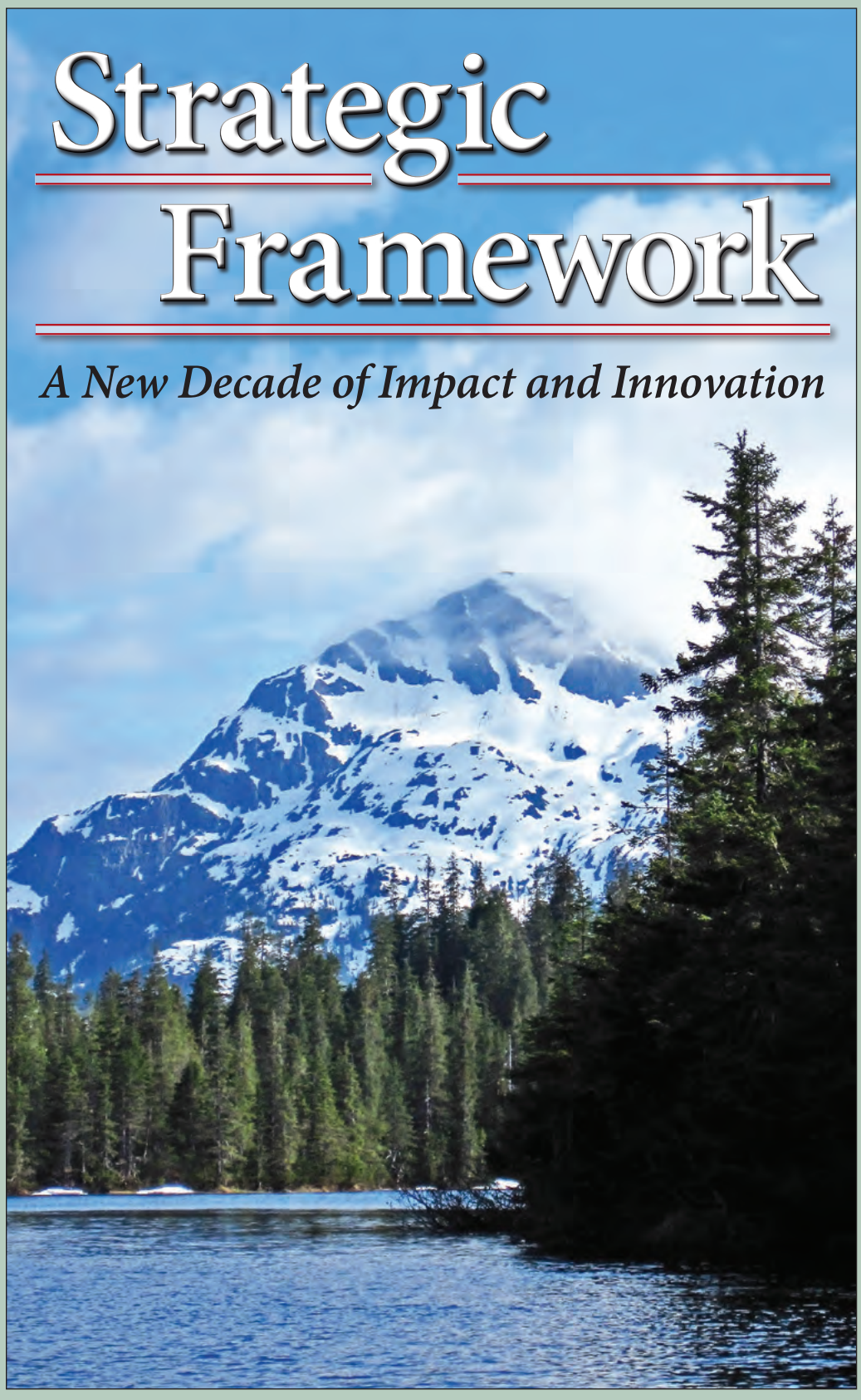
United States Department of Agriculture

PACIFIC NORTHWEST RESEARCH STATION

Strategic Framework

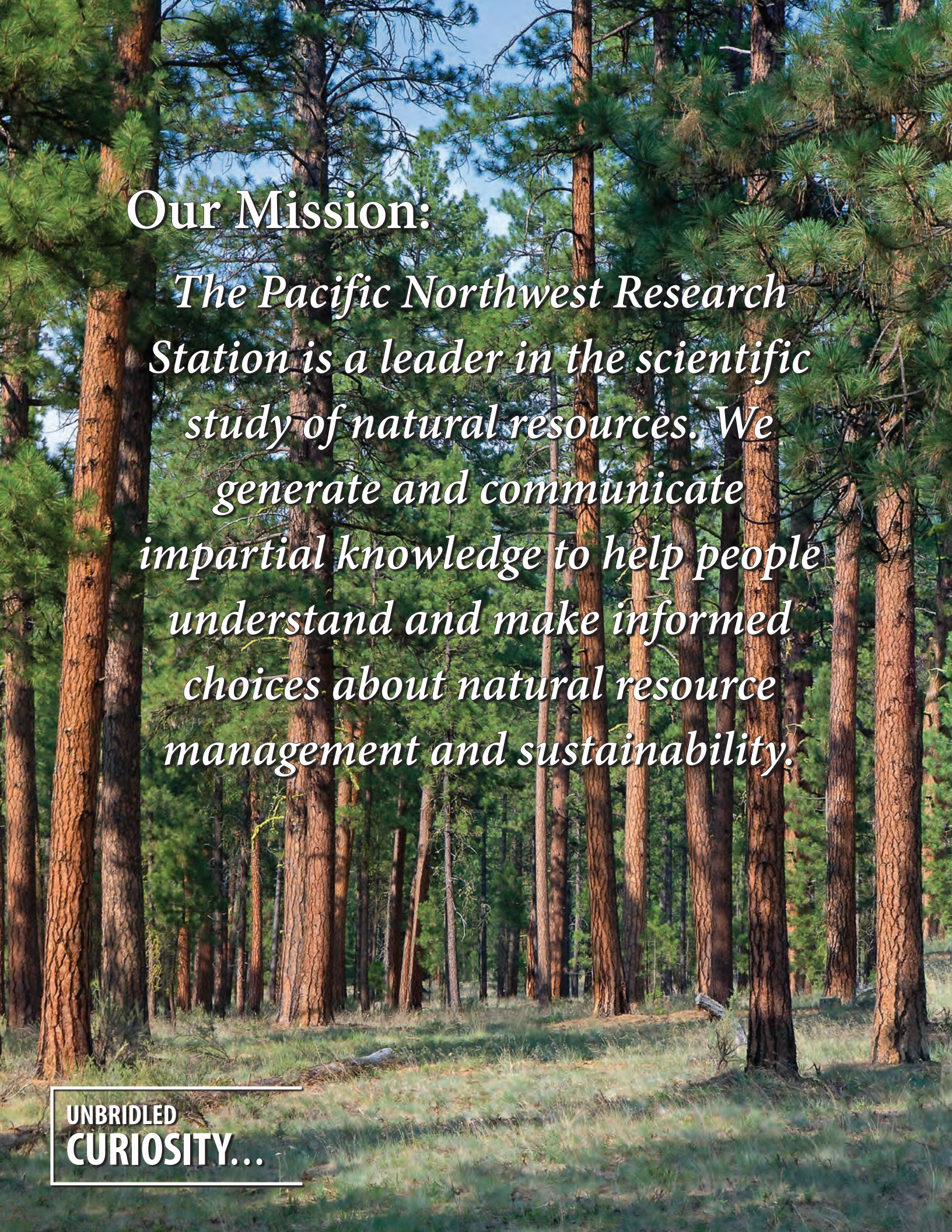
A New Decade of Impact and Innovation



Forest Service

Pacific Northwest Research Station

March 2015



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.

UNBRIDLED
CURIOSITY...

Contents

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.

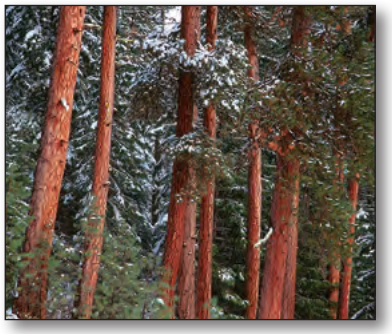
Photo: Ponderosa pine stand, central Oregon, © by Miles Hemstrom.

Keith Routman

Mount Jefferson, Oregon.

The Pacific Northwest (PNW) Research Station (U.S. Department of Agriculture Forest Service) oversees forest and rangeland science programs in Alaska, Oregon, and Washington—one of the most diverse regions in the United States. The region's biodiversity is remarkable, with all five of the world's biomes represented (aquatic, forest, grassland, desert, and tundra) as well as the climatic influence of the Pacific Ocean, the rainshadow effect of the Cascade Range, and the varied ecosystems of Alaska. The diverse people of the region live in growing cities as well as many rural communities.

Tom Iraci



Ponderosa pine stand.

This strategic framework brings the next 5 to 10 years of the PNW Research Station into focus. Beginning in 1925, the station has contributed decades of new knowledge to the world on the nature of complex forest ecosystems, from microorganisms in the soil to lichens at the tops of the tallest trees. Recent station findings affirm the value and significance of a long-term view of ecological systems in addressing broad, cross-ownership issues like climate change and wildfire. Few other research institutions have comparable opportunities to capture the long-term variability in forest and range ecosystems given the station's experimental land-based assets, which include 12 experimental forests, a volcanic national monument, 98 research natural areas, and more than 25 larger scale studies across our region.

Connie Harrington

Lichen on forest floor.

◀ View of Mount Adams from Mount Rainier, Washington. Photo by Steve Wondzell.

Who we are

The station is made up of highly trained personnel who draw upon one another and many partners. The core of our workforce is about 80 scientists whose expertise, often internationally recognized, is in the biological, physical, and social aspects of forests. Scientists work in teams that include highly trained specialists who prepare, conduct, and report on studies and integrate scientific knowledge into tools and communication products used by land managers, policymakers, and others. Together, about 300 people work to serve the public need for science information and technology. Station employees excel in reaching out to others in the wider community of natural resources. This community includes scientists and specialists at more than 75 universities as well as those in other government agencies, nongovernmental organizations, private industry, and other units of the U.S. Forest Service. We lend a hand in understanding how people can integrate science into decisionmaking, often across large, varied landscapes. Our work is reflected in how forests are managed throughout Alaska, Oregon, Washington, and other locations.

The Pacific Northwest (PNW) Research Station is one of seven research units in the U.S. Department of Agriculture, Forest Service. The station's headquarters are in Portland, Oregon. In 2015, we had:

11 Laboratories and research centers in Alaska, Oregon, and Washington

12 Active experimental areas (forests, range, and watershed)

98 Research natural areas

301 Permanent and temporary employees

Tom Iraci

Opal Creek, Oregon.

The complex, diverse ecosystems of the Pacific Northwest are known for their stunning natural beauty. These landscapes attract people to live and work here. Our employees are our greatest asset, and we strive to create a safe, inclusive workplace so that people look forward to coming to work each day.

Who we serve

We serve society. Knowledge of forests and the amenities they provide touches the lives of millions of people, including both city and rural dwellers. The station's scope includes all public and private forests and rangelands. Whether it's about the effects of wildfire on salmon habitat, the projected impacts of climate change, or the benefits of urban forests, the science we produce helps people from many interests make informed decisions, craft effective policies, manage land constructively, and participate in civic dialogue. Station stakeholders include land managers and policymakers from government agencies, Alaska Native organizations, American Indian tribes, nonprofit organizations, and private industry. We particularly aim to meet the needs of U.S. Forest Service land managers and specialists for up-to-date scientific information and tools.

Frank Vanni

Employees work with a host of partners and build on past scientific endeavors, as well as local and native understanding, to create knowledge of biological, physical, ecological, social, and economic relationships in forest and rangeland science. Traditionally, our research findings have been transferred to many audiences through peer-reviewed journals, printed reports, workshops, field tours, face-to-face communications, and specially designed tools such as user-friendly computer programs. Every research program participates in science delivery to a set of stakeholders. The PNW Research Station also publishes a widely disseminated periodical (*PNW Science Findings*) to deliver science results to the user community. Moreover, we are increasing the use of electronic media to communicate our research broadly.

Research highlights from the past 5 years span a broad range of topics: identifying species conservation priorities including marbled murrelets, amphibians, and fishers; new findings on invasive plants such as Scotch broom, knotweed, and tamarisk; and forest insects and diseases such as amber-marked birch leafminer, black-stain root

The station's values set the tone for the work we do and our interactions with stakeholders. They provide the basis for deciding what research is needed and how best to conduct it. 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.

disease, and mountain pine beetle; new methods for quantifying carbon fluxes from terrestrial and aquatic ecosystems in Alaska; and discoveries about the risks of debris flows. We have explored private landowner behavior in response to wildland fire risk and worked on salmon habitat recovery, the effects of riparian buffer management, and stream network modeling. Our science has helped shape how aquatic resources are managed in the Pacific Northwest and beyond. Our silviculture research has had a great influence on the economic well-being of the region and on the present characteristics of the region's forests. And we are known in the forest products community as a preeminent source of information and guidance on sustainable harvest techniques, wood quality, timber markets, and biomass utilization.

John Laurence

Research on the effect of trees on human health has broad public health implications, while our wildfire smoke modeling forms the basis for real-time smoke prediction systems and tools across the country and internationally. Studies of the effects of dam removal have provided essential knowledge as thousands of aging and deteriorating dams are coming to the end of their useful lives. Our work on amphibian population declines includes an unprecedented global mapping effort that tracks chytridiomycosis, an infectious disease of amphibians, while our research on elk provides definitive information on management issues that have multi-million-dollar effects on land management and recreation across the American West.

Rhonda Mazza

Urban trees.

Tom Iraci

Smoke from wildfire.

Gordon Grant

Removing a dam on the Sandy River, Oregon.

Alex Foster

Ensatina salamander.

K.H. Coe

Elk research at Starkey Experimental Forest and Range.

Some of the knowledge we create is not applied immediately but addresses long-term goals, while some provides the basis for rapid development of research products to resolve current natural resource problems. For example, we recently provided forest managers with side-by-side comparisons of fuel treatments, produced a comprehensive guidebook for national forest managers on responding to climate change, designed a Web-based tool to help communities evaluate proposed biomass projects, provided the U.S. Environmental Protection Agency with new techniques for creating a national smoke emissions inventory for wildland fire, and helped land managers of local governments implement rapid assessment approaches for urban forests.

Keith Routman

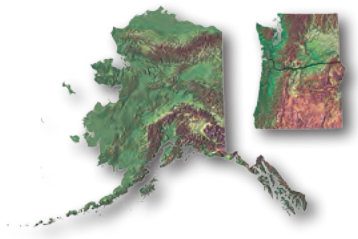
The issues faced by society today provide important context for our work.

Global

- Climate change makes forests more vulnerable to increased fire extent and intensity, reduced snowpack and water availability, and greater threats from insect outbreaks, forest diseases, and invasive plants.
- By 2050, the global population is projected to be 9.6 billion, with 70 percent of the human population living in cities.
- Communication and technology advances transform how people create and receive information, resulting in huge, often overwhelming volumes of information.

National

- The population of the United States is expected to rise to 438 million by 2050 (from 296 million in 2005).
- Following the 2007–2009 recession, U.S. economic growth resumed but at a slower pace. Fiscal circumstances continue to be tight for federal agencies.
- The departure of "baby boomers" from the workforce will affect retention of institutional knowledge and the future vitality of the Nation's job market. Federal agencies are striving to draw on the talents and interests of all sectors of the Nation's diverse population.



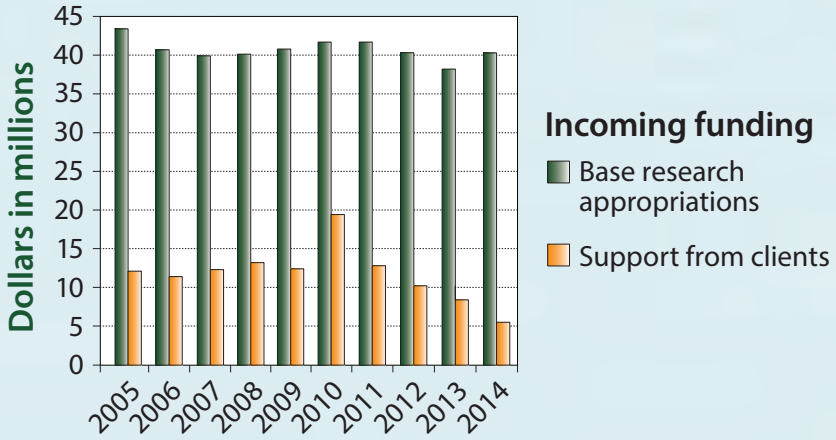
Regional

- Rural communities continue to look beyond traditional resource-based industries for ways to diversify economic development and prosper in the global economy.
- Land managers are challenged to address continuing forest health declines, particularly in east-side forests in Oregon and Washington, that result from damage by insects, disease, and uncharacteristically severe wildfires.
- Water shortages are increasing conflicts over allocation and quality protection.
- Controversy sometimes arises over competing uses of forests.
- Increased urbanization is making the livability and sustainability of cities in the region a critical concern.

View of Mount Rainier and Mount Adams, Washington, from Mount Hood. Photo by Keith Routman. ▶

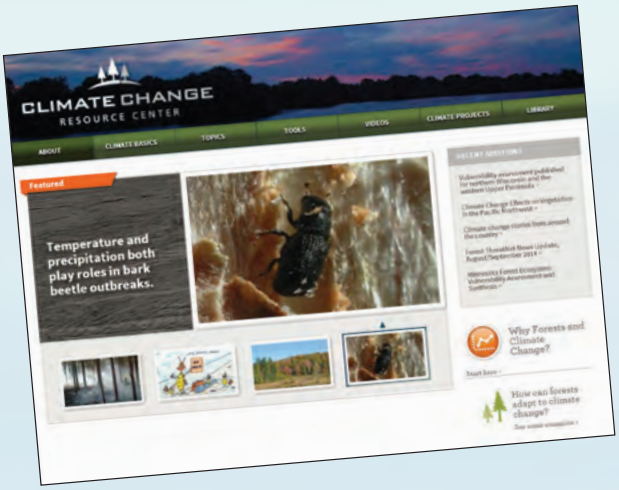
Finances

We align resources to address issues critical to our stakeholders. Moreover, we leverage appropriated funding and grants to increase our capacity, build partnerships, and bring benefit to cooperators. Our innovative and increasingly integrated research provides a high return on investment and yields tangible, high-impact results.



Communications

The communication of science information for science-based management and policy decisions is a critical component of the station's mission. We are observing several trends: (1) the Internet and social media are shaping how science is shared, (2) the synthesis of scientific information is highly valued, and (3) demand is high for useful scientific information that can be applied to urgent issues. For us to stay relevant, we need to find ways to keep pace with increasing demand.



Keith Routman

In 2013, we reassessed our research programs

and science delivery. We did so by inviting stakeholders who use our science and partner with us in conducting research to identify the strengths on which they would like us to focus. We asked them their opinions on priority work for the next 5 to 10 years. We also asked our employees these same questions.

Specifically, the process for gaining stakeholder and employee input included interviews with external stakeholders; stakeholder and employee listening sessions in Juneau, Alaska; Corvallis and Portland, Oregon; and Seattle, Washington; and a survey available to all station employees.

This strategic effort helps us clarify our priorities, unify us in the pursuit of shared goals, guide the station's decisions, and foster communication between our stakeholders and us.

A critical element of our approach is to focus this framework on the station's strengths.

◀ Field trip to the Meadow Creek Restoration Project, Starkey Experimental Forest and Range, Oregon. Photo by Rhonda Mazza.

Science strengths


Jon Williams

Field crew training.

A strong foundation—

With almost a century of research behind us, the PNW Research Station is uniquely positioned to conduct long-term studies compared to most other research institutions. The existence of long-term data sets from station experimental forests, ranges, and watersheds, as well as large-scale studies elsewhere, has enhanced our ability to respond to stakeholder requests and changing social and policy needs. Our capacity to provide insight and describe complex consequences is greatly elevated by the quality and extent of our data and our strong foundation of meaningful research.


Jon Williams

Alaska landscape.

A landscape view—

The PNW Research Station has long been at the forefront of big-picture, "all-lands" science. The groundbreaking science that informed the Northwest Forest Plan was the start of other ambitious research projects that address connectivity and interactions across large watersheds and landscapes. Keeping pace with advancing geographic information systems, remote sensing, and ever-growing computing power has enabled research by the station to inform an expanding vision of all-lands conservation.

Innovation—

The concept of sustainable management of natural resources now seems an obvious goal. But putting this concept into practice is extremely difficult and took decades to gain acceptance. The PNW Research Station was a major player in introducing the rest of the forestry world to the concept of ecosystem management and demonstrating the role forest science could play in the blossoming field of landscape ecology. Our innovative knowledge


Lee Cerveny

Human ecology workshop.

contributions have changed the way forestry is done on the ground. Ecosystem management is the philosophy that shifted thinking away from a single-issue focus. We also helped pioneer adaptive management as the methodology for implementing ecosystem management. And we continue to break new ground in defining the concept of resilience, which provides a benchmark that helps land managers find the intersection of ecological, social, and economic goals.

Integration—

Tom Iraci

Portland, Oregon.

The heated controversy over the northern spotted owl in the early 1990s put the PNW Research Station on a crash course in developing science that goes beyond a single issue. Since then, we have had success in approaching our research through ecological, social, and economic lenses. With millions of people in the Pacific Northwest living within 5 miles of national forest land, it has been essential to design research that recognizes people as an integral part of ecosystems. We provide information to help improve understanding of human values and choices that sustain our environment, promote public health, support rural economies, and reduce conflict. PNW Research Station social and economic science helps bring people to the forest and enhances fulfillment of both halves of the Forest Service motto of "caring for the land and serving people."

Relevance—

The Forest Service is the only federal land management agency with its own research and development branch. With an extensive land base of national forests for field research, we have a unique opportunity to support the agency's broad land management responsibility. The station has made concerted efforts to focus on informing natural resource management through applied science and user-friendly tools. Through our longstanding efforts to partner with the National Forest System, we achieve a capability to address natural resource challenges that is known worldwide.

Walter Foss

Vegetation study in Alaska.

Glenn Christensen

Interior Alaska boreal forest.

Tom Iraci

Southeast Alaska coastal rain forest.

Miles Hemstrom

Dry forest east of the Cascade Range.

Larry Korhnak

Urban forest.

Diversity—

We have access to boreal forests in Alaska, coastal rain forests with some of the most productive forest land in the world, disturbance-prone dry forests east of the Cascades, and urban forests in densely populated cities. These landscape "laboratories" contribute opportunities for observational and manipulative research that will help us solve problems in the region and beyond. The ecosystems of the Pacific Northwest make possible studies that will give us the tools to manage the effects of climate change, understand the consequences of an urbanizing environment, and develop a fundamental understanding of how natural systems will respond to rapid change.

Columbia Gorge National Scenic Area , Oregon. Photo © by Miles Hemstrom. ▶

Long-Term Studies, Experimental Forests, Research Natural Areas, and Resource Monitoring

Long-term studies are a cornerstone of the Forest Service research mission. The PNW Research Station is invested in long-term studies conducted at multiple scales and in a variety of settings, including experimental forests and ranges, research natural areas, national forests, and other federal, state, and private lands. Long-term studies are conducted to identify and characterize important ecosystem structures and processes, monitor environmental conditions and the production of ecosystem and societal benefits, and experiment with alternative approaches to land management practice and policy. These long-term studies frequently contribute to broader monitoring networks or synthetic assessments at local, regional, or continental scales—extending their relevance both in time and space.

Experimental forests. Important examples include gauged watersheds, which provide a long-term record of local and regional hydrology and their interaction with climate dynamics, disturbance events, and vegetation manipulation and succession; and large-scale silviculture studies to explore vegetation management strategies. Studies develop understanding of biodiversity, restoration of ecosystem structure and processes, and the production of a wide array of ecosystem services, from conventional fiber-based products to wildlife habitat for species such as elk.

Long-term studies are distinct in several respects. By definition, such studies extend beyond the typical 3- to 5-year planning horizon (with data-collection activities often spanning multiple decades). Studies can be multigenerational; as new investigators replace the old, they capitalize on the experience of their predecessors while integrating fresh or novel insights. These studies commonly involve collaborations and partnerships beyond the Pacific Northwest or the Forest Service. Uncertainties in sustained funding, stakeholder interest, organizational structure, and station scientific capacity over extended timeframes demand that long-term studies be undertaken thoughtfully. Although generally established in the context of a contemporary problem, successful long-term investigations can address fundamental issues that transcend a current problem and allow its adaptation to emergent issues without loss of scientific integrity.

The Forest Inventory and Analysis (FIA) program provides foundational data and research via a long-term ecological research network encompassing public and private forest lands. The network spans the entire United States, with data collected on permanent field plots spaced at about 3-mile intervals. Basic data on species and structural composition, forest conversion, ecosystem indicators, and forest health provide a wealth of information used in a variety of research on forest status and trends. Techniques and policy-relevant research within the FIA program help link other types of monitoring methods and data to the long-term FIA research network. For example, spatially continuous mapping of ecosystem attributes (GNN), biomass/biofuel availability and feasibility (BioSum), and carbon marketing (Air Resources Board, Climate Action Reserve) all depend on FIA data and research partnerships.

Beyond the development and evolution of monitoring techniques, FIA research examples include wildlife habitat modeling; climate change effects; species migration; land cover and land use change; watershed health; biomass and carbon sequestration; land ownership change and effects; fire hazard, risk, and effects; insects and disease; forest succession; and riparian assessments.

Research emphasis areas

Forest and range ecosystem science, in the broadest sense, is the PNW Research Station's core work. We focus on the biological, physical, and socioeconomic aspects of terrestrial, aquatic, riparian, and rural and urban systems in Alaska, Oregon, and Washington. Our research is organized into five research emphasis areas (REAs): (1) climate change, (2) inventory and monitoring, (3) natural disturbances, (4) resource management and landscape resilience, and (5) socioeconomic dimensions. These REAs provide a framework for responding to urgent, interdisciplinary, and policy-oriented demands. They reflect the station's long-term work, span all locations and research programs and teams, and tie to the U.S. Forest Service Strategic Plan. They encompass both foundational and applied research.

Projects commonly span multiple REAs. In particular, the REAs of climate change and socioeconomic dimensions have considerable overlap with the other three REAs (see illustration below). The climate change and socioeconomic dimensions REAs are cross-cutting by nature and weave much of the station's work together. Fish, wildlife, and rural and urban forestry issues are included across all five REAs. The following sections are not meant to be a comprehensive accounting of all the work we do, but rather serve to highlight some of the work being done now and work we are planning for the future.

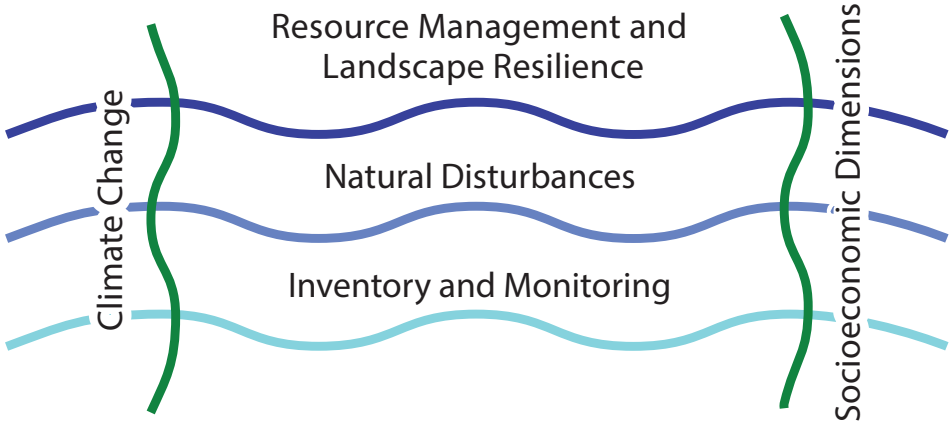
Connie Harrington

What is research?

Systematic, critical, intensive investigation using scientific methods to discover, develop, and apply new or more complete scientific knowledge.

A researcher is someone who

- Uses scientific methods.
- Applies critical and objective judgment.
- Has research capabilities founded substantially on graduate education.
- Makes scientific contributions.
- Possesses scientific stature and recognition.



Vegetation survey at H.J. Andrews Experimental Forest, Oregon. Photo by Rhonda Mazza. ▶

What helps the station assure quality science?

Research Grade Evaluation Panels

- Each scientist is evaluated every 4 or 5 years.
- Four scientists from the U.S. Forest Service or other research agencies make up a panel along with a chair-person and a personnel specialist.
- One panel member serves as a subject matter reviewer who contacts the scientist's peers to affirm that the scientist's work has impact and significance.
- The panel determines if the scientist is promoted, stays at their current level, or is demoted.

Study Plans

- All but exploratory studies need a study plan.
- They are often done as part of competitive funding awards and cooperative agreements.
- They provide clear objectives and rationale as well as details about data collection, statistical approaches, and communication of results.

Technical Review

- An article or report, including those in the station series, is always technically reviewed prior to publishing.
- Three reviewers, including one from outside the station, provide comments.
- Most journal and some station series publications are blind peer-reviewed; that is, the author is not provided names of reviewers.
- Databases, models, software and other technology are also technically reviewed.

Climate Change


Keith Routman

Managers are challenged to address environ-mental changes from climate variation on regional to global scales through adaptation and mitigation measures. Many natural resources—including the waterflows that supply our agricultural, fishing, forest, rangeland, rural, and urban communities—are already affected by climate change, with much stronger effects projected for the near future. Stakeholders expressed a strong need for climate change science and recognition of the impact this topic has on all other research areas. Climate change research includes effects of disturbances, resource management adaptation, and climate change projections.


Glenn Christensen

Retreating glacier in Alaska.

Alaska is at the frontier of climate-related environmental changes—from melting glaciers and receding ice caps to coastal erosion and thawing permafrost—with severe effects for many communities and individuals. Our scientists investigate how climate change affects Alaska's boreal and temperate forests and the communities that depend upon them. We focus especially on forest ecology, timber production, carbon sequestration, water and carbon flux from land to ocean, and salmon and deer habitat quality.

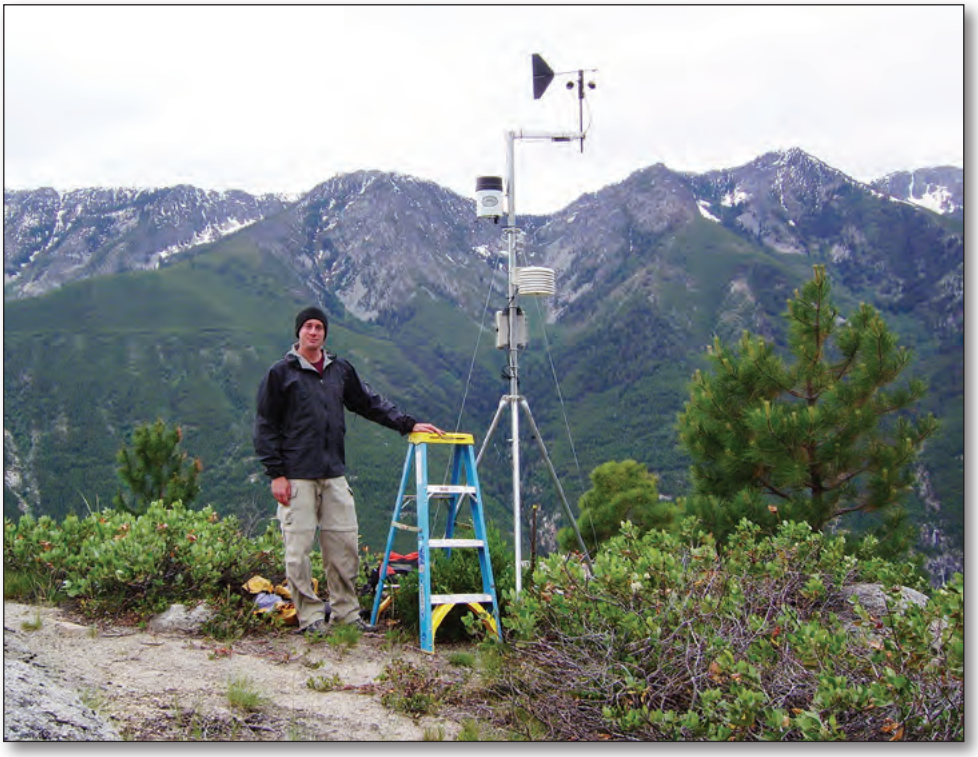
With the U.S. Department of Agriculture's Agricultural Research Service and Natural Resources Conservation Service, the station leads the Northwest Regional Climate Hub in response to the growing threat that climate change poses to the region's forests, rangelands, farms, and rural economies, including those of Alaska Natives and American Indians. From its headquarters in Corvallis, Oregon, the Northwest Hub provides technical support, regional forecasts, and outreach to farmers, forest landowners, and ranchers to help them anticipate the projected effects of a changing climate in Alaska, Idaho, Oregon, and Washington.

The PNW Research Station studies climate change effects relative to many natural resource themes, including carbon, fire, fish, genetics, insects and diseases, socioeconomics, vegetation, water, and wildlife. To align this current work with the REAs, we identified the following three outcomes that will define areas for expanded work.


Connie Harrington

Study of climate change impacts.

Rick Woodsmith



Collecting climate data at the Entiat Experimental Forest, Washington.

Outcomes:

A. Improved understanding of the effects of projected changes in temperature and in timing and volume of precipitation in the Pacific Northwest on ecosystems, and implications for policy and management decisions.

B. Information to help manage and adapt forests that are resilient to the expected effects of climate change in Alaska, Oregon, and Washington.

C. Syntheses of climate change research findings, with implications for improved management.

Impacts of our future work—

We provide information relevant to people and forest and rangeland management across the Pacific Northwest. Station work predicts areas of the Northwest where the extent and intensity of wildfire, carbon dynamics, and air quality will be affected. We also help landowners and managers view impacts through the lens of multiple stressors by integrating scenarios used in predicting climate change outcomes across large landscapes. We study precipitation trends at high-elevation monitoring stations and explore how geology and groundwater mediation of precipitation inform the concept of snow retention. Snowpack levels in the mountains will have a huge impact on spring and summer streamflows and the water supply to meet municipal drinking water needs.

Janet Ohmann

Willamette National Forest.

Our models improve understanding of vegetation types and shifts that are expected across the region and their implications for wildlife habitat. For example, genetics research gives managers information to help them explore the option of assisted migration, in which species and populations are moved to new locations where they are better adapted to changes in climate. We also will be forecasting the effects of climate change on insect and pathogen outbreaks.

Richard Cronn

Sampling for genetic analysis.

Station research helps managers predict how projected climate changes will alter the location of Western tree species. Where habitat becomes unsuitable, these tree species will exhibit slower regeneration and increased mortality. We will map current ranges of tree species (using Forest Inventory and Analysis data) across all of Washington, Oregon, and California; predict their range shifts based on projected changes in precipitation and temperature; and predict potential mortality and regeneration problems. This will help landowners and managers know where to plant trees, what species to plant, and how to conduct restoration activities after fire or harvest.

Other activities can affect how trees respond to climate change. For example, thinning has been suggested as a way to reduce water stress on trees. Drought is thought to be causing large-scale declines in temperate forests, and climate change is predicted to increase the intensity and frequency of drought in many regions. Water stress can reduce growth and resilience to insect outbreaks. Building on over 70 years of silviculture research, we will evaluate the effects of stand thinning on the vigor and productivity of residual trees in Douglas-fir stands. Complementing this work, we will evaluate high-resolution precipitation projections for each national forest in the Pacific Northwest, under the newest climate change scenarios.

Dennis Dykstra

Thinning project on the Colville National Forest.

We also collaborate with Alaska Natives to understand their concerns about the effects of climate change on first foods and tribal resources. For example, climate change is already shifting fire regimes in boreal Alaska, making fires larger and more severe. This directly affects permafrost regimes, which in turn makes human access to nutritionally and culturally important subsistence resources increasingly unpredictable. We will examine the effects of fire-permafrost interactions and produce maps and a quantitative vulnerability assessment. We will synthesize information on management options available to counter expected changes and integrate traditional knowledge.

Harvesting of native berries, a tribal first food. Photo by Richard Carstensen. ▶

Inventory and Monitoring

Andy Tasler

A key emphasis for the station is monitoring changes in various natural resources. The resulting assessments support fields of inquiry such as characterizing biomass, carbon flux, invasive species, drivers of change, impacts of disturbance agents, fish and wildlife habitat, and forest products availability. Inventory and monitoring are fundamental to many of the land management activities in Alaska, Oregon, and Washington.

This REA includes the Pacific Northwest unit of Forest Inventory and Analysis (FIA), a national program that collects data on all public and private forests from field plots across the entire Nation. The FIA program provides data and basic resource information needed to assess the current status and potential future of America's forests.

Outcomes:

Brita Janson

Southeast Alaska FIA crew returning from the field.

A. Improved understanding of change over time in terrestrial, aquatic, or human conditions in response to climate, disturbance, insects and pathogens, management policies, or pollution, with projections of likely scenarios.

B. Tools or methods for integrating ground and remotely sensed data to create regional spatial predictions of vegetation attributes, including assessment of the accuracy and appropriate spatial scale of these predictions.

C. Novel methods for efficiently estimating key resources, e.g., at-risk wildlife populations, forest growth, forest carbon and biomass, or aquatic ecosystems.

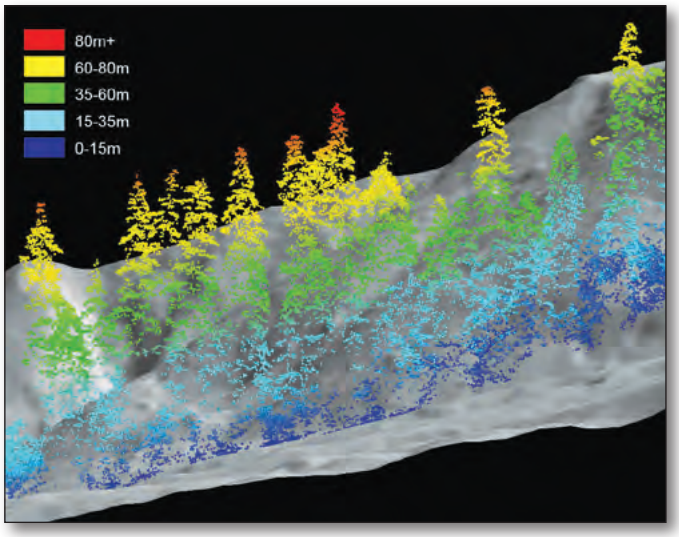
Ken Winterberger

FIA field crew collects data on black spruce plot in Alaska.

Impacts of our future work—

We focus on providing foundational data and research. By establishing baseline tree growth, regeneration, and mortality trends, we can help assess climate change impacts. For example, tree ring analysis in interior Alaska will help us track historical growth patterns to see how past climate variation affected tree growth. Interior Alaska contains 15 percent of the forested land in the United States. Until we initiated sampling there in 2014, there had been no large-scale inventory.

Notably, interior Alaska is experiencing the greatest warming in North America in the past 50 years, and this is expected to continue. Large-scale declines in tree health are being seen across much of the region. This could change the lives of local communities, which depend on wildlife and forest resources. Is this because of climate-induced drought? We will find out by assessing patterns of tree growth and relating these patterns to yearly temperature and precipitation trends. Understanding past trends in tree growth related to climate will help us make better projections of future conditions for the region.



LiDAR remote-sensing data reveals fine details of complex forest structure.

With FIA data, we examine spatial and temporal shifts in carbon stocks, invasive species, and vegetation. Techniques and policy-relevant research from these studies inform many other management issues.

We are partnering with the Pacific Southwest Research Station to extend our ongoing inventory and monitoring programs in California, Hawaii, and the Pacific Islands to better address the specific needs of these regions.

Tom Iraci


Monitoring invasive species.

Our broad scope includes, but is not limited to, analyzing carbon storage and sequestration related to disturbance and climate change. We are also evaluating changes in land cover and use, fire-fighting strategies, timber management, and wildlife habitat. For example, we are studying effective methods for monitoring wolverine populations. The wolverine is already a sensitive species but is proposed to be listed as threatened under the Endangered Species Act.

Current monitoring systems are useful only in winter, when conditions pose safety concerns for researchers to be in the field. The new methodologies could be used year-round and will be tested for how effective they are at monitoring wolverines.

John Rohrer


Wolverine study.

Natural Disturbances

We focus on the interacting effects of disturbances on ecological, geophysical, and socioeconomic systems. Forests and rangelands in the West supply a variety of services such as a consistent supply of high quality water for human consumption (including irrigation and generation of electricity), forest products, recreation, grazing, and suitable habitat for both terrestrial and aquatic species. As the climate changes, these wildlands are highly vulnerable to fire, insect infestation, disease epidemics, invasive species, and drought. Often, the disturbances caused by these stresses, alone or in combination, are uncharacteristically severe and result in significant and lasting effects on ecological and socioeconomic values.

Bark beetle infestation.

We provide information and tools that will allow land managers and owners to anticipate these disturbances and take action to prevent or ease the effects of such stressors.

Tom Iraci

2006 Mount Hood Complex Fire.

Outcomes:

A. Techniques or strategies that enhance the capacity to assess, manage, mitigate, or adapt to risks associated with disturbance.

B. New and improved models of fire dynamics and smoke based on novel integrated measurements and scientific analyses designed to better understand the underlying physical processes.

C. Improved understanding of disturbance interactions between terrestrial and aquatic ecosystems through developing and analyzing new methods and data, syntheses, applied theory, or remote-sensing applications.

D. Decision support tools based on an understanding of landscape-level disturbance, including remote sensing applications for early detection and monitoring of resource quality and models for predicting risk to high-value resources.

Fire aftermath in southern Washington. Photo by Julia Biermann. ▶

Tom Iraci

Southwestern Oregon wildfire.

Impacts of our future work—

Throughout the Nation, wildfires and smoke significantly affect both ecosystems and people. We specifically focus on creating tools for managers to better manage lands to reduce wildfire risk, manage and mitigate wildfires and smoke, and communicate with the public. This work includes developing new physically based fire dynamics models that can address risk within the wildland-urban interface, creating improved measurements of fuels important for understanding fire behavior and effects, developing new models and systems to assess fire emissions and smoke impacts, and working directly with managers to ensure that the latest scientific results can be directly applied to decisions in the field.

Tom Iraci

Fuel reduction treatment.

Understanding the need to increase forest resilience to disturbances through forest management has come a long way. We are adding to this knowledge by assessing the effectiveness of fuel treatments to dampen fire behavior and protect communities threatened by large wildfires. Our work on fuel reduction helps integrate fire management with ecological objectives such as conservation of the northern spotted owl. In addition, we

will specifically focus on the effects of wildfire on salmon. Salmon populations, many of which are threatened or endangered, are struggling to survive in shrinking areas of high quality habitat. These habitats are altered by disturbances like wildfire, which is predicted to increase in a changing climate. Effects of wildfire on streams might include reduced shading from trees or increased sedimentation from hillside erosion. We are studying how past wildfires in Washington, Oregon, and Idaho have affected aquatic habitat and are measuring these impacts on Chinook salmon development. Our information helps managers understand the far-reaching effects of wildfire and to identify areas likely to experience aquatic habitat shifts in a changing climate.

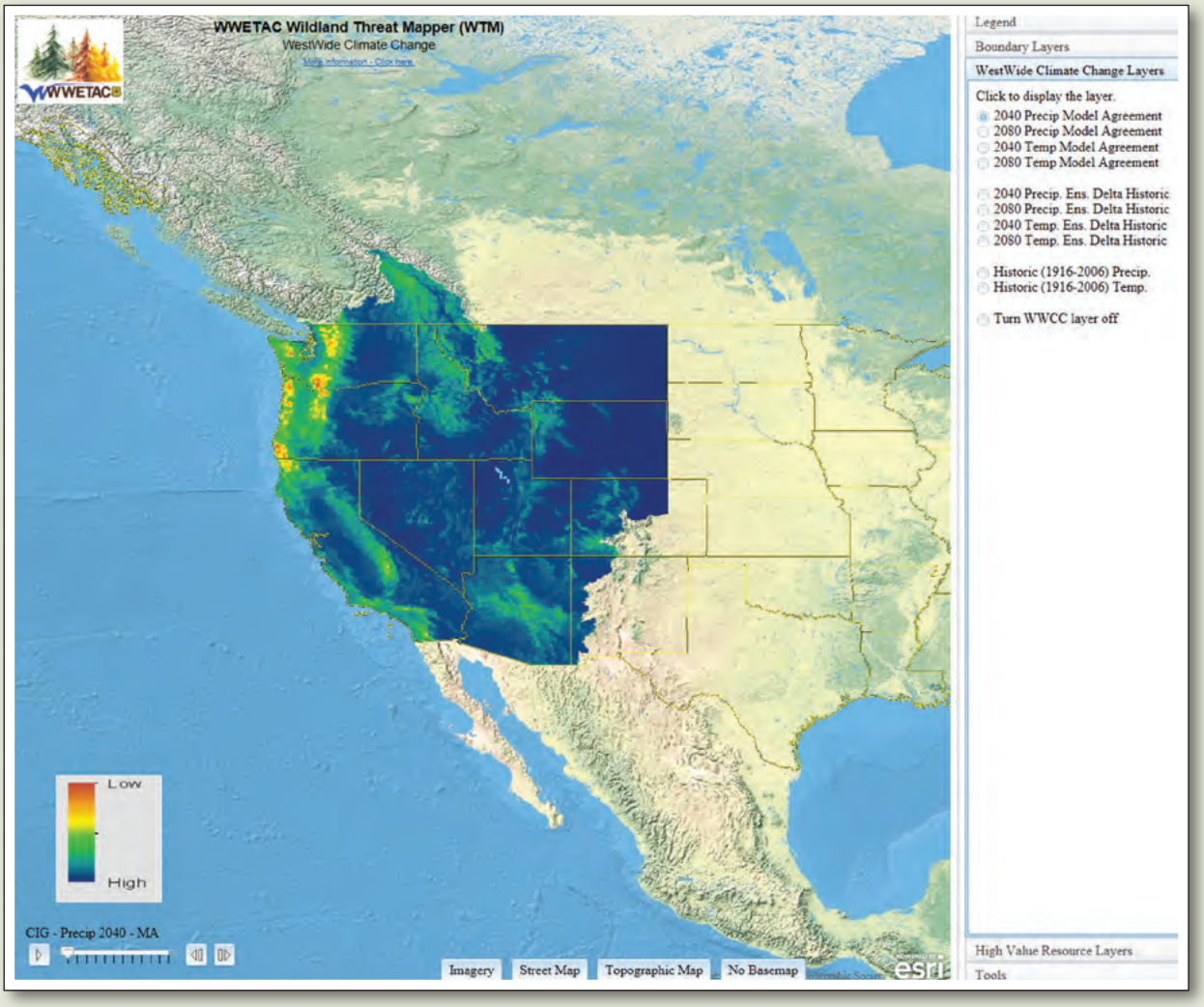
Jon Dickey

Chinook salmon, Tye River, Washington.

Other work explores how disturbances interact with vegetation patterns on a broad scale. Historically, frequent fires dotted the landscape in eastern Oregon and Washington, creating a mosaic of forest patches of varying size, age structure, and species composition. Understanding the relation between vegetation patterns and landscape resilience is critical to our success in forest restoration efforts. Our work provides guidance on the fire regimes in this region, with data-rich descriptions of historical forest conditions to help address questions about whether active management is justified and what silvicultural practices would be most beneficial. We are also weaving in traditional ecological knowledge of American Indian tribes to gain new insights about how forest conditions and fire regimes were shaped by interacting natural and human-caused disturbances.

John Marshall

Eastern Washington landscape.



A series of map services published by the Western Wildland Environmental Threat Assessment Center enables users to view and evaluate wildland threats in relation to highly valued resources. Here, climate change data have been downscaled to make them easier to interpret at smaller scales.

The Pacific Northwest Research Station is home to the **Western Wildland Environmental Threat Assessment Center** (WWETAC) in Prineville, Oregon. Established as a West-wide program, the center is supported by three deputy areas of the Forest Service (Research and Development, National Forest System, and State and Private Forestry). The center focuses on science and technology transfer—providing bibliographies, scientific syntheses, threat assessments, and application tools to federal, state, and private land managers and resource specialists across the West. The primary environmental threats WWETAC addresses are wildfire risk, fuels management, invasive species, and climate change, at the project to landscape level. The center has a small staff and a large number of cooperators.

Much of WWETAC's work is interdisciplinary. For example, its wildfire risk mapping and projections of vegetation response to climate change will inform both biophysical and socioeconomic vulnerability assessments being conducted in the Forest Service's Pacific Northwest and Pacific Southwest Regions. Wildfire risk assessments are requested nationally, regionally, and by individual states and national forests. Scientists from WWETAC are developing a prioritization tool to treat invasive plants with help from specialists and scientists from national forests, other Forest Service research stations, states, and regional and national interdisciplinary teams. ForWarn, an application developed along with the Eastern Forest Environmental Threat Assessment Center and other partners, is being used to develop a rapid-response tool that can tally the acreage of forest land affected by disturbance and assess what stand types are likely to have been affected. The center is also developing a new tool to quantify and attribute the sources of disturbance, such as tree drought stress, defoliators, insect outbreaks, mistletoe, and mortality at the tree level.

WWETAC welcomes inquires, requests, and cooperators. For more information, visit http://www.fs.fed.us/wwetac/.

Furthermore, we are developing a fire-danger model for regional and national planning for fuel reduction treatments and creating a cohesive suite of tools for managing smoke. Our work examines the effectiveness of postfire rehabilitation and restoration practices in eastern Cascade forests and provides management options for disturbances such as bark beetle outbreaks, wildfires, and invasive plants.

Another disturbance for which we are known internationally is an active volcano. Since the 1980 eruption of Mount St. Helens, hundreds of thousands of organisms (small mammals, fishes, arthropods, fungi, and plants) have been chronicled to assess the full extent of ecosystem response to this intense, large-scale forest disturbance. We are preserving scientifically invaluable specimens in museums, thereby safeguarding a substantial research investment (several million dollars) to date. Research discoveries are also used for interpretive programs, increasing their value to all Americans and global society.

Tom Iraci

Mount St. Helens, Washington.

Resource Management and Landscape Resilience

Unprecedented stresses on forest ecosystems, including wildland fire, climate change, and land use changes are complicating the ability of land managers and policymakers to provide sustainable forests, rangelands, and watersheds. This REA provides managers, policy makers and decisionmakers, regulators, private landowners, and the public with a better understanding of the agents and pathways of change in terrestrial, aquatic, and riparian ecosystems. Topics relate to forest and stream-wetland resource characterization; silviculture; and fish, wildlife, and other species. Land management and restoration activities, biomass utilization and energy development, and how society values resources and perceives the interplay of the management are topics for this REA.

Connie Harrington

Douglas-Fir Seed Source Movement Trial.

Outcomes:

A. Tools and information that will advance stand, landscape, and watershed management and restoration.

B. Tools and information to assess tradeoffs that land managers and others face as they work to improve and restore natural resources.

C. Improved understanding of how restoration and management activities affect ecosystem resilience.

Impacts of our future work—

We provide big-picture science by developing landscape models that forecast the future of land and aquatic systems and examine management scenarios such as restoration, thinning, prescribed fire, and climate change and its mitigation. New knowledge about physical processes in watersheds and their influences in maintaining clean water and healthy ecosystems will contribute to "next-generation" riparian and watershed management plans and policies in the Pacific Northwest region and beyond.

Old-growth Douglas-fir trees. Photo by Dominique Bachelet. ▶

U.S. Fish and Wildlife Service

Spawning chinook salmon.

We address many issues important to our stakeholders, such as integrated watershed management, carbon cycling in aquatic systems, the potential impacts of increased winter waterflows on Alaska salmon, and young-growth management in Alaska. We focus on restoration of fish spawning and rearing habitat, the effects of streamside buffer designs and riparian management on aquatic resources, and evaluating shrub recovery for endangered salmon and steelhead under varying levels of cattle, elk, and deer grazing.

Another area we are examining is how restoration treatments affect carbon storage. Understanding this is important because well-intentioned policies can have unforeseen effects on other ecosystem values. Under the new Forest Service planning rule, Forest Service managers must develop strategies for integrating carbon and sustainable consumption goals with those of other ecosystem services. We will evaluate these tradeoffs among ecosystem values in landscapes across a climate-disturbance regime gradient from coastal Oregon to the Blue Mountains.

M.L. Gasser

Restoration project, Willamette National Forest, Oregon.

We continue to study some issues with which we have been strongly associated, such as northern spotted owls. Managers in the Pacific Northwest are required to make decisions about silvicultural practices, timber harvests, and other activities in light of their impact on these iconic birds and their prey. We are studying the ecology of northern flying squirrels (a key prey species for the owl) to contribute to a much fuller understanding of management effects on spotted owls, particularly in terms of techniques for keeping owl prey on the landscape after forest thinning.

Bureau of Land Management

Northern spotted owl.

Northern flying squirrel.

We also are concerned about precipitous declines in the populations of some native pollinators, such as the western bumblebee. Bees pollinate about 70 percent of flowering plants globally, making them essential to the production of food crops, flowers, and seeds in diets of humans and wildlife. We are embarking on studies to explore the impact of restoration and land management on these pollinators in forested riparian ecosystems. Results will have national and even global significance, helping land managers understand how these beneficial native pollinators respond to active management.

Fir0002/Flagstaffoto

Honeybee landing on thistle flower.

Socioeconomic Dimensions


Frank Vanni

Demand for social and economic science related to natural resource issues is on the rise. Patterns of land use, recreation, and economic development are changing. The U.S. population is becoming more diverse and urbanized. Rural communities face the need to shift their economic foundation away from dependence on natural resource extraction. Quality of life increasingly depends on understanding the human values and choices that sustain our environment, promote public health, support rural economies, and reduce conflict. Additional research is needed to integrate social and natural systems across all lands, from rural to urban, and to address environmental justice.

Pacific Northwest Research Station social and economic science directly addresses national challenges like these by recognizing the integral role that people play in natural resource management. Our work includes identifying and evaluating ecosystem services and exploring options for recreation management in areas of growing population, as well as addressing urban forestry and stewardship issues, community economic health, and wildfire preparedness. Social science also helps us improve science delivery as we work with our audiences to better understand their needs. This REA examines socioeconomic processes, policies, and management and their influence on ecological and biophysical conditions and processes.


Mountains to Sound Greenway Trust

Planting street trees.

Outcomes:

A. Improved understanding of the interactions between socioeconomic and biophysical systems at landscape scales.

B. Identification and evaluation of the goods, services, and benefits produced by ecosystems and management.

C. Tools to assist land managers in evaluating local economic and social conditions.

Impacts of our future work—

We examine a range of activities that contribute to rural sustainability, such as forest products, recreation and tourism, environmental restoration and stewardship, collaboration and partnerships, and biofuel energy development. We are looking at why some forest management strategies are more effective at contributing to rural wealth than others.

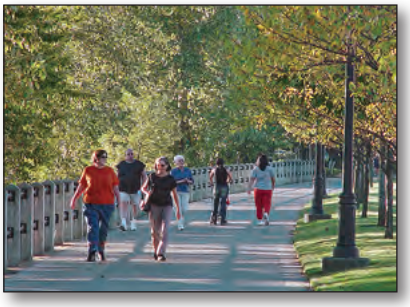
Station scientists are examining the role of street trees in enhancing human health and well-being. Photo by M.O. Stevens. ►


STOP


A. Paige Fischer

Private forest landowners assess their wildfire risk.

Collaborations among different land ownerships and organizations that arise to collectively address conservation issues have been widely touted as a successful model for community-based resource management. We are investigating what motivates private forest landowners to form conservation collaboratives to restore fire-prone forests. Cooperation between private forest landowners is an important strategy for managing wildfire risk, because hazardous fuels are found across fire-prone landscapes. Many collaboratives have been successful in facilitating information exchange, building trust, and reducing appeals and litigation, but little research exists about whether they achieved restoration goals or contributed to community resilience. Station work informs land management practice by identifying the benefits of different social arrangements and policy incentives for cooperation, and how to better align social processes with ecological needs. For example, how well are they meeting the twin objectives of forest restoration and job creation?


Guy Kramer

New research shows connections between tree health and human health.

Our studies also focus on urban forests, particularly the social and economic values of trees in urban areas, the link between trees and human health, and the benefits associated with stewardship activities in urban areas. One innovative area of station work involves human exposure to polycyclic aromatic hydrocarbons (PAHs), air pollutants linked to several public health concerns, including cardiovascular disease, asthma, and cancer. Children are particularly susceptible. Monitoring PAHs with traditional air quality monitors is very expensive. But moss, which absorbs PAHs, provides a noninvasive, inexpensive, and useful way for measuring PAH at lower levels than conventional monitors. The station is exploring how moss might help reveal PAH levels in the environment.

The station is providing information and tools for understanding community vulnerability and adaptation to climate change, particularly for American Indian and Alaska Native subsistence. Tribes rely on cultural resources on federal lands. For example, some Western tribes use beargrass for basketry. We are assessing beargrass productivity on different forest sites and evaluating conditions at those sites. Understanding the forest characteristics that allow beargrass to thrive helps district rangers and fuel planners who manage forest land, as well as tribe members who rely on these plants. Other studies look at *Acacia koa*, an


Chris Schnepf, U. of Idaho, Bugwood.org

Beargrass.


J.B. Friday

Koa tree.

important Hawaiian tree species with many traditional uses. Old-growth koa is dwindling, but our research focuses on the potential market value for young-growth koa wood and helps build cultural connections between Hawaii's people and their forests.

Our research involves forest ecosystem services—the ecological life-support systems, goods, and services that are vital to human health and livelihood. Many of these goods and services, such as wildlife habitat or abundant clean water, are traditionally viewed as free benefits to society and are therefore overlooked in decisionmaking. We are identifying and evaluating these ecosystem services to help close this gap, linking science, practice, and decisionmaking and promoting conservation of these natural resources.

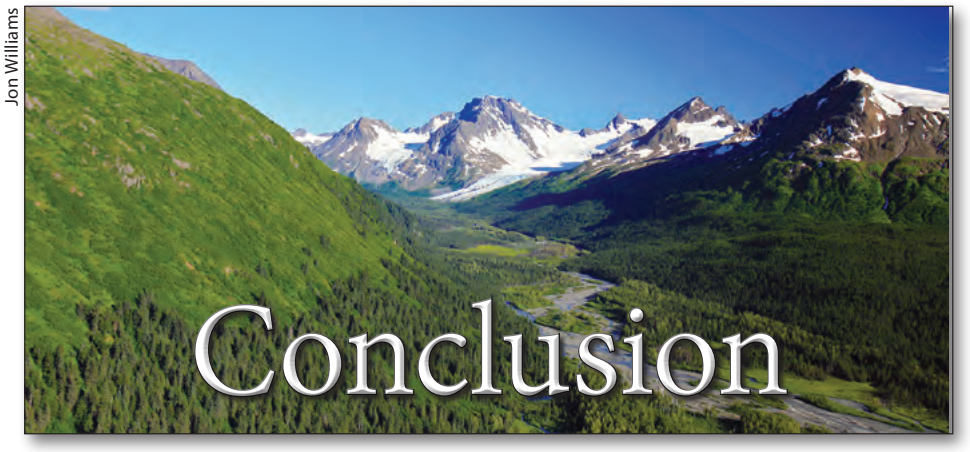

Susan Charnley

Biomass power plant.

The station is evaluating the carbon life cycle relationship of renewable and nonrenewable energy products, developing case studies to help implement biomass energy systems in Alaska, and contributing to the preparation of the next Chugach Land and Resource Management Plan Revision and Tongass Land and Resource Management Plan Amendment. Rural Alaskans need a sustainable, reliable source of energy. Alaska is the highest per-capita consumer of petroleum in the country, amplifying the impact of high prices, price spikes, and delivery challenges with remote locations. Many communities are isolated and surrounded by national forests. Using forest biomass for heating is a proven way to meet the thermal energy demands of communities and businesses, while providing an outlet for the byproducts of managing young-growth forests in southeast Alaska. It also creates jobs. We will provide southeast Alaska communities with a financial tool to help them quickly assess wood energy options. We are also evaluating the feasibility of microchip production to assist wood energy development of small industrial-scale systems in rural Alaska. Potential wood energy adopters include schools, government buildings, and Alaska Native organizations in southeast Alaska.


David Nicholls

Wood-fueled furnace used to heat buildings in Alaska.



The previous version of the PNW strategic framework was prepared in 2002. Since then, our core mission of generating and communicating science to help people make informed choices about natural resources remains unchanged. However, the context for natural resource management is changing, as are the ways in which people communicate and seek information. We accept the challenge and will address these issues through scientific leadership, innovative approaches, and proving our work to be relevant to people who make and influence land management decisions.

Our success lies in our ability to tap into the unbridled curiosity of our workforce to achieve our mission of delivering high-impact, timely information. We encourage our stakeholders to help us improve upon our history of strong science by staying engaged and helping us embark on a deliberate course to implement this strategic framework and achieve continued science excellence.

How can stakeholders and employees stay informed?

Station publications (in print and online):

- *PNW Science Findings* (http://www.fs.fed.us/pnw/publications/scifi.shtml)
- *Recent Publications of the Pacific Northwest Research Station* (http://www.fs.fed.us/pnw/publications/qlist.shtml)
- Our annual *Science Accomplishments* report (http://www.fs.fed.us/pnw/publications/accomplishments.shtml)

On the Web:

- PNW Research Station homepage (http://www.fs.fed.us/pnw/)
- Station scientist profiles (http://www.fs.fed.us/pnw/people/scientists.shtml)
- PNW newsroom (http://www.fs.fed.us/pnw/news/index.shtml)
- Twitter (http://www.twitter.com/usfs_pnwrs)
- Treesearch (http://www.treesearch.fs.fed.us/)
- GeoTreesearch (http://www.fs.fed.us/research/products/geotreesearch/)

◀ Alaska yellow-cedar seedling. Photo by Robin Mulvey.

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Doni McKay

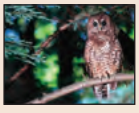
Postfire research on the Deschutes National Forest, Oregon.

Front cover photographs:

Soil study team.
Photo by Sarah Beldin.

Tree frog.
Photo by Elke Ward.

Study of post-volcanic-eruption ecology, Chaitén Volcano, Chilé.



Northern spotted owl.
Photo by Tom Iraci.

Stream study.
Photo by Rhonda Mazza.

Jackpot Lake, Chugach National Forest, Alaska. Photo by Steve Wondzell.

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