2003 Science Accomplishments

of the Pacific Northwest Research Station

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March 2004

Vision and Mission

We are highly sought for our scientific leadership and impartial knowledge.

Our mission is to generate and communicate scientific knowledge that helps people understand and make informed choices about people, natural resources, and the environment.

Station Director's Message

Thomas M. Quigley

Today, as in the past, complex forces of nature intersect with communities and society. Fire, climate change, invasive species, and large-scale shifts in forest cover and use are some of the key issues society currently faces.

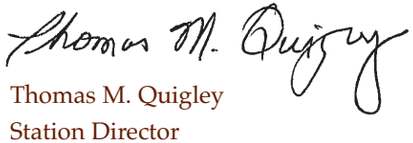
This accomplishment report encapsulates a year's work from our scientists. This work is often interdisciplinary, long term, geographically broad, and policy oriented. And most of all, we strive to make it relevant to the issues of today as we build a foundation for addressing issues of the future.

A sample of science findings found in this publication:

- The BlueSky smoke modeling framework predicts smoke impacts from wild and prescribed fires.
- The BioSum computer model evaluates an area's potential to supply wood for wood processing plants—a consideration in reducing hazardous fuels.
- Forest products consumption is projected to rise by 42 percent by 2050 in the United States.
- Pacific coastal old-growth forests are more diverse than previously thought; today's old growth developed along multiple pathways.
- The Alaska Wood Utilization Research and Development Center is finding ways for Alaska sawmills to add new value-added products and find new markets for them.

Our business is quality science. We recognize that generating information is not enough. Beyond generating excellent science, we must communicate and deliver the resulting information and products. This year we shared our information with tens of thousands of people through our Web sites, *Science Findings*, *Science Updates*, scientific journal articles, and technical publications. Our scientists and professionals have made presentations, conducted workshops, and provided training throughout the Pacific Northwest, United States, and World. We have met regularly with resource managers and policymakers as we continue the often difficult work of incorporating science into decisionmaking.

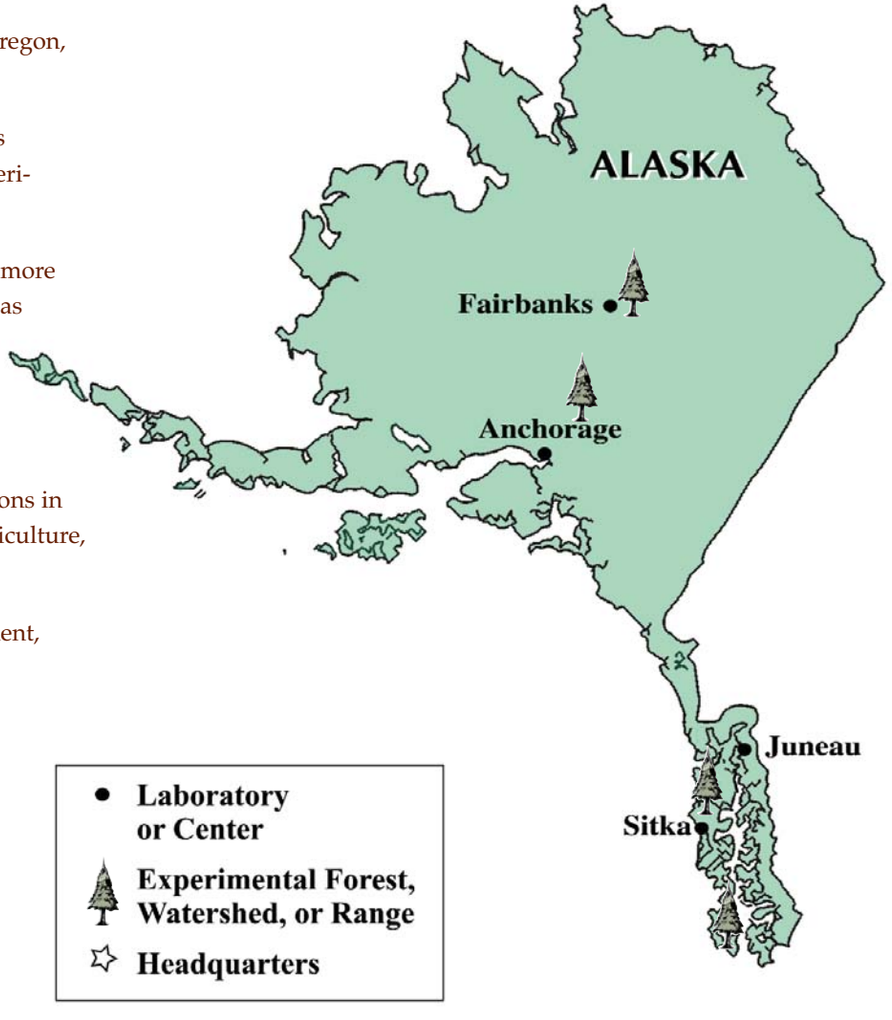
I am fortunate to work with people who are very dedicated to their professions. This includes PNW Research Station employees and our many cooperators, clients, and partners. I am honored to be among you and look forward to future work together.



Thomas M. Quigley
Station Director

PNW Research Station: The Setting

- 10 laboratories in Alaska, Oregon, and Washington
- 10 active experimental areas (watershed, range, and experimental forests)
- Research also conducted in more than 20 research natural areas (RNAs)
- Headquarters in Portland, Oregon
- PNW is 1 of 6 research stations in the U.S. Department of Agriculture, Forest Service
- 549 employees (288 permanent, 261 temporary)



Goal Accomplishments

Goal 1: Develop a Fundamental Understanding of Ecological, Social, and Economic Systems and Their Interactions

Key Findings:

- Natural disturbances throughout the watershed may have important influences on productivity and diversity in streams. Small headwater streams may be important sources of large wood in watersheds where mass movements, such as debris flows and landslides, are important natural processes.

- In southeast Alaska, small headwater streams with gradients >20 percent are used by resident and anadromous juvenile salmon and trout. Headwater tributaries compose a large proportion of most watersheds in southeast Alaska, and all these headwater streams combined may make a large contribution to the fish community.

- The northern flying squirrel serves as a model for understanding conservation genetics and ecosystem roles across wide geographical areas. In Washington, flying squirrel populations may become genetically isolated if open spaces interrupt forest cover. Complex forests may help promote permeability of managed landscapes, thus maintaining gene flow.

- Genetic analysis shows that fisher populations in Oregon are the result of introductions from Minnesota and British Columbia and are isolated from California fisher populations. Historically, gene flow occurred between fisher populations in British Columbia and those in the Pacific States, but the populations are now isolated.

- Marbled murrelet populations are affected by habitat quality, fragmentation, and predation of nests. In Washington, a broad array of predators, including at least 10 bird and mammal species, attempted to prey on decoy murrelet eggs and chicks. Predation rates are higher near forest edges when the surrounding area contains human settlements and recreation sites, but not when the area is dominated by regenerating forests.

- In the nearly 25 years since the Mount St. Helens volcanic eruption in 1980, ground-dwelling beetle communities have shown successional changes as the volcanically disturbed sites changed. Beetle succession has been related to changes in soil, organic litter, and plant communities. The beetle communities serve as a good barometer for measuring ecological condition of a site and as an index of biological impairment.

- Elk, mule deer, and domestic cattle have different foraging ecologies. The three species select and use habitats differently and also strongly partition their use of habitats, particularly by elevation, slope steepness, and logging pattern. The three species also have different forage preferences, each species with a distinctive dietary niche.

- Historical fire occurrence and extent are correlated with climatic variables at time scales ranging from annual to multidecadal in the inland Pacific Northwest. In five eastern Washington watersheds, the area burned was positively correlated with current-year drought but not correlated with wet or dry conditions in previous years. Variability in area burned also showed cyclical patterns consistent with the 4- to 8-year cycles of the El Niño southern

oscillation and the 20- to 40-year cycles of the Pacific decadal oscillation.

- Old-growth forests are regionally more diverse in both their structures and development than previously thought. The diversity is a result of regional differences in climate history, fire history, site productivity, and species composition. Today's old-growth forests developed along multiple pathways.

- Universal rules govern how tree roots use and redistribute water, regardless of vegetation type or other site-specific characteristics. Redistribution of soil water from deep to shallow roots plays a key role in diminishing the effects of summer drought on shallow roots.

- Coarse woody debris can be used to help predict the presence of western hemlock saplings in west-side stands. Management practices that increase the amount of coarse woody debris in forest stands should be considered as potentially beneficial to hemlock establishment.

Tom Iraci

Healthy rivers are not only resilient to disturbances but in fact are adapted to these events. The dynamic view moves the focus for planners to restoring natural watershed patterns.

Accomplishments

Finding on upslope sources of large wood leads to "out-of-channel" perspective on stream restoration projects

Each river ecosystem has a character shaped by a unique combination of geology, climate, biology, and history. General principles hold true across watersheds, but generalized prescriptions are likely to fail. One general principle in watershed science is that rivers are dynamic, and healthy rivers are not only resilient to disturbances but in fact are adapted to these events. Restoration projects that treat streams as unchanging systems, such as projects that hardwire large wood in streams, often fail or have limited success.

A scientific perspective thinks "out of the channel." This perspective views streams as dynamic systems intricately connected with watersheds and changing over decades or centuries. The dynamic view moves the focus to restoring stream processes, such as growing large trees that will eventually reach streams instead of engineering large wood into place.

The dynamic view also recognizes the role of disturbances throughout the watershed in restoring productivity and diversity to streams. For example, many previous studies have recognized only streamside sources of large wood in streams and missed the importance of upslope wood sources. In a pristine watershed in coastal Oregon, however, scientists found that wood from outside the streamside zone composed about 65 percent of the total number of pieces, and 46 percent of the total volume, of large wood. Large wood pieces from upslope areas totaled, on average, about one-third the volume of large wood from streamside sources.

Tom Iraci

Healthy rivers are dynamic systems intricately connected with their watersheds. The Rogue River, shown here, is in southwest Oregon.

Although natural disturbances are important sources of habitat diversity in watersheds, people's land uses often change the frequency and characteristics of disturbances. For example, infrequent forest fires and natural forest recovery are replaced by timber harvest and managed forests. These new, human-shaped disturbance patterns can homogenize streams instead of creating diversity.

People can change their management practices, however, with the aim of restoring closer-to-natural disturbance patterns. For example, it is known that headwater streams are major sources of large wood from upslope in watersheds where debris flows and landslides are important natural processes, such as many west-side Oregon and Washington watersheds. Planners could manage forests so that when landslides and debris flows do occur in headwater streams,

they include large wood and rocks, the building materials of complex waterways downstream. Many landslides stop short of reaching streams, and scientists have developed a new computer model that managers can use to identify the headwater streams most likely to deliver slide material all the way to streams.

Stream restoration is most likely to be successful, then, if people use both general scientific principles and detailed knowledge of individual streams, and if they plan projects mindful of both the stream's processes and connections with its watershed.

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Partner for restoration principles: Southern Research Station

Restoring large wood to streams is most successful when done in ecosystem management context

Over the last three decades scientific findings about wood in Western rivers have led to several important management trends. Today, managers view wood restoration more as a component of ecosystem management rather than as a simple, stand-alone mitigation tool. The trend is moving away from using "hard" engineering approaches to anchor wood in streams toward using "soft" placement techniques that allow some wood movement. Now wood is being placed in locations where the stream channel and hydraulics favor stability and wood would be likely to accumulate naturally. Restoration plans for wood in streams include landscape analysis and may emphasize recruiting trees from natural sources through channel migration, windthrow, and landslides, instead of engineering log placement.

Although large wood is generally thought to be critical for healthy streams, a literature review found that many studies show large wood not affecting aquatic biodiversity. A number of factors, not just the wood itself, determine patterns of aquatic biodiversity. Large wood is important, but just placing large wood in streams will not restore habitat; the total effects of all the other factors must be considered to have successful restoration. The success of wood restoration projects depends on the ability of resource specialists to (1) determine the functions of wood in target stream reaches and (2) evaluate the role of large wood relative to other factors affecting biological diversity.

This review helps to provide a sound scientific basis for (1) evaluating the importance of large wood to aquatic and riparian ecosystems, (2) planning projects to restore streams from past land use impacts, and (3) mitigating effects of current and future land use activities.

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Stream water temperatures are strongly influenced by upstream factors

Cool water is important for healthy, productive streams in the Pacific Northwest, and especially important for native salmon and trout. Warm water in streams is often attributed to hot air near streams, but no cause-effect relationship has actually been established between the two. New research demonstrates that although direct sunlight and hot weather do influence both air and stream temperatures, the local air temperature is only one factor, and not the most important one, affecting stream temperatures. In fact, conditions upstream, perhaps far removed, and the length of time that water spends in these various conditions, can have considerable effect on downstream water temperatures. This finding has significance both for projects that aim to lower warm water temperatures and for proposed management actions that may affect streams.

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Landforms in watersheds can control the nitrogen regime in streams

Nitrogen is a key nutrient in ecosystems, and the supply or loss of nitrogen affects plant growth and food webs. Denitrification is the conversion of nitrates to nitrogen gas, a process that removes nitrogen from soil or water and releases it to the atmosphere. New research shows that denitrification in the soils of dominant landforms can control the input of inorganic nitrogen to streams.

A positive relation was found between the level of organic matter and denitrification, pointing to the presence of organic carbon as possibly a major control on the process of converting nitrates into nitrogen gas. Nitrate availability was also an important potential control on denitrification. The findings suggest that large-scale features in watersheds, plus the factors just mentioned, can control the nutrient regime in streams, allowing nitrogen in soils either to reach streams or not.

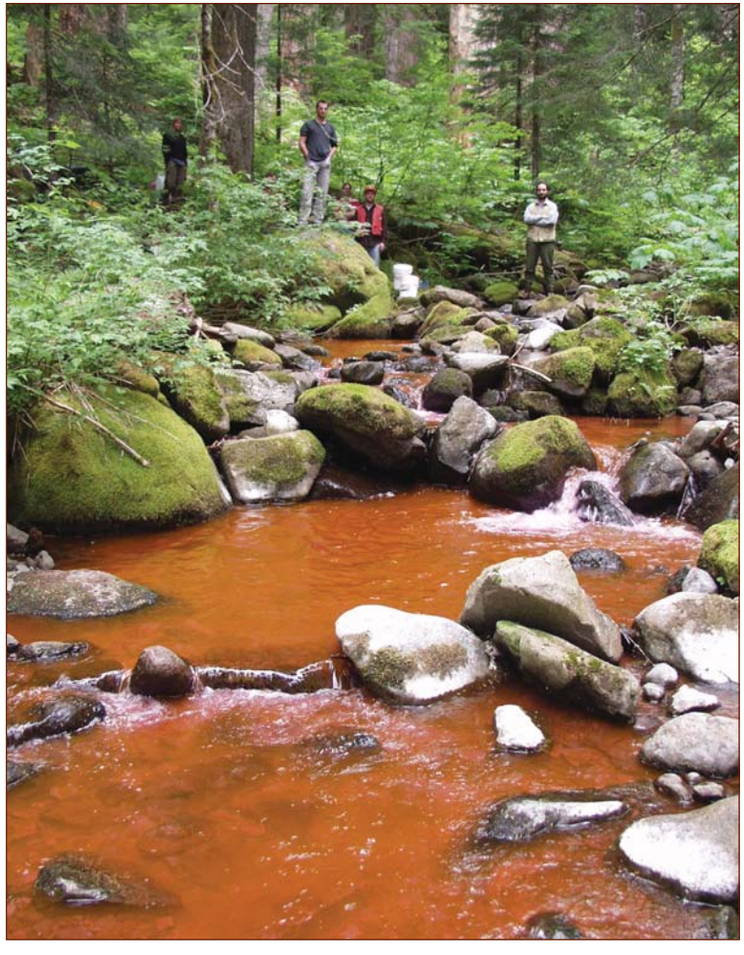
Other researchers have found that watersheds with salmon streams often have more nitrogen than watersheds with no salmon in their streams. This study found, however, that riparian soils along salmon spawning streams had a higher denitrification potential than soils along streams without salmon. The inherent differences between salmon and nonsalmon streams, based on the landforms and other factors, suggest that caution be used in estimating the amount of nitrogen that returning salmon bring into watersheds.

Contact: Richard T. Edwards, rtedwards@fs.fed.us, Aquatic and Land Interactions Program

Relationships found between aboveground stream features and subsurface water

Surface stream water moves down into the region below the streambed, banks, and floodplain, an area known as the hyporheic zone, and this water upwells back into the channel, perhaps exchanging many times over the length of the stream. Scientists have long known that as the water moves between aboveground and belowground flows, oxygen and nutrients are exchanged, stream life is affected, and water temperature is influenced. But they have known little about how hyporheic zones change in relation to aboveground stream characteristics.

By using nontoxic tracer dye studies and computer models, scientists have documented how the size and shape of stream features



Steve Wondzell

An inert red dye is used to trace the movement of subsurface (hyporheic) water into and out of Lookout Creek, Cascade Range, Oregon.

can influence the extent, flow paths, and water residence time in the hyporheic zone. Pool-step sequences, pool-riffle sequences, channel sinuosity, and other channel features all influence hyporheic water.

The research demonstrates that models can be used to quantify both amounts and residence times of hyporheic water, neither of which can be determined with other common methods. The OTIS model matches short-term residence times well, but the STAMMT-L model was more accurate for long-term residence times. These findings may be useful for understanding management effects on streams and hyporheic zones and for choosing the best model to analyze specific questions for individual streams.

Contact: Steven M. Wondzell, swondzell@fs.fed.us, Aquatic and Land Interactions Program

Deep pools in streams are shaped by landscape, not by logjams alone

High-quality stream habitat includes deep pools for fish and other stream life. In Pacific coastal forests, most deep pools in streams are formed and maintained by hydraulic forces created when water meets instream obstructions, such as large logs or boulders, or rocky banks resistant to erosion. The number, size, and shape of pools are, therefore, largely controlled by characteristics of these flow obstructions. But other important controls include stream geology, steepness, channel shape, streambed material, and streambank vegetation.

Stream restoration work is often designed to create or improve pools. Projects that only restore roughness, such as putting in wood or boulders to create pools, may fail if the other influences on pools are not considered.

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Postfire wood in streams causes few short-term problems in the eastern Sierra Nevada Range

After large fires, stream runoff can increase considerably for the next few years, with more frequent downstream flooding. Postfire rehabilitation work has often included removing wood from streams to reduce damage done by logs carried downstream by floods, and also on the assumption that fire-killed trees drop into streams and thus accumulate in excessive amounts after fires. The wood removals are controversial, however, because large wood is needed in streams for habitat recovery.

Tom Iraci

In southeast Alaska, some salmon species do use steep headwater stream reaches for certain life stages.

In the eastern Sierra Nevada Range, scientists found that the effects of large wood in streams after fires differed, depending on fire intensity in the watershed, width of the stream channel itself, and size of the wood pieces. If only a few long logs are in the stream (defined as length equal to the stream's width), the wood may pose little downstream danger in floods. One year after a wildfire, streams had less woody debris and logjams, not more. For the stream reaches studied, postfire debris jams and related damage did not seem to be a problem. Results are still short term at this point.

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Partner: Pacific Southwest Research Station

Young salmon do use steep headwater streams in southeast Alaska watersheds

In southeast Alaska, small headwater streams with gradients greater than 20 percent have not been recognized as habitat for young anadromous fish. However,

Landscape patterns of boreal spruce forests developed from intertwined relationships among fire, permafrost, and vegetation.

scientists found juvenile salmon living in these steep headwater stream reaches. Young Dolly Varden were the most abundant in these steep reaches, but young coho salmon (up to the age of 1+ years) also were found in reaches with gradients up to 10 percent.

Most fish movement up and down southeast Alaska streams occurred during fall and spring peak flows. Steelhead moved into the steep headwater streams during the fall and were still present in the spring. Anadromous Dolly Varden spawned in the uppermost reaches to which they could swim, jump, and fight their way. Although most fish movements were less than 1,000 feet up- or downstream, some fish moved more than half a mile (not counting migratory movement).

Because headwater streams are a large part of the stream networks in most southeast Alaska watersheds, their total contribution as fish habitat may be significant—if fish passage is not blocked. For salmon to use all possible habitat in a watershed, stream crossings under roads would have to be navigable for young salmon.

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Rare North American wetland type is found in southeast Alaska

The 17-million-acre Tongass National Forest is 30 percent wetlands, most of which are low-productivity bogs, poor fens, and forested wetlands. But scientists have recently found calcium-rich fens in areas downslope from limestone or marble ridges on northern Chichagof Island. Calcium-rich fens are the rarest of all North American wetland types and had not previously been found in southeast Alaska.

The groundwater in these calcareous fens is much less acidic and much higher in calcium and magnesium than water in most southeast Alaska wetlands, and the fens support abundant vegetation such as Sitka sedge, Barclay willow, and red-osier dogwood. Mountain bladderfern, a plant that grows only in calcium-rich soils, was found. Some plants found, such as thinleaf cottonsedge and arctic yellow violet, were at the southern limits of their ranges. The scientists noticed casual evidence of extensive use by brown bears, wolves, and Sitka black-tailed deer, including well-worn trails, crushed vegetation, and scat.

Mike McClellan

Caribou survive in a dynamic environment, where fire and frost create a mosaic of changing forests and open spaces.

Contact: Mike McClellan, mmcclellan@fs.fed.us, Resource Management and Productivity Program
Partners: USDA Forest Service Alaska Region, University of Alaska

Fire and frost play key roles in black spruce landscape mosaic and carbon budget

The boreal forest—the northernmost forest of North America, Europe, and Asia—is the second largest biome on Earth and stores about 30 percent of the world's terrestrial carbon. With carbon storage in forests now a strategy for dealing with climate change,

Tom Iraci

Native Alaskan master carver David Boxley shapes a totem pole from a yellow-cedar log in Ketchikan, Alaska.

remote forests in the land of permafrost and northern lights have been drawn into the global issue of climate change. Yet little was known about the dynamics and carbon fluxes of boreal forests until recently.

In interior Alaska, black spruce dominates the boreal forest. By using Landsat, scientists classified the spruce stands into three categories: wet/cold sites, which are the typical black spruce sites; dry/warm sites, which are less common and characteristically dominated by white spruce; and an intermediate class. The scientists found that the landscape patterns of these types developed not just from elevation, slope, aspect, and other stable abiotic factors, but from intertwined relationships among fire, permafrost, and vegetation. Fires can melt permafrost, releasing carbon stored in the frozen soil layer as well as carbon stored in trees. Once permafrost melts, many years can pass before a black spruce forest occupies the site again and shade from the spruce trees allows permafrost to form again.

Scientists modeled the intricate relations among forests, permafrost, fire, and abiotic factors, and they also included the effects of climate changes on spruce forests. These results are used in computer model projections of how Alaska spruce forests would store or release carbon under different climate scenarios. This research lays the groundwork for further work on fire, permafrost melting, forest change, and carbon budgets in the Alaska boreal forest, and what role these forests play in global carbon budgets.

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Soil nutrient chemistry and temperature are implicated in yellow-cedar decline

Alaskans appreciate yellow-cedar (or Alaska-cedar) for its ecological, social, and economic values. But this valuable tree species is dying across hundreds of thousands of acres in southeastern Alaska, mostly on water-saturated soils, and cedar decline is drastically changing the forest dynamics. Yet the cause of death is so far unknown.

Station scientists have shown that the yellow-cedar decline is not caused by management or biological agents, eliminating two possible causes. Now they are investigating other possibilities. Recent preliminary findings indicate that calcium has been depleted in the surface soils of dying cedar stands. There are also indications that soil temperature variations at low-elevation sites may lead to frost damage of roots or foliage, or both. Although the mechanism of death is still unknown, the latest research has provided evidence that soil nutrient chemistry and temperature are two of the factors related to yellow-cedar decline.

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Partners: Managing Disturbance Regimes Program, Aquatic and Land Interactions Program, USDA Forest Service State and Private Forestry

Scientists improve understanding of soil carbon storage and transport

The storage and transport of soil carbon is of great interest because of its critical role in land and water ecosystems. Scientists also study carbon storage and release from soils to better understand the global carbon cycle and climate

Forest managers can use the new model to predict likely murrelet habitat and survival.

change. In southeast Alaska, studies in forested wetlands show that organic material in these soils decomposes much more slowly than reported in earlier soil surveys. Differences are sharp enough that a new classification subgroup of organic soils is needed for the region. The data are also being used to refine carbon-storage values for organic soils. The findings have led to new research on carbon movement from these wetland soils into streams. Wetlands provide more dissolved organic carbon than upslope areas and may be a crucial factor controlling stream nutrient balance in many watersheds.

Contact: Dave D'Amore, ddamore@fs.fed.us, Resource Management and Productivity Program
Partners: Aquatic and Land Interactions Program, University of Alaska

Northern flying squirrel is case study for conservation genetics

Forest management is producing simplified forests in many places. In Washington, northern flying squirrels were studied to evaluate the effects of forest management on genetic diversity within a species, which is critical to long-term species survival. Flying squirrels in a highly fragmented forest had markedly lower genetic variation, a reduced gene pool, and less variety in genetic form than did squirrels within more continuous forests with few physical barriers to flying squirrel travel.

The study shows that genetic analysis can be used to evaluate the effects of forest fragmentation on animal populations. Research on flying squirrels—selected for their complex food web relationships that indicate overall ecosystem productivity—may lead to new forest management strategies, particularly in areas of mixed ownership and development where fragmentation may isolate populations. Complex forests may promote permeability of managed landscapes, thus maintaining gene flow. Maintenance of genetic diversity may require leaving some undisturbed forest near thinned stands for recolonization.

Related research has shown that northern flying squirrels in southeast Alaska eat a more general diet and fewer truffle fungi than northern flying squirrels in the Pacific Northwest, and thus the Alaska squirrels may be able to exploit a wider range of habitats than Pacific Northwest squirrels. Flying squirrels in Alaska remain an important vector for truffle spores, however.

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More information: Science Findings 51, February 2003. *Sex and the Single Squirrel: A Genetic View of Forest Management in the Pacific Northwest.* www.fs.fed.us/pnw/sciencef/scifi51.pdf.

Fisher populations in Oregon are the result of introductions from Minnesota and British Columbia and are isolated from California fishers

Fishers are forest carnivores, once widely dispersed in the Pacific Northwest but now limited to populations in the southern Oregon Cascade Range, the Siskiyou Mountains, and northern California. Fishers were extirpated from Oregon and Washington through trapping, timber harvest, and agricultural development, but were then reintroduced through transplants of animals from Minnesota and British Columbia.

Scientists did genetic analyses on Pacific Northwest fisher populations to determine the origin and distribution of fishers in Oregon and their degree of isolation from other breeding populations. Scientists analyzed samples from the study population, northern California population, and from both living fishers and museum samples from around North America. They found that the small fisher population in the southern Oregon Cascade Range is reintroduced and is descended primarily from fishers transplanted from British Columbia and, to a lesser extent, from Minnesota. The Siskiyou population is the northernmost extent of the California population and is genetically isolated from other Oregon fishers.

Catherine M. Raley

Genetic analysis yielded important information for conservation planning for Pacific Northwest fishers, such as these 10-week-old fisher kits in southwest Oregon.

Historically, gene flow occurred between fishers in British Columbia and those in Pacific States, but the populations are now isolated.

These research results played a prominent role in the decision to proceed with a 12-month review to determine whether the fisher should be listed under the Endangered Species Act. The results also can be used in the development of conservation plans to maintain and restore fisher populations.

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Marbled murrelet populations are affected by habitat quality, fragmentation, and predation of nests

The marbled murrelet is a threatened seabird that nests on branches of large trees within older coniferous forest in coastal areas of the Pacific Northwest. Surveys show that murrelets often nest in continuous stands of mature, complex forest, but they also nest in younger forests and in stands of only a few acres. New research shows how murrelet abundance and reproduction are related to the amount and pattern of nesting habitat at regional, watershed, landscape, and nest-site scales.

At regional and watershed scales, murrelet abundance (estimated from offshore surveys) correlated with the amount of nesting habitat and to a lesser extent with fragmentation of that habitat. But at the landscape and nest-site scales, fragmentation may have a more significant effect on the likelihood of nesting and nest success, perhaps due to increased predation by birds such as crows and jays. Over the past 5 years this possibility was tested in Washington by using artificial nests located in stands of different structural complexity, levels of fragmentation, and proximity to human activity. Results showed that a broad array of predators, including at least 10 bird and mammal species, attempted to prey on decoy murrelet eggs and chicks in the artificial nests. Predation rates are higher within 50 yards of forest edges when the surrounding area contains human settlements and recreation sites, but not when the area is dominated by regenerating forests.

By using these results, scientists are developing a model to predict likely murrelet habitat and survival. Forest managers will be able to use the model to assess the potential impact of management activities on murrelets and to develop conservation strategies over mixed-ownership landscapes.

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Beetle communities show successional changes as Mount St. Helens blast zone recovers

Beetles are fully one-fifth of the total number of species on land, and beetles play important ecological roles in pollination, herbivory, granivory, predator-prey interactions, decomposition and nutrient cycling, and soil disturbances. In the nearly 25 years since the Mount St. Helens volcanic eruption in 1980, ground-dwelling beetle communities have shown successional changes as the volcanically disturbed sites changed. Beetle succession has been related to

Ground-dwelling beetles serve as a good barometer for measuring ecological condition of a site.

changes in soil, organic litter, and plant communities.

On the pumice plain, the most severely affected study site, certain ground beetle species (no common names) were the first to colonize the area and were common for 7 years, after which other ground beetles replaced the pioneer species. Tiger beetle populations exploded between 1990 and 1995. Caterpillar hunters became abundant from 1995 to 2000, as plant cover increased and moth caterpillars fed on the plants.

Andrew Carey

Mushroom cap was gnawed by something very small, perhaps a deer mouse.

Beetle assemblage changes will likely continue with the changes in pulses, such as rapid change when forbs and grasses are replaced by shrubs, and shrubs are replaced by coniferous forest. Ground-dwelling beetles serve as a good barometer for measuring ecological condition of a site and as an index of biological impairment. The beetle assemblages may serve as a useful tool for assessing ecological condition or evaluating disturbance severity at other locations in the Pacific Northwest.

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Loss of nest trees may be a major cause of declines in Vaux's swift populations

The Vaux's swift, usually seen in open skies above forests, is one of many Neotropical migratory birds whose populations are declining. In 39 forested stands in northeastern Oregon, the abundance of Vaux's swifts dropped significantly from 1991 to 2003. Twelve years after the swifts were originally found in these stands, only 46 percent of the stands still had any Vaux's swifts at all. The loss of nest trees owing to a severe budworm beetle outbreak was identified as possibly a major factor contributing to the swift's decline. Of 58 swift nest trees located between 1990 and 1994, only 29 percent were still standing and presumably usable by swifts in 2003.

Evelyn L. Bull

The numbers of Vaux's swift have been declining in northeastern Oregon.

The swifts did, however, readily use 12-foot-long wooden nest boxes designed to simulate hollow trees. During a 4-year study, swifts nested in 30 of 103 nest boxes, with a 53 percent nest success rate. The proven nest box design could be used by forest managers to provide nest habitat for the Vaux's swift and potentially help the populations to rebound.

Contact: Evelyn Bull, ebull@fs.fed.us, Managing Disturbance Regimes Program
Partners: University of California, Driftwood Wildlife Association, Umatilla and Wallowa-Whitman National Forests

Elk, mule deer, and cattle have different foraging ecologies

Elk, mule deer, and cattle frequently share the same forests and rangelands in the interior Columbia basin. On the Starkey Experimental Forest and Range in northeastern Oregon, scientists have learned that these three species have different foraging ecologies. The three species select and use habitats differently and also

Frank Vanni

In the Blue Mountains, northeastern Oregon, the Starkey Project yields new information about elk foraging ecology.

strongly partition their use of habitats, particularly by elevation, slope steepness, and use of logged forests. Cattle are habitat generalists, and the native elk and mule deer avoid areas where cattle are. Mule deer and elk avoid each other during short periods but not over longer periods, particularly in fall when the least forage is available. Elk use low elevations if no cattle are there but move to higher elevations when cattle are moved onto low-elevation range, showing that cattle can displace elk.

The three ungulate species also have different forage preferences, each species with a distinctive dietary niche. Mule deer had the greatest variability in their diets and foraged on more plants in dry areas than did either elk or cattle.

People have many viewpoints about how to manage livestock and wildlife so that all three large grazing species can coexist and thrive and rangeland health can be maintained as well. Starkey research may help managers develop strategies for sustainable, joint use of rangelands by elk, mule deer, and cattle.

Contact: John Kie, jkie@fs.fed.us, Managing Disturbance Regimes Program
Partners: University of Alaska Fairbanks, University of Wyoming, Oregon Department of Fish and Wildlife

Quick method developed for measuring extent of fire damage to ponderosa pines

Ponderosa pines may survive flames and scorched bark if the fire does not injure the living stem tissues protected by the bark, but the extent of fire damage to these tissues has always been difficult to evaluate. Scientists have found that the amounts of ethanol present in stem tissues can be used as a direct measure of tree injury from fire. Ethanol concentrations in ponderosa pines increased as the degree of fire injury worsened. In fact, bark beetles may detect ethanol released from fire-damaged trees and home in on those trees.

This finding has led to a new technique for quickly predicting postfire tree mortality. Ethanol measurements done 2 weeks after a fire can be used to predict which trees will die, even though the trees may take up to 2 years to die from their fire injuries. Initially, this research will be used to correlate visual signs of fire injury, such as charred bark, to serious injuries in the living tissues. Eventually the ethanol-sampling techniques may be useful to assess the degree of tree damage from other causes, giving managers useful information.

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Partners: Deschutes National Forest, Bend-Fort Rock Ranger District

Fall prescribed burning results in more invasive plants than spring burning, in interior Columbia basin

Invasive plants are a serious threat to native plant communities and even to wildlife in forests of the interior Columbia basin, but little is known about how wildfires and prescribed fires affect the spread of these exotic species. Two research projects are exploring the relations between fire and invasive plants.

Prescribed burning is a major tool used to reduce fuel loads and restore ecosystem functions in ponderosa pine forests. Scientists studied the responses of understory plants after prescribed burning done in fall 1997 and spring 1998 in the southern Blue Mountains in eastern Oregon. They found significantly more species of invasive plants growing after fall burns, compared to spring burns

More species of invasive plants grow after fall burns than after spring burns. With this information, managers can time prescribed burning to minimize the spread of invasive plants.

Nan Vance

Researchers examine native plants and cheatgrass after a prescribed burn in the Frank Church River of No Return Wilderness, Idaho.

and no-burn control units. The most common invasive plants were cheatgrass and bull thistle; these two species covered significantly larger proportions of burned areas after fall burns, compared to spring burn areas and no-burn control areas. The spring burns and no-burn controls had statistically similar coverage of the two species. Cheatgrass is a strong invader and has the potential to inhibit natural successional processes. Bull thistle is considered ephemeral, meaning that it will probably disappear from an area as natural successional processes occur. The results give managers useful information for timing prescribed burning to minimize the spread of invasive plants.

Studies on fire and invasive plants are in their third year in the Salmon River Canyon of Idaho, where large wildfires and invasive plants are major issues. Scientists are examining the dynamics of native plant communities and invasive plants as affected by wild and prescribed fires and also are developing monitoring protocols.

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Partners: Malheur National Forest, Burns Ranger District
Contact for fire and invasive plants, Salmon River Canyon: Nan Vance, nvance@fs.fed.us, Resource Management and Productivity Program
Partners: Nez Perce National Forest, Salmon River Canyon Weed Management Area

Historical fires and their extent correlated with climate patterns

Recent severe fire years have raised the question of connections between fire occurrence and climate. Scientists found that historical fire occurrence and extent are correlated with climatic variables at time scales ranging from annual to multidecadal, in five eastern Washington watersheds on the Wenatchee-Okanogan and Colville National Forests. The scientists used a combination of fire-scar data from trees, reconstructions of past climate patterns from tree growth rings, and time-series analysis to establish the historical influence of drought, the El Niño southern oscillation, and the Pacific decadal oscillation (ocean conditions), on annual area burned in the five watersheds.

They found that the area burned was positively correlated with current-year drought, but not correlated with wet or dry conditions in previous years. Variability in area burned also showed cyclical patterns consistent with the 4- to 8-year cycles of the El Niño southern oscillation and the 20- to 40-year cycles of the Pacific decadal oscillation.

The research is being used to develop multiyear projections of fire extent and fire risk. As scientists improve their ability to predict shifts in ocean conditions such as El Niño, they may be able to forecast severe or mild fire seasons months or even more than a year in

advance. If so, wildland fire managers could use these forecasts to allocate firefighting resources further in advance.

Contact: Donald McKenzie, donaldmckenzie@fs.fed.us, Managing Disturbance Regimes Program

Ocean conditions and climate changes affect subalpine forests in Pacific Northwest

Scientists previously have established correlations between ocean conditions and climate fluctuations. New work now finds long-term correlations between high-elevation tree growth in the Pacific Northwest and ocean circulation patterns in the north Pacific Ocean. Scientists studied growth in populations of mountain hemlock and subalpine fir, the two dominant subalpine tree species, throughout their range in the Cascade and Olympic Mountains.

Growth at treeline and in the snowiest regions of these mountain ranges, where snowpack limits the growing season, correlated positively with changes in the Pacific decadal oscillation (PDO). The alternating 20- to 30-year periods of warm PDO, with associated warm, dry weather, correlated to high growth rates in the mountain hemlocks and subalpine firs; and, in turn, the periods of cool PDO, with associated cool, wet weather, correlated to low growth rates in the two tree species.

At lower elevations and in drier regions, where summer drought limits tree growth, the opposite relationship was found. In these areas, trees grew less during warm phases of the PDO, and trees grew more during cool phases of the PDO. Thus the effects of a greenhouse climate on trees in subalpine forests are likely to differ at different elevations and locations in mountain ranges.

In another study, Station scientists and partners found that well-defined ranges of annual precipitation and temperature controlled the distribution of tree species in the Wenatchee-Okanogan and Colville National Forests. Strong relationships were found between the distribution of mountain hemlock and winter precipitation, and between the distribution of ponderosa pine and availability of soil moisture. Thus, these two species, characteristic of upper and lower treeline,

Tom Iraci

The journey matters. Diverse pathways in forest development are ecologically important.

respectively, clearly are controlled by broad-scale environmental gradients. In contrast, relationships were weak for lodgepole pine and Engelmann spruce, tree species that respond more to local site conditions.

These studies show that ocean circulation in the North Pacific, through its effects on Pacific Northwest climate, has far-reaching and predictable effects on forest ecosystems. Eventually it may be possible to predict multidecadal patterns of tree growth and productivity, based on these patterns, and to better project how forests will respond to various climate change scenarios.

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Partner: National Center for Atmospheric Research

Old-growth forests are regionally more diverse in structure and development than previously thought

Pacific coastal old-growth forests are diverse regionally in both their structures and their development. The diversity is a result of regional differences in climate

Alders help to break down rocks with chemicals from their roots and symbiotic organisms, thus releasing nutrients from rocks into the soil.

history, fire history, site productivity, and species composition. Although the forests share the same general definition and similar attributes such as large live and dead trees, the details differ, and no one specific definition describes all Pacific coastal old-growth forests.

Today's old-growth forests developed along multiple pathways. Some developed under open conditions created by multiple fires and with different levels of biological legacies such as large live and dead trees. Others developed from closed, dense stands after a single major fire or other disturbance. In very wet, cool parts of the region, some old-growth forests developed without fire; these forests are dominated by shade-tolerant tree species in a mosaic of patches. These multiple pathways may have ecological implications not fully grasped yet.

All these forests developed from disturbances and under the climate conditions of the last millennium. The particular composition and structure of these old-growth forests may not occur again under modern climates and disturbance regimes, but forest managers can use these findings to encourage natural processes in this millennium's old-growth forests and to develop complexity in managed forests.

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More information: Science Update 4, June 2003. *New Findings About Old-Growth Forests.* www.fs.fed.us/pnw/pubs/science-update-4.pdf.

Even small old-growth remnants have value as refugia

Old-growth forests in western Oregon and Washington are valued as refugia and seed sources—"seed" meaning spores, eggs, and offspring, as well as seeds—for other forests, among other values. Under the Northwest Forest Plan, enough old-growth forest is to be retained to supply "habitat of sufficient quality, distribution, and abundance" to protect the viability of old-growth associated species. But scientists debate the question of exactly how much old growth is enough and what landscape patterns are most effective.

In one search for answers, scientists documented the ecological characteristics of remnant stands (from one-hundredth of an acre to about 100 acres) of mature and old-growth forests in the southern Washington Cascade Range. They evaluated the effectiveness of these remnants as refugia and sources of dispersal for lichens, mosses and liverworts, vascular plants (forbs, shrubs, and trees), and invertebrates such as snails. Results to date show that even the tiniest remnants have a subset of old-forest associated plants and invertebrates and can serve as refugia and sources of dispersal. Analysis further indicates that the Northwest Forest Plan's standard to retain 15 percent of cutting units as unharvested trees does little to protect refugia unless guidelines further specify the area and biological composition of what should be retained.

Contact: Bruce Marcot, bmarcot@fs.fed.us, Ecosystem Processes Program

Universal rules govern how tree roots use and redistribute water

Tree roots take up water from deep soil layers and then redistribute it near the surface during seasonal drought cycles. Studies in three coniferous forests and three tropical savannas indicate that universal rules may govern these processes, regardless of forest type or other site-specific characteristics.

In Washington and Oregon, studies in ponderosa pine and Douglas-fir stands suggest that redistribution of soil water from deep to shallow roots plays a key role in diminishing the effects of summer drought on shallow roots. The amount of water redistributed increased as the soil dried. Water lifted from wet, deep soil

Tom Iraci

Alder plays many ecological roles in coniferous forests.

layers keeps shallow soil layers from drying to critical levels that would cause shallow roots to stop functioning.

Other factors also affect stand water use and hydrology. Work at the Wind River Canopy Crane Research Facility showed that old-growth western hemlock trees infected with dwarf mistletoe change their hydraulic architecture to compensate for the loss of transport efficiency in infected branches. These adjustments minimize the effect of mistletoe on the tree needles but sharply reduce water use and photosynthesis in the entire tree, compared with uninfected trees of similar size.

The two studies have implications for understanding water use in trees, tree growth and productivity, stand regeneration, and water movement at the watershed level, through forests and into streams.

Contact: Rick Meinzer, fmeinzer@fs.fed.us, Ecosystem Processes Program

Alders and rocks lead to productive forest soils

Alders are the primary source of biologically fixed nitrogen in many Pacific coastal forests from Oregon through Alaska. With their ability to pull nitrogen from the air and convert it into soil nitrogen through a symbiotic relationship with bacteria on their roots, alders grow quickly, enrich the soil, and may be an important source of nitrate in streams. Alders help to break down rocks with chemicals from their roots and symbiotic organisms, thus releasing nutrients from rocks into the soil. The result is an annual crop of leaf litter, high in nitrogen and other elements, that provides an organic substrate, maintains soil structure, and increases the soil's water-holding capacity. Both understory plants and overstory trees benefit from alders in the stand. Instead of removing alders, forest managers are including alders in management plans, in recognition that alders can supply nutrients to other trees and improve wildlife habitat.

Contact: C.Y. Li, cyli@fs.fed.us, Ecosystem Processes Program

Western hemlock more likely to grow when coarse woody debris is available at the microsite level

Western hemlocks are a key part of old-growth forests in the Pacific Northwest, typically adding depth to the forest canopy and diversity to the tree ages. Foresters have long known that hemlocks sometimes take root on decaying, "nurse" logs. A new study in the Oregon Coast Range deepens knowledge about that relationship, finding a significant association between hemlock establishment and the amount of coarse woody debris at the microsite level, but not to the total amount of coarse wood available at the stand level.

These results suggest that coarse woody debris can be used to help predict the presence of hemlock saplings in a stand. Management practices that increase the amount of coarse woody debris in forest stands should be considered as potentially beneficial to hemlock establishment. Forest managers who want to accelerate the development of old-growth characteristics can apply these findings to promote the establishment of hemlock.

Contact: Vicente Monleon, vjmonleon@fs.fed.us, Forest Inventory and Analysis Program

Rare plants vary widely within a species on the number of genes each individual plant has, and individuals with the most genes may be the hardiest and most adaptable.

Humongous fungus in Blue Mountains may be the world's largest organism

Armillaria root diseases are widespread fungal diseases of conifers in North America. In a study started to map the populations of *Armillaria* species in a mixed-conifer forest, scientists realized they had discovered a contiguous clone of one species spread across nearly 2,400 acres in the Blue Mountains of northeast Oregon—an area of about 4.4 square miles. This single clone is estimated to be at least 2,000 years old, although it could be three or four times as old as that.

Scientists initially thought the underground clusters of fungus, revealed aboveground by ring-shaped patches of dead trees, were separate individuals. Analysis of DNA confirmed that all these clusters were actually filaments of one individual that had been growing underground for thousands of years. Other large *Armillaria* clones may exist, too. Wildfire regimes, forest cover types, and other factors appear to play roles in the spread of *Armillaria*, but the relations are not clearly understood. The information that large clones of the fungus may have thrived for thousands of years may lead to a new view of the ecological roles of *Armillaria*. The results have received wide media coverage, allowing Station scientists to reach new audiences.

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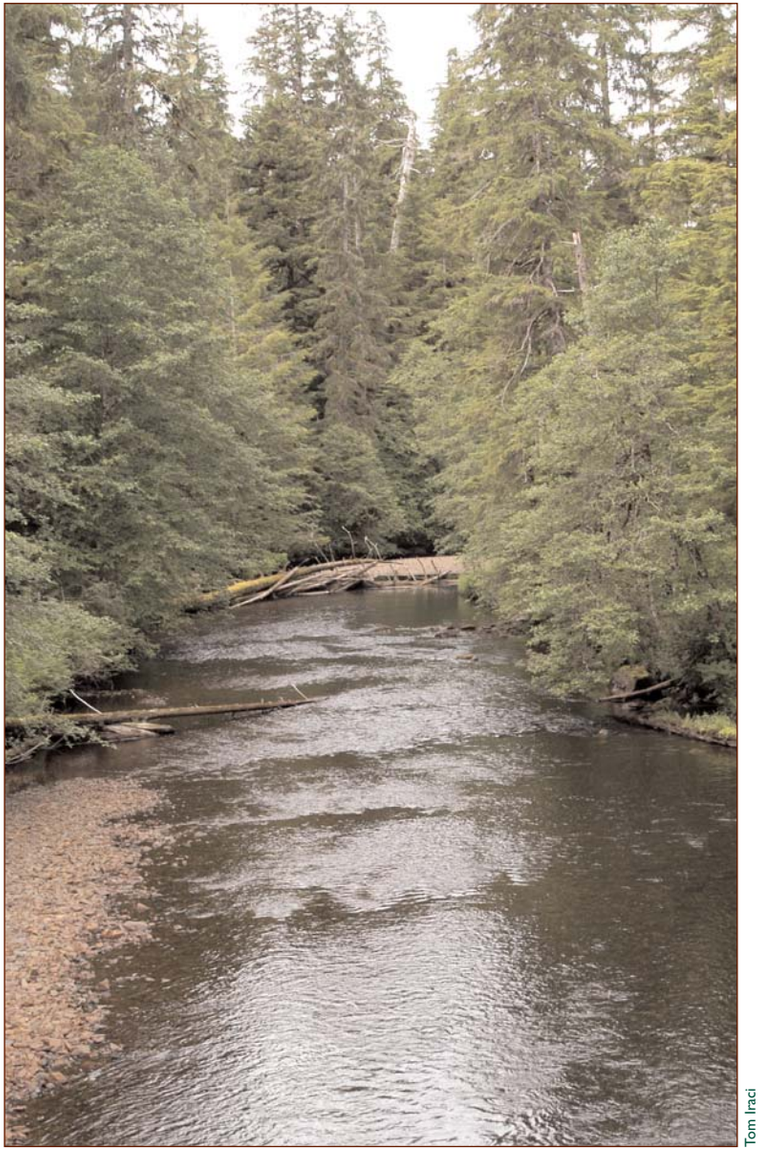
Partners: Oregon State University, Wallowa-Whitman National Forest

Forage lichens, a key food for spotted owl prey, are more common than thought

Lichens are little-known species, but they are important food for arboreal rodents, which in turn are food for northern spotted owls; the lichens have other ecological roles as well. One eastern Washington lichen species is listed as a survey and manage species under the Northwest Forest Plan. Scientists studied the lichen species of several low-elevation dry forests on the east slope of the



Tom Iraci

Washington Cascade Range. For lichen species that grow on trees (epiphytes), the scientists found that species diversity differs considerably among dry forest types, but species richness differs little. Important forage lichens are about three times more abundant in mature to old forest than in open pine forest. The survey and manage species, *Bryoria tortuosa*, a forage lichen, was found to be much more common than previously thought.

When forest managers plan fuel reduction, thinning, and prescribed burning treatments in dry forests, they need to analyze potential effects on wildlife, including effects on forage lichens, tree-dwelling rodents, and spotted owls. New information on the lichens answers questions about these effects; the study results also may be used to reevaluate the survey-and-manage status of *Bryoria tortuosa*.

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Partner: Wenatchee National Forest

Genetic analysis shows that different numbers of genes account for some differences in rare plants

About 70 percent of flowering plant species are polyploids, meaning that they have a duplicate set of genes (a characteristic shared by all vertebrate animals also). The extra set of genes means that a polyploid species has an extra set of genes for trial-and-error mutations, a creative process of adaptation that has led to the enormous variety of flowering plants, with over 225,000 species identified. Conifers, on the other hand, are not polyploids and have developed only about 1,000 species worldwide, owing to their slow, conservative rate of mutation.

Flowering plants include the grasses, forbs, and shrubs used for native plant restoration and the propagation of rare or endangered plants in the West. Traditionally, genetic diversity in these species has been measured by identifying the genetic basis of important traits. But flowering plants may vary widely within a species on the number of genes each individual plant has, and the individuals with the most genes may be the hardiest and most adaptable.

Richard Cronn

Alpine reedgrass, a sensitive grass in the Pacific Northwest, has a polyploid genome and stays genetically adaptable even with small population sizes.

For example, sagebrush bushes in the harshest sites usually have the highest number of genes per individual, compared to sagebrush in less severe sites. Yarrows in very dry sites frequently have more genes than yarrows in moister sites.

Scientists have developed techniques for estimating the number of genes activated in polyploid genomes. This innovation provides a bridge for understanding how the duplicate genes contribute to environmental adaptation. In addition, these methods are the first step toward understanding why populations of rare and endemic species show different tolerances for habitat fragmentation and inbreeding.

Contact: Richard Cronn, rcronn@fs.fed.us, Resource Management and Productivity Program
Partners: Iowa State University, USDA Forest Service Pacific Northwest Region

Goal 2: Assess the Status and Trends of Ecosystems and Natural Resources and Their Uses

Key Findings:

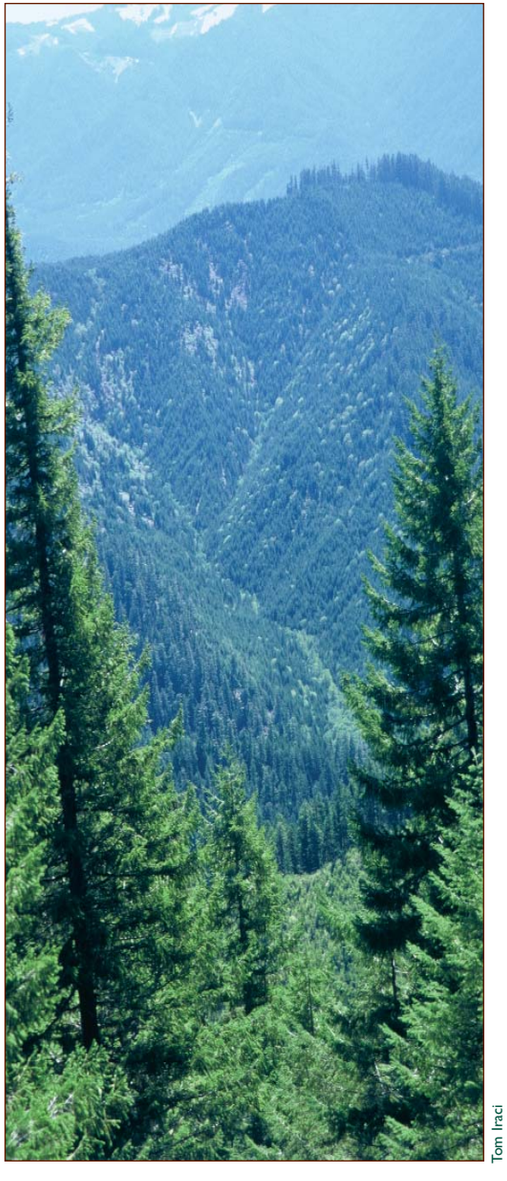
- The Resources Planning Act timber assessment projects that forest products consumption will rise 42 percent by 2050, with marked shifts in the extent and location of domestic and imported supplies. In the long term, U.S. timber harvest is projected to expand by 24 percent. Owing to steadily improving growth and productivity, total timber inventory is projected to expand even as harvest increases and fewer private acres are used as timberland.

- New timber inventories for the National Forest System project total inventory increases under all scenarios for both softwood and hardwood forest types, with increasing areas in older age classes. Under the base scenario, National Forest System timberland with stands older than 150 years would increase from 15 to 32 percent of total timberland by 2050.

- Western Oregon has an estimated 19 million acres of land; about 80 percent of this land is forested, with 71 percent being timberland. Lands administered by the Forest Service and BLM make up about 48 percent of the timberland. Eastern Oregon has an estimated 42.2 million acres of land; about 32 percent of this land is forested, with 76 percent of the forested portion being nonreserved timberland. About 71 percent of the timberland is on National Forest System lands.

- Communities in the Northwest Forest Plan area were defined by using a new approach based on aggregate census blocks. The new approach resulted in 1,325 communities being identified. Station scientists are working with USDA Forest Service Pacific Northwest and Pacific Southwest Regions on an assessment of how well the Northwest Forest Plan is meeting its socioeconomic goals.

- The accuracy of LIDAR (light detection and ranging) in mapping terrain was verified under heavy forest canopy conditions. LIDAR is potentially very useful for mapping small streams, gullies, and high-risk erosion sites under heavy forest cover, as well as providing better data for road and harvest planning.



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Accomplishments

Forest products consumption is projected to rise 42 percent in United States by 2050

The Resources Planning Act (RPA) timber assessment, done every 10 years, presents reasonable projections of changes in the Nation's demand for timber products and in the domestic timber resource. For more than a century, the RPA assessments have been the basis of public discussions on the future of forest resources and have guided the development of forest policies at federal and state levels.

The assessment projects that forest products consumption will rise 42 percent by 2050. Although per capita U.S. wood and paper product consumption is expected to remain just under three-quarters of a ton per person annually, total consumption will rise to meet the demands of another 126 million people. The wood and paper demands would be met by (1) an increase in U.S. timber harvest of 24 percent, (2) an increase in log, chip, and product imports of 85 percent, and (3) an increase in use of recovered paper of 85 percent. Canada is expected to remain the primary source of imports, but imports from Eastern Europe, the Nordic countries, and Southern Hemisphere countries are expected to increase.

Projections of timberland changes show that U.S. timberland area will be 3 percent smaller by 2050, and developed areas will increase by 79 percent, mainly because of growing demands for urban and related land uses from the growing population. To put this in perspective, that means the proportion of the total land base that is developed will increase from 5.2 percent to 9.2 percent.

In the South, however, pine plantations will cover more area, with an increase of 14 million acres, and plantation fiber output will increase by 239 percent (see following story). Owing to steadily improving productivity, total timber inventory is projected to expand even as harvest increases and fewer private acres are used as timberland.

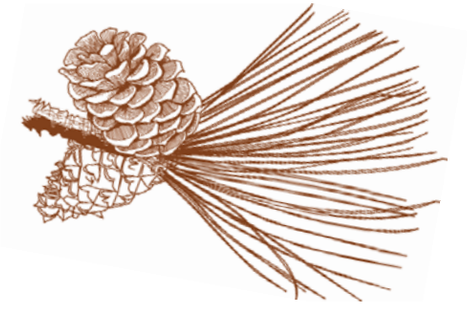
Contacts for timber assessment: Richard Haynes, rhaynes@fs.fed.us, and John Mills, jmills@fs.fed.us, Human and Natural Resources Interactions Program
Partners: Oregon State University, USDA Forest Service Forest Products Laboratory
Contacts for timberland area changes: Ralph Alig, ralig@fs.fed.us, and Jeff Kline, jkline@fs.fed.us, Human and Natural Resources Interactions Program
Partners: Oregon State University, North Carolina State University
More information: Science Findings 55, August 2003. *Biology, Ecology, and Economics at Play: Land Use and Land Cover Changes in the 21st Century*. www.fs.fed.us/pnw/sciencef/scifi55.pdf.

More Southern pine plantations could mean some loss of upland hardwoods

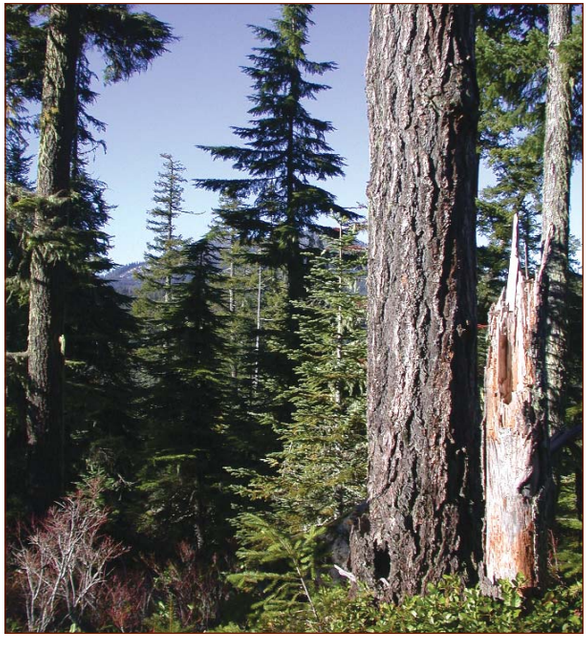
The recent RPA timber assessment predicts that Southern pine plantations, first started in the 1950s, will supply much of the Nation's domestic softwood by 2050. The South will likely become the Nation's "wood basket." Trends are unclear, however, as to exactly how the shift to planted pine will affect the South's native forest types: natural pine, oak-pine, and upland hardwoods.

Projections based on recent historical data indicate that upland hardwood forests could be replaced by pine plantations. Projections that include expert forest manager predictions, however, suggest fast-growing pine plantations will replace slow-growing stands of natural pine. The final projection in the RPA timber assessment uses a hybrid approach, combining historical data with manager intentions. This hybrid approach projects that intensive pine production could occur along southern coastal plains and areas along the Alabama-Mississippi and Louisiana-Arkansas-Texas borders. Hardwood resources could drop in Kentucky, Tennessee, and a little along the Mississippi River.

Contacts: Xiaoping Zhou, xzhou@fs.fed.us, John Mills, jmills@fs.fed.us, Human and Natural Resources Interactions Program
Partner: Auburn University



Although ozone injury is common in California forests, no ozone injury has been detected in Oregon forests since ozone monitoring began in 1998.



Tom Iraci

Timber inventory is projected to increase on National Forest System lands

New timber inventories were completed for the National Forest System by using, for the first time, the same methods used on private timberlands and thus allowing better estimates of all U.S. forest resources. The results project that total inventory will increase under all scenarios for both softwood and hardwood forest types. Scenarios studied include large-scale disturbances such as large fires, insect outbreaks, and tree diseases. Under the base scenario, national forest timberland with stands older than 150 years would increase from 15 to 32 percent of timberland by 2050.

Contacts: John Mills, jmills@fs.fed.us, Xiaoping Zhou, xzhou@fs.fed.us, Human and Natural Resources Interactions Program

West coast forest health data contribute to international reports

The forest health monitoring program collects data on long-term changes in forest health in the United States. Data on carbon in Western forests are relevant to the carbon budget, a major factor in climate change. Carbon loss from dying trees can increase greenhouse gases; carbon stored in wood can mitigate for carbon released elsewhere. On plots in 10 ecoregions in California, forest health monitoring showed both carbon losses and gains. Most losses were in areas where drought and insect outbreaks killed many trees.

Since 1998, forest health monitoring has collected data on lichens that can be used to evaluate air quality. Forest lichens are sensitive to air pollution and climate changes, and are good indicators of forest ecosystem biodiversity. Results so far show a higher lichen species richness in Oregon and Washington than in California. West coast data on carbon and lichens are part of a national database on ecosystem health and condition, used in several recent reports on forest sustainability, including the Heinz Center study, the international Montréal Process, and an Environmental Protection Agency report.

Contact: Sally Campbell, scampbell01@fs.fed.us, Forest Inventory and Analysis Program

County-level data used to study historical trends in Oregon timberland area and volume

Scientists used county-level data in Oregon to find historical trends in Oregon timberland area and volume. The acres in timberland and the volume of timber on those acres both declined from the early 20th century until 1977 in all counties, regardless of whether those counties had low or high harvest levels in proportion to their total growing-stock volume. But after 1977 the trends diverged. Growing-stock volume per acre increased strongly for counties with low

Continue

timber harvest/volume ratios. The five counties with the lowest timber harvest/volume ratios were Josephine, Marion, Washington, Multnomah, and Tillamook. Most of these counties had rapidly growing populations and people who expressed concerns about viewsheds, forest fragmentation, and recreation needs in forests.

For counties with high timber harvest/volume ratios, the growing-stock volume per acre continued to decline slightly after 1977. The five counties with the highest timber harvest/volume ratios were Yamhill, Lane, Curry, Douglas, and Columbia. Changes in land uses appeared to be the overwhelming cause of changes in timberland area and volume; climate variations did not appear to be the cause.

Contact: Joseph Donnegan, jdonnegan@fs.fed.us, Forest Inventory and Analysis Program

Oregon forest inventory results provided to Oregon Department of Forestry

Updated information is available on Oregon forests, with "forest land" defined as land at least 10 percent covered by trees of any size, larger than 1 acre, and at least 120 feet wide. For inventory, the division between western and eastern Oregon is considered the crest of the Cascade Range. The information has been provided to the Oregon Department of Forestry for their upcoming review of the state Forest Practices Act.

Western Oregon has an estimated 19 million acres of land, with about 80 percent of this land forested and 71 percent of the forest acres being timberland. Lands administered by the Forest Service and BLM make up about 48 percent of the timberland.

Eastern Oregon has an estimated 42.2 million acres of land; about 32 percent of this land is forested, with 76 percent of the forest acres being nonreserved timberland. The amount of forest land in eastern Oregon has increased by about 650,000 acres since the 1930s. Ponderosa pine is predominant out of the 31 tree species in eastern Oregon. The Forest Service, BLM, and other federal agencies manage about 71 percent of eastern Oregon forests; about 27 percent is privately owned;

Tom Iraci

and the remaining 2 percent is managed by the Oregon Department of Forestry and other nonfederal public agencies. Eastern Oregon has about 25.7 billion cubic feet of timber, of which about 312 million cubic feet per year were harvested between 1987 and 1999. These results were published in PNW-GTR-578.

Although ozone injury is common in California forests, no ozone injury has been detected in Oregon forests since ozone monitoring began in 1998. Ozone causes visible injury to foliage and may cause long-term growth loss and contribute to tree death when combined with insects or disease.

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Contact for eastern Oregon forests: Sally Campbell, scampbell01@fs.fed.us, Forest Inventory and Analysis Program

Science-based framework for monitoring the success of riparian management and restoration projects will help in monitoring watersheds on large and small scales.

New method tested for predicting spotted owl abundance and nesting success

Traditionally, northern spotted owl populations have been assessed by calling in adult owls, banding them, locating owl nests, climbing trees to count young owls in nests, and then relocating owls and nests each year. These surveys are expensive and time consuming and may disrupt owls. Scientists are testing a method based on the type and amount of forest vegetation around a nest site for its accuracy in predicting owl survival and reproductive rates. The two methods have been tested in three Oregon forests, one near Roseburg, one in the Coast Range, and one in the west central Cascade Range.

Results suggest that it is difficult to predict survival and productivity of owls based on vegetation attributes alone, because weather, age of owls, and the presence or absence of barred owls have a strong influence as well. Preliminary comparison of the two methods indicates that the traditional demographic methods are more accurate.

Contact: Eric Forsman, eforsman@fs.fed.us, Ecosystem Processes Program

Red tree voles: Who are they and where do they go?

Tree voles are unique arboreal mice that occur only in Oregon and northern California. Red tree voles are also a primary food for northern spotted owls. Accurate information about the seldom-seen, canopy-dwelling voles has been scarce, but new taxonomic and genetic studies have clarified vole taxonomy. Scientists established conclusively that the red tree vole, found in Oregon and parts of northern California, is indeed a distinct species from the Sonoma tree vole, whose range is northern California beyond the red tree vole's range. Research also determined that both species are distinct from the whitefooted vole and heather voles, and that some debated populations of the tree voles are not valid subspecies. Genetic work continues to determine if there are unique and isolated subpopulations within the red tree vole species.

Scientists are also investigating red tree vole ecology and behavior. The use of tiny radio collars, weighing less than a gram each, has allowed scientists to track red tree vole movements in forest canopies and year-round. So far, the radio telemetry work has shown that red tree voles use multiple nests in different trees and that both male and female voles stay up in trees year-round. No use of ground nests has been detected, but occasional use of cavity nests has been documented. So far, no evidence has emerged of seasonal differences in vole movements. Better knowledge of red tree vole ecology can be used in estimating the effects of forest management on this preferred prey of northern spotted owls.

Contact: Eric Forsman, eforsman@fs.fed.us, Ecosystem Processes Program

New findings on wild salmon genetic diversity could lead to improved conservation strategies

Wild salmon have survived in the tumultuous and changing environments of southeast Alaska rivers by developing hundreds of specially adapted salmon runs, or "stocks." Each salmon stock is genetically adapted to its home watershed through variations in life history, disease resistance, size, and migratory behavior. The conservation of wild salmon requires giving thought to conserving their genetic diversity.

Scientists looked for these markers of wild salmon genetic diversity: (1) high potential for adaptive variation, including distinctive run timing; (2) a distinctive trait in combination with high spawner

Tom Iraci

Conservation of wild salmon requires thought to conserving their genetic diversity.

abundance, or genetic markers (allozymes) that diverge from geographic clustering patterns; and (3) more than one distinctive characteristic or freshwater habitat shared with other distinctive populations. Of 47 salmon populations that have been adequately sampled from a population of 9,000 populations in southeast Alaska, 22 populations met the criteria for genetic diversity.

Protecting freshwater habitats for these stocks with high genetic diversity may be the most practical approach for conserving Pacific salmon diversity. Freshwater habitats for 6 of the 22 identified populations are located in watersheds without restrictive land use designations such as roadless, wilderness, or national park. Habitat protection for just a few additional watersheds could help preserve much genetic diversity in wild salmon.

Contact: Mason D. Bryant, mdbryant@fs.fed.us, Aquatic and Land Interactions Program

Effectiveness monitoring asks if aquatic strategies are achieving goals in Northwest Forest Plan area

The Northwest Forest Plan (NWFP) brought together land-based strategies to protect old-growth forests, spotted owls, and associated species, with stream-network based strategies to protect watersheds, salmon, and other aquatic life. Effectiveness monitoring was a vital part of the plan, asking if the new strategies were achieving the plan's goals.

Station scientists developed a science-based framework and program for monitoring the success of riparian management areas and restoration projects in the NWFP area. The program is designed to evaluate the ecological status and trends of watersheds. A suite of indicators is measured: amounts and composition of riparian vegetation, number of roads and stream crossings, and other data that reveal the ecological integrity of and threats to streams. Data are fed into decision support models that can help determine trends and cause-and-effect relationships. The framework can be used to monitor watersheds at the scale of the NWFP area, and at smaller scales such as individual ranger districts.

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Community-level socioeconomic monitoring underway in Northwest Forest Plan area

In finding out how people are faring under the Northwest Forest Plan (NWFP), Station scientists looked to the U.S. census, conducted every 10 years, for socioeconomic data. Station scientists needed first to delimit communities, or describe their geographic boundaries. The U.S. census uses several types of geographic units for different purposes. "Census places" leave out many people in unincorporated rural areas, but "block group aggregations" count everyone. For the NWFP region, excluding major metropolitan areas, the block group aggregations include almost 4 million people, but the census places include only 2.5 million people, leaving out nearly 1.5 million people in the geographic area.

Using the block group aggregation process, scientists identified 1,325 communities in the NWFP area, including many unincorporated rural areas. These results, published in PNW-GTR-570, are being used as the framework for community-level socioeconomic monitoring, now underway in 12 communities and 4 federal forests in Washington, Oregon, and California. Scientists are monitoring social and economic trends in the communities and evaluating how these trends are linked to NWFP implementation. The results, to be published at the end of 2004, will be one measure of how well the NWFP is meeting its socioeconomic goals. Complete socioeconomic monitoring also may include indepth case studies, studies of non-place-based communities (skiers or hunters, for example), and other measures.

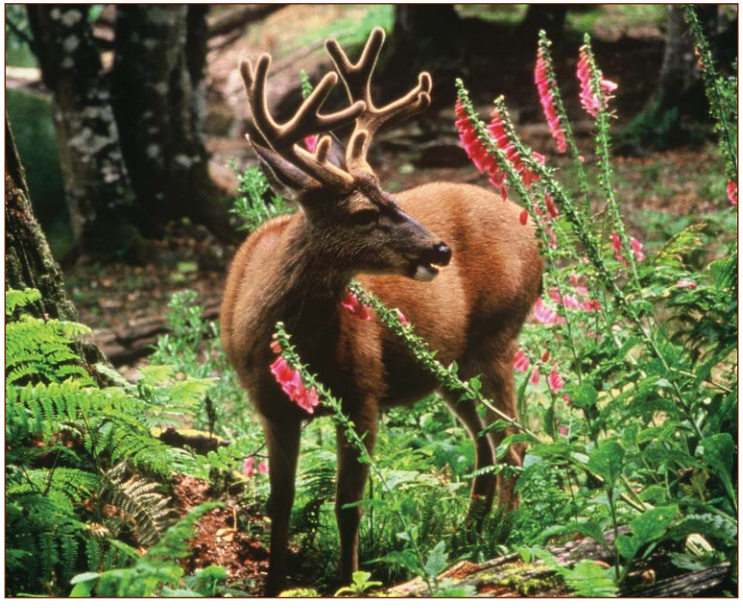
Contact for delimiting approach: Ellen Donoghue, edonoghue@fs.fed.us, Human and Natural Resources Interactions Program
Contact for socioeconomic monitoring: Susan Charnley, scharnley@fs.fed.us, Human and Natural Resources Interactions Program
Partners: USDA Forest Service Pacific Northwest and Pacific Southwest Regions

LIDAR maps the ground accurately through heavy forest canopy

Airborne laser scanning systems (commonly referred to as **LI**ght **D**etection **A**nd **R**anging, or LIDAR, systems) can map open ground with an accuracy within 6 inches of actual elevation. A new study tested the accuracy of LIDAR in heavily forested areas. A high-resolution map of the ground was produced from high-density LIDAR data for a mountainous second-growth forest near Olympia, Washington. Next, in a ground survey, coordinates were measured for several hundred checkpoints under canopy conditions ranging from clearcut areas to dense second-growth stands.

The LIDAR map was found to be extremely accurate. Overall LIDAR elevation error was extremely low (8 inches), with errors slightly higher in dense canopy areas. LIDAR is potentially very useful for mapping small streams, gullies, and high-risk erosion sites under heavy forest cover, as well as for providing better data for road and harvest planning. Further research is underway to determine whether LIDAR is useful for mapping forest vegetation structure and characterizing fuel conditions in forests.

Contact: Steve Reutebuch, sreutebuch@fs.fed.us, Resource Management and Productivity Program
Partners: Washington State Department of Natural Resources; USDA Forest Service Joint Fire Sciences Program; University of Washington; U.S. Department of Defense, Fort Lewis



Tom Iraci

Tom Iraci

New methods supply more accurate data about juniper expansion in eastern Oregon.

Plot sizes evaluated for western juniper seedlings, and plot designs tested for mature coastal Douglas-fir forests

The Station Forest Inventory and Analysis (FIA) Program collects data on over 2,000 forest plots in Oregon, Washington, and California annually. Scientists regularly test plot designs and sampling methods for efficiency and accuracy.

In western juniper forests, seedlings and saplings grow from natural regeneration and typically are sparsely and irregularly distributed among large junipers. Their chances of long-term survival are good, however, and a stocking survey needs to count these future overstory trees to be accurate. Scientists tested the accuracy of four plot sizes for evaluating western juniper forest land and tallying seedlings and saplings accurately. They found that the plot size can be adjusted depending on stand density and the level of acceptable error, offering a way to control sampling costs. Results should improve the accuracy of juniper forest land inventories. The FIA Program used this method to evaluate seedlings and saplings in the 1998 inventory of eastern Oregon.

In mature coastal Douglas-fir forests, an improved plot design is being used to monitor stand structure. A study showed that sampling 40 percent of a 1-hectare (2.471 acres) plot, using four subplots, was required to keep the error rate for estimated density of large trees (trees larger than 48 inches diameter breast height) to acceptable levels. The improved accuracy of the sampling makes inventory data more useful for looking at stand structure, forest development, carbon storage, and species diversity. The improved plot design is now being used on all FIA Program field plots.

Contact for plots in mature coastal Douglas-fir forests: Andrew Gray, agray01@fs.fed.us, Forest Inventory and Analysis Program
Contact for evaluating plot size in western juniper: David L. Azuma, dazuma@fs.fed.us, Forest Inventory and Analysis Program

Automated interpretation of aerial digital photographs tested for juniper inventory

In eastern Oregon, juniper inventory supplies data about the rapid expansion of juniper, changes in stand density, and effects on understory species. Scientists tested a method for automatically interpreting aerial infrared photographs of juniper plots. The juniper trees were generally apparent on most of these images, and trained staff could estimate juniper distribution, density, and size from the photographs. An automated interpretation technique was tested that used a combination of image preprocessing and rule-based, crown-delineation techniques, to identify the same information. The automated interpretation identified junipers correctly 74 percent of the time when junipers were present. In images with no junipers, the automated technique incorrectly identified junipers as being there only 2 percent of the time. When automatic interpretation reaches acceptable levels of accuracy, the technique could decrease inventory costs.

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Goal 3: Develop Science-Based Options for Informed Management

Key Findings and Products:

- The dynamic MC1 model can incorporate historical, current, and projected weather and climate information, along with vegetation information, to forecast current-year fire risks over the United States. Through MC1, scientists are producing 6-month fire risk forecasts that will allow agencies to better anticipate firefighting needs. Over the last several years, MC1's forecasts have been validated for accuracy as the fire seasons unfolded.

- The BlueSky smoke modeling framework effectively predicts smoke impacts from both wild and prescribed fires. In 2003, BlueSky became operational in the Northwestern United States and in parts of Arizona and New Mexico. It was used to coordinate and plan prescribed burning across land ownerships, and it was used on at least three large wildfires to help determine firefighting strategies and warn nearby communities of potential health impacts.

- The BioSum computer model can be used in any geographical area to evaluate the area's potential to supply wood for a biomass cogeneration plant or any other type of wood processing plant. BioSum can be used to determine whether areas proposed for these types of plants have the right mix of resources, terrain, and transportation infrastructure to make the proposed operation economically feasible.

- The new Spatial Resource Support System (SpaRSS) project uses geographic information system methods and existing information on forest inventories, population density, and fire threat to demonstrate a method for allocating funding to various state and private forestry programs.

- In the Blue Mountains of northeastern Oregon, analysis of the forests, fire threat, and potential timber removals associated with fuel reduction show that only 29 percent of the 5.5 million federally administered acres in the Blue Mountains are available for timber management activities. Only about one-fourth of the accessible, heavily stocked acres on federal lands have commercial potential. Of these, only about 10 percent (about 40,000 acres) would have enough timber value to offset the costs of fuel reduction treatment.

- The Douglas-fir levels-of-growing-stock (LOGS) study, begun in the 1960s, continues to yield results. The LOGS study has shown that thinning will produce larger trees quickly but also can reduce stand volume production over short rotations, depending on the intensity of the treatment and the productivity of the site.

- Thinning and underplanting increase structural diversity in stands previously managed intensively for wood production, which cover nearly a million acres in western Oregon alone. Heavy thinning and underplanting can lead to improved structural and biological diversity in young forests within 8 years.

- A new tool is available to advise forest managers on the role and importance of dead wood. Managers can use "DecAID" to prescribe snag and down wood sizes and amounts needed for wildlife and to evaluate the effects of current conditions and proposed activities on wildlife species that use snags and down wood.

- Genetic research has determined that

some families of Douglas-fir can tolerate Swiss needle cast infection. New seed orchards have been established to develop a Douglas-fir seed source that can be used in species mixes where moderate levels of the disease are present.

- Alternative mechanical harvesting techniques can reduce fuel loads and protect large, live, retention trees, but differ in environmental effects and economic efficiency. Two log extraction systems both reduced fuels and protected large trees, but the forwarder yarding system caused slightly more damage to trees than the skyline yarding system. However, operational costs for the skyline harvest units were nearly double the costs on the forwarder units.

- Wildland fires will continue to burn. The question before public land managers and policymakers is, How might we influence the timing, severity, and pattern of wildland fires to achieve ecological management goals such as renewal of stream habitats? Active management of fire and fuels for stream restoration goals is most effective when a full spectrum of ecological patterns and processes is considered.

- New methods were developed to characterize stream bottom types and were tested in the highly variable streams found in the upper Grande Ronde subbasin in northeastern Oregon. Managers can use these new methods as they design plans to protect and restore riparian ecosystems. For example, management needs are different for steep, high-gradient (Type A) streams and low-gradient, meandering (Type E) streams.

- Collaborative groups, such as the Applegate Partnership in southwestern Oregon, are successful where there is an opportunity for providing evaluation and feedback, engaging needed participants, and responding to groups critical of the collaborative process.

Accomplishments

Dynamic model effectively forecasts current-year fire risks over the United States

The dynamic MC1 model can incorporate historical, current, and projected weather and climate information, along with vegetation information, to forecast current-year fire risks over the United States. The model uses huge climate databases, with actual observed weather covering the whole country from 1895 to the present. Weather databases are brought up to date each month. For near-term forecasts, MC1 uses 6-month weather forecasts produced by three global climate models, all of which take into account fully dynamic oceans, including current sea surface temperatures and short-term anomalies such as El Niño.

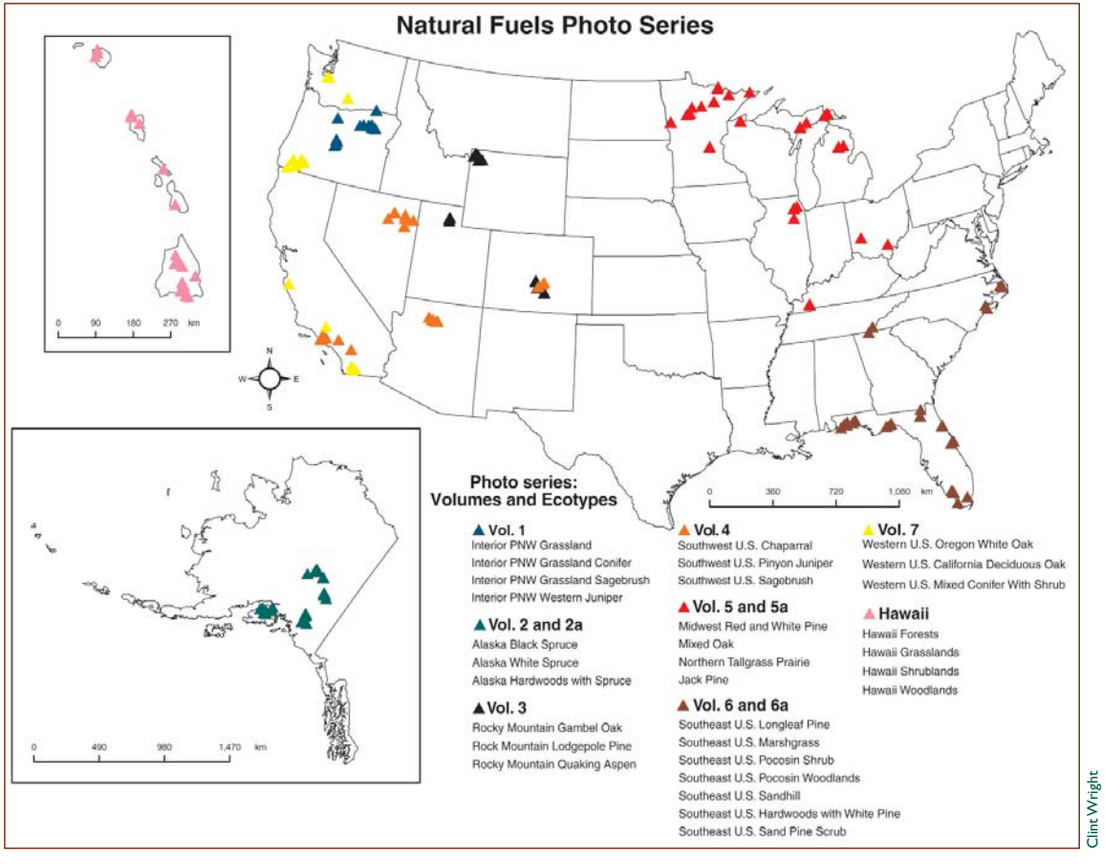
Tom Iraci

The new model's fire season forecasts have been validated over the last several years. This experimental model will eventually help managers plan for fire season contingencies.

Over the last several years, MC1's forecasts have been validated by their accuracy as the fire seasons unfolded.

The model's consensus forecast for the 2003 fire season predicted a lower level of fire risk compared to 2001 and 2002. Observed fire activity in the 2003 fire season correlated well with MC1's forecast. The model forecast the approximate location of the B and B complex in Oregon, and it forecast late-season fires in southern California. However, since the model does not yet incorporate Santa Ana winds, it did not predict the severity and extent of the late-season wildfire disaster in southern California.

Although preliminary results are encouraging, the model should still be considered experimental. Fire managers across the country are evaluating the model; eventually the model should be useful for anticipating firefighting needs. Policymakers at all levels, from local to national, are very interested in how the model can help them plan for fire season contingencies. Officials including the Secretaries of Agriculture and the Interior, USDA Undersecretary, and USDA Forest Service Chief have requested briefings on the model and research.



Clint Wright

Natural fuels photo series now cover ecotypes throughout the United States, including Alaska and Hawaii.

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Partners: Oregon State University, Desert Research Institute, Scripps Institute of Oceanography
More information: Science Update 6, January 2004. *Western Forests, Fire Risk,* and *Climate Change*. www.fs.fed.us/pnw/pubs/science-update-6.pdf.

Natural fuels photo series are used to rapidly assess fuel properties

Wildland fuel loads are critical data for fire behavior forecasts, prescribed burn plans, and smoke management. The collection of detailed and precise fuels data takes time-consuming field inventory; best guesses are a poor substitute. Fire managers have relied

on photo series guides for years as invaluable guides to quickly and accurately assess fuel loads on timber harvest units.

Scientists have developed photo series guides to natural forest and grassland fuels to provide the same quick, accurate assessments for the wide range of natural fuel situations. Over the past 5 years, 10 photo series volumes, representing 35 ecosystem types throughout the Americas from central Alaska to central Brazil, have been completed and distributed to thousands of land managers, scientists, and researchers throughout the world. Managers can use the guides to quickly figure the tons per acre in standard fuel categories and arrive at a total biomass for field sites.

Hundreds of managers are learning each year to use these guides, through National Wildfire Coordinating Group fire training courses. Today, nearly all federal, state, and private fuel and fire managers use these photo series to quantify fire severity and hazard, air pollutant emissions, and other fire effects. Average fuel inventory time per field site has been reduced from 21 to 3 person-hours, saving $1,500 in inventory costs per unit sampled. The photos and data are also being used to describe new fuel models for improved fire behavior prediction. Information for ordering the guides is at http://www.fs.fed.us/pnw/fera/pmsorder.html.

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Partners: Rocky Mountain, Pacific Southwest, and Southern Research Stations; USDA Forest Service Fire and Aviation Management (Washington Office) and Southwestern Region; USDI Fish and Wildlife Service

Smoke ventilation and hazard system is used by hundreds of fire managers

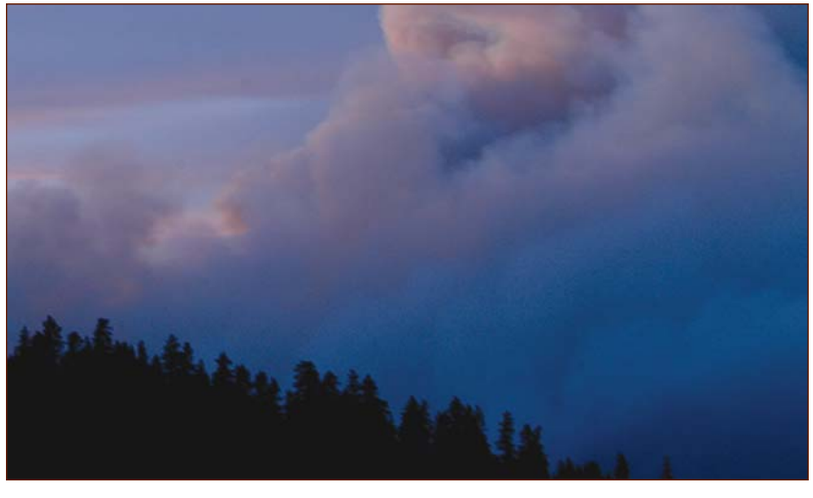
The ventilation climate information system (VCIS) is a 40-year database that includes twice-daily values of wind, smoke mixing height, and their product, a ventilation index. Users can determine the probability of good or poor smoke ventilation and smoke dispersal at any time of the year or from any point on the landscape, by accessing the system's Web-based map and database at http://www.fs.fed.us/pnw/fera/vent/. Prescribed-fire managers and forest planners use VCIS to estimate smoke effects. Through a geographic information system, data layers from VCIS can be combined with data layers about fuel condition, fire regime, grazing patterns, lightning potential, and drought potential, to produce fire risk maps that include all the risk factors.

About 400 fire managers have been trained to use VCIS for prescribed fire and forest planning. During the 2002 Biscuit Fire in Oregon, the incident command team used the system to estimate continuing smoke impacts and issue smoke hazard warnings to about 500,000 people in the region around the fire. Work continues to improve VCIS's documentation to meet National Environmental Policy Act requirements.

Contact: Sue Ferguson, sferguson@fs.fed.us, Managing Disturbance Regimes Program

BlueSky smoke model gives a clear picture of what smoke is doing

Smoke from prescribed fires and wildfires affects air quality. The BlueSky smoke modeling framework effectively predicts smoke impacts from both wild and prescribed fires. BlueSky links information on atmospheric processes with components of fuel structure, moisture dynamics, consumption, emissions, fire behavior, plume dynamics, and dispersion and deposition of gases and aerosols. The prototype uses several existing



Tom Iraci

The BlueSky smoke model is being used on large wildfires to warn nearby communities of potential health impacts.

BlueSky has been used on at least three large wildfires. Through eight workshops, Station scientists introduced BlueSky to over 150 managers and regulators from 10 states and 5 regional and local air agencies.

computer models (CONSUME, EPM, and FCC) also developed by Station scientists.

In 2003, BlueSky became operational in the Northwestern United States and parts of Arizona and New Mexico, and was linked with the Environmental Protection Agency's Rapid Access INformation System (RAINS). It gave fire managers a much improved ability to estimate how much smoke would be produced, to track the actual smoke produced, and to forecast smoke movement for the next several days. BlueSky is being used to coordinate and plan prescribed burning across land ownerships, and it has been used on at least three large wildfires to help determine firefighting strategies and warn nearby communities of potential health impacts. Through eight workshops, Station scientists introduced BlueSky to over 150 managers and regulators from 10 states and 5 regional and local air agencies.

The BlueSky smoke modeling framework can be accessed on the Web site http://www.fs.fed.us/BlueSky.

Contact: Sue Ferguson, sferguson@fs.fed.us, Managing Disturbance Regimes Program

BioSum model is in demand for analyzing biomass plant opportunities in several states

Recent proposals for large-scale fuel treatment have renewed interest in biomass-based energy generation as a way to use substantial volumes of small-diameter wood. Scientists have developed BioSum, a computer model that can be used in any geographical area to evaluate the area's potential to supply wood for a biomass cogeneration plant or any other type of wood processing plant. BioSum uses data from the established forest inventory plots, which offer an unbiased and statistically representative sample of all forested lands in Western States.

BioSum can be used to determine whether areas proposed for these types of plants have the right mix of resources, terrain, and transportation infrastructure to make the proposed operation economically feasible. The first BioSum analysis was done for southwestern Oregon. Biomass operators in northern California's Shasta County realized from that pilot study, that biomass recovery opportunities in southwest Oregon would be less enticing than they had hoped. Proponents of biomass plant construction in New Mexico and Arizona are very eager to have BioSum analysis conducted for their regions, to objectively assess the opportunities.

County commissioners and the New Mexico state forester are among the people requesting BioSum analyses. They recognize that the BioSum model provides an objective method to identify the most fruitful places to use wood product recovery to support hazardous fuels reduction activities. The model gives decisionmakers a tool for sorting through the constant stream of proposals to fund studies of these types of facilities.

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Partners: National Fire Plan, Joint Fire Science Program

Framework is being developed for cost-benefit analysis of fuel treatments

Hazardous fuels reduction treatments, such as prescribed burning and thinning, are advocated to reduce the threat of wildfires. The economics of these treatments are often unclear. A cost-benefit analysis involves how much the probability, size, and intensity of fires are reduced; whether marketable wood products can be generated; the costs of fuel treatments; and balancing the costs and benefits of wildfires vs. fuel treatments on other forest values. Costs and benefits are long term, and many factors are involved. Scientists are

Tom Iraci

New tools analyze the economics of fuel treatments.

developing a conceptual framework for cost-benefit analysis of fuel treatments, including an assessment of existing Forest Service research.

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New tools speed up economic analysis of fuel treatment plans

To meet National Environmental Policy Act (NEPA) requirements, fire managers need to provide information on the economics of their planned fuel treatments, including whether or not wood products can be generated to offset costs. Scientists are developing a synthesis of economics and wood use information, in products convenient for fire manager needs. One product is a series of fact sheets on key points that need to be addressed in NEPA planning.

The second product is a fuel treatment planner tool that provides a series of linked calculators that do much of the financial analysis required in a NEPA document for fuel treatment. The planner tool is linked to a broad synthesis of information needed for fuel treatment planning, including stand structure, fire behavior, fire effects, and social interactions.

Contact: Roger Fight, rfight@fs.fed.us, Human and Natural Resources Interactions Program
Partners: Focused Science Delivery Program; Rocky Mountain and North Central Research Stations, USDA Forest Service Fire and Aviation Management (Washington Office)

User-friendly system helps nonexperts use geographic information systems (GIS)

Maps with digital data layers, also known as GIS, are now vital tools in managing resources. Although many maps and supporting data layers are rapidly becoming available, decisionmakers have few user-friendly tools for interpreting these maps.

Scientists are developing the Spatial Resource Support System (SpaRSS), an evaluation system that accounts for human needs, ecological conditions of forests, and fire threat. SpaRSS focuses on three areas: (1) assembly of relevant multidisciplinary digital data layers and maps, (2) estimates that integrate the data as support for objective decisionmaking, and (3) comparison of results arising from different approaches to integrating GIS layers and from different management alternatives. The system features a user-friendly interface, does not require an extensive background in GIS, and will be available for installation on personal computers or via the Internet.

Scientists used the new GIS tool and existing information on forest inventories, population density, and fire threat to demonstrate a method for allocating funding to various state and private forestry programs. The system was used to

allocate National Fire Plan thinning funds from the national to the regional level in fiscal year 2003 and will be used with other cooperative forestry programs in fiscal year 2004.

Contact: Jamie Barbour, jbarbour01@fs.fed.us, Focused Science Delivery Program
Partners: North Central and Rocky Mountain Research Stations, USDA Forest Service State and Private Forestry

New decision-support system is a promising tool to set restoration priorities and strategies

The landscape patterns and disturbance regimes of interior Columbia basin forests have been dramatically changed by the past two centuries of settlement and land use. Scientists have developed a decision-support tool that helps forest managers understand how changes they see in individual stands affect the larger landscape, and how changes in landscapes affect the larger ecoregion.

Scientists first mapped and quantified the patterns of forest structure and species composition, down wood, and fire behavior attributes of one ecoregion from the earliest available historical (1930s) aerial photography. Then they reconstructed the vegetation characteristics of any stand showing evidence of early selective cutting or management. The reconstructed estimates of the range and variation of historical vegetation patterns (reference variation, RV) were then programmed into the ecosystem management decision-support system (EMDS) to evaluate the landscape conditions at varying scales.

At the ecoregion scale, the decision-support system gave a rapid and strategic view of conditions and estimated relative priorities and feasibility for watershed restoration. At the watershed scale, RV estimates were used to identify changes in landscape patterns beyond the typical, historical range of variation. The system is also used to evaluate the benefits and tradeoffs of different restoration scenarios. Benefits of the decision-support system include accounting for many

Tom Iraci

New decision-support tools help managers evaluate benefits and tradeoffs of restoration scenarios for interior Columbia basin forests.

factors and complex relationships in forests, all while tracking planning logic, assumptions, and important tradeoffs.

Forest managers in the Pacific Northwest and Northern Regions are beginning to use decision-support tools to develop restoration strategies and priorities and to track the tradeoffs associated with their decisions. The new system described here is a valuable addition to existing decision-support tools.

Contact: Paul Hessburg, phessburg@fs.fed.us, Managing Disturbance Regimes Program

Fuel reduction work in Blue Mountains has limited commercial potential

Federal forests and rangelands cover 5.5 million acres in the Blue Mountains of northeastern Oregon. Many of the forested acres have heavy fuel loads. At the request of Oregon's governor, Station

scientists helped with a major analysis of Blue Mountains forests, fuels, and potential timber removals associated with fuel reduction.

The analysis found that only 29 percent of the acres are available for timber management activities. Timber harvest is not permitted in areas such as the Eagle Cap and North Fork John Day River Wilderness Areas. Further analysis suggests that only about one-fourth of the accessible, heavily stocked acres on federal lands have commercial potential, defined as more than 400 cubic feet per acre of trees larger than 7 inches in diameter at breast height. (The analysis assumed that no trees larger than 21 inches in diameter would be harvested.) Of the federal forest acres with commercial potential, only about 10 percent, or about 40,000 acres, would have enough timber value to offset the costs of fuel reduction treatment. If restrictions on harvesting large trees were removed, the acres that could be treated without a subsidy might increase to about 80,000.

Contacts: Roger Fight, rfight@fs.fed.us, Human and Natural Resources Interactions Program; Jamie Barbour, jbarbour01@fs.fed.us, Focused Science Delivery Program;
Partners: Oregon Department of Forestry, USDA Forest Service Pacific Northwest Region

Tom Iraci

In the Blue Mountains of northeastern Oregon, only about one-fourth of the accessible, heavily stocked acres on federal land have commercial potential.

New tools are being developed to assist with fuel hazard reduction

The Interior Northwest Landscape Analysis System (INLAS) is a tool to analyze the effects of forest succession, disturbances such as fires, and forest management, on forests in the interior Columbia basin. Of specific interest is the measurement of long-term cumulative effects of fuels management. Scientists have developed two alternative methods to create the model framework. The INLAS framework will be linked to other models on wildlife habitat, stream conditions, and socioeconomic values.

The first analyses with INLAS suggest that returning east-side forests to single-story, more open, old forests through passive management could take several hundred years and would need a higher fire frequency than is now common. On the other hand, thinning and fuel treatment could create more acres of single-story old forests in 100 years than passive management would in that same time. Thinning also would produce some merchantable timber and create more habitat for some wildlife species.

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Partners: Blue Mountains Demonstration Area, Wallowa-Whitman National Forest, Boise Cascade, Oregon State University, Oregon Department of Forestry

New system being developed to track the costs of fighting wildfires

Fire managers are concerned with tracking and controlling the costs of fighting wildfires. The Forest Service's long-time wildfire budgeting model has been the National Fire Management Analysis System (NFMAS), which is based on a cost plus net value change model. Scientists found two errors in the NFMAS model formulation, errors with serious implications for the model's capacity to identify the most efficient level of fire management expenditure. The scientists are now developing a corrected model, still using the cost plus net value change framework. This model architecture will be used to develop a replacement for NFMAS and should be a useful tool for controlling wildfire costs.

Contact: Geoffrey Donovan, gdonovan@fs.fed.us, Human and Natural Resources Interactions Program

Managers can use DecAID Advisor to prescribe snag and down wood sizes and amounts needed for wildlife.

Timely results from long-term thinning research in Douglas-fir

The Douglas-fir levels-of-growing-stock (LOGS) study, begun in the 1960s, continues to yield results. The LOGS stands are already 40 to 50 years old, older than the planned rotations on some intensively managed plantations, and the LOGS study is of most interest to managers who plan to manage young forests under long, extended rotations. The LOGS study has shown that thinning will produce larger trees quickly but also can reduce stand volume production over short rotations, depending on the intensity of the treatment and the productivity of the site. In the 40 years since the study began, forest landowner goals have expanded from wood production to include wildlife habitat, recreation, and aesthetics. The LOGS study is yielding unexpected positive outcomes related to these goals, showing the role of thinning in accelerating stand structure development that can benefit aesthetics and many wildlife species.

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Partners: Washington State Department of Natural Resources, Canadian Forest Service, British Columbia Ministry of Forests, Oregon State University, Weyerhaeuser Company

Conifer seedlings respond strongly only when both overstory and understory vegetation reduced

In a new phase of research for the overstory density study at Capitol State Forest in western Washington, competing vegetation was removed in 2002 and 2003 with herbicides around seedlings of Douglas-fir, western hemlock, and western redcedar growing in clearcuts, shelterwoods, and thinned stands of mature Douglas-fir. First-year results indicate that soil water increased strongly only when densities of both overstory and understory vegetation were reduced. Seedling growth also increased as the density of competing vegetation was reduced, but the rate of growth increase leveled off as the density of competing vegetation approached zero. In shelterwoods and thinned stands, western hemlock and Douglas-fir had little response to removal of competing vegetation because overstory trees had already limited the amount of soil water available to the seedlings.

Contact: Tim Harrington, tharrington@fs.fed.us, Resource Management and Productivity Program
Partner: Washington State Department of Natural Resources

Thinning and underplanting increase structural diversity in stands previously managed intensively for wood production

Nearly a million acres of 30- to 50-year-old forests in western Oregon were previously managed intensively for wood production. Many landowners now wish to expand their objectives for the young forests and add more tree species, increase structural complexity, grow large-diameter trees, and develop understories and large down wood.

Tom Iraci

New silvicultural studies tend to focus on what is left behind in the forest, rather than on what is taken out.

Tom Iraci

DecAID Advisor helps managers meet snag and down wood needs for wildlife from bluebirds to bats.

Station scientists and their partners are finding that heavy thinning and underplanting can lead to improved structural and biological diversity in young forests within 8 years. After the heavy thinning, overstory trees grow faster, develop deeper crowns, and keep their lower branches alive longer. Hardwoods and conifers regenerate under the thinned stands, with underplanted trees growing nearly five times taller than naturally regenerated trees. In sum, the treatments promote development of multilayered, diverse stands, a good foundation for future old-forest habitats. Forest managers are already using the information, and the findings are being used to improve models of stand development.

Contact: Samuel Chan, schan@fs.fed.us, Resource Management and Productivity Program
Partners: Siuslaw National Forest, Oregon State University

New tool advises forest managers on snag and down wood prescriptions

The many ecological roles of dead and decaying wood have been recognized in recent years. Scientists developed the "DecAID Advisor" from data and research in Oregon and Washington forests. DecAID Advisor is a planning tool that managers can use as they conserve and manage snags, partially dead trees, and down wood.

Managers can use DecAID Advisor to prescribe snag and down wood sizes and amounts needed for wildlife, and to evaluate the effects of current conditions and proposed activities on wildlife species that use snags and down wood. The name "DecAID" can be read as decayed wood advisor and management aid ("decay-aid" or "decision-aid"). Or, the name can signify long-term planning advice, as over "decades" of time.

Contacts: Bruce Marcot, bmarcot@fs.fed.us, and Janet Ohmann, johmann@fs.fed.us, Ecosystem Processes Program
Partner: USDA Forest Service Pacific Northwest Region, U.S. Fish and Wildlife Service

PNW Research Station strengthens Agenda 2020 partnerships

The Agenda 2020 program was established several years ago as a research partnership among the forest products industry, the U.S. Department of Energy, and the USDA Forest Service. Agenda 2020 represents the industry-supported research agenda to ensure substantial forest resources and sustainable management for the future. National projects are in areas such as biomass gasification and new forest products.

Last year, the PNW Research Station's Resource Management and Productivity Program (RMP) established a regional template for others to use in competing for regional projects from the Agenda 2020 program. The RMP process for competing, selecting, and funding Agenda 2020 research has been emulated by other research stations. In March 2003, RMP hosted a workshop where principal investigators and management from all three western Forest Service research stations met with the Western American Forest and Paper Association executive

committee to present the science content and progress, discuss funding commitments, and collect all the study plans for statistical review. RMP also collaborates in the Fall River long-term site productivity study, funded through the national Agenda 2020 program.

Contact for Agenda 2020 program: Charley Peterson, cepeterson@fs.fed.us, Resource Management and Productivity Program

New seed orchards are established with Swiss-needle-cast-tolerant Douglas-fir

Swiss needle cast, a native fungal disease of Douglas-fir needles, has intensified in the Oregon Coast Range since the early 1990s. The disease leads to needle loss, reduced photosynthesis, and severely reduced growth for infected trees. Scientists made progress on two fronts to help foresters manage the disease's effects.

Genetic research has determined that some families of Douglas-fir can tolerate Swiss needle cast infection, able to grow even with moderate levels of defoliation. New seed orchards have been established to develop a Douglas-fir seed source that can be used in species mixes where moderate levels of the disease are present. Douglas-fir is still not recommended in areas of high disease pressure.

In the second project, scientists are developing a risk assessment model that can identify sites in the northern Oregon Coast Range where Swiss needle cast effects will be minimal. The model is based on research into Douglas-fir carbon assimilation and correlations between reduced carbon assimilation and tree growth. The risk assessment model uses these data, in conjunction with a fungal epidemiology model currently being tested. Forest managers can use the model to identify planting sites where Douglas-fir may be suitable. An updated version of the model, compatible with common software, is currently available from the contact scientist.

Contact for Swiss-needle-cast-tolerant Douglas-fir: Randy Johnson, randyjohnson@fs.fed.us, Resource Management and Productivity Program
Partners: Swiss Needle Cast Cooperative; Northwest Tree Improvement Cooperative; Oregon State University
Contact for model to assess risk of Swiss needle cast damage: Daniel Manter, dmanter@fs.fed.us, Managing Disturbance Regimes Program
Partners: Swiss Needle Cast Cooperative (interagency); Oregon State University

Genetically improved Douglas-fir show early gains in growth over unimproved trees

Considerable work and funds have been invested in Douglas-fir tree improvement programs in the Pacific Northwest, and seed orchards are now producing large amounts of improved seed. Despite the large investment, fundamental questions remain unanswered about the growth of genetically improved trees and the interactions of genetics and silviculture. Station geneticists have been working with the Northwest Tree Improvement Cooperative to establish large-plot trials comparing genetically improved and unimproved trees.

Jeff Riddle

Genetically improved trees, such as this Douglas-fir in western Oregon, are growing faster than unimproved trees.

Initial results show that genetically improved trees are growing at the rates predicted from earlier testing. Five years after planting, improved trees gained 6 percent more height, 8 percent more diameter, and 28 percent more stem volume, than genetically unimproved trees. Results provide a high level of confidence in the first-generation testing and selection procedures despite some limitations in those procedures.

Contact: Brad St.Clair, bstclair@fs.fed.us, Resource Management and Productivity Program
Partners: Northwest Tree Improvement Cooperative
More information: Science Findings 52, April 2003. *Conserving and Managing the Trees of the Future: Genetic Resources for Pacific Northwest Forests*. www.fs.fed.us/pnw/sciencef/scifi52.pdf.

Soil disturbance is not always bad

For many years foresters and soil scientists have seen soil disturbance from heavy equipment, and many have been concerned that soil compaction or top-soil displacement could reduce future tree survival or growth. Those who have seen stunted trees growing on log landings or other high-traffic areas have often generalized that all equipment impacts were bad.

Several recently completed studies compared tree growth with and without soil disturbance. Results were mixed; the studies found negative, neutral, and positive effects of soil disturbance on tree growth. Soil disturbance can positively influence tree growth if it reduces competition from other vegetation, increases soil temperature that may favor root growth, or increases soil water-holding capacity. Soil disturbance can hurt tree growth if it removes fertile topsoil or reduces soil aeration, affecting tree roots.

At this point, the effects of soil disturbance on tree growth cannot be predicted perfectly. Tree reactions differ under specific site conditions, and long-term effects are different from short-term effects. For resource managers concerned about the effects of soil disturbance on trees, the best course of action may be to measure tree growth directly.

Contacts: Connie Harrington, charrington@fs.fed.us, Resource Management and Productivity Program
Partners: Weyerhaeuser Company, Colville National Forest

James McIver

In northeastern Oregon, cost per metric ton of using a skyline yarding system was nearly double that of using a forwarder yarding system.

Mechanical harvesting techniques can reduce fuel loads and protect large, live, retention trees

Alternative mechanical harvesting techniques can reduce fuel loads and protect large, live, retention trees, but differ in environmental effects and economic efficiency. Two log extraction systems were tested in three paired, mixed-conifer stands in northeastern Oregon. A single-grip harvester was coupled with either a forwarder or a skyline yarding system. Economics, fuel reduction, stand damage, soil disturbance, effects on soil biota, and down woody material were all measured.

Both systems reduced fuels and protected residual large trees, but the forwarder yarding system caused slightly more damage to trees than the skyline yarding system. Fire risk was lowered in all stands, but large woody material for wildlife also was reduced. Light displacement of soil resulted in a short-term increase in the abundance of soil microarthropods, but forest litter compaction resulted in litter microarthropods being reduced for at least 1 year after harvest.

WestPro will help managers predict growth and yield for uneven-aged stands.

Revenue was similar for both systems, but total operational costs were $81/metric ton in the skyline units, nearly double the $46/metric ton costs in the forwarder units. Information is needed on the effects and efficiencies of harvesting systems for fuel reduction; already over 65 managers have requested information from this study.

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Partners: Oregon State University, University of California, Wallowa-Whitman National Forest, and Andy Munsey, logging contractor, Pendleton, Oregon

Free software estimates the costs of harvesting small-diameter timber

In the Western United States, the number of small-diameter trees is at a historic high, and managers plan to thin many of these small trees. The costs of small-tree harvest are generally higher than costs for harvesting larger trees, however, and cost can be a major issue in getting thinning work done.

Scientists developed STHARVEST, a Windows-based, public-domain software used to estimate costs of small-tree harvest, either in pure small-tree stands or as one part of a mixed-size stand. The free software can be used by planners with little background in forest engineering to get reasonable estimates of harvest costs, in U.S. dollars per 100 cubic feet or per green ton, for clearcutting or partial cutting. Costs can be estimated for six harvesting systems over a wide range of stand conditions: two ground-based systems and one cable system with manual felling; and two ground-based systems and one cable system with mechanical felling.

STHARVEST runs under Windows 98 and newer operating systems and is documented in PNW-GTR-582. It can be downloaded for free, along with a users guide, from the Web page http://www.fs.fed.us/pnw/data/stharvest/stharvest_home.

Contact: Roger Fight, rfight@fs.fed.us, Human and Natural Resources Interations Program

Tom Iraci

The STHARVEST software can be used to estimate harvest costs for small-diameter trees.

Partner: University of California Davis
(The use of trade or firm names is for reader information only and does not imply any endorsement by the U.S. Department of Agriculture of any products or service.)

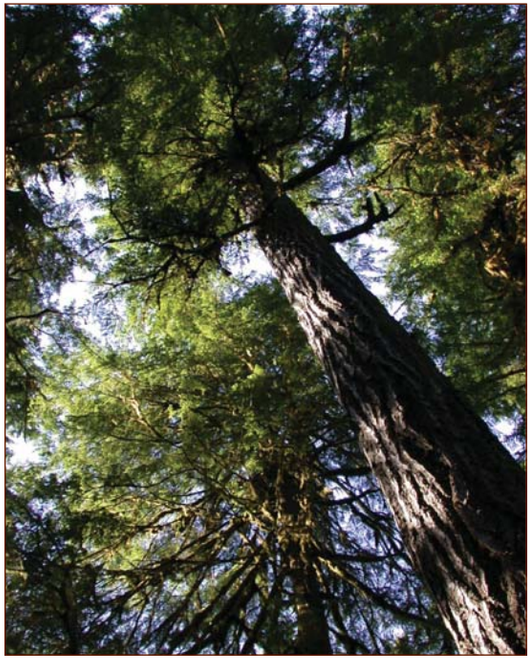
Simulations estimate the effects of thinning on development of late-successional forest structure

Many forest managers are interested in accelerating the development of late-successional forest characteristics in young forests through silvicultural practices. However, experiments that produce data on what works take years to complete and are costly. Scientists developed a simulation model that uses existing findings to estimate the effects of different thinning intensities on development of late-successional forest attributes.

In general, the model estimated that heavy thinnings at stand ages 40 and 60 would promote rapid development of large boles, vertical diversity, and tree-species diversity, but would provide the

least amount of timber volume and require artificial creation of snags and dead, down logs. Thinning may accelerate the development of some late-successional characteristics by several decades, but additional management may be needed to generate snag densities comparable to late-successional forests. Ecosystem scientists can use the model to simulate other silvicultural prescriptions and estimate some likely outcomes for the treatments.

Contact: Tom Spies, tspies@fs.fed.us, Ecosystem Processes Program



Tom Iraci

Analysis of tradeoffs between wildfire threat and old-forest structure is being used in planning for Gotchen Late-Successional Reserve in the Washington Cascade Range.

New software provides growth and yield information for uneven-aged Douglas-fir stands

Many silvicultural prescriptions today are developing uneven-aged Douglas-fir stands, and traditional growth and yield programs cannot model these stands very well. A recently developed program, WestPro, can be used to predict growth and yield for these uneven-aged stands. WestPro uses the initial stand state, defined as the number of softwood and hardwood trees per acre by diameter class, and defines management regimes by a target stand distribution of age classes and a planned cutting cycle. The software can predict the growth of the stand each year, for a set number of years into the future. Performance indicators include diversity of tree sizes and species, timber yield, and net present value of harvest over the given number of years. More information can be found in PNW-GTR-574.

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Findings on silviculture, fire threat, and late-successional forests are used in management planning

Under the Northwest Forest Plan, late-successional reserves are managed to maintain and enhance late-successional forests. Some forest characteristics that are desirable for wildlife habitat, such as canopy layering and dead wood, also create conditions favorable for wildfires and insects in the drier part of the plan area. Tradeoffs between wildfire threat and old-forest structure were examined in simulations for a 30-year period for one 15,000-acre reserve in the Gifford Pinchot National Forest in Washington.

The study compared variable-intensity silvicultural treatments on how well they would reduce the threat of large, severe wildfires and maintain late-successional forest structure. Ecological and economic factors were considered. Simulation results indicate that a combination of variable-intensity treatments would be most efficient for meeting multiple landscape objectives. Fire threat was reduced the most by treating more acres of structurally simpler forest; treatments of existing late-successional forest structures contributed less to reducing fire threat in the simulations. The USDA Forest Service and USDI Fish and Wildlife Service planning team used the study results in a draft environmental impact statement on reserve management that is currently available for public review and comment.

Contact: Susan Hummel, shummel@fs.fed.us, Human and Natural Resources Interactions Program
Partner: Gifford Pinchot National Forest

Three approaches to calculating log values compared

Appraisals of log values start with the gross value of products that can be manufactured from a tree. Scientists evaluated three log appraisal systems. Logs used for the comparison included ponderosa pine, Douglas-fir, western hemlock, and true fir species. The three systems were used to estimate volumes and grades of lumber, and volumes of chips and residues, produced from the logs. Scientists found that if users wish to make a simple calculation of value of a forest stand, a simple method would suffice. If information is needed also on the recovery proportions of chips and residues, and price in dollars per board foot, then a more complex method is needed. The most detailed method provides extensive information on the volumes of different lumber grades as well as a means to do a complete analysis of forest management activities; the other two methods do not. However, the detailed method results in slight losses of accuracy on the gross values of logs.

Dean L. Parry

Timber scalers develop lumber recovery data used in calculating log values.

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First postharvest results are available from the Alternatives-to-Clearcutting study

The Alternatives-to-Clearcutting (ATC) study began with a retrospective study in the old-growth forests of southeastern Alaska. The operational-scale silviculture experiment, a major part of the study, will test the effects of harvesting intensity, retention patterns, and patch size on forest development. The 5-year assessment of the first block of nine units was completed in 2002, with data gathered on the postharvest responses of overstory and understory vegetation to the varying retention levels. The 5-year assessment of the second block is scheduled for 2004. The third and final block of nine units will be harvested within the next 2 years. To date, 25 publications have been produced from the ATC study. Recent publications include discussions of the social acceptance of alternative harvesting practices, bird community ecology, headwater stream ecology, harvesting costs and production rates, and disturbance regimes in old-growth temperate rain forests.

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Partners: USDA Forest Service Alaska Region, University of Alaska

In southeast Alaska, red alder in young-growth forests has several benefits

Southeast Alaska has vast stands of young-growth forests. Scientists are studying ways to produce wood, wildlife habitat, and fisheries simultaneously from these even-aged, young-growth forests. Of particular importance is the establishment of thriving understory vegetation to support deer populations. Two approaches were

tested for promoting diverse and abundant understory vegetation in these young stands: the inclusion of red alder in the overstory canopy, and commercial thinning for the older young-growth stands. Both approaches were much more successful than silviculture treatments attempted previously. Potential benefits include more wood products, improved wildlife habitat, and better fish habitat. The Tongass National Forest is including red alder in young-growth stands in a large-scale adaptive management study.

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Progress is made toward modifying kiln-drying guidelines for western hemlock in southeast Alaska

Western hemlock is an important commercial tree in southeast Alaska, making up nearly 60 percent of the region's timber. Alaska western hemlock, however, is sometimes characterized by localized regions of high-moisture-content wood, referred to as wet pockets. Wet pockets, or wetwood, develop in western hemlocks as a result of bacterial infections. When freshly milled lumber is kiln dried, wet pockets can cause uneven drying and defects such as warping and checking, lowering the value of the boards.

Scientists evaluated moisture content in western hemlock lumber from trees harvested near Sitka, Alaska. Preliminary results suggest that great variation occurred in the samples, ranging from 50 to 100 percent. This work was a first step in developing kiln-drying schedules for western hemlock in southeast Alaska. Scientists may be able to develop modified kiln-drying guidelines that group lumber batches by green moisture content and prevent uneven drying and defects. Properly kiln-dried hemlock lumber will have a significant price premium over undried or defective wood, and the dry lumber can potentially be used for value-added made-in-Alaska products.

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Partners: Flagstaff Partnership, USDA Forest Service Pacific Northwest Region and Alaska Region
More information: Science Update 5, September 2003. *Alaska Forest Products: Using Resources Well.* www.fs.fed.us/pnw/pubs/science-update-5.pdf.

Bob Szaro

Special kiln-drying guidelines may be needed for western hemlock, which makes up about 60 percent of southeast Alaska's timber.

Standard southeast Alaska growth and yield model found to be biased

Forest growth-and-yield models can be valuable tools for predicting stand growth under different management alternatives, but model predictions must be reliable and unbiased to be useful. Models are rarely validated adequately, however. FVS-SEAPROG is the growth model commonly used in southeastern Alaska, and Station scientists recently used data from two long-term silvicultural trials—dating from the early 1920s and mid 1970s—to evaluate the model's performance. The actual growth on 259 plots across southeastern Alaska was compared with FVS-SEAPROG predictions for the same periods.

The Chugach National Forest is heavily used as a scenic resource where road access is critical for recreation activities; this and many other findings will be used in revising the forest management plan.

Bob Szaro

The study found large differences between observed and predicted values for several key stand characteristics and provided evidence of significant bias in FVS-SEAPROG. The results validated people's concerns about the model's predictions and showed where the model can be improved.

Contact: Mike McClellan, mmcclellan@fs.fed.us, Resource Management and Productivity Program

Subsistence deer hunting remains important to residents on southeast Alaska island

In rural Alaska, the average annual harvest of all subsistence food, including game, seafood, and berries, is 375 pounds per person, with deer the most common animal hunted in southeast Alaska. Scientists studied factors influencing hunter demand for deer on Prince of Wales Island, a large island with several small communities, not far by floatplane from Ketchikan, Alaska.

The cash-based market economy on Prince of Wales Island has declined in recent years as logging and commercial fishing have declined, and the subsistence economy has assumed greater importance. Despite this change, overall hunter demand for deer has not changed significantly on the island in the last 10 years (1989-99). In communities with a smaller percentage of Native Alaskans, deer were a larger component of the subsistence harvest. As the percentage of Native Alaskans in a community increased, the dependence on deer decreased and use of other resources such as halibut increased.

Although overall hunter demand did not change, the pounds of deer eaten annually per capita did increase in five communities on the island with declines in household median income. Thus this study, published in PNW-GTR-581, found a correlation between increased deer harvests and increased poverty for Prince of Wales Island residents.

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Partner: Alaska Department of Fish and Game

Social and economic reports tell Chugach planners about the human environment of the south-central Alaska region

The Chugach National Forest extends south and east of Anchorage along the south-central Alaska coast, encompassing most of the Prince William Sound area, northeast Kenai Peninsula, and the Copper River Delta. The Chugach National Forest is revising its forest management plan, and Station scientists did social, economic, and recreation assessments of the area for the planning team's use. Results were published in PNW-GTR-561.

Bob Szaro

The scenic Seward Highway gives tourists easy access to Alaska's Kenai Peninsula.

Although parts of the Chugach are remote, much of the forest is easily accessible to tourists via Seward Highway on Kenai Peninsula, cruise ships or Alaska state ferries, and highways to Valdez. The Chugach National Forest is heavily used as a scenic resource where road access is critical for recreation activities such as fishing, camping, hiking, and wildlife viewing. Active forms of recreation and "soft adventure" activities are growing faster than other types of recreation. The assessment found that entrepreneurial efforts to provide short-duration recreation and tourism experiences would lead to increasing use of the Chugach National Forest.

The Chugach area has three main population areas: Anchorage, Kenai Peninsula, and the Valdez-Cordova area. Of the three areas, the Valdez-Cordova area shows the most economic volatility and has the least economic diversity. Resident population is increasing and aging in south-central Alaska, especially on the Kenai Peninsula. Total employment is growing at a faster rate in south-central Alaska than in the United States as a whole, and growing fastest in the Kenai Peninsula Borough. Many of the new jobs are in services and retail trade sectors.

Public lands are highly important to residents' quality of life in this area. Results of a mail survey showed that residents both near the Chugach National Forest and in other parts of Alaska rate the amenity values of the Chugach higher than the commodity values. People rely on public lands to maintain their quality of life, especially clean air and water, beauty of surrounding area, and open undeveloped areas. People generally favored "no change" in their community's current level of economic activity in forest-resource-related sectors.

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Partner: Chugach National Forest

Fire on the mountain—what it means for fish

Wildfires, floods, and landslides can be destructive in the short term, but long term these disturbances are natural processes that help to create and renew diverse and healthy stream habitats and ecosystems. After wildfires, burned mountain slopes are often susceptible to accelerated erosion, water runoff, and landslides for the next few years.

Wildfires will continue to burn. Research suggests, however, that active management of fire and fuels could influence the timing, severity, and pattern of wildland fires to achieve ecological management goals such as renewal of stream habitats. Fire management for stream restoration goals is most effective when a full spectrum of ecological patterns and processes is considered. An adaptive management approach tests alternative management treatments, each based on different assumptions about how ecosystems function and how they will respond to treatment. This approach requires (1) well-articulated hypotheses of how ecosystems will behave, (2) commitment to monitoring and rigorous data gathering, (3) creative, yet rigorous analytical approaches to provide inferences based on data.

One part of the research challenge is understanding how ecosystems respond after wildfires. People sometimes assume that wildfires pose a short-term risk to endangered fish. Research shows, however, that local and regional factors affect

The Applegate Partnership established specific criteria to measure change, and a decade later they can point to major, positive changes in their watershed. This and other keys to success offer lessons for other collaborative groups.

Tom Iraci

Burned forests pose risks such as erosion—and benefits such as future large wood—for streams and fish

the actual risk level, including factors such as watershed geology and topography, prevailing climate, difference in the degree that original vegetation modified erosion, and differences in fire severity and fire regime. The likelihood of postfire erosion can only be ascertained in the context of these factors. This work is a context for better understanding of what drives erosion and sedimentation, how these processes are influenced by fire, and what the short and long-term risks—and benefits—are for streams and fish, when there's fire on the mountain.

Contacts for managing fire to restore stream ecosystems: Peter A. Bisson, pbisson@fs.fed.us, and Gordon Reeves, greeves@fs.fed.us, Aquatic and Land Interactions Program; Paul Hessburg, phessburg@fs.fed.us, Managing Disturbance Regimes Program
Partners: Rocky Mountain and Pacific Southwest Research Stations
Contacts for postfire erosion: Michael J. Furniss, mfurniss@fs.fed.us, and Steven M. Wondzell, swondzell@fs.fed.us, Aquatic and Land Interactions Program

New stream assessment methods are tested in upper Grande Ronde basin

In the arid lands of the interior Columbia basin, streamside areas are a geographically minor part of the landscape, showing up as only thin lines on landscape-scale maps. But in this dry land, streams and streamsides are the primary habitat for 71 vertebrate species, and source habitats for at least 90 terrestrial species and perhaps more. Landscape-scale management could miss not only the streams but the many variations in stream types and conditions, critical information for protecting and restoring these ecosystems while allowing other management activities.

Scientists developed new methods to characterize stream bottom types and tested them in the highly variable streams found in the upper Grande Ronde subbasin in northeastern Oregon. The new methods use GIS, watershed analysis, and landscape simulation modeling, to assess streamside conditions across large landscapes. Eventually these methods will be a module in the Interior Northwest Landscape Analysis System (INLAS).

Managers can use these new methods as they design plans to protect and restore riparian ecosystems, and they can link the information to landscape-level wildlife and aquatic habitat planning. For example, management needs are different for steep, high-gradient, cascading step-pool (Type A) streams, and low-gradient, meandering, riffle-pool (Type E) streams, which are highly sensitive to vegetation change along their banks.

Contact: Miles Hemstrom, mhemstrom@fs.fed.us, Focused Science Delivery Program

Tom Iraci

Rafters float by anglers on the popular Kenai River in Alaska. Both groups may come in conflict with grizzly bears fishing for salmon.

Scientists develop tools to help land managers understand recreation and tourism on federal lands

The growing American population loves to get outdoors and loves to visit their national forests. Scientists are asking managers what they could use from science to help them manage recreation and tourism compatibly with other national forest resources valued by the public.

Managers have said they urgently need information on exactly where conflicts are occurring between recreation user groups and activities, and effects of both authorized and unauthorized recreation on the forest resources. Scientists have summarized the current state of knowledge and propose to integrate recreation data and analysis with extensive, existing GIS data. The result will be GIS map layers backed up by extensive databases on recreational use, information that should be useful for teams revising forest plans. This work is aimed to help managers efficiently target where they can improve recreation capacity within budget constraints, and to help planners look at the forest-wide picture of recreation use and its effects.

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Sponsoring program: Focused Science Delivery Program

Applegate Partnership is a good example of a successful collaborative group

Scientists evaluated the effectiveness of collaborative groups by using the Applegate Partnership as a case study. Results were published in PNW-GTR-565. The Applegate watershed, in southwestern Oregon's Siskiyou Mountains, has more resident environmental activists than most rural areas in the Pacific Northwest. The Applegate Partnership was formed by residents of the Applegate River watershed in 1992 to address forest management, forest health, and fire risk issues.

Since then the partnership has moved through a series of successes, failures, and more successes. An early goal, ecosystem health, was hard to measure. But by establishing specific criteria to measure change, a decade later the group can point to major changes in their watershed: a shift from clearcutting to selective cutting, a shift from cutting large-diameter trees to small-diameter trees, development of a small-diameter materials program, more attention to fire risk on private lands, and an increase in number and mix of people on field trips. From the beginning the partnership worked to be as open and inclusive as possible. Among other techniques, the partnership used skilled facilitators to get diverse viewpoints expressed and still make progress as a group.

The partnership has found that specific measures of progress, and revisions as the group evolves, are the best answers to criticism. Other results in the Applegate watershed include securing grants to reduce fire danger and accomplishing the

risk-reduction work, taking over a county park that would have closed and starting weekend outdoor movies and developing nature trails, installing fish-friendly irrigation pipes on private land, regulating sand and gravel operations that affect river habitat, and expanding their mission to include local economic development.

The scientists found that collaborative groups can be successful when there is an opportunity for providing evaluation and feedback, engaging needed participants, and responding to groups critical of the collaborative process.

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Partner: Applegate Partnership

Most forested counties in the United States have medium or high viability and adaptability

The Montréal Process for Sustainable Forest Management, an international process, recognizes that forest-dependent communities must be healthy for forest management to be truly sustainable. The Montréal Process calls for evaluation of the "viability and adaptability to changing economic conditions, of forest-dependent communities, including indigenous communities" as an indicator of well-being.

Scientists have developed a composite measure to evaluate forest community well-being at the national level; the analysis is published in PNW-GTR-567. The composite measure was developed from county-level data that combined population density (a proxy for civic infrastructure), lifestyle diversity (a proxy for social and cultural diversity), and economic resiliency. Counties with fewer than six people per square mile got the lowest rating on the population density measure; these have been called frontier counties.

Tom Iraci

Counties with both forests and large cities, such as Multnomah County, Oregon, generally are resilient in coping with social and economic changes.

Counties with 6 to 27 people per square mile are classified as rural counties; counties with 28 to 250 people per square mile are called intermix counties, and those with over 250 people per square mile are called interface counties, essentially urban areas.

The United States has a total of 3,110 counties (including some city-county and borough combinations). When ranked by the composite measure just described, 837 counties got a low rating; these counties represent 36 percent of the U.S. area but have less than 3 percent of the U.S. population. Low adaptability does not mean that the areas are economically distressed; it just indicates low resiliency to social and economic changes.

Of the 742 forest-dependent counties with a high proportion of forest land, only 102 were rated as having low viability and

adaptability. The other 640 heavily forested counties have medium or high rankings. Many of these are counties with both forests and large cities, such as Seattle, Portland, and Atlanta, and others have significant recreation areas such as Shenandoah and Olympic National Parks.

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Logic-based system can organize expert judgments about sustainability

Many projects are underway to apply the Montréal Process to assess the sustainability of temperate and boreal forests. This year scientists described a logic-based system for evaluating the sustainability of forests at regional and national levels. Such a system can evaluate sustainability more consistently and transparently by providing a systematic way to organize expert judgment about ecological, economic, social, and institutional relationships, and by providing a policy framework that can be used to reveal decisions about values and what is meant by sustainability.

Contact: Keith Reynolds, kreynolds@fs.fed.us, Human and Natural Resources Interactions Program

Local watershed groups have become important part of management landscape

Scientists found that watershed groups established through government initiatives have become an important part of the natural resource management landscape in developed economies. For these groups to be successful they need to have broad stakeholder representation, and they need to be embedded within a supportive institutional framework that identifies realistic roles for private landowners, local organizations, and regional planning bodies. Success also requires that people within the group must have the commitment and skills to establish processes that build trust and competency among citizens and agencies.

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Nan Vance

Findings on the ecology of survey-and-manage plants such as the mountain lady's slipper are used by managers.

Progress is made on understanding the ecology of survey-and-manage plants

In 1996 the World Wildlife Fund cited the lady's slipper genus as one of the "10 most wanted" of threatened plants and animals on the planet. More locally, the Northwest Forest Plan, adopted in 1994, included survey-and-manage guidelines for a list of rare, little-known species associated with old-growth forests. Two lady's slipper species are on the survey-and-manage list in the Pacific Northwest. Station scientists are working on key questions about these two rare species. Two major concerns are the flowers' reproductive success and their response to disturbances such as thinning and fire.

Research on the clustered lady's slipper orchid has resulted in new information on its reproductive biology and response to fire and other disturbances. Early results of a 2-year study of the mountain lady's slipper indicate the flower associates with species common to dry forest types, helping to define habitat qualities associated with successful seed production for the species. These findings are being incorporated in the revised management recommendations for high-priority site management.

Contact: Nan Vance, nvance@fs.fed.us, Resource Management and Productivity Program

Study begins on genetic variation of antelope bitterbrush

Antelope bitterbrush is often used in restoration work because it is a primary winter food for antelope, deer, and elk. No guidelines exist on how far bitterbrush seed can be moved and still be "local." At times seed has been acquired from locations distant from the planting site.

Nancy Mandel

Seed from over 200 antelope bitterbrush populations is being tested for genetic variation, including seed from Potamus Canyon in eastern Oregon.

Scientists are studying genetic variation in antelope bitterbrush seed to establish guidelines for moving seed between locations. Over the past 2 years, seed was collected from over 200 populations of antelope bitterbrush in eastern Oregon. Preliminary analysis of the seed collection times supports previous findings that the date of seed shatter is strongly associated with the elevation. Seed shatter date could be explained even better with a regression equation using latitude, longitude, and elevation.

The seed collections will be used for a common garden study that explores patterns of genetic variation in adaptive traits and their relations to environment. Seed movement guidelines can then be designed to reflect patterns of genetic variation.

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Partner: USDA Forest Service Pacific Northwest Region

Volunteer network collects data on Oregon white oak acorns

In Oregon, Washington, and British Columbia, volunteers have been helping scientists who are studying the factors influencing acorn production in Oregon white oak (also known as Garry oak). Once an oak tree is selected for the survey, the volunteers collect information on tree and site characteristics and then code its acorn production each fall. Acorn production can only be coded during a fairly short period; if coded too early the green acorns are hard to see against the green leaves, and if coded too late the acorns have been eaten or fallen on the ground. So the volunteer network allows sampling many more trees than could be done otherwise.

The survey began in 1999, and so far more than 1,200 trees have been surveyed, some three or four times. Each year more volunteers have joined the survey and some of the early volunteers have added more trees to the group they survey. The number and geographic range of the surveyed oaks, as well as the repeat sampling, enable researchers to look at tree and site characteristics associated with acorn production, regional patterns in acorn production, and the consistency of production from year to year. Volunteers download instructions and survey forms from a Web site that also includes background information on the species, some survey results, and links to related sites. The Web site is http://www.fs.fed.us/pnw/olympia/silv/oaksurvey/oak.htm.

Contacts: David Peter, dpeter@fs.fed.us, and Connie Harrington, charrington@fs.fed.us, Resource Management and Productivity Program
Partners: U.S. Department of Defense, Fort Lewis, and many dedicated volunteers

Dave Peter

Oregon white oak, once common in western Oregon and Washington, has lost much habitat to conifers or to other land uses.

Goal 4: Communicate Science Findings and Enhance Their Application

Key Products:

- A synthesis report was developed on the influence of forest structure on wildfire behavior and effects. Research addressed the environmental benefits of active fuels management in reducing unwanted fire behavior. As science support for a healthy forests initiative, Station scientists are working on additional synthesis products about wildfire behavior and the economics of fuel planning.

- Four sessions were held to discuss significant science findings with regional and local managers on key topics: late-successional reserves, socioeconomic planning issues, the management implications of existing information about hydrologic function, and management scenarios for Oregon's Blue Mountains. The major findings discussed were documented in a report.

- A textbook, *Compatible Forest Management*, was published by Kluwer Academic Publishers. The book examines approaches to forest management that emphasize compatibility among various goods and services, shows ways that science can help, and discusses examples of Pacific Northwest forests already being managed to produce both diverse forests and wood products.

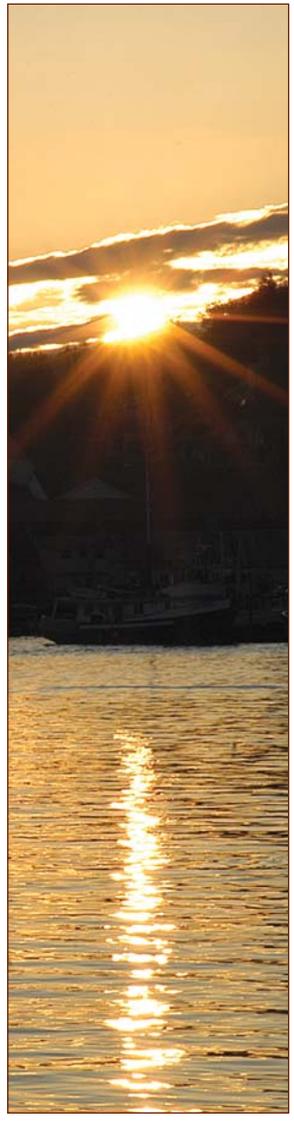
- Interior Columbia basin science findings are available on a set of five compact disks (CD-ROM set). The set includes all maps, databases, and metadata compiled during the Columbia basin research project.

- Station research on wetland soils went into a guide developed by the U.S. Army Corps of Engineers in collaboration with the Alaska Department of Environmental Conservation. The recently published guidebook is used to assess and rate southeastern Alaska wetlands, and it has already been used in training for land managers, planners, researchers, and private industry.

- Scientists developed a software application called FishXing that integrates elements of fish biology, hydrology, hydraulics, and engineering to evaluate road culverts for fish passage. FishXing has quickly become the standard tool in the West for evaluating fish passage in road culverts.

- The PNW Research Station Web site was converted to the USDA Forest Service template and new features were added. The site offers downloadable software, an extensive library of publications, and a wide range of information on Station research.

- Media reporters covered stories emerging from Station research, including stories on spotted owls, logging, and people; dam removal; smoke management; and other fire science research.



Tom Iraci

The Pacific Northwest forests demonstrate that a high degree of wood production is taking place without impairing other forest values.

Accomplishments

New report is a major synthesis of research on forest structure and wildfire behavior

Under the National Fire Plan, a national project has been developed to address four key areas of fuel planning in the dry forest types of the Western United States: wildland fire behavior and forest structure, wildland fire effects, economics and utilization of wood removed, and social science. The goal is to improve access and use of existing research information for fuel planning. Meeting this goal will require several delivery approaches to reach the intended audiences—in formats and styles understandable and useful to the field.

Scientists developed a synthesis report on the influence of forest structure on wildfire behavior and effects. The information was compiled from university and federal scientists throughout the Western United States whose research addressed the relation between fuel levels and fire behavior and severity. The report also addressed the environmental benefits of active fuel management in reducing unwanted fire behavior. The report is a synthesis of 153 peer-reviewed articles and is available at http://www.fs.fed.us/projects/hfi/2003/november/documents/forest-structure-wildfire.pdf. As science support for the Healthy Forests Initiative, Station scientists are working on additional synthesis products about wildfire behavior and the economics of fuel planning.

Contacts for economics: Roger Fight, rfight@fs.fed.us, Human and Natural Resources Interactions Program; Jamie Barbour, jbarbour01@fs.fed.us, Focused Science Delivery
Contact for fire behavior: David L. Peterson, peterson@fs.fed.us, Managing Disturbance Regimes Program
Partners: Rocky Mountain and North Central Research Stations, USDA Forest Service Fire and Aviation Management (Washington Office)

Workshops held to discuss science findings with land managers

The Focused Science Delivery Program delivers science information through multiple formats to ensure various clients get useful information. Formats include workshops, conferences, briefing papers, client meetings, scientist-manager interactions, data analysis, client mailing lists, bibliography databases, and other specialty products on an ongoing basis.

Tom Iraci

In the Santiam Pass area, photos taken in different years show the same landscape before thinning, after thinning, and after the B and B Complex burned the area in 2003.

Tom Iraci

In the Oregon Cascade Range, the Blue River Landscape Study is testing a new approach to sustain native habitats and species, maintain ecological processes, and provide a sustained flow of timber.

A team of scientists held four sessions to discuss significant science findings with regional and local managers on key topics: late-successional reserves, socioeconomic planning issues, the management implications of existing information about hydrologic function, and management scenarios for Oregon's Blue Mountains. The major findings discussed were documented in a report.

Contact: Becky Gravenmier, bgravenmier@fs.fed.us, Focused Science Delivery Program

Book on compatible forest management gets international audience

Work was completed on the Wood Compatibility Initiative, a short-term research program that looked for approaches to forest management that emphasize the compatibility among various goods and services and that avoid counterproductive arguments about conflicting tradeoffs between timber, jobs, and ecological values in ecosystems.

Science can play a key role in finding ways to produce compatible goods and services. The challenge in this kind of cutting-edge, broad-scale science is that a fundamental uncertainty always remains. The answer "it depends" doesn't mean "we don't know," but indicates that the answers depend on context, specifics, multiple variables, and possible pathways. The answers aren't in growth and yield tables, but depend on the complexities of trees, forests, animals, weather, and people's changing values.

Kluwer Academic Publishers published a textbook on the research as part of their Managing Forested Ecosystems series. The final book, *Compatible Forest Management*, was edited by Robert A. Monserud, Richard W. Haynes, and Adelaide C. Johnson, and included chapters by many PNW authors.

The Pacific Northwest has a rich legacy of forests managed for a variety of goods and services. These forests demonstrate that there is a high degree of wood production taking place without impairing other forest values. A history of deliberate forest management carried out by many landowners with diverse objectives has contributed to this rich legacy. Two watershed-scale case studies, including the Blue River Landscape Study in the Oregon Cascade Range, indicate that a variety of environmental indicators can be increased while producing wood. The key is to manage the entire watershed simultaneously, rather than in a piecemeal fashion.

FishXing has quickly become the standard tool in the West for evaluating whether or not culverts are currently accessible to fish and other aquatic life.

No single management regime will meet all of society's needs or desires. Diverse management regimes may help to achieve compatibility at a landscape scale, in terms of both diverse forests and diverse wood qualities. In one sense, compatible forest management merges our scientific understanding with changing societal values to shape the forest legacy for the next generation.

Contacts: Bob Monserud, rmonserud@fs.fed.us, and Richard Haynes, rhaynes@fs.fed.us, Human and Natural Resources Interactions Program

Redesigned Web site includes early results on alternative harvest strategies for mature forests

The Demonstration of Ecosystem Management Options study (DEMO) will provide data on alternative harvest strategies in mature Douglas-fir forests. DEMO studies the ecological effects and public perceptions of different levels of green-tree retention, and dispersed vs. aggregated patterns of green-tree retention, in harvest units. Study components include overstory and understory vegetation, breeding birds, forest-floor small mammals, amphibians, tree-dwelling rodents, canopy arthropods, fungi, and public perceptions of visual quality. Pretreatment sampling was completed in 1997, harvest treatments in 1998, and the first year of postharvest sampling in 2001. A new study began this year on interrelations of birds and bark-dwelling invertebrates.

The DEMO Web site was redesigned and updated this year. It now includes detailed information on the history, experimental design, and research results of DEMO. The Web site can be accessed at: http://www.cfr.washington.edu/research.demo/index.

Contacts: Charley Peterson, cepeterson@fs.fed.us, Resource Management and Productivity Program; Keith Aubry, kaubry@fs.fed.us, Ecosystem Processes Program
Partners: University of Washington; Oregon State University; University of Oregon; Louisiana State University; Cascadien, Inc.; Washington State Department of Natural Resources; Gifford Pinchot National Forest; Umpqua National Forest

Strategies for restoration of Puget Sound rivers have lessons for all

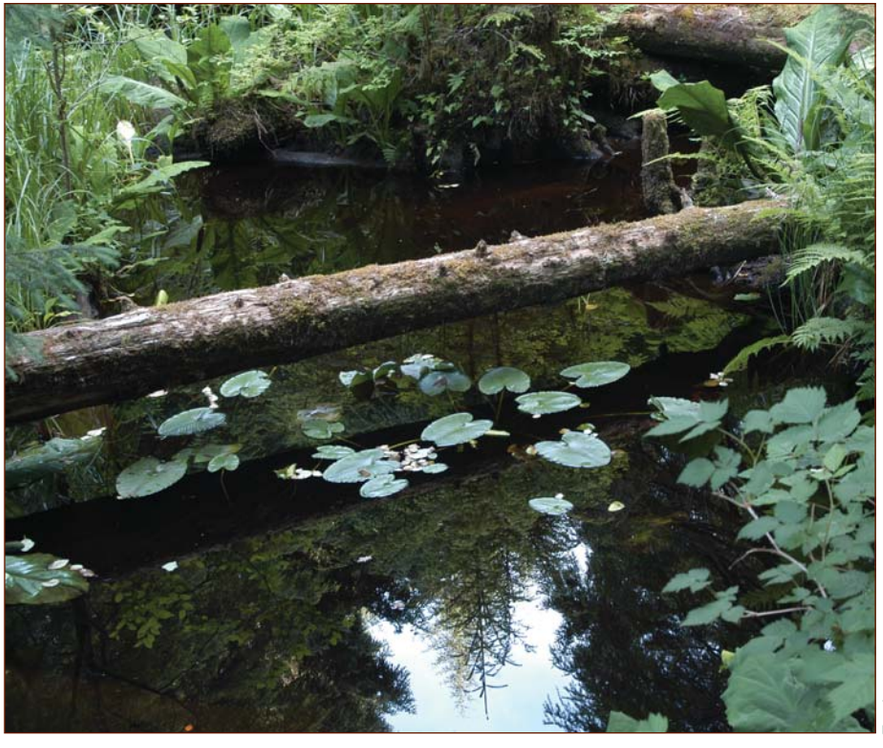
Station scientists offered insights on stream restoration principles in the book *Restoration of Puget Sound Rivers* published by University of Washington Press. The success of restoration strategies is likely to depend on careful consideration of a stream's physical environment, including local climate, topography, and geology, and common disturbances, such as fire. These factors control elements of habitat quality such as stream channel pattern and form, and size of streambed gravels.

Streams are embedded in watersheds, and the physical context limits the range in habitat quality that is likely to be sustainable. Not all things can be accomplished in all streams. Understanding these limits, the processes that control them such as landslides, and how upslope actions affect streams, will raise the likelihood that restoration work will succeed. Watershed context is critical in stream and watershed restoration.

Contact: Richard D. Woodsmith, rwoodsmith@fs.fed.us, Aquatic and Land Interactions Program

HydroDB—making hydrology data available

The Hydrology Database project (HydroDB) is a cross-site synthesis of long-term records of streamflow and meteorology from a network of USDA Forest Service experimental watershed sites and National Science Foundation-funded long-term ecological research sites. The assembled databases establish a baseline response of watersheds to climate variability for monitoring environmental change and assessing disturbance effects, and are widely used in intersite comparisons, modeling studies, and land management-related studies. The intersite HydroDB features a data harvesting



Tom Iraci

Station research on southeast Alaska wetlands contributed to a guide newly published by the U.S. Army Corps of Engineers.

system, a central cross-site database, and a Web interface to display, graph, and download data.

The HydroDB Web site is averaging over 500 hits per month. Additionally, over 120 separate computers have viewed, graphed, or downloaded data sets in the past 4 months, which resulted in the display of 750 data plots, 250 data views, and 215 data downloads.

Contact: Don Henshaw, dhenshaw@fs.fed.us, Ecosystem Processes Program

Science on wetland soils is used in guidebook on southeastern Alaska wetlands

Station soil scientists contributed to a guidebook on the assessment and rating of southeastern Alaska wetlands. Their research on wetland soils went into a guide developed by the U.S. Army Corps of Engineers in collaboration with the Alaska Department of Environmental Conservation. It is part of a national series on wetland characteristics. Guidebook users can determine if soils are truly wetland soil types, rate wetland functions objectively, assess the potential effects of proposed actions, and develop mitigation measures. The recently published guidebook has already been used in training for land managers, planners, researchers, and private industry, sponsored by the Society of Wetland Scientists, state of Alaska, and PNW Research Station.

Contact: Dave D'Amore, ddamore@fs.fed.us, Resource Management and Productivity Program
Partners: Alaska Department of Environmental Conservation, University of Alaska

Road culverts can be barriers to fish migration, with potentially devastating effects

Road culverts can act as barriers to migration of fish and other aquatic species, with potentially devastating effects on their conservation. Fish passage has become the priority activity for fisheries restoration and recovery in all Forest Service regions. Assessment of fish passage requires a broad knowledge of hydraulic engineering, fisheries biology, stream channel geomorphology, and hydrology.

Scientists have developed a software application called FishXing (pronounced "fish crossing") that integrates elements of fish biology, hydrology, hydraulics, and engineering to evaluate road culverts for fish passage. FishXing has quickly become the standard tool in the West for evaluating whether or not culverts are currently accessible to fish and other aquatic life. The software is now being adopted in the Eastern United States.

Contact: Michael J. Furniss, mfurniss@fs.fed.us, Aquatic and Land Interactions Program

Every day about 1,300 people visit the PNW Research Station Web site. The Web site is at http://www.fs.fed.us/pnw.

Visualization tools help interpret remote sensing data for complex forest landscapes

New remote sensing technologies can produce large quantities of unprecedented high-resolution information on forested environments. Some systems produce millions of data points per square mile, often making interpretation of data time consuming and difficult with existing GIS and image processing systems. Scientists have developed new visualization tools that allow researchers to combine data from many sensors and then filter, categorize, and display these large, complex data sets. These new visualization tools can help researchers and managers assess the accuracy and value of remotely sensed data for monitoring and communicating forest conditions.

Contact: Bob McGaughey, rmcgaughey@fs.fed.us, Resource Management and Productivity Program
Partners: Washington State Department of Natural Resources; USDA Forest Service Joint Fire Sciences Program; University of Washington; U.S. Department of Defense, Fort Lewis

Historical forest surveys from 1930s made available again after decades out of print

The first large-scale, complete forest surveys of Oregon and Washington were done in the 1930s by foresters from the Pacific Northwest Forest Experiment Station (now PNW Research Station). Survey reports and maps, difficult to find for decades, are now available in a new publication and CD-ROM from the Station; the CD-ROM also has the maps in digital format. The maps display forest composition and size classes for all forests in the two states at a scale of 1:253,440. County maps (at a scale of 1:63,360) were produced for all forested counties, but many are now missing; the history lists missing maps in the hope they will be found.

Tom Iraci

Historical surveys again available show that in the 1930s, western Oregon and Washington already had large acreages of trees less than 60 years old, as well as over 3 million acres of Douglas-fir old growth.

The 1930s surveys are a valuable record of forest conditions in the early 20th century. A 1934 report noted that western Oregon and Washington had over 3 million acres of Douglas-fir old growth with trees over 40 inches diameter at breast height, and another 3½ million acres of old-growth Douglas-fir "of the 20- to 40-inch type." The 1934 report further recorded that Oregon had large acreages in 30-, 40-, 50-, and 60-year age classes. These stands occurred largely in old burns and were established in 1870-1900, a period "coincidental with the era of intensive land settlement and the development of rail transportation that followed the Civil War."

Contact: Connie Harrington, charrington@fs.fed.us, Resource Management and Productivity Program
Partner: Umatilla National Forest

Synthesis published on managing chanterelle mushrooms in Pacific Northwest

Chanterelles are globally renowned as one of the best edible forest mushrooms, and their international commercial value likely exceeds a billion dollars annually. A number of chanterelle species fruit plentifully in Pacific Northwest forests, and their abundance has spawned a significant commercial harvest industry during the last two decades. Because chanterelles grow symbiotically with the roots of forest trees, managing the fungi for sustainable harvests also means managing forest habitats.

Research results have been summarized in a major synthesis publication, PNW-GTR-576. Findings include the effects of thinning and related forest management on chanterelle productivity, DNA analysis that is refining species distinctions, and influence of high and low levels of coarse woody debris on chanterelles. The new synthesis publication is used by national forests and BLM districts to manage these valuable special forest products.

Contact: Randy Molina, rmolina@fs.fed.us, Ecosystem Processes Program

PNW Research Station Web site adds new features

The Station converted its Web site to the USDA Forest Service template in 2003, a format that is easy to use and offers enhanced features. The home page offers links to the Station newsroom, answers to "frequently asked questions," research programs and teams, experimental forests, and a calendar of events.

These links are in addition, of course, to the extensive library of publications. A new feature called "TreeSearch" offers more convenient search choices, allowing Web visitors to search by author, title, and keywords, and to access publications from other research stations as well. Recent Station publications and public-domain journal articles are available electronically as well as in hard copy, and many classic publications are being scanned in so they too are available electronically.

Scientists and managers can access databases and software from the Web site. The databases include a bibliography on Oregon white oak and a database on insect damage to trees. Downloadable software offers free tools for biomass calculations, financial evaluation of ecosystem management, stand- and landscape-scale visualization, and smoke management, among other items. Instructions are available on system compatibility and software use.

With so much information available, it's no surprise that on average 1,300 people visit the Station Web site every day. The Web site is at http://www.fs.fed.us/pnw.

Contact: Tiffany Dong, tdong@fs.fed.us, Communications and Applications Program

Media information

The story of how people use forests received attention from many angles. The release of the Resources Planning Act fifth timber assessment led to a front-page article in The Oregonian, and eventually to reports in other newspapers and radio stations. Richard Haynes, among others, was interviewed about the shift from the Pacific Northwest to the Southeast as the Nation's biggest timber-producing region.

KIRO-TV in Seattle did a sequel to their early 1990s "War in the Woods" documentary, on spotted owls, logging, and people. Oregon Field Guide, an Oregon Public Broadcasting program, covered red tree voles, a main food species for spotted owls. Several TV stations and newspapers did features on the status of spotted owl populations, the effects of barred owls, and implications for people; Eric Forsman was interviewed several times. Other stories on forest resources featured grazing and noxious weeds in Hells Canyon, the "humongous fungus" in the Blue Mountains, diversity in second-growth forests, and the big game and cattle grazing research of Starkey. The History Channel's "Modern Marvels" program did a show on cranes, from early cranes used to build the Egyptian pyramids to modern construction cranes, and the show included a segment on the Wind River canopy crane. In Alaska, Trish Wurtz was interviewed by several reporters about the spruce bark beetle outbreak on the Kenai Peninsula.

Water, salmon, and dams were featured in other stories. The Los Angeles Times and the Public Broadcasting System both interviewed Mark Wipfli on the story of how marine nutrients, brought upstream in the bodies of salmon, fuel freshwater and riparian food webs. Dam removal was a hot topic, with Gordon Grant interviewed by several reporters about how dam removal can affect rivers. KTOO in Juneau interviewed Mason Bryant about fish passage through culverts and effects on fish.

Tom Iracci

Station scientists shared their findings with the media as a contribution to public discussion of topics such as the spruce bark beetle outbreak on Kenai Peninsula and wild salmon issues.

The 25th anniversary of the 1980 Mount St. Helens eruption is in 2005, and media interest has already started, with German public television covering the ecology of a recovering landscape. Perhaps the most unusual request was the interview of Charlie Crisafulli, a Mount St. Helens scientist, for a BBC program on the plagues of Egypt. Historical evidence shows that a huge volcanic eruption occurred about the same time as the plagues of Egypt, and Egypt was in the depositional path of the volcanic plume. Although Crisafulli did not comment directly on Egyptian history, he did explain how the Mount St. Helens ash cloud darkened daytime skies and how frogs and grasshoppers responded in the posteruption landscape.

Tom Iracci

The 25th anniversary of the 1980 Mount St. Helens eruption is in 2005. Station scientists have studied the recovering landscape extensively.

In fire-related stories, Sue Ferguson was interviewed about the BlueSky program, a smoke management technology used on about 100 wildfires during the 2003 fire season. Japanese public television covered the Station's fire science research in interior Alaska as part of a report on forest fires and possible global warming. Finally, media traveled to southwest Oregon to see what scientists are learning about postfire recovery after the 2002 Biscuit Fire.

Educational videos produced

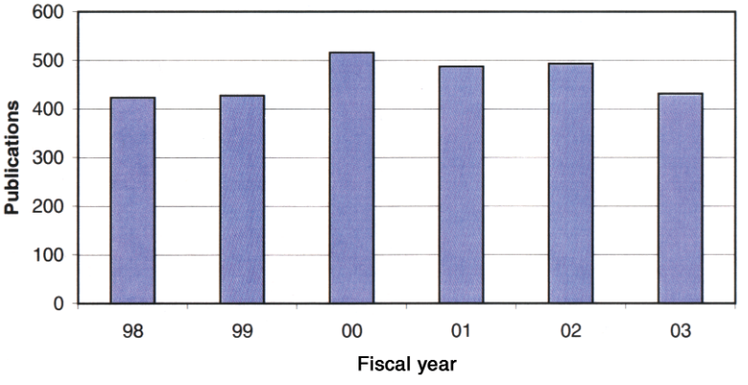
Michael Furniss produced videos that educate managers about the migrations of many aquatic organisms, not just anadromous fish. Also, Jack Piccolo and Jenny Grayson produced a video on the feeding ecology of juvenile coho salmon and steelhead in Alaska streams, in cooperation with the National Fish and Wildlife Foundation.

Contact for migrations video: Michael Furniss, mfurniss@fs.fed.us, Aquatic and Land Interactions Program
Contact for feeding ecology video: Brenda Wright, bwright01@fs.fed.us, Aquatic and Land Interactions Program

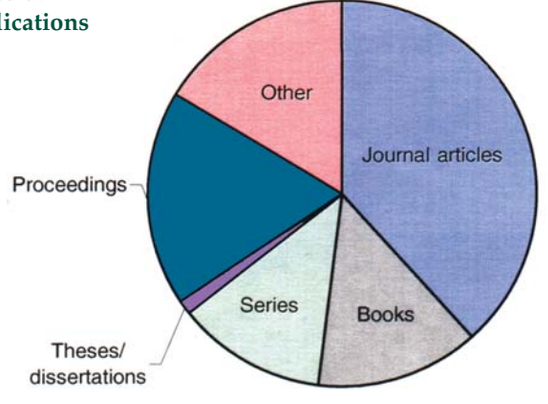
Publications

- 431 publications total.
- 230,000 copies of Station series publications distributed.
- 9,000-13,000 journal article reprints distributed by scientists in response to requests.
- 586 publications are available in electronic format. All new Station publications are placed online, and scanned versions of journal articles and older Station publications are being added.
- 10 issues of *PNW Science Findings* published; about 9,500 copies distributed each issue.
- 3 issues of *PNW Science Update* published; about 8,000-10,000 copies distributed each issue.
- 2 CD-ROM sets published.

Total Publications



Types of Publications



Tom Iracci

2003 Technology Transfer Events

Event	Number of participants
Workshops and symposia	1,620
Field tours	1,750
Conservation education	7,450

Symposia, Workshops, and Tours

Alaska Region, USDA Forest Service, forest management workshop. A total of 40 people attended this workshop in Juneau, Alaska. Station scientists gave presentations on silvicultural options, growth-and-yield studies, and forest health topics to national forest personnel.

American Birding Association field trips. Eric Forsman and the owl crew led field trips to northern spotted owl sites in the Oregon Coast Range for people at the American Birding Association annual meeting in Eugene, Oregon. About 200 birders were able to see spotted owls and other native forest birds.

Applied forest ecological experiments. PNW Research Station cosponsored this International Union of Forestry Research Organizations (IUFRO) meeting in Davos, Switzerland, in August 2003. The conference presented state-of-the-art research results and techniques for the management and analysis of applied forest ecological experiments. The Switzerland conference was a building block for the international symposium on sustainable forestry being hosted in 2004 by PNW Research Station. "Large-Scale Experiments for Sustainable Forestry: Balancing Ecosystem Value" is planned for August 15-20, 2004, in Portland, Oregon.

BlueSky workshop. A total of 57 people attended this workshop in Seattle, Washington. Scientists and managers from several states, universities, and federal land management agencies met to discuss progress to date on the BlueSky smoke management program and discuss research needs in smoke modeling.

Capitol State Forest silvicultural options tours. In separate groups (38 people total), students from the University of New Brunswick and the University of Washington and staff from the Cedar River watershed, city of Seattle, visited the studies of silvicultural options on Capitol State Forest outside Olympia, Washington.

Cascade Center for Ecosystem Management. The center hosted its annual public forum on young stand management. Over 100 people attended the conference in Springfield, Oregon, and field trips. The Cascade Center is sponsored by the PNW Research Station, Willamette National Forest, and Oregon State University.

Density management and riparian buffer study field tours. In six separate field trips, over 200 people visited density-management and riparian-buffer study sites in western Oregon. The field trip groups were from the 2003 North American

Tom Iraci

Group learns about spruce bark beetle outbreak, Kenai Peninsula, Alaska.

Forest Ecology Workshop, Bureau of Land Management (BLM) National Science Review Board, the Levels-of-Growing-Stock committee, and federal and state agencies. The BLM and Oregon State University were partners in organizing the tours.

Forest ecosystem study. Andrew Carey led a field trip to Fort Lewis, Washington, for people interested in ecological and collaborative forest management. The 10 participants included representatives from Northwest Ecosystem Alliance, Northwest Old-Growth Campaign, and the Washington Department of Fish and Wildlife.

Forest inventory and analysis meetings and technology transfer workshops. Scientists from the Forest Inventory and Analysis Program held their annual meeting with FIA clients from Washington, Oregon, and California, with about 75 people attending. Along with Station presentations about our research, clients presented results from research they have done based on inventory data.

Frank Vanni

Old growth, young stands, and landscape management are just a few of the research topics being studied at the H.J. Andrews Experimental Forest in the Oregon Cascade Range.

The FIA scientists conducted 21 technology transfer events, such as workshops, and made 11 presentations to layperson organizations.

Genomics of Douglas-fir. A total of 50 people attended this workshop in Corvallis, Oregon. Scientists, policymakers, and tree breeders met to learn about the field of genomics and to discuss how genomics may be used to increase forest productivity and promote gene conservation in the Pacific Northwest.

H.J. Andrews Experimental Forest. Over three dozen field tours were conducted at the Andrews in the Oregon Cascade Range, bringing more than 1,000 scientists, land managers, students, media, and other visitors to discuss science and management issues. Featured field stops included new research on air flow in small watersheds and implementation of the Blue River Landscape Study.

Hungry Bob Fire and Fire Surrogate study. A total of 65 people attended this conference in La Grande, Oregon. Station scientists made presentations on the economics and ecological consequences of fire and fire surrogate treatments in a ponderosa pine forest.

Identifying barriers to aquatic organism passage at road-stream crossings workshops. Scientists developed two courses on inventory and assessment procedures for identifying barriers. One course was given in Boise, Idaho, for the USDA Forest Service Intermountain Region, and in Rutland, Vermont, for the Eastern Region. The other course was given in four locations in Oregon and Washington for the Pacific Northwest Region. Total attendance for all workshops was about 130 people, all involved in stream crossing design for the remediation of fish migration.

Frank Vanni

Staff explain the ungulate ecology research on Starkey Experimental Forest and Range in northeastern Oregon.

Innovations in species conservation. Held in Portland, Oregon, in April, 2003, this symposium focused on approaches to conserving rare, little-known species of plants and animals. Many of these species could face extirpation because of habitat loss. Participants discussed the social, economic, and legal issues, as well as the biological issues, in species conservation. A theme emerged that multiple-species approaches seem more efficient and essential, but their outcome is yet untested. About 200 people attended.

Invasive plants research tours. A total of 35 people, on two separate tours, looked at invasive plant infestations in northeastern Oregon. The scientists and land managers saw sulfur cinquefoil and yellow hawkweed, and they discussed research needs and management options.

Late-successional reserve meeting. A group of 12 people met in Portland, Oregon, to discuss key findings related to late-successional reserves and information needs for revising forest plans. Attendees were from the USDA Forest Service Pacific Northwest Region and PNW Research Station.

Levels-of-growing-stock (LOGS) tour. About 30 people from Oregon and Washington toured LOGS research sites in western Oregon. The studies are investigating management of stand structure for multiple objectives, early spacing control, and management of riparian buffers.

North American forest ecology workshop. Over 300 scientists and managers from North America and other continents attended the "Ecosystems in Transition" conference in Corvallis, Oregon, in June 2003. People looked at research about forest ecosystems, including new ideas about nonequilibrium, chaos, complexity, and uncertainty. A symposium within the conference examined silviculture for changing objectives including conservation, restoration, and intensified timber production. As part of the forest ecology workshop, Station scientists led field trips to places such as the Biscuit Fire, the Metolius Research Natural Area, old-growth forests, the young stand thinning and diversity study, and the H.J. Andrews Experimental Forest.

Olympia Forestry Sciences Laboratory seminars. Scientists at the Olympia Lab give monthly presentations on natural resource topics. The seminars are well attended by natural resource professionals from the south Puget Sound area.

Olympic Peninsula silvicultural studies tours. A group of 25 people visited the Olympic Habitat Development study and Clearwater Young Stand Management study. Participants were from the Makah Indian Nation, Cedar River Watershed, Olympic National Forest, Tacoma Power, Washington State Department of Natural Resources, and the University of Washington.

Riparian restoration density management field tour. A 20-person Chinese delegation on restoration and forest health visited Corvallis, Oregon, in July 2003. The delegation was headed by China's Deputy Directorate General of Afforestation, State Forestry Administration, and included scientists and managers. In collaboration with the USDA Forest Service Washington Office, BLM, and the U.S. Fish and Wildlife Service, PNW Research Station hosted a field trip on restoration projects and studies that develop structurally and biologically diverse riparian

and upland forests. The visit evolved after the Chinese State Forestry Administration and the USDA Forest Service signed a memorandum of understanding in 2002. This field trip sets the stage for collaboration in China.

Second International Precision Forestry Symposium. A total of 80 people met in Seattle, Washington, to discuss precision operations and equipment; remote sensing and measurement of forest lands and vegetation; terrestrial sensing, measurement, and monitoring; and design tools and decision-support systems.

Small hydrology and management implications workshop. A group of 21 people met at the H.J. Andrews Experimental Forest in Oregon to identify future research needs and discuss management implications relating to small hydrology research in the Pacific Northwest. Attendees were regional and forest hydrologists from BLM and the USDA Forest Service, technology transfer staffs, university scientists, and Station scientists.

Socioeconomic planning issues meeting. A group of 20 people met in Portland, Oregon, to discuss socioeconomic information needed for forest plan revisions. Attendees were from BLM, USDA National Forest System, universities, and PNW Research Station.

Starkey Experimental Forest and Range. Several tours were conducted on the Starkey Experimental Forest and Range in the Blue Mountains of northeastern Oregon, with over 60 people visiting. Groups included the Rocky Mountain Elk Foundation project advisory committee, Oregon Congressional staffers, the Oregon State Parks and Recreation Commission committee on all-terrain vehicles, and all-terrain vehicle riding clubs in Union and Wallowa Counties.

Starkey Project symposium. A full-day symposium was held on the Starkey Project at the Rocky Mountain Elk Foundation annual meeting in Reno, Nevada. A total of 76 people learned about the first 10 years of the long-term research project on deer, elk, cattle, grazing, and forests. Future research directions also were discussed.

Sustainable wood production issue client meeting. A group of 25 people met in Portland, Oregon, and developed a list of key topics that the sustainable wood production issue should address. Participants represented universities, state and federal agencies, industry, and private landowners.

Wildland fire workshops. Three workshops on the 2002 fire season were held in collaboration with Oregon State University, the Joint Fire Science Program, the Bureau of Indian Affairs, and the Pacific Southwest Research Station. At workshops in Oregon, Arizona, and Colorado, a total of about 265 managers, researchers, educators, community groups, and others identified research topics based on manager needs. Workshop recommendations will be used by the Joint Fire Science Program board to evaluate its current program and report to Congress on needed research. Recommendations also will be published.

Wind River canopy crane. About 50 people attended a science conference on research done from the canopy crane, at the Wind River Experimental Forest, June 10-11, 2003.

Wind River Experimental Forest silvicultural studies tours. A group of 35 people attended the summer field trip and meeting of the Stand Management Cooperative.

Conservation Education

Edna Mo

Teenager learns about stream hydrology and ecology, near Alsea Falls, Oregon.

Expanding Your Horizons (EYH) Workshop. At this workshop in Seattle, Washington, a Station scientist introduced 90 girls to tools and procedures used in fire weather forecasting during three hands-on sessions, and all 600 girls at the workshop visited a booth where a Station scientist showed equipment used in fire weather research. One girl from the workshop is now volunteering at the Pacific Wildland Fire Sciences Laboratory as a research assistant in atmospheric sciences. The workshop gives girls in 9th through 12th grades a chance to meet adults with careers in mathematics, science, and technology; get hands-on experiences in these fields; and learn about careers in these fields. The workshop is cosponsored by the Women's Math and Science Network and Shoreline Community College.

Forest camp outdoor school. Six Station employees taught modules on disturbance, ecosystem management, and the web of life to over 120 sixth-grade students from the Corvallis area at the Alsea Forest Camp. Station scientists were also involved in similar outdoor schools in Corvallis, Lebanon, and Astoria, all in Oregon.

Girls in Science. Station staff participated in this all-day session, sponsored by Eastern Oregon University, to introduce seventh and eighth-grade girls to career opportunities in the sciences.

H.J. Andrews Experimental Forest. Andrews staff hosted several educational activities, including the Teachers in the Woods program sponsored by Portland State University and the Science and Math Investigative Learning Experiences program (SMILE) sponsored by Oregon State University and attended by about 200 young people.

Hispanic Association of Colleges and Universities National Internship Program (HNIP). An intern hired through the HNIP program spent the summer of 2003 at the Corvallis Lab. The student worked on a conservation education project about watershed management, and she also participated in field, laboratory, and analytical experiences related to research on restoration ecology, plant biology, managing forests for diversity, riparian area ecology, and management. The intern also assisted with the Inner-City Youth Institute summer camp.

Inner-City Youth Institute (ICYI). The Station continued its support to ICYI, which encourages underrepresented youths to learn about the environment and related careers. The program sponsors ecology clubs in inner-city middle and high schools, and it also sponsored a summer program called Alberta Nature Teams (ANTS), geared for elementary school children from inner-city communities. Station scientists also helped with this year's summer camp program for high school students, held in Corvallis. A total of 200 students participated in this year's ICYI programs. ICYI is a collaborative effort among the USDA Forest Service, Oregon State University, the Audubon Society of Portland, and the Bureau of Land Management.

Juneau Science Fair. Scientists and staff from the Juneau Forestry Sciences Laboratory mentored several students participating in the Juneau Science Fair. One student placed second with her project on using lichens as bioindicators of air quality, and she qualified for the national competition in Cleveland. Another student mentored by Station scientists won a spot in the top 10 at Juneau, and yet another student won two special awards at Juneau.

Northwest Science Expo. The PNW Research Station sponsored awards for middle and high school students at the 2003 Northwest Science Expo in March at Portland State University. A high school and a middle school student were each awarded with "Outstanding Science Project About Forests" plaques.

Old-growth forest posters and activity guides. The Station helped develop posters of Pacific coastal old-growth forest and distributed about 1,500 posters with a Station-developed student activity guide to school teachers, organizations, and interested people in the Pacific Northwest.

Oregon High Desert Museum. Station scientists worked with the Oregon High Desert Museum and several federal agencies to release two juvenile spotted owls into the wild. The young owls, born in captivity at the museum, were placed into nests of wild spotted owls near Roseburg, Oregon. Both owls were accepted by their foster parents and were raised along with their wild siblings. This is the first case where captive-bred spotted owls have been fostered into nests of wild owls. Station scientists gave presentations about spotted owls at the museum to over 200 people.

Oregon Saturday Academy apprenticeships in science and engineering (ASE) program. The ASE program pairs promising high school students with science or engineering professionals as mentors, to help students learn about careers in those fields. As part of the program, a Station scientist mentored an apprentice in summer 2003.

School presentations. Station scientists gave presentations at several schools. In northeastern Oregon, a Station scientist taught students from two high schools how to teach younger students about insects and spiders, as part of the "whole ecosystems in balance" (WEB) program. A scientist also taught elementary and high school students in Cove about insects and spiders. In La Grande, scientists took children ages 7 through 12 outside to learn what roles insects have in stream and agricultural ecosystems, as an activity with the Think Link Children's Museum.

Sciences and Tribes Educational Partnership (STEP). The STEP program brought 60 high school students from Native American tribes in the Pacific Northwest to the Big Beef Creek Research Station near Seabeck, Washington, in June 2003. The teenagers studied fisheries biology in the field with instructors including one Station scientist. Partners were University of Washington, Yakama Nation, Colville Nation, and Quileute, Muckleshoot, Quinault, and Lummi Tribes.

Starkey Experimental Forest and Range conservation education. Staff from Starkey hosted four educational trips to the forest with 155 participants. Groups included students from Echo, Oregon, and from Eastern Oregon University, and Rocky Mountain Elk Foundation volunteers. Students learned about the 10-year-old Starkey Project and toured the facilities and research sites.

Watershed Stewardship Education Program (WSEP). Station scientists taught classes and led field trips in several Oregon counties on riparian area ecology and management as part of the WSEP. Participants included agency people, local landowners (farmers and woodlot owners), fishermen, interested residents, school teachers, and even OMSI representatives, who took the class to be certified as watershed stewards. These watershed stewards then become local experts who work with other landowners on restoration projects. Indirectly, over 1,000 people benefit from this program.

Wolftree. Station employees served as mentors in ecology programs with Portland and Vancouver area middle and high schools. Over 3,000 students participate in Wolftree activities annually, with 45 percent from primarily low-income, inner-city, and rural populations that have little or no access to high-quality science or outdoor programs. The Station also contributed funds for supplies and equipment.

Honors and Awards

Savery and Outstanding Master's Student Award

Shannon Claeson, of the Station's Aquatic and Land Interactions Program, won the Savery Award at Oregon State University in recognition of her public service, leadership, research capability, and research that benefits Oregon natural resources. She also won an outstanding master's student scholarship from the Oregon Chapter of the American Fisheries Society, a research scholarship from the Department of Fisheries and Wildlife, and the Thomas G. Scott Award, also from the Department of Fisheries and Wildlife at Oregon State University.

Society of American Foresters Golden Member Award

Robert Curtis, mensurationist emeritus, received this award in recognition of his half-century of SAF membership and his contributions to the forestry profession.

USDA Forest Service New Century of Service Award

Dean DeBell, research forester emeritus, received this award. As part of the 100th anniversary of the Forest Service in 2005, the agency is recognizing employees such as Dean DeBell who epitomize what the agency stands for: service, excellence, relationships, and innovation.

Best Technology Transfer Tool Award

Sue Ferguson, team leader and research atmospheric scientist, received this award given annually by the Joint Fire Science Program. She was cited for her exemplary efforts in creating the brochure and Web site for the ventilation climate information system (VCIS) and her leadership in promoting use of VCIS.

Gold Medal for Innovation

Team leader **Sue Ferguson** and the atmosphere and fire interactions research and engineering team and collaborators from the University of Washington and the Environmental Protection Agency (EPA), received the gold medal for innovation, awarded annually by the EPA. The team was cited for developing BlueSkyRAINS, a technology that allows incident command teams and smoke managers to use one Web site to manage smoke from planned fires and wildfires.

John Wesley Powell Award for 2002

Michael J. Furniss, hydrologist, received this award from the Watershed Management Council. The lifetime award honors an individual providing outstanding contributions to watershed management in the Western United States.

Wildlife Publications Award for Outstanding Article

John Kie, team leader and research wildlife biologist, received this award from the Wildlife Society for his article "Landscape Heterogeneity at Differing Scales: Effects on Spatial Distribution of Mule Deer," published in *Ecology* 83: 530-544.

Merit Award for Outstanding Contribution

Jim Lenihan, **Ray Drapek**, and **Lisa Balduman** (USDA Forest Service) and **Dominique Bachelet** (Oregon State University) received this award in recognition of their outstanding dedication and contribution to the U.S. national assessment of the ecological impacts of global warming and the production of a world-class,

Tom Iraci

peer-reviewed legacy in support of the assessment. They are members of the Mapped Atmosphere-Plant-Soil Systems (MAPSS) Team.

Secretary of Agriculture's Honor Award for Maintaining and Enhancing the Nation's Natural Resources and Environment

Ronald P. Neilson, team leader and bioclimatologist, received this award for outstanding contributions to understanding the potential impacts to ecosystems, water resources, and fire regimes under climate change at regional, national, and global scales.

Chief's Award for Natural Resource Stewardship

Gordon Reeves, research fish biologist, received this award for helping to build a strong foundation for management and conservation plans in aquatic ecosystems and for contributions to conservation biology and natural resource management.

USDA Forest Service Exemplary Volunteer Service Award

Roy Silen, research geneticist emeritus, received this national award for his contributions as a volunteer since his retirement in 1985. He was cited for his contributions in measuring, maintaining, documenting, and publishing results from long-term studies, and for work that has made an important difference in advancing forest genetics research as well as maintaining a historical record of forestry research in the Pacific Northwest.

Chief's Honor Award for Global Stewardship

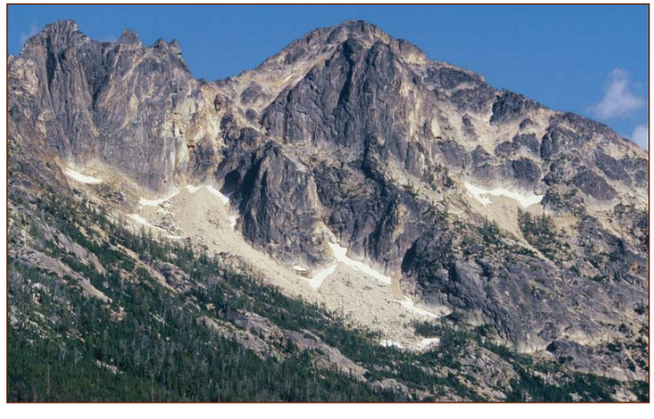
Robert Szaro, Deputy Station Director, received this award in recognition of his sustained efforts in contributing to the improvement of global forest stewardship, promoting U.S. foreign policy objectives, contributing to the improvement of international forestry, and establishing innovative and effective partnerships to further international objectives.

Certificate of Appreciation

Martin Vavra, Starkey Project team leader, received this certificate from the American Society of Animal Science in recognition of his 6 years as editor of the contemporary issues section in the *Journal of Animal Science*.

Toward a Multicultural Organization Award

Tammy Verhunc, administrative officer for the Portland Forestry Sciences Laboratory, received this award from the Station for her leadership in bringing cultural diversity to the lab through presentations, coordinating national civil rights observances, and creating an atmosphere of cohesiveness in the lab environment.



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Finances and Workforce

The PNW Research Station is supported by two funding sources. The largest part of our funding comes from federal appropriations. Our other funding source is direct client support, which comes from organizations needing scientific information.

2003: PNW Research Station Finances and Workforce, by the Numbers

Fiscal year 2003: October 1, 2002, to September 30, 2003

Incoming Funding

- Base research appropriations . . . . . $39.2 million
- Direct client support* . . . . . $11.9 million
- Total funding . . . . . $51.1 million

* Includes national fire research funds ($2.8 million), National Forest System monitoring funds ($3.8 million), state and private research funds ($1.1 million), and nonfederal sources ($4.2 million).

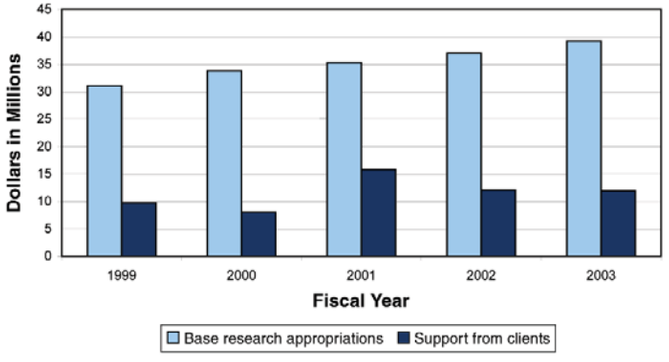
Distribution of Funds

- Employee costs . . . . . 53 percent
- Support and operations . . . . . 33 percent
- Distributed to cooperators . . . . . 14 percent
- Of $8.4 million to cooperators . . 85 percent went to educational institutions

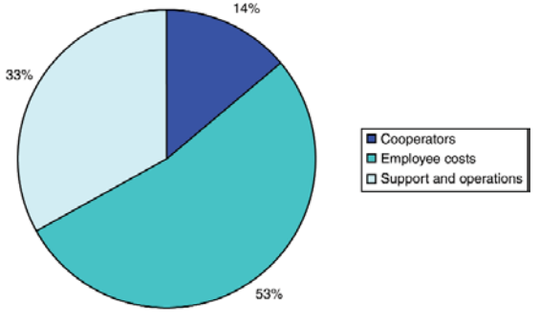
Workforce Statistics

- Permanent workforce . . . . . 288 employees
- Of the permanent workforce . . . . . 32 percent or 91 employees are scientists
- Temporary workforce . . . . . 261 employees
- Station total workforce . . . . . 549 employees

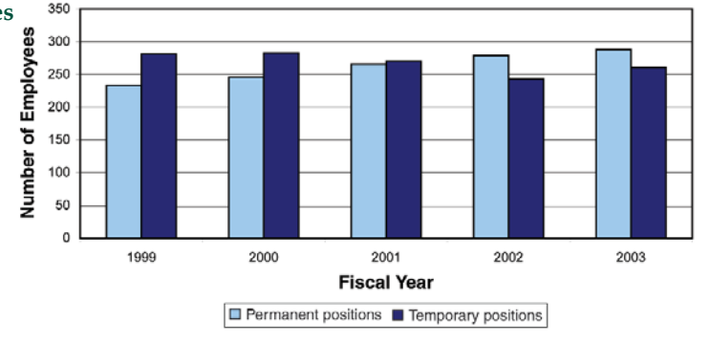
Incoming Funds



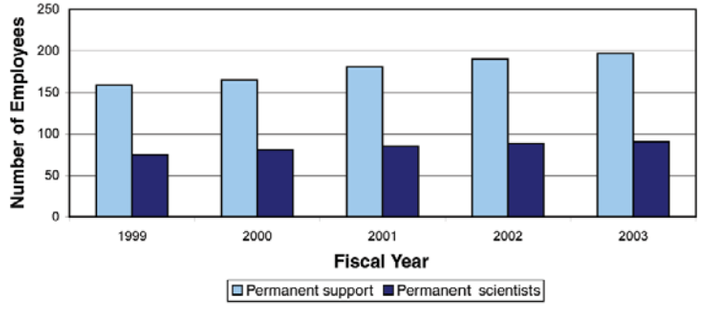
Distribution of Funds



Employees



Types of Positions



Cooperators Who Receive Funding for Studies from the PNW Research Station

In 2003, the PNW Research Station distributed about $8.4 million to its cooperators. The list below includes all cooperators who currently have agreements and partnerships with the Station.

Educational Institutions

Colorado State University
Eastern Oregon University
Humboldt State University
Michigan State University
Michigan Technological University
Ohio State University
Oregon State University
Pennsylvania State University
Saint Louis University
Southern Oregon University
University of Alaska (Anchorage, Fairbanks, and Juneau)
University of Arizona
University of California (Berkeley and Davis)
University of Georgia
University of Idaho
University of Minnesota
University of Montana
University of Washington
University of Wisconsin
University of Wyoming
Utah State University
Washington State University

Other Federal Agencies

U.S. Department of Agriculture, Agricultural Research Service
U.S. Department of Energy
U.S. Department of the Interior, Bureau of Land Management
U.S. Department of the Interior, Geological Survey, Biological Sciences Division
U.S. Department of the Interior, National Park Service

State Agencies

Oregon Department of Agriculture, Plant Division

Government Agencies in Other Countries

Forest Research (New Zealand)
University of Leeds (United Kingdom)

Indian Tribes

Confederated Tribes of Grand Ronde

Nongovernment Organizations

Alaska Manufacturers Association
Earth Systems Institute
Institute for Applied Ecology
Institute for Culture and Ecology
Wildlife Conservation Society

Private Industry

National Council for Air and Stream Improvement
Sealaska Corporation

Clients Who Provide Funding for Studies to the PNW Research Station

In 2003, the PNW Research Station received about $2.7 million in support from clients other than the National Forest System, State and Private Forestry, and other research stations. The list below includes all clients who currently have agreements and partnerships with the Station.

Educational Institutions

Montana State University
Oregon State University
Washington State University

Other Federal Agencies

Bureau of Land Management
Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
National Aeronautics and Space Administration
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Defense, Fort Lewis

State Agencies

California Resources Agency
Oregon Department of Forestry
Oregon Parks and Recreation Department

Nongovernment Organizations

Columbia Basin Fish and Wildlife Foundation
National Council for Science and the Environment

Private Industry

Northwest Power and Conservation Council

PNW Research Station Organization

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Publications mentioned in this report can be requested by calling (503) 808-2138 or e-mailing pnw_pnwpubs@fs.fed.us. Many publications can be downloaded from the PNW Research Station Web site at: http://www.fs.fed.us/pnw.

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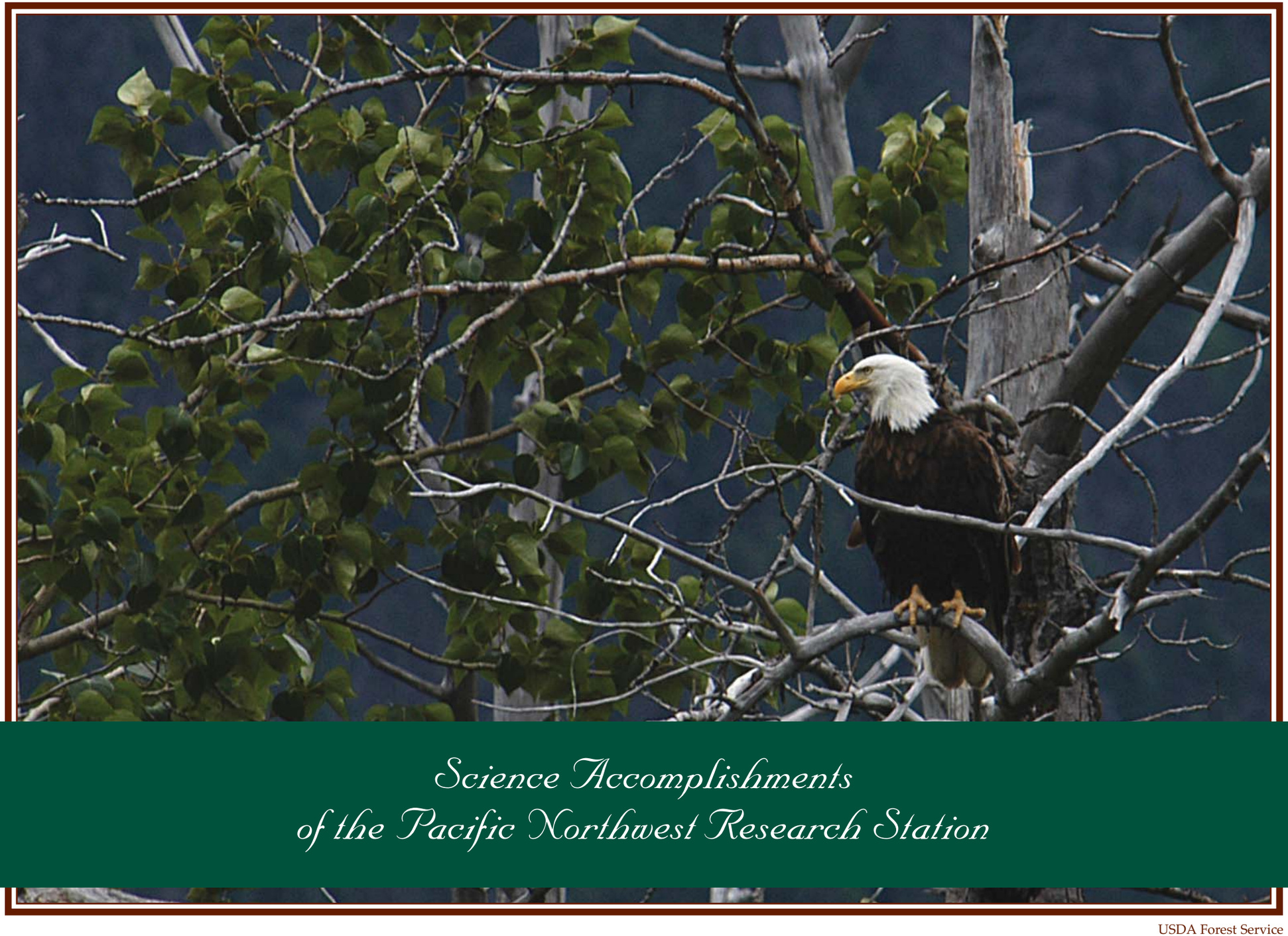

Science Accomplishments of the Pacific Northwest Research Station

USDA Forest Service