Work begun in the 1980s to restore a western larch forest in Montana has led to its recovery. Foresters on the Lolo National Forest worked with scientists from the Fire Sciences Laboratory in Missoula and consulted the written record to gain an understanding of the role fire has had in maintaining the ecosystem from presettlement times to the present and will have moving forward.

THE SEELEY LAKE LARCH

LIVING LINK TO INDIAN AND FRONTIER HISTORY

Western Montana's Big Blackfoot River was once the gateway to a magnificent forest and the conduit that fed an immense sawmill. Epic log drives once choked the waterway full of timber each spring.[1] The Big Blackfoot drainage was known for its majestic, centuries-old ponderosa pine and western larch trees. Although stately old ponderosas were widely distributed across the American West,[2] western larch (*Larix occidentalis*), locally called tamarack,[3] is restricted to the inland Northwest and occupies only limited areas there. It is a deciduous tree with needlelike leaves, and it stands out among the darker pines and firs as a towering, ramrod-straight tree with bright green foliage that turns yellow and then golden before falling in autumn.

Thanks to the foresight of early-twentieth-century foresters, several hundred acres of the Blackfoot watershed's original larch forest survives around Seeley Lake and its thriving resort community on lands administered by the Lolo National Forest. Before becoming the first chief of the U.S. Forest Service, Gifford Pinchot hiked through this forest in 1896 and described the huge western larch as his "favorite among all American trees."[4] Seeley Lake's big-tree larch forest harbors many trees 500 to 1,000 years old and four to seven feet in diameter, including the world's largest known larch.[5] In 1945, pioneer forester Elers Koch described this forest "as unique and as beautiful in its own way as the [much] better known redwoods." It was nearly pure larch growing in "an open, park-like, sunny stand with the big cinnamon colored tree columns rising from a low ground cover."[6] This forest was exceptional, since western larch usually grew in dense stands with an abundance of evergreen conifers.

By the 1980s Seeley Lake and its big-tree larch forest had become major recreational attractions, but foresters on the Seeley Lake Ranger District were concerned that the trees were declining in health and susceptible to severe wildfires. A thickening understory of Douglas-fir and other evergreens, plus accumulating dead wood and tree litter, posed a fire hazard to the forest and to the local community, whose population swells to a few thousand in summer. District foresters recognized that the original forest structure as described by Koch was an important historical feature as well as an attractive and relatively fire-safe environment for people. They invited researchers from the Forest Service's Fire Sciences Laboratory in Missoula to study this larch forest and provide insight about how to restore it, reduce its vulnerability to severe fire, and perpetuate it.

BY STEPHEN F. ARNO

COURTESY OF THE AUTHOR

This is the largest known living western larch tree. Located in the Girard Grove, it is 7.2 feet in diameter and 162 feet tall, and is estimated to be about 1,000 years old. The photo was taken prior to any thinning or fuels reduction treatment.

Resulting studies revealed that Seeley's original larch forest had been shaped through the centuries by low-intensity fires burning beneath the big trees about every 20 to 30 years and had inflicted little damage. Such frequent burning was unusual in moist larch habitats like this one, and evidence suggested that Native peoples ignited many of the fires at Seeley Lake. The studies gave hints that would guide forest stewardship.

FEATURES OF WESTERN LARCH

Early naturalists in the inland Northwest extolled the grandeur of western larch, which is by far the largest of the world's eleven larch species (genus *Larix*). In 1808 explorer David Thompson encountered 200-foot-tall western larch trees on the Kootenai River in present-day Montana and observed that they would make fine masts for the Royal Navy.[7] In his 1884 publication, Charles Sargent noted that western larch was unusual—in fact, unique—among forest trees in attaining its greatest size and abundance in western Montana rather than in the milder climates of Washington, Oregon, or Idaho.[8]

Western larch's thick corky bark, its high, open, nonflammable crown, and its deciduous foliage make it the most fire-resistant tree of the inland Northwest. Historically, larch depended on fire to prosper despite intense competition from firs. However, larch flourishes only on relatively cool, moist sites where fires occurred infrequently, at average intervals of about 50 to 200 years.[9] The fires killed many trees, but larch survived more often than did its competitors. Larch cones, borne high in the crowns of tall trees, produce light seeds that disperse well in the breeze and readily germinate on freshly burned soil. Also, larch seedlings tend to grow faster than their competitors, and larch ultimately grows taller, too. However, over time, most of its evergreen associates will outcompete larch for moisture and nutrients; thus it needs occasional fires or other major disturbances to kill its competitors and create openings that allow it to regenerate.[10]

PRESETTLEMENT FIRES IN THE FOREST

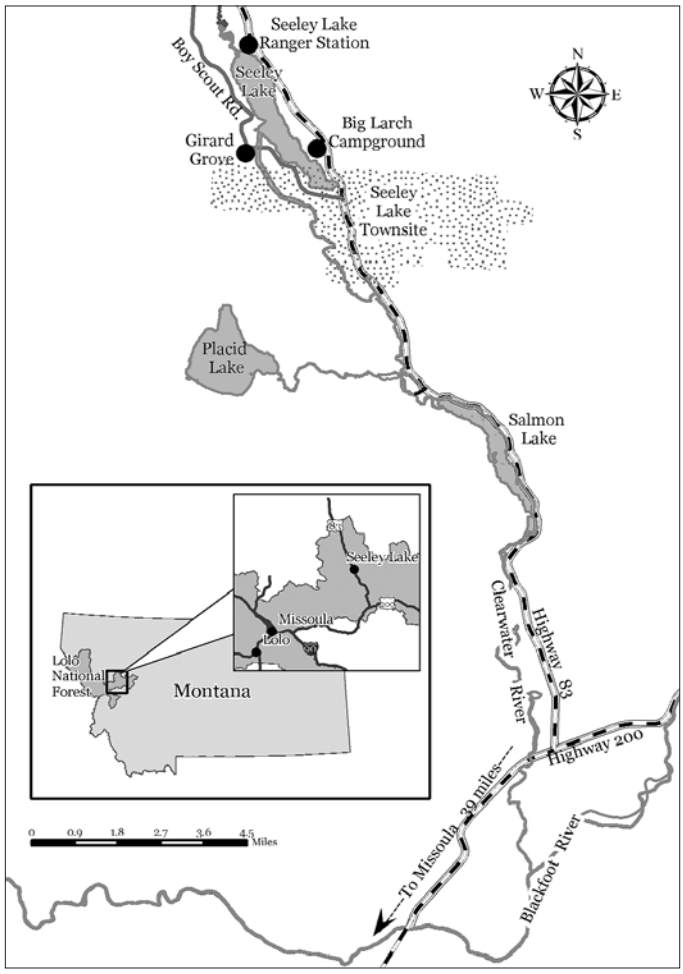
As part of a larger study of old-growth forests in western Montana, research personnel from the U.S. Forest Service (including myself) made a detailed inventory of a 2.4-acre (1-ha) plot in a portion of Seeley Lake's larch forest that had never been logged.[11] We measured and mapped all trees and determined the approximate age of each tree greater than 8 inches in diameter by counting annual growth rings on increment cores—pencil-size borings made with hollow drills up to 32 inches long. A few of the larger trees had heart rot, which prevented determination of total age. We also determined approximate dates of past fires in the stand by sampling and aging fire scars on the trees.[12]

Our study plot was in the Girard Grove—near the lake's outlet into the Clearwater River, a tributary of the Big Blackfoot—and it appeared to be representative of Seeley Lake's big-tree larch forest.[13] Many other parts of this forest were less suitable for study because they were in campgrounds, leased cabin lots, and other recreation sites, or because some trees had been removed in the early 1900s. Our plot did not contain trees as large and old as those in some other parts of the Seeley larch forest, but it did have at least four larch trees that had become established in the fifteenth century and at least six from the sixteenth century.[14] Other trees were dated to the next three centuries. Fire scars indicated that nine low-intensity fires swept through this stand between about 1671 and 1859, with none thereafter. Regeneration of larch saplings (as identified by age classes of larch trees) occurred after most of these fires, but no new larch trees had become established after the burning stopped. Age classes of the fire-dependent larch indicated that the pattern of frequent low-intensity fires extended at least back to early in the sixteenth century.

Our study confirms Koch's description of the original big-tree larch forest with its open understory and at most a few dozen small trees (less than 12 inches in diameter) per acre. In 1995 our plot contained about 300 small trees per acre, mostly patches and thickets of Douglas-fir and less than 1 percent larch. Basal area of living tree stems, an approximation of tree biomass, increased about 2.7 times between 1900 and 1995, largely as Douglas-fir.[15] These dramatic structural changes underlie the forest's growing fire hazard and competition-weakened condition detected by local foresters.

CAUSES OF PRESETTLEMENT FIRES

Until late in the nineteenth century, fires burned through Seeley Lake's larch forest about four times per century, much more frequently than in other larch-dominated forests. Fires occurring at



COURTESY OF LISA M. BLACKBURN, U.S. FOREST SERVICE

Loggers would drive logs down the Clearwater River and then the Blackfoot to the mill in Bonner, outside of Missoula. State highways 83 and 200 roughly follow the same path today.

such short intervals evidently prevented accumulation of understory tree thickets, dead wood, and other forest fuel that in most larch forests allowed fires to kill many trees. In western Montana prior to about 1850 and white settlement, fires were caused primarily by lightning and Native Americans. It is often assumed that lightning was the primary source of fires that shaped the region's forests. However, in some areas, fires started by Native Americans clearly were of great importance in determining the structure and composition of presettlement vegetation.[16] Oregon's Willamette Valley provides a definitive example of this phenomenon; explorers' accounts and mid-nineteenth-century government land surveys provide clear evidence that frequent burning by Native peoples in the area maintained open oak woodlands and prairies on more than a million acres, land that without such burning typically becomes dense woodland and even conifer forest.[17]

Circumstantial evidence suggests that human-caused fires were largely responsible for maintaining Seeley Lake's big-larch forest. In 1899, Horace Ayres, employed by the U.S. Geological Survey, made a detailed inspection of the new Lewis and Clark Forest Reserve, which encompassed Seeley Lake. Referring to the valley terrain that harbors Seeley Lake, his report states,

> *There is no doubt that some of the fires, especially on the higher range, are due to lightning, but most of those in the valley seem to have been set by Indian and other hunting parties or by prospectors. The trails most frequented by Indians, as the Jocko and Pend Oreille, are noticeably burned, especially about the camping places.*[18]

The Jocko Indian Trail was a major east-west route that passed just south of Seeley Lake and is shown on some of the original U.S. General Land Office survey maps.[19] Another Indian trail followed the general route of present-day U.S. Highway 83 from Swan Lake south past Seeley Lake to the Big Blackfoot River; perhaps this was the "Pend Oreille Trail" that Ayres referred to.[20] Numerous artifacts suggest a sustained level of aboriginal activity in the immediate vicinity of Seeley Lake, dating back 3,500 years. Archaeologist C. Milo McLeod states that the Clearwater (containing Seeley Lake) and Blackfoot valleys represent "one of the richest archeological areas in western Montana in terms of numbers and types of sites. Chronologically, all of the major prehistoric periods are represented."[21]

The vegetation and microclimate of Seeley Lake's big-larch forest seems unlikely to favor frequent lightning fires, a pattern of burning commonly associated in this region with semiarid grasslands and ponderosa pine forests, where cured grass and highly flammable pine needle litter are abundant. In contrast, the big-tree larch forest occupies the humid lowland around the lake where vegetation (including kinnikinnick, dwarf huckleberry, and pinegrass) does not cure and dry out until after sharp frosts in early autumn, at which time there is little opportunity for lightning ignition coupled with warm, dry weather. Ponderosa pine, a source of flammable surface fuel, is sparse in most of the larch forest, evidently because of its low tolerance for growing-season frost.[22] On the other hand, the above conditions would not hinder a pattern of frequent low-intensity fires ignited by people, especially during dry periods in early autumn. This might have been done to clear brush, obstacles, and hiding cover for enemies from the vicinity of camping areas and travel routes, or to stimulate succulent forage that would attract deer.[23]

EARLY LOGGING AND CONSERVATION

Completion of the transcontinental Northern Pacific Railroad through western Montana's Clark Fork Valley in 1883 increased demand for lumber and a means of shipping it to expanding communities and mining enterprises. By 1886 a large sawmill was completed at Bonner, located just east of Missoula near where the Big Blackfoot River empties into the Clark Fork. The mill was supplied that spring by 20 million board feet of logs—equivalent to 4,000 of today's logging-truck loads—driven down the Blackfoot. By 1889 the Bonner sawmill called itself the largest between Wisconsin and the West Coast. In 1898 the mill was acquired by the Anaconda Company and continued to provide lumber for the company's mining operations at Butte and its smelters at Anaconda and Great Falls.[24]

The first logging operations at Seeley Lake were conducted in about 1892, with logs driven down the Clearwater and Blackfoot rivers to Bonner the following spring.[25] At the turn of the twentieth century, a homesteading rush hit the Seeley Lake area, and at that time some employees of lumber companies filed claims to federal forestland for the benefit of their employers. This resulted in more logging of area forests. In 1906 the newly

W. J. LUBKEN, U.S. FOREST SERVICE

Log decks of larch, ponderosa pine, and Douglas-fir and a view of trees left for seeding in the logged area at the big timber sale near Seeley Lake, October 1908.

established U.S. Forest Service designated one of its first large timber sales, putting up for bid 50 million board feet of big larch, ponderosa pine, and Douglas-fir at the south end of the "quiet, jewel-like lake named after the only resident, Jasper Seely [sic]."[26] The Anaconda Company, which owned the Bonner sawmill, was awarded the sale and began a major logging operation when the first snows arrived in the fall of 1906.

Old-growth larch trees have a butt of especially dense, heavy wood nearly saturated with moisture and a heavy gum (arabinogalactan); this section is so heavy that it typically will not float. Fire scars, bole rot, and ring shake (separation of wood along the annual rings) add to the unsuitability of the butt for lumber. Thus, larch trees were commonly "long-butted" after felling, with a section 4 to 6 feet long left lying in the woods. Loggers also left behind stumps 8 to 10 feet high, a result of sawing while standing on snowpack or on "spring boards" driven into notches several feet above ground. The notches are still visible today.

According to historian John Toole, the Forest Service's timber sale inspector at Seeley Lake, Jim Girard, considered the practice of leaving the larch long butts in the woods intolerably wasteful. He required the loggers to shovel snow away from the base of each tree and cut a low stump, so that the heavy butt was part of the first log.[27] It required herculean efforts to coerce the heavy butt logs through the shallow Clearwater River and into the Big Blackfoot. This included building small "splash dams" that could be dynamited in spring to create a floodlike flow to drive the logs, and lashing each larch butt log to more-buoyant pine to get the wood through Salmon Lake, midway down the Clearwater drainage. These and other expensive measures were part of an all-out effort to get the logs to Bonner, where they could be milled and shipped by rail to the Anaconda Company's mining and smelting operations, but proved superfluous in June 1908, when the Great Flood helped greatly in flushing the logs downriver.[28]

Although logging operations continued in and around Seeley Lake's big-larch forest through the middle of the twentieth century, the management priority for the lakeside forest was shifting toward recreation. By the late 1920s, a few dozen summer homes had been built on lake lots leased from the Forest Service, and a Boy Scout camp now known as Camp Paxson was established. Resorts, dude ranches, and Forest Service campgrounds and summer homes on state lands soon followed.[29] By the 1970s, better roads and the increasing popularity of snowmobiling, cross-country skiing, ice fishing, and other winter sports had transformed Seeley Lake into a major year-round recreational area, with the remaining big-tree larch forest a cherished feature.

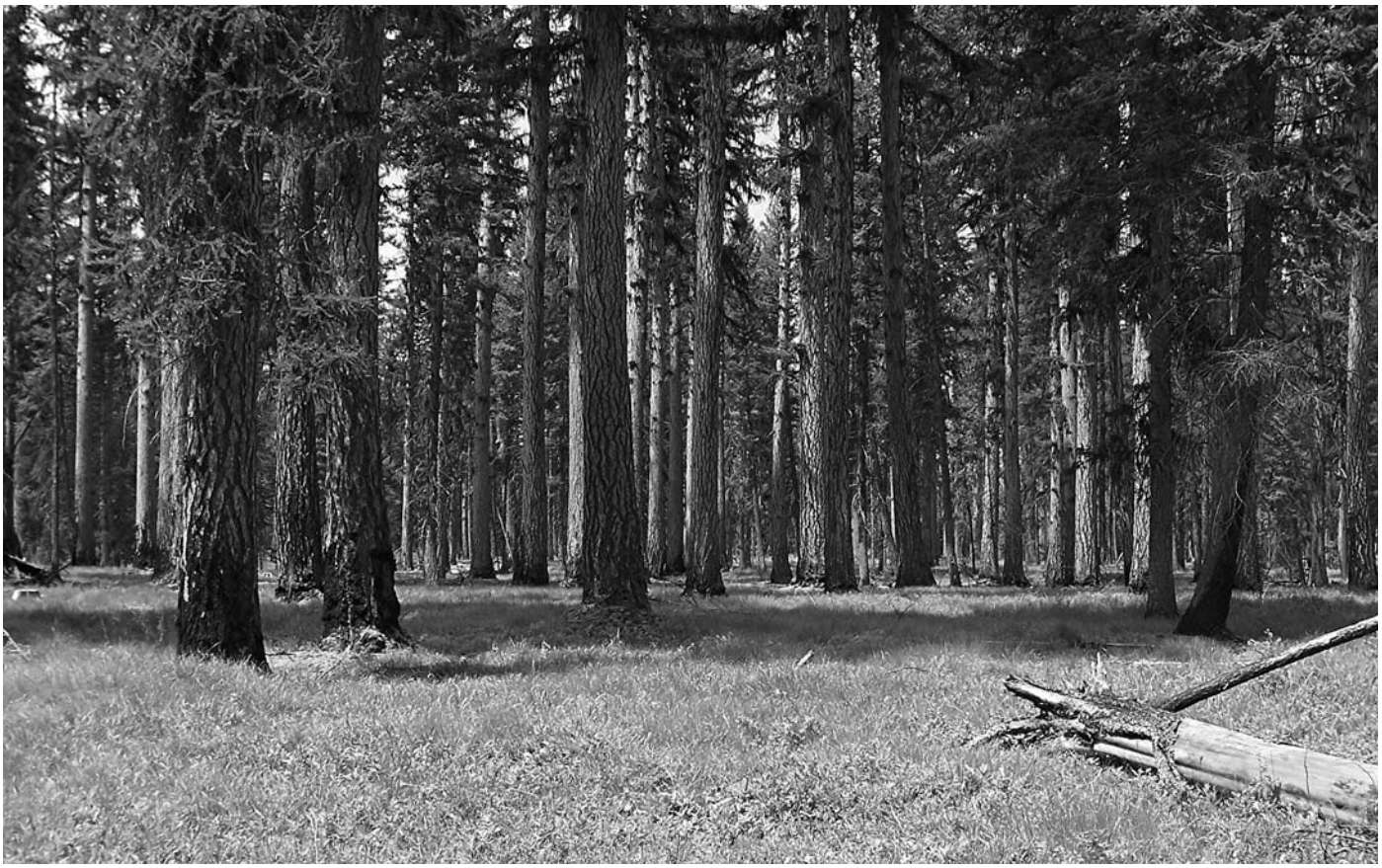
By the 1980s, hundreds of new summer cabins and year-round homes had been constructed in the surrounding forests, all served by an extensive network of power lines snaking their way through the trees. District foresters recognized the growing potential for devastating wildfires from the accumulating forest fuels and tree thickets and from power lines that ignite fires when wires are downed in windstorms. That potential was realized when, in the summer of 1984, Gov. Ted Schwinden declared a wildfire emergency as uncontrollable fires seared forests all across Montana

W. J. LUBKEN, U.S. FOREST SERVICE

Larch butts left after the first timber sale in 1908. Burned slash piles are visible.

W. J. LUBKEN, U.S. FOREST SERVICE

A Forest Service scaler and a larch "long butt" on the Seeley Lake timber sale, 1908. Unhappy with the wasteful practice of leaving long butts, the Forest Service forced loggers to change how they cut and moved lumber to the mill.



COURTESY OF THE AUTHOR

The thinned, underburned big-larch forest in Girard Grove, as of summer 2010. Suffering heavy mortality from bark beetles, the understory of lodgepole pine and Douglas-fir (which replaces larch in the absence of fire) was removed using a mechanical harvester, leaving low stumps. Then a prescribed fire was used to reduce surface fuels including duff mounds that had accumulated at the base of big-larch trees. Larger openings (not shown here) now have an abundance of larch regeneration.

on a scale beyond anything that had happened in the previous half-century. The summer of 1988 was far worse. While massive fires in Yellowstone National Park captured international attention, two dozen miles east of Seeley Lake the Canyon Creek fire exploded eastward from the Scapegoat Wilderness, overrunning ranches and rural homes and charring 247,000 acres.

The threat of devastation to the Seeley Lake community and its big-larch forest became obvious when on two occasions, small fires near the lake blew up in minutes, torching tall trees and beginning to crown out across the forest. Fire manager Margaret Dougherty knew that these developing conflagrations were checked only because of unusually good fortune: in each case an air tanker filled with retardant happened to be quickly available to knock them down.[30] Dougherty and other district foresters soon made a concerted effort to enlist fire research specialists to learn how the big-larch forests had survived fires in past centuries and how that knowledge might be employed to safeguard forests and people today. They also reached out to share their concerns with the community's volunteer fire department, local residents, frequent visitors, and members of the business community. The widely reported increase in wildfire damage to homes, communities, and recreational forests throughout the West that began in the 1980s also helped bring the Seeley Lake community together to support measures that could reduce the fire hazard, such as removing much of the in-growth of fir trees and excessive dead material, and using prescribed burning where feasible.

FOREST STEWARDSHIP INFORMED BY HISTORY

In 1995 the Seeley Lake Ranger District embarked on its first restoration project in the big-larch forest—the 100-acre Archibald unit. The goal was to reduce competition and understory thicket fuels to protect and revitalize the larch and scattered large old Douglas-firs by removing most of the smaller firs; none of the larch was cut. This operation, conducted on the winter snowpack, produced a million board feet of small timber sold to the local sawmill, as well as wood chips (hog fuel) used for energy production, pulpwood, and firewood. Part of the unit was then treated with prescribed fire and thereafter gave rise to the first crop of new larch saplings in this forest since the late 1800s. By 2008 about 2,000 acres had been similarly treated around Seeley Lake and a few miles up the Clearwater Valley toward Lake Inez. Initially, some people opposed cutting trees and burning in the big-larch forest. After some demonstration treatments, which showed that the big trees were unharmed and much more visible, strong support emerged.

Soon dozens of home and summer cabin owners were taking advantage of advice, help, and incentives offered in cooperation with the volunteer fire department to thin trees and reduce flammable material on and around their dwellings. By August 2007, private landowners had reduced forest fuels on more than 250 acres. The results were tested when strong winds drove the 18,000-acre Jocko Lakes wildfire directly toward the town. Recently completed fuel reduction work on private land enabled

firefighters to safely "back burn," giving them a tactical advantage in stopping the wildfire. Thus, the community-wide effort to tend and restore neighborhood forests has already demonstrated its worth in safeguarding the community and its historic big-larch forest. □

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NOTES

1. The big lumber mill at Bonner, where the Blackfoot joins the Clark Fork, operated continually from 1886 until it closed in May 2008, supplying timber for railroads and mines and buildings at Butte and Anaconda. See John Toole, *The Barron, The Miner, The Logger, and Me* (Missoula, MT: Mountain Press Publishing Company, Inc., 1984), 114–147; Bicentennial Committee, Bonner School, *A Grass Roots Tribute: The Story of Bonner, Montana* (Missoula, MT: Gateway Printing, 1976), 10–14; and Kim Briggeman, "Logging Off," *Missoulian* (March 23, 2008).
2. See Stephen F. Arno, Carl E. Fiedler, and Matthew K. Arno, "'Giant Pines and Grassy Glades': The Historic Ponderosa Ecosystem, Disappearing Icon of the American West," *Forest History Today*, Spring 2008: 12–19.
3. Tamarack is the official name for *Larix larcina*, a smaller larch that is abundant in swampy areas of the northeastern United States and much of Canada. Local people often use "tamarack" for any species of larch, and even for lodgepole pine in California's Sierra Nevada.
4. Gifford Pinchot, *Breaking New Ground* (1947; repr., Seattle: University of Washington Press, 1972), 99.
5. Robert Van Pelt, *Forest Giants of the Pacific Coast* (Vancouver and San Francisco: Global Forest Society and University of Washington Press, 2001), 148–155.
6. Elers Koch, "The Seeley Lake Tamaracks," *American Forests* 51(1) (Jan. 1945): 21, 48.
7. Jack Nisbet, *Sources of the River: Tracking David Thompson across Western North America* (Seattle: Sasquatch Books, 1994), 116.
8. Charles S. Sargent, "Report on the Forest Trees of North America," in *Tenth Census of the United States* (Washington, DC: U.S. Department of the Interior), 9: 216.
9. Stephen F. Arno and William C. Fischer, Larix occidentalis—*Fire Ecology and Fire Management*, General Technical Report, GTR–INT-319 (USDA Forest Service, 1995), 130–135; Stephen F. Arno, "Fire in Western Forest Ecosystems," in James K. Brown and Jane Kapler Smith, eds., *Wildland Fire in Ecosystems: Effects of Fire on Flora* (General Technical Report, RMRS-GTR-42) (Ogden, UT: USDA Forest Service, Rocky Mountain Research Station, 2000), 97–120.
10. Wyman C. Schmidt and Raymond C. Shearer, "Larix occidentalis," in *Silvics of North America: Conifers* (Washington, DC: USDA Forest Service, 1990), 1: 160–172.
11. Stephen F. Arno, Helen Y. Smith, and Michael A. Krebs, "Old Growth Ponderosa Pine and Western Larch Stand Structures: Influences of Pre-1900 Fires and Fire Exclusion," INT-RP-495 (Ogden, UT: USDA Forest Service, 1997), 1–20.
12. Stephen F. Arno and Steven Allison-Bunnell, *Flames in Our Forest: Disaster or Renewal?* (Washington, DC: Island Press, 2002), 103–117.
13. This tract, immediately south of Camp Paxson, was set aside by the U.S. Forest Service in 1953 as memorial to Jim Girard, a prominent early forester whose career began at Seeley Lake in 1907; Suzanne Vernon, *Cabin Fever: A Centennial Collection of Stories about the Seeley Lake Area* (Seeley Lake, MT: Vernon Print. & Pub., 1989), 118–125.
14. Nearby in the Girard Grove, an old informal campsite contains the largest known larch (7.2 feet in diameter and 162 feet tall, with a broken top) and two other larch trees greater than 6 feet in diameter, all of which have extensive heart rot and cannot be accurately aged but probably are about 1,000 years old.
15. Basal area per acre is the combined area of the cross-sections of stems of living trees. In our study plot, basal area per acre was calculated to be about 85 square feet per acre in 1900 and 226 square feet per acre in 1995. A tree 13.5 inches in diameter has a basal area of 1 square foot.
16. Stephen W. Barrett and Stephen F. Arno, "Indian Fires as an Ecological Influence in the Northern Rockies," *Journal of Forestry*, October 1982: 647–651; Robert Boyd, ed., *Indians, Fire and the Land in the Pacific Northwest* (Corvallis: Oregon State University Press, 1999); M. Kat Anderson, *Tending the Wild: Native American Knowledge and the Management of California's Natural Resources* (Berkeley: University of California Press, 2005).
17. Robert Boyd, "Strategies of Indian Burning in the Willamette Valley," in Boyd, *Indians, Fire and the Land*, 94–138; Stephen F. Arno and Ramona P. Hammerly, *Northwest Trees: Identifying and Understanding the Region's Native Trees* (Seattle: Mountaineers Books, 2007), 184–185.
18. H. B. Ayres, "Lewis and Clark Forest Reserve, Montana," 21st Annual Report, U.S. Geological Survey, Part V (1900), 72. The land was later moved into the Lolo National Forest.
19. *Cabin Fever*, 22 and 141.
20. Darris Flanagan, *Indian Trails of the Northern Rockies* (Stevensville, MT: Stoneydale Press, 2001), 162–163.
21. Interview with C. Milo McLeod, Archeologist, Lolo National Forest, Missoula, June 3, 2008; C. Milo McLeod and Douglas Melton, "The Prehistory of the Lolo and Bitterroot National Forests," Report on file, Lolo National Forest (Missoula, 1986), VIII–37.
22. Conversely, ponderosa pine becomes abundant on west- and south-facing slopes and warmer terraces immediately above Seeley Lake.
23. Stephen W. Barrett, "Relationship of Indian-caused Fires to the Ecology of Western Montana Forests" (master's thesis, University of Montana, 1981), 198; George E. Gruell, *Indian Fires in the Interior West: A Widespread Influence*, General Technical Report, INT-182 (USDA Forest Service, 1985), 68–74.
24. *Grass Roots Tribute*, 10–13.
25. Vernon, *Cabin Fever*, 96.
26. Vernon, *Cabin Fever*, 121; letter from Ron Cox, Seeley Lake Historical Society, to author, October 11, 2009; quote in Toole, *Baron*, 119. The lake was named for Jasper Seely but his name was misspelled by the survey crew who mapped the area. A sale of 37 million board feet eventually acquired by the Anaconda Company was awarded on the Bitterroot National Forest in 1906. See Helen Y. Smith and Stephen F. Arno, eds., *Eighty-Eight Years of Change in a Managed Ponderosa Pine Forest*, General Technical Report, RMRS-GTR-23 (Ogden, UT: USDA Forest Service, Rocky Mountain Research Station, 1999), 10.
27. Ron Cox of the Seeley Lake Historical Society credits A. J. Norton, who was initially in charge of the sale, with starting the controversy about "wasteful" long butts.
28. Toole, *Baron*, 120–129.
29. Vernon, *Cabin Fever*, 161–169.
30. Stephen F. Arno and Carl E. Fiedler, *Mimicking Nature's Fire: Restoring Fire-Prone Forests in the West* (Washington, DC: Island Press, 2005), 132–133.