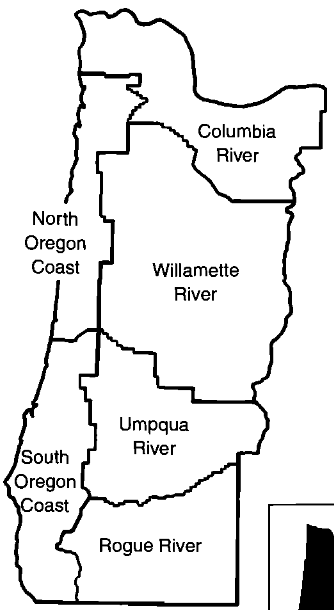
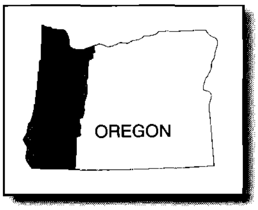
Historic Spatial Patterns of Old Forests in Western Oregon





The long-term sustainable management of our forests may be most attainable when we determine their original, natural conditions. "Ecosystem management" is guided by information on spatial variability of forest landscape patterns over time and how human influence has affected that variability. Such information is critical for developing timber-harvest plans, maintaining biodiversity, and designing future landscapes. Ecosystem management plans can be developed to maintain and/or create forest landscape patterns within the range of those that existed before European settlement.

By William J. Ripple

Fire initiated, maintained, and destroyed most old-growth Douglas-fir forests of western Oregon during the centuries before European settlement (Agee 1991, 1993). Information on the role of historical disturbances such as fire in western Oregon is limited. In areas that have not been extensively logged, fire history is reflected by forest age-class distribution, and fire regimes are varied due to a wide range of environmental conditions.

Booth (1991) estimated the amount of prelogging old-growth in western Washington and Oregon using the first detailed forest survey of this region (Andrews and Cowlin 1934, 1940). Booth determined that 61% of western Oregon's forests were old-growth before European settlers began logging. It is possible to hypothesize that the amount of prelogging old-growth would vary spatially across that region, reflecting differences in climate-based fire regimes and fires caused by both European settlers and Native Americans.

The first objective of the study discussed here was to estimate the prelogging extent of conifer forests by large- and small-size class for various survey units in western Oregon. The prelogging timeframe includes the period just prior to late 19th-century and early 20th-century logging. Estimates of the prelogging extent of old-growth forests were also made for the Oregon Coast Range. Refinements were made to Booth's methodology in making these estimates. A second objective was to make comparisons between size-class distribution and areas of known human activity (riparian areas). Research included a spatial analysis using geographic information systems (GIS) to analyze human influence near rivers and estuaries. Higher numbers of second-growth forests near rivers would be evidence of anthropogenic influences such as the clearing and burning of old-growth in valleys near settlements and along transportation routes.

Methods

To estimate prelogging forest patterns, a size-class and spatial analysis was conducted for five of the six 1933 forest survey units in western Oregon (see map, this page). The exception was the Columbia River Unit, which had a high incidence of cutting prior to 1933 (Teensma et al. 1991).

Forest area for each survey unit was summarized by large- and small-size classes and by dominant conifer species. The large-size class included large old-growth, small old-growth, and large second-growth. Old and recent cutover lands were reallocated to large- and small-size classes based on the proportion of land

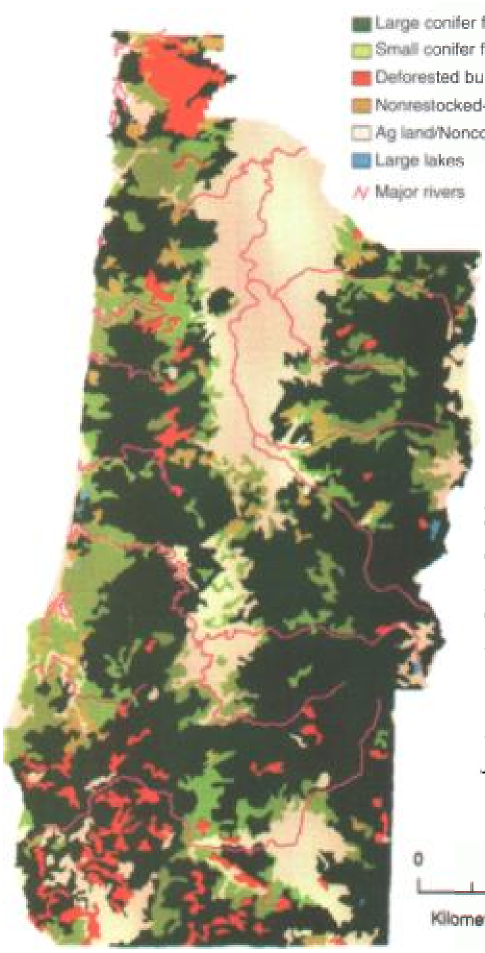


Figure 1. Study area map showing conifer forest patterns from the 1933 survey. The Willamette Valley is the large opening in the center of the top half of the map. The area of the Tillamook fire is shown at the very top of the map. The Columbia River survey unit in northwestern Oregon is not shown.

area in each size class for a given species and survey unit. Fifty percent of the seedling class was reallocated to the large class since Andrews and Cowlin (1940) estimated that one-half of the seedling land was a result of postharvest forest reestablishment.

Deforested burns were partly the result of natural wildfires and partly the result of human activity. Some of the fires occurred as a result of logging activity with an estimated 30% of the burns on previously harvested land (Andrews and Cowlin 1940). Therefore, the study reallocated 30% of deforested burn area to the large-size class and 70% to the small-size class. Analysts tabulated the adjusted areas in each size class by forest type and survey unit along with old/recent cutover areas and deforested burns. Hardwood forests, woodlands, subalpine, and rocky areas were not included in the analysis.

Estimates of the old-growth percentage of prelogging forests in the Coast Range were based on the 1933 forest survey (Andrews and Cowlin 1934) and a fire-cycle model developed by Van Wagner (1978). Van Wagner's assumptions were that regular, small-fire events randomly occur across the landscape regardless of stand age and result in stand-replacement burns. Fahnestock and Agee (1983) and Booth (1991) described the technique:

1. Estimating the amount of land in large and small forest size classes using the 1933 survey data.
2. Running an annual stand fire probability model based on the negative exponential age distribution function.
3. Estimating the proportion of each forest type with prelogging stands greater than 200 years old based on fire probabilities and the exponential age distribution.

The Rogue, Umpqua, and Willamette River areas were excluded from the fire-cycle/old-growth analysis since the Van Wagner technique only applies to stand-replacement fires; these three areas typically have nonstand-replacement fires in which

Table 1. Estimated prelogging coniferous forestland area by survey unit, species, and large- and small-size classes. Also shown are areas in nonstocked/cutover and deforested burns by survey unit.

Survey unit	Forest type (ha)[a]			Nonstocked/ cutover (ha)	Deforested burns (ha)
Willamette River	Douglas-fir	Mountain hemlock/ true fir	Other conifer species[b]	97,733	61,336
Large	(72%)[c] 1,044,524	(86%) 130,124	(32%) 27,924	—	—
Small	406,600	21,245	60,520	—	—
North Oregon Coast	Douglas-fir	Western hemlock	Other conifer species	30,081	122,915
Large	(67%) 273,360	(71%) 52,477	(55%) 30,552	—	—
Small	132,307	21,296	24,906	—	—
South Oregon Coast	Douglas-fir	—	Other confier species	41,417	86,397
Large	(64%) 464,534	—	(59%) 35,960	—	—
Small	264,251	—	25,482	—	—
Umpqua River	Douglas-fir	—	Other confier species	9,474	31,093
Large	(80%) 689,474	—	(68%) 76,522	—	—
Small	175,749	—	35,960	—	—
Rogue River	Douglas-fir	Ponderosa pine	Other confier species	10,972	117,814
Large	(75%) 415,756	(50%) 107,339	(81%) 66,291	—	—
Small	123,094	109,180	12,702	—	—

[a]*Large size was greater than 20"dbh for Douglas-fir and western hemlock, greater than 16" dbh for mountain hemlock/true fir, and greater than 22" dbh for ponderosa pine.*
[b]*If a forest type represented less than 9% of the total, it was placed in the "other conifer species" category.*
[c]*These numbers represent the percentage of forest type in large class.*

Table 2. Estimated prelogging annual probability of fire, fire cycle, and percent old-growth by forest survey unit and forest type for the Oregon Coast Range.

Survey unit/forest type	Percent in large class (L)[a]	Minimum age (A)[b]	Annual fire probability (P)[c]	Fire cycle (C)[d]	Estimated old-growth (%)[e]
North Oregon Coast					
Douglas-fir	.674	98	.00403	248	44.7
Western hemlock	.711	87	.00392	255	45.7
Other conifer species	.551	108	.00552	181	33.2
Area-weighted mean	—	—	—	242	43.6
South Oregon Coast					
Douglas-fir	.637	107	.00421	238	43.1
Other conifer species	.585	119	.00451	222	40.6
Area-weighted mean	—	—	—	237	42.9

[a] *L is proportion of forest type in large class.*
[b] *A is estimated age, in years, for the minimum tree diameter in the large class from yield tables.*
[c] *P = –Ln(L)/A, where Ln is natural log.*
[d] *C = 1/P*
[e] *Proportion of forest greater than 200 years old.*

stand age is not correlated with fire (Agee 1993).

Yield tables organized by site-quality classes offered age estimates for each forest type by survey unit. Analysis employed standard yield tables to determine the age at which the average tree diameter equalled the lower limit for the large-size class on each site (Forbes 1955).

Analysts digitized and entered a version of the Andrews and Cowlin (1940) forest-type map into the GIS program. Major rivers and estuaries of western Oregon were also digitized. Buffer zones were created as a function of the distance from the rivers and estuaries. These zones were overlaid with the forest-type map to determine the proportion of each forest type in each river-distance class. Analysts conducted regressions to determine the relationship between the proportion of large-class forest in relation to distance from major rivers and estuaries; and the proportion of deforested burns in relation to distance from major rivers and estuaries.

Results

The adjusted area for each tree-size class is shown in *table 1* by forest type and survey unit along with old/recent cutover areas and deforested burns. The proportion of Douglas-fir in the large-size class—the dominant species found within each survey unit—ranged from a low of 64% on the South Coast to a high of 80% in the Umpqua River area. The proportion of all conifers in the large-size class was lowest in the coastal units (67% in the North Coast and 63% in the South Coast) due to fires in the 1840s. It was highest in the Umpqua River (78%) followed by the Rogue River (71%) and Willamette River areas (71%) due to nonstand-replacement fire regimes. The average proportion of all conifers in the large-size class was 71%.

Table 2 shows the proportion of each forest type in the large class, the estimated annual probability of burning, the stand-replacement fire cycle, and the percent of old-growth for the Coast Range. Results indicate a stand-replacement fire cycle of 237 years in the South Coast area and 242 years in the North Coast area. The estimated percentage of conifers in old-growth was 42.9% for the South Coast and 43.6% for the North Coast.

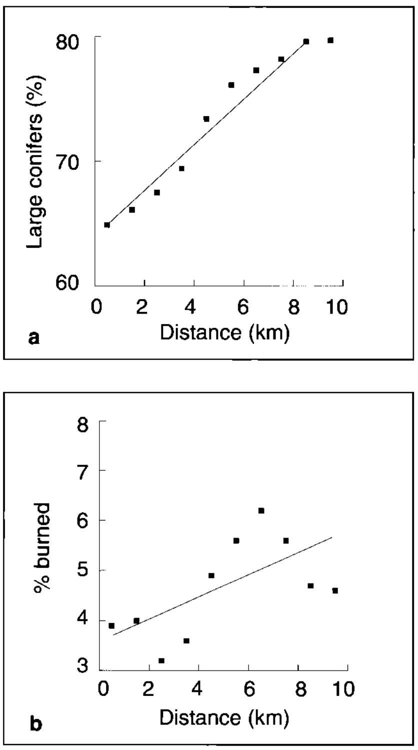


Figure 2. (a) distance from major rivers and estuaries (x-axis) and percent of conifers in large class (y-axis) and (b) distance from major rivers and estuaries (x-axis) and percent of conifers in deforested burns (y-axis).

Researchers used GIS to illustrate the forest-type patch distributions in western Oregon (*fig. 1*). At this regional scale, 89% of the forest area in the large-size class was in one large connected patch extending throughout most of western Oregon forestland with the exception of the North Coast. Mean patch size for the small conifer forests was highest in the South (18,417 ha) and North Coast areas (17,674 ha), lowest in the Umpqua area (5,384 ha), and intermediate for the Willamette (11,933 ha) and Rogue River areas (16,633 ha). Deforested burn patches were the largest by far in the North Coast areas (13,210 ha) due to the Tillamook burn, followed by the South Coast (4,662 ha), Rogue (3,873 ha), Willamette (2,889 ha), and Umpqua areas (2,140 ha). It should be noted that these patch sizes represent forest patterns at a very general scale.

The results of the distance-from-rivers analysis indicated a direct relationship between distance from water and percent of large-class conifers (r=0.98, *fig. 2a*). The area in deforested burns was also directly related to distance from rivers and estuaries, although the correlation was not as high (r=0.60, *fig. 2b*). Areas within 10 kilometers of rivers and estuaries comprised 28.4% of this western Oregon study area and 49.4% of all conifer forestland.

Discussion

The old-growth estimates in *table 2* may be in part a reflection of human-caused fires that altered the structure of these forests. If the age-structure of these forests was caused mainly by fire from lightning ignitions, the North Coast area would be expected to have a low frequency of ignitions. Lightning-caused fires in the Oregon Coast Range are rare, and there is no record of large wildfires in the Oregon Coast Range resulting from lightning between 1770 and 1933 (Zybach 1993). However, it is possible that lightning was not considered a source of ignition by early settlers. For most people from the east coast in the mid-1800s, lightning was a common phenomenon, but it did not start many fires back east.

Some of the historic fires in the Coast Range may also have been caused by people living in the Willamette Valley and Umpqua Valleys just east of the Coast Range (Zybach 1993). An estimated 34.5% of the Coast Range forests burned in the late 1840s (Teensma et al. 1991), and many of these fires have been linked to European settlers. According to tree-ring data, however, the 1840s were also drier than normal (Graumlich 1985). Not considering areas burned in the 1840s, only 3.5% of the Coast Range forests were in stands under 100 years old in 1850 (Teensma et al. 1991). Morris (1934) stated that in western Oregon approximately seven times as much land was deforested in 1845 to 1855 as in any of the three previous decades. He attributed this increase in deforestation to fires caused by European settlers.

Old-growth estimates for the Coast Range in *table 2* closely agree with the Teensma et al. (1991) estimate that 40% of the Coast Range forests were over 200 years old in 1850. Using the Teensma et al. data, it can be concluded that approximately 61% of the Coast Range forests were over 200 years old before the 1840s fires, equating to a 406-year fire cycle.

Native Americans living in the Coast Range may have also been partially responsible for creating forest fires. Sauter and Johnson (1974) reported that the Tillamook Indians of the Oregon Coast Range typically established villages along rivers and bays for transportation, water, food, and home-material transport. Twenty of the 26 known Native American campsites in the Coast Range were adjacent to major rivers or estuaries. These Native Americans used fire for hunting game animals. Sauter and Johnson noted, "large areas of brush and small trees were burned away each year to clear the land for easier hunting and travel. This cleared land also provided new browse each spring to attract deer and elk." Large areas of even-age old-growth in the Coast Range could have also been created, in part, by Native American fires in the open valleys east of the Coast Range. Boyd (1986) stated that the Kalapuya tribe burned "valley edge" sites each fall as part of large-scale communal hunting for deer. Late summer fires may have infrequently spread across into the Coast Range forests because, as shown in *figure 1*, significant gaps in the large-size class extend west from the Willamette Valley into the Coast Range. The dense understory conditions of the Coast Range forests would have aided the spread of these fires. Agee (1991) points out that although Native Americans have been implicated in anecdotal accounts as the source for some fires, the evidence is not convincing for widespread aboriginal burning in Oregon forests.

Eighty percent of the Douglas-fir forest in the Umpqua was in the large-size class in 1933. This high percentage of large trees was probably due to the lack of stand-replacement fires, even though the probability of fire by lightning ignition increases from the northern to the southern Cascades. Agee (1991) reported that the Wind River area in the Washington Cascades near the Oregon border has a 60% lower probability of lightning ignition than the McKenzie River in the central Oregon Cascades. He also reported that the Siskiyou Mountain area has more than twice the number of lightning ignitions as the McKenzie River area. Another possibility for the high proportion of large trees in the Umpqua area is a lower rate of human ignitions because the Umpqua Cascades were more isolated from human (particularly European) settlement.

This study has shown that much of the large-class forest increased in relation to distance away from rivers *(fig. 2a)*. If lightening caused forest-fire ignitions, much of the small-size class would be expected in the dry upland areas away from riparian zones as indicated by the burn patterns found in this study *(fig. 2b)*. Burke (1980) mapped the location of lightning-caused fires in the central Cascades between 1910 and 1977. But she reported no definite patterns in such fires, with the distribution widely scattered throughout the study area. These results indicate a possible anthropogenic influence on forest patterns since both European settlers and Native Americans have been associated with major river corridors. Also, some of the land logged earlier may have been restocked by the time of the Andrews and Cowlin survey in the early 1930s. Early lumber mills were commonly located near major rivers Teensma (1987) also reported that Native Americans apparently burned the valley bottoms of some of the tributaries of the Willamette River in the Cascades. Easterly winds may have caused many fires to advance to the west along the major river valleys, which lie predominantly in an east-west orientation.

This relationship (shown in *fig. 2a)* would probably not, however, describe forest patterns near smaller streams. For example, Juday (personal communication) found that old forest patches tended to be located along third- and fourth-order streams in the Oregon Coast Range. The steep, moist riparian areas associated with these smaller mountain streams seemed to protect these forests from fire. At the same time humans did not typically use these streams as travel or settlement corridors

Conclusions

To successfully develop forest harvest plans and maintain biological diversity, including such old-forest dependents as the northern spotted owl, we will need to manage ecosystems at a variety of scales and analyze long-term data. This study focused on the size-class distribution, amount of prelogging old-growth, fire cycles, and spatial forest patterns of western Oregon, using the first detailed forest survey of western Oregon. The results show that 71% of all conifer forests were in the large-forest class, of which 89% was spatially connected as one patch. The amount of old-growth in the Coast Range was approximately 43% based on the 1933 forest survey and 61% before the great fires of the late 1840s.

The study found evidence of an anthropogenic influence on the conifer size-class distribution near major rivers and estuaries; although the actual extent of this influence remains unclear. Additional research will be needed on the historical human influence on forest landscape patterns in order to understand the disturbance ecology of these forests and employ ecosystem management techniques. JOF

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Partial funding for this study was provided by the USDI Fish & Wildlife Service through the Cooperative Wildlife Research Unit, Research Work Order 7. The Oregon Department of Fish and Wildlife and the USDA Forest Service also provided partial funding through Cooperative agreements.

The author wishes to thank Jim K. Agee, Douglas E. Booth, Ross Kiester, E. Charles Meslow, and Robert Zybach for reviewing and making suggestions on an earlier version of this paper. Fred Swanson and David Wallin also made valuable comments.

By Lawrence W. Hill and I. Cameron Carte

This month's *JOURNAL OF FORESTRY* discusses pest and fire management issues. So let's spend a few lines on the topic in terms of private property rights. Is there an issue that burns more hotly in the hearts of private forest landowners or that is more of a pest to state and federal policymakers?

Congressional reluctance to tackle private rights in 1994 partially explains why legislation was not enacted to reauthorize the Clean Water and Endangered Species Acts. Seven private property rights bills languished in committee at adjournment. Some would have required agencies to assess whether regulations may result in property takings or provide for owner compensation if property values would significantly diminish through a federal agency decision.

State legislatures were also busy with private property rights legislation this year. Thirty-three states introduced a total of 86 bills, with five of these—Idaho, Mississippi, Missouri, Tennessee, and West Virginia—adopting takings laws.

But back to the real theme: The wildfires of 1994 remind us that keeping managed fire out of forestland managers' tool boxes is like forbidding surgeons to use the scalpel. Patient health can suffer dramatically in both situations.

Central Washington's August fires destroyed 207,901 acres of timber, and the cost of fighting the fireball reached nearly 55 million dollars as of August 9 (*The Seattle Times* 1994). The Southern California firestorm of 1993 burned 200,000 acres, destroyed over 1,100 structures, cost an estimated 1 billion dollars in suppression efforts and damage and restoration costs. It also killed three people.

The human price of forest fire control and suppression can be devastating. The professional forestry community was saddened when 14 professionally trained USDA Forest Service and Bureau of Land Management firefighters perished on July 6 fighting the South Canyon Fire in Colorado.

As a result of increasingly sophisticated fire protection, suppression, and public education, both the size of fires and the area burned has been significantly reduced. Only 3 to 5 million acres of US forests burn in an average year. An aggressive fire prevention and suppression campaign has excluded fire from millions of acres of mature forestland, ironically creating an unnatural, inordinate dry fuel load and a potential fire liability problem.

Today's forestland manager must fool Mother Nature by mimicking the forest patterns wildfire creates, while reducing the risk of destroying the entire forest. The Clinton Administration recently announced a policy on western public forest management that includes more extensive use of selective logging and timber thinning combined with prescribed burning to reduce the incidence of major wildfire. Not everyone agrees with this shift in policy. Nonetheless, Jim Lyons, Assistant Secretary of Agriculture for Natural Resources and Environment stated in an August 5, 1994, interview with the *Seattle Post-Intelligencer* that this policy uses "good forest management as a means of reducing the risks of wildfire." Some question whether timber harvesting and prescribed burning is good forest management. However, the debate may center more on a clash of ideologies about where and when to harvest timber than on whether science supports conclusions that fire exclusion or fuel load reduction affect forest health.

The Society of American Foresters has a practical position on fire management in forest and range ecosystems:

- Fire management decisions should reflect the land management objectives selected for an area. SAF supports managed natural fires, when contained within predetermined prescriptions, as important ecological components of natural ecosystems. Human-ignited prescribed burning can be a tool to achieve land-management objectives, such as reducing fuel loads.
- Natural and prescribed fires should be suppressed when fire becomes incompatible with land management objectives or when the danger to public safety and resource values is too great.
- Fire management planning, suppression, and prescriptions must be executed by qualified professionals.

Resolving fire management issues will not come swiftly or easily. As foresters we must challenge when others argue fire-management issues without sound forest science underpinning.

There is a new avenue for SAF members to become more active in forest policy —PLAN (Policy and Legislative Action Network). Get involved! Refer to the August POLICY WATCH, or contact Larry Hill at ext. 115, or Cam Carte at ext. 116. JOF