

Mount Rainier: Fire and Ice

By Mark Huff

Wildland fires are not an everyday event at Mount Rainier National Park (MORA): the climate is notoriously wet and lightning storms are rare. The mean fire-return-interval for MORA's montane forests exceeds 400 years (Hemstrom and Franklin 1982). Likewise, subalpine forests east of Mount Rainier burn infrequently; I have found fire-return-intervals of about 300 years on dry sites and considerably longer intervals for more mesic sites.

The infrequent fire record might lead one to underestimate fire as an integral component of MORA's natural processes. In forests composed of long-lived tree species, the time scale between fires can be deceptive. Most of the forested portion of MORA has burned one or more times over the last 1000 years, even though the presence of past fires is concealed by the reestablishment of new forests. Whether small or large, fires at MORA have created an array of patterns over forest landscape, diversifying the natural beauty of the park. Though MORA is famous for record-setting snow accumulations, magnificent old-growth forests, massive glaciers, and stunning vistas of the "mountain," when one of the long-awaited fires occurs, one cannot but take notice.

To the surprise of park managers and scientists, on May 7, 1987, during the middle of subalpine spring snowmelt, three subalpine fires were ignited in MORA by a lightning storm that swept through the Washington Cascades. These fires burned almost exclusively in tree crowns, leaving the partially snow-covered understory, for the most part, unburned. In 1986, a similar type of subalpine fire occurred in the Oregon Cascades on Willamette National Forest, once again during spring snowmelt. Since the MORA fires are not an isolated incident, the significance of spring subalpine fires is just now being realized.

The occurrence of spring subalpine fires adds a new dimension to our perception of subalpine fire dynamics in the Pacific Northwest. Park scientists and managers were quick to realize the need and opportunity to examine the ecological effects of such fires. Through cooperation between NPS Cooperative Park Studies Unit/University of Washington and its ongoing Pacific Northwest fire ecology projects (coordinated by Jim Agee, Research Biologist), NPS Pacific Northwest Regional Office (Jim Larson, Regional Chief Scientist), and MORA (Bob Dunnagan, Assistant Superintendent for Resources Planning), funding was pieced together to initiate a small study.

Objectives of the study are to 1) document the ecological effects of a crown fire burning over a snow-covered understory, 2) simulate environmental conditions and behavior of the fire, and 3) establish a permanent ecological research site to monitor the long-term effects of the fire on a north-facing slope.

Study Area

The study focuses primarily on the South Mowich Fire, largest of the three subalpine fires, approximately 25 ha (62 ac). It burned the steep north and south slopes of a knife-edged spur-ridge between the North and South Forks of the Mowich River, on the northwest flank of Mount Rainier. The Paradise Fire burned < 0.04 ha (< 0.1 ac) near the Paradise Visitor Center. The North Puyallup Fire burned approximately 6 ha (15 ac) on the south aspect of a steep east-west spur ridge above the North Puyallup River, the next watershed south of the Mowich River.

Data were collected and a permanent plot was established at the South Mowich Fire, on the north side of the ridge, at approximately 1705 m (5,600 ft) elevation. Here, the main tree species are mountain hemlock (*Tsuga mertensiana*) and Pacific silver fir (*Abies amabilis*). The ground cover is dominated by red mountain heather (*Phyllodoce empetrifolius*), partridgefoot (*Luetkea pectinata*), and Cascade blueberry (*Vaccinium delicosum*).

Fire Weather and Burning Conditions

On May 4, after several days of cold rain and snow in the subalpine zone: a strong Pacific high pressure cell moved onshore bringing unseasonably dry and warm weather to the Pacific Northwest. This front dominated regional weather for the next 7 days, until a low pressure system brought rain on May 12. For the duration of the high pressure cell, weather typical of mid-summer prevailed. Temperatures ranged from 63-74 degrees F for six days at MORA's subalpine weather station near Paradise Ranger Station. East and northeast winds carried very dry air centered east of the Cascade Mountains westward to create "fire weather," more typical of the summer months in the Pacific Northwest (Huff and Agee 1980).

Weatherwise, the stage was set for a fire to burn, although ground fuels were buried under deep snow or saturated with snowmelt water and incapable of carrying a fire. If log moisture alone had been used as indicator of fire danger (no moisture measurements were made), no fire danger would have existed.

Since spring subalpine fires tend to be crown rather than surface fires, tree crown moisture should be the most reliable indicator of fire danger. Although no moisture measurements were taken, I suspect that needle moisture was critically low at the time of the fire. Subalpine tree roots were anchored in near freezing soils making the translocation of water from the root system up to the foliage difficult. During the 8 days of warm dry weather, transpiration demands for water within the trees must have been high, thereby making the water-starved needles susceptible to burning.

Fire Behavior

More is known about the behavior of the Paradise Fire than the other two fires. The fire fighting crew observed the Paradise Fire spread slowly among tree crowns of subalpine fir (*Abies lasiocarpa*) and mountain hemlock: 1) by igniting lichens draped along the fine branches, 2) preheating and igniting the foliage, and 3) spreading to a nearby tree by igniting its lichens, starting the burning cycle over again. Intensity was most severe near standing dead trees. Ground fuels in the burning tree islands were snow-free, but none was consumed. Outside the tree islands snow was a meter deep and in the process of melting; this provided a steady flow of water over the forest floor keeping the surface fuels damp.

With the aid of excellent road access and several tanker truck loads of water, the Paradise Fire was extinguished within three hours after ignition. If control action had not been taken, it is likely that this fire would have burned at least another 5 days and grown larger, potentially threatening the Paradise Visitor Center and recreational facilities nearby.

The South Mowich Fire was not discovered until May 10, three days after ignition. It is assumed that

the fire smoldered for the first three days, then took off as conditions got drier. Most of the burning took place on May 10 and 11. The fire ignited on the steep (> 80%) south slope at around 1580 m (5200 ft) elevation, which appeared to be snow-free at this time. The fire spread in three directions: 1) downslope, probably as a result of rolling firebrands; 2) cross-slope in a northeasterly direction; and 3) upslope over the ridge and down the snow-covered north slope. The fire spread appeared to be more rapid on the south slope. Here, the tree canopy was more or less continuous, the slope was steeper, and conditions were drier than the north slope, where trees are clustered among small, snow-laden meadows.

Permanent Plot

One 50 x 50 m permanent plot was established on the north slope of the South Mowich Fire. Herb and shrub cover was measured in 40-0.5 sq m subplots around the perimeter of the permanent plot. All tree saplings between 0.2-2.0 m were identified to species, height measured, and mapped. All trees > 2 m tall were tagged, identified to species, determined whether live or dead, and mapped; diameter, total height, and scorch height were measured; and the amount of crown damage by heat scorch or needle consumption was estimated.

Ecological Effects of the South Mowich Fire

As the fire moved through the tree canopies on north slope, most of the actual burning took place in the foliage of tall, large 400-600 year-old mountain hemlocks. The foliage of the shorter, 300-450 year-old, Pacific silver firs was generally only singed. If the canopy of a Pacific silver fir was set ablaze, usually only a small proportion was consumed. Foliage damage to Pacific silver fir was more severe, especially if it grew close to mountain hemlock. Because of this, I suspect that hemlock was more sensitive to desiccation and apt to burn more intensely than Pacific silver fir.

The canopies of all trees > 5 m were either heat scorched or consumed by the fire. However, initial survival of trees > 5 m was high, nearly 60 percent. Still, most of the survivors had more than 50 percent crown damage, and a large proportion of these trees will likely die over the next year or two.

Because of snow, the scorch line on most tree boles started at 5 m above the ground. Trees < 5 m height, if affected by the fire, were heat scorched only. Sixty-three percent of the trees < 2 m height were unaffected. The patchy distribution of scorching within the understory indicates that snow depth at the time of the fire was variable. The least amount of scorching occurred in the meadows being invaded by small trees, where apparently snow was deepest. At locations where trees grew close together, the fire in some instances burned down to the ground inside the snow-well that surrounded the trees.

Trees between 0.2-2 m height were abundant, numbering > 5,000 trees/ha. Pacific silver fir dominated this tree layer: 74 percent Pacific silver fir, 19 percent mountain hemlock, and 7 percent other species. These small trees are expected to be dominants as the stand develops over the next few centuries. If so, the new forest canopy will be somewhat different from the old forest canopy that existed before the fire: 48 percent Pacific silver fir, 48 percent mountain hemlock, and 4 percent other species. The species mix of equal



North slope of the South Mowich fire on the northwest flank of Mount Rainier is shown here as it looked on June 3, 1987, 27 days after the fire started. Many of the tall trees have sparse crowns from being burned and snow still remains between the tree clusters.

amounts mountain hemlock and Pacific silver fir is expected to give way to a forest dominated by Pacific silver fir. Because Pacific silver fir is the more shade tolerant species, this fire has essentially moved the species composition closer to "climax," quite the opposite effect of fires burning in the summer months.

Management Implications

This year MORA has completed a draft fire management plan, in which some natural fires will be allowed to burn under a proposed management prescription. Because MORA is only 95,339 ha (235,404 ac), 25 percent of which is rock, snow and ice in the central mountain core, and because it has merchantable timberlands surrounding a large portion of its borders, natural fire management is difficult. Spring subalpine fires, however, are a low risk phenomenon. They will most likely be relatively small in size, be confined to the subalpine, and burn for only a few days.

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