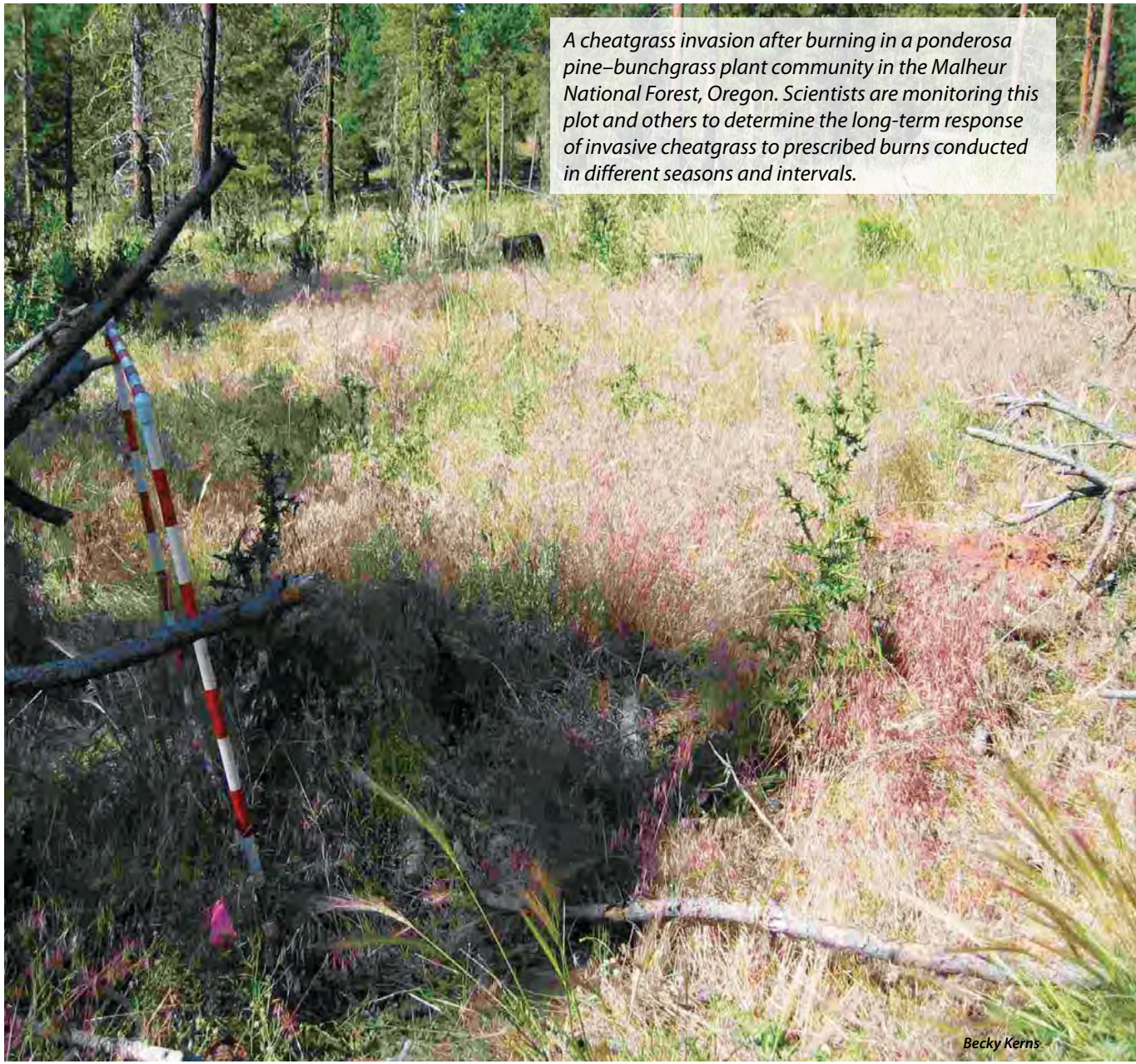
They found the following:

- Influence of fire, native plant cover, and other factors related to cheatgrass spread vary based on invasion stage.
- Cheatgrass cover increased with fall burning regardless of burn frequency (one burn vs. three burns) between 2002 and 2012.
- At fine scales, initial burn coverage facilitated cheatgrass establishment, while native annual forb cover (biotic resistance) constrained spread.
- Initial cheatgrass abundance in 2002 was key in explaining the extent of cheatgrass by 2012.

These findings will be helpful to resource managers planning restoration and conservation efforts in ponderosa pine forests.

Partners: Malheur National Forest, Oregon State University

For more information, click here.



A cheatgrass invasion after burning in a ponderosa pine–bunchgrass plant community in the Malheur National Forest, Oregon. Scientists are monitoring this plot and others to determine the long-term response of invasive cheatgrass to prescribed burns conducted in different seasons and intervals.

Becky Kerns

TOOL PRE-LOADS MAPS OF TREES IN POOR HEALTH TO iPADS FOR FIELD VERIFICATION AND USE

Fuels reduction treatments are an opportune time to remove trees in poor health and significantly increase the proportion of high-vigor trees remaining in the stand after treatment. Having a tool that helps identify clusters of trees in poor health could help prioritize restoration activities the following year and reduce the probability of a landscape-level insect outbreak.

WORKING ON THE FREMONT-WINEMA NATIONAL FOREST

The Western Wildland Environmental Threat Assessment Center collaborated with The Nature Conservancy and the Fremont-Winema National Forest to develop just such a tool for identifying and prioritizing removal of ponderosa and Jeffrey pine in poor health.

This approach also can be used to assess the effect of different fuels treatments on stand health through time.

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

Partners: Fremont-Winema National Forest, The Nature Conservancy

The Fremont-Winema National Forest, Oregon.

Forward Thinking

Changes in precipitation, average temperature, fire regimes, and growing seasons: we know that climate in the future is going to be different than in the past. To get a sense of how different, and to begin planning for change, it's essential to know the current status of the environment and past trends. Station science, particularly the Forest Inventory and Analysis program, provides data and analysis that inform many efforts to model likely future scenarios.

Different forest types will respond differently, which means that information must be tailored to be relevant to the management project at hand—whether it is a forest plan or project, or national policy.

Jeffrey Sprovkin

THE RIGHT SEED IN THE RIGHT PLACE FOR THE FUTURE

Seeing the need for a tool that could help managers, scientists, and policymakers plan for the effects of changing climates, Brad St. Clair, a research geneticist with the station, and his colleagues developed the Web-based Seedlot Selection Tool. Users can explore options for matching seedlots to planting sites based on current and predicted climatic information. The tool allows managers to explore alternative scenarios with alternative scenarios, including those that respond to concerns about climate change using assisted migration.

APPLICATION

The U.S. Forest Service and other agencies have begun using the Seedlot Selection Tool to explore options for appropriate seedlots for reforestation. For example, in Oregon, the tool was used to determine that available plant material on the Ochoco National Forest was appropriate to plant at a site following a burn on the Malheur National Forest.

The tool has also been used by researchers and managers to explore adaptation of native populations and options for assisted migration at sites in the Pacific Northwest; the Northeast; Alaska; and Ontario, Canada.

Partners: Canadian Forest Service, Conservation Biology Institute, Northern Forests Climate Hub, Northwest Climate Hub, Oregon State University, USDA Forest Service International Programs

How to get it: https://seedlotselectiontool.org/sst/

Horning Seed Orchard, Oregon.

DOUGLAS-FIR IN THE FUTURE

How will changes in air temperature and precipitation affect the growth of Douglas-fir, a dominant species throughout much of the Pacific Northwest? Research forester David Bell and research ecologist Andrew Gray examined how the proportion of biomass accumulation differed in Douglas-fir across vegetation zones representing broad gradients in precipitation and temperature.

Their findings suggest that wetter, warmer conditions will likely favor biomass accumulation in Douglas-fir. However, continued accumulation of forest biomass in drier regions may be more limited. A shifting climate that alters the geographic distribution of warm vs. cool and wet vs. dry landscapes could dramatically change Douglas-fir biomass dynamics and alter regional species dominance.

Douglas-fir in western Oregon. Warmer, wetter conditions will likely favor Douglas-fir growth, while accumulation of Douglas-fir biomass in warmer, drier conditions may be more limited.

HOW DO DOUGLAS-FIR AND PONDEROSA PINE SEEDLINGS HANDLE HEAT STRESS?

Temperature and the frequency and intensity of heat waves are predicted to increase throughout the 21st century. Germinant seedlings are expected to be particularly vulnerable to heat stress because they grow close to the soil surface where intense heating occurs in open habitats.

DOUGLAS-FIR SEEDLINGS TOLERATE HEAT STRESS BETTER THAN PONDEROSA PINE

Fundamental research by a study team including station scientists Rick Meinzer and David Woodruff quantified how different populations of ponderosa pine and Douglas-fir seedlings respond to heat stress. They found that Douglas-fir was more heat tolerant than ponderosa pine, and heat tolerance did not differ among populations within species. They did find apparent genetic differences in water-use efficiency within the species. These findings contribute to an essential knowledge base for seed orchard managers and others who are selecting seed sources for reforestation that will be adapted to future climates.

Partners: Oregon State University, University of Wisconsin

For more information, click here.

Ponderosa pine seedlings. This study evaluated the response of different populations of ponderosa pine and Douglas-fir seedlings to heat stress. Seedlings can be particularly vulnerable to heat waves because they grow close to the soil surface where intense heating occurs in open habitats.

ASSESSING HOW FIRE, INSECTS, DISEASE, AND TIMBER HARVEST AFFECT ABOVEGROUND CARBON STORAGE

Carbon sequestration is a vital ecosystem service. The ability of vegetation to absorb carbon dioxide from the atmosphere during photosynthesis and store the carbon in its tissue could be a key component of climate change mitigation efforts. But variation in climate, disturbance regimes, and forest management can affect the amount of carbon that is stored on the landscape. Fire, for example, releases the carbon stored in wood.

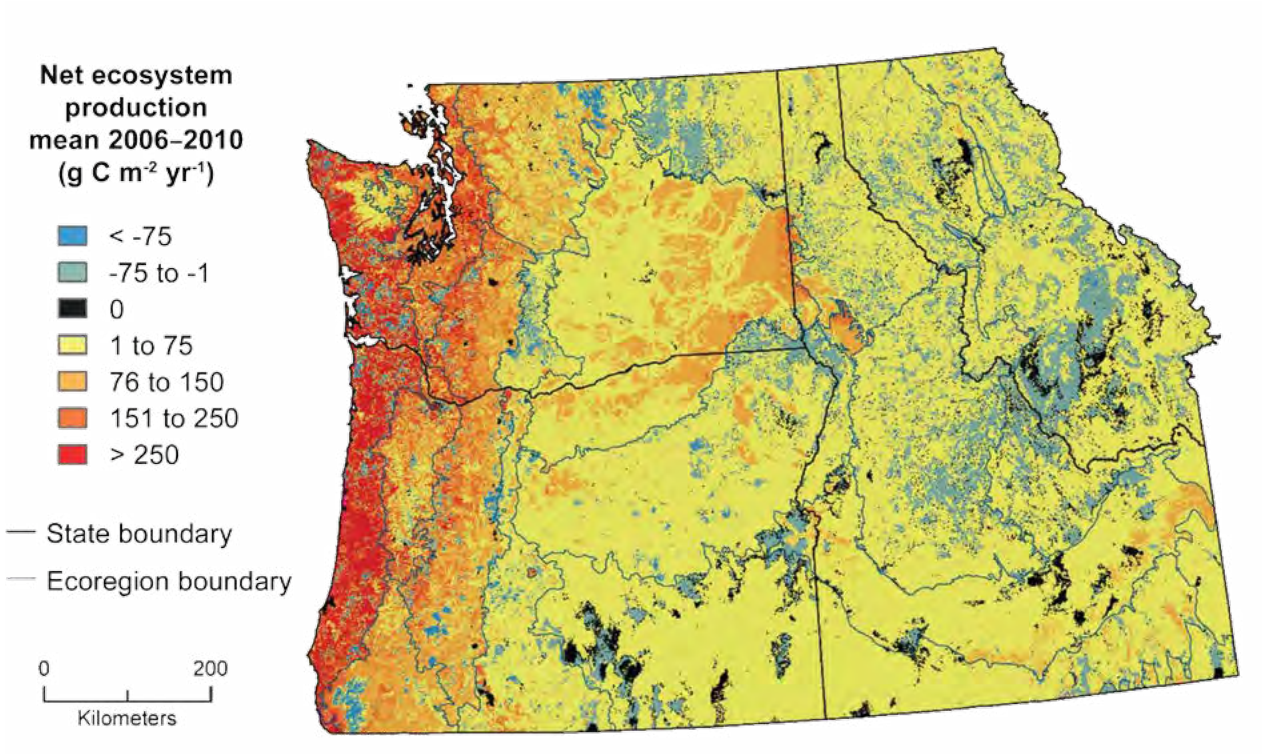
DESPITE DISTURBANCES, PACIFIC NORTHWEST FORESTS WERE A NET CARBON SINK FROM 2006 TO 2010

A team of scientists, including station scientist Andrew Gray, examined carbon sequestration, as measured by net ecosystem production, from 1986 to 2010 on forest land across Oregon, Washington, Idaho, and western Montana. Overall disturbance rate on forest land across the four-state region was 0.8 percent per year.

- 49 percent was from timber harvests
- 28 percent was from fire
- 23 percent was from pests or pathogens

The team found that the four-state region was a net carbon sink from 2006 to 2010. Annual variation in climate, however, influences net ecosystem production and fire emissions; in relatively warm years, the region can become a carbon source. Within the study area, the Coast Range accumulated the most carbon. Areas with localized negative net ecosystem production were mostly associated with recent disturbances. Regional net ecosystem production varied from year to year, with notably low values across the region in 2003, which was also the warmest year in the interval.

Partners: Oregon State University, USDA Forest Service Rocky Mountain Research Station



The distribution of net ecosystem production (mean for 2006–2010). Areas in red denote highest productivity and therefore sequestered the greatest amounts of atmospheric carbon.

ASSESSING CHANGE IN INTERIOR ALASKA'S SPRUCE FORESTS

Boreal forests are critical carbon sinks in the global carbon cycle. However, recent studies have revealed increasing frequency and extent of wildfires, decreasing landscape greenness, increasing tree mortality, and declining growth of black and white spruce in boreal North America. To learn more about this, station scientists analyzed tree growth rings of black and white spruce in interior Alaska. After accounting for the effects of stand density and standard changes in ring width as trees become larger, their analysis revealed these findings:

- A pronounced growth peak for black and white spruce centered near 1940.
- Recent growth of black and white spruce in interior Alaska is near the historical mean.
- Growth declined with increases in temperatures during the growing season but increased in years when August precipitation was higher.
- Growth of both species might decline with future warming, if not mitigated by increasing precipitation.
- Widespread drought-induced mortality is probably not imminent, given that recent growth was near the long-term mean.

Partners: University of Alaska Anchorage, USDA Forest Service Boreal Cooperative Research Unit

For more information, click here.

Eric Straley and Chad Ocrop collect forest inventory data from a black spruce stand in interior Alaska.

Ken Winterberger

MAPPING CURRENT SOIL MOISTURE NECESSARY TO PROJECT FUTURE CHANGES

Reduced snowfall and snowpack, earlier spring runoff, increased winter streamflow and flooding, and decreased summer streamflow are potential effects of climate change. These factors are closely linked to the water balance in Alaska's coastal temperate rainforest.

WORKING COASTAL FORESTS OF SOUTHEAST ALASKA

Improved measurement and modeling of water is required to develop predictive estimates for plant distributions, soil moisture, and snowpack, which all play important roles in ecosystem planning in the face of climate change. Station scientist Dave D'Amore and Scott Rupp, with the University of Alaska Fairbanks, used geographic information systems, field measurements, and spatial analysis techniques and tools to develop four products: seamless, spatially explicit datasets of elevation, flow accumulation, and topographic wetness index, and water table models for the watersheds in the southeast Alaska drainage basin and the Alaska coastal temperate rainforest. These tools advance the ability of researchers and land managers to apply spatially explicit values for soil moisture in research projects and land management planning.

This information can be applied to a variety of land-use planning needs, watershed assessments, and terrestrial ecosystem mapping assessments.

Partner: University of Alaska Fairbanks

Southeast Alaska.

INNOVATION

USING LICHEN AS BIOINDICATORS OF CLIMATE CHANGE

Lichens may respond more quickly to changing environmental conditions than trees. Monitoring changes in lichen communities is one way to anticipate how climate change will affect forests. Sarah Jovan, a lichenologist with the PNW Research Station, and colleagues explored several key questions that will facilitate use of lichens as indicators of changes in climate and how these changes might affect forest ecosystems in the western United States.

- The researchers identified lichen indicator species and developed an index for associations between the lichen species and climate.
- These lichen-based climate scores demonstrated clear relationships to temperature, moisture, and other factors over large areas and within specific regions.
- The indicator species revealed affinities to high-latitude/coastal, continental/montane, and low-latitude/hot/dry habitats across Alaska, Washington, Oregon, and California.

These findings demonstrate that lichen indicator species and community climate scores are promising tools for meeting regional forest management objectives.

Partners: Oregon State University, USDI National Park Service

For more information, click here.

Robert J. Smith

The Bryoria *lichen growing on tree the in foreground tends to be an indicator of cool montane climate zones; in the background, Mount Rainier, Washington.*

TREE FORENSICS: COMBATTING ILLEGAL LOGGING WITH TECHNOLOGY

The link between crime forensics and the timber industry might not be obvious, but it's crucial for detecting and stopping illegal logging.

Illegal logging is a significant concern within the United States and around the world. Globally, $10 billion to $15 billion is lost by businesses and governments to illegal logging activity. Illegal timber imports to the United States, one of the largest importers of timber and wood products in the world, is estimated to be $3 billion to $4 billion annually from 2009 to 2013 according to Chatham House: the Royal Institute of International Affairs. This negatively affects the economies of timber-producing countries and the global timber industry as a whole.

THE COST OF ILLEGAL LOGGING

$10–15 billion: Global revenue lost to illegal logging

$3–4 billion: Value of illegally logged timber imports to the United States

ILLEGAL LOGGING HAS ECONOMIC, SOCIAL, AND ECOLOGICAL CONSEQUENCES

But the costs of illegal logging go beyond economics. From forest destruction and decreased biodiversity to the loss of sustainable employment opportunities and conflicts over resource rights, illegal logging has far-reaching implications.

Despite legislation that prohibits the import and sale of illegally logged timber in the United States, the practical implementation and enforcement of such laws is challenging. Currently, establishing a chain of custody from the production of raw timber materials to commercial sale is the main method of tracking legal logging activity. However, this is a difficult, time-consuming process that runs the risk of records falsification. Reliable tools are needed to rapidly test and identify illegally logged timber.

CHEMICAL FINGERPRINTS

Richard Cronn of the PNW Research Station, his colleagues at Oregon State University, and the U.S. Fish and Wildlife Service have developed such a tool through chemical testing of timber. Trees have unique chemical compositions, or chemical "fingerprints," based on their provenance. Testing a tree's chemical fingerprint can validate claims of geographic origin and inform officials on the legality of certain timber. Plus, the chemical screening takes only seconds to perform.

Cronn and colleagues found their test to be accurate at determining the geographic origin of 75 percent of tested Douglas-firs, a commonly poached tree species in national forests and parks. Moving forward, they plan to combine the chemical fingerprinting method with specific genetic testing to identify illegally logged timber. Such tools are critical to enforcing prohibitions on illegal logging that protect the health of domestic and foreign forests.

For more information, click here.

These illegal logs were seized, while in transit, and were impounded at district police offices, Riau, Sumatra, Indonesia.

Sofi Mardiah/CIFOR

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