USDA

United States Department of Agriculture

Forest Service Pacific Northwest Research Station

General Technical Report PNW-GTR-711

July 2007

Ponderosa Promise: A History of U.S. Forest Service Research in Central Oregon

Les Joslin

Author

Les Joslin is a retired U.S. Navy commander; former U.S. Forest Service firefighter, wilderness ranger, and supervisory social scientist; and adjunct instructor for the College of Forestry, Oregon State University, Corvallis, OR 97331.

Cover photo by Tom Iraci.

Abstract

Joslin, Les. 2007. Ponderosa promise: a history of U.S. Forest Service research in central Oregon. Gen. Tech. Rep. PNW-GTR-711. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 121 p.

Research interest in the forests of Oregon and Washington east of the Cascade Range can be traced back to 1897, when Fredrick V. Coville of the Division of Forestry, U.S. Department of Agriculture, reconnoitered the Cascade Range Forest Reserve to report on forest growth and sheep grazing there in an 1898 report. Subsequent forest survey in the late 1890s and early 1900s was stimulated by anticipation of the timber boom that would follow arrival of a railroad. In 1908, Gifford Pinchot's new Forest Service sent young Thornton Taft Munger to study the encroachment of lodgepole pine (*Pinus contorta* Dougl. ex Loud.) on the more valuable ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) stands. By the end of the year, Munger was in charge of the North Pacific District's one-man Section of Silvics, which evolved to become the Pacific Northwest Forest Experiment Station in 1924 with him at the helm. The forest research effort east of the Cascade Range picked up speed with establishment in 1931 of the Pringle Falls Experimental Forest to research the ecologically and economically viable silvicultural systems that would convert the stagnant old-growth forests into more-productive second-growth forests. During the ensuing six and one-half decades, a small group of Forest Service researchers and their university counterparts working at the experimental forest and, beginning in 1963, the Bend Silviculture Laboratory, pioneered and pursued the practical silvicultural research that both led and responded to the evolution of their science.

Keywords: Pringle Falls, experimental forest, history, ponderosa pine, Bend Silviculture Laboratory.

Preface

This is the story of the origins, evolution, and contributions of U.S. Department of Agriculture Forest Service research in central Oregon at the Pringle Falls Experimental Forest and the Bend Silviculture Laboratory from 1931 to 1996. It is the story of the people and places key to the long-term search for knowledge about our resources—in this case, of the magnificent and valuable ponderosa pine forests and other forests east of the Cascade Range in Oregon and Washington—that is the very nature of forest science.

This summary history of Forest Service research east of the Cascade Range focused on central Oregon reflects the three relatively distinct periods in Forest Service and general forestry history identified by Duncan and Miner.[1] As a unit of the Pacific Northwest Research Station, the Pringle Falls Experimental Forest from its founding in 1931 until the end of World War II followed the Station's lead as it "conducted pioneering research work on topics that are basic to any planned management" for a National Forest System "still largely custodial" (see footnote 1). During the second period—the quarter century following the war, the Deschutes Research Center that evolved into the Bend Silviculture Laboratory shared a focus on timber production. But, for a variety of reasons, the central Oregon research effort ultimately failed to transition to the third period that led to research into whole ecosystems. Although it accomplished some pioneering prescribed burning research and made other valuable contributions, the Bend Silviculture Laboratory was closed before it was able to remake itself into a research center that fit the new research direction.

This project began in spring 1999 when Russ Mitchell suggested to the Pacific Northwest Research Station history committee that I conduct and transcribe oral history interviews of three researchers—Walt Dahms, Jim Barrett, and Pat Cochran—long affiliated with the Pringle Falls Experimental Forest and the Bend Silviculture Laboratory. These interviews, all in Bend during a week that June, benefited immensely from the participation and perspectives of Mitchell and fellow retired entomologist Boyd Wickman. So did a January 2000 interview with Bob Martin. This fourth interview followed by about 2 weeks the January 13 history committee meeting at which I had the honor of meeting, among others, the late Ken Wright.

In April 2002, I was selected to research and write this history. This research involved another 10 oral histories with research foresters and allied scientists, research technicians, and others in Bend and other Oregon cities. These were supplemented by lengthy research visits to the Forestry and Range Sciences Laboratory in LaGrande and the Pacific Northwest Research Station Headquarters in Portland. As in the case of most research projects, these interviews and investigations turned up additional leads and sources to track down.

[1] Duncan, S.; Miner, C. 2000. Closer to the truth: 75 years of discovery in forest and range research. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 76 p.

Unfortunately, some people who would have been valuable sources of information were deceased or otherwise not available. The fire at the Bend Silviculture Laboratory in 1974, with loss of valuable historical files and photographs and a recorded interview with the forester who had pioneered the Pringle Falls Experimental Forest, hindered the effort as did the closing of the lab in 1996 when its records were dispersed to other facilities. My teaching and seasonal employment imposed time constraints compounded by a surprise appointment to serve on the Deschutes National Forest staff commencing in September 2003 as I was completing the first draft. The ensuing year was, indeed, a hectic one.

Many challenges confront the researcher and writer of history. Among these—for the reader as well as the writer—is that, over the years, names change. The current Pacific Northwest Research Station is a case in point. Founded in 1925 as the Pacific Northwest Forest Experiment Station and renamed the Pacific Northwest Forest and Range Experiment Station in 1936, it was renamed again in 1985 as the Pacific Northwest Research Station. Similarly, Oregon State University was founded in 1885 as Oregon Agricultural College, and was named Oregon State College from the 1920s until 1961 when it was renamed Oregon State University. And, also, the name of *The Bend Bulletin* changed to *The Bulletin*.

Foremost among the challenges is the fact that history, by its very nature, is selective and summary. That is especially the case in a short history such as this. The necessary focus on identification and interpretation of principal themes and supporting stories and facts necessarily excludes some minor themes and details important to some. It is my fervent hope that this effort does not suffer excessively in that way.

Contents

Chapter 1: Sunrise: Research for Timber Management

Deschutes County Historical Society

Bend, Oregon, in 1910. Deschules County Historical Society photograph.

John Riis, a young U.S. Forest Service ranger,[1] rode "out of the smoke and travail" (Riis 1937) of "The Big Blowup" of late August 1910, when 3 million acres of Idaho and Montana forests burned and 78 firefighters perished, toward a new assignment in Oregon east of the Cascade Range. He arrived from the Cache National Forest the following spring in a relatively new land on the cusp of change. This change would transform Bend, the sleepy new town of 536 souls in which he dismounted, into a small but thriving industrial city of 10 times that number within as many years. And this change would beget a Forest Service research effort to understand the forest resource on which central Oregon's future would be founded and sustained.

At first disdained by the early explorers and emigrants who passed through en route to the Willamette Valley, central Oregon was wrested from Native Americans after the Civil War by ranchers who grazed sheep and cattle, followed in a few decades by homesteaders and irrigation farmers. The coming change was based on timber and transportation, "the two interlocked ingredients of central Oregon's developing economic base" that, in the early decades of the 20th century, "brought wealth to some and jobs to thousands" (Cogswell 1981).

The timber was ponderosa pine (see "Common and Scientific Names" section), called western yellow pine until the early 1930s, "an estimated 26 billion board feet of it, in open forests on flat or gently sloping ground, waiting, seemingly, for someone to come and cut it," as described by historian Philip Cogswell, Jr. (1981).

> But getting to the trees was only a relatively easy first step; getting the trees—or more precisely the lumber made from them—to market was the difficulty. Central Oregon [in 1910] was virtually isolated from the rest of the nation, including other parts of Oregon, as far as volume commercial transportation was concerned, and the exploitation of *Pinus ponderosa* would have to wait for a railroad.

Don P. Rea, editor of *The Bend Bulletin*, had opined in 1903 that as soon as Bend saw a railroad, it would see "the logs moving toward the mills at Bend, and thousands of men . . . working in the mills and in the woods" (Johnson 2003).

[1] John Riis, one of three sons of Jacob Riis, a famous New York photojournalist and social reformer whom President Theodore Roosevelt called "one of my truest and closest friends," served in the Forest Service from 1907 to 1913 and later became a respected Richmond, Virginia, newspaperman.

Anticipation of access to timber markets and acquisition of timber resources, however, didn't have to wait. Indeed, 15 years before railroad magnates James J. Hill of the Northern Pacific and Great Northern railroads and Edward H. Harriman of the Union Pacific and Southern Pacific railroads began their legendary race toward central Oregon[2] (Carlson 2001), their timber industry counterparts had begun acquiring timber holdings in the region. Although, in 1893, President Grover Cleveland had included large tracts of the public domain in the Cascade Range Forest Reserve, "by the mid-1890s, chunks of what had been public domain timberland were passing into private hands, a process that would come to a climax a decade later" (Cogswell 1981).

Some of these public timberlands were obtained legally by individuals and private companies under laws—including the Homestead Act of 1862, the Timber and Stone Act of 1878, and later the Forest Homestead Act of 1906. These acts encouraged Euro-American settlement and development of the West. Some of these lands were later sold to timber interests. As time passed, and "central Oregon's timber began to look commercially attractive, a timberland rush broke out in 1902" that led to widespread corruption and perversion of these laws. With this rush, according to Cogswell,

> droves of "entrymen," interested not in settling and improving but in filing and selling, came to the region from around the country, many having their way paid by the timber interests. At times, with the collusion of federal authorities, they conveniently ignored provisions of the law preventing transfer of title, turning their acquisitions over to their sponsors or other speculators.

This went on "until July 31, 1903, when President Theodore Roosevelt withdrew timberlands in the Deschutes area from entry under the Timber and Stone Act" (Cogswell 1981).

Courtesy of Tom Jones and Deschutes County Historical Society

John Riis, Distrist Ranger, Big River Ranger District, Deschutes National Forest, 1911 to 1913.

Then, in 1905, federal forest reserves were transferred from U.S. Department of the Interior administration to Gifford Pinchot's new Forest Service in the U.S. Department of Agriculture. The reserves were soon renamed and reorganized as national forests. From then on, private timberland acquisition activity in central Oregon "was characterized by efforts of major investors, buying timberland wherever the price was acceptable" and, under a land exchange process worked out by John E. Ryan of the Deschutes Lumber Company, "blocking up" their holdings into economically viable units (Cogswell 1981).

Assigned to a district soon to be transferred from the Cascade National Forest to the Deschutes National Forest, Ranger Riis witnessed the change wrought by timber and transportation in central Oregon from the Big River Ranger Station on the Deschutes River. There, as a district forest ranger, he was charged with protecting thousands of acres of that increasingly valuable timber. Writing in 1937, former Ranger Riis indicated that the Forest Service foresaw the day the vast private timber holdings would have to be supplemented by national forest timber.

[2] Hill's and Harriman's parallel efforts to build a railroad to Bend proved "the last railroad-building race of the wild west." The often violent race ended at the Crooked River Canyon where "Hill had purchased the only feasible place to build a bridge across the chasm, and the Union Pacific was effectively blocked. An agreement was reached, giving Hill the victory, but allowing Union Pacific trains to use the new bridge" (Carlson 2001).

> Before the opposing armies racing South [constructing parallel railroads for rival magnates Hill and Harriman] through the tortuous [Deschutes River] canyon finally joined forces and a single span of shining steel rails linked Bend to the outside world, the great lumber interests had turned their eyes to the timber in my district. [Riis 1937].

On July 1, 1911, his Big River Ranger District became part of the Deschutes National Forest when the headquarters of that forest was moved from Prineville to Bend (Baker 1950).

Bend was "the Mecca of the Rangers on the Deschutes" where they went "every now and then to have horses shod, replenish the larder, or for a few days of detail in the Supervisor's office" (Riis 1937). Ranger Riis was in town on October 4, 1911. It was the day before Railroad Day, the day James J. Hill would drive the golden spike marking completion of the Oregon Trunk Railroad route to central Oregon and the day the first train would arrive in Bend.

Forest Supervisor J. Roy Harvey had been urging Riis and his fellow district rangers to get on with their timber cruising, and Riis had been rounding up a crew. Not wishing to leave town on the eve of the big event, Riis had countered that the private timber owners "have enough timberland to keep them busy a long time; better timber than there is in any [national forest] district."

"Sure, but the railroad's here and this country is in for some tall timber cutting," the forest supervisor rejoined. "The Fall River timber [on Riis' district] is easier to get out and closer to the railroad than the private holdings. Get your crew in the field as soon as you can."

"The railroad had come to Bend at last," Riis reflected in 1937. "Another frontier wiped out by the march of progress."

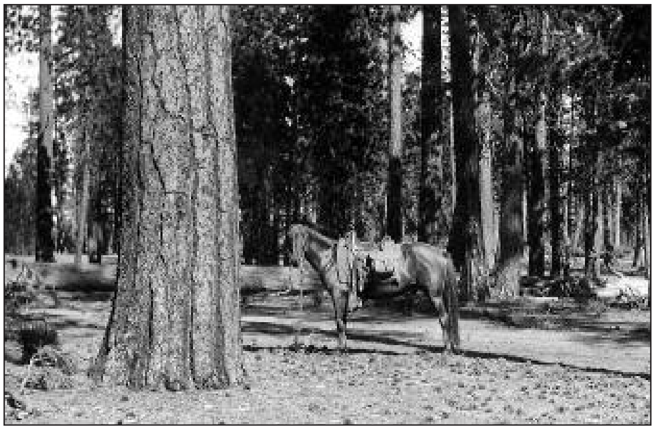
> Always the railroads came and the country settled up. Two-gallon hats gave way to the derby and the fedora, the rattling stage with its flapping canvas side-curtains succumbed to the automobile. Now even some of the supervisors were forsaking their saddle horses for the little tin roadsters that whirled and bumped over the dusty roads and got one there entirely too soon.
>
> I had thought I was secure at Big River twenty-five miles from town with the woods and the desert barring the outside world. The great inland empire that had slept in picturesque peace since the days of Lewis and Clark, would soon be overrun by the drudges of commerce and industry.
>
> It was not difficult to complete my timber cruising crew, and load the chuck wagon for the trip into the hills. Getting them out of town was another matter. "Tomorrow, sure. But not on Railroad Day" [Riis 1937].


T.T. Munger

Thornton T. Munger photographed Ranger John Riis on Brown's Mountain, Big River Ranger District (as it was called then), Deschutes National Forest, during the summer of 1912.

The train was expected to arrive at noon on October 5, but it was about midnight before that "first train into central Oregon rolled slowly down the track and came to a stop." Most of Bend's townsfolk, a brass band, and Riis met the train. And the young ranger met a young lady named Ruth from North Carolina who arrived on that first train and would someday become his wife. They enjoyed the celebration together. Then, "all too soon the train pulled out for Portland carrying her away." It was time to get to work in the woods.

Ranger Riis and his crew cruised timber on the Big River Ranger District during the fall of 1911. "With



Thornton Munger used his horse for scale when he photographed ponderosa pine stands during his autumn, 1908, reconnaissance of central Oregon forests. He took this photograph on the Deschutes National Forest near Crescent, on October 5, 1908.

November, winter set in just as we finished cruising the high lands and moved down to the head of Fall River"—only 2 miles northwest of the site on which the headquarters of the future Pringle Falls Experimental Forest would be built 20 years later. "In the course of our work," Riis wrote in 1937, "we cruised and mapped more than thirty-six square miles of land and added two small lakes to the map of Oregon, North and South Twin Lake." And then he added: "Thornton Munger dropped in to check up on our work occasionally" (Riis 1937).

Just turned 28, Thornton Taft Munger, who would become the first director of the Pacific Northwest Forest Experiment Station in 1924, was by then an old hand in central Oregon. Munger had completed a master's degree at the Yale Forest School in 1908 and joined the Forest Service. After 2 months as a forest assistant with Raphael Zon in the Office of Silvics,[3] the research branch in the Washington, D.C., headquarters referred to then and since as the Washington Office, he had been sent to central Oregon to study the encroachment of lodgepole pine on the more valuable ponderosa pine. This encroachment by the tree Munger soon called "a practically worthless weed" (Munger 1914) worried W.H.B. Kent, a western forest inspector who viewed fire as "an unnatural agency of disturbance" (Langston 1995) and who had suggested the study. Munger traveled by train to Portland and Shaniko, then by stagecoach via Bend to the hamlet of Rosland near the present La Pine. Still working under Zon, he spent 11 weeks in September, October, and November roaming central Oregon, mostly on horseback, examining lands of the Deschutes, Cascade, Fremont, Umpqua, and Crater National Forests and the Klamath Indian Reservation, trying to puzzle out the ecological relationship between the two pines (Fry 1967; Munger 1946, 1962).

Munger was, in a very real sense, a pioneer. Central Oregon and its forests weren't exactly terra incognita in 1908, nor were they especially well known. Peter Skene Ogden had passed through in 1825 and Nathaniel Wyeth had camped at Pringle Falls during his winter 1834–35 exploration of the upper Deschutes River country. Fabled scouts Kit Carson and Billy Chinook had guided Lieutenant John C. Fremont and his party of U.S. Army Topographic Engineers through the area in 1843. And in 1855, a decade before settlement began, scientist and physician Dr. John Strong Newberry had explored the area with the Pacific Railroad Survey party led by Lieutenant Henry Larcom Abbot, another Army engineer.

In the summer of 1897, a year before Gifford Pinchot succeeded Bernhard E. Fernow as chief of the Division of Forestry in the U.S. Department of Agriculture (Steen 1976), Frederick V. Coville of that Division inspected the Cascade Range Forest Reserve. He published *Forest Growth and Sheep Grazing in the Cascade Mountains of Oregon* in 1898 (Coville 1898). Then, while Bend was being founded, several U.S. Geological Survey investigators reconnoitered the area. Arriving close on Coville's heels, John B. Leiberg attributed to fire the "noticeable and

---

[3] **Silvics** is "the study of the life history and general characteristics of forest trees and stands, with particular reference to locality factors, as a basis for the practice of silviculture." **Silviculture** is "generally, the science and art of cultivating (i.e., growing and tending) forest crops, based on a knowledge of silvics. More particularly, the theory and practice of controlling the establishment, composition, constitution, and growth of forests" (Ford-Robertson 1951).

striking" absence of young growth and underbrush in central Oregon's ponderosa pine forests. This made it possible, in colleague H.D. Langille's words, for "one to ride or even drive without hindrance" through the forest. "The yellow pine," Leiberg concluded, "is by all odds the best fire resisting tree in the sylva of the North Pacific slope" (Lieberg 1900).

In 1903, geologist Israel C. Russell explored the area. Munger almost certainly had read Russell's 1905 report. In that report, Russell wrote that the "yellow pine forests" in the "central part of Oregon are not only extensive, but contain magnificent, well-grown trees, which will be of great commercial value when railroads . . . bring them within reach of markets." Russell also observed of the area that "little seems to be generally known concerning its timber resources" (Russell 1905). This confirmed that Munger was a pioneer forester there, and certainly one who agreed with Russell's optimistic justification for his being there.

> It is fortunate that these great forests have escaped the demands of industry so long, as large portions of them have now been included in national forest reserves and can be utilized under the supervision of skilled foresters, so that their continuance is assured [Russell 1905].

Munger also likely had read Coville's 1898 observations on "the forest fire evil in the Cascades" and the effect of fire on "reforestation in certain areas" (Coville 1898) as well as Leiberg's conclusion that fires associated with "the advent of the white man" and his settlements were "more numerous and devastated much larger areas" (Langille et al. 1903 in Robbins and Wolff 1994) than those burned by Native Americans.

Munger "studied the composition of the forest" and "found many places where there had been a ponderosa pine forest" that he determined "had been killed by repeated fires and had been replaced by lodgepole pine." He found "other places where the lodgepole pine seedlings and the ponderosa pine seedling were in competition" and where "the lodgepole seedlings were getting the best of it."

> There was what I called a tension zone, which was suitable for both species, and there the lodgepole pine seemed to be gaining ground, I thought as a result of repeated fires which are disastrous to the ponderosa pine but not to the lodgepole, because it is such a prolific reproducer after fires. There was also a zone that was confined wholly to lodgepole pine [Fry 1967].

Munger's peregrinations stimulated the early asking, if not the conclusive answering, of the kinds of questions he and those soon to work for him researched east of the Cascades—at the Pringle Falls Experimental Forest and the Bend Silviculture Laboratory—for decades.

The real questions, of course, were yet to be formulated. And when they were, some of the answers seemed to prove early foresters' conviction "that fire should be kept out of the timber at all times and at all costs" (Coe 1940). In fact, this fire exclusion became the cause of the increasingly destructive fires and insect populations that plagued central Oregon's forests and propelled forest research there for most of the 20th century. In his 2004 *Landscapes in Conflict,* historian William G. Robbins summarized the situation as characterized by Dr. Urling Coe, writing in 1940 of his 13 years in Bend that began in 1905, and by University of Wisconsin professor Nancy Langston, writing in the 1990s.

> Urling Coe, an early Bend physician, remembered "an open park-like forest, without any underbrush," where lightning-caused fires periodically burned "the dead pine needles, cones and twigs that had been blown to the ground by the wind." The result was a forest floor clear of debris and destructive pine beetles. Coe noted that over centuries of time, annual fires "had produced the beautiful and open forests free from dangerous underbrush, and killed so many pine beetles that they were held in check." Fire shaped the pine forests that Coe so admired, and, according to historian-ecologist Nancy Langston, "without fires those forests changed into something utterly different." When two large mills

Van Vleet Collection, Deschutes County Historical Society

Historically, periodic fires kept many central Oregon ponderosa pine stands in open, parklike condition, as shown in this early 20th century photo.

> . . . began cutting their extensive timber holdings in 1916 [8 years after Munger's first visit], the elimination of fire and rapid timber harvests began to create a very different forested landscape [Robbins 2004].

In a very real sense, early forestry policies and practices created the problems that early forestry research would be asked to solve. "Cultural practices—keeping fire out of the woods and cutting only large-diameter ponderosa pine ("highgrading")—had consequences for the forest environment" (Robbins 2004). These consequences, "manifested in accumulated litter and dead and dying trees, increased stand densities, altered species compositions, and disruption of historic insect population levels, can be attributed to decades of fire exclusion and past management activities" (Youngblood and Riegel 2000), Forest Service scientists who followed Munger's trail concluded almost a century later.

While in central Oregon, Munger was told to report to Portland to take charge of a one-man Section of Silvics at the soon-to-be-created North Pacific District (later the Pacific Northwest Region) office. On December 1, 1908, Chief Forester Pinchot had decentralized the Forest Service and established six district offices, "miniature Washington Offices" that were renamed regional offices in 1930, in the Western United States. District 6 included the states of Oregon, Washington, and Alaska until 1921 when Alaska was made District 10. To reach Portland, Munger rode his horse over 75 miles of icy roads from Klamath Falls to Medford, sold his companion of 3 months, and caught the Southern Pacific train to Portland (Fry 1967, Munger 1962). Munger arrived in Portland on December 1, "just as the great migration arrived from Washington to establish the District 6 office," and went to work for Fred Ames, Chief of Silviculture. District Forester E.T. Allen was 33 years old, and most of the staff still in their 20s (Fry 1967, Munger 1962).

Munger got right to work, and on December 31 submitted his 89-page *Report of a Study of the Encroachment of Lodgepole Pine on Western Yellow Pine on the East Slopes of the Cascade Mountains in Oregon* in which he attributed the encroachment problem to frequent forest fires (Munger 1908). He repeated his thesis that "this whole transformation in the forest type is due to the increase in the frequency of forest fires" since Euro-American settlement in the 1914 *Proceedings of the Society of American Foresters.* There he outlined what he termed "a logical explanation of how this process works." Essentially, the lodgepole pine, more prone to burn hot and to reproduce after a hot burn than the yellow pine, invades "a land where the latter was adapted to grow."

> With the advance of the process and an increase in ` the proportion of lodgepole pine, the fires are more severe and run more in the crowns, thereby hastening the process just so much by damaging yellow pine and promoting lodgepole [Munger 1914].

Among forest management practices that Munger recommended to favor yellow pine was "the absolute prevention of forest fires" (Munger 1914). Many years later, studies by Forest Service soil scientist Robert F. Tarrant showed that it was soil and surface air temperatures that were positive factors in lodgepole pine encroachment (Cowlin 1988). More recently, fire exclusion from this forest has proven a grave mistake.

Thornton T. Munger

"It has since struck me how audacious or naïve it was for the Washington Office to assign a forest assistant with no experience, who had not even seen the two species before, to such a study that now would be assigned only to subject specialists with Ph.D.s," Munger mused in 1962 of his autumn 1908 sojourn (Munger 1962).

Forest Service research in those early days was characterized as a "hit-and-miss" proposition by Ivan Doig (1977). There was so much to know, and there were so few foresters and allied scientists with so little time to study and learn.

> Because so little was known, the first questions were quite simple: What's out there? What are the range and characteristics of the various tree species? How much timber volume is available? How much of it is dead? How does it grow, and how and where does it grow best? [Duncan and Miner 2000].

It was all new. Sometimes efforts to answer such questions hit, sometimes they missed. The "how much" and "where" questions were addressed by a research effort eventually called the Forest Survey. The more esoteric "how does it grow" and "how and where does it grow best" questions became the topics of long-term silvicultural research.

According to the April 7, 1909, issue of *The Bend Bulletin*, Munger returned to central Oregon to "conduct experiments this summer in reforestation in the vicinity of Rosland. His task is to learn whether yellow pines will grow on the lands now covered with a dense growth of black jack [lodgepole] pines, an inferior variety" (Bend Bulletin 1909a). "I probably will lay off three plots of about one acre each, and try three different methods," Munger told the paper, perhaps anticipating techniques including research plots and local Forest Service cooperation employed a quarter century later at Pringle Falls Experimental Forest.

> One will be to scatter pine seeds broadcast, another will be to plant seeds with a cornplanter, and on the other I will plant some yellow pine seedlings from the government nursery stock. These plots will be marked so that forest officers will be able to visit them from time to time to see what results can be obtained. The forest rangers in that district will assist me in the work.
>
> It will take probably four or five years' time before we can arrive at any conclusions as to results, and I will simply plant the seeds and young trees and let nature take her course. There are large areas in the region about Crescent lake in northern Klamath county which are barren, and the Rosland experiments will indicate what can be done there as well, for the soil and conditions are practically the same [Bend Bulletin 1909b].

Although his forest investigations, as research was termed at the time, emphasized Douglas-fir growth and yield west of the Cascade Range, as reflected in his office's first publication (Munger 1911), Munger didn't ignore ponderosa pine. Indeed, even as the Douglas-fir studies progressed, his Section of Silvics turned its attention to the growth of western yellow pine in 1910, when "two three-man crews were in the field under Dean Hugo Winkenwerder [of the Forest School, University of Washington] in the Klamath region and George Bright [a Wenaha National Forest silviculturist] in the Blue Mountains. I worked with both crews."

This pine growth study was continued in 1911 and later expanded to cover the silvicultural aspects of pine management.

In 1913 I was in on the establishment of three 15-acre Methods of Cutting plots on the Whitman National Forest, the first of a large series of plots to study the silviculture of western yellow pine. These were laid out by T.J. Starker, E.H. MacDaniels and others to show the effects of leaving a 15%, 25%, and 35% reserved stand [Munger 1962].

This fieldwork contributed to Munger's pioneering *Western Yellow Pine in Oregon* published in 1917 (Munger 1917). But knowledge of ponderosa pine ecology and silviculture was in its infancy, and some of the management policies and practices prescribed, from fire exclusion to frequent light harvests, produced unfortunate results (Langston 1995) that proved the need for long-term research.

But time was short. Forest science was in a race to catch up with forest industry. It was a race science couldn't win, as industry cut a wide swath through what it considered a "one-time crop" without regard for the future. The anticipated timber boom in central Oregon was at hand. In 1915, two Minnesota-based timber giants announced construction of mills—the Shevlin-Hixon Company in May and the Brooks-Scanlon Company in August—on the western and eastern banks of the Deschutes River at Bend. To supply these mills, "Shevlin-Hixon had amassed more than 200,000 acres of prime ponderosa timber; Brooks-Scanlon, a small but rapidly expanding acreage" (Robbins and Wolf 1994). These mills soon gave birth to the timber-based economy of central Oregon that arrival of the railroad had made possible. Among the largest and most modern pine mills in the country, both cut their first boards in 1916 (Cogswell 1981) and kept cutting as they expanded their logging and milling capacities. George Palmer Putnam's *The Bend Bulletin* celebrated this development.

The dream, Bend, the sawmill and lumbering center of Central Oregon is now an actuality. . . . After years of "watchful waiting" by men who were possessed with faith that one day saws would be humming and that vast area of Deschutes timber would be manufactured at Bend, they have today to take a 10-minute walk from the center of town to see that realization of their dreams [Bend Bulletin 1916].

Walt Perry

Walter J. Perry reviews timber harvest operations done by the Shevlin-Hixon Company on the Deschutes National Forest, circa late 1920s.

Walt Perry collection

Walter J. Perry scales a ponderosa log on a Shevlin-Hixon timber sale outside Bend, Oregon.

Before long, each mill employed 600 men and probably twice that number of loggers (Robbins and Wolf 1994), and each cut more than 200 million board feet a year

Van Vleet Collection, Deschutes County Historical Society

The giant pine mills of the Shevlin-Hixon Company and the Brooks-Scanlon Company faced each other across the Deschutes River in Bend for decades after they began operations in 1916.

(Briegleb 1936). Bend boomed, even as the private timber resource, on which the boom was based, dwindled.

Within a decade, both companies and many smaller ones had cut over most of their own central Oregon timberlands and were starting to buy Deschutes National Forest timber. By the early 1930s, at the height of Bend mill production, the Brooks-Scanlon Company asked the Forest Service for increased access to national forest timber. Heavy cutting of private timber had put Bend's timber-based economy on the brink. That economy looked to the national forest for the short-term support it wanted if not for the long-term stability it needed.

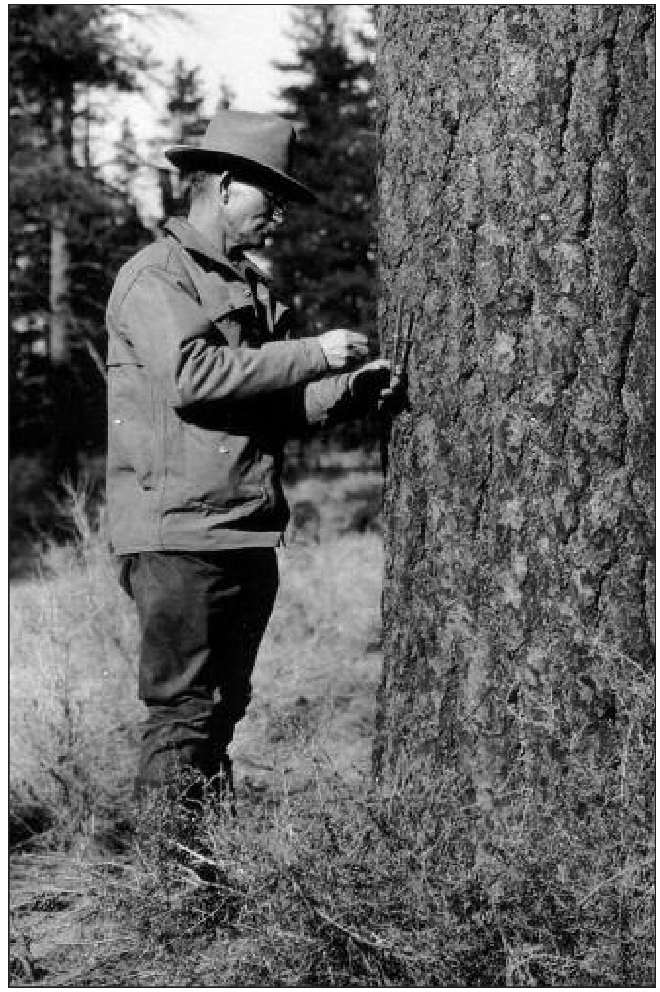
Walter J. Perry, a pioneer Forest Service ranger and self-trained forester with 8 years of experience at managing a large ponderosa pine timber sale on the Carson National Forest in New Mexico, had been transferred to Bend in 1925 to administer these sales. Perry had a timber management ethic that valued the forest and the future (Perry and Joslin 1999). Although he promoted the process through which central Oregon's "sensible operators eventually recognized that sustained-yield operations were necessary for continuation of their businesses" (Cogswell 1981), Perry and others knew that most of the scientific and economic questions on sustainable and profitable ponderosa pine forest management were yet to be answered.

The groundwork for answering those questions was being laid in Washington, D.C., and Portland. As early as June 1, 1915, the importance of answering such questions had been recognized when Chief Forester Henry S. Graves established the Branch of Research in the Washington Office under the direction of Earle H. Clapp as Assistant Chief to direct Forest Service research (Cowlin 1988, Geier 1998). Also in 1915, "Munger was made Assistant Chief of the Portland Office, Division of Silviculture," and his "Section of Silvics ceased to function as such" (Cowlin 1988). The result was Washington Office-District Office turf wars. While these new organizations worked out their new "lines of authority and responsibility" for "investigative projects" and "administrative studies" that asked and answered research questions on fundamental principles and specific cases, respectively, Munger worked at both. His attention directed to timber survey and timber sales, he continued to supervise administrative studies on the national forests even as he pursued the goal of long-range research that would advance scientific and sustainable forest management.

Establishment of the Pacific Northwest Forest Experiment Station on July 1, 1924, made possible by a Federal Appropriation Act of 1925 allocation of $26,000 for centralized forest research activities, made that latter goal of long-range research more attainable. So did clarification of the fact that experiment station directors reported to Assistant Forester Clapp in the Branch of Research in Washington, D.C., not to district foresters responsible for National Forest System administration. Munger, named Director, set the utilitarian tone of the Station's work on behalf of public and private interests:

> We have no time now for research for research's sake; for delving into incidental trifles of mere academic interest; for working on questions, the answers to which have no application in current affairs. I believe we have no justification now in working with our less important tree species or in the non-commercial forest types. For the present our major activities must lie in the important timber belts, where the extensive lumbering operations lie and where there are great areas whose future may be either devastation or reforestation. The selection of projects will depend on their economic importance [Munger 1924 in Geier 1998].

This practical focus on "the important timber belts" or "economic importance" boiled down to the Douglas-fir forests west of the Cascade Range and the ponderosa pine forests east of the Cascade Range, the Pacific Northwest's two major forest types, as the new Station's research priorities. He urged industry to replace forest exploitation with "timber farming," and emphasized growth and yield studies to increase timber production. "It may be presumptuous to say that man can improve on Nature, but he certainly can if he goes about it," Munger told the Pacific Logging Congress in Portland in October 1924. "Under proper management man can produce more wood per acre than Nature has in the wild stands" (Munger 1924). The research challenge, as Munger saw it, was to discover the ecologically and economically viable silvicultural systems that would convert the stagnant or slow-growing old-growth forests east and west of the Cascade Range into faster-growing and more-productive second-growth forests.



Carl B. Neal

This 1930 photograph shows Walter J. Perry using an increment borer to extract tree ring cores, to better understand how central Oregon's climate affected tree growth rates.

Among the talent transferred to the Station to help Munger "improve on Nature" were a junior forester named Richard E. McArdle, a future chief of the Forest Service, and Robert Marshall, a future leader of the wilderness movement. Also assigned were Leo A. Isaac, an innovative Douglas-fir researcher who would take time away from studies of that species to help found the Pringle Falls Experimental Forest in 1931, and Edwin L. Mowat, who eventually would pursue ponderosa pine silviculture at that experimental forest (Cowlin 1988, Doig 1977).

Although the new experiment station's work continued to emphasize Douglas-fir growth and yield studies, ponderosa pine was not ignored. On July 1, 1925, Ruthford H. Westveld, who Munger recalled "came directly to us from Michigan Agricultural College as a very promising young forester," was appointed a junior forester and assigned "largely to studies of ponderosa pine in central and eastern Oregon and Washington" (Fry 1967). Ponderosa pine studies were further strengthened in 1928 when Dr. Walter H. Meyer, a 1922 Yale Forest School graduate with European training in forest mensuration who joined the Station in 1926, initiated a study of growth and yield of this species. Ten years later, in 1938, Meyer's work culminated in publication of *Yield of Even-Aged Stands of Ponderosa Pine* as U.S. Department of Agriculture Technical Bulletin No. 630. This publication stood the test of time so well it was reissued in 1961 with only slight revisions (Meyer 1961). When, in 1928, Westveld—who had chosen the life of teaching forestry at Michigan State College over continuing to eat central Oregon logging camp grub—departed, Ernest L. Kolbe, who had served on Meyer's field crew, was chosen from the junior forester rolls in July to replace him. Within 3 years, Kolbe would join Isaac in founding the Pringle Falls Experimental Forest, and then develop that facility and its research program. In the meantime, this ponderosa pine work strengthened the research program east of the Cascade Range and to some extent balanced the Station's program (Cowlin 1988).

There were other early forest research efforts in central Oregon. In 1926, Munger had joined in a long-term genetics study, begun in 1911 and quite sophisticated for its time, to test the effect of seed origin on the growth of ponderosa pine in plantations in Arizona, Idaho, Oregon, Washington, and New Zealand. Recognizing that "regional races" or strains of ponderosa pine existed, he and others sought answers to two basic questions they hoped would lead to ponderosa pine forests with increased growth and yield. These questions were: Which of these races is best to use in artificial reforestation: the local strain, or a more rapid-growing strain from another region? Are the strains from different localities as hardy and resistant to diseases as the local strains? "To throw light on these questions, . . . in 1926 the seed from ten regional races was sown at the Wind River Nursery in Washington state, and two years later plantations from this stock were established in six quite contrasting sites"[4] (Munger 1947). Munger and Westveld, along with Walt Perry of the Deschutes National Forest, established one of these plantations about 8 miles south of Bend in March 1928. Monitored ever since, notably by Isaac and then by Forest Service geneticist Roy Silen even into the 21st century, this plantation and the others have provided the practical benefits—in this case important information about ponderosa pine reforestation—that met Munger's "research put into use" requirement (Silen 2002).

Freelance research not sponsored by Munger's office was also part of the central Oregon scene. Perry, for example, was attracted to the technique of dendrochronology—using tree rings to date natural phenomena—and applied it to studies of the region's climate and geology as well as to forest management. An article in the May 24, 1930, issue of *The Oregonian* reported the results of his "detailed study of rings of annual growth" of aged ponderosa pines to understanding the region's climate (Portland Oregonian 1930). And, as reported in the April 25, 1962, issue of *The Bend Bulletin*: "The late Walter J. Perry, Deschutes National Forest lumberman, used his increment borer in dating trees within the cone of Lava Butte and refuted the belief that the cone was born 'only yesterday'" (Brogan 1962). This belief was set forth by U.S. Geological Survey geologist Israel C. Russell, who in 1903 estimated the butte south of Bend erupted "at least a hundred and probably more than a hundred and fifty years ago" (Perry and Joslin 1999, Russell 1905). Modern dating techniques indicate the cone was built about 7,000 years ago.

---

[4] The Wind River Experimental Forest, formally established in 1913 as the Wind River Forest Experiment Station, often has been referred to as the "cradle of forest research in the Pacific Northwest." A tree nursery was established there in 1909, and an arboretum in 1913. More recently, the T.T. Munger Research Natural Area within the experimental forest has become the focal point for forest canopy research in old-growth forests.

In general, however, early forest research in central Oregon languished as a result of its inability to compete with the Douglas-fir region for research talent and dollars.

The importance of forest research, long recognized within the Forest Service, finally was recognized by Congress when it passed the McSweeny-McNary Act of 1928 called for by Assistant Chief Clapp's *A National Plan of Forest Research* that in 1926 "outlined what he called an organic act for Forest Service research" (Steen 1976). A blueprint for the regional experiment stations, the act directed the Forest Service to pursue research of "forest diseases; forest insects; forest animals, birds, and wildlife; forest fire weather; forest range and watershed; forest products; forest survey; and forest reforestation and economic studies" (Cowlin 1988). These broad fields of study were soon reflected in the Station's evolving organization into functional sections. On January 30, 1933, a Section of Silviculture under McArdle was created to better coordinate and supervise studies in fire, forestation, natural reproduction, management, forest influences, and phenology, among others. Companion sections were Forest Survey and Forest Products. Other studies such as economics and land transfers were not yet included in sections (Cowlin 1988).

McArdle's section included Kolbe and the Pringle Falls Experimental Forest he was developing in central Oregon to provide a relatively controlled environment for the scientific study of ponderosa pine silviculture.

Chapter 2: Pringle Falls: A Research Forest

When Forest Service Chief Robert Y. Stuart approved establishment of the Pringle Falls Experimental Forest in May, 1931, Forest Service scientists started down the long road toward understanding the ponderosa pine forests east of the Cascade Range crest.

E.L. Kolbe

This photo taken in August, 1932, shows Pringle Falls Experimental Forest from the Fall River Road on the north boundary.

The need for a permanent western yellow pine research forest—an experimental forest—in central Oregon was evident to Director Thornton T. Munger and his Pacific Northwest Forest Experiment Station advisory council.[1] The authority to administratively designate experimental forests within national forests was provided in Forest Service Regulation L-20, an agency policy written by Associate Forester Leon F. Kneipp in July 1929, at the direction of Chief Forester William B. Greeley (Steen 1976), and approved by the Secretary of Agriculture.

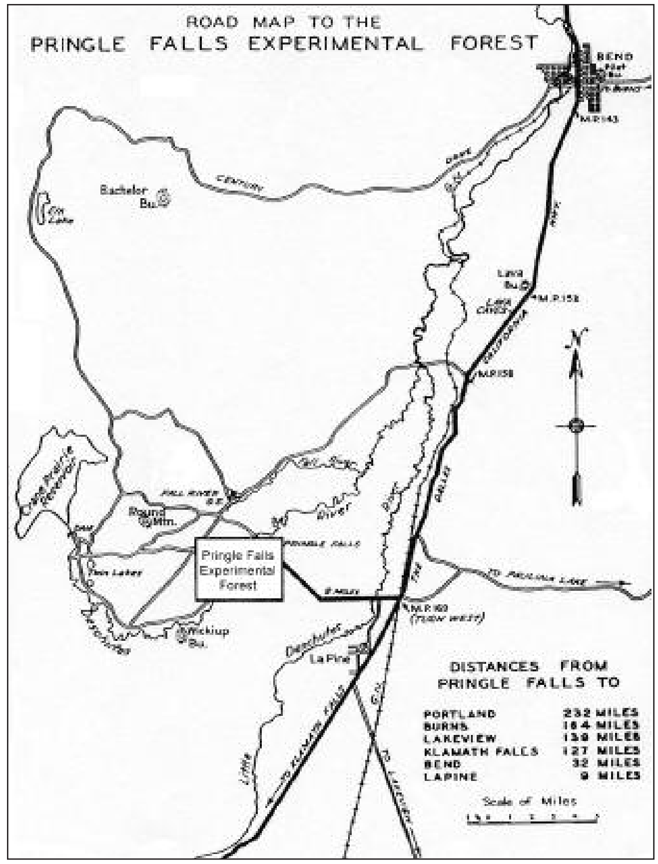
Once the advisory council's Committee on Experimental Forests proposed "two experimental forests east of the Cascades . . . typical of the western yellow pine region of eastern Washington and eastern Oregon" (Isaac and Kolbe 1931), designation of the Pringle Falls Experimental Forest south of Bend on the Deschutes National Forest came quickly. This first experimental forest in the Pacific Northwest is representative of the "fairly homogeneous" ponderosa pine forest that graces the eastern slopes of the Cascade Range in Oregon from the Warm Springs Indian Reservation on the north to the California line on the south.

Munger, familiar with the research potential of the Pringle Falls area from his western yellow pine work,

[1] "Forest research priorities at [the Pacific Northwest Forest Experiment Station] during the late 1920s were formulated in cooperation with a Forest Advisory Council appointed by [President] Calvin Coolidge's Secretary of Agriculture, William Jardine, and headed by C.S. Chapman, chief forester for Weyerhauser Timber Co., who was elected at the first meeting of the council. Thornton Munger served as secretary, and other members of the council included leaders from the timber industry, public and private professional foresters, faculty from the forestry schools at the state agricultural colleges of Oregon and Washington, and state and federal foresters" (Geier 1998).

Paul Hosmer Collection, courtesy Deschutes County Historical Society

The Deschutes River bisected the Pringle Falls Experimental Forest. Pringle Falls itself was known to cause log jams in early-day river drives, as shown in this photo.



Isaac and Kolbe's 1931 establishment report called for a 7,450-acre Pringle Falls Experimental Forest on the Deschutes National Forest, about 30 miles southwest of Bend.

assigned two members of his staff, assistant silviculturist Leo A. Isaac and junior forester Ernest L. Kolbe, to report on the proposed Pringle Falls Experimental Forest. The two, joined by Munger for 3 days and by Forest Supervisor Carl B. Neal for 1, examined the area in April 1931. All agreed that the area was "admirably suited for experimental purposes" (USDA FS 1931a). Isaac and Kolbe's establishment report, submitted to Munger on May 9, 1931, called for an experimental forest of 7,520 acres within the Deschutes National Forest about 30 miles southwest of Bend.

An Experimental Forest Is Planned

"The Deschutes River," their report read, "crosses the area from north to south." Pringle Falls, a narrow series of cascades on the Deschutes, was named for Octavius M. Pringle, who had come to central Oregon from Salem in 1873 or 1874 and settled on a ranch at Powell Butte near Prineville. In 1902, as allowed by the Timber and Stone Act of 1878, Pringle had acquired 160 acres at these falls where Native Americans once caught fish swimming upstream to spawn. By 1916, the erstwhile town site of Pringle Falls, advertised as "the most beautiful in Central Oregon," had been platted (Hatton 1987, McArthur and McArthur 2003) with a future as a lumber and hydroelectric center in mind. Fifteen years later, Isaac and Kolbe reported "the old sawmill, power, and town site . . . deserted and rapidly going to pieces" and Pringle's 160 acres, which had changed ownership, "being held for prospective power development" (Isaac and Kolbe 1931).

The adjacent proposed experimental forest "lies 18 miles east of the Cascade Summit and about an equal distance west of the Paulina Mountains," Isaac and Kolbe reported. "It is 6 miles west of the Oregon Trunk Railroad and the Dalles-California Highway at a point 3 miles north of La Pine," they continued, noting that "the only bridge across the Deschutes for some miles is in this area." They deemed these transportation facilities "adequate in making the area accessible for fire protection and experimental purposes" as well as "the profitable marketing of the products" that would result from "small cuttings for experimental purposes."

Isaac and Kolbe's report continued to describe the area and evaluate its potential for forestry research.

> The proposed area is well located in relation to its surroundings to make possible its dedication to research purposes without interference from or to the normal management of adjoining public and private forest lands. On the north and east is level yellow pine timberland, partly private and partly national forest ownership, which can be logged without material interference or demand upon the experimental forest. On the west is noncommercial lodgepole type in national forest ownership, and on the south is a ridge of hills mostly in private ownership, which presumably will be logged to the south away from the experimental forest. The wide Deschutes River bisects the tract and should act as a firebreak to isolate each half from fires that might start on the other half.

This vivid and specific report enabled readers to visualize the proposed experimental forest's topography, climate, and resources. "The elevation of the area varies from 4,250 to 5,050 feet," they reported. "Most of it is comparatively flat, lying between the 4,250 and 4,350 foot contours except in the east central portion where Pringle Butte rises to 5,050 feet."

> The flat land has several levels, which are distinguished by differences in the timber types and undergrowth. The lower flats are covered with lodgepole pine, which is typical of the cooler soils throughout the region. All the slopes and higher flats are covered with yellow pine, with a little admixture of lodgepole on the flats.
>
> The soil is of volcanic origin consisting of several feet of pumice and volcanic sand deposited on basaltic lava, which outcrops only on the buttes, in the river canyon, and occasionally elsewhere.

Three years of records from the Fall River Fish Hatchery weather station, just 2 miles away, showed Isaac and Kolbe "an extreme range of -36º[F] to 101º[F], frost every month of the year, and an annual rainfall of 17.5 inches." As "precipitation was exceedingly scanty" during those 3 years, they concluded that the "long term normal precipitation is undoubtedly over 20 inches a year."

Observing that poor soil, midsummer frosts, and lack of available irrigation water rendered the proposed experimental forest and surrounding area of little, if any, value for agriculture, Isaac and Kolbe concluded: "There is no question but that this area is all ultimate forest land" and not subject to other uses. The remainder of their report focused on the area's timber, grazing, water, wildlife, and recreational values.

Isaac and Kolbe based their assessment of the proposed experimental forest's timber resources on type and stand maps produced during the intensive 1911 and 1914 reconnaissance of the area by Munger, Ranger Riis and his crew, and others. According to their 1931 report:

> The proposed experimental forest includes large compact bodies of both western yellow pine and lodgepole pine types, and . . . three smaller areas classed as sugar pine type. The proportion is approximately 4,640 acres of yellow pine, 2,560 acres of lodgepole pine, and 320 acres of sugar pine.

The total amount of timber of each species within the proposed boundaries was 55,063 thousand board feet (mbf) of yellow pine, 6,080 mbf of lodgepole pine, 1,260 mbf of sugar pine, and 14 mbf of white fir.

They reported "notable variations in the yellow pine type with changes of slope and aspect that are conspicuous by the change in the ground cover" from bitterbrush on the flats to manzanita, snowbrush, and chinquapin on the slopes. They attributed similar variations in the lodgepole pine type to variations in the water table. They also noted that yellow pine reproduction, scarce on the flats except in openings, was more abundant on the slopes.

Otherwise, Isaac and Kolbe found grazing "next important to timber growing" on the proposed experimental forest, and that the entire area was "grazed under Forest Service permit . . . the area east of the Deschutes River by sheep and the area west of the river by cattle." They concluded grazing was not detrimental to yellow pine reproduction when properly managed. They determined that plans for power projects along the river, if implemented, would "not interfere with the water level on the proposed experimental area." And they recognized the inevitability of considerable hunting and fishing in the area and the potential for recreation development on lands along the river. Since designation and use of the proposed experimental forest would "not interfere to any extent with its present normal use by the public," Isaac and Kolbe judged "there is every reason to believe that a research forest in this vicinity will be received by all concerned with approval" (Isaac and Kolbe 1931).

This headquarters building for the Pringle Falls Experimental Forest was constructed during the summer of 1931 for $450. USDA Forest Service photograph was taken in October 1931.

E.L. Kolbe

This photo taken in October, 1933, shows the "office cabin" built at Pringle Falls Experimental Forest during the summer of 1933.

The Pringle Falls Experimental Forest Is Designated and Developed

Approval by the Forest Service was swift and sure. Indeed, Forest Supervisor Neal in Bend had approved the report on April 28, before it was submitted to Portland officials on May 9. Munger signed on May 11, and Regional Forester C.J. Buck signed on May 12. Then, in Washington, D.C., on May 20, 1931, Chief Forester Robert Y. Stuart exercised the authority vested in him by Regulation L-20 "relating to the occupancy, use, protection, and administration of the national forests" to "designate as the Pringle Falls Experimental Forest the lands described in a report dated May 9, 1931, by Leo A. Isaac and Ernest L. Kolbe," and approved the establishment report (Isaac and Kolbe 1931).

The next step of implementing this designation fell to Kolbe who, for all practical purposes, founded and developed this first experimental forest in the Pacific Northwest. While Isaac returned to the western side of the Cascades to resume the innovative research that made him an internationally recognized authority on Douglas-fir silviculture, Kolbe set about developing the physical infrastructure and the research program of the new experimental forest. The Great Depression made both jobs tough.

Kolbe proved more than equal to the job. A 1927 graduate of the University of Minnesota's forestry school, he had earned a master's degree in forestry at Cornell University before he joined the Forest Service in 1928 (Society of American Foresters News 1948). As one of Munger's junior foresters, he had spent his initial years with the Station as chief of a party surveying cutover lands in eastern Oregon and Washington and getting to know ponderosa pine. He was known as a man who matched his many words with action (World Forestry Center 1978).

E.L. Kolbe

Carpenters employed under the Emergency Relief Act of 1935 constructed a three-room residence at the Pringle Falls Experimental Forest headquarters during fall, 1935.

Physical Infrastructure Development

Despite funding constraints, Kolbe immediately began construction of the Pringle Falls Experimental Forest headquarters on the western bank site that his and Isaac's May 9 establishment report had identified as most suitable. This site was on the south side of the Wickiup-La Pine Road (now Forest Road 43), about one-third mile west of the bridge across the Deschutes River. During the summer of 1931, a headquarters building was constructed for $450 (Cowlin 1988, USDA FS 1931b). Availability of funds and personnel from New Deal emergency agencies including the Civilian Conservation Corps (CCC) soon stimulated additional construction. This made possible the 1933 construction of an additional office building, a weather and fire hazard station, a combination workshop-garage-woodshed building, and a water system "completing for the present time being the physical plant," in the words of Acting

This building was originally built as a crew house at Pringle Falls in 1935. It was later used as the administrative building and is still in use in 2006. Photo was taken in summer, 1936.

This November, 1936 photo shows the headquarters at Pringle Falls Experimental Forest from a viewpoint near the entrance.

Director McArdle (USDA FS 1933a, 1933b). Kolbe reportedly spent "a lot of time after dinner pounding nails [on these buildings] because he was afraid the CCC guys weren't going to finish the job before the snow flew" (Frewing 2002).

The Emergency Relief Act (ERA) of 1935, another effort to jump-start the economy, authorized the Works Progress Administration (WPA) to provide for a broad range of public works. With these funds, Kolbe put carpenters to work on a residence (now called the cottage) and a new crew house (now called the administration building). This latter structure is a two-story wood frame building with a full basement. Its 1,440-square-foot first floor includes a large living room with a stone fireplace, a kitchen, two bathrooms, and three bedrooms later used as offices, and its

790-square-foot second floor is a single dormitory sleeping area. An improved pressure water system supplied water to all the buildings and to four fire hydrants (USDA FS 1935b, 1936c). Another two-story structure, a 1,260-square-foot dormitory with a basement, was built in 1939, as were a 720-square-foot combination garage and shop building and a 288-square-foot gas house. A larger residence planned for the experimental forest's director was never built.

These fine improvements notwithstanding, life could be hard at Pringle Falls Experimental Forest. This was especially the case when work began during or extended into the colder months. To open the headquarters in early April 1935, for example, a project foreman named L.W. Frost had to break his way through deep snow for 6 miles. "The purpose of the early opening was to take advantage of snow and moisture conditions to burn down pine snags on a 320-acre demonstration plot" (USDA FS 1935a). The following January,

> an unusually heavy snowfall marooned Junior Forester Beeman, 20 CCC workers, and Project Foreman Frost, who were [completing construction of the new crew house begun the previous summer]. The telephone line was down, the pantry had few provisions, and above all the storm had put a peak load on all the local snow plowing equipment. It took most of a week to close the station and to return the men and equipment to the main [CCC] camp 60 miles from Pringle Falls [USDA FS 1936a].

While working at Pringle Falls, of course, the CCC and ERA enrollees lived under canvas in a spike camp.

The rigors of winter dictated the research schedule, too. "The people who established the first studies out there . . . worked in the summertime out there at Pringle Falls . . . and in the wintertime moved back to Portland" (Dahms 1999).

Other improvements completed during the 1930s included signs that identified and interpreted the Pringle Falls Experimental Forest and marked its boundaries, administrative roads and trails, fences, and firebreaks.

Some of those signs and fences identified and enclosed the two detached natural areas set aside in 1935 after Kolbe had made the "sufficient detailed examination" needed "to finally determine the best delineation of the natural areas" (Isaac and Kolbe 1931). Kolbe's report recommended "two detached natural areas of several hundred acres each, one east of the river characteristic of the ponderosa pine type with a little of the sugar pine type, and the other west of the river characteristic of the lodgepole pine flats." The natural area would be maintained "as far as possible in its natural state" (Kolbe 1935). Approval in June 1935 led to establishment in 1936 of the two-unit, 1,160-acre natural area—an eastern block of 600 acres and a western block of 560 acres—completely within the Pringle Falls Experimental Forest. Along with another 187 acres added in 1978, these compose today's Pringle Falls Research Natural Area (USDA FS 1978). Such areas preserve natural ecosystems in an undisturbed state solely for research and education. This two-unit research natural area has since afforded unique opportunities for research and education in the natural sciences.

Twenty acres of the old Pringle Falls town site, purchased in 1936 for $1,500 from Henry M. and Alice Parks of the Poplar Ranch in Fort Rock Basin, rounded out the headquarters area. Construction of Bonneville Dam on the Columbia River "had eliminated the need for and appeal of small power plants" such as the one contemplated for Pringle Falls, and the Parks family needed the money to "weather the miserable 1930s" (Parks 1997).

Research Program Development

Forestry research, the real work of Pringle Falls Experimental Forest, began even as Kolbe was completing construction of the initial facilities. As early as August 1931, associate silviculturist Walter H. Meyer and Kolbe "spent a week or so doing [their] first research work on this forest with the help of twenty-seven Iowa State Forest School students who [had] been spending the summer with Professors Horning and Jeffers on the Deschutes National Forest."

> This work was of great instructional value to the students and practical assistance to us. Land lines were rerun and new corners placed. A few sections

> were type mapped and estimated; twenty acres of permanent sample plots were laid out for a study of net yield in virgin stands; reproduction counts on a recent burn were made by the new stocked quadrat method and by the old method of seedling counts; and some permanent reproduction plots were established [USDA FS 1931b].

On August 31, only a little more than 3 months after the Pringle Falls Experimental Forest was designated, Meyer and Kolbe submitted the new experimental forest's first research design. The objective was "to determine the gross increment, the annual and the net increment of virgin stands of western yellow pine, when fire is kept out" (Meyer and Kolbe 1931). Both knew that success in such studies is based, among other things, on a good understanding of the study area.

To help develop that understanding, Kolbe was soon carrying out "Special Instructions for the Control and Mapping of the Pringle Falls Experimental Forest" issued on June 25, 1933, by Regional Forester Buck's engineering staff at Munger's request. The principal objective of this survey was to produce a topographic map of the area "at a scale of 8 inches to the mile with a contour interval of 10 feet" and to "set permanent monuments for horizontal and vertical positions" so that "the location of sample plots, selective logging areas, planting areas, etc., can be quickly and accurately marked." The second objective was "to cruise the timber and make a type map" as well as "a site map and a generalized soil map" of the area (Flach 1933). Kolbe prepared detailed "Special Instructions for Making an Intensive Reconnaissance of the Pringle Falls Experimental Forest" (Kolbe 1933a) to carry out this charge. "The work was done in part during the fall of 1933 and completed early in the summer of 1934 as a Civilian Conservation Corps project," supervised by Kolbe and C.W. Kline. Carried on by "qualified forest engineers and cruisers assisted by enrollees of the CCC who were trained on the project to run compass, Abney level, rod and chain," the effort achieved the stated "purpose of the reconnaissance . . . to gather sufficient data for the management and development of this experimental forest" (Kolbe and Frost 1935).

Work also began on the initial studies. Focused primarily on ponderosa pine, the objectives were "to discover by research and experimentation the methods of silviculture, protection, and utilization by which the maximum quantity and best quality of forest resources may be produced" (Kolbe 1938). True to the "can do" attitude of the early Forest Service, this first round of studies was installed early in the game; Kolbe formalized their objectives later. These objectives evolved to include additional resource management research problems that, given the long-term nature of forest science, established a pattern for decades of research. When, in 1938, Kolbe penned a plan, the objectives of this research were listed as:

> (1) To determine best methods of harvesting the virgin ponderosa pine stands for most profitable permanent production.
> (2) To develop methods of thinning, pruning, and other stand improvement in immature stands that are feasible and effective.
> (3) To find means of converting the very low quality lodgepole stands characteristic of the region to a useful forest.
> (4) To investigate the effectiveness of various methods of protecting forests against fire, insects, etc.
> (5) To develop methods of range management, in relation to silviculture, that will improve the forage resources [Kolbe 1938].

Research Plots Established

Permanent experimental plots were numbered as they were established. Kolbe laid out these studies knowing full well that, because of the long-term nature of forestry research, those who would follow him in decades to come would witness and benefit from the ultimate results. Such is the faith and the fate of the forester. As in the case of facilities development, the availability of New Deal labor—especially the CCC crews when it came to thinning, pruning,

The first 10 research plots at Pringle Falls Experimental Forest were set aside in 1932 to study the effects of grazing on tree and forage ecology. Photo shows plot 3.

pulling, and grubbing tasks on experimental plots—compensated for severe funding shortages and made installation of the early studies possible.

The first experimental plots Kolbe established eventually were reflected by the fifth objective on his 1938 list: To develop methods of range management, in relation to silviculture, that will improve the forage resources.

Grazing influence on ground cover and tree reproduction—
Sheep and cattle had grazed the experimental forest for decades, and the first 10 plots at Pringle Falls were set aside in 1932 for a study of the effects of grazing on tree and forage ecology. Five of the ten plots were exclosures, one each in the various forage subtypes—under pure ponderosa pine, grass under pure lodgepole pine, bitterbrush under pure lodgepole pine, under a mixture of ponderosa and lodgepole pines, and in a recent burn in ponderosa pine. The rest of the experimental forest remained open to sheep grazing (Kolbe 1938). A year after they were established, Kolbe's working plan for these "grazing demonstration plots" reflected both his keen insight into and meticulous enthusiasm for forest research needs.

> The utilization of the subordinate forest vegetation by grazing animals has long been recognized by the Forest Service to have an important influence on the ecological development of certain forest areas. In the ponderosa pine type, grazing is a dominant factor in forest regeneration and development and under some conditions an important influence on the severity of erosion and forest fires. To utilize the beneficial effects of grazing and to prevent those effects that are harmful, at least so far as the desired forest products are concerned, is one of the phases of the methods-of-cutting study now carried on in the ponderosa pine type.
>
> These plots are to serve as a demonstration of the effects of grazing and as study areas to determine:
>
> (a) The influence of sheep grazing on the production of bitterbrush (*Purshia tridentata*) in several forest types.
>
> (b) The influence of sheep grazing on the survival and growth of young ponderosa pine under virgin stand conditions.
>
> (c) The growth and composition of the forest vegetation when left undisturbed and that following a severe surface fire.
>
> (d) The growth and survival of ponderosa pine reproduction under lodgepole pine when grazed and ungrazed.
>
> (e) The mortality, growth and volume of the timber stands in the forest types that are represented by the plots in this project [Kolbe 1933b].

Kolbe's plan reflected certain practical limitations on the research.

> The objectives for this study . . . include . . . a rather detailed study of the grazing problem. Desirable as such a full study would be, it is recognized that funds and time permit doing only a reasonable minimum amount of work. As a result, this plan was prepared to conform to the limited funds that are available to carry out the work. It is recognized that a more detailed study could be made to advantage on the plots of this project [Kolbe 1933b].

Recognizing the demonstration value of the research, Kolbe located as many of the plots as possible within view

In 1934, plots were established at Pringle Falls Experimental Forest to explore thinning methods to improve lodgepole pine growth and survival.

The first of three early ponderosa pine thinning studies was installed in 1934, in plots on the western slope of Pringle Butte. This photo was taken on May 28, 1937.

from the forest roads. A CCC crew fenced the plots in, and a "Professor Steffen of Washington State College spent the month of July [1934] in a study of [their] vegetative cover" (USDA FS 1934). By 1938 "the contrast in vegetation inside and outside the fence [was] already notable" (Kolbe 1938). Periodic observations of the influence of grazing on ground cover and tree reproduction continued into the 1950s when grazing in the area tapered off and "the contrast between plots [was] not as marked . . . as it formerly was" (Mowat 1954).

The second series of plots, which Kolbe established in 1934, eventually was reflected in the second objective of "stand improvement" on his 1938 list, but did not relate to ponderosa pine silviculture.

Thinning experiments in lodgepole pine—
In 1934, perhaps with an eye toward a distant future when lodgepole pine would have commercial value, plots 11 to 13 were established to explore methods to improve lodgepole pine growth and survival. Two plots were thinned that year, and the third left as a check plot. At the time of thinning, growth in this immature 55-year-old stand was "about at a standstill because of insect and disease losses" (Kolbe 1938) on even the best sites. After thinning, diameter growth was 1.5 to 2.5 times as great as in the check plot. The most rapid growth was achieved by trees of medium size (about 7 to 10 inches in diameter at breast height) "that will live . . . to merchantable size and will become merchantable much sooner than those of unthinned sites." Even these short-term results, combined with other data, enabled Pringle Falls silviculturist Edwin L. Mowat to issue *Preliminary Guides for the Management of Lodgepole Pine in Oregon and Washington* in 1949 (Mowat 1949). Maintenance and measurement of these plots contributed to knowledge of lodgepole pine silviculture for several decades.

Most of the remaining early experimental plots reflected the Pringle Falls Experimental Forest's principal purpose "as a field laboratory for determining the basic facts in the management of ponderosa pine forests" (USDA FS 1937).

Thinning experiments in ponderosa pine—
The first of three early ponderosa pine thinning studies was installed in 1934 on plots 14 to 18 in a 49-year-old, even-aged stand on the west slope of Pringle Butte. This study "afforded a good opportunity to see what cultural treatment is necessary to improve the growth of overdense, stagnating thickets, so common in this type" (Kolbe 1938). Plots were thinned to 7- by 7-foot and 9- by 9-foot spacing or left unthinned as control plots.

After 15 years, the "average diameter growth for the 9- by 9-foot spacing was 1.5 inches; for the 7- by 7-foot spacing, 1.2 inches; for the unthinned, 0.6 inches. Height growth was about two feet greater on the thinned plots." Indeed, "between 1945 and 1949 the 100 largest trees per acre grew 33 to 67 percent faster in diameter and 15 to 69 percent faster in cubic volume than the unthinned" (Mowat 1954). These and other data helped Mowat conclude that "proper thinning of dense young stands of ponderosa pine increases the growth rate of remaining trees and thereby shortens the time required to grow timber of any desired size." Given "the long duration of release effect and the cost of premerchantable treatment," Mowat suggested that one early, fairly radical thinning "when stands are only 2 to 5 feet high" could prove most ecologically and economically feasible (Mowat 1953). "This publication really opened a lot of foresters' eyes to the possibilities of second-growth stands as old as 50 years," ponderosa pine silviculturist James W. Barrett commented in 2003 (Barrett 2003).

Removal of brush to encourage ponderosa pine reproduction—

"What effect does a dense cover of manzanita and snowbrush have on the establishment and growth of ponderosa pine reproduction?" was the research question for another experiment begun in 1934. Plot 19, a strip 66 feet wide and 1,000 feet long on the south slope of Pringle Butte, was completely cleared of a dense growth of brush that had developed following fires in 1919 and 1922. The manzanita was pulled by hand and the snowbrush was cut off at ground level or grubbed out by CCC labor. The brush on plot 19a, a short distance to the west, was left in place.

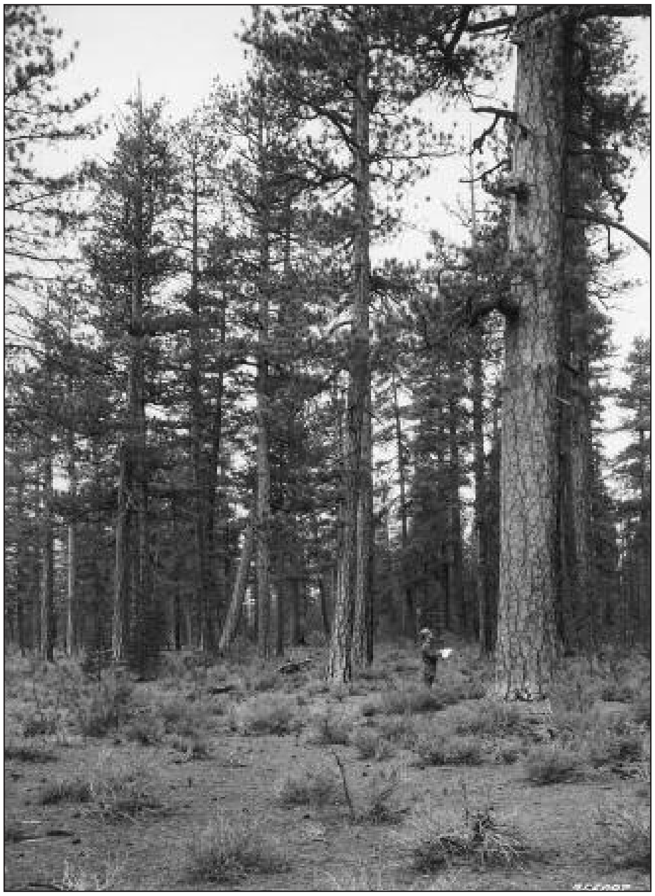
Fifteen years later, this study showed that "(1) the brush did not significantly affect the early establishment of pine seedlings, but (2) it sharply reduced the growth of established seedlings, and (3) manzanita is much more severe in its affect on growth of pine seedlings than snowbrush." The conclusion for forest managers was that "heavy brush competition, especially from manzanita, must be reduced if pine seedlings are to make satisfactory growth" (Dahms 1950). These plots later played a role in studies focused on developing chemical controls for brush in ponderosa pine forests.

Removal of lodgepole pine overstory to promote ponderosa pine growth—

The feasibility of "cutting to convert a borderland type of lodgepole pine into a ponderosa pine stand" (USDA FS 1937) of greater commercial value was tested on plots 20 and 21 "on the upper benches along the Deschutes River . . . where ponderosa pine and lodgepole pine compete for supremacy." In 1934, 1-acre plot 20, where "suppressed ponderosa seedlings [were] found under more rapid-growing but low quality lodgepole . . . was completely cleared of the lodgepole overstory" by CCC labor "and the ponderosa pine reproduction was carefully left unmolested." At the time of cutting, the lodgepole pine averaged 75 years old, and the suppressed ponderosa pine seedlings and saplings averaged 40 years old and only about 18 inches tall, and very few exceeded 5 feet in height. Control plot 21, left untreated, was established in 1937 (Mowat 1954).

By 1952, silviculturist Mowat reported the "surviving ponderosa seedlings on the cleared plot had grown to an average height of 7.5 feet, compared to 3.3 feet for those under the lodgepole overstory" on the control plot. Although response "was not pronounced . . . during the first 6 to 8 years after release," annual height growth between 1941 and 1948 was "about four times as rapid on the released seedlings as on the unreleased" (Mowat 1954). As silviculturist Mowat reported in the October 1950 *Journal of Forestry*, this experiment "demonstrated that ponderosa pine reproduction, even though severely suppressed for 40 years or more by an overstory of lodgepole pine, could recover vigor after overstory removal" (Mowat 1950 in Youngblood 1995).

Twenty-five years later, silviculturist Walter G. Dahms reported that the released plot supported a "vigorous" and "fairly well-spaced" stand of "young-appearing" ponderosa pines, while the unreleased plot presented a "sharp contrast" in which "the lodgepole pine overstory still dominates the stand and the ponderosa pines remain in an inconspicuous understory position" . . . "The results of this small-scale study," Dahms echoed Mowat, "indicate that foresters can release small ponderosa pines that have been severely suppressed, with confidence that they will respond and attain



In 1937, plots were set up to test methods of cutting ponderosa pine. The research goal was to find the best ways "to accelerate the conversion of the virgin, old-growth forest to a managed, rapidly growing condition." This photo shows plot 30 before any trees were cut.

This photo shows plot 30 after large trees were cut.

normal growth following a short adjustment period" (Dahms 1960).

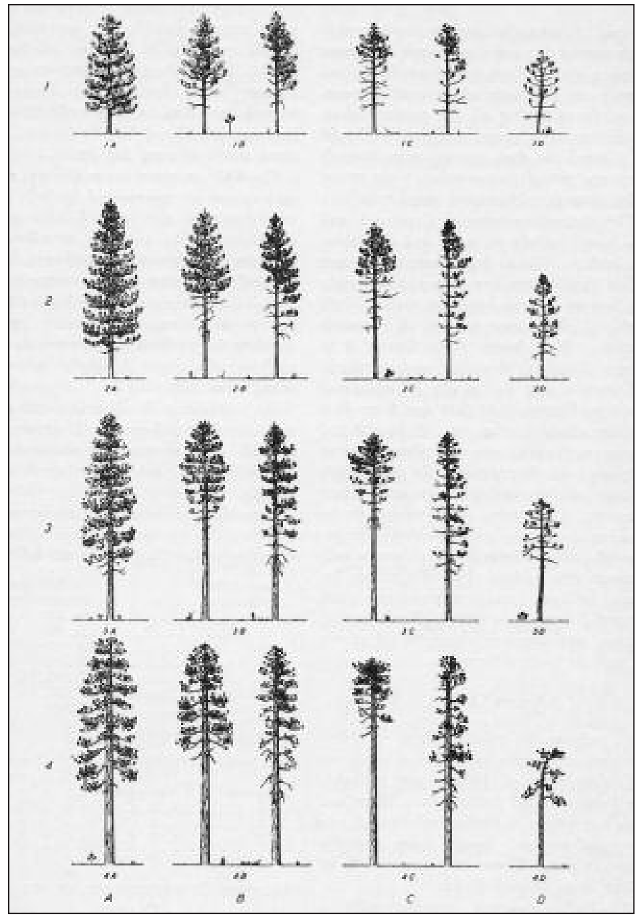
Growth and mortality in natural ponderosa pine forests—
Kolbe knew the objective of converting slow-growing natural ponderosa pine forests into fast-growing second-growth forests had to be based on a sound understanding of both types, attainable only through long-term research. Toward this end, "untreated sample areas"—plots 22 and 23, and later plots 25 to 28 within the research natural area—were established "for observing and obtaining individual tree measurements for determining growth, mortality, and yield" (USDA FS 1937) in natural ponderosa pine forests. These studies would produce data that could be "compared with results following various methods of cutting, as on plots 30 to 36" (Mowat 1954) that would support conversion of primeval forests to productive and profitable timberlands.

Methods of cutting in ponderosa pine—
"Conversion of the virgin old-growth forest to a managed, rapidly growing condition" was the principal "everyday job of forest managers in the pine region" (USDA FS 1948) in the 1930s. To accelerate this transition, silviculturists encouraged new "lighter selection" methods of cutting during the mid-1930s. This was made possible by "the economy and flexibility of tractor logging" (Mowat 1961) and F. Paul Keen's tree classification system (see below), which made silviculturists "more aware of subtle but significant

variations in the silvicultural characteristics of individual ponderosa pines" (USDA FS 1948).

Two new methods of cutting—the "thrift selection" system and the "economic maturity selection" system (Mowat 1954)—were tested on plots 30 to 36 in 1937. The seven 60- to 100-acre plots (USDA FS 1948) totaled 510 acres of old-growth ponderosa pine. The timber was sold to the Shevlin-Hixon Company and logged with horses and trucks (USDA FS 1940) during the summer of 1937 (USDA FS 1938). Under each of the two "light selection" systems of cutting employed, 20, 40, and 60 percent of the original volume was removed. "The thrift cutting removed the trees of poorest vigor and growth" within prescribed volume removal limits, and "the economic maturity cutting removed the trees of highest economic maturity, primarily those of high value and low earning power but including lower value trees in need of salvage" (USDA FS 1937). Plot 36 was cut by the 80-percent standard selection method that prevailed at the time. On all plots, trees at highest risk of pine beetle mortality were cut (USDA FS 1947a) to salvage timber that otherwise would be lost and to reduce the likelihood of losses to epidemics (Kolbe and McKay 1939). Over 20,000 remaining trees on these plots were tagged and measured and their value and growth rate studied (USDA FS 1938).

Ten years later, Mowat reported significant increases in growth on all logged plots and that "greater growth was generally produced by heavy than by light reserve volumes and 'thrift selection' resulted in greater growth and lower mortality than 'economic selection'." He also found that "the 20 percent cutting was as effective in reducing tree mortality as the heavier cuttings for both 'economic' and 'thrift' selections" (USDA FS 1938) and that cuts as light as 20 percent of the total stand may reduce mortality to only one-sixth of that occurring in uncut stands (Mowat 1948). Most of the mortality concern related to the western pine beetle. In 1951, as this study progressed, Dahms—a statistician as well as a forester—demonstrated in his master of forestry degree thesis that consideration of the size of treatment areas, the need for treatment replication, and the use of a covariance analysis could improve the design and results of this and similar studies (Dahms 1951).



This illustration shows the Keen Tree Classification System, developed by entomologist F. Paul Keen for determining the susceptibility of ponderosa pines to western pine beetle attack.

Ponderosa pine tree class and log grade demonstration—

Just east of the seven methods-of-cutting plots is plot 37, a 7.5-acre area of similar ponderosa pine timber left intact "to afford a visual demonstration of tree classification and evaluation in a typical uncut virgin forest" (Munger 1942). As forester and future Station director Philip A. Briegleb began the story:

> Every forester who works in . . . ponderosa pine. . . is impressed by the tremendous range in size, quality, age, and thrift of the trees found in the virgin

> forest. So great is this variation from tree to tree that stand averages mean little to the timber marker trying to select trees of high value and insect risk for cutting, and at the same time reserve for future harvest the trees of low carrying charge and rapid growth rate [Briegleb 1943].

In an attempt to provide a practical basis for estimating the mortality probabilities and growth potentialities of individual ponderosa pines, entomologist F. Paul Keen developed the Keen Tree Classification System for determining the susceptibility of ponderosa pines to western pine beetle attack. Keen and Kolbe had met in Portland, where their U.S. Department of Agriculture offices were in the same federal courthouse building, and became close friends. In charge of the Bureau of Entomology and Plant Quarantine unit's Forest Insect Investigations Laboratory, Keen found Kolbe's experimental forest in central Oregon a good place to work on his ponderosa pine classification system (Hagenstein 2002). This work revealed that "the trees more susceptible to [western pine beetle] attack are the weaker, less vigorous individuals and, to a certain degree, those more advanced in age." These are, essentially, the same trees the forester selects to cut "either for the purpose of salvaging valuable high-risk trees before they are damaged by beetle attack or for the silvicultural objective of reducing mortality and increasing net growth" (Keen 1936). Founded in entomology, Keen's classification method was adopted as a guide for marking trees for selection cutting (Duncan and Miner 2000) as well as for mortality and growth studies in the ponderosa pine forests of Oregon and Washington (Briegleb 1943). Many timber cruisers found carrying a pictorial chart of Keen's classes in the field useful because "the marking guide for the sale always referred to Keen's classes" (Barrett 2003).

Keen installed the plot 37 demonstration himself. On this plot, according to Munger:

> Each ponderosa pine tree over 15 inches in diameter has been given a number painted upon it, measured for diameter, classified by the Keen system, its class being shown by an embossed aluminum tag, and its contents by log grades estimated.
>
> For each tree its lumber sale value has been calculated, and by subtracting the cost of falling, bucking, etc., of the tree and the cost of transporting and milling each log (other than the investment cost of roads) the marginal value has been determined.
>
> Each tree has then been given a gross growth rate and a mortality rate, appropriate for its class, and the net growth computed.
>
> An annual carrying charge upon the capital value of the tree of 3 percent is assumed, from which is subtracted the net growth percent to give the net carrying charge (Munger 1942).

The real value of Keen's system, as demonstrated on this plot, was removal of high-risk trees by logging before attack by western pine beetle, thus capturing full economic value. In the process, a stand was made less susceptible to western pine beetle mortality. It reduced, but not necessarily prevented, mortality (Wickman 2003). This plot, which integrated the ecological and economic aspects of ponderosa pine silviculture and on which hundreds of timber cruisers and log graders have qualified for their jobs, remains in service as the Pringle Falls Cruising and Log Grading Plot.

As much as Keen's system reflected the real and growing relationship between entomology and economics in ponderosa pine forests east of the Cascade Range, it avoided a critical issue: the role of fire. As Dr. Urling C. Coe wrote in 1940:

> Keeping the annual ground fires out of the timber gave the [western pine] beetle a splendid chance to increase at an alarming rate. During the past eighteen years the government has spent huge sums fighting the beetle, and is spending more and more each year; but the beetle is thriving as never before [Coe 1940].

Others shared Coe's concern. As the *Portland Journal* observed on April 10, 1936:

> "The western pine beetle has killed more Ponderosa Pine in Oregon and Washington in the last five

> years than fires and the axes and saws of loggers," State Forester J.W. Ferguson said. . . .
>
> "Bark beetle claimed 4,507,000,000 board feet of pine in the states of Oregon and Washington from 1931, to 1935, inclusive," C.S. Martin, forest engineer of the Western Pine Association, wrote Ferguson. . . . "In the same period the fire loss. . . has been only 564,585,000 board feet. During the past five years the beetles have been killing Ponderosa Pine about three times faster than it has been replaced by growth," Martin said. "The beetle damage in timber killed is about eight times the fire loss for any one year. For eighteen years the Ponderosa Pine stands in Oregon . . . have shown a steady depletion due to bark beetle damage. For the greater part of the commercial stands in Oregon, this depletion has been at the average of one percent a year. No substantial yield of forest production is possible under such conditions" [Coe 1940].

Although many timbermen saw merit in annual "light burning" of ponderosa pine forests to keep pine beetles and understory fuels under control, Forest Service fire policy born of the Big Blowup experience would not allow it.[2] Keen's approach to minimizing mortality caused by the western pine beetle may have been an alternative driven by that fire-exclusion policy. And, as fuels accumulated as a result of fire exclusion, the belief expressed by Coe (1940) "that it is too late to correct the mistake and start burning the floor of the forest each year" because "the underbrush is now too heavy" likely discouraged meaningful fire ecology research for another three decades.

A final problem area identified in Kolbe's 1938 list was reflected in two early ponderosa pine forest protection studies that involved the relationship between snags and fire.

Ponderosa pine snag burning study—

Because "most forest administrators want to get rid of snags in the easiest and cheapest way. . . to better the chances for controlling accidental fires," Kolbe set out to determine the effectiveness of the "base-fire" method of snag disposal at low cost. About 200 snags of different sizes and degrees of decay "were burned in the spring of 1935 and again in the fall of 1937. . . on the same 320-acre tract of virgin ponderosa pine forest within the Pringle Falls Experimental Forest." This experiment "demonstrated that the time of the year and the amount of decay at the base of the tree are two very important factors influencing the method . . . ," and that "snags with 50 percent or more decay are most easily destroyed by the base-fire method" (Kolbe 1939).

Ponderosa pine snag falling study—

"How long will the average ponderosa pine snag remain standing and thus contribute to greater rate of spread and resistance to control of forest fires? Are there any readily discernible characteristics that will enable us to predict which will fall soon and which will stand for a long time?" These were the questions to be answered on 15-acre plot 29 installed in 1937. The snags on this plot resulted from an August 1926 fire, which burned "an average stand of mostly mature ponderosa pine growing on a deep pumice soil," or from subsequent beetle kill. In a 1949 research note, Dahms reported that smaller snags tended to fall sooner than larger snags, and that "fire" snags tended to stand longer than "insect" snags. He concluded that pine snags on pumice soils, such as at Pringle Falls Experimental Forest, "will constitute a fire hazard for a much longer period of time than has been generally expected" (Dahms 1949).

Other early studies—

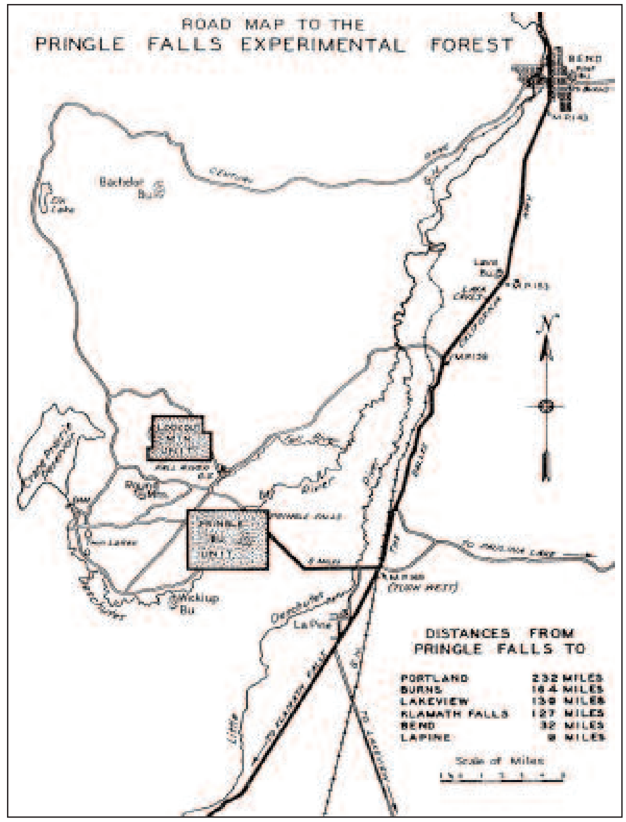
A range of other studies in the 1930s developed basic knowledge of the experimental forest and its environment essential to research and administration. At a headquarters weather and fire hazard station, also called Station A, daily climatic records were kept, and during the fire season, standard fire danger observations were made three times a day. At three stations, collectively called Station B, daily instrument observations collected data—air temperatures, soil temperatures at three depths, evaporation, and soil

---

[2] The consequences of the Big Blowup of 1910 for decades of Forest Service fire policy are explained in Pyne 2001.

Ray M. Fillon

In June, 1945, Bill Morris recorded weather data at the Pringle Falls Experimental Forest fire danger station.



The new Lookout Mountain Unit was added to the original Pringle Butte Unit in 1937 to enlarge the Pringle Falls Experimental Forest.

moisture—to identify the subtle “controlling environmental factors” behind the “abrupt, and economically very important, change in forest type . . . from ponderosa pine to lodgepole pine” in the area. As part of a regionwide study, phenological observations “of the time of leafing, flowering, and seeding of trees and associated vegetation” made through the growing season at Station C proved “useful in determining the length of the growing season, the fire hazard, time for seed collecting and range readiness.” Entomologists from the Forest Insect Investigations Laboratory of the Bureau of Entomology and Plant Quarantine studied “the activity of bark beetles following the cutting on the thinning plots; it [also used Station E on the eastern unit of the natural area] as a source for data on the epidemiology of tree-killing insects” (Kolbe 1938).

“On a favorable situation . . . on the east bank of the Deschutes River” known as plot 24, “small plantations of several exotic trees [were] made to determine their possibilities for forest planting in this soil and climate.” Among the species planted were Scots pine, Corsican pine, Jeffrey pine, and Japanese black pine. Another and perhaps more realistic planting study established in the spring of 1938 involved planting 1,100 ponderosa pine seedlings on plot 38 to test “survival and growth of eleven different classes of nursery stock. . . . All the trees in this planting were grown from the same seed supply but were differently treated in the nursery” (Kolbe 1938).

Sometimes even infrastructure development had research potential. “In fencing many of the plots,” for example, “posts . . . given various treatments [were] used and a record kept of each [so] that information may be collected on their durability in this soil and climate” (Kolbe 1938).

The Pringle Falls Experimental Forest Area and Uses Evolve

Within 5 years of the experimental forest’s designation, Kolbe realized that the growing research program would require more land. Early in September 1936, “Foreman Frost, Field Assistant McKay, and CCC enrollees began to map and examine several sections of even-aged ponderosa pine a few miles north of the Pringle Falls area, withdrawal of which for experimental use [was] being considered" (USDA FS 1936b). "The intensive reconnaissance and mapping of a 3,800-acre tract [was completed and] considered as an addition to the Pringle Falls Experimental Forest" (USDA FS 1936c).

Lookout Mountain Unit Added

The 3,515-acre Lookout Mountain Unit was added in 1937 to the 7,540-acre Pringle Butte Unit, resulting in a two-unit, 11,055-acre experimental forest with increased research potential. The new unit was covered largely with even-aged, immature ponderosa pine, most of it either about 50 or about 95 years old.

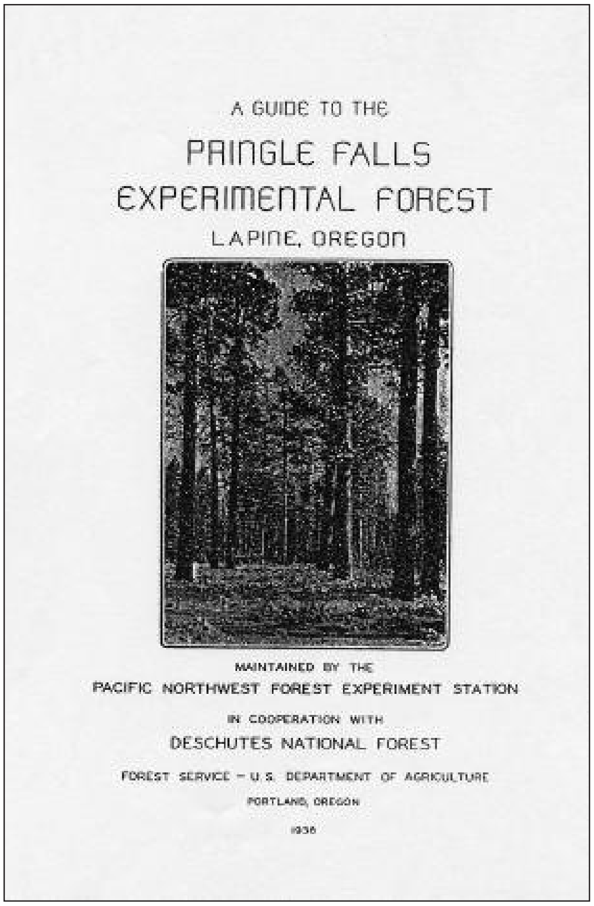
This addition was followed in 1939 by a memorandum of agreement on administration responsibilities for the enlarged Pringle Falls Experimental Forest shared by the Director of the Pacific Northwest Forest and Range Experiment Station (the name had been changed in 1936) and the Forest Supervisor of the Deschutes National Forest. The agreement specified that "the experimental forest is to be administered cooperatively by the Director of the Experiment Station and the Supervisor of the Deschutes National Forest and remains an integral part of the ranger district in which it is located." The Experiment Station, of course, was "responsible for initiating and supervising all experimental work." When this work was implemented through a timber sale, the station director would "determine the extent, location, and specific practices" required and the forest supervisor would advertise and administer the sale. Fire protection remained the responsibility of the forest supervisor, but "the experimental forest employees [were] considered an integral part of the [national] forest's protective force." National forest and experimental station responsibilities for infrastructure development and maintenance as well as other functions were specified. Approved by Forest Supervisor Thomas Burgess on April 25 and by Acting Director J. Elton Lodewick on April 26, the memorandum of agreement was signed by Regional Forester Lyle F. Watts on May 5, 1939 (Watts et al. 1939).

About 30 Forest Service silviculturists from the Western regions and experiment stations met in June, 1937, at the Pringle Falls Experimental Forest during a traveling conference on ponderosa pine silviculture. Among them were Leo Isaac (bottom row, left), Ernest Kolbe (top row, second from right), and Paul Keen (top row, right).

Conferences and Meetings Held

In 1937, the Pringle Falls Experimental Forest came into its own as a place for scientific conferences and meetings as well as research and university education. In June, about 30 Forest Service silviculturists from western regions and experiment stations held part of a traveling conference on ponderosa pine silviculture there. During this conference, many criticisms of the maturity selection system of harvesting ponderosa pine as "price tag forestry" were hashed out (Cowlin 1988).

In October 1937, about 60 foresters and lumbermen from around the Pacific Northwest attended a pine silviculture and logging economics conference that came to be known as "the Pringle Falls field meet." This conference was sponsored by the Forest Practice Committee of the Western Pine Association to give timberland owners and timber operators an opportunity to see and study the results of the seven methods-of-cutting tests conducted on plots 30 to 36 that summer. According to the Station's annual report for 1937, attendees learned the value of light selection cutting favored by Munger: "on the whole the lighter the cut the better the forestry and the greater the realization per


A GUIDE TO THE
PRINGLE FALLS
EXPERIMENTAL FOREST
LAPINE, OREGON
MAINTAINED BY THE
PACIFIC NORTHWEST FOREST EXPERIMENT STATION
IN COOPERATION WITH
DESCHUTES NATIONAL FOREST
FOREST SERVICE – U.S. DEPARTMENT OF AGRICULTURE
PORTLAND, OREGON
1938

A guide to Pringle Falls Experimental Forest, originally published in 1938, proved to be so useful that it was used for years and a revised edition published in 1954.

These logs from Lookout Mountain Unit thining-from-above study were loaded on railroad cars at Pringle Falls landing for transportation to the Shevlin-Hixon Company mill in Bend, Oregon.

thousand feet" (USDA FS 1938). Only a year before, Munger had argued that Forest Service silvicultural goals could "be achieved better by light and frequent cuttings" recently made "not only possible but apparently more profitable" by the increased flexibility and lower logging costs afforded by tractors and trucks "than by heavy and infrequent cuttings" required by the economics of railroad logging (Langston 1995). "Keen interest was shown in all phases of this demonstration and much favorable comment was given on the importance and significance of the work," the report concluded (USDA FS 1938).

Conferences, meetings, and "show me" trips soon became a Pringle Falls fact of life. A small illustrated publication entitled *A Guide to the Pringle Falls Experimental Forest* prepared by Kolbe and published by the Station in 1938 helped make all such gatherings more meaningful. A successor, Edwin L. Mowat, revised this guide in 1954.

Research up to World War II

Three additional studies, two on the new Lookout Mountain Unit and one on the Pringle Butte Unit, began in the late 1930s and early 1940s before the experimental forest virtually "closed down" for the duration of World War II. All studies experimented with thinning and pruning of ponderosa pine.

Thinning ponderosa pine from above—
In 1938, about 40 acres of 95-year-old, even-aged poderosa pine on the new Lookout Mountain Unit were thinned from above—the taller, or dominant and codominant, trees representing 20 percent of the original volume were removed, and the shorter, or intermediate and overtopped, trees were retained—to test both the practicality of this technique and its effects on growth and mortality among the remaining trees. The logs were removed and sawed into lumber by the Shevlin-Hixon Company.

Measurements on five thinned plots and two unthinned plots (plots 102 to 108) on the Lookout Mountain Unit demonstrated the long-term efficacy of thinning from above. Thirty years later, growth in the thinned plots remained nearly constant, whereas growth in the unthinned plots

A Civilian Conservation Corps enrollee was using a 14-foot pole saw for pruning treatments, in this September, 1939 photo. The research goal was to find the effects of removing various percentages of live crown on the growth, vigor, and mortality of ponderosa pines, as well as effects on wood.

In the pruning study, the ponderosa pine with the man standing on a limb was randomly selected to have three-fourths of its live crown pruned.

declined. Mountain pine beetle mortality in small merchantable trees during those 30 years suggested use of "light and frequent thinning from below to maintain the productive capacity of the stand" (Barrett and Newman 1974).

Plot 101 in this thinning area was used in 1939 to test pruning methods and tools. Long and short pole saws were found the most efficient of four methods tried (Mowat 1954).

Differential pruning of ponderosa pine—
In 1941, pruning treatments were assigned at random to 384 dominant or codominant ponderosa pine trees in four plots on the Lookout Mountain Unit. The four treatments were pruning dead limbs only, and pruning one-fourth, one-half, and three-fourths of the live crown, to determine the effects of removing various percentages of live crown on growth, vigor, and mortality as well as quality of lumber produced (Mowat 1954). After 5 years, diameter and height measurements demonstrated that "removing only the lower one-fourth of the live crown has a negligible effect on growth" and "pruning of more than one-fourth of the live crown reduces diameter growth significantly but has little effect on height growth" (Mowat 1947). After 10 years, it was apparent that "as much as one-third of the live crown length of ponderosa pine may be pruned away to increase production of clear, knot-free wood without significant reduction in both height and diameter growth," but that "more severe pruning may result in an undesirable reduction in both height and diameter growth" (Dahms 1954).

Degrees of thinning of ponderosa pine—
Also in 1941, plot 40 on the Pringle Butte Unit was established "to test two degrees of 'crop tree' thinning: light thinning by removing trees with intervening branches, and a heavier thinning, which left 3 to 4 feet of open space around selected crop trees. No thinning was done around a third series of test trees." After 10 years, the trees given the heavier thinning had grown slightly more than the trees given the light thinning, and the trees given the light thinning had grown slightly more than the trees not thinned. This type of thinning did not increase height growth (Mowat 1954).

Kolbe Leaves and Munger Steps Aside

After almost a decade developing the Pringle Falls Experimental Forest and its research program—while doing the same job for the Blue Mountain Experimental Forest on the Whitman National Forest in northeastern Oregon and serving as dendrologist on the Wind River Arboretum in Washington—Kolbe left the Pacific Northwest Forest and Range Experiment Station. On April 1, 1940, he transferred to the California Forest and Range Experiment Station as project leader of Department of Agriculture flood control surveys in that state into 1942, and during World War II served in Los Angeles as an ecologist for the guayule Emergency Rubber Project. Munger had lost a first-rate work-horse as well as a talented forester. "The loss of Kolbe after 12 years of service not only slowed down pine silviculture studies but also had an impact on other forest management studies," Cowlin wrote. "He was always willing to take on additional assignments and tackled the routine and tedious jobs with the same enthusiasm given major projects." Kolbe's departure in 1940 resulted from what Cowlin termed "fiscal stringencies in regular funds" (Cowlin 1988). The Station simply could not afford to pay the talent whose many accomplishments included the Pringle Falls Experimental Forest and its research program. Kolbe had been hand picked by Munger for that job. He served the sometimes difficult-to-work-for Munger, first indirectly through McArdle as head of the Division of Forest Management Research and then directly after McArdle left in 1934 to become dean of the School of Forestry at the University of Idaho.

As the Experiment Station grew, Munger tired of his increasing administrative burden and longed to return to what he called "real research" (Fry 1967).

> Munger had retained a direct interest in silvical studies undertaken by Isaac and Kolbe from the time they commenced their forest research careers under his immediate direction and tutelage. The studies these two men were making were, as a rule, either ones commenced by Munger or conceived and prompted by him. In some cases, he participated with them in report preparation and authorship [Cowlin 1988].

By the spring of 1938, "Munger had decided to relinquish his administrative duties in favor of returning full time to technical research" (Cowlin 1988). At his request, Chief Forester Ferdinand A. Silcox relieved him of the directorship on July 1, 1938, and appointed him to the Forest Management Research Chief position, left vacant by McArdle's departure 4 years earlier, under new Director Stephen N. Wyckoff. He was what he called a "real outdoor researcher" (Fry 1967) again, and able to work more closely with Kolbe and the Pringle Falls Experimental Forest. In less than 2 years, however, Kolbe was transferred to California. Had he not left in 1940, he almost certainly would have left in 1942 for wartime service. In 1944, Kolbe left government service to join the Western Pine Association, and became chief forester of that industry organization in 1948 (World Forestry Center 1978).

World War II Interrupts Research

Kolbe wasn't the only person to leave. After losses to the funding shortages of the Depression, World War II siphoned off many Forest Service personnel, including scientists, to military service or war agencies. The war also changed many Forest Service priorities, including research, to those supportive of national defense, and put many of its traditional tasks and projects on hold. Many experimental forests, including those east of the Cascades, were "closed for lack of funds," and "field work in ponderosa pine was at a standstill" by 1944. That summer, however, the Pringle Falls Experimental Forest was occupied for a month while Munger, by then 60 years old, and William G. Morris from the Portland office "made the essential current examinations on certain plots and performed the necessary maintenance on the many experimental areas" (USDA FS 1953b).

The Pringle Falls Experimental Forest and the Deschutes Research Center

At the end of World War II, the United States entered a period of unprecedented growth that increased demand for natural resources and challenged all facets of Forest Service research. New assistant chief for research in the Washington Office Edward I. Kotok set forth a 5-year plan for "orderly development" of this research effort that, among other things, called for the regional research stations to establish new field facilities called research centers. Each of these centers would cover the research needs of important forest types and economic units (Steen 1998).

In Portland, Dr. J. Alfred Hall, who succeeded Munger's 1938 successor Wyckoff as Station director in 1945, carried out this charge through "action to reshape major elements of the Station's program" (Cowlin 1988). Hall developed a major reorganization plan that Munger later characterized as "a rather radical field decentralization away from Portland" (Munger 1955) that was made possible by a substantial increase in funding for 1946. "The essence of the plan," as Cowlin explained it,

> was to divide the Station's territory into several homogeneous areal units called research centers, based upon geographic distinctions and character of the forest resource. The objective of the reorganization was to make the results of research more effective through more intensive problem analysis, more timely establishment of study programs, closer relationships between the research worker and the physical problem area, and [closing] the gap between research and application [Cowlin 1988].

According to Hall: "Most of the forest management research in the Station's territory had been excellent work but had been confined to plots—growth and yield and spacing and thinning and so on" as at Pringle Falls Experimental Forest. "The next step," as Doig put it, "was to test the results reached in the many studies of small sample plots on timber operations of commercial size" (Doig 1977) within these several "problem areas" or "research provinces." Each of these research provinces "was to have a local headquarters with a resident technical and clerical staff" and "one or more experimental forests or ranges" (Cowlin 1988). These centers would implement an "applied forest management" concept that would significantly expand forest management research.

This "center concept" of organization recognized the need to consolidate the results of past research and expand the scope of the research program. Hall's call for "increasing research in methods of intensive management of second growth and demonstrating these methods at field research centers" (Cowlin 1988) guided the central Oregon research program that would expand beyond the Pringle Falls Experimental Forest and immediately adjacent operations to other sites.

Deschutes Research Center Established

One of Hall's first two research centers was the Central Oregon Research Center, soon renamed the Deschutes Research Center, established in Bend in the fall of 1946. Ed Mowat was put in charge, and Walt Dahms soon joined him. Mowat, with a 1924 Bachelor of Science degree (B.S.) in forestry from Oregon State College, had been one of McArdles' field assistants in 1924 and then taught forestry and logging engineering at his alma mater before starting graduate studies in 1926. After earning a Master of Science degree (M.S.) from the Yale School of Forestry in 1927, he had served with the Lake States Forest Experiment Station and the Intermountain Forest and Range Experiment Station before taking on World War II timber production projects (USDA FS 1947b). Dahms, a 1937 forestry graduate of Washington State College with Prairie States Forestry Project experience, had just rejoined the Forest Service after World War II service as a naval officer (Dahms 1999).

Both were assigned to the Pringle Falls Experimental Forest to prepare "for revival of ponderosa pine forest management studies in the spring [of 1947] and . . . necessary plot and plant maintenance work" (Cowlin 1988). Mowat and the leaders of the Station's other research centers reported to Philip A. Briegleb who had become Hall's Chief of Forest Management Research when Munger retired on October 31, 1946. Mowat and Dahms shared cramped quarters with Deschutes National Forest personnel in upstairs offices in the Benson Building at 863 Wall Street, above Wetle's Department Store and the Skyline Steakhouse, in downtown Bend beginning in February 1947. There the Deschutes Research Center's offices remained until, in July 1960, the unit moved across the street and around the corner to offices in the O'Kane Building (Brogan 1963) on the corner of Oregon Avenue and Bond Street.

Establishment of this small center presaged an eventual emphasis shift in central Oregon forest research from Pringle Falls and the field to Bend and the laboratory. But that shift was still in the future, and the studies at Pringle Falls Experimental Forest that resumed after World War II dominated the central Oregon research scene into the 1950s.

Although the experimental forest remained the Deschutes Research Center's principal fieldwork venue, economic and social factors as well as changes in science prevented the realization of what one observer termed "the greater dream" of Pringle Falls Experimental Forest as a residential research center. That dream included the never-built director's residence across the Deschutes River from the main compound. Instead, over the years, the compound was reduced in size. Some if its buildings were moved for Deschutes National Forest use at the Crescent Ranger Station and the China Hat Guard Station. In addition to limited funds and changed needs, the "greater dream" observer cited a sociological reason for this demise:

> Scientists' wives didn't want to live out in the boondocks! The access road was very rough, electricity was undependable, and so forth. So the staff ended up commuting from Bend, and while the commute is only sixty miles round trip, after you've driven that far and worked hard in the woods all day, you're pretty tired. So, the [experimental forest compound] had a limited on-site residency to maintain it, and it [actually] became burdensome on the research [Roth 2002].

James E. Sowder became leader of the Deschutes Research Center in 1949.

Yet, the Pringle Falls Experimental Forest remained a popular facility for meetings as well as a productive facility for research. In July 1947, for example, Secretary of Agriculture Clinton P. Anderson spent two nights there with Regional Forester Horace J. "Hoss" Andrews, Director Hall, and forest industry executives with whom he was touring the Pacific Northwest. Briegleb and Supervisor Ralph W. Crawford of the Deschutes National Forest also were present. In addition to various conferences and discussions, the visit featured a brief tour of part of the experimental forest and a fishing trip to the Wickiup Reservoir during which Secretary Anderson caught his limit of trout (USDA FS 1947c).

James E. Sowder joined Mowat and Dahms as leader of the Deschutes Research Center in 1949. A 1931 University of Idaho forestry graduate, Sowder entered the Forest Service in 1932. After 3 years with the California Forest and Range Experiment Station, he transferred to the U.S. Indian Service (now the Bureau of Indian Affairs) in

Oregon. Two years later, he returned to the Forest Service in California to serve on the Tahoe National Forest until 1939 and the Modoc National Forest until June 1943, when he went on active duty in the U.S. Navy until November 1945. He was back on the Modoc National Forest until 1949 when he was transferred to Bend to lead the research effort there for a decade (USDA FS 1959a). Mowat remained in Bend to continue his distinguished career in ponderosa pine research until retirement in 1963 (USDA FS 1963a). Dahms spent his entire postwar Forest Service career in Bend in ponderosa pine and lodgepole pine research before retirement in 1976 (Dahms 1999).

Sowder, Mowat, and Dahms continued the research program at Pringle Falls Experimental Forest even as they extended their Deschutes Research Center's efforts beyond the experimental forest's boundaries. As a PNW Experiment Station report for 1950 attested: "Ed Mowat and Walt Dahms moved out in June to Pringle Falls; Mowat was at Pringle Falls most of the summer, while Dahms went to the Blue Mountain Experimental Forest on the Whitman [National Forest] in July" (USDA FS 1951). In May 1951, Helen Rastovich joined the Center as clerk-stenographer on transfer from the Deschutes National Forest, and the growing office acquired two additional rooms at the same Wall Street address. A group called the Deschutes Research Center Advisory Committee was formed in late 1952 (USDA FS 1954b). As reflected in Mowat's 1954 *A Guide to the Pringle Falls Experimental Forest*, studies of growing timber in the ponderosa pine forests east of the Cascade Range remained the center's focus for some time to come.

Soil survey—

After the Pringle Falls Experimental Forest research program resumed, the first soil survey on national forest land was completed in the fall of 1946. Robert F. Tarrant, a PNW Experiment Station research scientist just back from service as a naval officer, and W.J. Leighty, Assistant Inspector, Bureau of Plant Industry, Soils, and Agricultural Engineering, "tromped around the central part of the experimental forest," as Tarrant put it, "and he published a soil survey" (Tarrant 2002). "The purpose of the work was to establish soil, site, and type relationships to aid the reforestation program in the pine region." Leighty's detailed soil map covering 4 square miles showed a range of soil conditions considered representative of the Pringle Falls locality, and additional inspection of soils under lodgepole and ponderosa pine forests was made in the surrounding area. The survey revealed that

> timber type in this area is apparently related to soil drainage, throwing doubt on [Munger's 1908] theory that fire has been almost entirely responsible for the present distribution of the two species of pine. . . . In general, poorly drained soils were found to support lodgepole pine stands but not ponderosa. The well-drained to excessively well-drained soils are occupied by ponderosa pine to the exclusion of lodgepole [Tarrant 1947].

Tarrant's 1947 research note mentioned Munger's 1917 "suspicions of such a relationship."

Intermediate commercial thinning of ponderosa pine—

The first major postwar study at Pringle Falls Experimental Forest began in 1949 on plots 113 to 118 of the Lookout Mountain Unit with thinning four of these six 40-acre plots of 105-year-old, even-aged ponderosa pine stands. The objective was to determine if such "commercial thinnings would (1) reduce the stand's susceptibility to insect attack, (2) transfer growth to fewer more desirable trees, (3) improve the stand's health and vigor, (4) maintain present high growth rate, (5) increase total yields, (6) do the cutting at a profit" (Mowat 1954). Logs were selected from dense and open portions of the stand and cut and milled by the Brooks-Scanlon Company. This study demonstrated that close-grown trees produced 18 percent more volume per acre and a higher grade of lumber than did open-grown trees; open-grown trees, however, contained more than twice the board-foot volume per tree. Additional observations, on this and other ponderosa pine cuts, clearly demonstrated that (1) a higher percentage of the better grades of common lumber can be produced from fully stocked stands than from more open stands, and (2) even in fully stocked stands, it is impossible to produce clear lumber during any practical rotation period unless the trees are pruned of their lower limbs at a relatively early age (Sowder 1953). The study further indicated that such "commercial thinnings in even-aged ponderosa pine can be expected to increase total yields substantially" (USDA FS 1953a) and "can be made at a profit" (Mowat 1954).

Ponderosa pine sanitation-salvage marking—
"One of the forester's most urgent jobs is to reduce [the waste represented by] timber losses due to bark beetles in the ponderosa pine forests of eastern Oregon and Washington," Sowder wrote in 1951. He had arrived as two efforts to test a late-1930s Bureau of Entomology and Plant Quarantine thesis "that a substantial measure of control of the western pine beetle, and thus of ponderosa pine timber losses, could best be accomplished by light selection cuttings designed for that purpose." Such selection cutting had become known as "sanitation-salvage cutting" and the "development of mobile tractor-truck logging" had combined with improved market conditions during the postwar building boom to make "such cuttings practical and in many areas highly profitable" (Sowder 1951). And so, in 1949 and 1950, sanitation and salvage cutting was tested on the Pringle Butte Unit of the Pringle Falls Experimental Forest.

First, in 1949, 50-acre plot 41 "was established to demonstrate the characteristics of high risk trees; those which should be marked for removal in a sanitation-salvage cutting." Trees on this plot marked for cutting would not be cut. Instead, the plot would serve "as a check on the success of salvage-sanitation cutting on nearby areas, and for further observations and study of the high-risk trees themselves" (Mowat 1954).

Ponderosa pine sanitation-salvage cutting—
To test the sanitation-salvage cutting system on a commercial scale in the ponderosa pine forests of central Oregon, the high-risk trees on about 3,500 "nearby" acres were marked and cut the next year through the normal national forest timber sale process. "All of the old-growth ponderosa pine on the Pringle Butte Unit, excepting those areas already in permanent study plots and the natural area, was cut over during the fall and winter of 1950. All high-risk trees were removed along with merchantable dead or dying trees, and a road system was established" (Mowat 1954). Sowder concluded that the sanitation-salvage cut accomplished its primary objective of protecting the forest against beetle-caused timber losses and produced a timber crop in an economically feasible manner even as it developed a road system for administrative use and subsequent harvests and reduced fire danger.

Ed Mowat checked tree number 52 on plot 51 on September 15, 1953, before the experimental thinning treatment. The study, led by Walt Dahms, eventually demonstrated that pole-size, 65-year-old ponderosa pines "respond markedly to complete removal of all adjacent subordinate trees."

Heavy thinning to favor dominant ponderosa pines—
In 1953, Dahms established a new thinning study on plots 43 to 52 of the Pringle Butte Unit that soon demonstrated that dominant pole-size 65-year-old ponderosa pines "respond markedly to complete removal of all adjacent subordinate trees." Ten years later, Barrett concluded that even "stands having a good distribution of dominant trees need not be bypassed culturally because of the belief they are growing as rapidly as possible." Rather, "such stands may be treated to further accelerate growth of the fastest growing trees" and "maintain or stimulate the flow of wood to market" (Barrett 1963).

One of the Deschutes Research Center's more significant contributions to the literature of ponderosa pine silviculture appeared in June 1953 when the Station published Mowat's summary *Thinning Ponderosa Pine in the Pacific Northwest*. Mowat's paper presented "under one cover the main findings from a series of 25 thinning plots located in many parts of eastern Washington and eastern Oregon" (USDA FS 1954a) that started as early as 1927 and included plots 14 to 18 established in 1934 at Pringle Falls Experimental Forest. His analysis, which considered economics as well as ecology, "indicated that practically all forms and degrees of thinning tested were beneficial . . . , and that thinning should be relatively severe when only one operation is planned" (Youngblood 1995).

Effects of dwarf mistletoe on ponderosa pine—
Other influences on ponderosa pine silviculture investigated at Pringle Falls Experimental Forest in the early 1950s included western dwarf mistletoe (*Arceuthobium campylopodum*) studies by Dr. Lewis F. Roth, an Oregon State College professor of plant pathology. A botanist with a University of Wisconsin doctorate in forest pathology, Roth had joined the Oregon State College faculty in 1940, served in World War II as a naval officer, and returned to Oregon State and plant pathology after the war (Roth 2002). Sowder and Mowat, concerned there might be a dwarf mistletoe problem at the experimental forest and in central Oregon in general, invited him to investigate.

In the summer of 1952, Roth started "preliminary studies of dwarf mistletoe in ponderosa pine" at Pringle Falls that indicated that "it may be possible to control mistletoe indirectly through low-cost silvicultural treatments" but that further work was needed (USDA FS 1953a). Roth published his early findings of the relationships between dwarf mistletoe in the crowns of overstory trees and its intensity and distribution in the surrounding regeneration in 1953 (Roth 1953).

Roth knew he had a thorny, long-term project on his hands. "You just don't get the knowledge of what's going on [unless you base it on data collected] for a long time," he said of forest science, emphasizing the need to "continue data [collection and analysis] across the life of a forest stand" (Roth 2002). And so, like other dedicated forest scientists, he spent his professional life on a five-decade quest that resulted in many important discoveries about dwarf mistletoe and its control in ponderosa pine forests. His research, focused on plots 93 to 98 of the Pringle Butte Unit where he studied propagation mechanics and genetic resistance, continued into the 21st century.

Other threats to ponderosa pine—
The Deschutes Research Center also looked into ways to reduce the effects of certain vegetation and wildlife on ponderosa pine growth and yield. A study of the use of chemical herbicides to control manzanita and snowbrush was started in 1953 on sixty 20-foot-square study plots in the vicinity of Plot 19 on the Pringle Falls Unit. Four applications of two available chemicals in July and August demonstrated enough effectiveness on some species to justify planning an expanded program of further tests. In 1957, tests of chemical repellents identified two deer repellents that "showed promise" for reducing browsing damage to ponderosa pine seedlings (Cowlin 1988).

Lodgepole pine studies—
Postwar demand for forest products had increased interest in lodgepole pine for use as pulp and for manufacture into fiberboard, and growth studies of the species were given greater attention (Cowlin 1988). The Experiment Station published Mowat's *Preliminary Guides for the Management of Lodgepole Pine in Oregon and Washington* in 1949 (Mowat 1949). In 1957, important changes in the Forest Management Research program resulted in greatly expanded work on lodgepole pine management at the Deschutes Research Center. A large lodgepole pine pulpwood mill was built by the Johns Manville Co. near Chiloquin in south-central Oregon (Cowlin 1988).

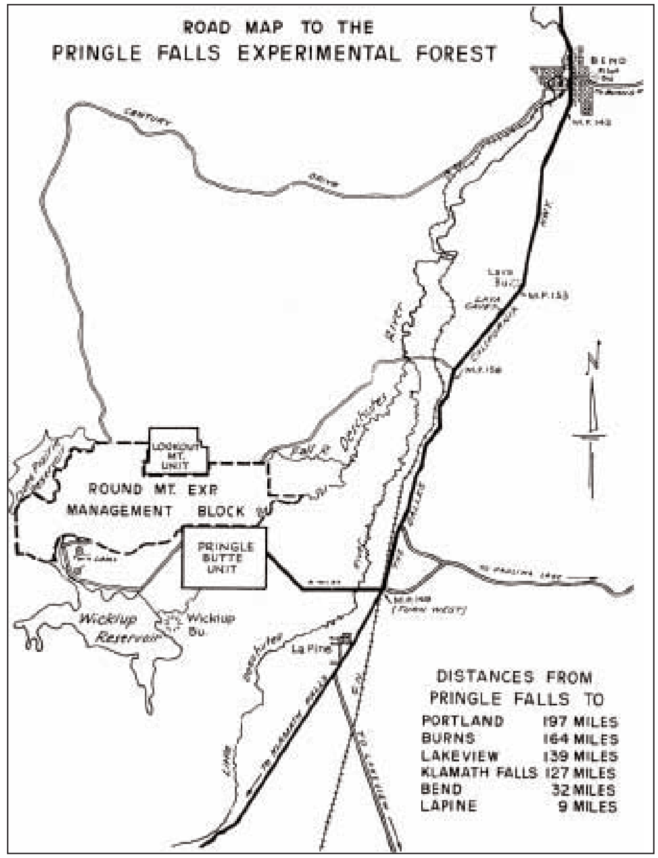
Wildlife habitat and range management studies—
Although forest management research dominated the Deschutes Research Center's agenda, wildlife habitat and range management studies were incorporated in 1956 with the arrival on August 1 of Richard S. Driscoll transferred

from the Starkey Experimental Forest and Range in northeastern Oregon. A 1951 range management graduate of Colorado A&M in Fort Collins (Bend Bulletin 1956), Driscoll was tasked with "analysis of game habitat problems in central Oregon and [development of] initial plans for game habitat research needed on forest and range lands" as well as "range management studies with regard to forage yields, maintenance of grass stands and invasion of noxious weeds" in the area (Bend Bulletin 1962a). In 1956 and 1957, this included exploratory studies of chemical repellents to reduce deer browsing of ponderosa pine seedlings (Cowlin 1988). After working with Driscoll during the summer of 1957 and earning a B.S. in wildlife and range ecology at Oregon State College in 1958, John Edward Dealy joined Driscoll's research project (USDA FS 1961).

Driscoll's and Dealy's charge to conduct wildlife habitat and range management research in eastern Oregon and Washington occasionally impinged on the Deschutes Research Center's primary role of forest management research because of the relationships between wildlife populations and forest habitats. For example, they were quoted in *The Bend Bulletin* on August 2, 1961:

> [H]eavy logging enhances production of natural deer forages which in turn acts to increase deer herd productivity. As the herd increases and without intensive control, the animals literally eat themselves out of house and home, destroying their natural forage plants.
>
> When this happens, they often begin browsing small trees which seriously affects future wood production. Hence, a major need in big-game range research is to develop methods to maintain or increase productivity of grazing lands and devise game management practices whereby game production is commensurate with livestock production, timber growing, watershed management, and outdoor recreation.

As part of the effort to address this issue, the two wildlife habitat scientists reported "a token study . . . on methods to reduce deer browsing damage to ponderosa pine seedlings." By 1961, they lamented that "the effects of



The Round Mountain Experimental Management Block encompassed national forest land between the Lookout Mountain and Pringle Butte Units of Pringle Falls Experimental Forest. The block extended west to Crane Prairie Reservoir.

logging or other forest management practices on big-game ranges [have] not been studied." They observed:

> The whole game management problem needs much more intensive study. If continued and sustained yields of game are to be expected a basis for proper management of the wildlife resource without detrimental impact to livestock, timber, soil, water, and recreation values must be developed [Bend Bulletin 1961d].

Round Mountain Experimental Management Block

The applied forest management concept, around which the Experiment Station's research centers had been organized in 1946, eventually required testing research conclusions from small sample-plot studies on commercial-size forest operations. To fully implement this concept, the Station would have to establish new experimental forests or arrange to use national forest study tracts dedicated to this purpose (Cowlin 1988). In 1953, the Deschutes Research Center and the Deschutes National Forest opted for the latter approach and planned an experimental management unit adjacent to the Pringle Falls Experimental Forest to "be used for pilot plant tests of management practices for ponderosa pine and lodgepole pine." These tests would emphasize: "all-aged versus even-aged silviculture, insect and disease control, inventory systems and requirements, determination of allowable cut, age-class control, and the costs and returns from intensive management" (USDA FS 1954a).

A working agreement for a Round Mountain Experimental Management Block was drafted, tentative boundaries were established, and guidelines for the initial development period were developed (USDA FS 1954b). Official approval of the 25,400-acre Round Mountain Experimental Management Block early in 1954 "made possible pilot plant tests of management practices for ponderosa pine and lodgepole pine" (Cowlin 1988). Developments during 1955 included sale of 32 million board feet to salvage dead, dying, and high-risk trees in a 15-percent cut; establishment of a road system on the unit; procurement of aerial photographs covering the unit at scales of both 1:20,000 and 1:10,000; and a preliminary study of inventory and accounting procedures for the unit made in cooperation with Professor Ray A. Yoder, School of Forestry, Oregon State College (USDA FS 1956). Although this experimental management block appeared briefly on maps, and despite this early activity, its research potential was never realized on the ground.

Winds of Change

Toward the end of the 1950s, two additional foresters who would make their marks on central Oregon silviculture joined the Deschutes Research Center staff. James W. Barrett arrived in 1958, followed by Carl M. Berntsen in 1959. Barrett, who had earned both a B.S. in forest management and an M.S. in forest management and forest pathology at

Deschutes Research Center staff in 1959. From left to right: Dick Driscoll, project leader Jim Sowder, Ed Mowat, clerk-stenographer Helen Rastovich, Jim Barrett, Walt Dahms, and Ed Dealy.

Iowa State University, ranched in South Dakota for several years before joining the Forest Service in 1956 as a Deschutes National Forest timber cruiser. He began his research career 2 years later at the Pringle Falls Experimental Forest, and spent the next 24 years focused on ponderosa pine propagation (Barrett 1999). Berntsen transferred from the Willamette Research Center in Corvallis, Oregon, to take charge of the Deschutes Research Center from Jim Sowder, who had been transferred to the Lake States Forest Experiment Station in St. Paul, Minnesota. A 1950 University of Idaho forestry graduate, Berntsen had just completed an M.S. degree in forestry at Oregon State College where, in 1967, he would earn a doctorate (Ph.D.) (Bernsten 2002).

Almost 15 years after its post-World War II reorganization, Forest Service research faced another profound change in scope and direction. For the Pacific Northwest Forest and Range Experiment Station this meant, among other things, reorganization from a "research center" concept to a "research project" concept. This reorganization would eventually replace the Deschutes Research Center and its emphasis on field studies at Pringle Falls Experimental Forest with a Bend Silviculture Laboratory and a new focus on laboratory studies. Berntsen was destined to lead this transition.

Chapter 3: Bend: A Research Laboratory

By the end of the 1950s, the research center concept had "matured" (Cowlin 1988), and the Forest Service research program was again ripe for change. In the 1960s, its funding increased; "as funding for all American science grew rapidly to 'keep ahead of the Russians,' Forest Service research expanded accordingly" (Steen 1999). Within a few years, the Forest Service program "went from a research center to a project concept" that, according to former Deputy Chief of the Forest Service Robert E. Buckman, "streamlined administration and put a lot more emphasis on science." Under the old research center concept: "The center leader was responsible for everything—community relations, science, everything" (Steen 1994). Science, it seemed, had suffered.

Deschutes Research Center staff about 1960. Top row, left to right: Ed Mowat, Walt Dahms, Ed Dealy, Jim Barrett, and project leader Carl Berntsen. Bottom row, left to right: forestry technician Clyde Webb and clerk-stenographer Helen Rastovich.

This nationwide "turning point in the scope and direction of the Forest Service research program" got a big push in 1960 when Congress, for the first time, appropriated funds specifically for construction of research facilities. This action, according to Cowlin, "signaled the intention to give forest research scientists the facilities to employ modern technology and equipment in seeking answers to fundamental and complex problems. It marked a shift in major emphasis from field studies largely empirical in nature to scientific laboratories where the many facets of complex forest problems could be investigated in totality" (Cowlin 1988).

"Coincident with [this research facility funding] was the development of the Man-in-Job concept" that was adopted by the Forest Service, and that "meant that a researcher's career was dependent on what he produced, not on his organizational position" (Steen 1994). This concept permitted a scientist to advance as a scientist instead of having to become an administrator to advance. It was supported by the Government Employees Training Act of 1958 that encouraged scientists to earn doctorate degrees, and was intended to upgrade the quality of Forest Service research (GETA 1958).

This change evolved over a few years. By 1962, the Pacific Northwest Forest and Range Experiment Station had reorganized its entire research program into 39 projects. A single project called the "Silviculture of Interior Conifer Types" was assigned to the forest management research staff at the Deschutes Research Center (Cowlin 1988). This staff and project were soon to be ensconced in a new facility that would be called the Bend Silviculture Laboratory and would complement the continuing Pringle Falls Experimental Forest field studies.

Carl M. Berntsen, who became leader of the Deschutes Research Center on July 1, 1959 (USDA FS 1959b), presided over this change in central Oregon. In theory, the transition from the research center to the project concept was intended to streamline administration and emphasize science. Berntsen's early years in Bend, however, seem to have been dominated by administering the planning and construction of a Bend research laboratory.

According to Berntsen, Senator John Stennis of Mississippi, a member of the Senate Appropriations Committee, "was making a strong political push to improve forest research field laboratory facilities. We took advantage of the political climate. Bob Chandler, owner-editor of *The Bend Bulletin*, led the charge" (Berntsen 2002).

The Bend Silviculture Laboratory Is Planned, Built, Occupied, and Dedicated

In expectation of research facility construction funds, the Experiment Station began to search for a building site. On the evening of August 3, 1960, the Bend city council, on recommendation of the city's planning commission, authorized construction of a Forest Service research center on the southern flank of Awbrey Butte, an extinct volcano that dominates Bend's northwestern skyline. The city had earlier agreed to donate the property to the Forest Service, and a deed had been prepared (Bend Bulletin 1960). The site commanded "spectacular views of Bend, the Paulina Mountains to the south, Pine Mountain to the southwest, parts of the Cascade skyline to the west" (Hatton 1987). It was a view to inspire silviculturists: in the foreground, Bend's two large mills, both operated by Brooks-Scanlon since 1950, flanked the Deschutes River; in the background, a landscape clothed by ponderosa pine forests—albeit much cut over to feed those mills—spread to the horizon.

It was a view that inspired residential development of Awbrey Butte, too, as well as some citizen opposition to the project proposed for a neighborhood zoned for single-family dwellings. Berntsen, by then leader of the Deschutes Research Center for just over a year, and city manager Walter Thompson managed to assuage this opposition at that August 3 meeting. As reported in *The Bend Bulletin* the following day, Berntsen and Thompson

> answered questions . . . on such points as a plot plan showing initial construction and subsequent development, restrictions which can be legally enforced, a binding time table and guarantee by the commission that this will be the highest possible use of the property.

Additional opposition centered on the city's donation of the land, a citizen "asking why the Forest Service needs that particular property, when it has a million and a half acres elsewhere, and why the government couldn't pay for it." To this, "Mayor William Miller said that other cities would be happy to cooperate to get such a development, and that it's important for Bend not to lose it." Much was made of the future of the facility, including the plan "to increase the professional staff to 12 with a full-time payroll of about 20" within 10 years (Bend Bulletin 1960).

This rendering shows architect A.P. DiBenedetto's plan for the Bend Silviculture Laboratory.

Early in 1961, in Washington, D.C., Senator Maurine Neuberger of Oregon urged earmarking $150,000 to cover the project's first phase: "an office-laboratory building and equipment" (Bend Bulletin 1961c). Other members of Oregon's congressional delegation, most notably Senator Wayne Morse and Representative Al Ullman, supported her action (Bend Bulletin 1961a).

A.P. "Benny" DiBenedetto, a Forest Service architect on the staff of the Division of Engineering, Pacific Northwest Region, prepared the plans and specifications for the facility that would become known as the Bend Silviculture Laboratory (USDA FS, n.d.) and that, upon completion, would be featured in the July 1964 issue of *Architectural Record.* As that journal interpreted DiBenedetto's work, "a non-institutional building appropriate to the neighborhood was achieved" (Architectural Record 1964).

A basic contract for $183,000 was awarded (USDA FS, n.d.) and, although construction lagged (Bend Bulletin 1962b), the project was completed on November 22, 1963, the day President John F. Kennedy was assassinated. Three days later, after a final inspection, the Forest Service accepted the structure from the contractor (USDA FS, n.d.).

This photo of the Bend Silviculture Laboratory was taken shortly after its completion and occupation.

On the morning of November 27, 1963, the Bend Silviculture Laboratory, constructed at a cost of $222,500, was placed in use. Berntsen and his small staff of scientists and technicians personally moved the contents of their offices from the O'Kane Building in downtown Bend, where they had been housed since July 1960, to their new facility on Awbrey Butte. Phil Brogan of *The Bend Bulletin* reported that the new facility had been "described as the finest of its kind in the country, 'in a scenic setting second to none" (Brogan 1963). Although work resumed immediately, formal dedication was put off until the following spring when a library, a greenhouse, and paving would be complete.

A supplementary contract for $39,500 to construct the library, the greenhouse, and to pave the access roads and parking areas, was awarded in June 1963. This contract was funded by the Accelerated Public Works Act of 1962 intended to initiate and accelerate federal, state, and local public works projects that provided "immediate useful work for the unemployed and underemployed in labor surplus areas" (Bend Bulletin 1964b). After completion and final inspection of this work, the Forest Service accepted the project from the contractor on February 11, 1964.

Dignitaries from around the Nation, as well as the Pacific Northwest, gathered in Bend for the Saturday morning, May 2, 1964, dedication of the Bend Silviculture Laboratory and Bend Chamber of Commerce-sponsored luncheon at Bend's fashionable Pine Tavern (Bend Bulletin 1964a). Attendees included about 500 members of the Society of American Foresters who scheduled a special Columbia River Section conference in Bend to coincide with the event (Portland Oregonian 1964a).

Philip A. Briegleb, Director of the Experiment Station and President of the Society of American Foresters, served as master of ceremonies. Senator Wayne Morse gave the dedicatory address. "Today, we dedicate more than a forest laboratory," Oregon's senior senator told the large crowd. "We dedicate ourselves to progress—progress through knowledge, progress through cooperation" (Portland Oregonian 1964b).

Edward P. Cliff, Chief of the Forest Service, captured the spirit of the day in a brief speech.

> This occasion symbolizes the changes taking place in forestry. Two decades ago, ponderosa pine was the uncontested king of the timber scene in eastern Oregon—both in the woods and in lumber mills. This magnificent tree is still our most prominent species, but as more and more of the "back country" is made accessible, we encounter more and more of the "associated" tree species—lodgepole pine, western larch, white fir, Douglas-fir—and we as well as the people in the industry are gaining a greater appreciation of the value of these species.

> Only ten years ago we were busy getting ponderosa pine regenerated on cutover or denuded land and sometimes where it had never grown before. Now, we are more concerned with growing the species or combination of species best adapted to the particular site. Our interest is to produce the maximum amount of wood for the widening variety of products that will probably be in demand in future years.
>
> Not too many years ago, our research program was based mainly on measuring and observing the timber stand and the individual tree. Now we dig deeper to learn the underlying principles of tree growth as influenced by soils, land form, associated vegetation, and even the air trees "breathe."
>
> The job of the silviculturist is to produce the greatest amount of usable wood on a given tract of land. But this objective must also be consistent with other forest land uses. Water yields, recreation use, and forage for livestock and wildlife are factors that frequently require modification of wood production goals. Occasionally on particular sites one or more of these other uses overrides timber in priority and thus may call for major adjustment in timber-growing objectives.
>
> One aspect of multiple use is already being studied at this laboratory. Scientists from two projects—silviculture and wildlife habitat—have teamed up to study production of deer browse as influenced by density of the timber stand. We are searching for that elusive point of compatibility that will lead to highest possible compatible production of both boards and bucks [Cliff 1964].

Thus inspired and charged, the small Bend Silviculture Laboratory staff invited its hundreds of guests to tour the beautifully designed building. Features included eight private offices, each finished in a different species of timber; three large laboratories—a plant laboratory, a soils laboratory, and a third containing growth chambers in which precise climatic conditions could be maintained; a photographic darkroom; separate rooms for radioactive materials and delicate weighing apparatus; a number of storage rooms; and a modern greenhouse. There were also a separate library and a beautifully furnished conference room (Van Wormer 1964).

The Bend Silviculture Laboratory Struggles

The research challenges of which Chief Cliff spoke so eloquently on that May 2, 1964, day of dedication were not the only challenges the Bend Silviculture Laboratory faced. From the day it opened, it suffered from short funds and small staff. Berntsen and his staff of five—principal silviculturist Walt Dahms and silviculturist Jim Barrett, forestry technicians Clyde Webb and Lee Baker, and clerk-stenographer-receptionist Helen Rastovich—were only one-third of the laboratory's projected staff and faced what Cowlin called "a host of problems in need of answers." Although the new office and laboratory facilities were "more than adequate," the "urgent need was increased personnel" (Cowlin 1988).

So far, the Bend project to study the silviculture of interior conifer types had focused on the two principal species Munger had focused on as early as 1908, lodgepole pine and ponderosa pine. Cowlin summed up what had been achieved by the mid-1960s.

> Past research in lodgepole pine proved that this conifer was capable of growth rates comparable to its better known associate, ponderosa pine.
>
> Rigidly controlled experiments in stand density of ponderosa have shown extraordinary diameter and height increments of widely spaced saplings. If these initial results hold up, production of merchantable wood could increase greatly over that of current yield table predictions. This would mean a big boost to the timber economy of this forest region [Cowlin 1988].

"However," Cowlin noted, "probably the greatest opportunity of the ponderosa pine region for satisfying

Brooks-Scanlon Corporation, Pine Echoes.

Carl M. Berntsen, project leader, checks experimental pine seedlings being grown in the greenhouse.

future demands for wood lies in intensive management of the mixed species of the interior conifer types. One of the obvious problems is which species to favor in these forests involving mixtures of as many as five coniferous species. Preliminary to such a determination was enlarging silvicultural knowledge of the individual species and the complex interactions" (Cowlin 1988). This required funds and staff the laboratory did not have but that Berntsen strove to acquire as he completed his studies toward a Ph.D. degree at Oregon State University and his current staff continued their focus on lodgepole pine and ponderosa pine.

Berntsen appealed for public understanding and support of the new Bend Silviculture Laboratory through the local media. Just after the facility was dedicated, the July-August 1964 issue of *Pine Echoes*, the Brooks-Scanlon Corporation's house organ, featured a picture story on the laboratory (Van Wormer 1964). Occasional articles appeared in *The Bulletin*, Bend's daily newspaper. A December 23, 1966, article entitled "Berntsen's Study Unlocks Secrets of Pine Production" explained the significance of the project leader's doctoral research and dissertation on "Relative Low Temperature Tolerance of Lodgepole and Ponderosa Pine Seedlings" conducted at the laboratory to that paper's readers.

> Berntsen explored the hypothesis that Central Oregon lodgepole pine occupies suspected frost pockets to the exclusion of Ponderosa pine by virtue of its tolerance to very low temperatures during the seedling emergence period.
>
> Tolerance thresholds to low temperatures for both species were determined in a controlled environment chamber [at the laboratory] designed specifically for the study. It had separate controls of soil and air temperature.
>
> The study was not confined to the laboratory [but] extended to the field, where the occurrence of low temperatures was made along a transect starting in a lodgepole pine flat and continuing through a lodgepole-Ponderosa transition zone up to a Ponderosa timber slope.
>
> The studies indicated that the pattern of distribution of lodgepole and Ponderosa is due in part to the greater tolerance of low temperature by lodgepole seedlings over those of the Ponderosa pines [Bend Bulletin 1966].

Appealing to the timber town's interest in propagation of lodgepole pine, once "the 'weed' tree of the industry—now . . . a Cinderella pine with pulp and other potentials" (Bend Bulletin 1966), Berntsen soon made the case for an improved Bend Silviculture Laboratory in a 1967 article penned by Phil Brogan (1967).

In 1967, after 8 years of presiding over the transition from the research center concept reflected in the Deschutes Research Center to the research project approach embodied in the Bend Silviculture Laboratory, the new Dr. Berntsen was transferred to the position of Assistant Chief, Branch of Silviculture, Division of Timber Management Research, in Washington, D.C. Dahms became Bend project leader. In that same year, funding began to improve, and soil scientist Dr. Patrick H. Cochran arrived to strengthen the research team. Two years later, in 1969, Dr. Kenneth W. Seidel arrived to focus on upper slope mixed-conifer species. Barrett and these researchers, freed by the man-in-job concept from pressure to become administrators, formed the core of the laboratory's research effort during those lean years. Their work, as well as that of Dahms and other researchers who joined the Bend Silviculture Laboratory team later, is summarized in chapter 4.

Dahms and his staff continued the effort to keep the public informed of their research at the Bend Silviculture Laboratory and the Pringle Falls Experimental Forest. An article prepared not by newspaper writers but carrying the byline "by the people of the Silviculture Laboratory" published in the March 15, 1972, issue of *The Bulletin* surveyed how "Researchers study ecology of trees at Pringle Falls" in a way that related their research to "producing successive crops of wood indefinitely" to support the community's economy (Bend Bulletin 1972).

In addition to its own research staff focused on its "Silviculture of Interior Conifer Types" project, the Bend Silviculture Laboratory housed a team of U.S. Department of the Interior wildlife researchers. Although they were non-Forest Service tenants, they contributed to the laboratory's studies. For example, Jay Gashwiler of the Bureau of Sport Fisheries and Wildlife—a unit of the U.S. Fish and Wildlife Service at the time—arrived soon after the laboratory opened to study the relationships of birds to forest and range habitats. "When baseline populations for various bird species are established in natural areas, comparisons can be made concerning the effect of logging, timber management and brush eradication upon birds," a 1967 article about Gashwiler in *The Bend Bulletin* (Callister 1967) explained. Such findings help silviculturists and timber managers adjust policies and practices to preserve wildlife habitat.

Vic Barnes, another Fish and Wildlife Service researcher, arrived at the Bend Silviculture Laboratory in 1970 to investigate the western pocket gopher (*Thomomys mazama*) problem in central Oregon's pine forests. According to a 1972 story about Barnes in *The Bulletin*, the "gophers kill young pine trees" and "are the number one forest problem animal east of the Cascades." Barnes pursued this intriguing problem in ponderosa pine silviculture in a small gopher-infested area of the Deschutes National Forest about 7 miles southwest of Bend and in the laboratory. After trapping, assessing, and banding the gophers, he attached miniature radio transmitters around their necks, released them on the site, and tracked them with a radio direction-finder to learn their lifeways. Two years into this long-term study, Barnes had discovered that up to 60 percent of freshly planted pine seedlings were killed by gophers during the winter and had reached some conclusions. Among these:

> "Logging and fires make a bad gopher habitat into a good gopher habitat," Barnes explains. "They're an open-area animal."
>
> He says it seems that habitat control is the best answer. "It is more desirable and has more long-range effects than direct control, such as trapping and poisoning" [Brickey 1972].

Fish and Wildlife Service researchers continued to work at the Bend Silviculture Laboratory well into the 1980s.

The Bend Silviculture Laboratory Burns and Is Rebuilt

Just after midnight, at about 12:20 a.m. on January 15, 1974, Trooper Robert McKethen, Oregon State Police, spotted and reported the blaze on Awbrey Butte. Whipped by a steady, strong southwesterly wind, the flames had engulfed the east wing of the Bend Silviculture Laboratory by the time the Bend Fire Department's six responding units and 45 firemen arrived. Spontaneous combustion of wood dust, left in a sander by a worker refinishing floors, ignited the blaze that destroyed the office wing and library, damaged the laboratory wing, and singed trees on the structure's northeastern side. "The rain helped us," Bend Fire Chief Pete Hansen observed. "I don't know what we would have done if this had happened in spring or summer" (Tripp 1974a).

Later that morning, Project Leader Walt Dahms and grim-faced members of his staff searched the ruins for research data. "It looks like there's very little left to salvage," commented Deschutes National Forest Supervisor Earl Nichols, after visiting the smoking remains. Nichols quickly invited Dahms and his crew to locate temporarily in his office (USDA FS 1974a). But, as file cabinet drawers

Fire destroyed the Bend Silviculture Laboratory office wing and library and damaged its laboratory wing during the early morning hours of January 15, 1974.

were pulled from the burned office wing and moved to the undamaged greenhouse, the outlook improved. Not as many records were destroyed as first thought. "Two factors are involved," Dahms said. "We had some fireproof files and we have research data processed on IBM cards in Portland. The guys were looking at the salvaged stuff and saying, 'It's a little smoky, but it'll work'" (Tripp 1974b). Because few records were destroyed and much laboratory equipment was undamaged, the momentum of the Laboratory's research program was slowed but not lost (USDA FS 1974b). Temporarily quartered in two trailer-offices, the staff resumed work.

At the time of the fire, according to Bob Tarrant, then Experiment Station assistant director, the Bend Silviculture Laboratory "was a candidate for being shut down." As far as the Portland office was concerned, the fire had sealed the beleaguered laboratory's fate. But politics—in the form of Representative Al Ullman of Oregon's Second Congressional District, which included Bend, and Bend newspaper publisher and editor Robert W. Chandler—soon intervened. Tarrant remembered being called from Bend at 7:30 in the morning and told "that the Lab had burned down overnight. And, as soon as I got through with that call, Congressman Ullman called me from his office in Washington to console me in my grief. And he said: 'I promise you that, within three months, a rider on a bill I am writing right now will rebuild that laboratory. Lock, stock, and barrel. Every stick of wood in it.' I said: 'Thank you' (Tarrant 2002).

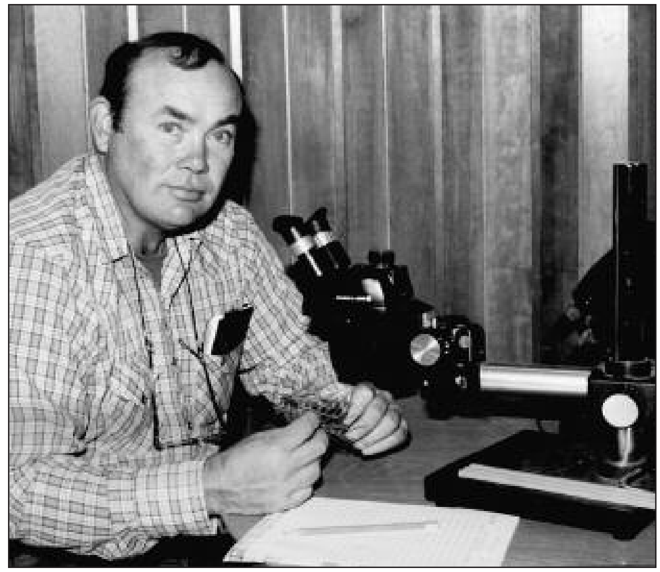
A January 18 editorial in *The Bend Bulletin* urged Ullman, a member of the House Ways and Means Committee, to follow through on that promise. "Ullman has worked hard to get funding for various other Forest Service projects, and there's no reason why he shouldn't put the same kind of effort into this one" (Bend Bulletin 1974c). An estimated $500,000 would be needed (Tripp 1974b).

Before long, Experiment Station Director Robert E. Buckman asked Chief of the Forest Service John S. McGuire to request reconstruction funds as quickly as possible (USDA FS 1974b). Congressman Ullman pressed on, and on May 17, *The Bend Bulletin* reported that "a House-Senate conference committee . . . approved spending $650,000 to reconstruct the U.S. Forest Service silviculture laboratory in Bend. Money for the rebuilding is part of a supplemental appropriations bill which will be sent back to both houses of Congress for final approval" (Bend Bulletin 1974d). Congress soon came through, and in June, President Richard M. Nixon approved the appropriation to rebuild the laboratory (Bend Bulletin 1974b).

The only change in plans between the new buildings and those that burned was the addition of a 2,000-square-foot service building near the greenhouse. The reconstruction schedule called for that structure—a combination garage and shop that also housed a constant-temperature growth chamber for trees—to be built first, within 90 days of contract award, to temporarily house the laboratory staff (Bend Bulletin 1974a). Otherwise, the office-laboratory and library buildings were duplicates of the burned buildings. The undamaged foundations and salvageable portions of the burned structures were incorporated into the new construction (USDA FS 1974c).

Construction was underway by October, and the service building was completed and occupied first. "My first office was in the shop where there was one little pathway

Dr. Bob Martin, project leader for the Bend Silviculture Laboratory, explained research projects to visitors including Representative Al Ullman (right) at the May 29, 1976 open house.



Mark Reid

Dr. Bill Hopkins led the Deschutes National Forest's Area IV ecology team, housed at the Bend Silviculture Laboratory.

[by] which I could get to the desk," recalled Dr. Robert E. Martin, who arrived in June 1975 to replace the retiring Dahms as project leader. "Everybody else was in mobile homes out in the driveway while they were rebuilding" (Martin 2000). Finally, on October 22, 1975, the staff moved into the new buildings. The next spring, on May 29, 1976, the Bend Silviculture Laboratory celebrated its new beginning with a luncheon and open house.

Ironically, the fire that destroyed much of the Bend Silviculture Laboratory's facilities bought it a new lease on life that kept it in operation for another 20 years.

The Bend Silviculture Laboratory Perseveres

Those were 20 years of production and perseverance. For most of those years, Bend Silviculture Laboratory research emphasized wildland fire behavior and fire effects as it continued to work on the silviculture, growth, and yield of principal east-side timber species. By the 1980s, research funding for the laboratory leveled off, and then declined. But the laboratory's small staff of researchers and technicians continued their long-term studies of silviculture east of the Cascade Range. The contributions of these researchers, some of whom had become identified with their specific projects during the Deschutes Research Center era and whose professional lives were defined by their specific projects, are detailed in chapter 4.

In addition to its own research staff focused on its "Silviculture of Interior Conifer Types" project and the "tenant" U.S. Fish and Wildlife Service researchers, the rebuilt Bend Silviculture Laboratory from 1977 housed the Deschutes National Forest-based Area IV Ecology Team, one of seven such teams serving Pacific Northwest Region national forests. Led by Dr. William E. Hopkins, plant ecologist for the Deschutes, Fremont, Ochoco, and Winema National Forests, this small team concentrated on "initial classifications and descriptions of natural forest, grassland, and alpine ecosystems" reflected in a series of plant association handbooks for the managers of those national forests. Hopkins also led the project in the late 1970s and early 1980s that added additional acreage to the research natural area system on these four national forests. Over the years,

Mark Reid

Joan Landsberg began as a technician at the Bend Silviculture Laboratory and eventually became a research chemist and project leader.

a series of assistants—range conservationist Kenneth Nieman, forester Bernard "Bud" Kovalchik, forest ecologist Steven Simon, range conservationist Dr. Gregg Riegel, and soil microbiologist Dr. Matt Busse—served with Hopkins on many projects (Hopkins 2003). These scientists also collaborated with their Bend laboratory colleagues on silvicultural research that would benefit national forest management and on the transfer of research results to managers.

Martin attracted new talent to the Bend Silviculture Laboratory. In January 1979, he hired Johanna D. "Joan" Landsberg, a local research chemist, as a temporary physical science technician "to run the chemistry of the samples brought in from the field" (Landsberg 2002). Although she had prepared for a career analyzing human food nutrients with an Oregon State University M.S. degree in food science, Landsberg's new job at the laboratory involved analyzing plant nutrients. "Many of the laboratory procedures are the same," the *PNW News* observed in a story about her, "and she likes being in the field as well as in the laboratory" (USDA FS 1982b). A career change soon followed. "I realized from chatting with Bob Martin," Landsberg recalled, "that I could either be the chemist and stand at the lab door and take the samples from whomever brought them in and hand back numbers to whomever was waiting for them, or I could be fully involved in the project" (Landsberg 2002). She decided on the latter course, was soon appointed a research chemist, and embarked on the research of the long-term effects of prescribed burning on nutrients and plant growth that defined her Forest Service research career.

After more than two decades as an Experiment Station research entomologist based in Portland and Corvallis, Dr. Russell G. Mitchell joined the Bend Silviculture Laboratory team in 1980 to work on insect issues associated with Martin's prescribed burning studies as well as the laboratory's other silvicultural studies. Mitchell, who had enjoyed lectures by Sowder and Mowat during undergraduate field trips to Pringle Falls Experimental Forest as an Oregon State College forestry student, earned a B.S. in forest management in 1956. He went on to earn an M.S. in forest entomology from New York State College of Forestry at Syracuse in 1957 and a Ph.D. in entomology from Oregon State University in 1967. He had also worked at the experimental forest as a graduate student. Best known for his work on the balsam woolly adelgid, Mitchell had worked throughout the 1970s on the Experiment Station's insect collection committee. After 2 short years in Bend, he was called to Portland as applications coordinator in the Station's insect control program, then returned to Bend in 1985 where he worked on mountain pine beetle, western pine beetle, western shoot borer, and a pandora moth infestation before he retired in 1991 (Mitchell 2003).

Also, while Martin was project leader, forestry technicians Dick Newman and Larry Carpenter joined the staff. Along with the laboratory's other technicians, "they did much of the skillful heavy lifting so essential to the success of forest science" (Barrett 2003). Michele Penner joined the staff as a physical science technician in 1980 (Penner 2003).

Martin's greatest challenge as program leader was the Bend Silviculture Laboratory's meager budget. "We didn't get a lot of money," he explained in 2000. "Everybody saw

Research entomologist Dr. Russ Mitchell came to the Bend Silviculture Laboratory after working in Portland and Corvallis and returned to the laboratory again after an assignment in Portland. After his retirement, he continued to be active as an emeritus scientist.

us in that nice building and thought we were rich. But some years there was hardly enough money to drive out to the experimental forest and back." This poverty required creative scheduling for some experiments, especially those involving fire. "We always burned on a 'first forty' [paid hours per week] basis, then gave comp time because we couldn't afford to pay overtime. Sometimes we had that first forty in by Wednesday." On certain experiments, "We'd burn in the morning or afternoon. Soon as I could I'd break off some of the people to take the fuel samples in to weigh for moisture content, then get one of the technicians to go in by midnight, then keep the other one out until we finished burning out the unit. Then, usually, I would sit the fire overnight and the other technician would come back in the morning. That was the only way we could afford to do it" (Martin 2000).

The funding issue came to a head in February 1982 when it appeared that cuts in the Forest Service's proposed 1983 budget would reduce staffing of or even close the Bend Silviculture Laboratory and nine other research laboratories around the country. "It was February 9," Martin recalled. Closure seemed imminent. "I was in Corvallis and got a call that the [Experiment Station] director and deputy director wanted to talk to me [in Bend] that night. I came over the pass that night, the fastest I ever came in a snowstorm. They got me in a room, announced they were going to close the lab, and said everyone should vigorously seek other employment" (Martin 2000). After the announcement, Cochran told a reporter from *The Oregonian* that it was "business as usual at the lab for right now, but we're trying to wrap up research projects rather than plan any new ones" (Shotwell 1982).

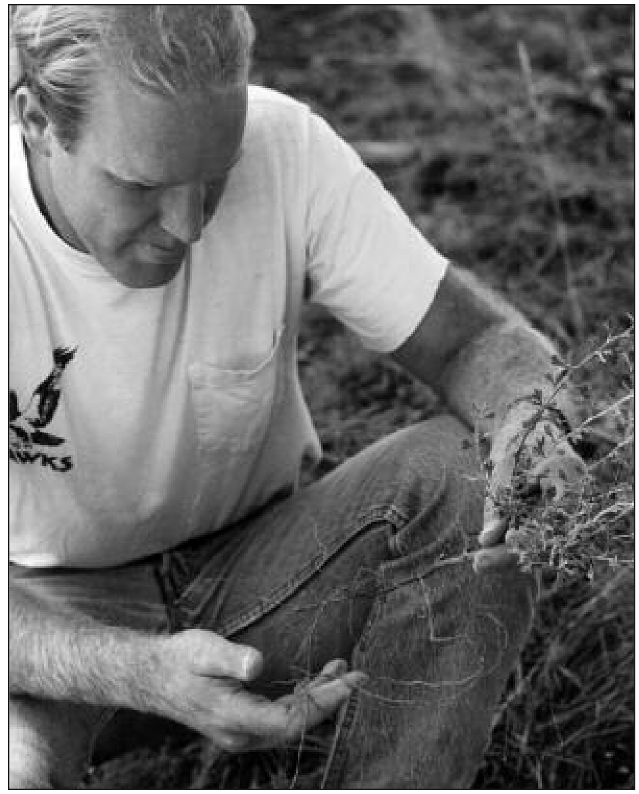
Although the work of Hopkins and his ecology team was not threatened, closure of the laboratory would force them to find another work location. The three Fish and Wildlife Service employees would have to be reassigned. "The writing on the wall doesn't look promising for 1983," Vic Barnes said. "I can't find any cause for optimism" (Bend Bulletin 1982).

The fact that the Bend laboratory would take the brunt of the cut for the Experiment Station—it represented 3.5 percent of the Station's operating body and would absorb 28 percent of the Station's cut—wasn't lost on Martin and his staff. Indeed, after half a year of controversy, Martin resigned from the Forest Service to accept a professorship in the Department of Forest and Resource Management at the University of California, Berkeley, where he taught wildland fire management until he retired in 1994. Ultimately, the decision to close the Bend laboratory foundered on the fact it would cost more to close it and move residual personnel and functions to the La Grande laboratory than to keep it open (Martin 2000). It remained open for another 14 years.

John Deeming, a research forester at the Experiment Station in Portland, replaced Martin as Bend Silviculture Laboratory project leader in September 1983. Martin had hoped that Deeming, whose Forest Service career had begun on the fire research staff at the Southern Forest Fire Laboratory in Macon, Georgia, and had also included a stint at the Northern Forest Fire Laboratory in Missoula, Montana (USDA FS 1983), would continue the Bend laboratory's prescribed burning research. Arriving in the wake of the closure threat, however, Deeming joined an organization where morale was depressed and prospects for the future seemed dim. Moreover, he arrived with "quite a load of residual work" in air quality management and fire danger rating system development—both reflective of his background in meteorology—that, along with keeping the laboratory funded, left little time for extensive involvement in prescribed burning research. As a result, Deeming gravitated toward administration of a laboratory at which a small staff of scientists—Cochran, Seidell, and Landsberg—and technicians pursued their established projects. "I just tried to keep things moving," Deeming said of his efforts that emphasized his priority to protect the Forest Service's investment in these long-term studies. As time passed, morale improved, and productivity reflected in publications on these studies continued.

Deeming did, however, assist Landsberg with developing replications of the underburning studies she and Martin had begun south of Bend near Lava Butte on three additional sites. He also planned with Hopkins to reintroduce beneficial effects of fire in the eastern, ponderosa pine portion of the Pringle Falls Research Natural Area and in ponderosa pine stands of the Metolius Research Natural Area, also on the Deschutes National Forest, and in ponderosa pine stands of the Ochoco Divide Research Natural Area on the Ochoco National Forest (Deeming 2003).

In 1985, the Bend Silviculture Laboratory's parent office in Portland changed its name from Pacific Northwest Forest and Range Experiment Station to Pacific Northwest Research Station (USDA FS 1985b). Also that year, when the Forest Service began to offer early retirements, Deeming opted to retire in February 1986. Ken Seidel, by then a 16.5-year veteran of the laboratory, succeeded Deeming as project leader of what by then had become known as the Culture of Eastern Oregon and Washington Forests Research Unit. More interested in science than administration, Seidel had several research projects nearing completion, believed it was not time to start new ones, and by late 1987 had decided "this seems to be a good time to leave. I still have some manuscripts to finish up," he added,



Mark Reid

Dr. Matt Busse, soil microbiologist, began his Forest Service research career at the Bend Silviculture Laboratory on a postdoctoral fellowship.

"so I'll be around for awhile" (USDA FS 1988). Seidel continued to write after retirement, and published the last of his research as senior author of a research paper on the influence of cattle grazing and grass seeding on coniferous regeneration and shelterwood cutting in eastern Oregon in 1990 (Seidel et al. 1990). Joan Landsberg succeeded Seidel as project leader, and combined administration with her research and pursuit of a Ph.D. degree in forest ecology.

In 1989, Matt Busse, who had just completed a Ph.D. in soil microbiology at Oregon State University, arrived at the Bend laboratory on a postdoctoral fellowship to begin a 20-year study of long-term site productivity in young ponderosa pine stands on the Deschutes National Forest.

> The goal was to improve understanding of ponderosa pine ecosystems by monitoring the response of these systems to various silvicultural practices, including thinning with three levels of usage (no

removal, bole only, and whole tree), fertilization, and three forms of slash treatment (broadcast burning, pile and burning, and crushing). The underlying scientific question and management concern was whether different rates of organic matter removal significantly alter biological, physical, and chemical processes in ponderosa pine ecosystems [Youngblood et al. 1994].

In 1992, Busse accepted a Forest Service appointment as a soil ecologist to continue this work under the auspices of the Area IV Ecology Team. By 1995, Busse had produced a manuscript on responses of these stands to various underburning treatments, Oregon State University cooperator Dave Myrold had produced a manuscript on foliar nutrient content in response to these treatments, and a third manuscript on growth response to these treatments had been planned (Busse 2002).

Despite its fiscal challenges, the Bend Silviculture Laboratory entered the 1990s as a modern research facility well equipped to address the forest research questions of the future. Its recent research in wildland fire behavior, fire effects, and the effects of timber harvesting on soil properties had left it with two physiology and analytical chemistry laboratories supplied with state-of-the-art equipment for both plant physiology and soil biology research (Youngblood 1993).

Mark Reid

Bo Bohannon maintained the Pringle Falls Experimental Forest and Bend Silviculture Laboratory facilities in the 1980s and early 1990s.

At the beginning of the 1990s, the Bend Silviculture Laboratory had contributed a proud scientific legacy. A major recent manifestation of this legacy were the contributions of several laboratory members and alumni—Martin, Deeming, Mitchell, Seidel, and Landsberg—to *Natural and Prescribed Fire in Pacific Northwest Forests*, a landmark work in the field edited by John D. Walstad and Steven R. Radosevich of the College of Forestry, Oregon State University, and David V. Sandberg of the Research Station, and published by Oregon State University Press in 1990. The previous six decades had produced many others.

Chapter 4: Pringle Falls and Bend: A Research Legacy

Jim Barrett (shown here) inherited from Ed Mowat and Walt Dahms the ponderosa pine research that dominated Forest Service research in central Oregon and defined his career.

The major themes of silvicultural research that originated in the 1930s at the Pringle Falls Experimental Forest progressed into the 1990s at the Bend Silviculture Laboratory and became identified with scientists whose research legacies are inextricably linked with their research careers. Most were Forest Service scientists, but scientists from universities also contributed to this legacy.

Walt Dahms: Lodgepole Pine Silviculture

Walt Dahms, who started at Pringle Falls Experimental Forest in December 1946, "got involved in lodgepole pine for a very long time" (Dahms 1999).

That involvement reflected the Pacific Northwest (PNW) Forest and Range Experiment Station's realization that year that "lodgepole pine has passed from the category of a noncommercial tree to a commercial tree. . . " Four decades later, Munger's "practically worthless weed" of 1914 was ". . .being cut extensively for poles, box shook, and even for lumber." Yet, lodgepole pine "silviculture in this region is practically unexplored" and "knowledge of management methods is practically nil" (USDA FS 1947a). The Station's 1948 annual report touted lodgepole pine as a "new pulpwood" (USDA FS 1949).

The silviculture of the lodgepole pine, which "forms the principal cover type over two million acres in the pine region [of the Pacific Northwest] and represents a large wood fiber supply and population support potential" (USDA FS 1947a), offered a research challenge initially—but only lightly—addressed by thinning experiments begun in 1934 at Pringle Falls Experimental Forest where research had focused on the more valuable ponderosa pine.

Dahms "went at [his lodgepole pine research] in a little different way than most other people had tried." His approach was to determine "how much wood was actually grown on an acre and on a site," and then determine—through analysis of data derived from spacing and levels-of-growing-stock studies—"how much of that can be grown on trees that really count. Little trees that are not merchantable are not worth anything from a forest management standpoint. So there were thinning studies and growing-stock studies that I was involved in" (Dahms 1999). Thus, instead of trying "to find plots that represented about full stocking and build up a yield table," Dahms "measured volume increment over a ten-year period and then built an equation" to develop and in 1964 publish *Gross and Net Yield Tables for Lodgepole Pine* (Dahms 1964). Dahms' interest, however, extended to everything that influenced those growth and yield tables.

Seed production and dissemination data, necessary for planning natural regeneration of any forest, were an essential aspect of Dahms' lodgepole pine research. "This kind of information is especially needed for central Oregon lodgepole pine (*Pinus contorta*) because, unlike the Rocky

Mountain variety, cones are generally not serotinous [i.e., they do not remain sealed for several years until heat from a fire or other source opens the cone scales] and seeds are shed within the first year after cone maturation" (Mowat 1960). Furthermore, central Oregon lodgepole pine stands "are normally regenerated by natural means, usually shelterwood." A 16-year seed production study "indicated sufficient lodgepole pine seed was produced to provide for satisfactory natural regeneration during 3 out of 4 years if other conditions were favorable" (Dahms and Barrett 1975).

Those "other conditions" that affected lodgepole pine regeneration after logging also were studied. Seed dispersal "into clearcut patches falls off rapidly as distance from timber edge increases. Only 2 or 3 percent of the lodgepole pole pine seed catch under timber falls at a distance of 2 chains [132 feet] from timber. Furthermore, the tremendous range in temperature of pumice soil seed beds and the tendency for those extremes to be greater in larger clearcuts (Cochran 1969a, 1969b) makes natural regeneration of large openings on pumice flats unlikely" (Dahms and Barrett 1975). Such findings informed timber harvest planning for natural regeneration.

Not all years are favorable for natural regeneration, Cochran (1973a) pointed out.

> A series of events is necessary. . . . Germination must be favored by warm and moist surface soils, daily surface temperature variation must be moderate, seedlings must survive summer drought, and weather conditions must prevent severe frost-heaving the fall after germination and the next spring [Dahms and Barrett 1975].

Specific moisture-temperature relationships were worked out in seedbeds at the Pringle Falls Experimental Forest and in growth chambers at the Bend Silviculture Laboratory (Yates, n.d.). These integrated field and laboratory studies showed "that lodgepole pine seedlings are more resistant to cold than ponderosa pine" and helped "to explain why many suspected frost-pocket sites in central Oregon are occupied exclusively by lodgepole pine." Such findings "help forest managers recognize sites that should be devoted primarily to culture of lodgepole pine" (USDA FS 1967b). "Furthermore, squirrels and other small mammals cut cones and eat seeds," and seedlings and saplings are subject to vegetation competition and mammal depredation. Mortality that results from suppression and insect infestation is a function of stand density (Dahms and Barrett 1975).

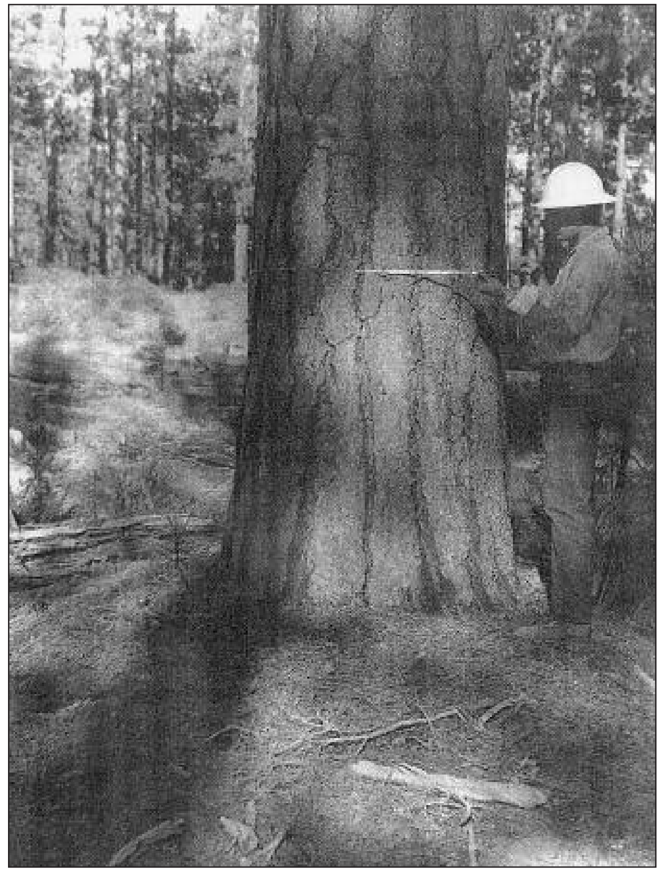
Dahms' studies of lodgepole pine growth and yield—aimed at minimizing mountain pine beetle mortality and maximizing useful wood production—evolved from the thinning experiments initiated by Kolbe on the Pringle Falls Experimental Forest in 1934. The inquiry continued with levels-of-growing-stock studies installed on the Deschutes National Forest near Twin Lakes in 1959 and Snow Creek in 1962. The most recent report issued on these latter studies was published in 2000, a quarter-century after Dahms retired from the Forest Service, again evidencing the long-term nature of forest research.

Twenty-two years of measurements by Mowat, Barrett, and Dahms of Kolbe's 1934 plots showed that "a 55-year-old, fully stocked, even-aged stand of lodgepole pine . . . responded exceptionally well" to thinning: "diameter growth was stimulated, mortality was reduced, and stems grew more rapidly into merchantable size classes" (Barrett 1961 in Youngblood 1995).

From his spacing and levels-of-growing-stock studies at Twin Lakes and Snow Creek, Dahms recognized that more definitive "information on variation of productivity and mortality with thinning levels is necessary to properly manage lodgepole pine stands. . . . The objective of these studies . . . [was] to compare mortality, growth-growing-stock relations, tree size development, and cumulative wood production under various regimes" on two representative central Oregon sites. He chose a highly productive 60-acre Twin Lakes stand "composed mostly of lodgepole pine" and a "pure, 40-acre lodgepole pine stand" of average productivity at Snow Creek (Cochran and Dahms 2000). Plots in these natural lodgepole pine stands were repeatedly thinned to one of five growing-stock levels (GSLs) and measured at 5-year intervals. As early as 1971, Dahms could report that results from the Twin Lakes study showed that individual trees developed larger crowns, grew more rapidly, and added more wood to potentially merchantable trees at lower stand densities. At the same time, total wood production as well as evapotranspiration drain on soil moisture was less (Dahms 1971). By 2000, Cochran and Dahms had identified stand densities attainable through "early spacing control coupled with later commercial thinnings" that "should reduce mortality [from mountain pine beetles and other causes] considerably, allow most of the wood produced to be captured by merchantable trees," and result in stands healthier than unmanaged stands of the same age that they found "relatively short lived in part because of [stand density]-tree size-pine beetle relations." Also, "[t]hese stands would be more pleasing visually, certain species of wildlife may benefit, and stand rotation ages may be longer" (Cochran and Dahms 2000).

Dahms' post-retirement production of LPSIM, a simulator of growth and yield of lodgepole pine stands used by silviculturists throughout central and eastern Oregon and Washington, further shows the long-term nature of forest research. It was not until after his 1976 retirement that availability of the microcomputer allowed Dahms to bring together information from decades of research to produce this model. Working as a volunteer, Dahms contributed hundreds of hours to this accomplishment, and was honored in 1985 with a certificate of achievement from Chief of the Forest Service R. Max Peterson (USDA FS 1985a). This growth-simulation model, "constructed by combining data from temporary and permanent sample plots . . . is similar to a conventional yield table with the added capacity for dealing with the standard-density variable." Published in 1983, the "simulator runs on a desk-top computer" and "provides foresters with the capacity to 'grow' lodgepole pine stands starting at three different initial spacings and with different stand-density regimes" (Dahms 1983).

Jokingly echoing Munger, Dahm's colleagues used to call the lodgepole pine "Walt's weed" (Martin 2000). As a result of Dahm's research, the silviculture of the lodgepole pine, called "the tree of the future" (Hopkins 2003) by ecologist Bill Hopkins, is now well understood.



Scientist Jim Barrett measures the diameter of an old-growth ponderosa pine. During the 1980s, hard hats became more widely used in research work than they had been historically.

Jim Barrett: Ponderosa Pine Silviculture

Jim Barrett, who joined the Deschutes Research Center in 1958, inherited from Ed Mowat and Walt Dahms the ponderosa pine research that dominated Forest Service research in central Oregon and defined his career for more than three decades. "The first thing they did was put me in charge of the Pringle Falls Experimental Forest," Barrett recalled, "and I just did everything down there: opened it in the spring, put it away in the fall, and looked after people who came down there . . . just like Ed and Walt did before I came" (Barrett 1999). He also continued the experimental forest's development. Roads were part of that job.

Another of Barrett's initial tasks was to help Mowat complete the Ponderosa Pine Methods of Cutting study begun on plots 30 to 36 of the Pringle Butte Unit in 1937. Barrett collected the field data, "and Ed worked it up" and published the findings in 1961 (Mowat 1961). "This work pointed out several principles for ponderosa pine management, including methods for increasing stand growth by releasing young trees from overstory and side competition," Barrett summarized (Barrett 2003). "I think that's the last thing Ed Mowat published," he mused in 1999 (Barrett 1999).

Even as he managed the experimental forest and assisted with other studies, Barrett planned and installed three long-term ponderosa pine studies—a spacing study and a mistletoe-tree spacing study on the Pringle Butte Unit and a levels-of-growing-stock study on the Lookout Mountain Unit—that spanned his career.

The spacing study on the Pringle Butte Unit was established to determine the best spacing of ponderosa pine for maximum wood production and to determine the influence of shrubs and herbaceous undergrowth on tree growth at different spacings. Barrett located a 160-acre stand "of old-growth ponderosa pine with an average of 20 trees per acre, a mean tree diameter of 25.6 inches, and an understory of 40- to 70-year-old suppressed ponderosa pine saplings. Average diameter of the understory trees was 1.0 inch, average height was 8 feet, and average density was 6,998 stems/acre." The undergrowth in this stand was mostly antelope bitterbrush, greenleaf manzanita, snowbrush ceanothus, and scattered grasses. To follow and compare the development of suppressed ponderosa pine saplings after overstory removal and thinning, thirty 0.192-acre plots were installed across the 160-acre site. "Six replications of five tree spacings were randomly assigned: 6.6 feet (1,000 trees per acre [TPA]), 9.3 feet (500 TPA), 13.2 feet (250 TPA), 18.7 feet (125 TPA), and 26.4 feet (62.5 TPA). Plot layout and treatment assignment were completed before overstory removal" (Cochran and Barrett 1999b).

Barrett considered "logging about four million [board] feet of ponderosa pine [overstory] in order to put the understory into a study . . . kind of a ticklish logging operation." The trick, of course, was to "get all those logs off without destroying the understory so we could thin it out to [the] different spacings" called for by the study plan. "And so we had to write up a special logging contract." Forester Bernard G. "Barney" Duberow of the Deschutes National Forest helped Barrett prepare the sale contract, and the Tite Knot Pine Mill in Redmond bought the sale (Barrett 1999).

Bend Ranger District foresters helped install the study. "If it hadn't been for Barney, I'd have really been in trouble," Barrett said.

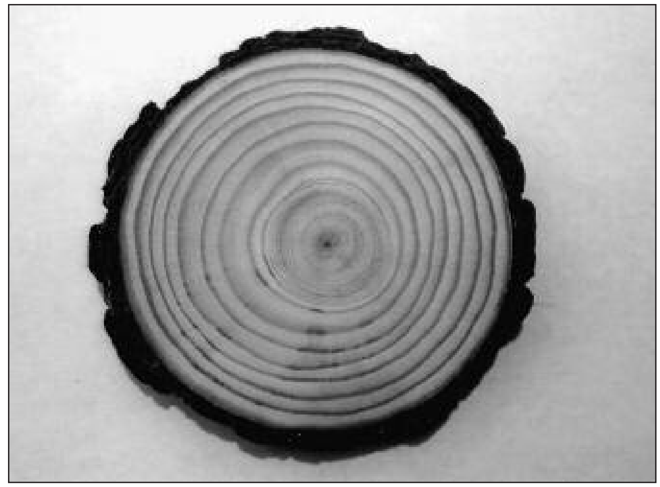
> He was really interested in what I was doing, trying to fall all those trees in a particular direction to preserve those plots. I marked all those trees for directional falling. Had arrows on 'em. That was sort of amusing. Some of those loggers would walk up to those trees, and the profanity that came out of 'em! "Who marked that? This is crazy!" I went to John Munier, bull buck for Barclay Logging, [who responded] "Well, it's going to be very difficult to fell some of those trees that way." And I said: "Well, why not climb 'em and put a choker on 'em and pull 'em over?" He thought about that for a whole day, then he said: "Well, we haven't got a climber." And I said: "Well, I'll climb 'em." I had done quite a bit, when I was back in Iowa. So they got me a climbing rig, and I took those chokers up there and tied 'em up about 32 feet. Then they got a big long winch line . . . and we pulled 'em over [Barrett 1999].

"Jim worked with those [loggers] and got them interested in it so that they did just a heck of a good job getting that study installed," colleague Walt Dahms recalled in 1999. "Could easily have wound up with all the trees banged up and . . . nothing left" (Dahms 1999) for the study. And so it was that Barrett supervised the logging operation as well as the study installation. After the overstory was removed in 1957, the residual ponderosa pine saplings were thinned to the specified spacings in 1958.

> All logging and thinning slash was removed from the plots and burned. All understory vegetation was removed by herbicides or mechanical means in the spring of 1960 and at successive 3- to 4-year intervals on three replications per tree spacing, randomly

Jim Barrett

In this spacing study, overstory ponderosa pines were felled in December 1957 with damage minimized to saplings in the stand. The residual saplings were thinned to study specifications in 1958.



Les Joslin

Jim Barrett's ponderosa pine spacing study showed "that even though the saplings were long-suppressed, response in diameter growth to thinning was immediate." He provided cross sections such as the one shown here as evidence to all who were interested.

Jim Barrett

In the second step of the spacing study started in 1957, a cutter used a chainsaw with a thinning attachment to thin residual ponderosa pine saplings to specified spacings.

> chosen in spring 1959, and allowed to develop naturally on the three remaining replications [Cochran and Barrett 1999b].

As he installed this study, Barrett "demonstrated that it is possible, by careful overstory removal, to save large numbers of understory saplings" (Barrett 1960, Cochran and Barrett 1999b). He concluded that these procedures—which included identification of skid trails before logging, directional falling, and the use of central landings—helped "ensure survival of the advance regeneration, thereby reducing the time to rotation age by 20 to 50 years because fill-in planting is not necessary" (Barrett et al. 1976 in Youngblood 1995). Barrett's interest in logging to save ponderosa pine regeneration was reflected in a 1973 case study of logging procedures that "if applied operationally, would cost less than regeneration efforts involving a clearcut harvest, site preparation, and replanting" (Barrett et al. 1976 in Youngblood 1995).

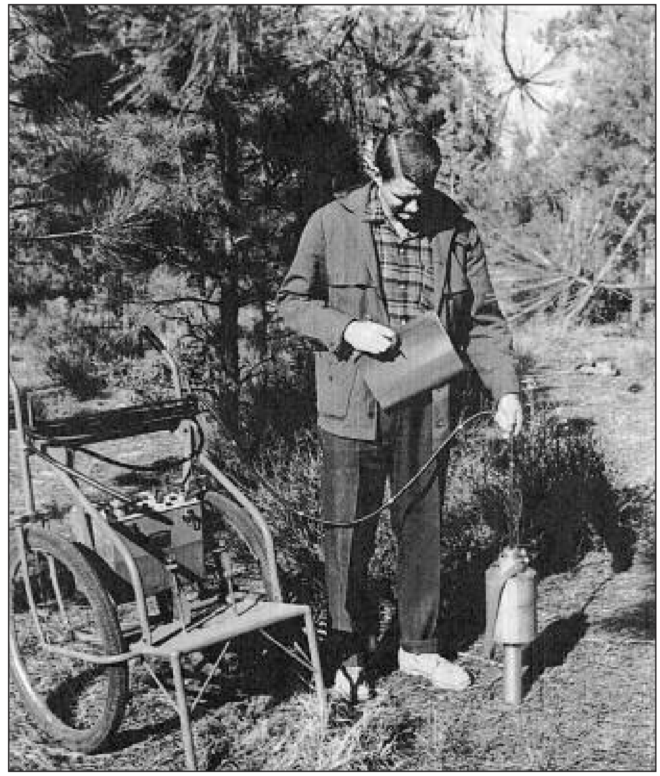
Cochran and Barrett summarized the previously published 1960 to 1994 results of this ponderosa pine spacing study in a 1999 research paper. In terms of the original timber production questions asked,

> Barrett (1965) found that even though the saplings were long suppressed, response in diameter growth to thinning was immediate. Height growth also responded to thinning, although [this] response took as long as 4 years after thinning to develop (Barrett 1970). Removal of competing understory grasses, forbs, and shrubs resulted in decreased water removal from the soil profile during the growing season and increased tree growth early in the study (Barrett 1965, 1970; Barrett and Youngberg 1965).

> Increased spacing resulted in increased [individual] tree growth and decreased stand [volume] growth (Barrett 1965, 1970, 1973, 1982) [Cochran and Barrett 1999b].

Once the trees were "off to a good start, we let the [understory] vegetation grow and furnish the necessary nutrients" that promote tree growth, Barrett explained (Barrett 2003). This proved a complicated but successful tradeoff. "[T]he 35-year absence of understory grasses, forbs, and shrubs produced changes in soil quality . . . (Busse and others 1996)" that slowed tree growth.

> During the last 15 years (1980–94), these differences in stand growth rates between understory vegetation treatments disappeared (Busse and others 1996). . . Initial increases in tree growth in the absence of understory vegetation were attributed to greater soil water availability. Subsequent changes in soil nutrient content and availability counterbalanced differences in water availability and potentially contributed to similar rates of tree growth at comparable densities during the last 15 years of measurement (Busse and others 1996) [Cochran and Barrett 1999b].



Jim Barrett uses the neutron probe to measure soil moisture content. The new device turned out to have limited use in forest research.

Another interesting aspect of Barrett's ponderosa pine spacing studies resulted from an Oregon State University professor's interest in the effects of tree spacing and understory vegetation on water use in pumice soils. In pursuit of this interest, soil scientist Dr. Chester T. Youngberg acquired what Barrett called "some really expensive instruments to measure . . . water use . . . in those different spacings" (Barrett 1999). One of these was a neutron probe that combined barium and radium to produce high-speed neutrons shot out of a tube sunk into the ground at desired depths. As reported in a contemporary newspaper account: "Neutrons are slowed as they strike hydrogen atoms in the soil's moisture. By bouncing off hydrogen atoms, some of the neutrons find their way back to the probe device. The speed and number are recorded and scientists can figure the amount of moisture at the given depth" (Stone, n.d.). Barrett, who "took a whole year of electronics courses [at Central Oregon Community College] so I could keep the instrument running," was not especially impressed with the results. Nor was Cochran, who took a lot of the measurements. "After we got further along," Barrett explained,

> we realized that this really wasn't as important as we thought, and the most important thing was how these stands were growing and responding to treatment in volume and height growth and diameter growth and that sort of thing. So [the neutron probe] kind of dropped out of the picture. I spent a lot of time on that without much reward [Barrett 1999].

Barrett's dwarf mistletoe spacing study brought him into contact with Oregon State College plant pathologist Dr. Lew Roth. "Lew and I became very good friends," Barrett recalled in 1999.

> I did a lot of my graduate work in pathology, and these disease people sort of hang together. We both

> got interested in mistletoe on Pringle Butte. Lew was interested in it long before I came. We got the idea that, if we thinned those [dwarf mistletoe infested] trees out . . . spaced those trees out . . . maybe we could outgrow that mistletoe . . . grow a usable tree . . . cut it as a small log . . . and still get something out of the land [Barrett 1999].

In 1985, 3 years after he had retired, Barrett and Roth, who had retired from Oregon State University in 1979, co-authored two research papers on the response of dwarf mistletoe-infested ponderosa pine to thinning (Roth and Barrett 1985). Both studies, based on three decades of data, found that some sapling-sized ponderosa pine released through thinning could accelerate growth and virtually "outgrow that mistletoe" that "remained largely limited to lower portions of tree crowns." It was a friendly, if not easy, collaboration. "When we were writing those two papers on thinning mistletoe trees, I got to the point where I called Lew up and said, hey, we've got to get this stuff published. And he and his wife came over and stayed at our place for a whole week, and we just sat there and ground [those] two papers out" (Barrett 1999).

Barrett's ponderosa pine studies weren't limited to the Pringle Falls Experimental Forest. "There was a big push on to put [spacing] studies all over the Pacific Northwest, so we put some in up in Washington, some in eastern Oregon," Barrett (1999) recalled. In 1959, Barrett "established a combination pine spacing-growth increment and forage production study in cooperation with the Washington Department of Game [in the Methow Valley on the] Okanogan National Forest to provide some guidelines for managing these areas" (USDA FS 1962). Barrett reported 20-year results of this study in 1981 (Barrett 1981) and Cochran and Barrett reported 35-year results in 1998 (Cochran and Barrett 1998).

"One of the reasons I wanted to open that Lookout Mountain Unit up was . . . it had a young stand of poles up there. . .where I could put in a levels-of-growing-stock study" (Barrett 1999). The study Barrett installed on the Lookout Mountain Unit in 1968 was one of six initiated in the West to determine optimum growing-stock levels in even-aged ponderosa pine. In addition to the central Oregon study, there were another in Oregon, two in the Black Hills of South Dakota, one in northern Arizona, and one in a plantation on the western slope of the Sierra Nevada in California.

Implementing a common study plan, "each installation evaluated growth response to thinning in stand sizes growing on site qualities common to each region" (Barrett 1983). "Each installation [was] scheduled to run for at least 20 years, with measurements at 5-year intervals and thinning at 10-year intervals, if appropriate" (Barrett 1999). Some of the most productive ponderosa pine stands in central Oregon were composed of densely stocked pole-size trees, and thinning to appropriate stocking levels could improve production of marketable wood and reduce mortality caused by mountain pine beetle attack. Barrett tested six growing-stock levels (GSLs) ranging from basal areas of 30 to 150 square feet per acre. He published the 15-year results of the Lookout Mountain study in 1983. "Timber stands in the midrange levels (GSL 80–100 square feet)," this study concluded, "grew reasonable amounts of wood without serious beetle attack" (Barrett 1983). An associated study agreed that maintaining ponderosa pine stand vigor through thinning reduced the risk of mountain pine beetle attacks (Larsson et al. 1983).

During the mid-1960s, Barrett completed other ponderosa pine studies. In 1966, his *A Record of Ponderosa Pine Seed Flight* addressed the question: What is the best way to clearcut ponderosa pine to ensure natural regeneration? Analysis of wind-disseminated seed fall measured in 1958 on a Pringle Butte Unit tract on which the overstory had been completely removed found that "ponderosa pine seed does not disseminate naturally over extensive areas" (Barrett 1966). Thus: "To ensure adequate stocking from natural regeneration, clearcuts consisting of small patches or narrow strips less than 100 meters wide, orientated at right angles to the prevailing winds, are recommended" (Youngblood 1995). The seed flight information resulting from this study, directly applicable to central Oregon ponderosa pine management, may prove useful elsewhere to determine how natural seed fall can be used in combination with other cultural measures to promote prompt restocking of ponderosa pine stands (Barrett 1966).

A related study of the size and frequency of ponderosa pine and lodgepole pine seed crops, which Barrett coauthored with Dahms in 1975 (Dahms and Barrett 1975), summarized 22 years of monitoring begun by Mowat and reported by Dahms in 1963 (Dahms 1963) and Barrett in 1966 (Barrett 1966). This study showed that "size and frequency of seed crops produced by ponderosa and lodgepole pines contrast sharply," with lodgepole pines producing larger and more frequent seed crops than ponderosa pines.

> Selection of trees to save as a seed source in a shelterwood type cut should logically follow nature's scheme. The largest, most vigorous, full-crowned dominants are the best genetic base for the next crop; and at the same time they are the best seed producers. . . . Consequently, if a reasonable shelterwood consisting of the largest, most vigorous trees is retained, the bulk of the stand's seed producing capacity will also be retained in either ponderosa or lodgepole pine stands [Dahms and Barrett 1975].

In 1968, Barrett's *Pruning of Ponderosa Pine . . . Effect on Growth* updated Dahm's 1954 results of Mowat's 1941 differential pruning study on the Lookout Mountain Unit with recommendations based on 1966 measurements and results of a similar study in California that "should be used to sharpen up or modify existing ponderosa pine pruning practices" (Barrett 1968). Barrett devised a response surface diagram to help foresters make pruning choices based on variable diameter-growth results of removing various lengths of ponderosa pine crowns. Almost a quarter-century later, Fight et al. (1992) explored the economic efficacy of such labor-intensive silvicultural treatments.

In 1978, Barrett published *Height Growth and Site Index Curves for Managed, Even-Aged Stands of Ponderosa Pine in the Pacific Northwest* east of the Cascade Range in Oregon and Washington "derived from stem analysis data for 27 plots in Oregon and 3 plots in Washington" (Barrett 1978). The destructive sampling on these plots, Barrett recalled, involved "a lot of disks and a lot of grunts. . . . The curves are most appropriate for use in constructing yield tables for managed, even-aged stands of ponderosa pine" (Barrett 2003).

In December 1979, the Station published Barrett's *Silviculture of Ponderosa Pine in the Pacific Northwest: The State of Our Knowledge* as a reference for forest managers (Barrett 1979). Although much of the ponderosa pine research cited in this publication came from throughout the Pacific Northwest, a notable portion derived from experiments and observations at the Bend Silviculture Laboratory and the Pringle Falls Experimental Forest. Indeed, in addition to Barrett, the names of central Oregon researchers—especially Cochran, Dahms, Dealy, Hopkins, Keen, Martin, Meyer, Mowat, Roth, Charles Sartwell, and Sowder—dominate the bibliography.

Significantly, and characteristically, Barrett approached a key silvicultural and management controversy in a constructive manner.

> Rather than professing that even- or uneven-aged management is best for ponderosa pine, we should keep in mind that both methods can be used successfully . . . because environmental constraints often urge managers of public lands into the uneven-aged regime although even-aged is often easier to implement. Actually, no well-documented research in the region shows one form to be superior over the other, but mature or larger trees have been shown (Barrett 1969) to exert a significant effect on smaller understory trees in both height and diameter growth. This seems to indicate that uneven-aged pine forests will need to be managed with low density to permit younger or smaller trees, which ultimately replace the larger ones, to grow at a reasonable rate. Uneven-aged management cannot be assumed an easy and inexpensive resolution to all other resource conflicts within the pine forests. To be successful, it will require expertise by the silviculturist and possibly expensive stocking-level

> control throughout all size classes of the structure visualized.
>
> The reason that some stands are maintained in uneven-aged management is simply that the lands came that way. An abrupt change to an even-aged regime . . . would require cutting too many small, young trees prematurely. Similarly, many public forests were acquired through land exchanges with private lumber companies after the merchantable or high-value trees were harvested. The emerging forests were often even aged. Therefore, the management regime on much of the land was decided many years ago by economics, fire, or other natural events.
>
> On public lands, the extent of even-aged management is often limited by environmental constraints. On industrial lands, most ponderosa pine acreages are being converted to even-aged stands and intensively managed for the highest possible yields [Barrett 1979].

After reviewing what was then known of ponderosa pine silviculture in a way useful to forest managers, Barrett commented on the state of that knowledge and set a course for future research of the species in terms of multiple-use management in a way that anticipated ecosystem management.

> A large portion of silvicultural and management research in ponderosa pine forests has concentrated on regeneration, growth, stand development, and final harvest. Our knowledge has expanded tremendously in these areas. Little, however, has been done to show how different silvicultural systems contribute to or detract from various multiple-use objectives. . . . This knowledge needs to be brought together . . . for land managers so they may estimate the full impact of tradeoffs where one resource may be emphasized over another.
>
> Throughout the West is a glaring lack of replicated silvicultural systems trials in various major habitats of the ponderosa pine type. These could be benchmark studies that would serve pine managers for many future rotations. Many disciplines—such as management of watersheds, range, wildlife, timber, landscape, logging, fuels, and prescribed burning—could be included in the undertaking. In addition to providing new information, studies of this kind will help to validate present-day predictions in a multitude of disciplines. Also, they would provide excellent ground for communicating with the public on management of renewable resources [Barrett 1979].

Barrett singled out "drastic changes in the forest brought about by human activity" and "updating yield tables for managed stands of ponderosa pine" as particularly important. With regard to the former, he stressed that "conversion by fire control of 25 percent of the commercial forest land east of the Cascades to mixed conifer or some single species is an alarming prospect to some insect ecologists" that "needs to be critically examined so we do not create breeding habitat for an undesirable insect." With regard to the latter, he noted that forthcoming "yield tables for managed stands of ponderosa pine . . . will be based on limited data and will need updating as growth information becomes available. Even though a change in research emphasis occurs," he concluded, ". . . spacing and levels-of-growing-stock studies, established in the 1950s, can continue to improve our yield estimates" and "should be periodically measured, maintained, and reported for several decades" (Barrett 1979).

"Ponderosa pine stands in the Pacific Northwest grow under such varied conditions," Barrett concluded, "that solving silvicultural problems in this region is a never-ending process that will continue to challenge the ingenuity of foresters" (Barrett 1979).

Barrett continued solving silvicultural problems in ponderosa pine for the remainder of his career. He continued to monitor and measure the Pringle Butte Unit thinning and the Lookout Mountain Unit levels-of-growing-stock studies installed early in his research career, and published results the year he retired (Barrett 1982) and the following year (Barrett 1983).

Jim Barrett explained the ponderosa pine spacing study he installed at Pringle Falls Experimental Forest in 1957 and 1958 to many groups, including these Bureau of Indian Affairs foresters who visited on May 12, 1966.

Retirement didn't mean the end of Barrett's productivity. In 1987, Barrett and Donald J. DeMars, a mensurationist at the Forestry Sciences Laboratory in Juneau, Alaska, published the *Ponderosa Pine Managed-Yield Simulator: PPSIM Users Guide*. This "complex simulation program . . . that estimates volume growth of natural and managed ponderosa pine in eastern Oregon and Washington" (DeMars and Barrett 1987) resulted from extensive field and laboratory work by both scientists and others. "My technicians and I destructively sampled a lot of tree plots of various densities" (Barrett 2003) for some of the data needed. Other sources of data used "to establish regression equations for the simulation model" included "natural-stand data collected in the 1930s (Meyer 1961)" and "remeasured plot data from stands infested with dwarf mistletoe." The product, PPSIM, was

> an even-aged stand model that calculates the yearly growth of stands, sums yearly growth estimates to obtain total yield for each year, and reports yield totals per acre for specified report ages. . . . The model allows a user to simulate commercial thinnings, simulate applications of fertilizer, adjust growth (either positive or negative), estimate impact of dwarf mistletoe . . . on volume growth, and vary rotation length [DeMars and Barrett 1987].

"I published five publications after I retired, on my own. I did it through the PNW Station," Barrett recalled. Then [retired Bend Silviculture Laboratory principal research soil scientist] Pat Cochran started in and we co-authored a bunch of them. But he did the majority of the work. He'd get the paper pretty well along and give it to me, I'd go over it and suggest a few things and give it back to him. . . . He was in an ideal situation to take over where I left off" (Barrett 1999).

In addition to publishing research results, Barrett was one of several Bend Silviculture Laboratory scientists who passed on what he had learned to agency and industry forest managers and university students during "show me" trips and classes conducted at the Pringle Falls Experimental Forest and other field sites. Barrett explained how he

> talked to a group of Oregon State University forestry students down at Pringle Falls every year, and it seemed like I always had trouble getting their attention. How do I wake these guys up? So I found and destructively sampled a plot that grew about 120 trees per acre for 50 years, and cut a fifth-acre

> plot and took those samples. Then I went to another plot that had 500 trees per acres, and took more samples. Then I laid all these breast-high diameter disks from [plots of] several different densities out on a table. And, of course, where I had fewer trees [per acre] I had rings that were wide, and as I got closer and closer spacing I got narrower and narrower rings and small diameter trees. And I said: "There it is. Right there. That's what's going to happen." They actually got interested. Lew Roth came up to me afterward and said: "My gosh, you finally reached those guys!" [Barrett 1999].

One show-me trip appeared to Barrett to have had far-reaching consequences. As Barrett told it:

> Pat [Cochran] overheard [Brooks-Scanolon executive Mike] Hollern say one day when we got back from a field trip looking at . . . insects and disease and mistletoe and root rot and all those other things that can happen . . . "I don't think we want to be in this business." Just like that. My gosh, it wasn't long before he wasn't! [Barrett 1999].

Brooks-Scanlon merged with Diamond International in June 1980 and ceased to exist as an independent corporation. A subsidiary and successor, Brooks Resources Corporation, became central Oregon's leading real estate developer.[1]

Ken Seidel: Upper Slope Mixed-Conifer Silviculture

Dr. Ken Seidel joined the Bend Silviculture Laboratory research staff in 1969. A forester with a background in Forest Service research in Kentucky and Missouri and a Ph.D. degree in tree physiology from the University of Missouri, he was assigned responsibility for upper slope mixed-conifer silviculture. That category comprised all the "interior conifer type" species "that grow at the higher elevations above the ponderosa pine zone" (Seidel 2002). Seidel's early work based at the Bend laboratory coincided with the Experiment Station's growing realization that "Management of upper-slope tree species is becoming increasingly important" and recognition that "regeneration is a special problem in these high-elevation timber types" (USDA FS 1975). Seidel spent almost 20 years, until he retired in 1988, studying natural regeneration of and conducting thinning, growth and yield, and levels-of-growing-stock studies among firs, hemlocks, and larches.

Dr. Ken Seidel accepted the research problem of upper-slope mixed-conifer silviculture. This photo was taken at a 1976 open house at the Bend Silviculture Laboratory.

The upper slope mixed-conifer forests of eastern Oregon and Washington are some of the region's more productive forests, and additional information on the growth and yield of managed stands was needed. True firs are an important component of these forests. In 1970, Seidel began a study in a 43-year-old, suppressed, even-aged stand of advanced grand fir and Shasta red fir regeneration on the Lookout Mountain Unit of the Pringle Falls Experimental Forest to obtain data on the growth of these species at several spacings and under a progressive thinning regime. After the

[1] When asked in August 2004 about Barrett's recollection, Brooks Resources Corporation board chairman Mike Hollern replied: "I have no recollection of saying that, though it is certainly possible. If I said it, it would have been in jest. Insects, disease, mistletoe, and root rot had no bearing on our decision to merge with Diamond." In a June 1999 oral history interview, Pat Cochran confirmed Barrett's account of the event with somewhat different details. At the last stop of the show-me trip, Cochran recalled, "I happened to walk near a group of Brooks-Scanlon people from Minneapolis . . . talking among themselves, and they said 'You know, there's just a lot of risk in trying to manage these forests.' And shortly after that, Brooks-Scanlon sold."

lodgepole pine overstory was killed with herbicides and left intact to prevent logging damage to and to provide partial shade for fir seedlings, seedlings and saplings on 16 small plots were thinned to various spacings. Seedling and sapling growth responded immediately to removal of the overstory, increasing to two to three times the 5-year pre-release rate (Seidel 1977b). Ten years later, Seidel reported:

> Diameter growth during the second and third 5-year periods after release increased significantly over that of the first 5 years. Differences in spacing had no effect on diameter growth during the first 5 years, but growth at the wider spacings increased considerably during the second and third periods. Increased growth after release suggested that saving true fir advance reproduction can be a desirable option [Youngblood 1995].

These study results provided forest managers an estimate of the growth rates they could expect after suppressed true fir sapling stands are released from overstory competition and thinned to various spacings. They also helped foresters decide whether to save advanced reproduction or to clearcut and plant and, if they decide on the former, to plan use of logging methods and slash disposal techniques that minimize damage to the understory.

Because temperature also affects regeneration, Seidel reported in *Northwest Science* in 1974 on results of Bend Silviculture Laboratory “tests to determine the time-freezing relations causing mortality in 1-week-old (unhardened) and 6-month-old (hardened) grand fir seedlings. . . Seeds from Pringle Falls Experimental Forest were collected and germinated, and seedlings were potted and grown in a greenhouse” (Seidel 1974). Various exposures of these seedlings, including exposure to freezing temperatures in a refrigerated growth chamber, showed that “[a]lthough unhardened seedlings may easily be killed by a combination of temperature and duration of exposure immediately after germination, lethal temperatures for hardened seedlings are rarely met in the field” (Youngblood 1995).

In another study of seedling establishment and survival in grand fir and mountain hemlock, Seidel and R. Cooley found that mortality of both species was heavy in a shelterwood cut: 71 percent of the fir and 90 percent of the hemlock died. Regeneration success depended on the number of trees left in the shelterwood. As stand density increased, more seedlings of both species were established and survival of fir improved” (USDA FS 1975).

Seidel occasionally studied the genus *Pinus.* In 1985, for example, he published the 10-year results of a ponderosa pine-grand fir spacing study on the Lookout Mountain Unit that yielded data about growth rates in pure and mixed stands of those species (Seidel 1985b). In 1986, he published results of a study that tested the tolerance of ponderosa pine, Douglas-fir, grand fir, and Engelmann spruce for high temperatures (Seidel 1986). The results “could be used with data on soil surface temperature obtained in regeneration units to better evaluate causes of seed mortality” (Youngblood 1995). In 1989, he published 20-year “results of a study comparing productivity of pure and mixed stands of ponderosa and lodgepole pine at several spacings” that provided “information on tradeoffs between diameter growth and volume yields at various stand densities” (Youngblood 1995).

As did his colleagues, Seidel pursued research projects throughout eastern Oregon and Washington. His research of regeneration after clearcutting and shelterwood cuttings in upper slope mixed-conifer types took him to national forests throughout the region.

His survey of clearcuts in mixed-conifer forests of the Cascade Range and Blue Mountains of eastern Oregon was “made to obtain an overview of reforestation status and to identify key environmental factors influencing regeneration establishment.” Conducted on “plots [that] were randomly located in clearcuts harvested during the 1953–1973 period” in several plant communities, the survey

> showed that, on the average, clearcuts were adequately reforested with a mixture of advance, natural, and planted reproduction. Planted ponderosa pine dominated clearcuts at elevations of less than 5,300 feet; and at higher elevations in the Cascades, considerable amounts of true fir and

> mountain hemlock advance reproduction were present. Seedling establishment was better on more northerly aspects while increasing amounts of grass had a negative effect on stocking (Seidel 1979b).

Seidel's special interest in shelterwood regeneration reflected in a 1979 paper.

> A survey of shelterwood cuttings in mixed conifer forests [on randomly-located plots on Deschutes and Winema national forest shelterwood units harvested during the 1970–1973 period] showed that, on the average, shelterwood units were well stocked with a mixture of advance, natural subsequent, and planted reproduction of a number of species. Because of slow invasion by understory vegetation, frequent heavy seed crops, and adequate density of the overstory, natural regeneration was prolific on most units. Planting was recommended only as a supplemental reforestation method. Greater stocking was associated with increasing overstory density and more exposed mineral soil; and such factors as aspect, slope, and elevation had a positive or negative relationship to stocking depending on the species and plant community [Seidel 1979c].

In 1978, Seidel measured a study begun in 1973 on the Crescent Ranger District of the Deschutes National Forest "to obtain information about natural regeneration using the shelterwood system in an old-growth mixed-conifer stand. The aim was to determine the effects of several residual overstory density levels and several slash treatments on establishment and growth of the regeneration." He found that "natural regeneration [comprising about 85 percent true fir (grand fir and Shasta red fir) and 15 percent ponderosa, lodgepole, and western white pine] was good to excellent 5 years after shelterwood cutting to three overstory densities." He determined "a residual overstory. . .adequate to provide natural regeneration within a 5-year period" (Seidel 1979a).

Seidel conducted a similar regeneration survey in mixed-conifer and Douglas-fir shelterwood cuttings on the Naches Ranger District of the Wenatchee National Forest and the Mount Adams Ranger District of the Gifford Pinchot National Forest, respectively, in 1981. This survey "showed that, on the average,

> shelterwood units were adequately stocked with a mixture of advance, natural postharvest, and planted reproduction of a number of species. Shelterwood cuttings in the Douglas-fir type had abundant regeneration, whereas those in the mixed conifer type had generally adequate stocking but fewer seedlings. Much of the understocking appeared to be related to a non-uniform overstory, lack of advance reproduction, or high elevation (Seidel 1983).

Seidel teamed with other researchers in a study begun in 1974 "on the Starkey Experimental Forest and Range in eastern Oregon . . . about the effects of grass seeding, grazing, and the shelterwood system on natural regeneration and growth, tree seed production, and seedbed condition in old-growth mixed conifer stands." After 6 years, the study showed that "natural regeneration was abundant, regardless of grazing and grass seeding treatments, after shelterwood cuttings to three overstory densities" (Seidel et al. 1990) and contributed useful management parameters.

In 1983, Seidel and S. Conrad Head of Eastern Oregon State College (now Eastern Oregon University) in La Grande published results of a survey that

> showed that, on the average, partial cuts in the grand fir [stands] were well stocked with a mixture of advance, natural postharvest, and planted reproduction of a number of species. Partial cuts in the mixed conifer [stands] had considerably fewer seedlings; some plots were understocked. Much of the understocking appeared to be related to low and irregular overstory density, lack of advance reproduction, reproduction destroyed by logging, and heavy grass cover [Seidel and Head 1983].

Seidel also studied the response of mixed-conifer reproduction to release by overstory removal. He began a study on the Ochoco National Forest in 1974 "to compare height growth before and after release, to compare diameter and height growth for several periods after release, and to develop an equation to predict diameter and height growth after release as a function of variables, such as live crown ratio, and initial height." Results published in 1980 indicated that "The best potential crop trees are vigorous advance reproduction having live crown ratios greater than 50 percent and those with the greatest height growth before release" (Seidel 1980).

Seidel conducted a similar study in clearcut and shelterwood units and uncut stands in upper slope mixed-conifer communities on the Deschutes and Winema National Forests in 1983 and 1984 "to obtain information about the diameter and height growth response of suppressed advance reproduction of grand fir, Shasta red fir, and mountain hemlock (*Tsuga mertensiana*) after release by removal of the overstory." This study showed that "Postrelease growth was greatest in clearcuttings, intermediate in shelterwood cuttings, and slowest in uncut stands." As in the case of the previous study, "Vigorous advance reproduction having live crown ratios greater than 50 percent are the best candidates for crop trees" (Seidel 1985a).

Teamed with entomologist Boyd Wickman and statistical assistant-technician Lynn Starr, both of the Forestry Sciences Laboratory in La Grande, Seidel helped survey "natural regeneration 10 years after severe grand fir mortality caused by an outbreak of Douglas-fir tussock moth (*Orgyia pseudotsugata*) . . . in the Wenaha-Tucannon Wilderness in the Blue Mountains of northeastern Oregon." The study concluded that, as a result of "past and present management regimes for this area, the pattern of gradual stand dominance by grand fir is the result of natural succession and lack of ground fires. . . . Within a hundred years," as a result of "past and present management regimes," they predicted that "history will probably repeat itself with a severe tussock moth outbreak that again reduces the grand fir component of the stand" (Wickman et al. 1986).

In 1977, Seidel assumed responsibility for a levels-of-growing-stock study installed in a 33-year-old even-aged western larch stand on the Union Ranger District of the Wallowa-Whitman National Forest "for the purpose of providing basic growth and yield information over a wide range of stocking levels" (Seidel 1977a). Seidel reported results after 20 years in 1987 (Seidel 1987) and, after his retirement, teamed with Pat Cochran to report results after 30 years in 1999 (see pages 75–76).

Bob Martin and Joan Landsberg: Fire and Silviculture

Dr. Bob Martin was a University of Michigan forester with an uncommon academic and research background in—and passion for—fire ecology. As the Forest Service's fire policy changed from fire control to fire management, he spent 7 1/2 years between 1975 and 1982 at the Bend Silviculture Laboratory focused on the job Experiment Station Director Bob Buckman sent him to do: "start prescribed burning research" (Steen 1994). He also replaced soon-to-retire Walt Dahms as project leader.

As a graduate student, Martin had worked for the Forest Service at its Southeastern Forest Experiment Station's Southern Fire Laboratory in Macon, Georgia, "where I picked up my skills in prescribed burning." Between earning a Ph.D. at Ann Arbor in 1963 and arriving in Bend in 1975, he had taught wood technology and fire management at Virginia Polytechnic Institute. After he "found that wood technology was not as exciting as fire," Martin moved to Seattle where he trained fire researchers in a cooperative Forest Service unit at the University of Washington for 4 years.

Martin's approach to fire ecology research and to "getting prescribed burning going" in central Oregon reflected his college teaching background minus its "publish or perish" syndrome: As he explained it:

> I told [the Experiment Station] in Portland, if you want me to help people do prescribed burning, I'm not going to get a lot of research publications out, because we'll be teaching people to do burning, and they'll come up with questions, and we'll try to answer those. . . . But, to start with, if they wanted prescribed burning, I'd be short on publications. That's what I did, and they bought it. So we did a lot of teaching. In fact, I had a lot more contact hours teaching [prescribed burning at the Bend

> Silviculture Laboratory and Pringle Falls Experimental Forest] than when I was at the university.

Martin had teamed with John Dell, the fuels manager for the Pacific Northwest Region who shared his interest, and "we started with a bunch of prescribed burning workshops," he recalled in 2000.

> We were running one or two a year. I preferred to run them [in Bend rather than in Portland], because at Pringle Falls [Experimental Forest] and on the Deschutes [National Forest] we could go from permanent snowfields to desert within thirty miles. Every time we had workshops, which were all hands-on workshops, we introduced people to fire ecology and prescribed burning one day, took them out and gave them a demonstration burn the next day, came back in the classroom the next couple days, had them plan some burns. We already had prescriptions for them, but we'd go through the motions of having them plan burns, and then we'd have everybody out there on prescribed burns at the end of the week.

"I preferred to do it here," he reiterated, emphasizing the value of central Oregon research facilities, "because we would always have some high-elevation, medium-elevation, and some very dry understory burn plots available. When we tried to do it elsewhere, usually they'd set up one set of plots and if it were too wet or too dry you couldn't do a good burn. . . . Either you'd do too much damage or it wouldn't burn well" (Martin 2000).

Prescribed burning on national forest lands east of the Cascade Range caught on and took off during those years.

> The first year I was at Bend, I could find only about four or five hundred acres of prescribed understory burning or range burning in eastern Oregon and Washington. Just wasn't that much. For the first couple years [of prescribed burning workshops], I could keep track of how much was done and where it was done, and then I couldn't keep track. I thought, well, we're accomplishing our goal, people are using so much of it I can't keep track of it. I think the last year I was [in Bend] there was somewhere between fifty thousand and one hundred thousand acres of understory burned. So, from 1975 to 1982, we got maybe a hundredfold increase in the amount of prescribed burning being done" [Martin 2000].

Buckman was pleased with Martin's work. "He had a special talent for that work," he told historian Harold K. "Pete" Steen in 1992, "and as a result of that research I am told that eastside Region 6 is burning as much as fifty to sixty thousand acres a year. I think it was the research program . . . in Bend . . . which had a lot to do with the legitimacy of fire research in eastern Oregon" (Steen 1994).

Martin's teaching of prescribed burning research was not limited to workshops. While in Bend, for example, he initiated and encouraged Oregon State University graduate student Joyce Bork's research of fire history in ponderosa pine forests in central Oregon intended "to determine the historic fire return intervals" and "provide reliable data to guide foresters in managing" those forests. This research, conducted on sites of high, intermediate, and low precipitation on Lookout Mountain and Pringle Butte within the Pringle Falls Experimental Forest and near Cabin Lake on the Fort Rock Ranger District of the Deschutes National Forest, respectively, culminated in Bork's 1984 Ph.D. dissertation (Bork 1984). Bork's basic conclusions supported prescribed burning in ponderosa pine forests:

> Whatever the historic frequency of fire was, there is no doubt that it is important to the ponderosa pine forests of eastern Oregon. The new fire management policies must consider the introduction of remedial fires to reduce fuel and danger of catastrophic wildfires. Then decisions can be made to introduce fire at a return interval that best fits forest management goals [Bork 1984].

In the case of the Pringle Falls Experimental Forest, Bork found that fire exclusion had increased the danger of destructive wildfires through excessive fuel buildup even as it had stagnated growth in formerly productive stands. "A wildfire at Pringle Butte with the . . . fuel load . . . accumulated since the late 1890s," she emphasized, "could be catastrophic" (Bork 1984). In 1985, Bork submitted a fire management plan for the 600-acre, ponderosa pine-dominated eastern block of the research natural area on the Pringle Falls Experimental Forest, and recommended similar plans for appropriate ecosystems within central Oregon's congressionally designated wildernesses (Bork 1985).

Jimmy Lee Reaves, an Atlanta University graduate student and Forest Service trainee assigned to the Bend Silviculture Laboratory during Martin's tenure, researched the relationship between prescribed fire and the root fungus *Armillaria mellea* on the Pringle Falls Experimental Forest. The results of his field and laboratory studies were presented in his 1985 doctoral dissertation (Reaves 1985). Results of a subsequent study led by Reaves suggested that judicious use of fire could play a role in controlling *Armillaria* root disease in ponderosa pine forests (Reaves et al. 1990).

In addition to foresters and graduate students, Martin taught the public to accept prescribed burning. Indeed, as soil scientist and colleague Pat Cochran put it, "Bob came here as an evangelist for prescribed burning" (Cochran 1999). Martin, as did Berntsen and Dahms before him, interested the local press in spreading the word. A feature article in Bend's daily newspaper, for example, interpreted Martin's experimental burns at Pringle Falls Experimental Forest in terms of fire's safety and silvicultural benefits. The article got the readers' attention with an explanation of how Martin's research "eventually may help lessen the destruction caused by raging wildfires in eastern Oregon and Washington."

> "In the past we've deliberately protected our forests [from fire], and fuels have built up," said Dave Frewing, a Forest Service technician. "It's becoming more difficult to control wildfires."
>
> By deliberately burning at times when the fire is not likely to run out of control, the amount of undergrowth and dead wood can be reduced without killing many healthy trees. That means when a fire starts accidentally, there is less to keep it going.
>
> The key is determining when a fire will burn hot enough to maintain itself, but not hot enough to kill adult trees. The right combination of conditions, or "prescription" as it is called by researchers, varies for each area. Only through a series of experimental burns under a wide range of conditions can the proper prescription be determined [Boyer n.d.].

After reviewing the scientific monitoring and measurements involved in such experimental burns, the article summarized the other benefits of prescribed burning.

> Lowering the potential for destructive wildfires is far from the only benefit of prescribed burning, said Bob Martin. . . . Regular occurrences of fire, which used to happen naturally, appear to control some types of diseases or parasites such as dwarf mistletoe. . . .
>
> Fires can help control damage by insects. . . . In many instances, the insects are attracted to forest areas where there is a large amount of dead or downed timber. When that is cleared by fire, the insects are less likely to appear.
>
> Fire can conduct a natural thinning operation as well. It removes young trees and undergrowth which would otherwise take nutrients from the soil. Those nutrients become available to the more mature trees, allowing them to grow faster for commercial harvest.
>
> "We have stands of trees that stagnated," Martin said. "Natural fires used to thin these stands and that's where we got these beautiful stands of ponderosa pine" [Boyer, n.d.].

Almost a decade after Martin left the Bend Silviculture Laboratory to teach at the University of California, a combination of mechanical thinning and prescribed burning was used to mimic the natural fires responsible for those "beautiful stands of ponderosa pine" on a Pringle Falls Experimental Forest demonstration plot. Reporter Tim Preso explained this use of fire to the public in a 1990 article in *The Bulletin* on "Re-creating a forest" of "the open, park-like character that the first frontiersman found.

Les Joslin

Les Joslin

This interpretive sign at the Pringle Falls Experimental Forest explains the role of fire in ponderosa pine forests; stands near the sign show the three types of forest described.

> This “turn-of-the-century” forest . . . will give visitors a taste of the Central Oregon landscape of the 1800s, according to Dave Frewing, operations manager for the experimental forest. . . .
>
> On this 173-acre section of the experimental forest about 25 miles southwest of Bend, the Forest Service is re-creating the look of the natural forest by clearing young lodgepole and ponderosa pines that have grown up under . . . the taller old-growth pines, most of which are 200 to 350 years old.
>
> The smaller trees grew up amid the pine stands here because naturally occurring forest fires, which once swept through the pine forests every eight to 10 years, have been suppressed by man. The natural fires killed off brush, small plants and young seedlings, but never burned hot enough to reach the lofty crowns of the old-growth pines.
>
> To mimic the effects of natural fires, the Forest Service plans to set small ground fires in the “turn-of-the-century” forest every eight years, beginning in the late 1990s [Preso 1990b].

This has been done, and the role of fire in ponderosa pine stands is interpreted for Deschutes National Forest visitors at a convenient pull-out on Forest Road 43. The need for such a public demonstration is found in an anecdote Frewing told about “the time his four-year-old son had to tell his nursery school class what daddy did for a living.”

> There were a couple of other Forest Service kids in the class, and they said “My daddy puts out forest fires.”
>
> They came around to my kid and he said, “My daddy starts fires.” That teacher sure had a lot of questions about what I really did [Boyer, n.d.].

Since that time, prescribed burning has become an accepted and standard forest management practice and a key to restoring and maintaining forest health.

Martin’s publications during his Bend Silviculture Laboratory years both consolidated fire ecology and prescribed burning knowledge and reported the results of prescribed burning research at Pringle Falls Experimental Forest and elsewhere east of the Cascades. A regular participant in the annual fire ecology conferences organized by the Tall Timbers Research Station, a private Florida laboratory, held from 1962 to 1975 (Pyne 1982), Martin was senior author of a paper in the proceedings of the 1975 conference (Martin et al. 1976). Several more papers on prescribed fire and fuel loads were authored by Bend laboratory scientists and others in the next 5 or 6 years (Martin and Dell 1978, Martin and Mitchell 1980, Martin et al. 1979). In 1981, Martin and Bend Silviculture Laboratory technicians Frewing and James L. McClanahan published “data on shrub fuel loads from several locations in Oregon and northern California, including [the] Pringle Falls Experimental Forest" (Youngblood 1995), in an Experiment Station research note intended to "serve as an interim tool to estimate fuel loads . . . until more exacting data are compiled and analyzed" (Martin et al. 1981).

Martin's first 1982 publication reported the results of what he termed "our biggest experiment" conducted "on the Lookout Mountain Unit of the Pringle Falls Experimental Forest" to study "the effects of prescribed burning for shrub control before timber harvesting" (Martin 2000). His second publication that year reviewed "literature relating fire return intervals to fire severity and effect on successional stage for various North American forest types," in which he noted that the "Pringle Falls Experimental Forest has a short fire-return interval" (Youngblood 1995). In two papers published in the same general technical report, he summarized Pringle Falls Experimental Forest research on antelope bitterbrush regeneration and reestablishment after fire (Martin 1983, Martin and Driver 1983).

> Martin advised national forest managers on prescribed burning. When the Winema National Forest, for example, was "doing a first burn in ponderosa pine-bitterbrush types . . . and must have had 80 people out there . . . and had to burn very slowly because conditions were so dry," he advised a different tack. "I told them they shouldn't be doing it that way. They were doing an awful lot of damage to the stand. They should be going out under very moderate conditions, skim off the surface, knock those fuels down, and then burn again. They said, 'Well, we can't afford to burn twice.' I said, 'Well, you're spending a lot more money burning once and doing a lot more damage to the stand than if you did it the other way. You wouldn't need 40 or 80 people. You'd do it with six or eight people'" [Martin 2000].

Martin also conducted prescribed burns off the National Forest System. He started the prescribed burning program on the Lava Beds National Monument in northeastern California in 1973, while still at the University of Washington, and continued after moving to the Bend Silviculture Laboratory. Two lightning fires that year, one near the monument headquarters, had proved the need. "It was the only place I got to burn big units," he remembered. "The biggest one was about 1,600 acres. . . . At the costs we were burning for, we could have burned the whole 46,000 acres [of the national monument] for the cost of fighting those two [1973] wildfires [that totaled 900 acres] on one day and still have had $10,000 to handle escapes. They have a good program going there now" (Martin 2000).

Martin started Joan Landsberg on the research that was a logical extension of the prescribed burning she had worked on with him. "My first big effort at the Lab was to [co-write with soil scientist Pat Cochran] the study plan for a project to determine the effects of prescribed fire on ponderosa pine lands," Landsberg recalled. The effects of fire on growth and yield in thinned stands of ponderosa pine were emphasized. The specific goal of this study reflected what Landsberg called "Bob Martin's charge . . . to introduce prescribed fire east of the Cascades."

> In order to do this with the national forests and ranger districts, [we had to answer their questions]: "Well, what's going to happen to tree growth, to regeneration? Aren't you going to burn up the nitrogen? What's going to happen to the nitrogen-fixers, the ceanothus and the bitterbrush?" These were questions that, as a research organization, we needed to answer as part of the package of introducing prescribed fire [Landsberg 2002].

"We started out [in 1979] with a site at Lava Butte, in an even-aged, second-growth ponderosa pine stand" about 8 miles south of Bend on the Deschutes National Forest. "We put in study plots" that allowed for "a control, a moderate fuel consumption burn, and a high fuel consumption burn." The moderate and high fuel consumption burns were obtained "by burning at different moisture levels. When the moisture level was higher, we'd get less consumption, and that created our moderate fuel consumption burn. Three weeks later, lower moisture level, lower humidity, and we got what we called our high fuel consumption burn."

Bend Silviculture Laboratory scientists and technicians conducted the underburns at the Lava Butte site themselves. Landsberg described one of her early field study experiences.

> I was working with Bob Martin, Pat Cochran, Dave Frewing, Dick Newman, and Lee Barker at Lava Butte. It was my very first experience on a prescribed fire. Since I was very new at this, my job was to walk the perimeter of the four- to six- to twelve-acre plots being burned. We would light off at four or five o'clock in the afternoon as the humidity started to rise so we would burn into the rising humidity . . . into conditions that would make [the burn] easier to control. I got to the far side of one unit about one-thirty in the morning, and looking across the unit . . . into the forest where there were no plots and no burns . . . was a spot fire! I was the new person on the block. I used good reason and decided, instead of going out there alone with a headlamp and a shovel, I would go back to let Bob and the others know. So I went back, not around the fire line but straight through the unit, barking my shins on just about everything I could find, found Bob, and said, "Bob, there's a spot fire over . . ." while pointing to where the moon was coming up! I was told it was not the first "lunar phenomenon" reported as a fire, and it didn't take any control work at all [Landsberg 2002].

Bend Silviculture Laboratory personnel who worked on prescribed burns were sent to the Deschutes National Forest fire guard school for safety education. In 1982, Landsberg and two temporary employees, forester Paul Flanagan and physical science technician Michelle Penner (Finck), won the rotating "Guard School Champs" trophy for earning the three highest grades at the school (USDA FS 1982a).

Four years into the study, Landsberg and her colleagues could report they had "quantified the growth response of

In 1982, Bend Silviculture Laboratory staff members Paul Flanagan, Michelle Penner (Finck) and Joan Landsberg, who worked on prescribed burns for research projects, won the rotating trophy for the highest grades earned at the Deschutes National Forest fire guard school.

thinned stands of *Pinus ponderosa* . . . to prescribed underburning in the interior Northwestern United States." In addition to reporting on tree growth response and tree mortality, they reported "the fuel loads, burning conditions, and fire behavior for the prescribed underburns . . . because fire effects need to be understood in the context of the fires that produced them and because of their importance to fire managers."

When the underburns at the Lava Butte study site resulted in "unexpected reductions in tree growth . . . , the research was expanded to three additional sites" on the Deschutes, Ochoco, and Mount Hood National Forests "where operational underburns were prescribed and conducted by personnel from the national forests." Research on the four sites, across a range of conditions, would produce more useful results.

> Fuel loading, burning conditions, and fire behavior were documented so the conditions that produced

> any growth changes would be known. Post burn observation periods ranged from 4 to 12 years. At all four sites, we asked the question: Are growth rates of trees the same on underburned plots as on plots that have not been underburned? On [the Lava Butte] site we also asked: Are the growth rates of ponderosa pine the same on plots with moderate fuel consumption as on plots with high fuel consumption?

Landsberg and her colleagues sought answers to these questions "because prescribed underburning [was] being recommended for expanded use in the silvicultural management of forests in the interior northwestern United States" (Landsberg et al. 1984).

But people and nature intervened to limit Landsberg's development of complete answers to many of these questions. Nature dealt the first major blow to tree growth measurements with two insect epidemics. After discovering at the Lava Butte site that underburning temporarily slowed tree growth, "we had hoped to continue monitoring tree growth until the growth rate of the burned areas . . . again [became] the same growth rate as [that of] the controls," Landsberg explained. "We wanted to find out how many years that would take. But the Lava Butte plot where we had the longest history had the pandora moth epidemic, and that blew our long-term measurements." At about the same time, on the Ochoco National Forest site, a mixed stand of Douglas-fir and ponderosa pine, a western spruce budworm infestation that resulted in "negative tree growth" among Douglas-fir cost the researchers their ability to determine height growth.

In 1986, as the study progressed, Landsberg succeeded Deeming as Bend Silviculture Laboratory project leader and, in addition to administrative duties, was immersed in the protracted struggle to secure funds to keep the facility open. On top of that, work on a doctoral dissertation associated with the prescribed burning project, as well as other research projects, consumed her time, and illness slowed her pace. In 1992, upon completion of her Ph.D. program, she was transferred to the Forestry Sciences Laboratory in Wenatchee, Washington. "We could have continued monitoring [the remaining two prescribed burning sites] had the Silviculture Lab not been closed," Landsberg observed.

"We didn't get to the answer on tree growth, because we didn't get to that point where tree growth resumed the same rate in the burned units as in the controls," Landsberg said of the study in 2002.

> We were about 4 years away from it, or maybe 8. Those 4 and 8 years have passed. But we could still get the information by going back. We know the dates they were burned, the conditions under which they were burned, their growth rates for 4 years at one location and 8 years at the other location, and we could find out what they're doing now. Have those growth rates closed? Are they the same? If they are the same, we [could] tell forest managers and fire managers that [if they conducted a prescribed burn] under these circumstances, [they] probably would encounter growth reductions of a certain percentage [that would] last for a certain number of years. Right now, we can tell them that in the first few years of a moderate-fuel consumption burn [they can expect] a 14-percent growth reduction, but we can't tell them how long it will last [Landsberg 2002].

Martin and Landsberg published some of the findings of this project in research papers, and these findings informed her 1992 Ph.D. dissertation (Landsberg 1992). These works informed such subsequent studies as those reported in Ronald W. Shea's and J. Boone Kaufmann's report completed for the Research Station in 1993 (Shea and Kauffman 1993). As recently as 2002, Landsberg expressed the opinion that the widespread prescribed burning common east of the Cascade Range was being done "for hazard reduction [without] knowing the full outcome." Completing this unfinished study, for which she then saw a 3- to 5-year window of opportunity, would provide some "very significant results. . . . But there is no funding" (Landsberg 2002).

Mark Reid

Dr. Pat Cochran's career at the Bend Silviculture Laboratory evolved from soil scientist to silviculturist. Cochran (center), flanked by forestry technicians Dick Newman (left) and Larry Carpenter (right), was a familiar researcher in central Oregon national forests.

Pat Cochran: Soils and Silviculture

Dr. Pat Cochran arrived at the Bend Silviculture Laboratory in July 1967 from a teaching and research position at the New York State University College of Forestry at Syracuse. "It was a good job, but I didn't like living there. After about 18 months, a job came up [at the Bend laboratory], so I applied for it and got it" (Cochran 1999). Appointed as a soil scientist, Cochran was assigned to research "the soil phases of reforestation and timber development problems, with emphasis on interior conifers—especially ponderosa pine and lodgepole pine" (USDA FS 1967a). His preparation for the job included a B.S. in forest management from Iowa State University in 1959 followed, after U.S. Army service, by M.S. and Ph.D. degrees in soils earned at Oregon State University. The interest "in heat and moisture transfer in pumice soils and how they affect tree growth" he developed in Corvallis proved useful in his new assignment (Cochran 1999).

Cochran was no stranger to central Oregon, having worked three summers for the Deschutes Research Center on the Pringle Falls Experimental Forest as a field assistant. In the summer of 1961, his work also included collecting seeds of the local thinleaf alder in Bend for use in experimental plantings in Japan (Bend Bulletin 1961b). He and his family spent the summers of 1962 and 1963 living in "the cottage" at the experimental forest compound. "The pavement ended right there by the driveway [into the compound]," Cochran reminisced in 1999, "and people would pull in there and ask for maps and directions. So we went down to the Deschutes National Forest supervisor's office and got a bunch of maps, and my wife would hand them out. They were just so grateful to get those maps" (Cochran 1999).

Cochran's early experiences at the experimental forest and the laboratory convinced him of the value of the long-term studies he and his colleagues pursued throughout their careers and into their retirements.

> I first went to work [at the experimental forest in 1961 when] Jim Barrett had just [installed] the Pringle Falls spacing study. There were a lot of [visits] by people from Washington, D.C. [over the years], and they were all very impressed with the study. And we found out a lot of really interesting things with the study. I think the primary thing [this study showed about] the value of long-term studies was that, during the first 20 years of the study, the plots without understory vegetation grew more . . . , and during the last 15 years, the growth rates of the plots with understory were superior. There'd been a change in soil quality. . . . So the results of the study were eventually reversed with time. And that was really important [Cochran 1999].

The need to understand those changes over time and what they meant to forest growth and yield drove Cochran's research.

This research began with the soil. Following in the footsteps of Munger, Experiment Station soil scientist Tarrant, and Oregon State University soils professor Youngberg, Cochran studied relationships between drainage and temperature on tree regeneration and growth. In 1967, he was senior author of a paper that held "regeneration of many logged-over areas may depend more upon thermal properties of the seedbed . . . than on any other factor" since "the probability and extent of seedling injury by heat or frost depend upon the temperature variations at the soil surface and in the air layer surrounding the seedlings" (Cochran et al. 1967). In a 1969 paper, Cochran reported that the size and shape of lodgepole pine clearcuts affects minimum temperatures near the soil surface. He had found that "circular openings provided more protection against low soil-surface temperatures" that could damage or kill seedlings "than did long strips with the same width" and that "strip clearcuts should not be wider than twice the height of the residual stand" (Cochran 1969a in Youngblood 1995). There, early in his career, were practical research results forest managers could use.

They could also benefit from his 1970 "review and synthesis of current literature and personal observations relating to successful direct seeding of ponderosa pine" in the proceedings of a 1969 Oregon State University symposium on ponderosa pine regeneration. After covering factors affecting seeding success, Cochran presented several biological and financial advantages of direct seeding over planting of seedlings. The seedlings are established in place and not subject to the root injury and shock associated with transplanting. Reforestation is not tied to nursery production schedules. Seeding requires low investment in equipment and facilities, generally costs less per acre than planting, and can be done on rocky or inaccessible sites where planting is not practical (Cochran 1970).

In 1972, Cochran published the results of his Bend Silviculture Laboratory greenhouse studies on how temperature and soil fertility affect lodgepole pine and ponderosa pine seedling growth in *Forest Science* and on the tolerance of lodgepole pine and ponderosa pine seeds and seedlings to high water tables in *Northwest Science*. In the first, he studied the growth of lodgepole and ponderosa pine seedlings, germinated from seed collected at the Pringle Falls Experimental Forest, under nine temperature regimes and four levels of soil fertility to increase understanding of the growth rates of the two species in south-central Oregon. He found that fertilization increased growth of both species under all nine temperature regimes, and that lodgepole pine growth was not as sensitive to night temperature fluctuations as was ponderosa pine growth (Cochran 1972). In the second, he studied the "effects of high soil water levels on seed germination, seedling survival, and early growth" of lodgepole and ponderosa pine, using seed and soil taken from the Pringle Falls Experimental Forest. He found that seed and seedlings of both species "had high tolerance to very wet soils and low oxygen diffusion rates," that "high soil water levels did not cause significant mortality of either species," and that "growth of both species tended to be lower with high soil water levels" (Youngblood 1995).

In 1973, Cochran published the results of several studies of natural regeneration of lodgepole pine in the Pringle Butte Unit of the Pringle Falls Experimental Forest combined with additional observations made in the field and laboratory (Cochran 1973a). In these studies, "lodgepole pine seed was sown and protected from small mammals in seed beds in the fall of 1969, 1970, and 1971. Subsequent germination, growth, and mortality were monitored. Seedling mortality was attributed to exposure to low night temperature, drought and heat injury, and frost heaving." Cochran described "the sequence of events necessary for establishment of lodgepole pine" in terms of a variety of factors (Youngblood 1995). In a related 1973 article, Cochran and Berntsen reported findings from their study of lodgepole and ponderosa pine seedling tolerance of low night temperatures (Cochran and Berntsen 1973). Growth chambers and other Bend Silviculture Laboratory facilities made such studies possible.

Cochran's early impression "that fertilizer wouldn't do much [to stimulate tree growth in central Oregon forests] because it was so dry" didn't hold up when his studies at Pringle Falls Experimental Forest and elsewhere proved "fertilizer did cause significant increases in growth [in] ponderosa and lodgepole pine and white fir" (Cochran 1999). He knew, though, that Tarrant and Silen in 1963 (USDA FS 1963b) and Youngberg in 1969 (Youngblood

1969) had reported mixed but promising results from ponderosa pine fertilization studies at the experimental forest and elsewhere east of the Cascades.

In 1969, Cochran set out "to determine the response of height and diameter growth to fertilization for small saw-log and pole-sized ponderosa pine in thinned stands" on the Pringle Falls Experimental Forest, on the Deschutes National Forest east and west of the experimental forest, and in the Sumpter Valley of northeastern Oregon. Four years after fertilization, he reported increases in diameter, height, and volume growth that indicated the need for "further study to determine the amounts and kinds of elements necessary to produce maximum response and [to determine] the duration of those responses." He emphasized that "the responses were in connection with thinning, a proven tool for producing more usable wood," and that "considerable work [was] necessary before the use of fertilizers in standard pine management [could] be evaluated" (Cochran 1973b). Cochran continued this work. At the 8-year point, he reported diameter and volume growth continued to respond to fertilization, but that height growth did not. He also reported that "removal of bitterbrush in one study area decreased volume growth in the seventh and eighth growing seasons," apparently because it "stimulated fescue growth, increasing water and nutrient competition." This study showed that foresters could expect "significant responses . . . to fertilization in thinned stands of pines . . . for at least 4 years and possibly more than 8 years on some sites," and allowed Cochran to make "tentative recommendations" to "land managers wishing to fertilize thinned ponderosa pine stands" (Cochran 1977). He later did not recommend "fertilization without thinning. . .since much of the increased growth may be by trees that will never reach marketable size" (Cochran 1979a).

In a related study, Cochran asked the question: "How fast will thinned ponderosa pine stands grow when fertilized repeatedly?" Answering this question, he wrote, "becomes increasingly important as the land base available for intensive timber management continues to shrink while rising energy costs escalate prices of fertilization and other stand treatments." Application of "moderate amounts of fertilizer at 5-year intervals to plots in a ponderosa pine stand [about 20 miles south of Bend and representative of large areas on the Deschutes National Forest] that had been precommercially thinned" provided at least a preliminary answer. Comparisons of "the fertilized and unfertilized treatments for the first 5-year period after initial application" showed growth rates [of height, basal area, volume, and bole] "were increased more than 50 percent by applications of nitrogen, phosphorus, and sulfur" (Cochran 1979a).

In yet another study, Cochran, Newman, and Barrett investigated the effects of fertilization and spacing on the growth of ponderosa pine seedlings planted in the absence of competing shrubs. The study at Pringle Falls Experimental Forest began in 1966 when ponderosa pine seedlings were planted at 9- by 9-, 12- by 12-, 15- by 15-, and 18- by 18-foot spacings in auger holes in which fertilizer had been placed. Common understory shrubs had been removed and were controlled by herbicide applications. Tree heights were measured annually from 1967 to 1973, and heights and diameters at breast height were measured in 1974, 1980, and 1984. In 1991, Cochran and his colleagues reported that

> fertilizer placed in the planting hole increased height growth . . . early in the life of the plantation. Later broadcast applications of fertilizer may have had little effect on growth. Wider spacings produced larger trees but less volume [of usable wood] per acre than narrower spacings after average tree height exceeded 7 feet. Fertilization produced larger trees and more volume per acre at each spacing [Cochran et al. 1991].

These results suggested that "fertilization at the time of planting should be investigated further" and that

> experiments . . . to determine the influence of different. . .commercial fertilizers . . . with and without the influence of competing vegetation need to be initiated. For now, practicing foresters can expect [fertilizer] as used in this study . . . will directly increase the growth rates of planted

> ponderosa pine in the pumice soil region of south-central Oregon for at least six growing seasons and indirectly for much longer where competing vegetation is not a problem [Cochran et al. 1991].

In an earlier study of soil effects on tree growth conducted on the Sisters Ranger District, Cochran and Deschutes National Forest soil scientist Terry Brock found that soil compaction during logging and related operations reduced height growth of ponderosa pine seedling planted to reforest central Oregon clearcuts. They proposed an additional study "to test the effect of tillage of compacted areas on growth rates" (Cochran and Brock 1985).

As time passed and scientists retired, Cochran's career at the Bend Silviculture Laboratory evolved from that of a soil scientist to that of a silviculturist. As he put it:

> Walt Dahms was the first to retire [in 1976], so I took over his lodgepole pine studies. And then Jim Barrett was the second to retire [in 1982], so I took over his ponderosa pine studies. And when Ken Seidel retired [in 1988], I took over his larch studies. When someone retired, I got his stuff, see! So my work sort of shifted from soils into growth and yield of these various timber types east of the Cascades [Cochran 1999].

And so it happened that Cochran inherited a small empire of study plots at Pringle Falls Experimental Forest and throughout eastern Oregon and Washington, along with the research responsibilities that went with them. He wound up writing studies with these retired colleagues as well as others still on the job.

Cochran had begun his shift from soils to silviculture in the latter half of the 1970s. "When the Forest Service on the east side started cutting the mixed conifer types, there were no data on growth," Martin said in 2000. "So I got Pat to take the study on. And we said 'Well, it's going to take us 5 years to do a quick and dirty study on growth' . . . by taking sections of trees at different ages on different sites and pasting it together. . . . That is not really the way you should do it, but we didn't have the time. I think he did that study in 3 or 4 years" (Martin 2000). Cochran's effort resulted in publication in 1979 of *Site Index and Height Growth Curves for Managed, Even-Aged Stands of White and Grand Fir East of the Cascades in Oregon and Washington* constructed from stem analysis data collected from 8 plots in Washington and 26 plots in Oregon (Cochran 1979b).

Cochran's greatest contribution to silviculture east of the Cascade Range probably was the work on stand density index (SDI) and the implications of managing various species outside certain ranges of SDI that he reported in *Stocking Levels and Underlying Assumptions for Uneven-Aged Ponderosa Pine Stands* (Cochran 1992) and that he and others concluded in *Suggested Stocking Levels for Forest Stands in Northeastern Oregon and Southeastern Washington* (Cochran et al. 1994). As Youngblood observed:

> This work ties together much of the earlier mensurational effort on growth and yield with later work on disturbance effects and the role of thinning and spacing, and probably represents the most significant impact on management of east-side Oregon and Washington ponderosa pine and Douglas-fir of any research theme at the Bend Silviculture Laboratory [Youngblood 2004].

To produce the latter publication, Cochran led an informal team of Research Station and Pacific Northwest Region scientists formed to implement existing science and stimulate applied research. Using existing information, this team "devised a method for estimating the upper stocking limits for managed stands of various species and species mixes in different plant associations" in northeastern Oregon and southeastern Washington (Cochran et al. 1994).

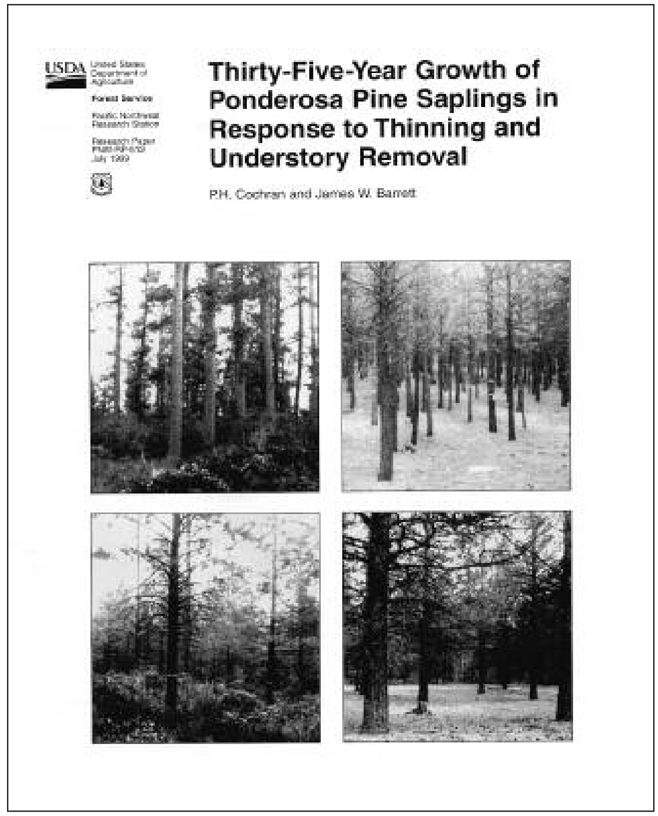
The effects of fire on forests and their productivity are a pervasive issue for many forest scientists. As reported in a 1990 paper by the same name, Cochran teamed with Area IV Ecologist Bill Hopkins to ask and attempt to answer the question "Does fire exclusion increase productivity of ponderosa pine?" Although comparison of yield data for "old-growth stands [that] had frequent, light ground fires" with data for "second-growth stands [that] had not been subjected to fire" produced inconclusive results, Cochran and Hopkins concluded that "Continued long-term investigations of the influence of prescribed burning on productivity . . . are necessary. These investigations should include the study of growth rates after fall and spring burns along with the processes that may be influenced by burning" (Cochran and Hopkins 1991).

After he retired in 1996, Cochran affiliated with the University of Idaho to write a series of research papers that wrapped up several of the long-term studies he and his colleagues had pursued for decades. "I was the logical person to get the job," he reasoned 3 years later. "I agreed to write nine papers, but I combined two of them into one, so I wrote eight papers" (Cochran 1999).

Two of these papers put a couple of Dahms' lodgepole pine studies to bed. Closest to home, the first reported results of the two levels-of-growing-stock studies Dahms initiated on the Deschutes National Forest near the Twin Lakes in 1959 and Snow Creek in 1962. These studies addressed measures to improve the health and productivity of natural lodgepole pine stands that, left unmanaged, tend to stagnate, die of natural causes or as victims of mountain pine beetle outbreaks, and create a fire hazard. Both demonstrated that "early spacing control coupled with later commercial thinnings should reduce mortality considerably" and "allow most of the wood produced to be captured by merchantable trees" (Cochran and Dahms 2000). The second reported:

> the 27-year responses of growth, mortality, and crown cover to five spacings imposed on a natural lodgepole pine stand 4 years after establishment. . . . Simulation to a breast high [sic] age of 100 years indicated the most merchantable cubic volume was produced at the 6-foot spacing but that the 12-, 15-, and 18-foot spacings produced about the same board-foot volume" [Cochran and Dahms 1998].

Three more research papers continued Barrett's ponderosa pine studies, two conducted on the Pringle Falls Experimental Forest and one on Washington State



Research Paper PNW-RP-512, published in July, 1999, reported 35-year findings from the spacing study on ponderosa pine saplings on Pringle Falls Experimental Forest. The four experimental treatments produced dramatic differences in tree sizes.

Department of Fish and Wildlife land in northern Washington. The first, published in 1999, reported the 30-year results of Barrett's effort to determine the optimum growing-stock level in even-aged ponderosa pine on the Lookout Mountain Unit. The paper noted that growth decreased with increasing stand density, bark beetles were the primary cause of mortality, and no mortality occurred at the lowest density (Cochran and Barrett 1999a). Similarly, a second 1999 paper reported the 35-year results of Barrett's classic spacing study on the Pringle Butte Unit. Cochran found that "average height growth for all trees increased . . . and volume growth decreased . . . as spacing increased" and "large differences in tree sizes with spacing developed over the 35 years of the study." Also, although "during the first 20 years of study, plots without understory grew more

. . . , during the last 15 years, growth rates on plots without understory were not superior to plots with understory. . . . Plots without understory produced the highest volume yields after 35 years, but the difference in yields between the two understory treatments is expected to diminish in the future" (Cochran and Barrett 1999b). A third paper updated Barrett's 1981 report of tree and stand growth on the Methow Valley spacing study that had been preceded by McConnell and Smith's 1965 and 1970 reports on understory response to thinning and Sassaman and others' 1973 economic analysis of timber and forage returns (Cochran and Barrett 1998).

By 1999, Cochran's work with retired colleague Seidel on the latter's western larch studies had determined that thinning every 10 years to five growing-stock levels "resulted in widely differing tree sizes and volumes per acre after 30 years." Whereas "the largest trees but the least cubic volume yield per acre were produced in the heaviest thinning level," the "highest board-foot yields were found in intermediate thinning levels." Citing factors that "rule out. . .uneven-age management for larch stands," Cochran and Seidel concluded that "thinning is necessary in many larch stands to maintain vigorous, rapidly growing trees." They added that these same factors "also would make it nearly impossible to maintain a significant larch component . . . in mixed-species stands managed . . . to maintain several size classes on each acre." Their contribution to western larch management transcended pure silviculture to observe that:

> Decisions about the desired future condition and appearance of landscapes containing western larch stands and the silvicultural practices necessary to create and maintain these landscapes need to be made, probably with public input. The public needs to know what is biologically possible and silviculturally reasonable, and at the same time managers need to obtain the public's concepts of the appearance of future forests. In this communication process, it might be possible to settle on management goals and methods to achieve these goals that would be supported by most people interested in future forests [Cochran and Seidel 1999].

Cochran reported the demise of a white fir (*Abies concolor*) levels-of-growing-stock study he had established in 1982 on the Deschutes and Fremont National Forests in March 1998. "Mortality between 1991 and 1995 destroyed the study," he pronounced in the research note-obituary for the once-promising effort. "At the time of establishment, little density-related mortality was expected. Suppressed trees were removed in the initial thinning and the study was to be repeatedly thinned. Mortality owing to agents other than suppression in even-aged white fir stands had not been shown to be related to stand density." But drought, western spruce budworm and fir engraver beetle, and root rot changed all that. Yet, Cochran found some useful results. He concluded that these "results raise doubts about maintaining stands with a large component of white fir on these sites over a long period. Managed stands on these sites should have a strong ponderosa pine (*Pinus ponderosa*) component and should be managed by using ponderosa pine stocking curves" (Cochran 1998a).

Another study affected by an unexpected natural event was documented by Cochran in July 1998. A pandora moth outbreak first detected in central Oregon in 1988 spread to the spacing study Barrett had begun in 1959 on the Pringle Butte Unit of the Pringle Falls Experimental Forest. Cochran seized the moment.

> The relation of defoliation to five tree spacings was examined, and stand growth reduction due to defoliation was estimated. Defoliation generally increased as spacing varied from [about 6 feet to 18 feet] and then decreased as spacing increased to [about 26 feet]. Partial defoliation in 1992 reduced stand volume growth, and partial defoliation in 1994 reduced height growth . . . [Cochran 1998b].

Defoliation significantly slowed growth of usable wood. "Basal area annual increments of sample trees were reduced by 25 percent in the first growing season after defoliation (1992), 30 percent the second year after defoliation (1993), and 63 percent after the second defoliation (1994)." The same drought that helped destroy Cochran's white fir study had "resulted in low stand growth rates in Oregon for some time, and defoliation by pandora moth [had] reduced growth even further." Noting in 1998 that "the effects of drought and defoliation are not yet over," Cochran opined that "serious mortality from bark beetles could occur in the next few years" (Cochran 1998b).

By the time the final paper in this series was published in 2000, Cochran had brought up to date—if not concluded—many studies pursued by retired colleagues, some of which had their roots in the early days of the Pringle Falls Experimental Forest, or even in Munger's 1908 peregrinations.

Ken Wright, Charlie Sartwell, Dick Mason, Boyd Wickman, and Russ Mitchell: Insects and Silviculture

Following in F. Paul Keen's pioneering footsteps, another generation of Forest Service entomologists researched a variety of insect infestations and their silvicultural ramifications at Pringle Falls Experimental Forest and elsewhere in central Oregon. One, Dr. Russell G. Mitchell, eventually was based at the Bend Silviculture Laboratory.

In the 1950s, Kenneth Wright, an entomologist in the PNW Research Station's Division of Insects and Disease under Robert L. Furniss, used the Pringle Falls Experimental Forest as a base for bark beetle surveys into the early 1960s (Wickman 2003). In 1964, Wright hired entomologist Charles Sartwell, then working at Hat Creek, California, for the Pacific Southwest (PSW) Forest and Range Experiment Station, to research the biology and ecology of the pine engraver beetle attacking residual ponderosa pine following extensive logging in central Oregon. These beetles bred in the slash of logged trees, then attacked and killed the smaller pines. "I'm not sure how *Ips pini* came to be my focus, since Ken thought mountain pine beetle was of far greater importance," Sartwell recalled.

> However, in the early 1960s, silviculturists on several eastern Oregon forests were resisting the advice to avoid thinning in summer. That advice was based on a study by Walt Buckhorn in the early 1940s that found more than 90 percent of tree killing by *Ips pini* in recently logged stands occurred where slash was deposited [from] July through September. Ken wanted the matter revisited [Sartwell 2004].

Working at and from Pringle Falls Experimental Forest for 3 years, Sartwell studied pine engraver emergence densities in slash felled in precommercial thinnings of ponderosa pine. His study determined that fairly reliable estimates of pine engraver beetle emergence from such slash could be obtained and used to manage slash disposal efforts to control infestations (Sartwell 1971).

When, in 1967, Sartwell's research focus shifted to mountain pine beetle as a pest of second-growth ponderosa pine, the nine 10-acre research plots in eastern Oregon and Washington that he cruised annually for mortality for 5 years included one on the Round Mountain Unit of the Pringle Falls Experimental Forest. He occasionally stayed at Pringle Falls during those years, but what he called "my romantic heyday on the banks of the Deschutes" when he, his wife, and young son lived in the cottage there was gone. As did so many other Pringle Falls scientists, Sartwell "really liked the place" (Sartwell 2004).

An extensive lodgepole needleminer infestation in central Oregon in 1967 brought entomologists Richard R. Mason and Boyd E. Wickman, who had just replaced Wright as project leader, to study the insect's effects on lodgepole pine growth and mortality. Timothy C. Tigner, a University of Michigan graduate student researching a Ph.D. dissertation on the needleminer (Tigner 1970), helped establish the original sample plots. The significance of this study, based partly at Pringle Falls Experimental Forest, was reflected in a September 1967 field meeting there of about 30 entomologists from the PNW Research Station and some of its laboratories, the PSW Research Station, the University of California, Oregon State University, and private timber companies. Mason and Wickman researched the lodgepole needleminer for another year or two, and Mason and Tigner reported that vigorous stands on productive sites were most resistant to population buildup (Mason and Tigner 1972). In 1999, after analysis of 30 years of data, Mason and H. Gene Paul, a technician at the PNW Research Station's Forestry and Range Sciences Laboratory in La Grande, Oregon, published "Long-Term Dynamics of Needle Miner Populations in Central Oregon" in *Forest Science* (Mason and Paul 1999).

By the 1970s, when forest insect problems were more prevalent in the Blue Mountains of eastern Oregon, the research effort shifted and Sartwell focused on the mountain pine beetle while Mason and Wickman focused on the Douglas-fir tussock moth. In 1981, the PNW Research Station entomology unit was transferred en masse from Corvallis to the Forestry and Range Sciences Laboratory in La Grande; however, Wickman and Bob Martin agreed that Russ Mitchell would be based at the Bend Silviculture Laboratory as a detached member of Wickman's unit. And so it was that the Bend Laboratory's only entomologist was "attached" rather than "assigned" to a laboratory the PNW Research Station "was trying to find ways to terminate" (Wickman 2003). Mitchell knew something of central Oregon. As an Oregon State College undergraduate, he had listened to lectures by Ed Mowatt and Jim Sowder during a 1954 field trip. Later, as a Forest Service seasonal employee and a graduate student, he had worked there with Wright and Sartwell (Mitchell 2003).

In 1980, his first year in Bend, Mitchell collaborated with Martin on two papers on fire-insect interactions (Martin and Mitchell 1980, Mitchell and Martin 1980) as he focused on three insects—the western pine beetle, the mountain pine beetle, and the western pine shoot borer—that stalk pine forests east of the Cascade Range.

In 1982, as his tour in Bend was cut short by a 2-year assignment in Portland, Mitchell and two members of the Department of Forest Science, College of Forestry, Oregon State University, published "Thinning Lodgepole Pine Increases Tree Vigor and Resistance to Mountain Pine Beetle" in *Forest Science.* Pursuing the role of entomology in silviculture to maximize growth and yield and prevent mortality caused by insects, he and his co-authors reported findings at Dahms' experimental plots on the Wallowa-Whitman National Forest that suggested "lodgepole pine can be managed through stocking control to obtain fast-growing, large-diameter trees and to avoid attack by the mountain pine beetle" (Mitchell et al. 1983).

After completing the 2-year assignment in Portland, Mitchell was again attached to the Bend Silviculture Laboratory in 1985 to study the silvicultural management of the mountain pine beetle under the co-sponsorship of Wickman's unit (Wickman 2003) and the Deschutes National Forest (Pederson 2003). Between 1987 and 1989, he authored or co-authored two more publications on the mountain pine beetle and three on the western pine shoot borer as well as additional papers not related to central Oregon entomology. His 1987 analysis of a mountain pine beetle outbreak in central Oregon (Mitchell 1987) helped him conclude that the presence of lodgepole pine invites attack by the mountain pine beetle and increases the likelihood that ponderosa pine will be killed along with lodgepole pine (Mitchell 1988). In general, Mitchell concluded, "the mountain pine beetle wouldn't exist [as a problem] if it weren't for overstocked stands. The solution to the mountain pine beetle is to manage stands, thin them properly, let fire play its natural role, and [thus] reduce the potential for population growth."

Mitchell regarded the western pine shoot borer as "a great insect to work on. Other insects come and go, but the western pine shoot borer is a chronic pest to both ponderosa pine and lodgepole pine. And it is a stealth pest. The damage to height growth and form is significant but hard to recognize" (Mitchell 2003). He and Lonne L. Sower of the Forestry Sciences Laboratory in Corvallis, who had previously researched the shoot borer with other Forest Service entomologists including Sartwell, described host tree selection in an article in *Environmental Entomology* (Sower and Mitchell 1987). In a 1991 paper in the *Journal of Economic Entomology*, Mitchell and Sower (1991) described the insect as "a common terminal miner in ponderosa pine in central Oregon and elsewhere" that is "occasionally responsible for considerable height-growth loss and stem deformities throughout the range of lodgepole pine (Hessburg et al. 1994). In 1994, 3 years after Mitchell retired, he and Sower explained how synthetic sex attractants called pheromones could reduce the shoot borer's impact by making it difficult for male insects to find and mate with females (Sower and Mitchell 1994).

Mark Reid

From 1988 to 1991, Russ Mitchell researched a pandora moth epidemic in central Oregon and interpreted the event for national forest managers and concerned citizens.

From 1988 until 1991, when he retired, Mitchell interpreted a central Oregon pandora moth epidemic for national forest managers and concerned citizens. The outbreak came to Mitchell's attention when physical science technician Michele Penner (Finck) noticed "big caterpillars" and told him about them. "You just don't see pandora moths often, and I could see we were in for an outbreak like the one in the Grand Canyon" in the early 1980s, Mitchell recalled. Sizing up the outbreak, he prepared forest managers and the public alike for the epidemic, explaining that the pandora moth requires 2 years to complete its life cycle and that populations increase for three or four generations—6 to 8 years—before becoming infected by a naturally-occurring virus and crashing (Mitchell 2003). He got the word to the general public in "The Pandora Moth is Coming to Central Oregon" (Mitchell 1989) in the fall 1989 issue of *Cascades East*, a popular regional magazine, and through other local media.

The epidemic progressed, and by the spring of 1990 the Deschutes National Forest was receiving "numerous calls from residents of . . . southern Deschutes County . . . who were worried that their trees [were] dying" because they looked "moth-eaten." Mitchell's answers reported by Nellie Nix in *The Bulletin* on May 17, 1990, helped allay their fears.

> "They can completely defoliate the tree, and it looks absolutely like a disaster," Mitchell said. "But what they do is eat the old needles. The new needles haven't come out by the time the larvae are through feeding. The defoliation [prior to spring "bud burst," when new needles that keep the trees alive appear] rarely kills a tree [Nix 1990].

The central Oregon outbreak hadn't become severe by 1990, but Mitchell warned that "the moths' flight in 1991 [would] probably be followed by another year of defoliation. The moths could then fly again in 1993." And that's just how the epidemic continued until it crashed. In the meantime, Mitchell suggested in 1990, "if people get tired of the larvae munching on their trees, they could always gather the larvae to cook and eat. . . . That's what the Paiutes of the Mono Lake area of California do," he observed. "They call the larvae *piuga* and traditionally roast, boil and eat them like popcorn or in a stew" [Nix 1990].

While central Oregon's ponderosa pine forests survived the pandora moth outbreak, Landsberg's study of the effects of fire on tree growth was interrupted by the change to nutrient cycling the epidemic caused.

> "Mother Nature has thrown us a ringer" with the epidemic of the pandora moth, said Joan Landsberg, project leader of the prescribed burn study. "What they're doing in essence is taking the needles that would fall over a period of three, four, or five years and putting them down on the forest floor in one year"[Nix 1990].

The needles hit the forest floor as frass, or moth feces, that Mitchell explained made the caterpillars' presence known. "If you're in a place where they're quite heavy, you can feel the frass—or feces—dropping down out of the tree." Landsberg's physical science technicians, Penner (Finck) and Pat Joslin, who were gathering frass samples to help determine "the effect the frass [would have on] the prescribed-burn areas included in the study," joked about wearing hard hats while they worked. "In truth," *The Bulletin* reported in May 1990, "the falling frass has gotten

Pat Joslin's work as a physical science technician at the Bend Silviculture Laboratory included both field work and laboratory work.

so thick of late that they eat their lunches inside the pickup truck instead of outside in the sunshine" (Nix 1990).

> The frass will serve as sort of a fertilizer, Landsberg said. This means . . . that while the trees may not see any growth this year the extra nutrients in the soil contributed by the frass could cause a "substantial growth increase" in the future. As part of the study, researchers will try to determine if the trees will make up for this year's lost growth in subsequent years [Nix 1990].

Conditions beyond the researchers' control combined in the early 1990s to prevent even this gain from Landsberg's interrupted study.

At the same time, however, Wickman, Mason, and Paul availed themselves of the opportunity "to find out if a single treatment with nitrogen . . . would significantly reduce the impact of pandora moth defoliation in a thinned second-growth ponderosa pine stand" and its effect "on growth and behavior of pandora moth larvae and . . . the chemical composition of foliage and larval frass." The responses to this fertilization of both ponderosa pine and pandora moth were studied for 4 years and published in 1996 (Wickman et al. 1996). This pandora moth infestation stimulated yet another study that Wickman designed and pursued before and after his 1994 retirement in cooperation with the Laboratory of Tree Ring Research at the University of Arizona at Pringle Falls Experimental Forest and other central Oregon sites. Between 1992 and 1995, he and others collected dendrochronological data they analyzed to determine the multi-century cycles of pandora moth outbreaks. The results were published as "Changes in Pandora Moth Outbreak Dynamics During the Past 622 Years" in the journal *Ecology* in 2001 (Speer et al. 2004).

This pandora moth infestation, that affected ponderosa pine forests primarily, occurred at the same time a mountain pine beetle epidemic was decimating the area's lodgepole pine forests. Forest Service foresters were worried that "the pandora moth [would] weaken the [ponderosa pines] to the point they [would] become 'attractive' to the beetle." Mitchell's opinion that the moth's effect wouldn't attract the beetles held (Mitchell 2003).

Even as the pandora moth epidemic raged, Mitchell experimented with a new technique to control the mountain pine beetle by concentrating the insects "in one small part of a vulnerable timber stand until . . . thinning projects [could] make the trees throughout the stand less susceptible to infestation" (Preso 1990a). As reported by *The Bulletin*:

> Tried for the first time in Central Oregon this year, the strategy hinges on a relatively new technology —the use of synthetically produced chemicals called pheromones to mimic the natural signals mountain pine beetles send to call for a gathering.
>
> Based on results seen [in early September 1990] at one site 20 miles southeast of Bend in the Deschutes National Forest, the project seems to be working.
>
> There, the Forest Service placed 25 pheromone-releasing packages in a 1½-acre stand of dense second-growth ponderosa pines, and beetles are everywhere. The signs of their presence are obvious

—nearly every tree is dotted with small pitch globs where it attempted to push out infesting beetles by secreting sap.

"The tree is actually trying to fight off the beetle, and it looks like it might have done a pretty good job," said Forest Service entomologist Russ Mitchell, indicating a young pine particularly hard hit by the insects.

Even so, most of the trees in this small area are doomed, but the use of pheromones here may slow the spread of beetles through the surrounding timber stand.

"This is just designed to buy time," said Mitchell. "It isn't something you can use for control for a very long time."

By delaying a huge outbreak of the mountain pine beetle in second-growth ponderosa pines, the Forest Service hopes to gain enough time to prevent the insects from spreading as widely as they did in the Deschutes National Forest's lodgepole stands beginning in 1976 [Preso 1990a].

During that 14-year infestation in central Oregon, the mountain pine beetle had killed an estimated 65 million trees, 92 percent of them lodgepole pines. When beetle infestations dropped off in lodgepole pine stands and small beetle infestations began appearing in the forest's large expanses of more valuable second-growth ponderosa pines, Forest Service officials became worried. The agency began an ambitious program to thin second-growth pine stands so that each tree would be healthier—and more resistant to beetle infestation.

By the autumn of 1990, about 30,000 acres of the 100,000 acres of second-growth ponderosa pine on the Deschutes National Forest had been thinned, and the Forest Service was hoping this pheromone technology would give it time to thin the rest of the stands and prevent a major beetle epidemic. As effective as it seemed to be, the pheromone technology was still in its infancy and this was its first use in central Oregon. "It's really viewed as more experimental than operational . . . " (Mitchell 2003).

In 1991, the year he retired, Mitchell and Lonne L. Sower published the "results of a study of infestation patterns, effects on height growth, and seasonal history of the western pine shoot borer" (Mitchell and Sower 1991) conducted at the Pringle Falls Experimental Forest and three other study sites in the *Journal of Economic Entomology.* Mitchell wasn't ready to retire in 1991. "I would have liked to have worked 2 or 3 more years and to have wrapped up a few things," he mused, then noted that "I wrapped them up after I retired." He co-authored several more papers between 1991 and 2001. Two of these in *Forest Science*, coauthored with PSW Research Station biometrician Haiganoush K. Preisler, reported on mountain pine beetle colonization patterns on thinned and unthinned lodgepole pine plots on the south flank of Paulina Peak on the Deschutes National Forest (Mitchell and Preisler 1991). These studies concluded that thinned stands suffered far fewer attacks, partly because increased vigor discouraged primary attacks but also because the wider spacing discouraged secondary attacks (Wickman 2003). A third paper, stemming from data on the same plots that showed that lodgepole pine killed by the mountain pine beetle began to fall 3 years after death in thinned stands and 5 years after death in unthinned stands, was published in the *Western Journal of Applied Forestry* in 1998 (Mitchell and Preisler 1998). This kind of information helps foresters plan for salvage operations and assess fire danger. In 1994, Mitchell was a co-author of *Historical and Current Roles of Insects and Pathogens in Eastern Oregon and Washington Landscapes* (Hessburg et al. 1994). Mitchell's last paper, published in the *Western Journal of Applied Forestry* in 2001, addressed the effects of an introduced pest, the balsam woolly adelgid on true firs in the Cascade Range in Oregon and Washington (Mitchell and Buffam 2001).

Lew Roth: Pathogens and Silviculture

Although not a Forest Service scientist and never attached to the Bend Silviculture Laboratory, Professor Lew Roth's five decades of research and teaching at Pringle Falls Experimental Forest may well qualify him as the "dean" of central Oregon forest science.

As a young Oregon State College faculty member, Roth first visited the then-young experimental forest with a School of Forestry silviculture field trip. But he didn't begin work there until 1952. Jim Sowder and Ed Mowat of the Deschutes Research Center "were debating the reality of a mistletoe problem at the Pringle Falls Experimental Forest, specifically, and in central Oregon pine in general." They asked him "to come over and see if there was a real mistletoe problem." He accepted, found his life's calling, and became a Pringle Falls fixture for the next 50 years. "I spent the summer of 1952 surveying mistletoe on one full section centered around Pringle Butte," Roth related in 2002.

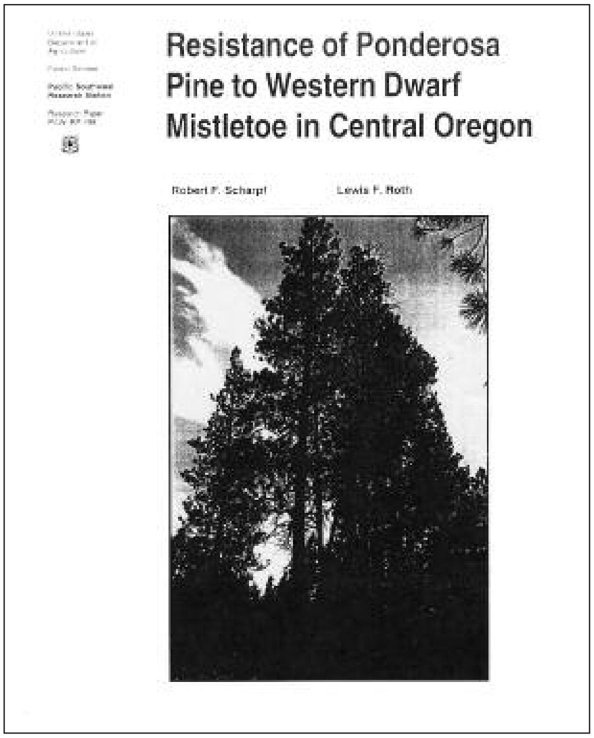
> This provided an excellent look at the effects of topography on mistletoe occurrence and severity. Much insight came out of that year. The frequency and severity [of dwarf mistletoe] increased upslope, irrespective of aspect. Overall abundance was much lower on the northeast exposures than on the southwest. This clearly supported existing notions that mistletoes like warm, bright sites, and not dark, shady sites. And so, on the sunny, steeper exposures, there certainly was a mistletoe problem on the Pringle Falls Experimental Forest, and that is true throughout Pacific Northwest pine forests in general. From then on, I was pretty well caught by opportunities to do research at the Pringle Falls station [Roth 2002].

Roth shared the lessons he learned from his simple mapping on Pringle Butte and early studies in two publications, *Pine Dwarfmistletoe on the Pringle Falls Experimental Forest* published by the PNW Experiment Station in 1953 (Roth 1953) and "Distribution, Spread, and Intensity of Dwarf Mistletoe on Ponderosa Pine" published in the journal *Phytopathology* in 1954 (Roth 1954).

Roth was soon one of the Pringle Falls Experimental Forest's principal researchers and perhaps its leading citizen. "In summers of the early years, I lived with my wife and two youngsters in the lower cottage. After my children and the cottage were gone, I was privileged to occupy my trailer close beside the dormitory where my students lived." In addition to research and teaching and learning, Roth and his students "put a lot of effort into maintenance and care" of the experimental forest's headquarters compound that "suffered from the lack of an on-site supervisor" (Roth 2002).

Roth once said: "Simple observations thoughtfully considered can have tremendous value" (Roth 2002). He proved it in the late 1950s when a seemingly simple observation led to a breakthrough discovery "contrary to what the textbooks say" and essential to understanding the "very complicated dynamics of propagation" on which any method to control spread of dwarf mistletoe would have to be based. Roth told the story this way:

> I had learned from the literature that mistletoe propagated by sticky seed forcibly shot out from single-seeded fruits. [These seeds] strike young pine twigs where they stick and later germinate to infect. I wanted to know more about seed behavior.
>
> My wonderful wife, Evelyn, was a great helper. One day early in my studies I tried to catch some seed. Lyn held a herbarium blotter (these have a slightly soft knap) a few feet from a large mistletoe plant on a small tree. I shook the tree. I could hear seeds bombarding the blotter. Great! When Lyn took the blotter down, there was almost nothing on it. Do mistletoe seeds strike twigs and infect? Of course not. They ricochet, usually to the ground. When I looked at Lyn, her hair was full of seed. Seeds must strike something resilient: needles (that can yield to impact)? Hair? Rodents? Feathers? Birds? This simple observation opened a whole new door on mistletoe epidemiology.
>
> The seeds do infect the twigs, but how do they get there? Usually, with the first rain (usually about a quarter-inch), part of the seed adhesive gelatinizes, absorbing much water adding mass and enabling response to gravity, and in fact becomes a lubricant. On erect needles, seeds slip into the axils where



Professor Lewis Roth, Oregon State University, and Robert Scharpf, Pacific Southwest Research Station, summed up the long-term study on ponderosa pine resistance to western dwarf mistletoe in central Oregon in a 1992 publication.

> they again stick and in the spring germinate. With more or less rain . . . seeds either don't move or they wash off (Roth 2002).

Roth published these findings in a 1959 article (Roth 1959), and the emphasis "shifted from twigs to needles, to tree crowns, to their proximity, shape, density, etc." (Roth 2002). After years of trapping seeds on targets and crown enclosures, Roth and Mary Ann Strand prepared, and in 1976 published, the first computer model detailing seed dispersal basic to epidemiology (Strand and Roth 1976).

Simultaneously, experimental studies of mistletoe populations and their hosts and years of observation told Roth something of the parasite's impact on stand development. Small trees suffer especially (Roth 1971, 1974a) as do saplings (Roth 2001) and poles (Roth and Barrett 1985). "Much of the effect," Roth concluded, "appears to be a function of stand density" (Roth 2002).

One study involving different stand densities that required critical long-term observation fortified Roth's impression that some ponderosa pines had potential, developable, genetically-based resistance to mistletoe. Roth observed that:

> Exceptional trees occur with drooping rather than erect needles. Seeds on these are washed from the tree, precluding infection. Genetic development of planting stock with drooping foliage should have high mistletoe control value. This contention is supported by the near absence of mistletoe in . . . parts of the pine region where drooping needles are common. Heritability of needle length and hypodermal thickness, both of which are involved in needle droop, has been demonstrated [Roth 1966].

Roth tested this and other ideas. In 1974, Roth reported on work on Pringle Butte to develop trees with resistance to the parasite (Roth 1974b). He expanded on this in a 1978 paper presented at a Berkeley, California, symposium (Roth 1978). This long-term study was summed up in 1992 when Roth collaborated with pathologist Robert F. Scharpf of the PSW Research Station to present the results of comparisons of natural resistance to dwarf mistletoe infestation (Scharpf and Roth 1992).

> The objectives of the study were (1) to determine the resistance of clonally propagated ponderosa pines from apparently resistant and susceptible trees, (2) to determine the survival of resistant and susceptible trees with different levels of infection, and (3) to determine whether resistance was correlated with tree size, foliar habit, or crown characteristics. Scions taken from trees on the Ochoco, Rogue River, and Deschutes national forests thought to be resistant to infection were grafted to seedlings planted from 1967 to 1969 at the Pringle Falls Experimental Forest in a stand of pines heavily infested with dwarf mistletoe. Tree survival, growth, crown size, and number of dwarf mistletoe infections were recorded in 1989. High levels of resistance were found in grafts produced from resistant

> selections of ponderosa pine from the Deschutes and Ochoco national forests. Mortality of both susceptible and resistant selections from the Rogue River National Forest was higher than [that of trees from] other sources. The drooping needle form of pine, common in the Rogue River source, did not develop when grown in central Oregon, and showed no resistance to dwarf mistletoe. Dwarf mistletoe-resistant pine in central Oregon may be an important component of forest biodiversity, and identification, preservation, and use in future tree improvement and pest management programs are recommended [Youngblood 1995].

Scharpf's involvement in this paper more than a dozen years after Roth's retirement was motivated by that 1978 Berkeley symposium. He became "so excited about this resistance thing that he took the data and wrote it up as a published paper," an exuberant Roth remembered (Scharpf and Roth 1992, Roth 2002). Roth's enthusiasm was more infectious than the dwarf mistletoe he spent decades studying.

As he researched, Roth taught and inspired students who went on to make significant contributions to forest pathology. His graduate students at Pringle Falls helped him, but spent most of their time on their own thesis and dissertation research.

In 1960, Peter Paul Sikorowski, one of his graduate students, wrote a master's thesis on the dissemination of spores of the fungus *Elytroderma deformans* that causes a disease commonly known as pine needle blight based on studies conducted in a stand of infected ponderosa pine saplings and small poles on the Pringle Falls Experimental Forest (Sikorowski 1960). Two years later, Sikorowski and Roth published the results of microscopy studies of the fungus *Elytroderma mycelium* in the phloem of ponderosa pine growing at the experimental forest (Sikorowski and Roth 1962).

David H. Adams, another of Roth's graduate students, discovered the first fruiting bodies of the root fungus *Armillaria mellea* at Pringle Falls Experimental Forest while working with Roth on dwarf mistletoe research (Roth 2002). This led to Adams' 1972 doctoral dissertation on the relation of cover to the distribution of *Armillaria* based on field and laboratory analysis of numerous isolates of the fungus obtained within a 250- by 450-foot study area in a Pringle Butte ponderosa pine plantation (Adams 1972). Analysis of *Armillaria* isolates recovered from one study plot and three infection centers on the Pringle Butte Unit supported a subsequent study on identification of clones of *Armillaria* (Adams 1974).

Still another of Roth's graduate students, Andrea L. Koonce, explored the relationship between fire and dwarf mistletoe at the Pringle Falls Experimental Forest. In 1980, she and Roth reported that fire had beneficial effects on canopy structure and tree density that discouraged dwarf mistletoe survival and dispersal (Koonce and Roth 1980).

> Dwarf mistletoe was partially sanitized from thinned and unthinned stands by prescribed understory burning. Scorch heights between 30 and 60 percent of the live crown length were required to reduce the proportion of dwarf mistletoe in the crowns of crop trees. Mistletoe levels were reduced from severe to tolerable when the crowns were not severely infected throughout their length [Youngblood 1995].

In her 1981 doctoral dissertation, Koonce (1981) demonstrated that dwarf mistletoe infections on both surface and aerial fuels caused "diseased trees [to be] more susceptible to crown scorch and [to have] greater levels of mortality than . . . healthy trees. In general," she found, "30 percent of crown scorch was sufficient to kill 80 percent of severely infected branches and reduce the mistletoe rating from severe to moderate" (Youngblood 1995). Koonce went on to a career in Forest Service research.

Forty-nine years after Roth began his dwarf mistletoe research at Pringle Falls Experimental Forest, he explored the relationships between stand density and age and western dwarf mistletoe incidence in Northwestern ponderosa pine forests (Roth 2001). He emphasized his conviction that the species of dwarf mistletoe in the Pacific Northwest has not been recognized as the major killer it is—as the species in the Southwest has—because "ponderosa pine in the Northwest regenerates so densely that foresters there welcome anything that thins." And the killing doesn't stop there. "In mistletoe infested [ponderosa pine forests] the ground is covered with resinous mistletoe kills that constitute a major fire hazard" (Roth 2002).

Roth was circumspect about his contribution to ponderosa pine silviculture. "You just can't tell how much good you're really doing. As pathologists, it's our responsibility to provide good, solid evidence for workable things, and at that point put it in other people's hands" (Roth 2002).

In Other People's Hands

The essence of a legacy is a bequest to the future or, as Roth put it, to put something of use "in other people's hands." That was the role of the scientists at the Pringle Falls Experimental Forest and the Bend Silviculture Laboratory from 1931 until 1996 and, of course, remains the role of Forest Service research. The value of these scientists and their contributions is found throughout the literature in the field, to which they contributed copiously and creatively, and in what every silviculturist east of the Cascade Range now considers common knowledge. The knowledge they developed through painstaking and pioneering research over more than six decades, and others have applied to managing forest resources for almost as long, epitomizes an enduring scientific legacy.

This page is intentionally left blank.

Chapter 5: A New Dawn: Research for Ecosystem Management

A comment in the Pacific Northwest Research Station's annual report for 1969 that "ecology" and "environment" had become "household words" (Cowlin 1988) reflected the growing American awareness of and concern for what President John F. Kennedy called "the common estate" (Udall 1963). This awareness and concern transformed not only the relationship between the natural environment and human activity, but forest management and the questions asked of forest science. And these changes combined with fiscal issues to determine the fate of the Bend Silviculture Laboratory and the Pringle Falls Experimental Forest.

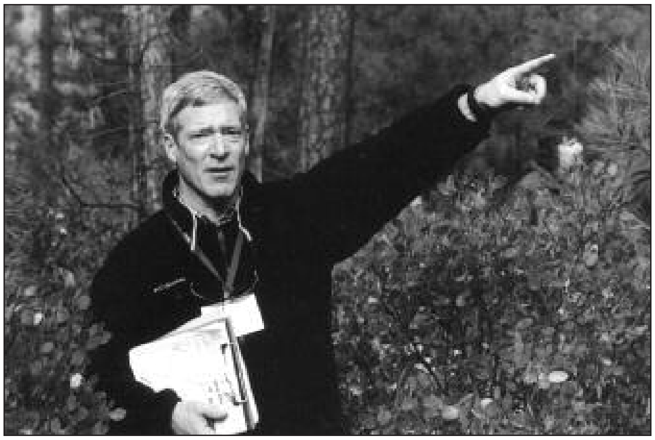
By the late 1980s, "public demand for consideration of nontimber forest values and a growing concern for forest health" had led the Research Station "to review [its research] effort and reassess [its] research priorities" (Youngblood 1993). Much of this review coincided with the Forest Service's effort to replace its "old forestry" based on "timber primacy" with a more holistic approach known by the early 1990s as "ecosystem management" (Jensen and Bourgeron 1994). For the Forest Service:

> "Ecosystem management" means using an ecological approach to achieve the multiple-use management of National Forests and Grasslands by blending the needs of the people and environmental values so that National Forests and Grasslands represent diverse, healthy, productive, and sustainable ecosystems [USDA FS 1992b].

Chief of the Forest Service Jack Ward Thomas explained this philosophy and policy as "the skillful, integrated use of ecological knowledge at various scales to produce desired resource values, products, services, and conditions in ways that also sustain the diversity and productivity of ecosystems" (USDA FS 1992a). It is the means the Forest Service will use to meet society's needs in ways that also restore and sustain healthy, diverse, and productive ecosystems.

"Regional Foresters and Station Directors were directed to develop a joint strategy for making ecosystem management an integral part of the organization and its decisions, tasks, and dealings with the public" (Youngblood 1993). The old forestry and its emphasis on timber management—the forestry around which research had evolved for three decades at the Bend Silviculture Laboratory and for six decades at the Pringle Falls Experimental Forest—was yielding to a new forestry focused on whole ecosystems. A new ecosystem management strategy was developed for Pacific Northwest Region national forests and Pacific Northwest Research Station research. "To successfully carry out ecosystem management," a shift toward "research [that is] "interdisciplinary, integrative, and considers differences of temporal and spatial scale" was needed (Youngblood 1993). This strategy reflected the "significant evolution from managing stands toward managing resources at a landscape scale" (USDA FS 2002) that implemented the ecosystem management philosophy and policy and characterized the Research Station through the 1990s and into the 21st century.

This evolution was epitomized by the Interior Columbia Basin Ecosystem Management Project (ICBEMP) chartered in January 1994 by the chief of the Forest Service and the director of the Bureau of Land Management "to undertake work necessary to develop and then adopt a scientifically sound, ecosystem-based strategy" for managing all Forest Service- and Bureau of Land Management-administered lands "in the Columbia River basin within the United States and east of the Cascade crest, and portions of the Klamath and Great basins in Oregon." Although decades of research, including that at the Pringle Falls Experimental Forest and the Bend Silviculture Laboratory, "had addressed many forest health problems on the east side, the status of the Basin as a whole had never been addressed." By late 1996, the Research Station was able to summarize "over 2,000 pages of scientific, technical methods and findings produced by the project's Science Team"



Les Joslin

During the early 1990s, Dr. Andy Youngblood moved to recast the Bend Silviculture Laboratory as the home of an east-side ecosystem management research team, as Forest Service research responded to the evolution of ecosystem management.

that describe "the status of [Basin] ecosystems . . . in terms of current conditions and trends under three broadly defined management options." This "scientific information . . . will be used in decision-making, and may potentially amend Forest Service and Bureau of Land Management plans within the Basin. The information," the summary emphasized, "represents an integrated view of biophysical and socioeconomic elements at a scale never before attempted" (USDA FS 1996b).

In anticipation of and response to this evolution, Dr. Andrew Youngblood moved to recast the Bend Silviculture Laboratory as the home of an "Eastside Ecosystem Management Research Team." By 1993, he had proposed an initial 10-year research program "to enhance understanding of the health and functional processes in forests east of the crest of the Cascade Range in Oregon and Washington" (Youngblood 1993) as the new basic mission for the Bend laboratory. Only a year earlier, in 1992, Youngblood, a Utah State University forester with a Ph.D. in forest ecology from the University of Alaska, was transferred from the Institute of Northern Forestry, Fairbanks, Alaska, to replace Joan Landsberg as leader of the Bend laboratory.

At that time, the Research Station was reorganizing in response "to the high priority themes of the National Research Council Report on Forestry Research—A Mandate for Change, the National Research Strategic Plan, and the Milliken-Chapman assessment of Forest Service Research" in a way that would be "responsive to the recommendations of the Forest Service 1990 Program for Forest and Range Resources." This program included "increased integrated research, adapting to changing needs of clients, and ability to match organizational strengths with research needs" among its objectives. In addition to Station leadership changes, the reorganization proposal called for several interdisciplinary "science-driven" research programs "designed to provide an environment for research [that would] give Station scientists opportunity to address gaps in scientific knowledge, develop long-term approaches, and explore questions to great depth when appropriate" (USDA FS 1990). The previous organization around projects and project leaders was abolished.

The change in direction from traditional silviculture research projects to evolving ecosystem management programs and their missions posed major challenges to both the Research Station headquarters and field units such as the Bend Silviculture Laboratory. By the time Youngblood arrived in Bend, the laboratory's small staff was split between two of the Station's several programs—Ecosystems Processes Research and Resource Management and Productivity Research—that recently had supplanted its three-decade Silviculture of Interior Conifer Types research project mandate. These programs were articulated as early as 1990 in the Station's reorganization proposal. The mission of the Ecosystem Processes Research Program was to "improve understanding of biological, physical and ecological components and processes of terrestrial ecosystems." The mission of the Resource Management and Productivity Research Program was "to understand factors affecting the productivity of forest and range lands and to understand the cumulative effects of management alternatives on this productivity" (USDA FS 1990). Detailed objectives were listed for each of these programs.

Taken together, this reorganization proposal and the programs it proposed signaled "an end to approaching problems from a single angle—single species, single forest plan—and an end to the notion that science and policy could remain forever politely separated" (Duncan and Miner 2000). It also signaled that the scientists who had pursued long-term silvicultural studies at the Pringle Falls Experimental Forest and the Bend Silviculture Laboratory had contributed their piece to the puzzle. It was time to move on to the more esoteric process of putting the puzzle together to support not just timber management but ecosystem management decisions.

Youngblood took stock of his situation and set out to deal with it. Assigned by Charles W. Peterson as the team leader, he found "that the team was going to consist of individuals belonging to [those] two different programs. We had folks who were assigned to the Ecosystem Processes Research Program led by Hermann Gucinski, and a number of folks who were assigned to the Resource Management and Productivity Research Program led by Charley Peterson." Youngblood led "an effort to develop a new team charter and document that would lay out a strategy for the kinds of research we would be engaged in for the next 10 years" (Youngblood 2002).

Despite some difficulties and differences, Youngblood and his Bend Silviculture Laboratory colleagues hammered out the planning document they called *Eastside Ecosystem Management Research: A Challenge for the 21st Century* (Youngblood 1993). This 10-year proposal

> set direction for new areas of research by an Eastside Ecosystem Management team assigned primarily to the Bend Silviculture Laboratory; research that [would] help resource managers understand how management activities affect not only the growth of trees but also the functions, processes, and interactions of all ecosystem components. In this way, management and enjoyment of natural resources might be improved while forest health is maintained or improved.

Youngblood emphasized that the proposal was "not a detailed plan" but "part of a process that sets broad objectives and establishes priorities for new areas of research" that also "suggests potential partners and opportunities for collaboration" to pursue that research. "Within this framework," the proposal specified, "Program Managers and scientists together will develop more-detailed problem analyses and study plans. Individual lines of current research will be modified or discontinued, and new research initiated, to meet the objectives established in this proposal" that were "a synthesis of ideas . . . from a broad array of scientists, clients, potential partners, and other interested parties" (Youngblood 1993).

"I think we did a very good job," Youngblood reflected.

> [The proposal] really emphasized the work in fire and fundamental ecosystem processes that we could do there [and] was a significant departure from the kind of work that had occurred there . . . that emphasized traditional growth and yield research. It [spoke] to the opportunity to really capitalize on the fact that we had a core of ecologists . . . the area ecologists in that whole Ochoco-Deschutes-Winema-Fremont national forest group . . . Bill Hopkins, Gregg Riegel, and Matt Busse . . . all stationed right there [in the Bend Silviculture Laboratory facility]. It really spoke to how we were going to incorporate and make use of them in our research program" [Youngblood 2002].

But, because of significant budget reductions throughout the federal government, it was not to be.

In a December 4, 1995, letter to all Research Station personnel, new Station Director Thomas J. Mills announced that the Bend Silviculture Laboratory would close in 1996 "because of proposed Federal budget reductions for Forest Service research" (USDA FS 1996a) that included a $4 million cut in the Station's budget. Although the President's budget for fiscal year 1996 for the Station was $30.8 million, the Congressional appropriation process had left only $26 million—a 13-percent reduction from the President's proposal and 6 percent less than the fiscal year 1995 enacted appropriation (Mills 1995). Something had to go, and the Bend laboratory—as well as the Institute for Northern Forestry in Fairbanks, Alaska—failed to meet the Station's "explicit decision criteria" to continue.

The end came on February 15, 1996, when the Bend Silviculture Laboratory officially closed. “The employees at the Bend Silviculture Laboratory . . . have contributed significantly to the advancement of Forest Service research,” Mills said to mark the event. “The work done at Bend has had broad implications to ponderosa pine research and the scientists there have done fine work in fire research.” And the Research Station announced that “a silviculture position has been moved from Bend to the La Grande Forestry Sciences Lab to be part of an interdisciplinary team that will address east-side ecosystem research problems” (USDA FS 1996a).

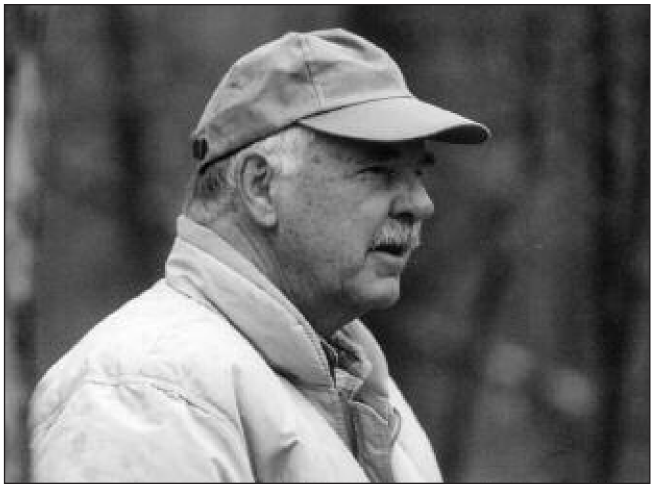
Youngblood, at the Forestry and Range Sciences Laboratory in La Grande as a research forester, led the process that determined how “numerous long-term studies established through the Bend Silviculture Laboratory” (Youngblood 1997) would be “dropped or wrapped up” (Denton 1997)—as one participant put it—in the wake of the Bend laboratory closure.

A meeting in Bend on November 13, 1996, kicked off the process. At this meeting, representatives of the closed laboratory including Youngblood and Pat Cochran, the PNW Research Station and the Pacific Southwest (PSW) Research Station, the Deschutes National Forest, and Oregon State University conducted what George H. Moeller, Deputy Station Director for Programs, called a “first assessment” (Moeller 1998). After participants “discussed opportunities to continue work on some of the long-term studies of stand development, growth and yield, stocking control, and effect of thinning established by Pat Cochran, Jim Barrett, Walt Dahms, and Ken Seidel” (Youngblood 1997), “some studies were terminated, some were continued through cooperative agreements through the University of Idaho, with Pat Cochran as principal investigator, and some were taken over by . . . Andy Youngblood” (Moeller 1998). Although the status and disposition of others remained to be determined, Phillip S. Aune of the PSW Research Station’s laboratory in Redding, California, submitted a draft memorandum of understanding between the PSW Research Station and the PNW Research Station “which listed studies that scientists at PSW were interested in either adopting or at least gaining access to the data” (Youngblood 1997).

A year later, on November 25, 1997, Peterson led “a conference call . . . to assess and agree upon the disposition of 15 studies that remained following the [November 13, 1996] meeting” (Moeller 1998). The same organizations were represented. The session resulted in agreement on disposition of studies, study files, data, and responsibilities, for 12 of the 15 studies. Cochran wrote six research papers and two research notes, published by the Research Station between 1998 and 2000, that wrapped up studies he, Barrett, Dahms, and Seidel had pursued at Pringle Falls Experimental Forest and elsewhere (see chapter 4). Youngblood at the Forestry and Range Sciences Laboratory in La Grande, Matt Busse and Bill Oliver at the Silviculture Laboratory in Redding, California, Ward McCaughey at the Forestry Sciences Laboratory in Bozeman, Montana, and Professor Doug Maguire at the College of Forestry, Oregon State University, assumed custody of the data for these studies.

Youngblood retained responsibility for two active studies, one begun in 1995 at the Metolius Research Natural Area on the Deschutes National Forest to assess the effects of fire on maintaining late-successional ponderosa pine forests and another to assess the effect of pandora moth defoliation on long-term changes in stand structure begun in 1995 on the Deschutes National Forest. He also retained responsibility for an Oregon State University graduate student’s study of stand dynamics on forested lavas begun in 1994 on the Deschutes National Forest, and took custody of data for a fertilizer study begun in 1988 on the Umatilla and Wallowa-Whitman National Forests.

Others stepped up. Busse took over Barrett’s classic 1959 spacing study at Pringle Falls Experimental Forest and retained leadership of a study of long-term productivity in young ponderosa pine he had begun on the Deschutes National Forest in 1990. Oliver took custody of data for an inactive 1967 spacing study and two active 1974 spacing studies on the Pringle Falls Experimental Forest. Maguire



Les Joslin

Boyd Wickman, Forest Service entomologist emeritus, cared for the Pringle Falls Experimental Forest after the Bend Silviculture Laboratory closed in 1996.

took over an active 20-year comparison of even- and uneven-age management in ponderosa pine stands on the Deschutes and Ochoco National Forests. Finally, Joan Landsberg at the Forestry Sciences Laboratory in Wenatchee, Washington, retained the active ponderosa pine underburning study she and Bob Martin had begun in 1979 on the Deschutes National Forest (Peterson 1998). The dismemberment of the Bend Silviculture Laboratory research program was complete. The facility itself was given to Central Oregon Community College.

Not all was lost to progress. Its site selected by Thornton Munger in 1914 and designated in 1931 by Chief Forester Robert Y. Stuart, the Pringle Falls Experimental Forest, remanded to Andy Youngblood's care and watched over by retired entomologist Boyd Wickman, remains a special place of current and potential long-term research. To assure its continuance, Youngblood and colleagues from both the Research Station and the Deschutes National Forest have evolved and begun to implement a set of silvicultural prescriptions designed to protect the experimental forest—its historic administrative site and research plots "currently at risk from stand-replacement wildfire" and "increasingly at risk from recreational impacts and nearby urban development"—and to enhance its special values (Youngblood et al. 2004a).

Protection of these special values continues to pay off in the new era of ecosystem management. East of the Cascade Range, as Youngblood and two Research Station colleagues wrote in 2004:

> There is widespread recognition of the need to restore health and resiliency to eastside forest ecosystems (Quigley et al., 2001). Land managers are more aware of the many disturbance agents affecting forests, yet often lack the knowledge of how disturbance agents interact with each other and how they interact across multiple scales to cause changes that may affect ecosystem integrity [Youngblood et al. 2004b].

To address this need, Youngblood and his colleagues studied the "age, size structure, and the spatial patterns . . . in old growth ponderosa pine forests at three protected study areas east of the Cascade Range: Metolius Research Natural Area and Pringle Falls Research Natural Area in Central Oregon and Blacks Mountain Experimental Forest in Northern California" to "develop quantitative measures of horizontal and vertical structural attributes in eastside old-growth ponderosa pine forests to guide the design of restoration prescriptions." Their results were another step toward "designing and implementing restoration treatments specifically for eastside ponderosa pine ecosystems" (Youngblood et al. 2004b). These treatments include reintroducing fire into fire-dependent ponderosa pine ecosystems, studies of the long-term effects of which began at the nearby Metolius Research Natural Area in 1992 (Youngblood and Riegel 2000). After more than 70 years, the Pringle Falls Experimental Forest—along with a few similar areas—remains a viable research facility.

And, to this day, foresters return to learn from the Pringle Falls Experimental Forest research legacy. On October 20, 2004, Youngblood and Wickman hosted some 30 academics, Forest Service and Bureau of Land Management researchers and practitioners, and others there. They were participants in the 4-day "Ponderosa Pine: Management, Issues and Trends" conference in Klamath Falls sponsored by the College of Forestry, Oregon State University. On that day, these field trippers revisited the

Les Joslin

Dr. Andy Youngblood and Boyd Wickman hosted some 30 participants in Oregon State University's 4-day workshop on issues and trends in ponderosa pine management at Pringle Falls Experimental Forest in October, 2004.

Chris Jensen

Professor Lewis Roth (center) attended the dedication of the Lewis Roth Dwarf Mistletoe Trail on Deschutes National Forest in 2005.

results of and considered the conclusions drawn from several of the long-term silvicultural research projects through which those who went before—Kolbe, Mowat, Dahms, Sowder, Roth, Barrett, Cochran, Seidel, Martin, Landsberg, Mitchell, and others—teach their posterity and speak to the future.

Change is constant and inevitable. Its consequences, gains and losses, sometimes become clearer with time. The contributions of the Pringle Falls Experimental Forest and the Bend Silviculture Laboratory to forest science and forest management may be documented and assessed as gains. What may have been lost to change is difficult to estimate. Walt Dahms may have come as close as anyone ever will to such an estimate in 1982 when the Bend Silviculture Laboratory seemed on the brink of closure: "When you shut something like this down, you lose a lot of what's been done" (Francis 1982). And, it might be added, a lot of what could be done.

And the sighing of the pines
Up here near the timberline
Makes me wish I'd done things different
But wishing don't make it so.

—Ian Tyson, *Fifty Years Ago*

Common and Scientific Names

Common name	Scientific name
Trees:	
Corsican pine	*Pinus nigra* Arnold ssp. *laricio* Maire
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Engelmann spruce	*Picea engelmannii* Parry ex. Engelm.
Grand fir	*Abies grandis* (Dougl. ex D. Don) Lindl.
Lodgepole pine	*Pinus contorta* var. *murrayana* (Grev. & Balf.) Engelm.
Mountain hemlock	*Tsuga mertensiana* (Bong.) Carr.
Japanese black pine	*Pinus thunbergii* Parl.
Jeffrey pine	*Pinus jeffreyi* Grev. & Balf.
Ponderosa pine	*Pinus ponderosa* Dougl. ex Laws.
Scots pine	*Pinus sylvestris* L.
Shasta red fir	*Abies magnifica* A. Murr.
Sugar pine	*Pinus lambertiana* Dougl.
Thinleaf alder	*Alnus incana* (L.) Moench ssp. *tenuifolia* (Nutt.) Breitung
Western larch	*Larix occidentalis* Nutt.
Western white pine	*Pinus monticola* Dougl. ex D. Don
White fir	*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.
Shrubs:	
Antelope bitterbrush	*Purshia tridentata* (Pursh) DC.
Big sagebrush	*Artemisia tridentata* Nutt.
Golden chinquapin	*Castanopsis chrysophylla* (Dougl. ex Hook.) DC.
Greenleaf manzanita	*Arctostaphylos patula* Greene
Guayule	*Parthenium argentatum* Gray
Snowbrush ceanothus	*Ceanothus velutinus* Dougl. ex Hook.
Pathogens:	
Armillaria root fungus	*Armillaria mellea* (Vahl) Quel.
Pine needle blight	*Elytroderma deformans* (Weir)
Root rot	*Armillaria ostoyae* (H. Romagnesi) Herink.
Western dwarf mistletoe	*Arceuthobium campylopodum* (Engelm.) Gill
Insects:	
Balsam woolly adelgid	*Adelges picea* Ratz.
Douglas-fir tussock moth	*Orgyia pseudotsugata* McDunnough
Fir engraver beetle	*Scolytus ventralis* Leconte
Larch casebearer	*Coleophora laricella* Hubner
Lodgepole needleminer	*Coleotechnites* sp. nr. *milleri* Busck
Mountain pine beetle	*Dendroctonus ponderosae* Hopkins
Pandora moth	*Coloradia pandora* Blake
Pine engraver	*Ips pini* Say
Western pine beetle	*Dendroctonus brevicomis* Leconte
Western pine shoot borer	*Eucosma sonomana* Kearfott
Western spruce budworm	*Choristoneura occidentalis* Freeman

Acknowledgments

The assistance and understanding of many helped me meet many of the challenges in this project and made its completion possible. I thank the many interviewees including Walt Dahms, Jim Barrett, Pat Cochran, Russ Mitchell, Boyd Wickman, and Bob Martin, among others, for their invaluable knowledge. In addition, I appreciate (in alphabetical order) Matt Busse, Barney Duberow, Dave Frewing, Bill Johnson, Joan Landsberg, Lew Roth, Ken Seidel, the late Roy Silen, the late Bob Tarrant, and Andy Youngblood for participating in the oral history process. I thank Andy Youngblood, also, for hosting my October 2002 research visit to the La Grande Forestry and Range Sciences Laboratory and for follow-up efforts, and Cindy Miner and Val Rapp for hosting my January 2003 research visits to the PNW Research Station Headquarters in Portland and for all their subsequent work on the project. I greatly appreciate inputs from others including scientists Carl Berntsen, Bill Hopkins, and Charlie Sartwell, and technicians Larry Carpenter and Michele Penner (Finck). Special thanks to Cindy Miner, Val Rapp, Carolyn Wilson, and Lynn Sullivan—who took over the project when Val Rapp retired and saw it to completion—at PNW Research Station Headquarters for editorial review of the drafts, and to Jim Barrett, Dave Frewing, Russ Mitchell, Michelle Penner (Finck), and Boyd Wickman for technical reviews of the drafts and continuing assistance and encouragement. For setting encouraging and inspiring examples, I am indebted to others who have written history for the PNW Research Station, especially Ivan Doig, Max Geier, and Bill Robbins. Finally, for her patience and support, I thank my wife, Pat Joslin, a former Bend Silviculture Laboratory physical science technician and Deschutes National Forest botanist.

Metric Equivalents

When you know:	Multiply by:	To find:
Inches	2.54	Centimeters
Feet	.305	Meters
Acres	.405	Hectares
Board feet (logs)	.0045	Cubic meters
Square feet per acre	.229	Square meters per hectare
Trees per acre	2.47	Trees per hectare

References

Adams, D.H. 1972. The relation of cover to the distribution of *Armillaria mellea* in a ponderosa pine forest. Corvallis, OR: Oregon State University. 115 p. Ph.D. dissertation.

Adams, D.H. 1974. Identification of clones of *Armillaria mellea* in young-growth ponderosa pine. Northwest Science. 48(1): 2–28.

Architectural Record. 1964. Laboratory for research in forest timber. 32(2): 32–2, 32–4.

Baker, G.C. 1950. Historical writeup of the Deschutes National Forest. Bend, OR: U.S. Department of Agriculture, Forest Service, Deschutes National Forest. 47 p.

Barrett, J.W. 1960. Intensive control in logging ponderosa pine. Iowa State Journal of Science. 34(4): 603–608.

Barrett, J.W. 1961. Response of 55-year-old lodgepole pine to thinning. Res. Note RN-206. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 8 p.

Barrett, J.W. 1963. Dominant ponderosa pine *do* respond to thinning. Res. Note PNW-9. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 8 p.

Barrett, J.W. 1965. Spacing and understory vegetation affect growth of ponderosa pine saplings. Res. Note PNW-27. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 8 p.

Barrett, J.W. 1966. A record of ponderosa pine seed flight. Res. Note PNW-38. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 5 p.

Barrett, J.W. 1968. Pruning of ponderosa pine . . . effect on growth. Res. Pap. PNW-68. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 9 p.

Barrett, J.W. 1969. Crop-tree thinning of ponderosa pine in the Pacific Northwest. Res. Note PNW-100. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 13 p.

Barrett, J.W. 1970. Ponderosa pine saplings respond to control of spacing and understory vegetation. Res. Pap. PNW-106. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 16 p.

Barrett, J.W. 1973. Latest results from the Pringle Falls ponderosa pine spacing study. Res. Note PNW-29. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 22 p.

Barrett, J.W. 1978. Height growth and site index curves for managed, even-aged stands of ponderosa pine in the Pacific Northwest. Res. Pap. PNW-232. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 14 p.

Barrett, J.W. 1979. Silviculture of ponderosa pine in the Pacific Northwest: the state of our knowledge. Gen. Tech. Rep. PNW-97. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 106 p.

Barrett, J.W. 1981. Twenty-year growth of thinned and unthinned ponderosa pine in the Methow Valley of northern Washington. Res. Pap. PNW-286. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 13 p.

Barrett, J.W. 1982. Twenty-year growth of ponderosa pine saplings thinned to five spacings in central Oregon. Res. Pap. PNW-301. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 18 p.

Barrett, J.W. 1983. Growth of ponderosa pine poles thinned to different stocking levels in central Oregon. Res. Pap. PNW-311. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 9 p.

Barrett, J.W. 1999. Author's oral history interview, June 14. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Barrett, J.W. 2003. Personal communication. Research forester, retired. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Bend Silviculture Laboratory.

Barrett, J.W.; Newman, R.P. 1974. High yields from 100-year-old ponderosa pine. Res. Note PNW-220. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 12 p.

Barrett, J.W.; Roth, L.F. 1985. Response of dwarf mistletoe-infested ponderosa pine to thinning: 1. Sapling growth. Res. Pap. PNW-330. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 15 p.

Barrett, J.W.; Tornbom, S.S.; Sassaman, R.W. 1976. Logging to save ponderosa pine regeneration: a case study. Res. Note PNW-273. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 13 p.

Barrett, J.W.; Youngberg, C.T. 1965. Effect of tree spacing and understory vegetation on water use in pumice soil. Soil Science Society of America Proceedings. 29(4): 472–475.

Bend Bulletin. 1909a. Will experiment with yellow pines. April 7.

Bend Bulletin. 1909b. Forest expert has begun experiments. April 28.

Bend Bulletin. 1916. March 20. In: Cogswell 1981.

Bend Bulletin. 1956. Forest range man shift announced. August 16.

Bend Bulletin. 1960. Green light on research center given. August 4.

Bend Bulletin. 1961a. Research center appears assured.

Bend Bulletin. 1961b. Seed from local species of alder to go to Japan. September 13.

Bend Bulletin. 1961c. Sen. Neuberger urges research project here. February 1.

Bend Bulletin. 1961d. Work of the Bend Research Center. August 2.

Bend Bulletin. 1962a. Driscoll gets doctor's degree. June 27.

Bend Bulletin. 1962b. Work rushed on silviculture lab on Heights. November 26.

Bend Bulletin. 1964a. CofC [Chamber of Commerce] plans luncheon for dignitaries. May 1.

Bend Bulletin. 1964b. Dedication of silviculture lab to mark milestone for region. May 1.

Bend Bulletin. 1966. Berntsen's study unlocks secrets of pine production. December 23.

Bend Bulletin. 1972. Researchers study ecology of trees at Pringle Falls. March 15.

Bend Bulletin. 1974a. Bids sought for silviculture laboratory. September 16.

Bend Bulletin. 1974b. Lab facility contract due. July 9.

Bend Bulletin. 1974c. Rebuild. January 18.

Bend Bulletin. 1974d. Silviculture money okayed. May 17.

Bend Bulletin. 1976. Ullman attends silviculture lab event in Bend. May 31.

Bend Bulletin. 1982. Federal cut may affect other office. February 12.

Berntsen, C.M. 2002. Personal communication. Research forester, retired. U.S. Department of Agriculture, Forest Service, Deschutes Research Center and Washington office.

Bork, J.L. 1984. Fire history in three vegetation types on the eastern side of the Oregon Cascades. Corvallis, OR: Oregon State University. 94 p. Ph.D. dissertation.

Bork, J.L. 1985. Fire management plan for the Pringle Falls Research Natural Area. Bend, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Bend Silviculture Laboratory. 29 p.

Boyer, S. [N.d.]. New image for forest fires. Bend Bulletin.

Brickey, D. 1972. Solution sought to mid-state gopher problem. Bend Bulletin. March 29.

Briegleb, P.A. 1936. Forest statistics for Deschutes County, Oregon. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest Experiment Station. 6 p.

Briegleb, P.A. 1943. Growth of ponderosa pine by Keen tree class. Res. Note RN-32. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 15 p.

Brogan, P.F. 1962. Studies of sun spots and tree rings had bearing on dating Deschutes pines. Bend Bulletin. April 25.

Brogan, P.F. 1963. Bend Silviculture Laboratory on Awbrey Heights put in use. Bend Bulletin. November 27.

Brogan, P.F. 1967. Bend's unique Silviculture Lab has been faced with shortage of funds. Bend Bulletin.

Busse, M.D. 2002. Personal communication. Research microbiologist. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Silviculture Laboratory, 2400 Washington Avenue, Redding, CA 96001.

Busse, M.D.; Cochran, P.H.; Barrett, J.W. 1996. Changes in ponderosa pine site productivity following removal of understory vegetation. Soil Science Society of America Journal. 60(6): 1614–1621.

Callister, S. 1967. Study may end with retirement of bird expert. Bend Bulletin. January 5.

Carlson, W. 2001. The great railroad building race up the Deschutes River. In: Little known tales from Oregon history. Bend, OR: Sun Publishing: 74–77. Vol. IV.

Cliff, E.P. 1964. A key to tomorrow: speech presented at the dedication of the Silviculture Laboratory, Bend, Oregon, May 2. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Cochran, P.H. 1969a. Lodgepole pine clearcut size affects minimum temperatures near the soil surface. Res. Pap. PNW-86. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 9 p.

Cochran, P.H. 1969b. Thermal properties and surface temperatures of seedbeds, a guide for foresters. Portland, OR: U.S. Department of Agriculture, Forest Service. Pacific Northwest Forest and Range Experiment Station. 19 p.

Cochran, P.H. 1970. Seeding ponderosa pine. In: Hermann, R.K., comp., ed. Regeneration of ponderosa pine: Proceedings of the symposium. Corvallis, OR: Oregon State University: 28–35.

Cochran, P.H. 1972. Temperature and soil fertility affect lodgepole and ponderosa seedling growth. Forest Science. 18(2): 132–134.

Cochran, P.H. 1973a. Natural regeneration of lodgepole pine in south-central Oregon. Res. Note PNW-204. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 18 p.

Cochran, P.H. 1973b. Response of individual ponderosa pine trees to fertilization. Res. Note PNW-206. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 15 p.

Cochran, P.H. 1977. Response of ponderosa pine 8 years after fertilization. Res. Note PNW-301. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 7 p.

Cochran, P.H. 1979a. Response of thinned ponderosa pine to fertilization. Res. Note PNW-339. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 8 p.

Cochran, P.H. 1979b. Site index and height growth curves for managed, even-aged stands of white or grand fir east of the Cascades in Oregon and Washington. Res. Pap. PNW-252. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 13 p.

Cochran, P.H. 1992. Stocking levels and underlying assumptions for uneven-aged ponderosa pine stands. Res. Note PNW-RN-509. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 10 p.

Cochran, P.H. 1998a. Examples of mortality and reduced annual increments of white fir induced by drought, insects, and disease at different stand densities. Res. Note PNW-RN-525. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 19 p.

Cochran, P.H. 1998b. Reduction in growth of pole-sized ponderosa pine related to a Pandora moth outbreak in central Oregon. Res. Note PNW-RN-526. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 14 p.

Cochran, P.H. 1999. Author's oral history interview, June 16. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Cochran, P.H.; Barrett, J.W. 1998. Thirty-five-year growth of thinned and unthinned ponderosa pine in the Methow Valley of northern Washington. Res. Pap. PNW-RP-502. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 24 p.

Cochran, P.H.; Barrett, J.W. 1999a. Growth of ponderosa pine thinned to different stocking levels in central Oregon: 30-year results. Res. Pap. PNW-RP-508. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 27 p.

Cochran, P.H.; Barrett, J.W. 1999b. Thirty-five-year growth of ponderosa pine saplings in response to thinning and understory removal. Res. Pap. PNW-RP-512. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 28 p.

Cochran, P.H.; Berntsen, C.M. 1973. Tolerance of lodgepole and ponderosa pine seedlings to low night temperatures. Forest Science. 14(4): 272–280.

Cochran, P.H.; Boersma, L.; Youngberg, C.T. 1967. Thermal properties of pumice soil. Soil Science Society of America Proceedings. 31: 454–458.

Cochran, P.H.; Brock, T. 1985. Soil compaction and initial height growth of planted ponderosa pine. Res. Note PNW-434. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 4 p.

Cochran, P.H.; Dahms, W.G. 1998. Lodgepole pine development after early spacing in the Blue Mountains of Oregon. Res. Pap. PNW-RP-503. Portland, OR: U.S. Department of Agriculture, Forest Service. 24 p.

Cochran, P.H.; Dahms, W.G. 2000. Growth of lodgepole pine thinned to various densities on two sites with differing productivities in central Oregon. Res. Pap. PNW-RP-520. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 59 p.

Cochran, P.H.; Geist, J.M.; Clemens, D.L.; Clausnitzer, R.R.; Powell, D.C. 1994. Suggested stocking levels for forest stands in northeastern Oregon and southeastern Washington. Res. Note PNW-RN-513. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p.

Cochran, P.H.; Hopkins, W.E. 1991. Does fire exclusion increase productivity of ponderosa pine? In: Harvey, A.E.; Neuenschwander, L.F., comps. Proceedings, Management and productivity of western-montane forest soils. Gen. Tech. Rep. INT-280. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 224–228.

Cochran, P.H.; Newman, R.P.; Barrett, J.W. 1991. Fertilization and spacing effects on growth of planted ponderosa pine. Res. Note PNW-RN-500. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 13 p.

Cochran, P.H.; Seidel, K.W. 1999. Growth and yield of western larch under controlled levels of stocking in the Blue Mountains of Oregon. Res. Pap. PNW-RP-517. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 35 p.

Coe, U.C. 1940. Frontier doctor: observations on central Oregon and the changing West. New York, NY: Macmillan Co. 264 p.

Cogswell, P., Jr. 1981. Deschutes country pine logging. In: Vaughn. T., ed. High and mighty: selected sketches about the Deschutes country. Portland, OR: Oregon Historical Society: 235–259.

Coville, F.V. 1898. Forest growth and sheep grazing in the Cascade Mountains of Oregon. Bull. No. 15. Washington, DC: U.S. Department of Agriculture, Division of Forestry. 54 p.

Cowlin, R.W. 1988. Federal forest research in the Pacific Northwest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 244 p.

Dahms, W.G. 1949. How long do ponderosa pine snags stand? Res. Note RN-57. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 3 p.

Dahms, W.G. 1950. The effect of manzanita and snow-brush competition on ponderosa pine reproduction. Res. Note RN-65. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 3 p.

Dahms, W.G. 1951. Intensity of cut as related to ponderosa pine management: a statistical approach to the problem of isolating cutting effect. Syracuse, NY: State University of New York. 101 p. M.S. thesis.

Dahms, W.G. 1954. Growth of pruned ponderosa pines. Journal of Forestry. 52(6): 444–445.

Dahms, W.G. 1960. Long-suppressed ponderosa pine seedlings respond to release. Res. Note RN-190. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 3 p.

Dahms, W.G. 1963. Dispersal of lodgepole pine seed into clear-cut patches. Res. Note PNW-3. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 7 p.

Dahms, W.G. 1964. Gross and net yield tables for lodge-pole pine. Res. Pap. PNW-8. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 14 p.

Dahms, W.G. 1971. Fifty-five-year-old lodgepole pine responds to thinning. Res. Note PNW-141. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 13 p.

Dahms, W.G. 1983. Growth simulation model for lodge-pole pine in central Oregon. Res. Pap. PNW-302. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 22 p.

Dahms, W.G. 1999. Author's oral history interview, June 11. 17 p. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Dahms, W.G.; Barrett, J.W. 1975. Seed production of central Oregon ponderosa and lodgepole pines. Res. Pap. PNW-191. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 13 p.

Deeming, J.E. 2003. Personal communication. Research forester, retired, U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.

DeMars, D.J.; Barrett, J.W. 1987. Ponderosa pine managed-yield simulator: PPSIM user guide. Gen. Tech. Rep. PNW-GTR-203. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 36 p.

Denton, K.E. 1997. Bend lab meeting notes (23 November). On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Doig, I. 1977. Early forestry research: a history of the Pacific Northwest Research Forest and Range Experiment Station 1925-1975. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 32 p.

Duncan, S.; Miner, C. 2000. Closer to the truth: 75 years of discovery in forest and range research. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 76 p.

Fight, R.D.; Bolon, N.A.; Cahill, J.M. 1992. Financial analysis of pruning ponderosa pine. Res. Pap. PNW-RP-449. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 17 p.

Flach, V.H. 1933. Special instructions for the control and mapping of the Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, North Pacific Region. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Ford-Robertson, F.C., ed. 1951. Terminology of forest science, technology practice and products. Washington, DC: Society of American Foresters. 349 p.

Francis, M. 1982. Research will falter if science lab closes. Bend Bulletin. February 14.

Frewing, D.W. 2002. Author's oral history interview, July 10. 25 p. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208–3890.

Fry, A.R. 1967. Thornton T. Munger: forest research in the Pacific Northwest. Berkeley, CA: Regional Oral History Office, The Bancroft Library, University of California. 245 p.

Geier, M.G. 1998. Forest Service research and scientific communities in Alaska: a history of the origins and evolution of USDA Forest Service research in Juneau, Fairbanks, and Anchorage. Gen. Tech. Rep. PNW-GTR-426. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 220 p.

Government Employees Training Act [GETA]. 1958. Title 5, United States Code, Chapter 41.

Hagenstein, W.D. 2002. Personal communication. Forester and executive vice president, retired. Industrial Forestry Association.

Hatton, R.R. 1987. High country of central Oregon. Portland, OR: Binford and Mort Publishing. 144 p.

Hessburg, P.F.; Mitchell, R.G.; Filip, G.M. 1994. Historical and current roles of insects and pathogens in eastern Oregon and Washington forested landscapes. Gen. Tech. Rep. PNW-GTR-327. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 72 p.

Hopkins, W.E. 2003. Personal communication. Ecologist, retired. U.S. Department of Agriculture, Forest Service, Area IV Ecology Team.

Isaac, L.A.; Kolbe, E.L. 1931. The proposed Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest Experiment Station. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Jensen, M.E.; Bourgeron, P.S. 1994. Ecosystem management: principles and applications. Gen. Tech. Rep. PNW-GTR-318. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 376 p. Vol. 2.

Johnson, J. 2003. Becoming a timber town. Bend Bulletin, June 15.

Keen, F.P. 1936. Relative susceptibility of ponderosa pine to bark-beetle attack. Journal of Forestry. 34(10): 919–927.

Kolbe, E.L. 1933a. Special instructions for making an intensive reconnaissance of the Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest Experiment Station. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Kolbe, E.L. 1933b. Working plan for grazing demonstration plots at the Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest Experiment Station. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Kolbe, E.L. 1935. The Pringle Falls Natural Area representing the sugar pine, lodgepole and ponderosa pine types, Deschutes National Forest. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Kolbe, E.L. 1938. A guide to the Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 18 p.

Kolbe, E.L. 1939. Burning ponderosa pine snags by the base-fire method. Journal of Forestry. 37(10): 894–896.

Kolbe, E.L.; Frost, L.W. 1935. Final report on the timber reconnaissance and mapping of the Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest Experiment Station. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Kolbe, E.L.; McKay, D.F. 1939. Seven methods of cutting tested at Pringle Falls. Res. Note RN-27. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 1 p.

Koonce, A.L. 1981. Interactions between fire and dwarf mistletoe in ponderosa pine. Corvallis, OR: Oregon State University. 53 p. Ph.D. dissertation.

Koonce, A.L.; Roth, L.F. 1980. The effects of prescribed burning on dwarf mistletoe in ponderosa pine. In: Martin, R.E.; Edmonds, R.L.; Fulkner, D.A. [and others]. Proceedings, 6th conference on fire and forest meteorology. Bethesda, MD: Society of American Foresters: 197–203.

Landsberg, J.D. 1992. Response of ponderosa pine forests in central Oregon to prescribed underburning. Corvallis, OR: Oregon State University. 282 p. Ph.D. dissertation.

Landsberg, J.D. 2002. Author's oral history interview, October 21. Research forester, retired. U.S. Department of Agriculture, Forest Service. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Landsberg, J.D.; Cochran, P.H.; Finck, M.M.; Martin, R.E. 1984. Foliar nitrogen content and tree growth after prescribed fire in ponderosa pine. Res. Note PNW-412. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 15 p.

Langille, H.D.; Plummer, F.G.; Dodwell, A.; Rixon, T.F.; Leiberg, J.B. 1903. Forest conditions in the Cascade Range Forest Reserve, Oregon. Prof. Pap. 9, Series H., Forestry, 6. Washington, DC: U.S. Department of the Interior, Geological Survey.

Langston, N. 1995. Forest dreams, forest nightmares: the paradox of old growth in the inland West. Seattle, WA: University of Washington Press. 368 p.

Larsson, S.; Oren, R.; Waring, R.H.; Barrett, J.W. 1983. Attacks of mountain pine beetle as related to tree vigor of ponderosa pine. Forest Science. 29(2): 395–402.

Lieberg, J.B. 1900. Twenty-first annual report of the United States Geological Survey to the Secretary of the Interior, 1899-1900. Part V, Forest reserves: Cascade Range and Ashland forest reserves and adjunct regions. Washington, DC: U.S. Department of the Interior, Geological Survey.

Martin, R.E. 1983. Antelope bitterbrush seedling establishment following prescribed burning in the pumice zone of the southern Cascade Mountains. In: Tiedemann, A.R.; Johnson, K.L., comps. Proceedings—research and management of bitterbrush and cliffrose in western North America. Gen. Tech. Rep. INT-152. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 82–90.

Martin, R.E. 2000. Author's oral history interview, January 29. Professor, Department of Forestry and Resource Management, University of California, Berkeley. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Martin, R.E.; Anderson, H.E.; Boyer, W.D.; Dietrich, J.H.; Hirsch, S.N.; Johnson, V.J.; McNabb, W.H. 1979. Effects of fire on fuels: a state-of-knowledge review. Gen. Tech. Rep. GTR-WO-13. Washington, DC: U.S. Department of Agriculture, Forest Service. 64 p.

Martin, R.E.; Dell, J.D. 1978. Planning for prescribed burning in the inland Northwest. Gen. Tech. Rep. PNW-76. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 68 p.

Martin, R.E.; Driver, C.H. 1983. Factors affecting antelope bitterbrush reestablishment following fire. In: Tiedemann, A.R.; Johnson, K.L., comps. Proceedings —research and management of bitterbrush and cliffrose in western North America. Gen. Tech. Rep. INT-152. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 266–279.

Martin, R.E.; Frewing, D.W.; McClanahan, J.L. 1981. Average biomass of four northwest shrubs by fuel size class and crown cover. Res. Note PNW-374. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 6 p.

Martin, R.E.; Mitchell, R.G. 1980. Possible, potential, probable, and proven fire-insect interactions. In: Proceedings, 1980 national convention. Bethesda, MD: Society of American Foresters: 138–144.

Martin, R.E.; Robinson, D.D.; Schaeffer, W.H. 1976. Fire in the Pacific Northwest: perspectives and problems. In: Proceedings: Tall Timbers fire ecology conference. Tallahassee, FL: Tall Timbers Research Station.

Mason, R.R.; Paul, H.G. 1999. Long-term dynamics of needle miner populations in central Oregon. Forest Science. 45(1): 15–25.

Mason, R.R.; Tigner, T.C. 1972. Forest-site relationships within an outbreak of lodgepole needle miner in central Oregon. Res. Pap. PNW-146. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 18 p.

McArthur, L.A.; McArthur, L.L. 2003. Oregon geographic names. Portland, OR: Oregon Historical Society Press. 1073 p.

Meyer, W.H. 1961 [1938]. Yield of even-aged stands of ponderosa pine. Rev. Tech. Bull. 630. Washington, DC: U.S. Department of Agriculture. 56 p.

Meyer, W.H.; Kolbe, E.L. 1931. Outline for establishing plots for growth and deterioration in virgin stands of western yellow pine at Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest Experiment Station. On file with: UDSA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Mills, T.J. 1995 (4 December). Letter to all Station employees. Summary of key elements of downsizing decisions. On file with: USDA Forest Service, Pacific Northwest Research Station. P.O. Box 3890, Portland, OR 97208-3890.

Mitchell, R.G. 1987. Anatomy of a mountain pine beetle outbreak in central Oregon. In: Bark beetle infestation in ponderosa pine and lodgepole pine: environmental assessment. Bend, OR: U.S. Department of Agriculture, Forest Service, Deschutes National Forest. Appendix A.

Mitchell, R.G. 1988. Mixed host strategies for mountain pine beetle control in central Oregon. In: Proceedings –symposium on the management of lodgepole pine to minimize losses to the mountain pine beetle. Gen. Tech. Rep. INT-262. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 60–63.

Mitchell, R.G. 1989. The pandora moth is coming to central Oregon. Cascades East. 14(2): 55–56.

Mitchell, R.G. 2003. Personal communication. Research entomologist, retired. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Mitchell, R.G.; Buffam, P.E. 2001. Patterns of long-term balsam woolly adelgid infestations and effects in Oregon and Washington. Western Journal of Applied Forestry. 16(3): 121–126.

Mitchell, R.G.; Martin, R.E. 1980. Fire and insects in pine culture of the Pacific Northwest. In: Proceedings, 6th conference on fire and forest meteorology. Seattle, WA: Society of American Foresters: 182–190.

Mitchell, R.G.; Preisler, H.K. 1991. Analysis of spatial patterns of lodgepole pine attacked by outbreak populations of the mountain pine beetle. Forest Science. 37(5): 1390–1408.

Mitchell, R.G.; Preisler, H.K. 1993. Colonization patterns of mountain pine beetle in thinned and unthinned lodgepole pine stands. Forest Science. 39(3): 528–545.

Mitchell, R.G.; Preisler, H.K. 1998. Fall rate of lodgepole pine killed by the mountain pine beetle in central Oregon. Western Journal of Applied Forestry. 13(1): 23–26.

Mitchell, R.G.; Sower, L.L. 1991. Life history of the western pine shoot borer (Lepidopters Olethreutidae) and effects on lodgepole pine in central Oregon. Journal of Economic Entomology. 84: 206–211.

Mitchell, R.G.; Waring, R.H.; Pitman, G.B. 1983. Thinning lodgepole pine increases tree vigor and resistance to mountain pine beetle. Forest Science. 29(1): 204–211.

Moeller, G.H. 1998 (7 December). Letter to Station Director Thomas Quigley. Disposition of research studies, Bend laboratory. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Mowat, E.L. 1947. Effect of pruning on growth of ponderosa pine. Res. Note RN-38. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 3 p.

Mowat, E.L. 1948. Selection cutting reduces ponderosa pine losses at Pringle Falls. Res. Note RN-45. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 3 p.

Mowat, E.L. 1949. Preliminary guides for management of lodgepole pine in Oregon and Washington. Res. Note RN-54. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 10 p.

Mowat, E.L. 1950. Cutting lodgepole pine overstory releases ponderosa pine reproduction. Journal of Forestry. 48(10): 679–680.

Mowat, E.L. 1953. Thinning ponderosa pine in the Pacific Northwest—a summary of present information. Res. Pap. 4. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 24 p.

Mowat, E.L. 1954. A guide to the Pringle Falls Experimental Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 26 p.

Mowat, E.L. 1960. No serotinous cones on central Oregon lodgepole pine. Journal of Forestry. 58(2): 118–119.

Mowat, E.L. 1961. Growth after partial cutting of ponderosa pine on permanent sample plots in eastern Oregon. Res. Pap. 44. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 23 p.

Munger, T.T. 1908. Report on a study of the encroachment of lodgepole pine on western yellow pine on the slopes of the Cascade Mountains in Oregon. Portland, OR: U.S. Department of Agriculture, Forest Service, North Pacific District. 89 p.

Munger, T.T. 1911. The growth and management of Douglas fir. Circular 175. Portland, OR: U.S. Department of Agriculture, Forest Service, North Pacific District.

Munger, T.T. 1914. Replacement of yellow pine by lodgepole pine on the pumice soils of central Oregon. In: Proceedings of the Society of American Foresters 9. Washington, DC: Society of American Foresters: 396–406.

Munger, T.T. 1917. Western yellow pine in Oregon. Bull. No. 418. Washington, DC: U.S. Department of Agriculture, Forest Service. 124 p.

Munger, T.T. 1924. Governmental forest research: a paper concerning the work of the Pacific Northwest Forest Experiment Station for the annual meeting of the Western Forestry and Conservation Association, Vancouver, BC, December 3, 1924. Typescript. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 2770 Sherwood Lane, Suite 2A, Juneau, AK 99801-8545.

Munger, T.T. 1942. A demonstration of tree classification and evaluation for maturity selection cutting: Pringle Falls plot 37. 2 p. Unpublished paper. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Munger, T.T. 1946 (November 21). The Forest Service then and now. Talk presented at a luncheon in Portland, Oregon. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Munger, T.T. 1947. Growth of ten regional races of ponderosa pine in six plantations. Res. Note RN-39. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 4 p.

Munger, T.T. 1955. Fifty years of forest research in the Pacific Northwest. Oregon Historical Quarterly. 56(3): 226–247.

Munger, T.T. 1962. Recollections of my thirty-eight years in the Forest Service, 1908-1946. Timber Lines. Vol. XVI (supplement). 30 p.

Nix, N. 1990. Larvae may pry Pandora's box. Bend Bulletin. May 17.

Parks, M.Y. 1997. The Fort Rock Basin: a valley in transition. Oregon Historical Society Quarterly. 98(1): 56–90.

Pederson, D. 2003. Personal communication. Forester, retired. U.S. Department of Agriculture, Forest Service., Deschutes National Forest.

Penner (Finck), M. 2003. Personal communication. U.S. Department of Agriculture, Forest Service, Deschutes National Forest.

Perry, W.J.; Joslin, L., eds. 1999. Walt Perry: an early-day forest ranger in New Mexico and Oregon. Bend, OR: Wilderness Associates. 184 p.

Peterson, C.E., Jr. 1998 (15 January). Letter to station director. Reply to your 8/19 letter "Status of studies: Bend Laboratory and Pringle Falls." On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Portland Oregonian. 1930. Tree ring weather showing indicates dry era's close. May 24.

Portland Oregonian. 1962. Forest agency rejects bids. June 5.

Portland Oregonian. 1964a. Foresters to confer. April 28.

Portland Oregonian. 1964b. Forest lab dedicated. May 3.

Preso, T. 1990a. Alluring pines may spell beetle's doom. Bend Bulletin. September 9.

Preso, T. 1990b. Recreating a forest. Bend Bulletin. April 14.

Pyne, S.J. 1982. Fire in America: a cultural history of wildland and rural fire. Princeton, NJ: Princeton University Press. 654 p.

Pyne, S.J. 2001. Year of the fires. New York, NY: Viking Penguin. 322 p.

Quigley, T.M.; Hayes, J.L.; Starr, L.; Datermann, G.E. 2001. Improving forest health and productivity in eastern Oregon and Washington. Northwest Science. 75: 234–251.

Reaves, J.L. 1985. Interaction between Armillaria root disease, *Trichoderma*, and prescribed fire in a ponderosa pine forest. Atlanta, GA: Atlanta University. 146 p. Ph.D. dissertation.

Reaves, J.L.; Shaw, C.G.; Mayfield, J.E. 1990. The effects of *Trichoderma* spp. Isolated from burned and non-burned forest soils on the growth and development of *Armillaria ostoyae* in culture. Northwest Science. 64(1): 39–44.

Riis, J. 1937. Ranger trails. Richmond, VA: The Dietz Press. 160 p.

Robbins, W.G. 2004. Landscapes of conflict: the Oregon story, 1940-2000. Seattle, WA: University of Washington Press. 414 p.

Robbins, W.G.; Wolf, D.W. 1994. Landscape and the intermontane West: an environmental history. Gen. Tech. Rep. PNW-GTR-319. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 32 p.

Roth, L.F. 1953. Pine dwarf mistletoe on the Pringle Falls Experimental Forest. Res. Note RN-91. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 3 p.

Roth, L.F. 1954. Distribution, spread, and intensity of dwarf mistletoe on ponderosa pine. Phytopathology. 44: 504.

Roth, L.F. 1959. Natural emplacement of dwarfmistletoe seed on ponderosa pine. Forest Science. 5: 365–369.

Roth, L.F. 1966. Foliar habitat of ponderosa pine as a heritable basis for resistance to dwarf mistletoe. In: Gerhold, H.D.; Schreiner, E.J.; McDermott, R.E.; Winieski, J.A., eds. Breeding pest-resistant trees: proceedings of a symposium. Oxford: Pergamon Press: 221–228.

Roth, L.F. 1971. Dwarf mistletoe damage to small ponderosa pines. Forest Science. 17(3): 373–380.

Roth, L.F. 1974a. Juvenile susceptibility of ponderosa pine to dwarf mistletoe. Phytopathology. 64(5): 689–692.

Roth, L.F. 1974b. Resistance of ponderosa pine to dwarf mistletoe. Silvae Genetica. 23(4): 116–120.

Roth, L.F. 1978. Genetic control of dwarf mistletoe. In: Scharpf, R.F.; Parmeter, J.R., tech cords. Dwarf mistletoe control through forest management; Proceedings, symposium. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 69–72.

Roth, L.F. 2001. Dwarf mistletoe-induced mortality in Northwest ponderosa pine growth studies. Western Journal of Applied Forestry. 16(3): 136–141.

Roth, L.F. 2002. Author's oral history interview, May 10. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Roth, L.F.; Barrett, J.W. 1985. Response of dwarf mistletoe-infested ponderosa pine to thinning: 2. Dwarf mistletoe propagation. Res. Pap. PNW-331. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 20 p.

Russell, I.C. 1905. Preliminary report on the geology and water resources of central Oregon. Bull. No. 252. Washington, DC: U.S. Department of the Interior, Geological Survey. 138 p.

Sartwell, C. 1971. *Ips pini* (Coleptera: Scolytidae) emergence per exit hole in ponderosa pine thinning slash. Annals of the entomological Society of America. 64(6): 1473–1474.

Sartwell, C. 2004. Personal communication. Entomologist, retired. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station and Pringle Falls Experimental Forest.

Scharpf, R.F.; Roth, L.F. 1992. Resistance of ponderosa pine to western dwarf mistletoe in central Oregon. Res. Pap. PSW-RP-208. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

Seidel, K.W. 1974. Freezing resistance of hardened and unhardened grand fir seedlings. Northwest Science. 48(3): 195–202.

Seidel, K.W. 1977a. Levels-of-growing-stock study in thinned western larch pole stands in eastern Oregon. Res. Pap. PNW-221. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 14 p.

Seidel, K.W. 1977b. Suppressed grand fir and Shasta red fir respond well to release. Res. Note. PNW-288. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 7 p.

Seidel, K.W. 1979a. Natural regeneration after shelterwood cutting in a grand fir-Shasta red fir stand in central Oregon. Res. Pap. PNW-259. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 23 p.

Seidel, K.W. 1979b. Regeneration in mixed conifer clearcuts in the Cascade Range and Blue Mountains of eastern Oregon. Res. Pap. PNW-248. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 24 p.

Seidel, K.W. 1979c. Regeneration in mixed conifer shelterwood cuttings in the Cascade Range of eastern Oregon. Res. Pap. PNW-264. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 29 p.

Seidel, K.W. 1980. Diameter and height growth of suppressed grand fir saplings after overstory removal. Res. Pap. PNW-275. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 9 p.

Seidel, K.W. 1983. Regeneration in mixed conifer and Douglas-fir shelterwood cuttings in the Cascade Range of Washington. Res. Pap. PNW-314. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 17 p.

Seidel, K.W. 1985a. Growth response of suppressed true fir and mountain hemlock after release. Res. Pap. PNW-344. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 22 p.

Seidel, K.W. 1985b. A ponderosa pine-grand fir spacing study in central Oregon: results after 10 years. Res. Note PNW-429. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 7 p.

Seidel, K.W. 1986. Tolerance of seedlings of ponderosa pine, Douglas-fir, grand fir, and Engelmann spruce for high temperatures. Northwest Science. 60(1): 1–7.

Seidel, K.W. 1987. Results after 20 years from a western larch levels-of-growing-stock study. Res. Pap. PNW-RP-387. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 18 p.

Seidel, K.W. 1989. A ponderosa pine-lodgepole pine spacing study in central Oregon: results after 20 years. Res. Pap. PNW-RP-410. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 14 p.

Seidel, K.W. 2002. Author's oral history interview, April 25. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Seidel, K.W.; Geist, J.M.; Strickler, G.S. 1990. The influence of cattle grazing and grass seeding on coniferous regeneration after shelterwood cutting in eastern Oregon. Res. Pap. PNW-RP-417. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 32 p.

Seidel, K.W.; Head, S.C. 1983. Regeneration in mixed conifer partial cuttings in the Blue Mountains of Oregon and Washington. Res. Pap. PNW-310. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 14 p.

Shea, R.W.; Kauffman, J.B. 1993. Effects of prescribed fire and thinning activities on fuel mass and nitrogen redistribution in pinus ponderosa ecosystems in central Oregon. Manuscript submitted to the Pacific Northwest Research Station, Portland, OR, by Department of Rangeland Resources, Oregon State University, Corvallis, OR, pursuant to Agreement No. PNW 90–473.

Shotwell, R.E. 1982. Cuts threaten Bend forest laboratory. Portland Oregonian. February 18.

Sikorowski, P.P. 1960. Dissemination of spores of *Elytoderma deformans* (Wier) Parker. Corvallis, OR: Oregon State College. 58 p. M.S. thesis.

Sikorowski, P.P.; Roth, L.F. 1962. *Elytoderma* mycelium in phloem of ponderosa pine. Phytopathology. 52(4): 332–336.

Silen, R.R. 2002. Author's oral history interview, June 28. 11 p. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Society of American Forestry News. 1948. Kolbe new chief forester of Western Pine Association. July.

Sowder, J.E. 1951. A sanitation-salvage cutting in ponderosa pine at the Pringle Falls Experimental Forest. Res. Pap. 2. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 24 p.

Sowder, J.E. 1953. Lumber grade recovery from young ponderosa pine. Res. Note RN-88. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 2 p.

Sower, L.L.; Mitchell, R.G. 1987. Host tree selection by western pine shoot borer (Lepidoptera: Olethreutidae) in ponderosa pine plantations. Environmental Entomology. 16: 1145–1147.

Sower, L.L.; Mitchell, R.G. 1994. Mating disruption of western pine shoot borer (Lepidoptera Olethreutidae) in lodgepole pine. Journal of Economic Entomology. 87: 144–147.

Speer, J.H.; Sweetnam, T.W.; Wickman, B.E.; Youngblood, A. 2004. Changes in pandora moth outbreak dynamics during the past 622 years. Ecology. 82(3): 679–697.

Steen, H.K. 1976. The U.S. Forest Service: a history. Seattle, WA: University of Washington Press. 356 p.

Steen, H.K., ed. 1994. View from the top: Forest Service research. Durham, NC: Forest History Society. 365 p.

Steen, H.K. 1998. Forest Service research: finding answers to conservation questions. Durham, NC: Forest History Society. 102 p.

Steen, H.K., ed. 1999. Forest and wildlife science in America: a history. Durham, NC: Forest History Society. 453 p.

Stone, D. [N.d.]. Radioactive materials used in studies at silviculture lab. The Bend Bulletin.

Strand, M.A.; Roth, L.F. 1976. Simulation model for spread and intensification of western dwarf mistletoe in thinned stands of ponderosa pine saplings. Phytopathology. 66: 888–895.

Tarrant, R.F. 1947. First soil survey gives significant results. Res. Note RN-36. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 4 p.

Tarrant, R.F. 2002. Author's oral history interview, May 9. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Tigner, T.C. 1970. Resistance to a needle miner in lodgepole pine. Ann Arbor, MI: University of Michigan. 79 p. Ph.D. dissertation.

Tigner, T.C.; Mason, R.R. 1973. Resistance to a needle miner in lodgepole pine varies with foliage source. Environmental Entomology. 2: 947–949.

Tripp, J. 1974a. Flames gut silviculture laboratory. Bend Bulletin. January 15.

Tripp, J. 1974b. Lab replacement may cost $500,000. Bend Bulletin. January 17.

Udall, S.L. 1963. The quiet crisis. New York: Holt, Rinehart and Winston. 196 p.

U.S. Department of Agriculture, Forest Service [USDA FS]. [N.d.]. Final Region 6 construction report for Silviculture Laboratory, Pacific Northwest Forest and Range Experiment Station, Deschutes County, Bend, Oregon. 10 p. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1931a. Report of the Pacific Northwest Forest Experiment Station for the month of April. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1931b. Report of the Pacific Northwest Forest Experiment Station for the month of August. On file with: USDA Forest Service, Pacific Northwest Research Station. P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1933a. Report of the Pacific Northwest Forest Experiment Station for the months of June-September. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1933b. Report of the Pacific Northwest Forest Experiment Station for the month of October. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1934. Report of the Pacific Northwest Forest Experiment Station for the months of June-September. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1935a. Report of the Pacific Northwest Forest Experiment Station for the month of April. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1935b. Report of the Pacific Northwest Forest Experiment Station for the month of October. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1936a. Report of the Pacific Northwest Forest Experiment Station for the month of January. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1936b. Report of the Pacific Northwest Forest Experiment Station for the months of June-September 1936. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1936c. Report of the Pacific Northwest Forest Experiment Station for the month of November. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1937. Letter: The Pringle Falls Experimental Forest. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1938. Annual report of the Pacific Northwest Forest Experiment Station for the calendar year 1937. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1940. Notes for visitors: Pringle Falls Experimental Forest, October 10. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1947a. Annual report to the Chief of the Forest Survice [sic] of the Pacific Northwest Forest and Range Experiment Station for the calendar year 1946. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, Oregon 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1947b. Pacific Northwest Forest and Range Experiment Station history supplement for calendar year 1946. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1947c. Pacific Northwest Forest and Range Experiment Station history supplement for calendar years 1946-1947. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1948. Annual report—1947. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, Oregon 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1949. Annual report—1948. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1951. Pacific Northwest Forest and Range Experiment Station history supplement for calendar year 1950. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1953a. Pacific Northwest Forest and Range Experiment Station annual report—1952. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1953b. Pacific Northwest Forest and Range Experiment Station history supplement for calendar years 1944-1953. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3820, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1954a. Pacific Northwest Forest and Range Experiment Station annual report—1953. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1954b. Pacific Northwest Forest and Range Experiment Station history supplement for calendar year 1953. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1955. Pacific Northwest Forest and Range Experiment Station annual report—1954. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1956. Pacific Northwest Forest and Range Experiment Station annual report—1955. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1959a. News release. February 25. Pacific Northwest Region and Pacific Northwest Forest and Range Experiment Station. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1959b. Press Release 6-1159. June 11. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1961. PNW News. Pacific Northwest Research Station. Dealy retires. May.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1962. Pacific Northwest Forest and Range Experiment Station Annual report 1961. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1963a. News release. April 2. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 2890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1963b. News release. October 25. On file with: UDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1967a. News release 5-62967. June 29. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1967b. Pacific Northwest Forest and Range Experiment Station Annual report 1966. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1974a. Fire destroys PNW's Bend Silviculture Laboratory. R6 Greensheet. Pacific Northwest Region. January 18.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1974b. Lab rebuilding funds requested. PNW News. Pacific Northwest Forest and Range Experiment Station. February 4.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1974c. Laboratory buildings funded. Forestry Research News. Pacific Northwest Forest and Range Experiment Station. September 6.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1975. Pacific Northwest Forest and Range Experiment Station Annual report: research progress 1974. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1976. Bend open house set. PNW News. Pacific Northwest Forest and Range Experiment Station. May 29.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1978. Press release. Forest Service enlarges natural area. May 16. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1982a. Bend staff wins trophy. PNW News. Pacific Northwest Forest and Range Experiment Station. November 1.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1982b. Joan Landsberg. PNW News. Pacific Northwest Forest and Range Experiment Station. January 18.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1983. Deeming named project leader at Bend. PNW News. Pacific Northwest Forest and Range Experiment Station. August 8.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1985a. Dahms honored. PNW News. Pacific Northwest Forest and Range Experiment Station. March 11.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1985b. Station has "new," shorter name. PNW News. Pacific Northwest Research Station. August 12.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1988. Ken Seidel retires. PNW News. Pacific Northwest Research Station. January.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1990. PNW Research Station reorganization proposal. Portland, OR: Pacific Northwest Research Station. October 15.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1992a. 1330-1 memorandum from Chief, June 25. Washington, DC.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1992b. Ecosystem management charter for Washington Office staff and interdisciplinary teams. Washington, DC.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1996a. Laboratories closed at Bend, Fairbanks. PNW Research News. Pacific Northwest Research Station. February/March.

U.S. Department of Agriculture, Forest Service [USDA FS]. 1996b. Status of the interior Columbia basin: summary of scientific findings. Gen. Tech. Rep. PNW-GTR-385. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; U.S. Department of the Interior, Bureau of Land Management. 144 p.

U.S. Department of Agriculture, Forest Service [USDA FS]. 2002. Strategy for the future. Portland, OR: Pacific Northwest Research Station. 38 p.

Van Wormer, J. 1964. Bend's silviculture laboratory. Pine Echoes. July-August: 12–17.

Watts, L.F.; Lodewick, J.E.; Burgess, T.H. 1939. Memorandum of agreement. April 20. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Westveld, R.H.; Munger, T.T.; Perry, W.J. 1928. Unpublished map of regional races of western yellow pine, Deschutes National Forest. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Wickman, B.E. 2003. Personal communication. Research entomologist, retired; scientist emeritus. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Wickman, B.E.; Mason, R.R.; Paul, H.G. 1996. Ponderosa pine response to nitrogen fertilization and defoliation by the pandora moth. In: Mattson, W.J.; Niemela, P.; Rousi, M., eds. Dynamics of forest herbivory: quest for pattern and principle. Gen. Tech. Rep. NC-183. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 118–126.

Wickman, B.E.; Seidel, K.W.; Starr, G.L. 1986. Natural regeneration 10 years after a Douglas-fir tussock moth outbreak in northeastern Oregon. Res. Pap. PNW-RP-370. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 15 p.

World Forestry Center. 1978. Ernest L. Kolbe, 1903–1978 [Brochure]. Portland, OR: World Forestry Center.

Yates, B. [N.d.]. They are planning the forests of tomorrow. Bend Bulletin.

Youngberg, C.T. 1969. Fertilizing planted pine. Paper presented at symposium; September 11-12, 1969; Oregon State University, Corvallis, OR. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Youngblood, A. 1993. Eastside ecosystem management research: a challenge for the 21st century. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 30 p.

Youngblood, A. 1995. Research publications of the Pringle Falls Experimental Forest, central Oregon Cascade Range, 1930 to 1993. Gen. Tech. Rep. PNW-GTR-347. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 45 p.

Youngblood, A. 1997 (13 November). Letter to: Phil Aune, Pacific Northwest Research Station; Jo Booser, Deschutes National Forest; Pat Cochran, University of Idaho; Ken Denton, Pacific Northwest Region; Doug Maguire, Oregon State University; Charley Peterson, Pacific Northwest Research Station. Status and disposition of Bend silviculture laboratory long-term studies. On file with: USDA Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850.

Youngblood, A. 2002. Author's oral history interview, October 29. On file with: USDA Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, Oregon 97208-3890.

Youngblood. A. 2004. Personal communication. Research forester, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Youngblood, A.; Everett, R.; Busse, M. 1994. Building National Forest System-Research partnerships for ecosystem management of east-side Oregon and Washington forests. In: Silviculture: from cradle of forestry to ecosystem management. Proceedings of the National Silviculture Workshop. Gen. Tech. Rep. SE-88. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Experiment Station: 207–214.

Youngblood, A.; Johnson, K.; Schlaich, J.; Wickman, B. 2004a. Silvicultural activities in Pringle Falls Experimental Forest, central Oregon. In: Shepperd, W.D.; Eskew, L.G., comps. 2004. Silviculture in special places: proceedings of the national silviculture workshop. Proceedings RMRS-P-34. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 31–48.

Youngblood, A.; Max, T.; Coe, K. 2004b. Stand structure in eastside old-growth ponderosa pine forests of Oregon and northern California. Forest Ecology and Management. 199(2004): 191–217.

Youngblood, A.; Riegel, G. 2000. Reintroducing fire in eastside ponderosa pine forests: a long-term test of fuel treatments. In: Neuenschwander, L.F.; Ryan, K.C.; Gollberg, G.E., eds. Proceedings of the Joint Fire Science conference and workshop, Boise, ID, 1999 June 15-17. Moscow, ID: University of Idaho: 142–150.

Index

Pacific Northwest Research Station

Web site	http://www.fs.fed.us/pnw
Telephone	(503) 808-2592
Publication requests	(503) 808-2138
FAX	(503) 808-2130
E-mail	pnw_pnwpubs@fs.fed.us
Mailing address	Publications Distribution Pacific Northwest Research Station P.O. Box 3890 Portland, OR 97208-3890