HOZOMEEN FIRE MANAGEMENT STUDY

PROJECT NUMBER 92-3

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North Cascades National Park Service Complex

Report by Janet Kailin
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The majority of the fieldwork was performed by Catherine Bruno, Pam Bullington, and Dylan Wirta. Data entry was done by Pam Bullington and Loretta Duke.

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Ann Braaten produced the GIS maps. Jon Reidel wrote sections on landforms, weather, and vegetation. Jesse Kennedy provided guidance on statistical methods.

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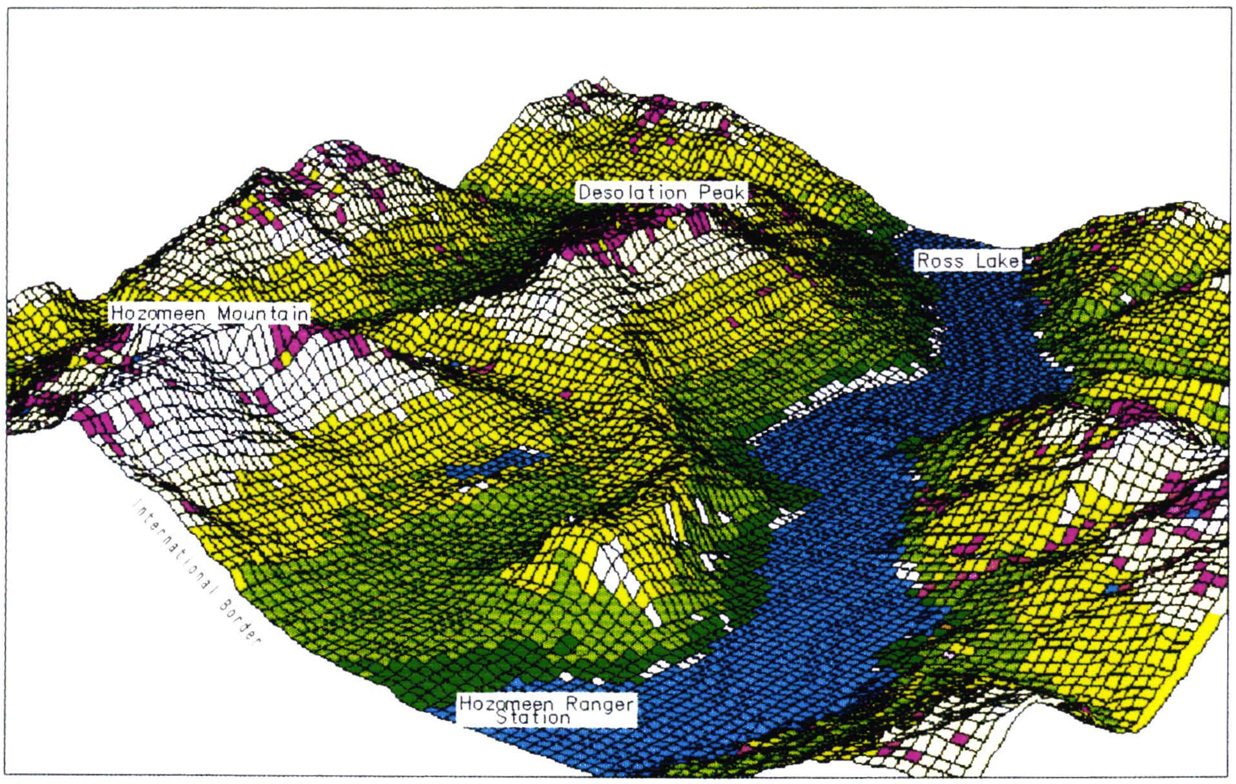
Desolation Peak
Ross Lake
Hozomeen Mountain
International Border
Hozomeen Ranger Station

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1.0 INTRODUCTION

The Hozomeen area of the Ross Lake National Recreation Area lies at the north edge of the North Cascades National Park Service Complex ("NPS Complex"), and meets the Canadian border at the 49th parallel [Figure 1]. On both sides of the international border recreationists use the campgrounds, trails, and Ross Lake reservoir during the summer months. The management of fire is a concern for this recreational area surrounded by a mixed conifer forest, because of the extensive evidence of past fires, and the potential threat to current United States and Canadian resource values at risk.

The intent of this study was to gather fuels, vegetation and site information on which to base a fire management plan. This report contains background information related to fire management concerns at Hozomeen; a summary of the field information gathered in 1992 and 1993; and recommendations for future fieldwork and fire management at Hozomeen.

The background materials include information on the fire environment, values at risk, sources of ignition, and suppression resources at Hozomeen.

In the field portion of the study fifteen forest monitoring plots were installed in the Hozomeen area. Data was gathered from these plots on fuel loadings, vegetative species, size class and relative cover. Analysis of the data gave an indication of the range of variability in the Hozomeen area in natural fuel and vegetation areas.

Preliminary conclusions and recommendations have been made, based on the information gathered to date. Additional fieldwork is recommended to evaluate the disturbed sites along the developed areas, where thick stands of young tree reproduction pose the highest fire hazard in the Hozomeen area.

NORTH CASCADES NATIONAL PARK SERVICE COMPLEX

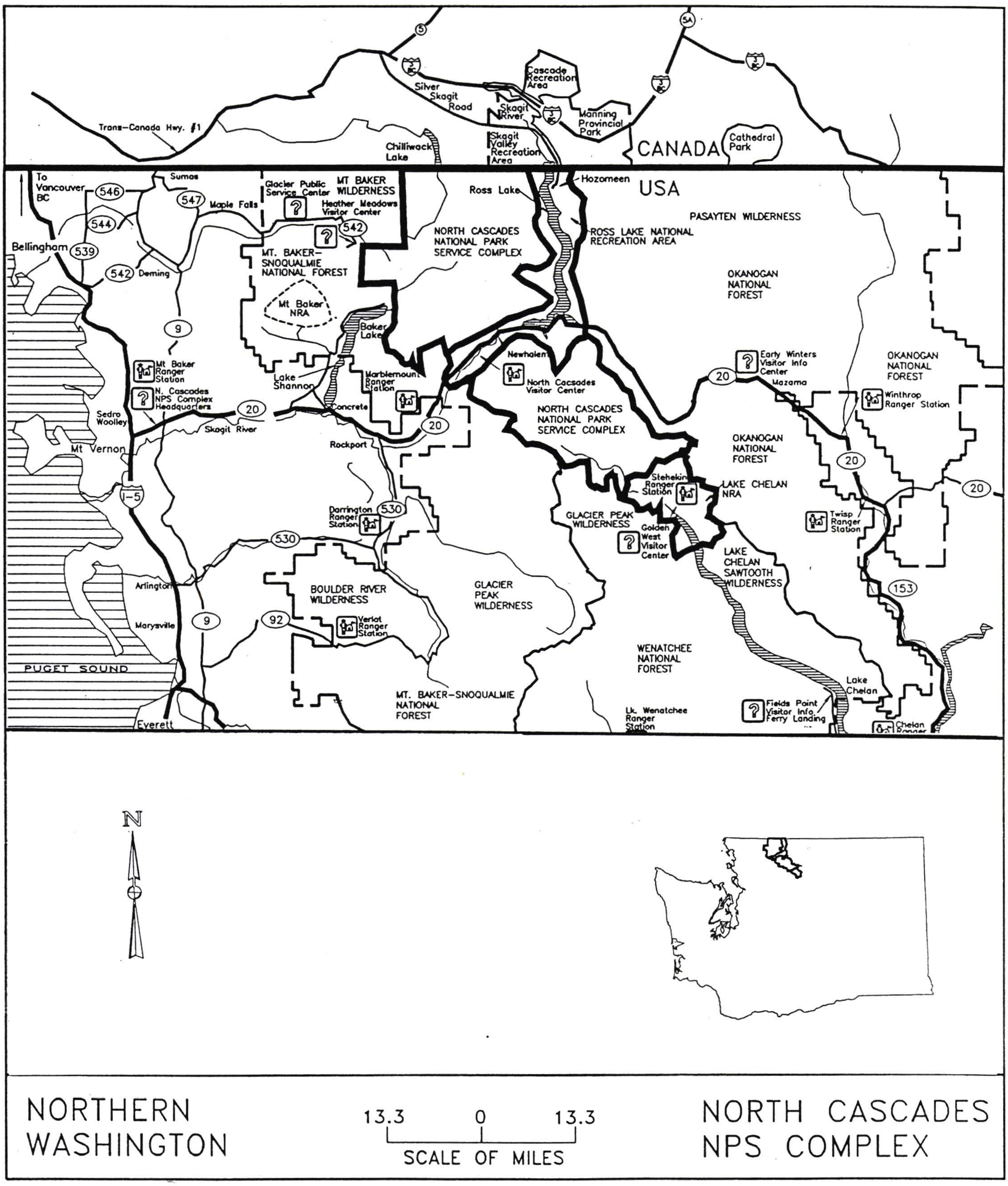


Figure 1. Location Map

2.0 BACKGROUND INFORMATION

Natural and cultural factors have interacted to create the present fire environment at Hozomeen. Some of the major factors are summarized below.

2.1 CLIMATE

Northwestern Washington's climate is classified as marine with wet, mild winters and cool dry summers (NOAA, 1979a). Primary factors influencing the climate of the North Cascades are latitude, proximity to the Pacific Ocean, height of the range, and semi-permanent high and low pressure cells located over the North Pacific Ocean (NOAA, 1979b). Prevailing westerlies continually carry wave cyclones and moisture-laden air from the Pacific into contact with the North Cascades. The orographic effect causes increased precipitation with altitude as Pacific air cools while rising over the range. The presence of semi-permanent pressure regions over the North Pacific imparts a strong seasonal component to precipitation in the Cascades: less precipitation falls during the summers because a vast region of high pressure dominates the Pacific. Circulation around the high pressure cell causes a northwesterly flow of relatively cooler, drier air onto the continent. In late fall and winter the Aleutian low pressure dominates the Pacific, bringing a predominantly southwesterly flow of warmer, moister air into the North Cascades. Cooling and condensation as a result of the orographic effect is enhanced by the relatively cool land mass.

The Skagit Valley drains the wet west slope of the North Cascades, although precipitation in the valley varies with respect to local topography and geographic position. The Ross Lake Basin, a north/south orientation, lies in the rainshadow of the crystalline core of the range (the Picket Range and Mt. Prophet) and receives less rainfall than the lower valley, which has a westerly orientation.

Weather stations in the study area are located at the north end of Ross Lake at Hozomeen campground and at the Ross, Diablo, and Gorge powerhouses. A third weather station at the Marblemount Ranger Station is located 4 miles downvalley from Bacon Creek. The Marblemount and Hozomeen stations collect fire weather data during the fire weather season (late spring to early fall). Annual precipitation decreases upvalley from 78 inches (198 centimeters) at Newhalem, to 71 inches (180 centimeters) at Diablo, 56 inches (142 centimeters) at Ross powerhouse and 31 inches (79 centimeters) at the international boundary (International Joint Commission, 1971). Mean annual temperature is 49^{0}F at Newhalem, and 48^{0}F at Diablo and Ross powerhouses (Phillips, 1966). Temperature extremes increase upvalley in response to increasingly continental conditions.

Wind data from the Hozomeen station reflects strong up-valley flow from the south and southwest. The strongest winds in the valley are sea breezes that develop during summer afternoons when high inland temperatures draw air from the relatively cooler Pacific Ocean. Wind speed increases in the narrow river canyon sections of the valley between Newhalem and Ross Dam. A strong northeast component to summer winds at the Hozomeen station probably reflects storm wind patterns.

TABLE 1. SUMMER WIND DATA FROM THE HOZOMEEN WEATHER STATION. TABLE LISTS NUMBER OF OBSERVATIONS AT DIFFERENT SPEEDS AND DIRECTIONS SINCE 1960 (DATA FROM THE THE U.S.F.S., BOISE, IDAHO).

HOZOMEEN STATION (TOTAL OBSERVATIONS 1595)

	DIRECTION								
WIND SPEED(MPH)	NE	E	SE	S	SW	W	NW	N	CALM
0-5	76	81	29	166	293	161	81	122	327
6-10	4	5	10	33	40	11	4	12	
11-20	0	2	4	10	7	1	4	5	
21-30	0	0	0	2	1	1	1	1	
96-100	0	0	0	0	0	1	0	0	
TOTALS	80	88	43	211	341	175	90	140	327

2.2 LANDFORM AND SOILS

The Hozomeen area lies in a deep valley cut into the late paleozoic to middle Mesozoic metamorphic rocks of the Hozomeen group. The Hozomeen group consists of metamorphosed chert, basalt and argillite.

Alpine and continental glaciers have taken turns shaping the geomorphology of this area over the past 2.5 million years. The glaciers created a broad, U-shaped cross valley profile in the Skagit Valley, and left the Hozomeen Creek valley as a hanging valley. Local relief from the Skagit River to the summit of Hozomeen Mountain is around 6,500 feet.

The most recent ice to occupy this part of the valley was the Cordilleran Ice Sheet, which retreated from the Hozomeen area about 11,000 years ago. Deposits from this glacier are the primary parent material for soils in the area. On lower valley slopes, soils have formed in compact glacial till. These soils are generally deeply weathered, but poorly drained. On flat outwash terraces where the valley walls meet the floodplain of the Skagit River, excessively drained soils have formed in coarse-grained sand and gravel deposits.

Alluvium is the parent material for soils developed along the Skagit River, Hozomeen Creek and Howlett Creek floodplains. These soils are generally composed of sand, silt and gravel, but are less well developed than soils in older glacial deposits. Wetland soils are found along the US-Canadian border near beaver ponds.

2.3 VEGETATION AND FUELS

Four broadly defined vegetation zones are found in the North Cascades. They are defined on the basis of altitude (or temperature gradient) and the strong west to east precipitation gradient. From west to east across the Cascade crest they are the lowland forest, the montane forest, the subalpine forest, and the alpine tundra (Heusser, 1983). The study area is dominated by the lowland forest, which grows from sea level to 2950 ft. and is dominated by western hemlock (Tsuga heterophylla), western red cedar (Thuja plicata), and Douglas-fir (Pseudotsuga menziesii).

Within the Ross Lake basin drier plant communities are found than usually exist on the western slope of the Cascades, reflecting the drier conditions in the rainshadow of the Picket Range. These communities are particularly prevalent in rocky outcrops on the eastern shore of the lake. Dominant species within the drier communities include ponderosa pine (Pinus ponderosa), lodgepole pine (Pinus contorta), and aspen (Populus tremuloides). On the western shore, wetter communities (including Douglas-fir and western hemlock) more typical of the western slope are found interspersed with lodgepole pine communities.

The categorization and mapping of plant communities of the North Cascades varies from study to study, based on different standards or definitions of plant community characteristics. A new Geographic Information System (GIS) database is being prepared by Pacific Meridian Resources to characterize the variation in vegetation and landforms in the North Cascades based on satellite imagery, geology map data and field measurements. Final hardcopy maps are expected to be ready by spring 1996.

Agee and others (1985) created a fuels map for the North Cascades NPS Complex based on Landsat Multispectral Scanner imagery, information from 425 field plots, and ecological modeling of plant communities [Figure 2]. The fuel characteristics for most of the Hozomeen fire study area were classified as Northern Forest Fire Laboratory Fuel Model 8 (short needle conifer). Small areas near the road were classified as a mixture of Fuel Model 8 and Fuel Model 5 (low brush), or as Fuel Model 1 (open grassland).

2.4 PREHISTORIC AND HISTORIC FIRE PATTERNS

Fire history studies performed near Hozomeen suggest very dissimilar fire frequencies at various locations in the upper Skagit Valley. From preliminary studies it appears that fires occurred much more frequently in the valley bottom near Hozomeen than at the higher elevations of Desolation Peak to the south, although lightning strikes normally occur at the higher elevations. This pattern may be due to localized burning in the valley bottom by Native Americans in prehistoric times.

In 1866 Henry Custer, one of the earliest white explorers in the North Cascades, reported on his 1857 travels as a topographer for the U. S. Northwest Boundary Commission. With nine Native Americans, and two white men, he explored the Cascade Mountains in the vicinity of the 49th parallel. In his narrative he describes many days during his travel (between mid-July and early September), where visibility was limited by smoke. At one location along the Skagit he observes:

> On this side of the stream we found the whole forest burned by late fires, ignited by persons recently encamped here. Smoke was still arising in all directions from numerous footlogs & trees ect. Fires are very frequent during summer season in these Mountain forests and are often ignited purposely by some of the Indian hunting in these Mountain regions, to clear the woods from under brush & make travel easier. Once ignited, they generally burn the whole summer, and only the drenching rains of the fall are able to check their further spread.

In an unpublished report Taylor (1977) describes tree stumps found in a 10 meter x 10 meter plot in the drawdown area near Hozomeen. The stumps are from trees that began growing in 1770-1790, and were cut down in 1947. Of the 88 stumps examined, 21 stumps had fire scars; 7 had multiple scars. The earliest fire scar dated to 1802 and the most recent was 1887. On the stumps with multiple scars the average interval was 12 years with a range of 5 to 40 years. No scars were found in the interval from 1887 to 1947. The pattern of scarring led Taylor to conclude that the fires were of low intensity. He speculated that the frequent, low intensity fires were caused by Native Americans who were living in the upper Skagit Valley.

Another preliminary study examined the cores of 23 trees and a partial cross-section of one tree along Ross Lake, north of Lightning Creek (Allen, 1983). The oldest fire scar dated to 1782. Fire scar intervals ranged from 6 to 74 years. Fire disturbance averaged a 20 to 30 year interval. Based on the preliminary study, the author observed that the suppression policies this century had apparently not disrupted a "natural" fire frequency.

A detailed fire history study for the Desolation Peak area, five miles (8 kilometers) south of Hozomeen, found evidence of fires dating back more than 400 years (Agee and others, 1986). The area examined was bounded to the west by Ross Lake, to the south and east by Lightning Creek, and extended to the north as far as Willow Lake. The fire frequency was described in this study in terms of the Natural Fire Rotation (NFR), defined as a selected time period divided by the proportion of the total area burned during that time period. The NFR, analyzed for each century, varied from 60 to 208 years; and for the whole time period was 100 years. When the NFR was analyzed by slope aspect for the whole time period it was found to range from 65 years on southwest slopes to 182 years on north slopes. When analyzed by community type the NFR varied from 52 years in the Douglas fir/ponderosa pine community to 137 years in the Pacific silver fir/subalpine fir community.

Fires in the Desolation area were not all of stand replacing severity, but some major fires appear to have swept through much of the study area (1648, 1851, 1926). The 1851 fire burned from Desolation Peak north into British Columbia. Under less severe conditions (cooler, wetter conditions), north aspects appear to have acted as fire breaks.

Although fire management policies during much of the current century required full suppression of all fires, the Desolation fire history study did not detect changes in the natural fire rotation at Desolation due to those policies.

In the past 26 years since the Ross Lake National Recreation Area was established 29 fires have occurred on NPS Complex lands east of Ross Lake and north of Jack Point [Figure 2]. Thirteen of these were human caused, and were located near developments; and 16 were lightning caused. Most of the lightning fires were located at higher elevations more than 1/2 mile south of the developed areas. All but two of these fires were less than 1/4 acre (0.1 hectares) in size. One fire was 1 acre (4 hectares); a second one was 26 acres (10.4 hectares). The number of fires per year in the NPS Complex is highly variable. About one year in ten there are numerous fires, followed by years of little activity.

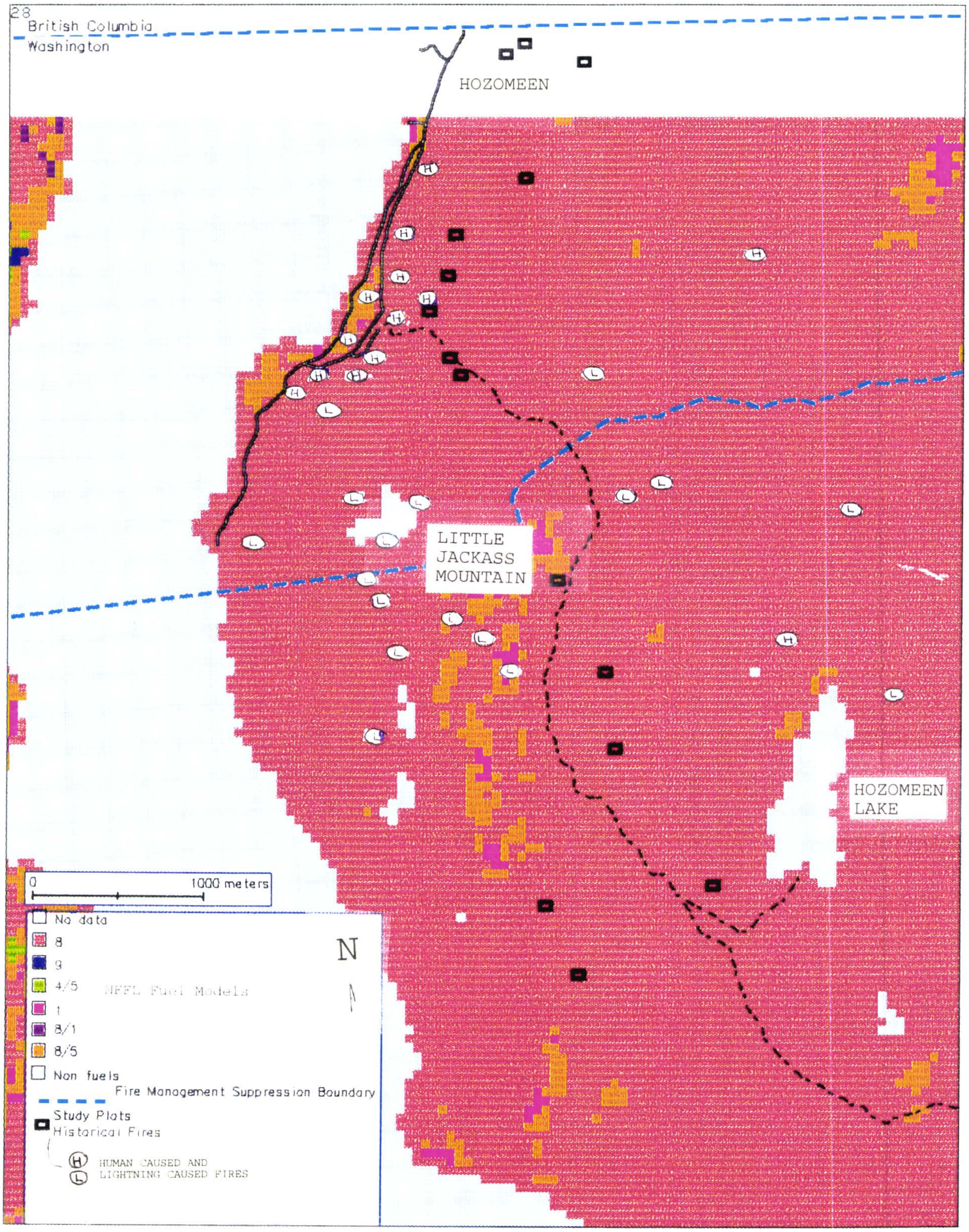


Figure 2. Fuels and fire history map.

2.5 20TH CENTURY FIRE MANAGEMENT

For most of the current century the lands at Hozomeen were managed by federal agencies under policies of full suppression of all human and lightning-caused fires. The National Park Service acquired the lands from the United States Forest Service in 1968 and continued the policy of full fire suppression until 1978. Between 1978 and 1988 some lightning ignitions were managed as natural fires. Five of these ignitions were in the Hozomeen area and were less than a 1/4 acre (0.1 hectares). Following the Yellowstone Fires of 1988, the NPS Complex returned to full suppression of all fires pending review and revision of its Fire Management Plan under revised national guidelines (NPS-18).

In the revised Fire Management Plan, approved in 1991, a suppression zone was delineated along the Canadian border for the protection of the Hozomeen campgrounds, NPS administrative facilities, Seattle City Light maintenance facilities, and lands outside of the Complex. Figure 3 shows the fire suppression unit boundary. In the Hozomeen area the unit boundary does not follow natural barriers; it follows an east-west line, approximately 1 mile from the international border. The objective of fire management in this fire suppression unit is to minimize the size of wildfires through confinement, containment or control strategies. Management-ignited prescribed fire has not been used in this area to date, but may be used (Fire Management Plan, 1991):

- to maintain as near natural an environment as is consistent with protection of private and public development in keeping with the mandate of the enabling legislation to conserve "...the scenic, scientific...and other values...."

- to reduce hazardous fuel accumulations in order to prevent the spread of wildfire and to eliminate the resulting impact on public and private developments.

- to reintroduce fire to areas where it is not feasible, because of adjacent land values or developments, to allow natural fire to play a role in ecosystem dynamics.

To the south of the suppression zone is a prescribed natural fire zone where lightning ignitions may be permitted to burn if they meet prescription criteria listed in the Fire Management Plan.

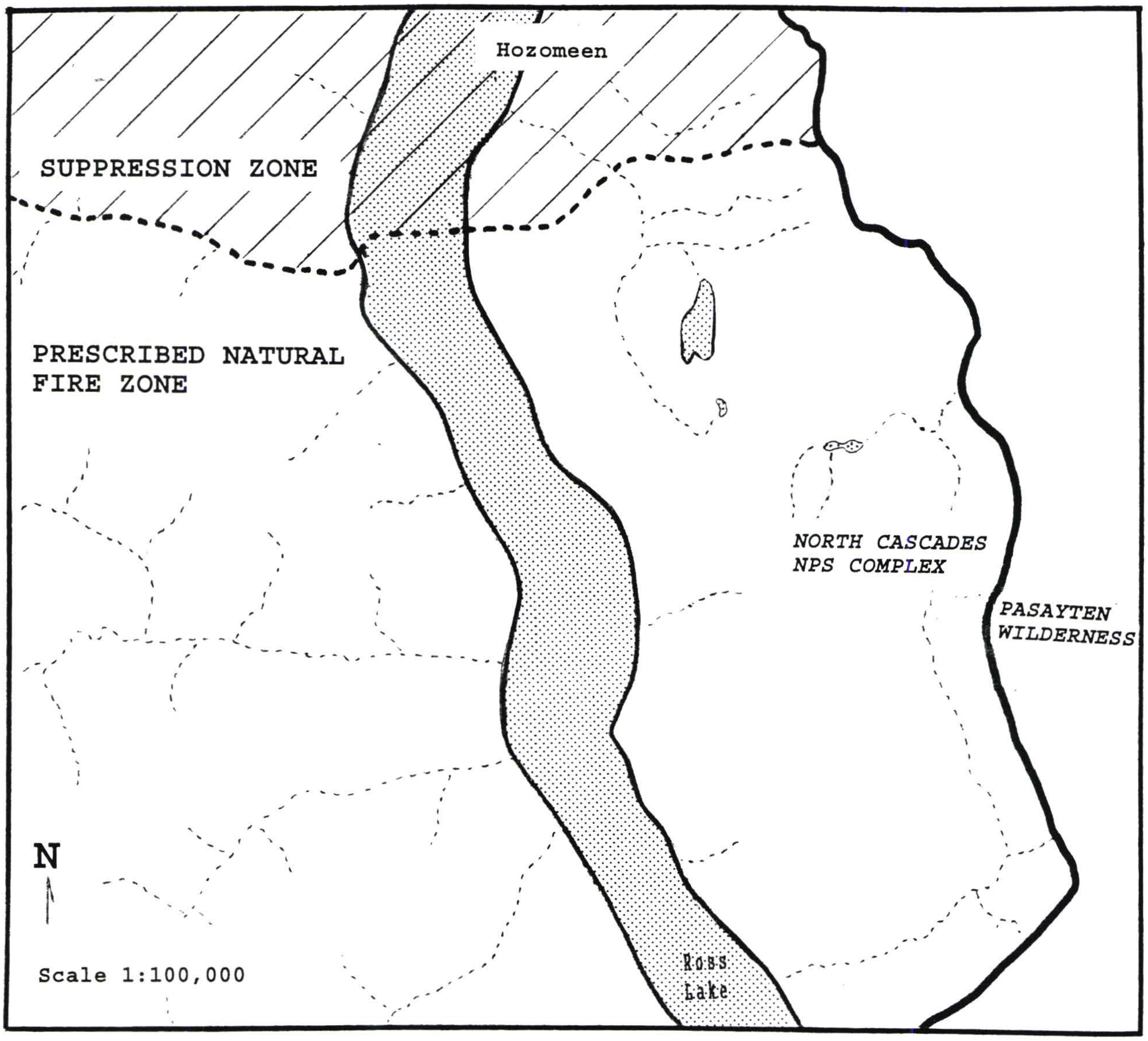


Figure 3. Suppression and Prescribed Natural Fire Zones

Both ground and aerial detection are used to locate fires at Hozomeen. Two to five NPS personnel are stationed at Hozomeen in the summer. Among other duties, they aid in detection of fires and initial attack. The Desolation Lookout is also staffed. From the lookout a portion of the Hozomeen area is visible, but the view of the southern portion of the developed area is blocked by Little Jackass Mountain [Figure 4]. The Fire Management Plan includes a step-up plan to increase detection and initial attack capabilities during periods of high fire danger. Aerial detection flights are used following lightning storms when there is a likelihood of ignitions. Reports are also received from detection flights performed by neighboring agencies. Lightning detection maps have not proved reliable in this rugged terrain.

Fires in the NPS Complex are suppressed using hand tools, portable pumps, chainsaws, helicopter bucket drops, and retardant drops. At Hozomeen there is a small cache with a portable pump, chainsaw, and a few handtools. Ninety-three percent of the NPS Complex is part of the Stephen Mather Wilderness. Minimum impact fire suppression techniques are used both within and outside of the designated wilderness area. Vehicles are used only on existing roads. The use of heavy equipment, i.e., bulldozers is considered only in rare instances when necessary for the protection of developed areas and then only with approval of the Superintendent.

To the north of the border, the B.C. Forest Service has one 3-person initial attack crew stationed at Haig Camp near Hope, B.C. By helicopter their response time to the border area would be about 30 minutes. There is also an air tanker base at Abbotsford, B.C.

B.C. Parks has two rangers trained in initial attack who are assigned to the Skagit Valley Recreation Area from about June 1 to September 30. They have a small cache of firefighting equipment at Hozomeen, including a pump, chainsaw, and 20+ handtools.

Seattle City Light stations three employees at Hozomeen in the summer. They have a dump truck that has been fitted with a 300 gallon slip-on, and a reel with 250 feet of 1-inch hose. Additional firefighting supplies include three portable pumps, 1000 feet of 2-inch hose, and handtools for a crew of five firefighters. During periods of high fire danger fire tools are carried in the Seattle City Light pick-up. Three fire hydrants are located in the Seattle City Light housing area.

Figure 4. Viewshed from Desolation Lookout.
(Shaded areas can be seen from the lookout.)

Communications between Hozomeen and the rest of the NPS Complex, or the outside world are limited to two-way radio. There is no phone. The NPS Complex and B.C. Parks have a radio use agreement to allow use of each other's frequencies. Three radios in the NPS Complex are programmed with B.C. Parks' frequency. One of the B.C. Parks rangers carries a portable radio that has the NPS Complex frequency. Hozomeen rangers can also contact the Manning Park dispatch office by radio.

2.6 MODERN DEVELOPMENT AND USE OF HOZOMEEN AREA

In the past 150 years, the Hozomeen landscape has been altered by humans for political, economic and recreational purposes. The most conspicuous modifications include the international boundary swath, the Silver Skagit Road, Ross Lake, and Hozomeen campsites [Figure 5].

The international boundary, first surveyed in 1858-1860, is currently marked with monuments and a 40 foot (12 meter) swath cut through the forest along the length of the boundary. This swath, maintained by an International Boundary Commission, is re-cut approximately every 30 years, and was last cut in 1985. The swath was not constructed to be a fire break or fire access, and does not serve that purpose. It is choked with brush, trees that are 10-20 feet (3-6 meters) tall, and piles of debris from the 1985 cutting.

The Silver Skagit Road, the only road access to Hozomeen, approaches the area through British Columbia, Canada. It was constructed in the late 1930's as a haul road for the trees being removed from the Skagit Valley area that was to be flooded by Ross Lake Reservoir. In the Hozomeen area, the road is gravel surfaced, and is bordered by dense thickets of young trees, primarily Douglas fir, hemlock and cedar reproduction. The road originally extended south to Lightning Creek, but is now covered by Ross Lake south of Hozomeen. The limited road access to Hozomeen is a significant factor when responding to fires. Travel by vehicle from the fire management office at Marblemount takes about 5 hours.

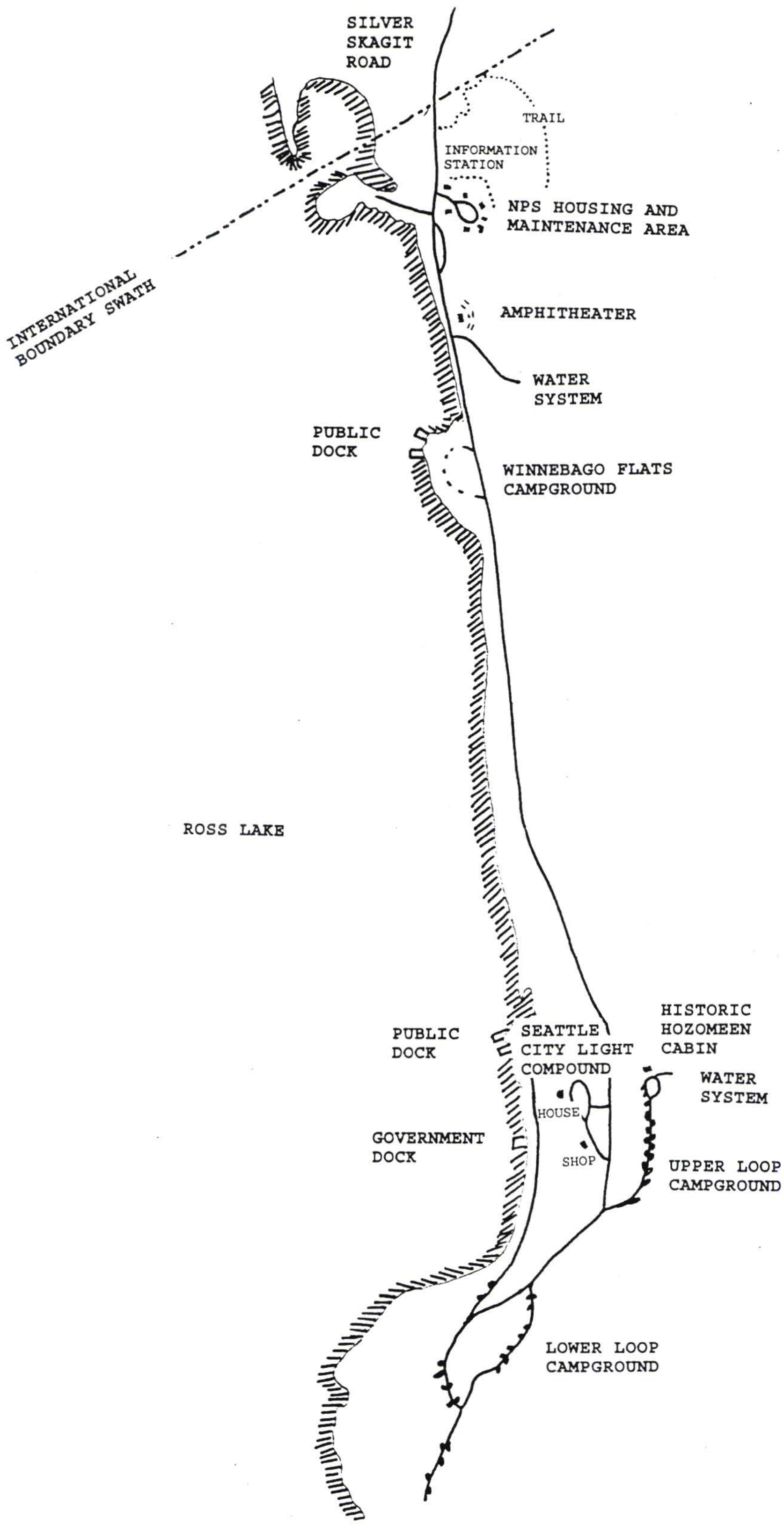


Figure 5. Existing Development at Hozomeen.

The Skagit River was dammed in 1949 to form Ross Lake, a source of water power for Seattle City Light generators. The lake created by the dam affects fire management at Hozomeen in several ways:

- It forms a barrier to the spread of fire across the Skagit Valley, and provides a ready source of water for helicopter buckets used in firefighting. When the reservoir is at high pool it is also a ready source of water for portable pumps.

- It enables boat access from Ross Dam at the south end of the lake to Hozomeen at the north end. (By this route, it takes firefighters about 3 hours to travel from the fire management office at Marblemount to Hozomeen.)

- It has probably altered the local weather to a small degree, increasing the relative humidity near the shore and altering the wind patterns.

- During periods when the lake is in low pool, it can be difficult or impossible to reach Hozomeen by boat. During the drawdown period it would also be more difficult for personnel at Hozomeen to access the lake as a source of water for firefighting. These access problems pose the greatest concern during April and May when fuels are beginning to dry out, and the lake is still low.

There have also been changes to some of the fuel patterns along the shore of the lake. The drawdown area of the lake, logged in the 1940's in preparation for the lake, now supports thick grasses that may be a carrier of fire. Near the lake edge dense thickets of young trees have grown up in sites disturbed by the 1940's logging activities.

Three Seattle City Light personnel who are employed to remove the floating debris on Ross Lake are housed on the Seattle City Light compound, 200 feet (60 meters) south of the mouth of Hozomeen Creek. This site once held six large bunkhouses. The site presently contains a house and maintenance shed on an open, grassy circle, surrounded by dense small trees.

An additional effect of the lake on fire management lies in its attraction to boaters, fishermen, and campers. Historically, Hozomeen has had one of the highest concentrations of human-caused wildfires in the NPS Complex. About 10,000 people visit the Hozomeen area each year between June and October. Many of these visitors camp in Hozomeen campsites, or in the Ross Lake Campground located just north of the international border. The Winnebago Flats Campground, south of the border consists of a large grassy parking area that has held as many as 100 recreational vehicles at one time. The grass poses a potential fire hazard. More than 30 additional campsites are located in the Upper Loop Campground, Lower Loop Campground, and along the road. Most of these campsites are small openings in the forest. Camping is not restricted to designated campsites. There is an information station, and a small NPS housing/maintenance compound near the border. If fire threatened these facilities and visitors, the Silver-Skagit Road offers the only land-based escape route.

2.7 VALUES AT RISK

On the south side of the international border, values at risk from wildfire include:

* A small A-frame visitor information building is located about 600 feet (180 meters) south of the border.

* The NPS maintenance and employee housing area lies just south of the information building. It consists of two single-wide trailers with lean-to additions, a seasonal bunkhouse, a small shop, two underground fuel storage tanks, a small flammable storage locker, and an outdoor maintenance storage yard. These structures are aging, and are considered inadequate for the needs at Hozomeen. They will be removed when a new compound is developed. A preliminary site plan has been completed for a joint NPS-SCL housing/maintenance compound to be developed at what is currently the Seattle City Light compound [Figure 6]. Three NPS housing structures and a maintenance shop will be constructed. Construction may start in 1996 if funds are available.

* The historic Hozomeen Cabin - originally built by the border patrol in the 1930's, and now used seasonally by NPS and Washington State Fish and Game Department personnel - sits next to Hozomeen Creek, at the north end of the Upper Loop campground [Figure 7]. This structure has been nominated to the National Register of Historic Places (Multiple Resource Area Nomination for North Cascades National Park Service Complex, 1987).

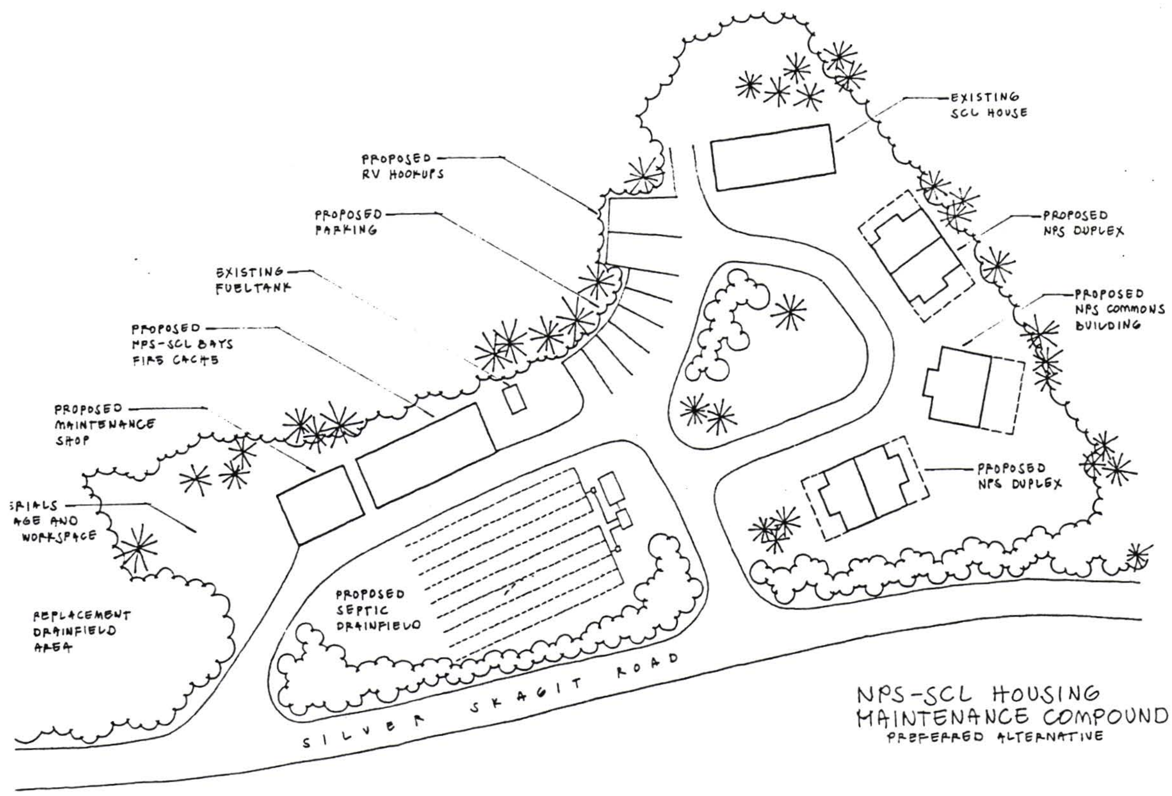


Figure 6. Preliminary site plan for joint SCL/NPS compound.

Figure 7. Historic Hozomeen Cabin.

* There are two water treatment facilities. One is on Howlett Creek, near the amphitheater. The other is on Hozomeen Creek, near the historic Hozomeen Cabin.

* The Seattle City Light (SCL) Compound consists of a modern, four bedroom modular house and a maintenance shed, about 200 feet (60 meters) south of the mouth of Hozomeen Creek.

* The NPS government dock with a small shop and covered boat storage is located west of the SCL compound. A public dock is located near the government dock, and another is located on Winnebago Flats Campground.

* Minor values at risk include several pit toilets, located in the campgrounds and near the boat launching sites. There is also an old, log seating amphitheater near Winnebago Flats.

* The boundary between the Ross Lake Recreation Area and the United States Forest Service Pasayten Wilderness, lies 2.5 miles (4 kilometers) to the east of Hozomeen.

* Archaeological sites may exist in the Hozomeen area. Fire effects can be significant on archaeological resources, though less than fire suppression efforts which generally involve ground disturbance.

* Rare, threatened or endangered animals that are sensitive to fire may be present at Hozomeen, but complete quantitative data is lacking for these species. Surveys for spotted owl will be conducted in the spring and early summer of 1995.

To the north of the international border, values at risk include [Figure 8]:

* The Ross Lake Campground, consisting of 88 campsites with firepits, picnic tables and pit toilets, is located immediately north of the border.

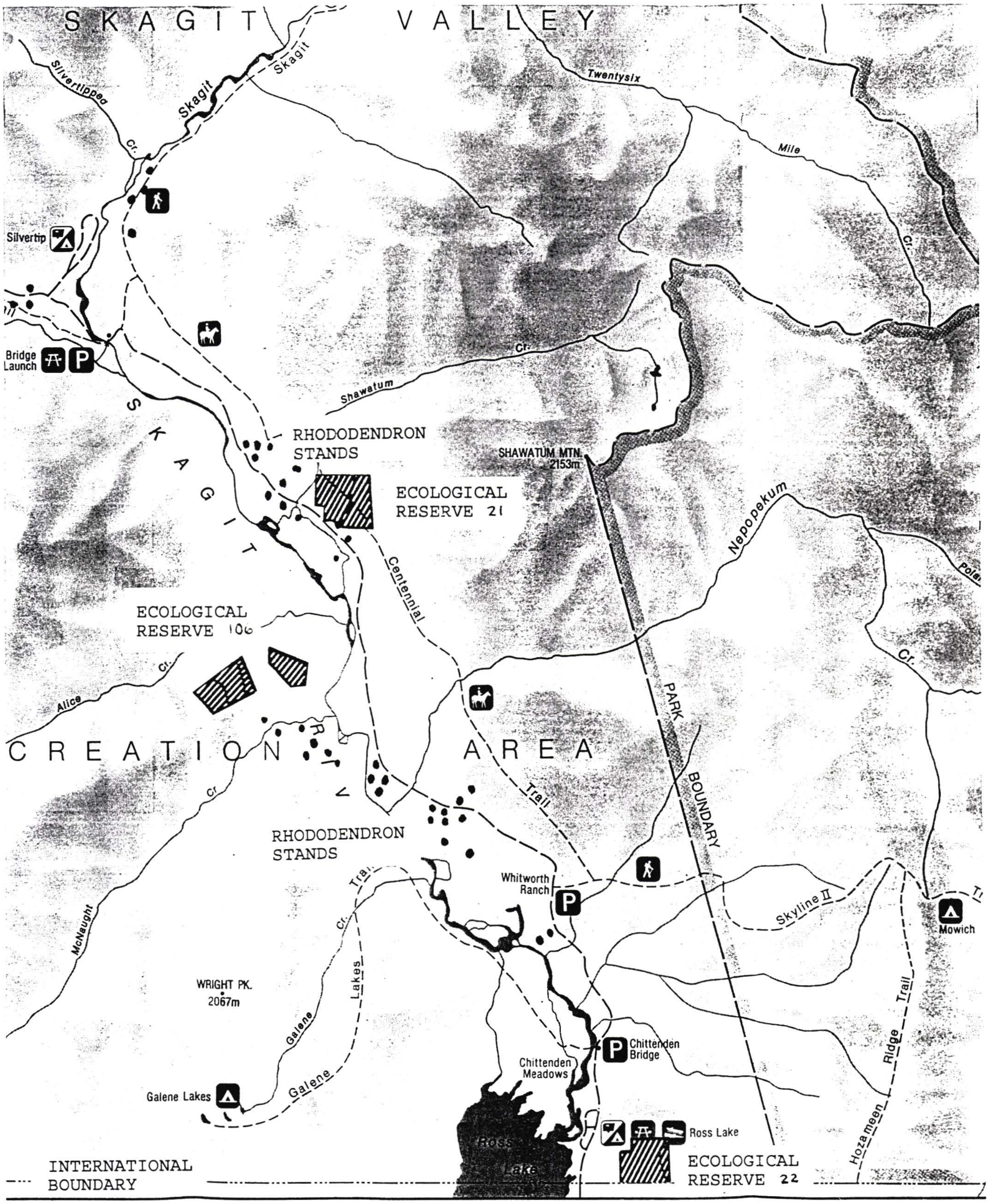


Figure 8. Neighboring values at risk from fire.

* Four Ecological Reserves have been established within the Skagit Valley Provincial Recreation Area of British Columbia. The three closest to Hozomeen include:

  - The Ross Lake Reserve (Reserve Number 22), is a 64 hectare (158 acre) unit that adjoins the international border. It preserves the most westerly ponderosa pine - bunchgrass vegetation at this latitude in British Columbia.

  - The Skagit River Rhododendrons Reserve (Reserve Number 106) consists of two units, totalling 70 hectares (173 acres) 10 kilometers (six miles) northwest of Hozomeen. It preserves a population of Red Rhododendron (Rhododendron macrophyllum), a rare plant in British Columbia, found only in the Skagit River watershed, Chilliwack River valley, and two sites on Vancouver Island. Rhododendron stands also occur outside of the Reserve. Pacific rhododendron has been rated Vulnerable in the List of Endangered Plants of British Columbia (B.C. Committee, 1990).

  - The Skagit River Forest Reserve is a 73 hectare (180 acre) unit located approximately 13 kilometers (8 miles) northwest of Hozomeen, on the alluvial fan of Shawatum Creek. It preserves a representative valley-bottom forest in an area transitional between coastal and interior climatic conditions.

* Nineteen rare vascular plant species were found in the B.C. portion of the Skagit Valley by Ogilvie and Ceska (1990). (Appendix D).

* The main portion of the Skagit Valley is a natural forest where the objective is to provide for non-vehicular recreation in a primarily natural environment. Wildfire could adversely affect trails and campsites in this area. At this time there is not an approved plan for prescribed natural fire. The trails closest to Hozomeen include the Hozameen Ridge Trail, Skyline II Trail, Galene Lakes Trail and Centenial Trail. The Mowich wilderness campsite is located approximately 7 kilometers (5 miles) northwest of Hozomeen, along the Skyline II Trail. The Galene Lakes wilderness campsite is located about 5.5 kilometers (3.5 miles) northwest of Hozomeen, on the Galene Lakes Trail.

* The Chittenden Bridge on the Silver Skagit Road is about 3 kilometers (1.5 miles) north of Hozomeen.

* The British Columbia Forest Service maintains permanent growth and yield forest plots in the Skagit Valley.

3.0 STUDY METHODS

The field methods used in this study are based on those described in the NPS Western Region Fire Monitoring Handbook, 1992, with few modifications. Those methods for collecting fuels and vegetation information were chosen for several reasons:

- The design is intended to allow managers to track short and long-term change in the vegetation and fuels.

- They are procedures that have become standardized in the Western Region, and are also used by several parks outside of the Western Region. (The North Cascades NPS Complex is in the Pacific Northwest Region.)

- Use of common procedures may facilitate the sharing of fire-related information.

- A handbook of the techniques and a computer program for the analysis of the data are both available.

The first stage of the procedure is to select and define "monitoring types", which are relatively similar fuel and vegetation complexes; and to chose one or more fuel and vegetation variables that are to be sampled to statistical significance. In addition to these key variables, a number of standard variables are also to be measured. The second stage of the procedure is to select and install 20 x 50 meter rectangular index plots. And the third stage is to collect and analyze data.

The procedures are summarized below. The Western Region Fire Monitoring Handbook contains a detailed description of the methods.

3.1 MONITORING TYPES AND VEGETATION/FUEL VARIABLES

Based on a general reconnaissance of the study area in 1992, and vegetation maps from the Grizzly Bear research study, two monitoring types were defined. The first, named "Douglas fir", was chosen to represent the drier sites in the Hozomeen area. The second, named "Western hemlock", was chosen to represent the forests found on moister sites.

The Douglas fir monitoring type (coded FPSME1T08) is found on well drained sites, and less developed soils; sometimes on rocky outcrops. The sites are usually located in relatively warm, dry areas of southeast, south, southwest, or west slopes. Douglas fir is the dominant species, and is usually represented in all of its age classes. Lodgepole pine is represented as a seral stage of this monitoring type. Western cedar, western hemlock, Douglas maple, and vine maple may be present.

The western hemlock monitoring type (coded FTSHE1T10) is found on relatively moist sites, and less well drained soils. Some of these sites are influenced by funnel drainage, potholes, seeps and late season snowfields. Tree cover is predominantly Western hemlock, in all size classes. Douglas fir and western red cedar may also be present, and may include large individuals. Douglas fir is not well represented in the understory. Other species that may be present include black cottonwood, birch, big leaf maple, pacific silver fir, and western white pine.

For both monitoring types, rejection criteria that would cause a candidate plot to be excluded from study included the following:
- Plot location was less than 30 meters from trail or stream.
- Plot was located in riparian zone.
- Plot was located in a microsite, not representative of larger forest habitat.
- Major cliff bands or avalanche slopes ran through the plot.

The key variable that was of interest for this study was the total fuel loading. Other variables that were measured or derived included:

1. Tree layer
   a. Density and
   b. diameter (diameter at breast height, dbh) by species for overstory trees, pole-sized trees, and seedling trees

2. Dead and downed fuel loads
   a. Fuel load by size class
   b. Duff depth
   c. Litter depth

3. Brush and herbaceous layer
   a. Number of transect hits by species
   b. Relative cover by species
   c. Number and percent of non-native species
   d. Number and percent of native species

4. Brush density by species and age

Procedures described in the Handbook call for 10 plots to initially be established in each monitoring type. The data is then analyzed to estimate the total number plots that would be needed to represent the key variable(s) to a level of statistical validity. Those variables that are not sampled to a level of statistical validity may still prove useful in long-term monitoring, alerting managers to possible changes that are taking place in the stand. In this study, time did not permit the required number of plots to be established. A total of fifteen plots were established; eight in the Douglas fir monitoring type, and seven in the western hemlock monitoring type.

3.2 LOCATION OF PLOTS

The study area is shown in Figure 9. Plots were randomly located in the 1880 acre (750 hectare) study area. An XY grid was placed over a map of the area, and the origin was selected in the upper left had corner, where X,Y = 0. Pairs of random numbers were selected to chose plot location starting points. The map of starting points was taken to the field. After a starting point was located in the field, a random compass direction was chosen, and a random distance (0-20 meters) was chosen using a random number generator. This new location was accepted as the plot origin if the area met the criteria for the monitoring type. If the location met rejection criteria, then a new origin point was attempted by returning to the plot location starting point and travelling a distance of 50 meters in a direction of 180 degrees away from the previously randomly selected azimuth. The new location was then examined for suitability.

Plots in the Douglas fir monitoring type were labeled FPSME1T08 Plot 1, Plot 2, etc. The plot label was abbreviated P1, P2, etc. Plots in the western hemlock monitoring type were labeled FTSHE1T10, Plot 1, Plot 2, etc. The plot label was abbreviated T1, T2, etc.

3.3 PLOT LAYOUT

A 50 meter line was placed at the plot origin, so that the center of the line was at the origin, and the line extended in either direction along a random azimuth chosen for the plot. This became the long axis of the rectangular plot. The plot corners were marked to define an area that extended 10 meters to each side of the long axis, so the whole plot covered an area 50 x 20 meters in size. Some of the variables listed in section 3.1 were examined over the whole plot. Others were examined in subsections of the plot. Figure 9 shows the plot layout for different variables.

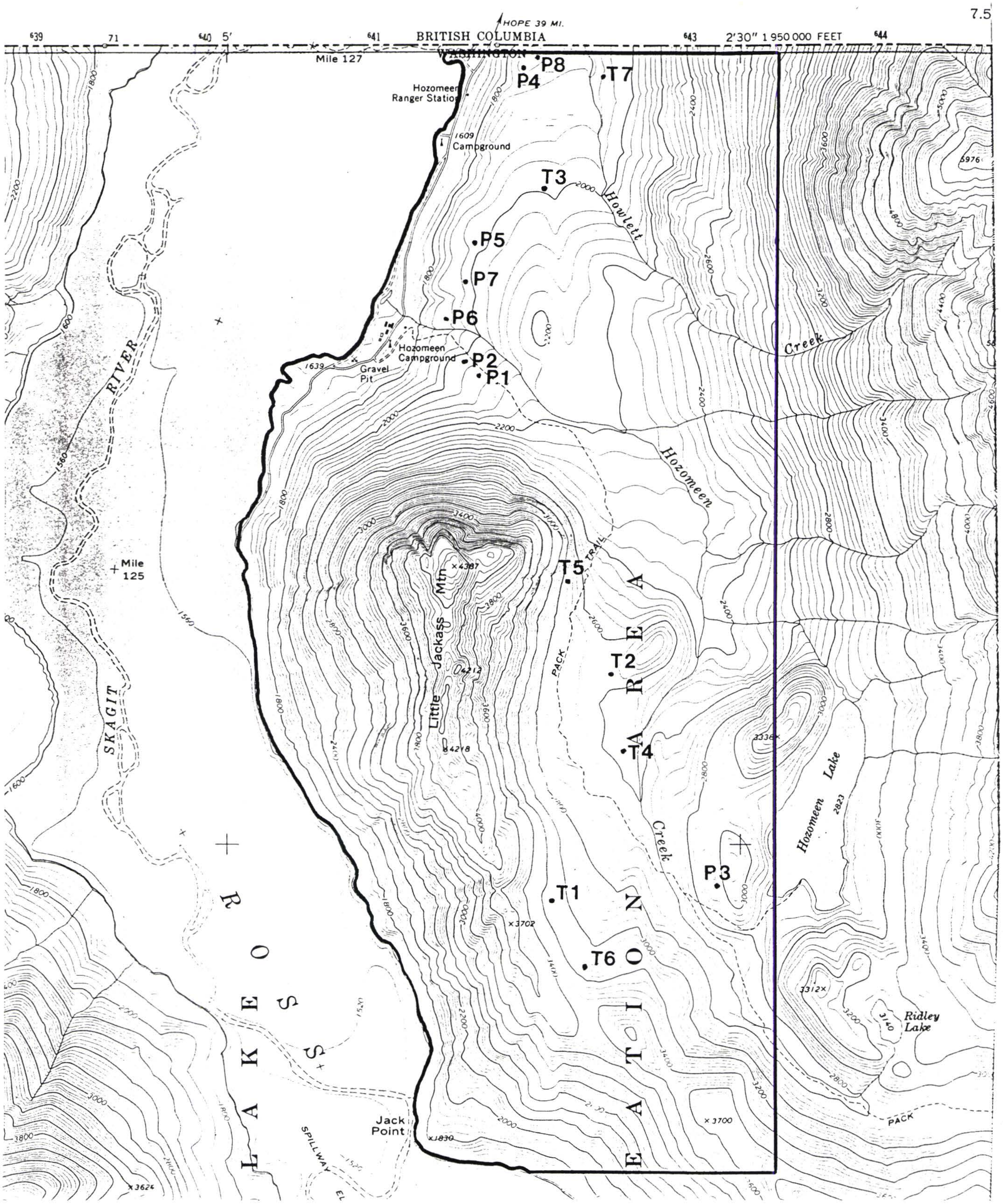
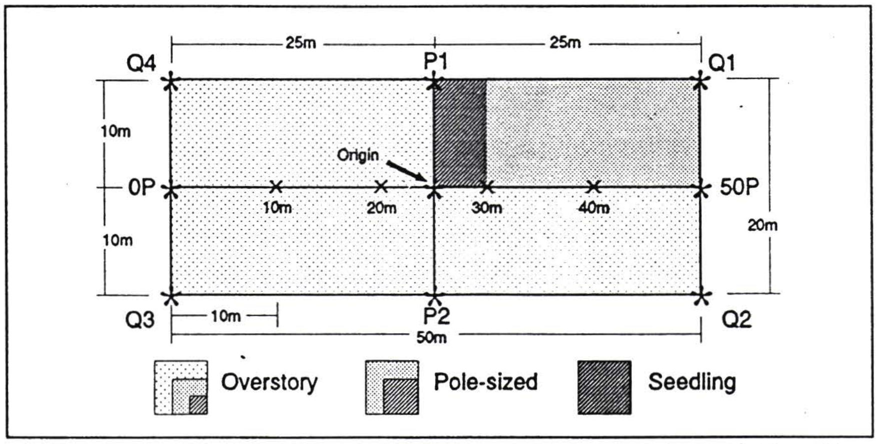
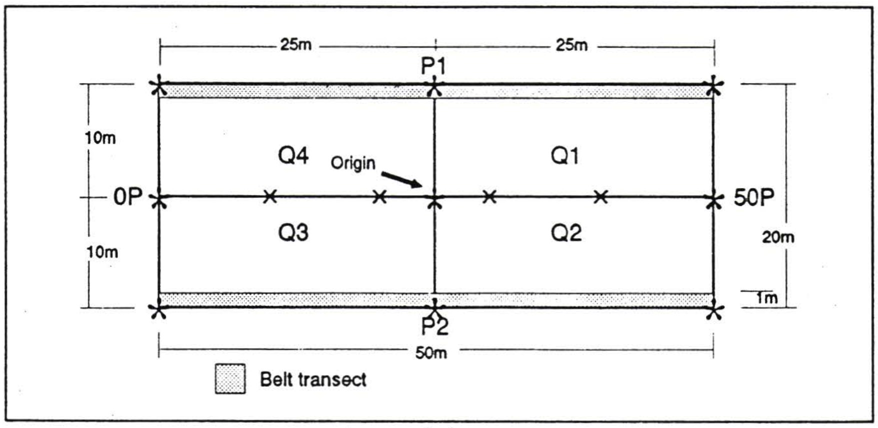


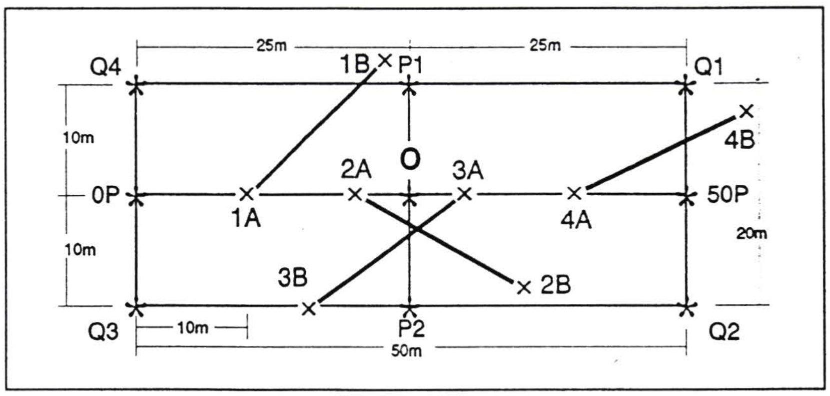
Figure 9. Study area and plot locations.



OVERSTORY AND UNDERSTORY TREES



BRUSH



DOWNED WOODY FUEL TRANSECTS

Figure 10. Plot layout for different variables.
(Adapted from Western Region Fire Monitoring Handbook)

3.4 MEASUREMENT OF VARIABLES

Overstory trees, defined as living and dead trees with a diameter at breast height (dbh) greater than 15 centimeters, were measured and mapped for all four quadrants of the plot. For each tree, the species, diameter, whether it was alive or dead, crown position (dominant, codominant, intermediate or subcanopy), and tree damage was recorded.

Pole-sized trees, defined as those living and dead trees with a dbh between 2.5 centimeters and 15 centimeters, were measured and mapped for quadrant 1. The species and diameter of each tree, and whether it was alive or dead was recorded.

Seedling trees, defined as living trees with dbh less than 2.5 centimeters, were tallied by species. The area over which they were measured varied in the different plots. The area used in each plot was recorded and was used in calculations of seedling density.

The brush and herbacious layer were measured using a point line-intercept to measure the number of transect hits, relative cover, and density of brush by species. The transects ran along the 50 meter lines on the outside of the plot. Every 30 centimeters along the transect line a 1/4 inch diameter rangepole was placed perpendicular to the ground. Every species that touched the pole was recorded. Brush density was measured along the same transects, widened to a 1 meter belt. For each 5 meter segment of the belt a tally was made of the number of individuals of each species having 50 percent or more of their rooted base within the transect. Data was recorded by species, age class (recruit, sapling or mature), number of individuals, and whether the plant was living.

Dead and downed fuel load was measured along four 50-foot transects originating from the centerline at 10, 20, 30 and 40 meters. Each transect was oriented in a random direction. A line intercept method was used to estimate fuel loading. A tally was made of the number of particles of each size class that crossed a given length of the transect. Size classes and transect lengths are as follows:

0 - 1/4" diam.	(1-hr timelag fuels)	tally from 0 to 6 feet
1/4 - 1"	(10-hr timelag fuels)	tally from 0 to 6 feet
1 - 3"	(100-hr timelag fuels)	tally from 0 to 12 feet
>3"	record each individual from 0 to 50 feet.	

Particles larger than or equal to 3 inches in diameter were measured to the nearest 1/2" (diameter), and were separated into sound and rotten categories.

Litter and duff depth measurements were taken at ten points along each fuel transect (at points 1, 5, 10, 20, 25, 30, 35, 40, and 45 feet).

Plots P1 and P2 were established and read in the summer of 1992. The rest of the plots were read in 1993.

3.5 PHOTOGRAPHY

Each plot, except for plots 2 and 3 of the Douglas fir monitoring type, was photographed from at least eight points of view. Four of these photographs were taken from the outside of the plot to the plot center; and four were taken along the outer edges of the plot. The original photographs, taken in the summer of 1993 were very dark. Additional photographs were taken in 1994 of eleven of the plots. The later photographs were taken along the long center axis of the plot. Two of the original photographs, and eleven of the later photographs are reproduced in this report. Color copies can be made from the original photographs which are stored at the NPS Complex fire management office.

3.6 COMPUTER ANALYSIS

The data was analyzed using a micro-computer program FMH.EXE (Sedoriak, 1991) that was designed to be a companion to the Western Region Fire Monitoring Handbook. The computer program provides a means to enter and analyze fire monitoring data using the handbook methods.

4.0 RESULTS

4.1 INDIVIDUAL PLOT DATA SUMMARIES

Abbreviations used on following pages:

in	Inches.
%FREQ	Relative density percent of a tree or plant species.
#/HECTARE	Number of trees per hectare.
#/ACRE	Number of trees per acre.
AVG DBH	Average diameter at breast height.

DOUGLAS FIR MONITORING TYPE -- PLOT 1

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.320
1/4 - 1	0.000
1 - 3	8.810
3+ sound	0.000
3+ rotten	11.872
Sum 3+	11.872
Woody	21.002
Duff	5.494
Total	26.496

DOUGLAS FIR MONITORING TYPE -- PLOT 1

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pinus contorta	Y	45	76.3	450.0	182.2	19.9
2	Pseudotsuga menziesii	Y	13	22.0	130.0	52.6	19.0
3	Pinus monticola	Y	1	1.7	10.0	4.0	18.3
Total			59		590.0	238.9	19.7

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	29	50.0	1160.0	469.6	9.0
2	Pinus contorta	Y	27	46.6	1080.0	437.2	13.1
3	Pinus monticola	Y	1	1.7	40.0	16.2	5.8
4	Thuja plicata	Y	1	1.7	40.0	16.2	5.8
Total			58		2320.0	939.3	10.8

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Pseudotsuga menziesii	Y	190	100.0	12666.7	5128.2
Total			190		12666.7	5128.2

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	55.12	49.70	-
2	Moss species	Y	54.52	39.16	76.37
3	Lichen species	Y	5.42	1.20	7.59
4	Arctostaphylos uva-ursi	Y	4.22	3.92	5.91
5	Vaccinium membranaceum	Y	3.01	2.71	4.22
6	Cladonia bellidiflora	Y	1.81	1.51	2.53
7	Spireas betulifolia	Y	1.20	0.90	1.69
8	Vaccinium parvifolium	Y	0.60	0.60	0.84
9	Chimaphila umbellata	Y	0.30	0.00	0.42
10	Pachistima myrsinites	Y	0.30	0.30	0.42

Total # points = 332, Avg. species/point = 1.4, Avg. height = 0.042m
Nat. species = 239 of 239 plants (100.0%)

DOUGLAS FIR MONITORING TYPE -- PLOT 2

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.472
1/4 - 1	2.049
1 - 3	3.829
3+ sound	26.138
3+ rotten	3.354
Sum 3+	29.493
Woody	35.843
Duff	10.411
Total	46.254

DOUGLAS FIR MONITORING TYPE -- PLOT 2

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pinus contorta	Y	28	80.0	280.0	113.4	22.5
2	Pseudotsuga menziesii	Y	6	17.1	60.0	24.3	21.4
3	Pinus monticola	Y	1	2.9	10.0	4.0	17.3
Total			35		350.0	141.7	22.1

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pinus contorta	Y	5	50.0	200.0	81.0	9.7
2	Pseudotsuga menziesii	Y	5	50.0	200.0	81.0	7.3
Total			10		400.0	161.9	8.5

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Pseudotsuga menziesii	Y	1391	76.7	55640.0	22526.3
2	Abies grandis	Y	278	15.3	11120.0	4502.0
3	Tsuga heterophylla	Y	65	3.6	2600.0	1052.6
4	Pinus contorta	Y	62	3.4	2480.0	1004.0
5	Thuja plicata	Y	18	1.0	720.0	291.5
Total			1814		72560.0	29376.5

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	61.14	55.72	-
2	Moss species	Y	44.58	32.53	78.72
3	Cladonia bellidiflora	Y	5.42	5.42	9.57
4	Vaccinium membranaceum	Y	3.01	2.71	5.32
5	Chimaphila umbellata	Y	1.20	1.20	2.13
6	Pachistima myrsinites	Y	0.90	0.90	1.60
7	Goodyera oblongifolia	Y	0.30	0.30	0.53
8	Hieraceum albiflorum	Y	0.30	0.30	0.53
9	Lichen species	Y	0.30	0.30	0.53
10	Salix scouleriana	Y	0.30	0.30	0.53
11	Spireas betulifolia	Y	0.30	0.30	0.53

Total # points = 332, Avg. species/point = 1.2, Avg. height = 0.065m
Nat. species = 188 of 188 plants (100.0%)

DOUGLAS FIR MONITORING TYPE -- PLOT 3

No photograph for this plot.

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.198
1/4 - 1	1.105
1 - 3	2.521
3+ sound	10.738
3+ rotten	3.072
Sum 3+	13.810
Woody	17.634
Duff	5.040
Total	22.674

DOUGLAS FIR MONITORING TYPE -- PLOT 3

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	62	98.4	620.0	251.0	23.8
2	Thuja plicata	Y	1	1.6	10.0	4.0	15.5
Total			63		630.0	255.1	23.6

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	41	100.0	1640.0	664.0	8.0
Total			41		1640.0	664.0	8.0

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Acer circinatum	Y	169	38.9	1690.0	684.2
2	Pinus monticola	Y	123	28.3	1230.0	498.0
3	Pseudotsuga menziesii	Y	103	23.7	1030.0	417.0
4	Thuja plicata	Y	40	9.2	400.0	161.9
Total			435		4350.0	1761.1

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	34.04	29.79	-
2	Moss species	Y	30.40	13.07	28.09
3	Arctostaphylos uva-ursi	Y	29.48	25.53	27.25
4	Chimaphila umbellata	Y	10.03	6.99	9.27
5	Pachistima myrsinites	Y	8.51	5.17	7.87
6	Berberis nervosa	Y	6.99	4.56	6.46
7	Spireas betulifolia	Y	5.17	3.65	4.78
8	Hieraceum albiflorum	Y	3.04	1.52	2.81
9	Rosa gymnocarpa	Y	3.04	2.74	2.81
10	Vaccinium membranaceum	Y	3.04	1.82	2.81
11	Castileja spp.	Y	2.13	1.52	1.97
12	Pseudotsuga menziesii	Y	1.52	0.61	1.40
13	Goodyera oblongifolia	Y	1.22	0.30	1.12
14	Lonicera ciliosa	Y	0.91	0.91	0.84
15	Pyrola picta	Y	0.61	0.61	0.56
16	Acer circinatum	Y	0.30	0.00	0.28
17	Almelanchier alnifolia	Y	0.30	0.30	0.28
18	Graminae specieosa	Y	0.30	0.00	0.28
19	Hieraceum scouleri	Y	0.30	0.30	0.28
20	Lichen species	Y	0.30	0.00	0.28
21	Pinus monticola	Y	0.30	0.30	0.28
22	Salix scouleriana	Y	0.30	0.30	0.28

Total # points = 329, Avg. species/point = 1.4, Avg. height = 0.097m
Nat. species = 356 of 356 plants (100.0%)

DOUGLAS FIR MONITORING TYPE -- PLOT 4

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.140
1/4 - 1	1.232
1 - 3	2.100
3+ sound	8.140
3+ rotten	49.526
Sum 3+	57.666
Woody	61.138
Duff	15.152
Total	76.290

DOUGLAS FIR MONITORING TYPE -- PLOT 4

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	19	36.5	190.0	76.9	54.3
2	Thuja plicata	Y	19	36.5	190.0	76.9	27.6
3	Tsuga heterophylla	Y	14	26.9	140.0	56.7	28.2
	Total		52		520.0	210.5	37.5

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Thuja plicata	Y	17	85.0	680.0	275.3	7.4
2	Tsuga heterophylla	Y	3	15.0	120.0	48.6	6.5
	Total		20		800.0	323.9	7.3

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Tsuga heterophylla	Y	1146	32.9	45840.0	18558.7
2	Thuja plicata	Y	880	25.2	35200.0	14251.0
3	Acer circinatum	Y	868	24.9	34720.0	14056.7
4	Pseudotsuga menziesii	Y	512	14.7	20480.0	8291.5
5	Taxus brevifolia	Y	80	2.3	3200.0	1295.5
	Total		3486		139440.0	56453.4

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	68.37	65.36	-
2	Berberis nervosa	Y	23.19	23.19	57.46
3	Moss species	Y	6.63	3.61	16.42
4	Chimaphila umbellata	Y	4.82	2.71	11.94
5	Pachistima myrsinites	Y	3.01	2.11	7.46
6	Clintonia uniflora	Y	1.51	1.51	3.73
7	Acer circinatum	Y	0.30	0.30	0.75
8	Cornus canadensis	Y	0.30	0.30	0.75
9	Dead perennials	-	0.30	0.30	-
10	Lonicera ciliosa	Y	0.30	0.30	0.75
11	Vaccinium membranaceum	Y	0.30	0.30	0.75

Total # points = 332, Avg. species/point = 1.1, Avg. height = 0.106m
Nat. species = 134 of 134 plants (100.0%)

DOUGLAS FIR MONITORING TYPE -- PLOT 5

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.130
1/4 - 1	0.258
1 - 3	4.408
3+ sound	4.636
3+ rotten	19.417
Sum 3+	24.053
Woody	28.849
Duff	7.162
Total	36.011

DOUGLAS FIR MONITORING TYPE -- PLOT 5

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	33	100.0	330.0	133.6	39.4
Total			33		330.0	133.6	39.4

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	18	94.7	720.0	291.5	7.9
2	Thuja plicata	Y	1	5.3	40.0	16.2	9.7
Total			19		760.0	307.7	8.0

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Pseudotsuga menziesii	Y	443	57.9	8860.0	3587.0
2	Acer circinatum	Y	139	18.2	2780.0	1125.5
3	Tsuga heterophylla.	Y	50	6.5	1000.0	404.9
4	Thuja plicata	Y	39	5.1	780.0	315.8
5	Abies amabilis.	Y	38	5.0	760.0	307.7
6	Pinus monticola	Y	34	4.4	680.0	275.3
7	Salix scouleriana	Y	22	2.9	440.0	178.1
Total			765		15300.0	6194.3

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Moss species.	Y	80.12	34.94	67.51
2	Non-plant	-	42.77	31.93	-
3	Berberis nervosa.	Y	13.25	10.84	11.17
4	Chimaphila umbellata.	Y	7.23	5.42	6.09
5	Lonicera ciliosa.	Y	4.22	4.22	3.55
6	Vaccinium membranaceum.	Y	3.61	3.61	3.05
7	Rosa gymnocarpa	Y	2.41	2.41	2.03
8	Graminae unk.	N	2.41	2.41	2.03
9	Arctostaphylos uva-ursi	Y	1.81	1.81	1.52
10	Fragaria vesca.	Y	1.81	1.20	1.52
11	Vaccinium parvifolium	Y	1.20	1.20	1.02
12	Almelanchier alnifolia.	Y	0.60	0.00	0.51

Total # points = 166, Avg. species/point = 1.6, Avg. height = 0.103m
Nat. species = 193 of 197 plants (98.0%)

DOUGLAS FIR MONITORING TYPE -- PLOT 6

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.125
1/4 - 1	1.254
1 - 3	1.999
3+ sound	1.119
3+ rotten	19.312
Sum 3+	20.431
Woody	23.809
Duff	20.132
Total	43.941

DOUGLAS FIR MONITORING TYPE -- PLOT 6

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	33	78.6	330.0	133.6	25.7
2	Thuja plicata	Y	5	11.9	50.0	20.2	32.7
3	Tsuga heterophylla	Y	2	4.8	20.0	8.1	26.9
4	Abies grandis	Y	1	2.4	10.0	4.0	17.8
5	Pinus contorta	Y	1	2.4	10.0	4.0	22.6
Total			42		420.0	170.0	26.3

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	69	83.1	2760.0	1117.4	6.2
2	Pinus monticola	Y	4	4.8	160.0	64.8	4.7
3	Salix scouleriana	Y	4	4.8	160.0	64.8	8.3
4	Abies grandis	Y	3	3.6	120.0	48.6	10.4
5	Prunus emarginata	Y	2	2.4	80.0	32.4	6.7
6	Thuja plicata	Y	1	1.2	40.0	16.2	2.5
Total			83		3320.0	1344.1	6.4

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Pseudotsuga menziesii	Y	1330	73.3	53200.0	21538.5
2	Abies grandis	Y	312	17.2	12480.0	5052.6
3	Tsuga heterophylla	Y	92	5.1	3680.0	1489.9
4	Pinus monticola	Y	62	3.4	2480.0	1004.0
5	Thuja plicata	Y	18	1.0	720.0	291.5
Total			1814		72560.0	29376.5

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Moss species	Y	70.48	21.69	45.17
2	Non-plant	-	31.02	17.47	-
3	Berberis nervosa	Y	28.61	20.78	18.34
4	Pachistima myrsinites	Y	19.58	16.87	12.55
5	Linnaea borealis	Y	10.24	3.92	6.56
6	Vaccinium membranaceum	Y	9.04	6.93	5.79
7	Chimaphila umbellata	Y	7.23	4.82	4.63
8	Lonicera ciliosa	Y	4.22	2.41	2.70
9	Vaccinium parvifolium	Y	1.51	1.51	0.97
10	Almelanchier alnifolia	Y	0.90	0.60	0.58
11	Rosa gymnocarpa	Y	0.90	0.60	0.58
12	Shepardia canadensis	Y	0.90	0.90	0.58
13	Spireas betulifolia	Y	0.60	0.60	0.39
14	Arctostaphylos uva-ursi	Y	0.30	0.30	0.19
15	Lichen species	Y	0.30	0.00	0.19
16	Pinus monticola	Y	0.30	0.30	0.19
17	Pseudotsuga menziesii	Y	0.30	0.00	0.19
18	Pyrola asarifolia	Y	0.30	0.30	0.19
19	Trientalis latifolia	Y	0.30	0.00	0.19

Total # points = 332, Avg. species/point = 1.9, Avg. height = 0.188m
Nat. species = 518 of 518 plants (100.0%)

DOUGLAS FIR MONITORING TYPE -- PLOT 7

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.065
1/4 - 1	0.220
1 - 3	1.664
3+ sound	7.934
3+ rotten	1.781
Sum 3+	9.715
Woody	11.664
Duff	9.821
Total	21.485

DOUGLAS FIR MONITORING TYPE -- PLOT 7

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pinus contorta	Y	84	89.4	840.0	340.1	19.0
2	Pseudotsuga menziesii	Y	8	8.5	80.0	32.4	26.3
3	Thuja plicata	Y	1	1.1	10.0	4.0	22.6
4	Tsuga heterophylla	Y	1	1.1	10.0	4.0	16.5
Total			94		940.0	380.6	19.7

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pinus contorta	Y	15	62.5	600.0	242.9	12.6
2	Pseudotsuga menziesii	Y	9	37.5	360.0	145.7	4.1
Total			24		960.0	388.7	9.4

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Pseudotsuga menziesii	Y	1081	100.0	108100.0	43765.2
Total			1081		108100.0	43765.2

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Moss species	Y	74.10	28.31	63.08
2	Non-plant	-	40.96	33.73	-
3	Arctostaphylos uva-ursi	Y	10.84	10.24	9.23
4	Pachistima myrsinites	Y	6.02	4.82	5.13
5	Graminae specieosa	Y	4.82	4.82	4.10
6	Chimaphila umbellata	Y	4.22	1.81	3.59
7	Lonicera ciliosa	Y	4.22	3.01	3.59
8	Vaccinium parvifolium	Y	4.22	4.22	3.59
9	Berberis nervosa	Y	3.61	3.61	3.08
10	Rosa gymnocarpa	Y	1.20	1.20	1.03
11	Shepardia canadensis	Y	1.20	1.20	1.03
12	Vaccinium membranaceum	Y	1.20	1.20	1.03
13	Almelanchier alnifolia	Y	0.60	0.60	0.51
14	Holodiscus discolor	Y	0.60	0.60	0.51
15	Lichen species	Y	0.60	0.60	0.51

Total # points = 166, Avg. species/point = 1.6, Avg. height = 0.121m
Nat. species = 195 of 195 plants (100.0%)

DOUGLAS FIR MONITORING TYPE -- PLOT 8

Photo by R. Morgan

Downed Fuel Inventory	
Size (in)	Tons/Acre
0 - 1/4	0.121
1/4 - 1	0.985
1 - 3	2.253
3+ sound	1.659
3+ rotten	4.596
Sum 3+	6.255
Woody	9.614
Duff	4.012
Total	13.626

DOUGLAS FIR MONITORING TYPE -- PLOT 8

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	75	85.2	750.0	303.6	25.5
2	Thuja plicata	Y	8	9.1	80.0	32.4	22.0
3	Tsuga heterophylla	Y	4	4.5	40.0	16.2	21.4
4	Pinus monticola	Y	1	1.1	10.0	4.0	44.2
Total			88		880.0	356.3	25.3

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Thuja plicata	Y	11	42.3	440.0	178.1	8.4
2	Pseudotsuga menziesii	Y	9	34.6	360.0	145.7	12.0
3	Tsuga heterophylla	Y	6	23.1	240.0	97.2	6.7
Total			26		1040.0	421.1	9.2

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Tsuga heterophylla	Y	1766	35.0	70640.0	28599.2
2	Abies grandis	Y	1434	28.4	57360.0	23222.7
3	Thuja plicata	Y	947	18.8	37880.0	15336.0
4	Pseudotsuga menziesii	Y	384	7.6	15360.0	6218.6
5	Pinus monticola	Y	312	6.2	12480.0	5052.6
6	Alnus sinuata	Y	199	3.9	7960.0	3222.7
Total			5042		201680.0	81651.8

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Moss species	Y	58.13	25.30	54.06
2	Non-plant	-	49.40	31.33	-
3	Berberis nervosa	Y	24.10	23.80	22.41
4	Chimaphila umbellata	Y	12.95	10.24	12.04
5	Pachistima myrsinites	Y	3.92	3.01	3.64
6	Cornus canadensis	Y	2.11	1.51	1.96
7	Vaccinium parvifolium	Y	1.81	1.81	1.68
8	Gaultheria ovatifolia	Y	1.20	0.60	1.12
9	Pyrola asarifolia	Y	0.90	0.90	0.84
10	Lichen species	Y	0.60	0.00	0.56
11	Viburnum speciosa	Y	0.60	0.30	0.56
12	Acer circinatum	Y	0.30	0.30	0.28
13	Almelanchier alnifolia	Y	0.30	0.30	0.28
14	Goodyera oblongifolia	Y	0.30	0.30	0.28
15	Lonicera ciliosa	Y	0.30	0.30	0.28

Total # points = 332, Avg. species/point = 1.6, Avg. height = 0.099m
Nat. species = 359 of 359 plants (100.0%)

WESTERN HEMLOCK MONITORING TYPE -- PLOT 1

Photo by P. Bullington

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.207
1/4 - 1	2.547
1 - 3	2.109
3+ sound	7.130
3+ rotten	0.714
Sum 3+	7.844
Woody	12.707
Duff	12.847
Total	25.554

WESTERN HEMLOCK MONITORING TYPE -- PLOT 1

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	50	56.2	500.0	202.4	24.9
2	Pseudotsuga menziesii	Y	27	30.3	270.0	109.3	46.5
3	Thuja plicata	Y	8	9.0	80.0	32.4	38.5
4	Taxus brevifolia	Y	3	3.4	30.0	12.1	19.6
5	Pinus monticola	Y	1	1.1	10.0	4.0	17.8
Total			89		890.0	360.3	32.4

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	29	93.5	1160.0	469.6	6.7
2	Taxus brevifolia	Y	1	3.2	40.0	16.2	14.5
3	Thuja plicata	Y	1	3.2	40.0	16.2	15.0
Total			31		1240.0	502.0	7.2

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Thuja plicata	Y	141	91.6	5640.0	2283.4
2	Tsuga heterophylla	Y	13	8.4	520.0	210.5
Total			154		6160.0	2493.9

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	57.97	47.34	-
2	Moss species	Y	47.83	21.74	56.25
3	Berberis nervosa	Y	19.32	18.84	22.73
4	Chimaphila umbellata	Y	5.31	4.83	6.25
5	Clintonia uniflora	Y	2.90	1.93	3.41
6	Viburnum speciosa	Y	2.42	0.00	2.84
7	Vaccinium membranaceum	Y	1.93	1.93	2.27
8	Goodyera oblongifolia	Y	1.45	0.48	1.70
9	Pachistima myrsinites	Y	1.45	0.48	1.70
10	Dead perennials	-	0.97	0.97	-
11	Thuja plicata	Y	0.97	0.97	1.14
12	Cornus canadensis	Y	0.48	0.48	0.57
13	Pyrola picta	Y	0.48	0.00	0.57
14	Rosa gymnocarpa	Y	0.48	0.00	0.57

Total # points = 207, Avg. species/point = 1.5, Avg. height = 0.080m
Nat. species = 176 of 176 plants (100.0%)

WESTERN HEMLOCK MONITORING TYPE -- PLOT 2

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.112
1/4 - 1	1.089
1 - 3	1.611
3+ sound	14.095
3+ rotten	4.664
Sum 3+	18.759
Woody	21.571
Duff	8.1277
Total	29.698

WESTERN HEMLOCK MONITORING TYPE -- PLOT 2

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	87	94.6	870.0	352.2	21.5
2	Thuja plicata	Y	3	3.3	30.0	12.1	18.6
3	Pseudotsuga menziesii	Y	2	2.2	20.0	8.1	29.9
Total			92		920.0	372.5	21.6

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	70	98.6	2800.0	1133.6	8.8
2	Thuja plicata	Y	1	1.4	40.0	16.2	4.6
Total			71		2840.0	1149.8	8.7

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Tsuga heterophylla	Y	346	52.0	6920.0	2801.6
2	Thuja plicata	Y	255	38.3	5100.0	2064.8
3	Pinus monticola	Y	65	9.8	1300.0	526.3
Total			666		13320.0	5392.7

Forest Transect Vegetation Frequency and Relative Cover

---------------[Type:FTSHE1T10 Plot: 2 B/C:B Stat:PRE]----------------

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	62.65	38.25	-
2	Moss species	Y	52.41	26.51	56.49
3	Berberis nervosa	Y	15.36	14.16	16.56
4	Pachistima myrsinites	Y	6.63	5.72	7.14
5	Chimaphila umbellata	Y	5.72	4.52	6.17
6	Vaccinium membranaceum	Y	4.82	3.92	5.19
7	Pyrola asarifolia	Y	3.31	3.01	3.57
8	Clintonia uniflora	Y	1.20	0.60	1.30
9	Cornus canadensis	Y	0.90	0.60	0.97
10	Pseudotsuga menziesii	Y	0.90	0.90	0.97
11	Lonicera ciliosa	Y	0.60	0.60	0.65
12	Dead perennials	-	0.30	0.30	-
13	Pyrola picta	Y	0.30	0.30	0.32
14	Rosa gymnocarpa	Y	0.30	0.30	0.32
15	Tsuga heterophylla	Y	0.30	0.30	0.32

Total # points = 332, Avg. species/point = 1.6, Avg. height = 0.099m
Nat. species = 309 of 309 plants (100.0%)

WESTERN HEMLOCK MONITORING TYPE -- PLOT 3

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.029
1/4 - 1	0.349
1 - 3	1.519
3+ sound	28.836
3+ rotten	0.944
Sum 3+	29.780
Woody	31.677
Duff	10.614
Total	42.291

WESTERN HEMLOCK MONITORING TYPE -- PLOT 3

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	30	47.6	300.0	121.5	24.7
2	Pseudotsuga menziesii	Y	24	38.1	240.0	97.2	44.0
3	Thuja plicata	Y	9	14.3	90.0	36.4	27.1
Total			63		630.0	255.1	32.4

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Thuja plicata	Y	10	66.7	400.0	161.9	9.4
2	Tsuga heterophylla	Y	5	33.3	200.0	81.0	9.5
Total			15		600.0	242.9	9.4

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Thuja plicata	Y	499	58.0	19960.0	8081.0
2	Tsuga heterophylla	Y	229	26.6	9160.0	3708.5
3	Taxus brevifolia	Y	94	10.9	3760.0	1522.3
4	Acer circinatum	Y	39	4.5	1560.0	631.6
Total			861		34440.0	13943.3

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Moss species	Y	62.65	44.58	61.72
2	Non-plant	-	34.04	25.30	-
3	Berberis nervosa	Y	21.39	17.77	21.07
4	Chimaphila umbellata	Y	9.94	6.93	9.79
5	Vaccinium membranaceum	Y	2.11	1.81	2.08
6	Clintonia uniflora	Y	1.20	0.30	1.19
7	Pyrola asarifolia	Y	1.20	1.20	1.19
8	Vaccinium parvifolium	Y	1.20	0.90	1.19
9	Pachistima myrsinites	Y	0.90	0.60	0.89
10	Dead perennials	-	0.30	0.00	-
11	Lonicera ciliosa	Y	0.30	0.00	0.30
12	Pteridium aquilinum	Y	0.30	0.30	0.30
13	Rosa gymnocarpa	Y	0.30	0.30	0.30

Total # points = 332, Avg. species/point = 1.4, Avg. height = 0.117m
Nat. species = 338 of 338 plants (100.0%)

WESTERN HEMLOCK MONITORING TYPE -- PLOT 4

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.171
1/4 - 1	1.431
1 - 3	4.435
3+ sound	24.118
3+ rotten	27.272
Sum 3+	51.389
Woody	57.426
Duff	38.569
Total	95.995

WESTERN HEMLOCK MONITORING TYPE -- PLOT 4

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla.	Y	65	84.4	650.0	263.2	28.0
2	Pseudotsuga menziesii	Y	6	7.8	60.0	24.3	64.4
3	Thuja plicata	Y	6	7.8	60.0	24.3	60.1
Total			77		770.0	311.7	33.3

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla.	Y	13	100.0	520.0	210.5	10.3
Total			13		520.0	210.5	10.3

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Tsuga heterophylla.	Y	508	90.6	50800.0	20566.8
2	Abies grandis	Y	52	9.3	5200.0	2105.3
3	Thuja plicata	Y	1	0.2	100.0	40.5
Total			561		56100.0	22712.6

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Moss species.	Y	59.04	44.88	76.86
2	Non-plant	-	48.80	39.46	-
3	Berberis nervosa.	Y	4.82	4.52	6.27
4	Cornus canadensis	Y	2.41	2.11	3.14
5	Pachistima myrsinites	Y	2.11	2.11	2.75
6	Clintonia uniflora.	Y	1.81	1.51	2.35
7	Pyrola asarifolia	Y	1.81	1.81	2.35
8	Vaccinium membranaceum.	Y	1.20	1.20	1.57
9	Vaccinium parvifolium	Y	1.20	0.60	1.57
10	Gymnocarpium dryopteris	Y	0.90	0.60	1.18
11	Tiarella trifoliata	Y	0.90	0.60	1.18
12	Dead perennials	-	0.30	0.00	-
13	Osmorhiza chilensis	Y	0.30	0.30	0.39
14	Rhibes lacustre	Y	0.30	0.30	0.39

Total # points = 332, Avg. species/point = 1.3, Avg. height = 0.103m
Nat. species = 257 of 257 plants (100.0%)

WESTERN HEMLOCK MONITORING TYPE -- PLOT 5

Photo by P. Bullington

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.206
1/4 - 1	1.125
1 - 3	4.635
3+ sound	11.353
3+ rotten	19.843
Sum 3+	31.196
Woody	37.162
Duff	24.837
Total	61.999

WESTERN HEMLOCK MONITORING TYPE -- PLOT 5

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	58	69.0	580.0	234.8	20.8
2	Pseudotsuga menziesii	Y	12	14.3	120.0	48.6	65.3
3	Thuja plicata	Y	12	14.3	120.0	48.6	36.6
4	Pinus monticola	Y	1	1.2	10.0	4.0	15.7
5	Tsuga mertensiana	Y	1	1.2	10.0	4.0	48.5
Total			84		840.0	340.1	29.7

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	40	50.0	1600.0	647.8	8.5
2	Thuja plicata	Y	37	46.3	1480.0	599.2	5.3
3	Acer circinatum	Y	3	3.8	120.0	48.6	5.4
Total			80		3200.0	1295.5	6.9

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Thuja plicata	Y	880	83.2	35200.0	14251.0
2	Acer circinatum	Y	178	16.8	7120.0	2882.6
Total			1058		42320.0	17133.6

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	64.76	56.02	-
2	Moss species	Y	41.27	33.13	77.40
3	Berberis nervosa	Y	5.42	4.82	10.17
4	Linnaea borealis	Y	5.12	4.82	9.60
5	Chimaphila umbellata	Y	0.60	0.60	1.13
6	Gaultheria ovatifolia	Y	0.30	0.00	0.56
7	Goodyera oblongifolia	Y	0.30	0.30	0.56
8	Rosa gymnocarpa	Y	0.30	0.30	0.56

Total # points = 332, Avg. species/point = 1.2, Avg. height = 0.052m
Nat. species = 177 of 177 plants (100.0%)

WESTERN HEMLOCK MONITORING TYPE -- PLOT 6

No photograph for this plot.

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.150
1/4 - 1	1.427
1 - 3	5.386
3+ sound	12.103
3+ rotten	7.820
Sum 3+	19.923
Woody	26.886
Duff	30.473
Total	57.359

WESTERN HEMLOCK MONITORING TYPE -- PLOT 6

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla.	Y	94	84.7	940.0	380.6	24.6
2	Pseudotsuga menziesii	Y	10	9.0	100.0	40.5	66.9
3	Thuja plicata	Y	7	6.3	70.0	28.3	73.2
Total			111		1110.0	449.4	31.5

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla.	Y	12	85.7	480.0	194.3	10.8
2	Thuja plicata	Y	2	14.3	80.0	32.4	11.6
Total			14		560.0	226.7	10.9

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Tsuga heterophylla.	Y	777	68.9	31080.0	12583.0
2	Acer circinatum	Y	325	28.8	13000.0	5263.2
3	Thuja plicata	Y	26	2.3	1040.0	421.1
Total			1128		45120.0	18267.2

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	74.45	64.49	-
2	Moss species.	Y	29.60	22.74	67.86
3	Acer circinatum	Y	2.49	2.49	5.71
4	Clintonia uniflora.	Y	2.49	2.18	5.71
5	Berberis nervosa.	Y	1.87	1.56	4.29
6	Tiarella trifoliata	Y	1.87	1.87	4.29
7	Vaccinium membranaceum.	Y	1.56	1.56	3.57
8	Vaccinium ovalifolium	Y	1.56	1.56	3.57
9	Linnaea borealis.	Y	0.93	0.93	2.14
10	Goodyera oblongifolia	Y	0.62	0.31	1.43
11	Chimaphila menziesii.	Y	0.31	0.31	0.71
12	Dead perennials	-	0.31	0.00	-
13	Tsuga heterophylla.	Y	0.31	0.00	0.71

Total # points = 321, Avg. species/point = 1.2, Avg. height = 0.093m

Nat. species = 140 of 140 plants (100.0%)

WESTERN HEMLOCK MONITORING TYPE -- PLOT 7

Photo by R. Morgan

Downed Fuel Inventory

Size (in)	Tons/Acre
0 - 1/4	0.203
1/4 - 1	1.711
1 - 3	3.644
3+ sound	25.240
3+ rotten	20.624
Sum 3+	45.864
Woody	51.422
Duff	52.972
Total	104.394

WESTERN HEMLOCK MONITORING TYPE -- PLOT 7

Overstory Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Thuja plicata	Y	41	66.1	410.0	166.0	42.7
2	Pseudotsuga menziesii	Y	9	14.5	90.0	36.4	51.4
3	Tsuga heterophylla	Y	6	9.7	60.0	24.3	28.1
4	Pinus monticola	Y	4	6.5	40.0	16.2	58.9
5	Abies amabilis	Y	2	3.2	20.0	8.1	39.3
Total			62		620.0	251.0	43.5

Pole Tree Density and Average Diameter

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Thuja plicata	Y	9	69.2	360.0	145.7	7.5
2	Tsuga heterophylla	Y	3	23.1	120.0	48.6	10.3
3	Taxus brevifolia	Y	1	7.7	40.0	16.2	4.6
Total			13		520.0	210.5	7.9

Seedling Tree Density

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Acer circinatum	Y	726	48.9	29040.0	11757.1
2	Thuja plicata	Y	506	34.1	20240.0	8194.3
3	Taxus brevifolia	Y	199	13.4	7960.0	3222.7
4	Salix scouleriana	Y	54	3.6	2160.0	874.5
Total			1485		59400.0	24048.6

Forest Transect Vegetation Frequency and Relative Cover

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	67.47	51.81	-
2	Moss species	Y	33.13	21.99	52.38
3	Tiarella trifoliata	Y	20.18	17.47	31.90
4	Cornus canadensis	Y	2.71	2.41	4.29
5	Rhibes lacustre	Y	1.51	1.51	2.38
6	Clintonia uniflora	Y	1.20	1.20	1.90
7	Linnaea borealis	Y	0.90	0.30	1.43
8	Oplonanax horridum	Y	0.90	0.60	1.43
9	Vaccinium parvifolium	Y	0.90	0.90	1.43
10	Galium species	Y	0.60	0.60	0.95
11	Athyrium filix-femina	Y	0.30	0.30	0.48
12	Gymnocarpium dryopteris	Y	0.30	0.30	0.48
13	Pteridium aquilinum	Y	0.30	0.30	0.48
14	Streptopus amplexifolius	Y	0.30	0.30	0.48

Total # points = 332, Avg. species/point = 1.4, Avg. height = 0.093m
Nat. species = 210 of 210 plants (100.0%)

4.2 GRAPHS

DOWNED FUEL INVENTORY

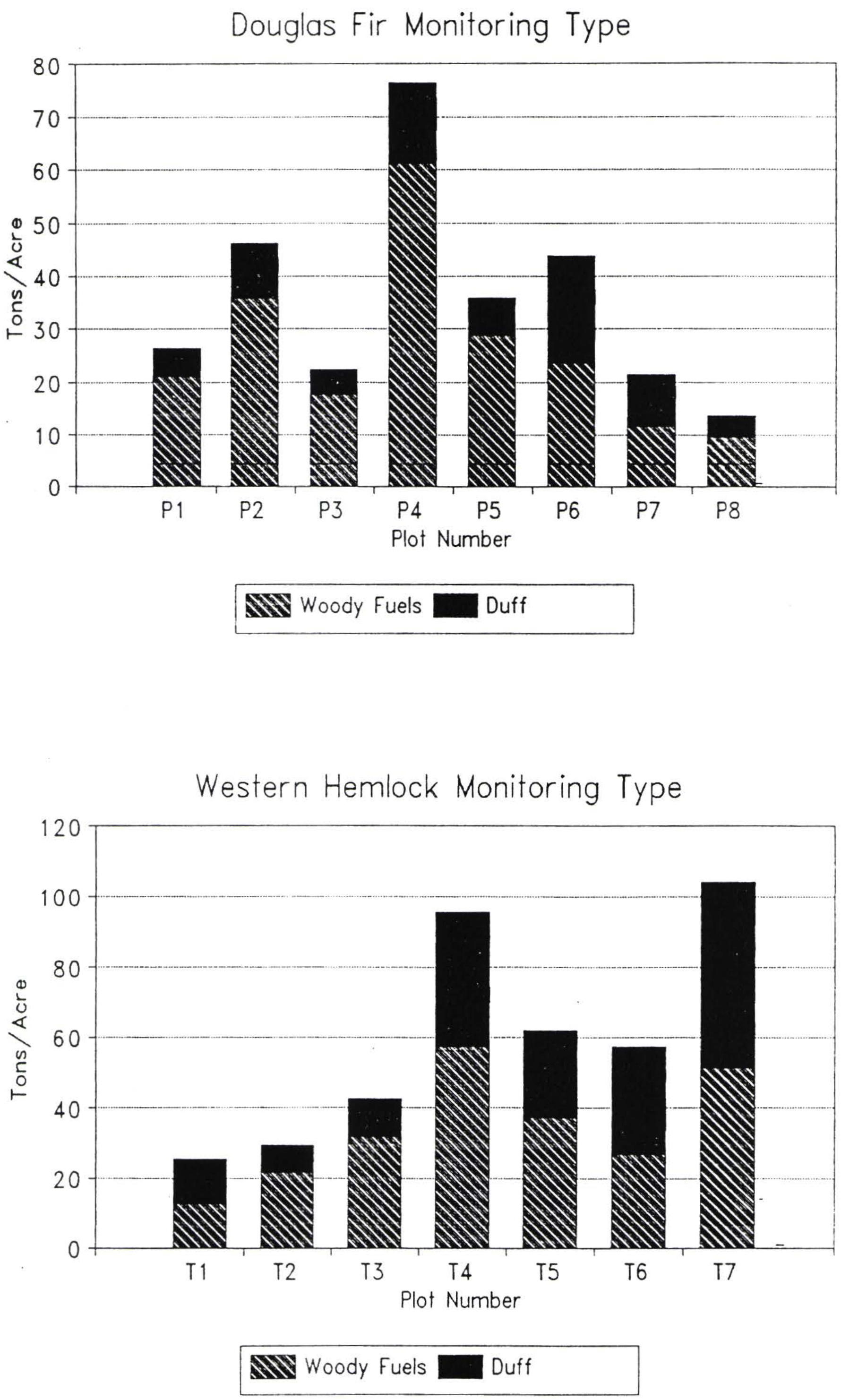
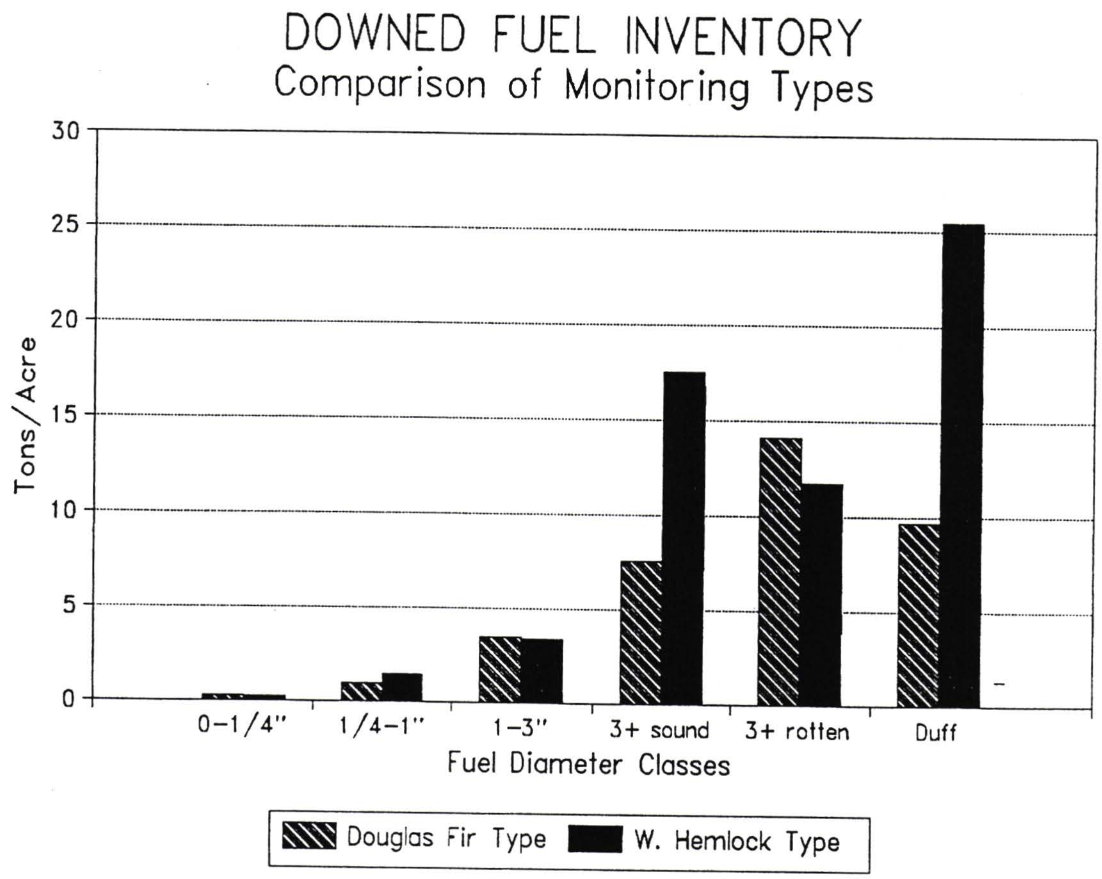
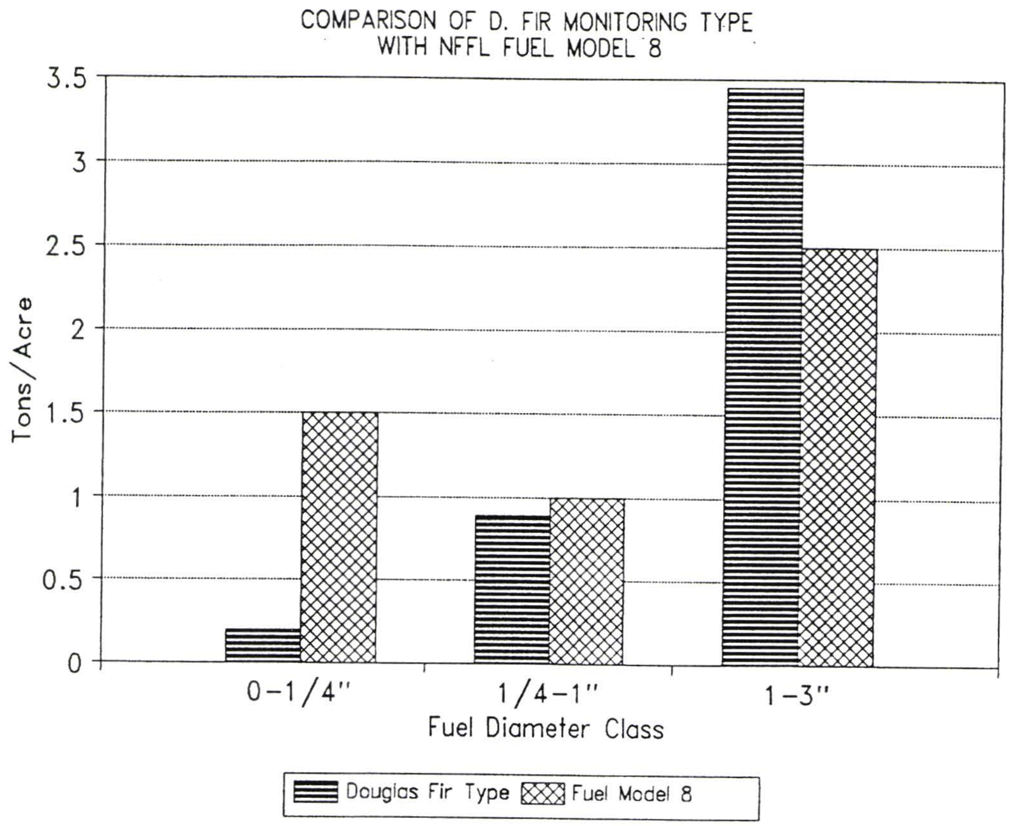


Figure 11. Downed fuel inventory: woody and duff fuel loads.



SUMMARY OF DOWNED FUEL INVENTORY (Tons/Acre)				
	DOUGLAS FIR MONITORING TYPE		WESTERN HEMLOCK MONITORING TYPE	
	Mean	Std. Dev.	Mean	Std. Dev.
0-1/4"	0.196	0.135	0.154	0.065
1/4-1"	0.888	0.685	1.383	0.669
1-3"	3.448	2.367	3.334	1.58
3+ sound	7.546	8.432	17.554	8.349
3+ rotten	14.116	16.011	11.697	10.719
Duff	9.653	5.571	25.491	16.503

Figure 12. Downed fuel inventory: comparison of monitoring types.



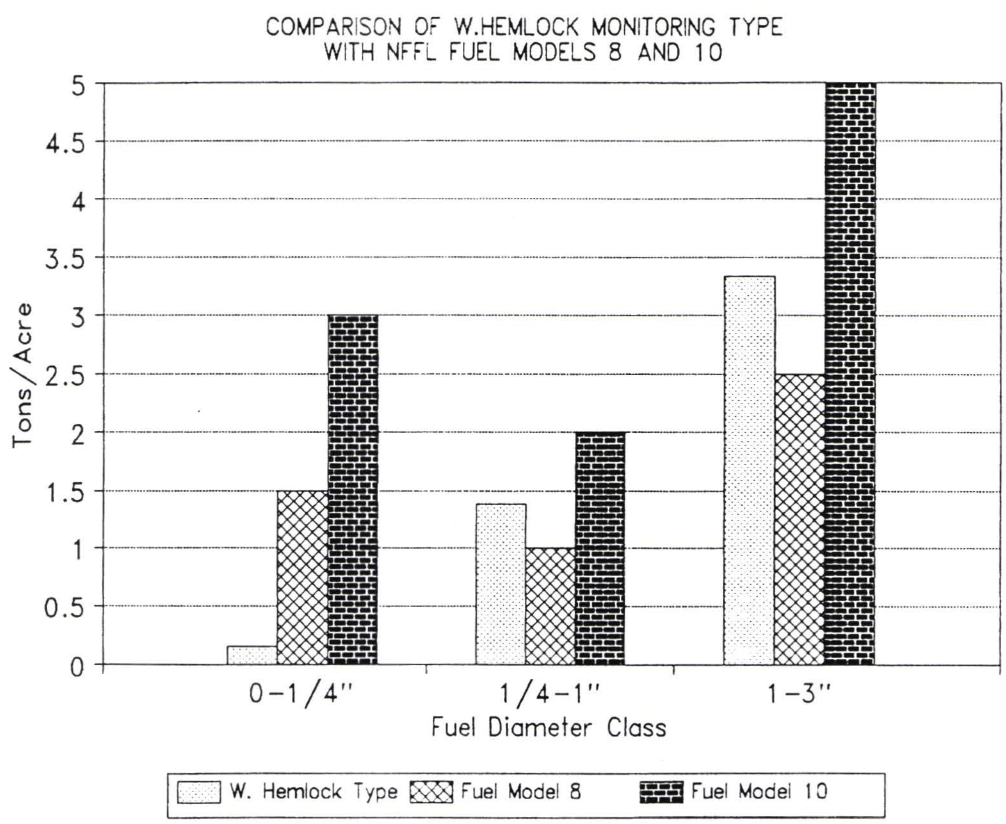


Figure 13. Comparison of monitoring types with NFFL fuel models.

OVERSTORY TREE DISTRIBUTION

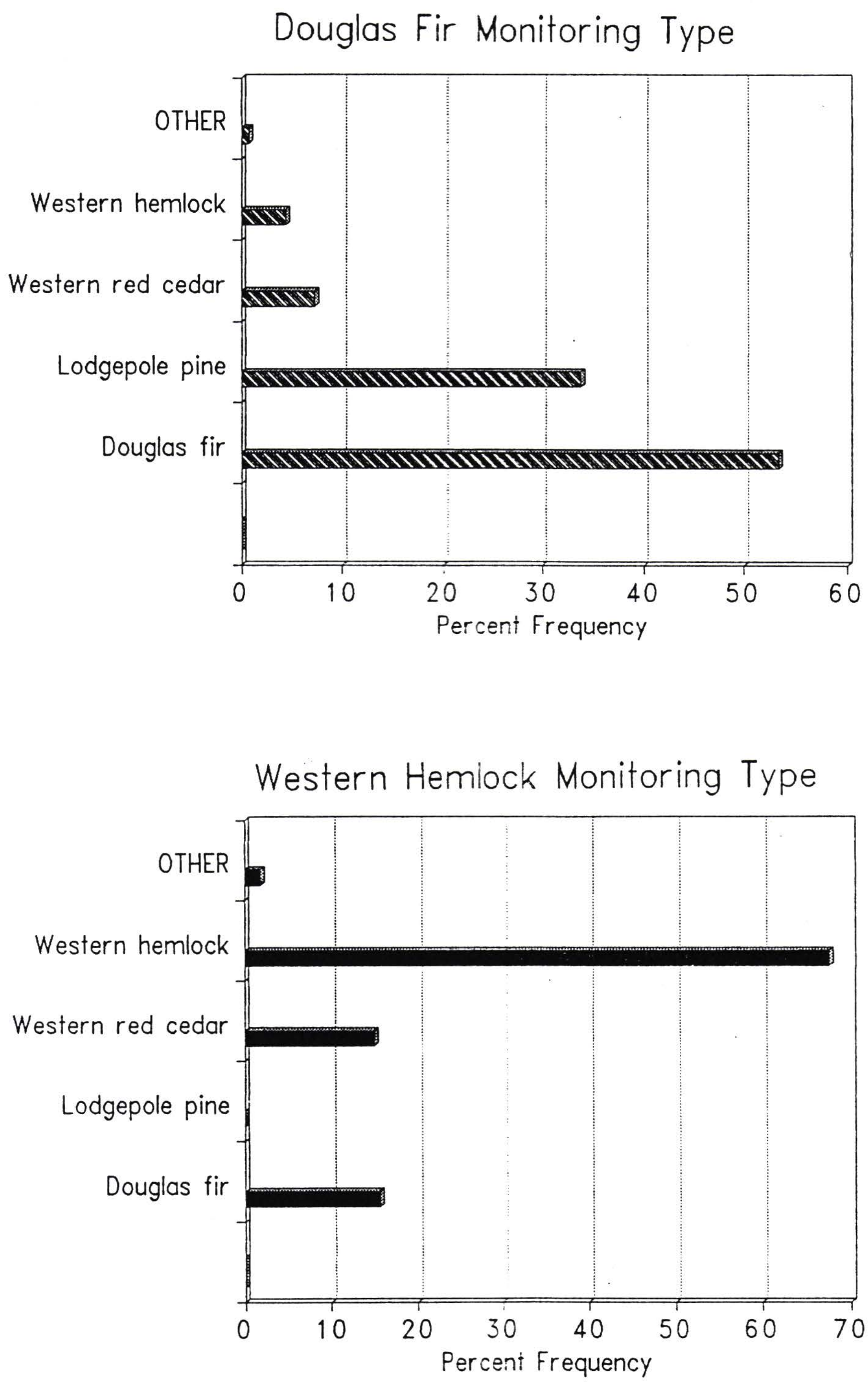


Figure 14. Overstory tree distribution by monitoring type.

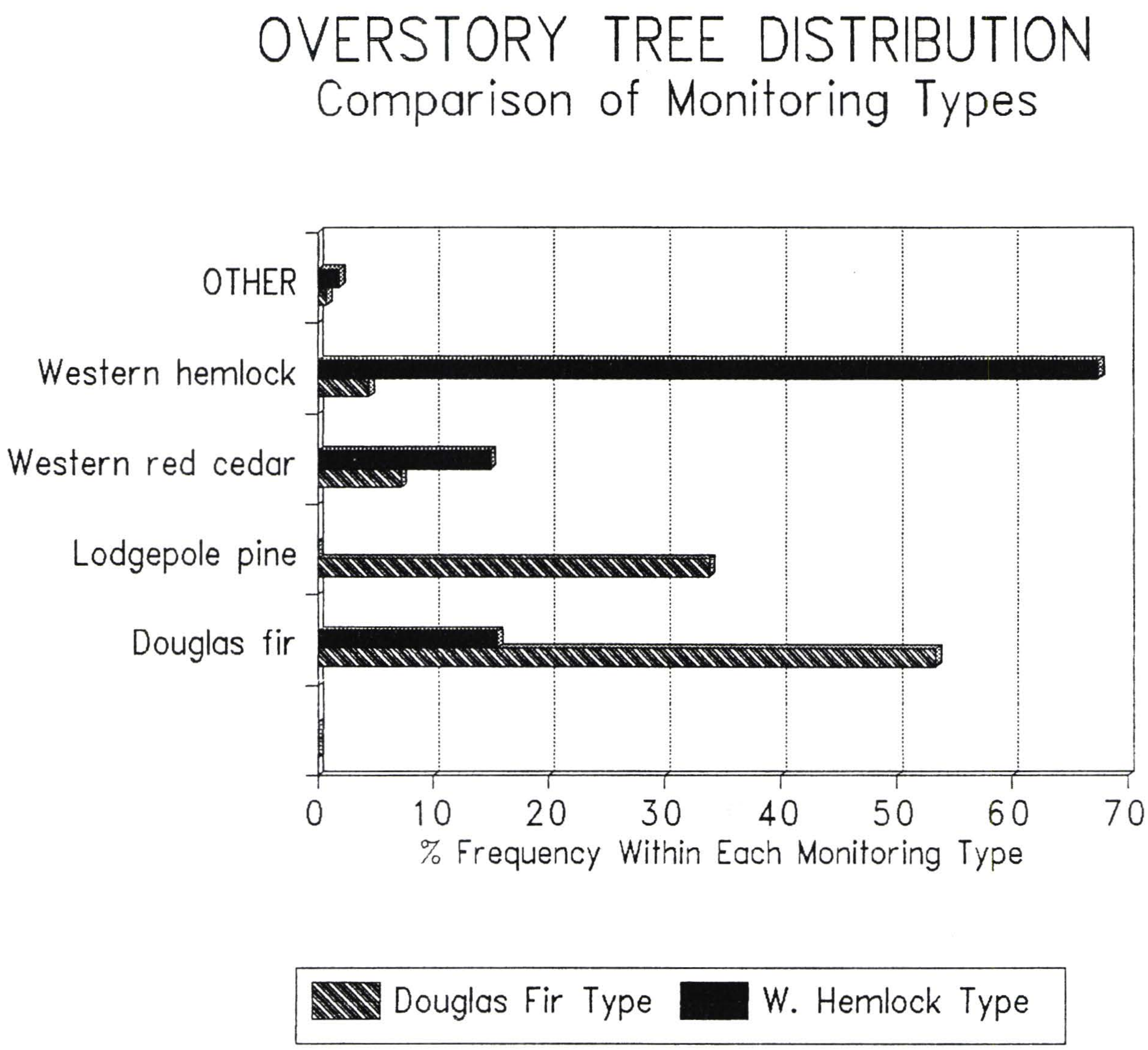
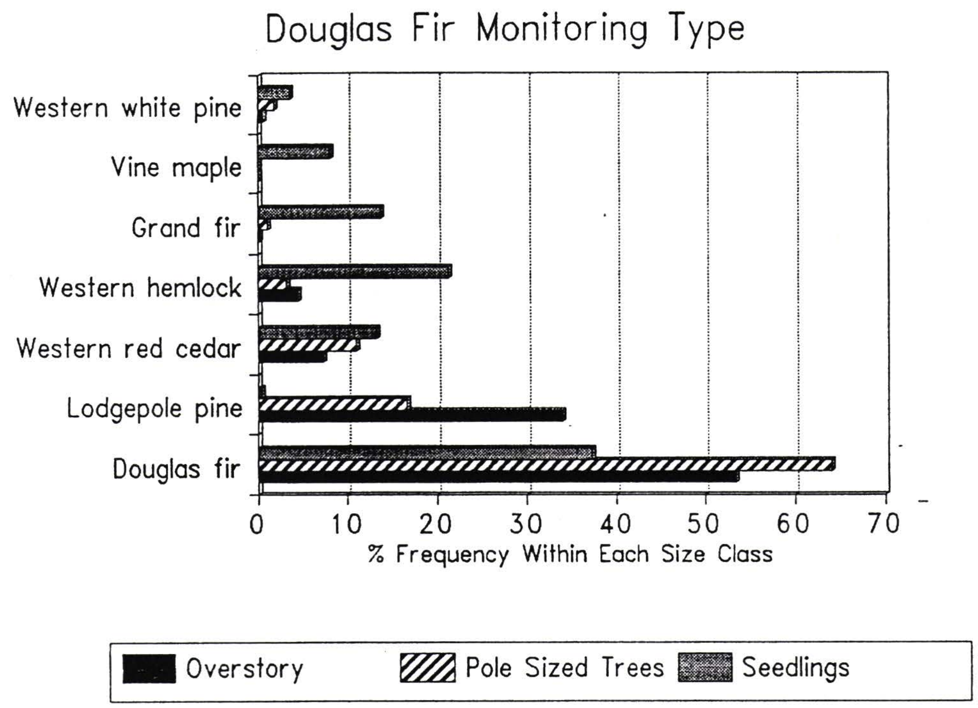


Figure 15. Overstory tree distribution: comparison of monitoring types.

OVERSTORY, POLE SIZED TREES, SEEDLINGS



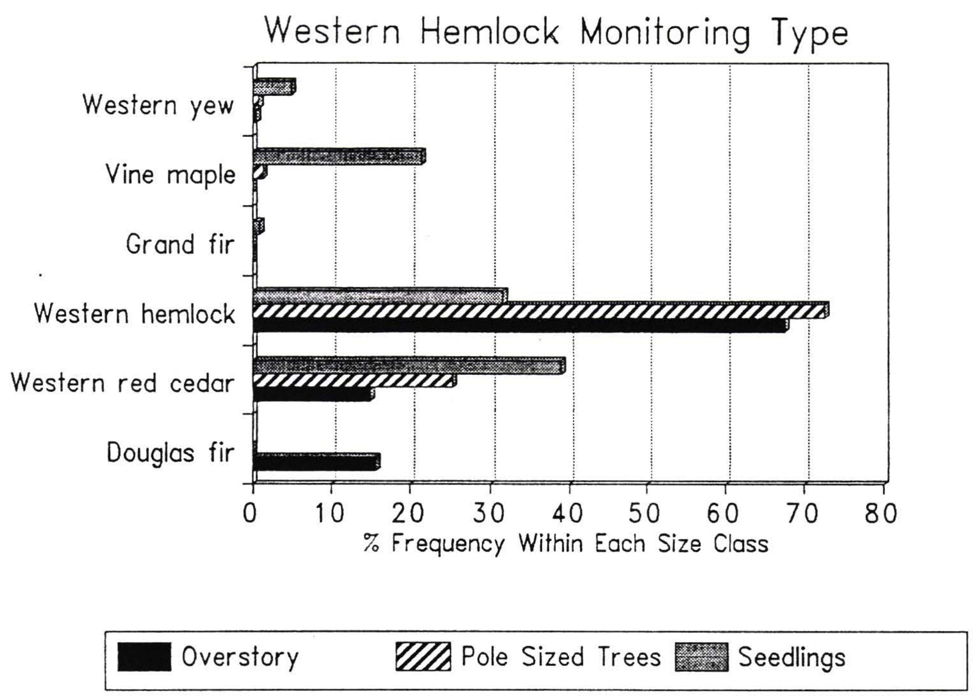
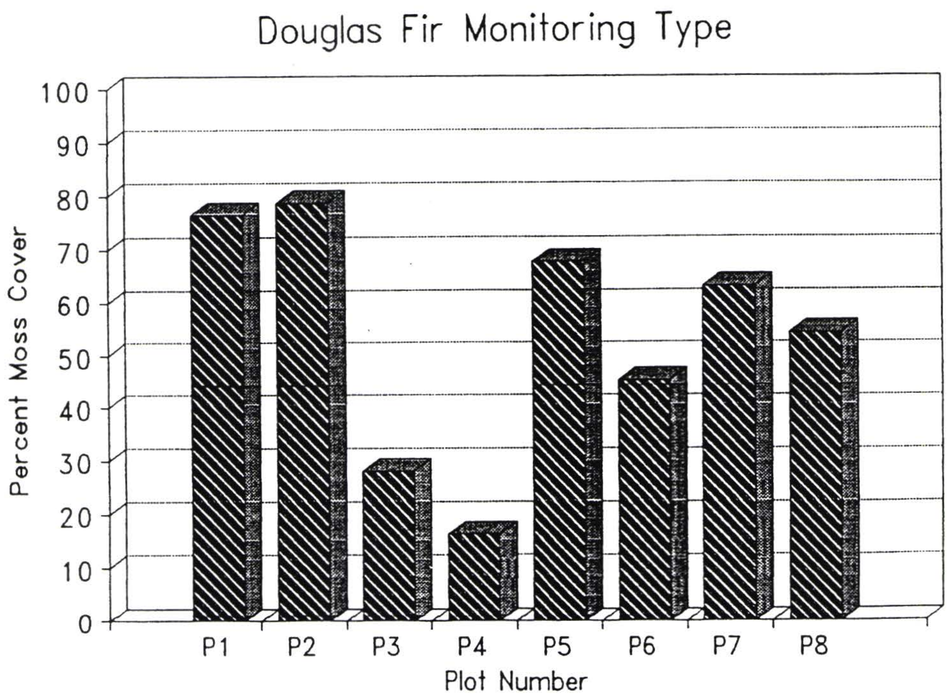


Figure 16. Overstory, pole-sized trees, and seedlings.

PERCENT MOSS COVER



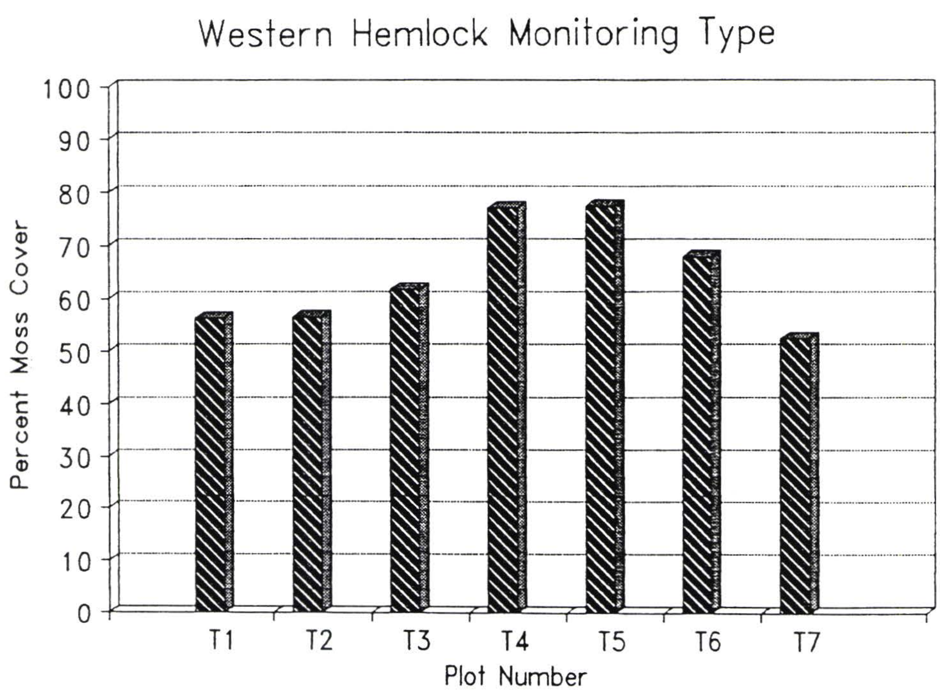


Figure 17. Vegetation cover: percent moss cover.

5.0 DISCUSSION

5.1 FUELS

Although there are "jackpots" of heavy fuels in the Hozomeen area, the average total fuel loads in the Hozomeen area are not unusually high. The total downed fuel load inventory varied from 13.626 to 76.290 tons per acre in the Douglas fir monitoring type, with an average of 35.847 tons/acre [Figure 12]. The standard deviation for the total fuel load was 19.894. The western hemlock plots ranged from 25.554 to 104.394 tons per acre, with an average of 59.6 tons per acre. The standard deviation was 30.808. The loading of 3+ inch diameter fuels and duff were much higher in the western hemlock type and caused the higher total fuel loads.

NFFL Fuel Model 8 (closed canopy, short needle conifer) could be used to describe either monitoring type. However, the western hemlock type fell in-between a Model 8 and a Model 10 (heavy timber litter) for total fuel loading.

An estimation of the number of monitoring plots needed to represent the total fuel load at a given levels of statistical significance was calculated based on the variability of the data in the initial 15 plots. (The Fire Monitoring Handbook Software Program was used for this calculation.) For the Douglas fir type, based on the initial 8 plots, at confidence = 0.80, t value = 1.415, and R = 25 (where R is a measure of precision), the minimum number of plots was estimated to be 10. For the western hemlock type, based on the initial 7 plots, at confidence = .80, t value = 1.440, R = 25, the minimum number of plots was estimated to be 9. Because of the slight under sampling that was done in this study, conclusions cannot be made with statistical confidence, but major patterns in the data are likely to be indicative of the actual fuel loadings.

The scarcity of fine woody fuels (0-1/4" diameter) is the most striking feature of the Hozomeen fuel beds. In both monitoring types the quantity of fine fuels was less than a sixth of the standard amount that is normally modeled for short needle conifer stands. None of the 13 established fuel models have such a low quantity of fine fuel. Usually it is the fine fuels that carry a fire. Yet at Hozomeen, where there is abundant evidence of fire - charred trunks, particles of charcoal in the soil, etcetera - fine fuels are scarce. What is the carrier of fire here?

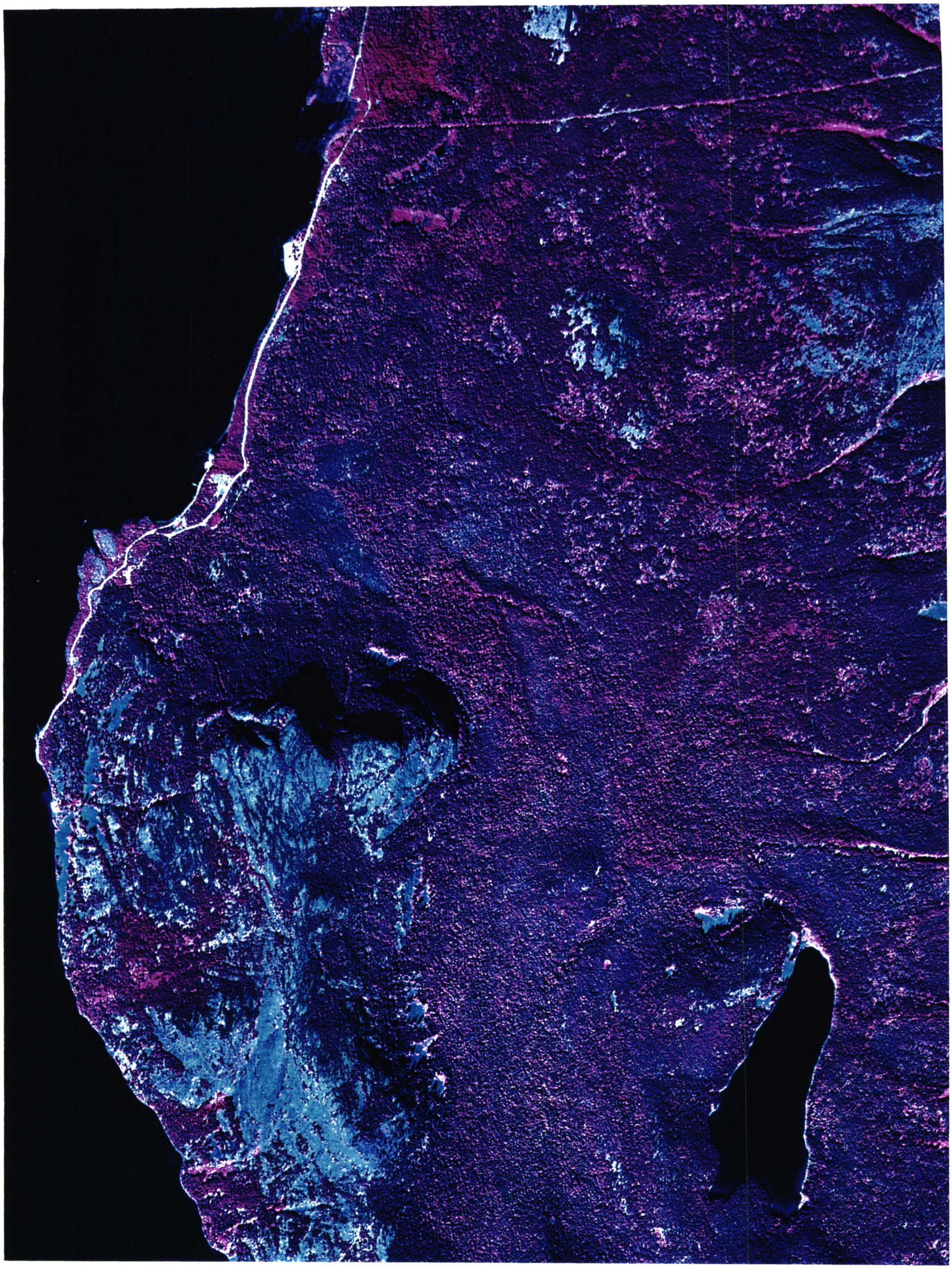


Figure 18. Aerial photograph of Hozomeen area showing vegetation mosaic.

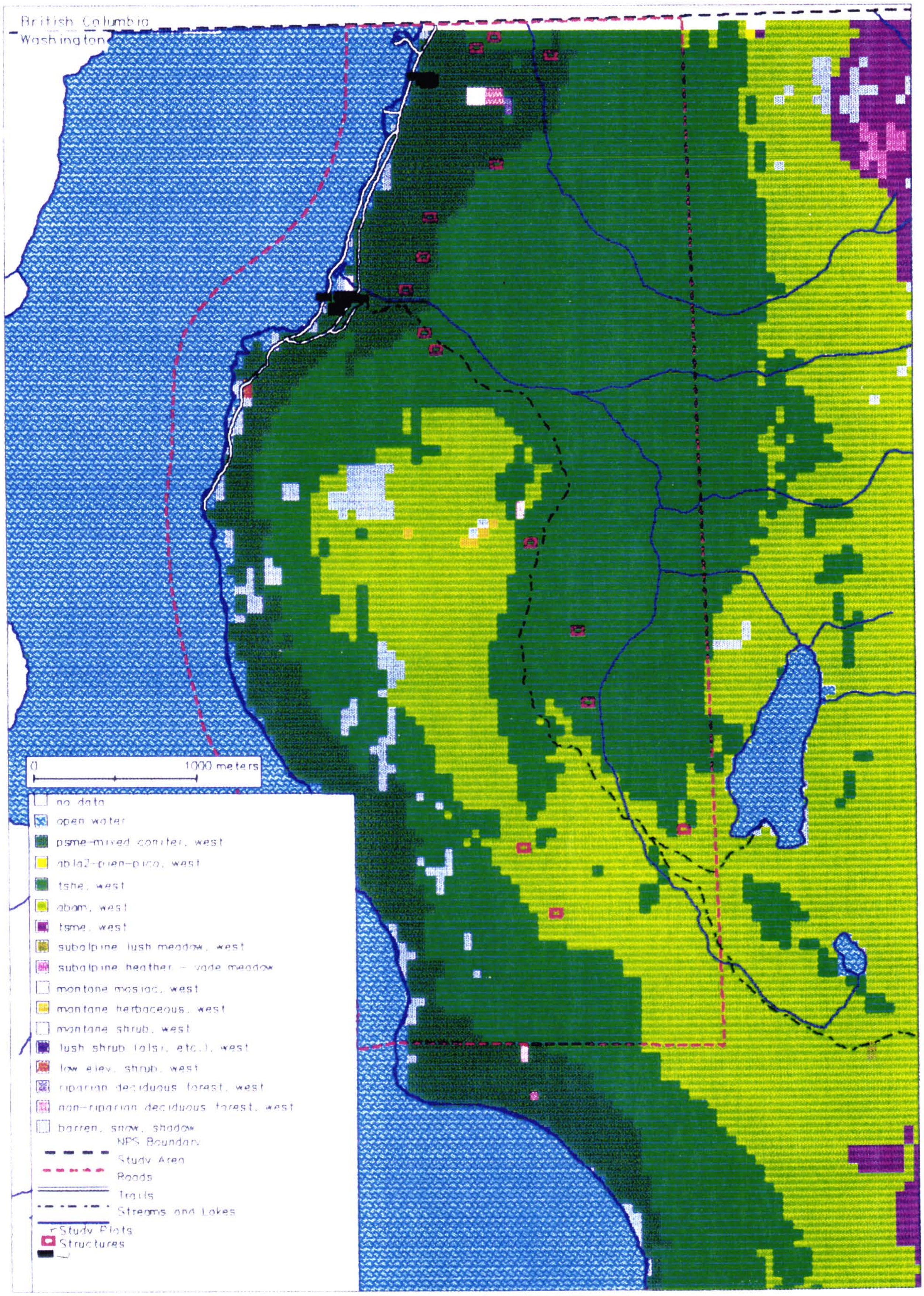


Figure 19. Study Plots shown on vegetation map.
(Map adapted from Almack and others, 1994.)

5.2 VEGETATION

The information available from the monitoring plots supports subjective observations of diversity in the Hozomeen area. At least two monitoring types can be distinguished in a mosaic pattern. The mosaic nature of the vegetation is visible in aerial photographs [Figure 18]. The mosaic probably reflects a combination of influences. The underlying landforms/soils create moist or well drained sites, which in turn contribute to the establishment of predominantly western hemlock or Douglas fir stands. Fire spread patterns are likely to be affected by the dryness of the site, the nature of the stands, and local weather conditions.

In both monitoring types the understory trees show a trend towards more shade tolerant species than in the overstory, but there are some interesting differences between the two types [Figure 16]. The understory trees in the Douglas fir monitoring type show a relatively high proportion of Douglas fir pole-sized trees and seedlings. Douglas fir is entirely absent in the understory of the western hemlock monitoring type.

In the Douglas fir monitoring type the overstory is composed primarily of Douglas fir (53 percent) and lodgepole pine (34 percent), with small amounts of western red cedar and western hemlock. The understory pole-sized trees show a larger proportion of Douglas fir (64 percent) and small amounts of lodgepole pine (17 percent), western red cedar (11 percent), and western hemlock (3 percent). The seedling trees shift to a smaller percentage of Douglas fir (37 percent), and an increase in western hemlock (21 percent), grand fir (14 percent) and vine maple (8 percent). Lodgepole pine drops out almost entirely in the seedling size class. In the absence of fire to open the stands and favor lodgepole pine, the lodgepole pine would be expected to disappear from this forest.

In the western hemlock monitoring type the overstory is composed of western hemlock (67 percent), Douglas fir (16 percent) and western red cedar (15 percent). The understory pole-sized trees show a larger amount of western hemlock (73 percent), western red cedar (25 percent), and small amounts of vine maple and western yew. In the seedling size class there is less western hemlock (32 percent), and an increase in western red cedar (39 percent), vine maple (21 percent), and western yew (5 percent). A small number of western white pine, Scouler's willow, and grand fir seedlings are found in this monitoring type.

In both monitoring types there is a remarkable amount of moss cover on the ground (and in the trees) [Figure 17]. In the Douglas fir monitoring type 52 percent of the ground cover is moss, and in the western hemlock monitoring type 64 percent of the ground cover is moss. This may provide the answer to the mystery of what carries fire in this forest where there is so little fine woody fuel. During periods of low relative humidity (below 28%) moss will dry out, and become an available fuel.

In the developed areas near the road, dense thickets of young trees could be considered a third monitoring type that was not measured in this study. Crown fires in these dense, low stands would be uncontrollable. The highest values at risk - structures, campsites, and the international border - are located next to this type of vegetation. Human-caused ignitions tend to occur in or near the developed areas.

5.3 FIRE SPREAD

Under average fire weather conditions fire spread may slow or stop at the boundaries of mosaic patches. The fuel loadings on adjacent patches may be dissimilar, and fuel moistures are likely to vary as well. However, under severe fire conditions, when all fuels are dry and/or when there is a wind driven crown fire, fire may carry across these mosaic boundaries, especially where dry moss provides fuel continuity. The large fire of 1851 which burned from Desolation Peak up into Canada, probably occurred under such conditions. Many of the large fires which have been observed on the west slopes of the Cascades have occurred when drought and east winds combined to affect fire behavior.

Ross Lake and the rocky Hozomeen ridge provide natural barriers to the spread of fires to the east or west of Hozomeen. There are no secure natural barriers to the spread of fires to the north or south. North slopes appear to have acted as a barrier to the spread of some fires in the Desolation area, but all of the terrain north of Little Jack Mountain has a west to southwest aspect, and would not be expected to slow a fire. The southwest slopes - with a continuous cover of forest vegetation - extend into Canada. Drainages, rock outcrops and scree slopes are small, and do not create secure barriers.

In the developed portion of Hozomeen fire could spread rapidly through grassy campground areas and through the dense stands of young trees that line the road [Figures 20 and 21]. Fire in the young trees could be difficult to control, and these trees could act as a ladder, carrying fuels into the crowns of older trees.

Figure 20. Grassy fuels in the vicinity of the Winnebago Flats Campground

Figure 21. Dense stands of young trees along the road.

5.4 THE HUMAN FACTOR

Measures such as public education and hazard fuel reduction are especially valuable in a remote location such as Hozomeen, because, with limited personnel on hand, it may not be possible to respond quickly and effectively to fire ignitions.

Efforts are currently made to provide visitors at Hozomeen with fire prevention information during periods of high fire danger. During these periods rangers perform extra patrols to contact visitors and to detect fires. When the fire danger is very high campfire use is restricted.

5.5 FUEL REDUCTION

Hazard fuel reduction of the dense thickets of young trees could be accomplished through manual thinning of the stands. Additional study is needed to map the thickets, and estimate the costs of a thinning operation.

Prescribed burning could be used for hazard fuel reduction in the Douglas fir and western hemlock monitoring types, but may not be a cost-effective approach. Difficulties in conducting a prescribed burn program at Hozomeen include the following:

- There is probably not enough fine fuel to carry a prescribed fire under average weather conditions and only "jackpot" ignitions would be practical (i.e. isolated ignitions of fuel accumulations). If conditions become dry enough for the moss to dry out and carry fire, a prescribed fire may become uncontrollable. Rapid warming and drying has been observed at Hozomeen.

- Secure natural barriers do not exist. A fireline would have to be constructed around each burn unit, and/or a very elaborate hose lay and sprinkler system would be required. Even with aggressive mop-up, smoldering is likely to continue in the heavy fuels for more than a week within a unit, so secure unit boundaries would have to be maintained for some time.

- Because of the lack of personnel at Hozomeen during spring months it is difficult to monitor weather and fuel moisture conditions for spring prescribed burns.

- All of the personnel needed to conduct a prescribed burn would have to be brought into the area from other locations in the NPS Complex, or from neighboring forests.

- The remoteness of the location increases time and transportation costs.

- Contingency forces might not be able to respond quickly to this location.

- An escaped fire would threaten neighboring lands.

- More than one burn may be required to reduce surface fuel loads. Typically, the initial burn creates additional fuels by killing but not consuming brush and small trees.

6.0 RECOMMENDATIONS

Manual thinning of the thickets of small trees near developed areas could reduce the risk of wildfire losses at Hozomeen. In preparation for this, mapping and measurement of the stands needs to be done. The information from these measurements will aid in a cost-analysis of manual thinning, and an evaluation of environmental impacts and feasibility.

Given the difficult access to lake water during the period when Ross Lake is at low pool, additional mapping work should be done to identify Skagit River pools, beaver ponds, and other potential water sources for fire suppression actions. This will aid in expanding a fire suppression action plan for the area.

A large prescribed burning program does not appear to be practical or cost effective at this time, but small research burns may provide useful information about fire behavior in these fuel mosaics. This information would be useful in developing strategies for fire suppression; and for managing prescribed natural fire in the PNF zone to the south of Hozomeen. Research burns could begin in drier, more fire dependent vegetation types such as lodgepole pine.

This study provided some information about the characteristics of the Douglas fir and western hemlock monitoring sites. Additional work could be done to map the fuel mosaic. Patterns visible in aerial photographs may be related to fuel conditions found on the ground. The new Global Positioning System technology will help with such mapping.

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APPENDICES

APPENDIX A. Plant Species List

FMH-6

Species Code List FMH Data - P09

Code	Nat.	Perennial	Genus	Species	Subspecies	Variety	Common name
ABAM1	Y	Y	Abies	amabilis			Pacific silver fir
ABGR1	Y	Y	Abies	grandis			grand fir
ABLA2	Y	Y	Abies	lasiocarpa			subalpine fir
ABPR1	Y	Y	Abies	procera			noble fir
ACCI1	Y	Y	Acer	circinatum			vine maple
ACGL1	Y	Y	Acer	glabrum			Douglas/Rocky Mtn. maple
ACMI1	Y	Y	Achillea	millefolium			yarrow
ACRU1	Y	Y	Actaea	rubra			baneberry
ACTR1	Y	Y	Achlys	triphylla			vanillaleaf
ADPE1	Y	Y	Adiantum	pedatum			maidenhair fern
AGSP1	Y	Y	Agropyron	spictatum			bluebunch wheatgrass
ALRU1	Y	Y	Alnus	rubra			red alder
ALSI1	Y	Y	Alnus	sinuata			slide/wavy alder
AMAL1	Y	Y	Amelanchier	alnifolia			western serviceberry
ANDE1	Y	Y	Anemone	deltoidea			white anemone
ANLU1	Y	Y	Antennaria	luzuloides			woodrush pussy-toe
ANMA1	Y	Y	Anaphalis	margaritacea			pearly-everlasting
ANMI1	Y	Y	Antennaria	microphylla			rosy pussy-toe
ANOR1	Y	Y	Anemone	oregana			Oregon anemone, blue
APAN1	Y	Y	Apocynum	androsaemifolium			spreading dogbane
AQFO1	Y	Y	Aquilegia	formosa			red columbine
ARCO1	Y	Y	Arnica	cordifolia			heart-leaf arnica
ARDI1	Y	Y	Arnica	discoidea			rayless arnica
ARLA1	Y	Y	Arnica	latifolia			mountain arnica
ARMA3	Y	Y	Arenaria	macrophylla			big leaf sandwort
ARNE1	Y	Y	Arctostaphylos	nevadensis			kinnikinnick,pinemat manz
ARPA1	Y	Y	Arctostaphylos	patula			green-leaf manzanita
ARTR1	Y	Y	Artemisia	tridentata			big sagebrush
ARUV1	Y	Y	Arctostaphylos	uva-ursi			kinnikinnick, bearberry
ASCA1	Y	Y	Asarum	caudatum			wild ginger
ATFI1	Y	Y	Athyrium	filix-femina			lady fern
BARE1	--	--	*BARE	GROUND			
BASA1	Y	Y	Balsamorhiza	sagittata			arrowleaf balsamroot
BENE1	Y	Y	Berberis	nervosa			Cascade Oregon grape
BERE1	Y	Y	Berberis	repens			creeping Oregon grape
BOLE1	--	--	*BOLE				
BRTE1	N	N	Bromus	tectorum			cheatgrass
CABU2	Y	Y	Calypso	bulbosa			fairy slipper
CACH1	Y	Y	Castanopsis	chrysophylla			golden chinkapin
CADE3	Y	Y	Calocedrus	decurrens			incense-cedar
CAGE1	Y	Y	Carex	geyeri			elk sedge
CAHI2	Y	Y	Castilleja	hispida			harsh paintbrush
CAPE5	Y	Y	Carex	pensylvanica			long stolon sedge
CAQU1	Y	Y	Camassia	quamash			common camas
CARO1	Y	Y	Carex	rossii			Ross sedge
CARU1	Y	Y	Calamagrostis	rubescens			pinegrass
CASC2	Y	Y	Campanula	scouleri			Scouler's harebell
CASP1	Y	N	Castileja	spp.			indian paintbrush
CELE1	Y	Y	Cercocarpus	ledifolius			curlleaf mt mahogany
CEPR1	Y	Y	Ceanothus	prostratus			squaw carpet
CESA1	Y	Y	Ceanothus	sanguineus			redstem ceanothus
CEVE1	Y	Y	Ceanothus	velutinus			snowbrush
CHME1	Y	Y	Chimaphila	menziesii			little prince's pine
CHNA1	Y	Y	Chrysothamnus	nauseosus			gray rabbitbrush, rubber
CHUM1	Y	Y	Chimaphila	umbellata			prince's pine, pipsissewa
CHVI1	Y	Y	Chrysothamnus	viscidiflorus			green rabbitbrush
CLRA1	Y	Y	Cladonia	bellidiflora			lichen
CLRH1	Y	Y	Clarkia	rhomboidea			elk horns clarkia
CLUN1	Y	Y	Clintonia	uniflora			beadlily, queencup beadli
COCA1	Y	Y	Cornus	canadensis			bunchberry
COCO2	Y	Y	Corylus	cornuta			hazelnut
COGR2	Y	Y	Collomia	grandiflora			salmon-colored collomia

Continued

Code	Nat.	Perennial	Genus	Species	Subspecies	Variety	Common name
COPA1	Y	Y	Collinsia	parviflora			blue-eyed Mary
COUM1	Y	Y	Comandra	umbellata			bastard toad-flax
CYMO1	Y	Y	Cypripedium	montanum			mountain lady's slipper
DENU3	Y	Y	Delphinium	nuttallianum			upland larkspur
DIHO1	Y	Y	Disporum	hookeri			Hooker's fairy bell
DOCO1	Y	Y	Dodecatheon	conjugens			desert shooting star
ELCA2	N	N	Elymus	caput-medusae			medusahead wildrye
EPAN1	Y	Y	Epilobium	angustifolium			fireweed
ERGR1	Y	Y	Erythronium	grandiflorum			yellow fawn lily
ERUM1	Y	Y	Eriogonum	umbellatum			sulfer buckwheat
FEID1	Y	Y	Festuca	idahoensis			Idaho fescue
FEOC1	Y	Y	Festuca	occidentalis			western fescue
FRVE1	Y	Y	Fragaria	vesca			woods strawberry
FRVI1	Y	Y	Fragaria	virginiana			broadpetal strawberry
GABE1	Y	N	Galium	species			bedstraw species
GAOR1	Y	Y	Galium	oreganum			Oregon bedstraw
GAOV1	Y	Y	Gaultheria	ovatifolia			slender wintergreen
GATR1	Y	Y	Galium	triflorum			sweet scented bedstraw
GETR1	Y	Y	Geum	triflorum			prairie smoke avens
GOOB1	Y	Y	Goodyera	oblongifolia			rattlesnake plantain
GRSP1	Y	N	Graminae	specieosa			
GYDR1	Y	Y	Gymnocarpium	dryopteris			oak fern
HIAL1	Y	N	Hieracium	albiflorum			white flowered hawkweed
HICY1	Y	Y	Hieracium	cynoglossoides			hounds-tongue hawkweed
HISC1	Y	N	Hieracium	scouleri			wooly hawkweed
HODI1	Y	Y	Holodiscus	discolor			ocean-spray
HYCA1	Y	Y	Hydrophyllum	capitatum			waterleaf
JUOC1	Y	Y	Juniperus	occidentalis			western juniper
KOCR1	Y	Y	Koeleria	cristata			prairies junegrass
LALA2	Y	Y	Lathyrus	lanszwertii			thick-leaved peavine
LAOC1	Y	Y	Larix	occidentalis			western larch
LIBO2	Y	Y	Linnaea	borealis			twinflower
LICH1	Y	N	Lichen	species			lichen sp.
LICO4	Y	Y	Lilium	columbianum			tiger lily, columbia lily
LIDE1	Y	Y	Libocedrus	decurrens			incense cedar
LIPE1	Y	N	Linum	perenne			wild blue flax, western
LIRU1	Y	Y	Lithospermum	ruderale			growmwell
LITT1	--	--	*LITTER				
LIWA1	Y	Y	Lilium	washingtonianum			Washington lily
LOCA4	Y	Y	Lomatium	canbyi			canby's desert parsley
LOCI1	Y	Y	Lonicera	ciliosa			trumpet honeysuckle
LOCO1	Y	Y	Lomatium	cous			biscuit root, bread root
LOIN1	Y	Y	Lonicera	involucrata			bearberry honeysuckle
LOMA2	Y	Y	Lomatium	martindalei			desert parsley
LONE2	Y	Y	Lotus	nevadensis			yellow deervetch
LONU1	Y	Y	Lomatium	nudicaule			wild celery,barestem loma
LOTR1	Y	Y	Lomatium	triternatum			nine-leaf lomatium
LUCA1	Y	Y	Lupinus	caudatus			tailcup lupine
LULA1	Y	Y	Lupinus	latifolius			broadleaf lupine
LUST1	Y	Y	Luina	stricta			tongue-leaf luina
MEAR3	Y	Y	Mentha	arvensis			field mint, wild tea
MEFE1	Y	Y	Menziesia	ferruginea			rustyleaf
MOSS1	Y	Y	Moss	species			
OPHO1	Y	Y	Oplonanax	horridum			devil's club
OSCH1	Y	Y	Osmorhiza	chilensis			mountain sweet-cicely
PABR1	Y	Y	Paeonia	brownii			peony
PAMY1	Y	Y	Pachistima	myrsinites			Oregon boxwood
PEEU1	Y	Y	Penstemon	euglaucus			glaucous penstemon
PEGA2	Y	Y	Perideridia	gairdneri			indian carrot
PEHU1	Y	Y	Penstemon	humilis			lowly penstemon
PERA1	Y	Y	Pedicularis	racemosa			lousewort/parrot's beak
PHHA1	Y	Y	Phacelia	hastata			silverleaf phacelia

Continued

Code	Nat.	Perennial	Genus	Species	Subspecies	Variety	Common name
PHHE1	Y	Y	Phacelia	heterophylla			varileaf phacelia
PHLE2	Y	Y	Philadelphus	lewisii			mock orange
PICO1	Y	Y	Pinus	contorta			lodgepole pine
PIEN1	Y	Y	Picea	engelmannii			Engelmann spruce
PILA1	Y	Y	Pinus	lambertiana			sugar pine
PIMO1	Y	Y	Pinus	monticola			western white pine
PIPO1	Y	Y	Pinus	ponderosa			ponderosa pine
POGL1	Y	Y	Potentilla	glandulosa			sticky cinquefoil
POGR1	Y	Y	Potentilla	gracilis			palmate-leaf cinquefoil
POMU1	Y	Y	Polystichum	munitum			sword fern
PONE1	Y	Y	Poa	nervosa			Wheeler's bluegrass
POSA3	Y	Y	Poa	sandbergii			Sandberg's bluegrass
POTR1	Y	Y	Populus	tremuloides			quaking aspen
PREM1	Y	Y	Prunus	emarginata			bittercherry
PRVI1	Y	Y	Prunus	virginiana			common chokecherry
PSME1	Y	Y	Pseudotsuga	menziesii			Douglas fir
PTAN1	Y	N	Pterospora	andromedea			pinedrops
PTAQ1	Y	Y	Pteridium	aquilinum			bracken fern
PUTR1	Y	Y	Purshia	tridentata			antelope bitterbrush
PYAS1	Y	Y	Pyrola	asarifolia			alpine pyrola
PYPI1	Y	Y	Pyrola	picta			white vein pyrola
PYSE1	Y	Y	Pyrola	secunda			one-sided wintergreen
QUGA1	Y	Y	Quercus	garryann			Oregon white oak
RAGL1	Y	Y	Ranunculus	glaberrimus			sagebrush buttercup
RAOC1	Y	Y	Ranunculus	occidentalis			western buttercup
RHDI1	Y	Y	Rhus	diversiloba			poison oak
RHMA1	Y	Y	Rhododendron	macrophyllum			pacific rhododendron
RICE1	Y	Y	Ribes	cereum			squaw currant, wax
RILA1	Y	Y	Rhibes	lacustre			prickly currant
RISA1	Y	Y	Ribes	sanguineum			red-flowering currant
RIVI1	Y	Y	Ribes	viscosissimum			sticky currant
ROCK1	--	--	*ROCK				
ROGY1	Y	Y	Rosa	gymnocarpa			baldhip rose
RONU1	Y	Y	Rosa	nutkana			Nutka rose
ROWO1	Y	Y	Rosa	woodsii			little woods rose
RULA1	Y	Y	Rubus	lasiococcus			dwarf bramble
RUPA1	Y	Y	Rubus	parviflorus			thimbleberry
RUUR1	Y	Y	Rubus	ursinus			Pacific blackberry
SACE1	Y	Y	Sambucus	cerulea			blue elderberry
SASC1	Y	Y	Salix	scouleriana			Scouler's willow
SEBO1	Y	Y	Senecio	bolanderi			Bolander's groundsel
SEIN1	Y	Y	Senecio	integerimus			western groundsel
SEST1	Y	Y	Sedum	stenopetalum			worm-leaf sedum
SETR1	Y	Y	Senecio	triangularis			arrowleaf grounsel
SHCA1	Y	Y	Shepardia	canadensis			buffalo berry
SIDO1	Y	Y	Sisyrinchium	douglasii			grass-widows
SIHY1	Y	Y	Sitanion	hystrix			bottlebrush squirreltail
SMRA1	Y	Y	Smilacina	racemosa			Solomon-plume
SMST1	Y	Y	Smilacina	stellata			false solomon-seal,starry
SOSC2	Y	Y	Sorbus	scopulina			mountain ash, Cascade mt
SOSI1	Y	Y	Sorbus	sitchensis			mountain ash
SOSP1	N	N	Sorbus	speciocia			
SPBE1	Y	Y	Spireas	betulifolia			birchleaf/white spirea
SPDO1	Y	Y	Spiraea	douglasii			Douglas spirea
SPPX1	--	--					
STAM1	Y	N	Streptopus	amplexifolius			twisted stalk
STCO1	Y	Y	Stipa	columbiana			columbia needlegrass
STCO2	Y	Y	Stipa	comata			needle and thread
STOC1	Y	Y	Stipa	occidentalis			western needlegrass
STTH1	Y	Y	Stipa	thurberiana			thurber needle grass
SUBA1	--	--		basil			
SYAL1	Y	Y	Symphoricarpos	albus			common snowberry

Continued

Code	Nat.	Perennial	Genus	Species	Subspecies	Variety	Common name
SYMO1	Y	Y	Symphoricarpos	mollis			creeping snowberry
TABR1	Y	Y	Taxus	brevifolia			western yew
THPL1	Y	Y	Thuja	plicata			western red cedar
TITR1	Y	N	Tiarella	trifoliata			tree-leaved coolwort,foam
TIUN1	Y	Y	Tiarella	trifoliata		unifoliata	trefoil foamflower
TRER1	Y	Y	Trifolium	eriocephalum			wooly-head clover
TRLA2	Y	Y	Trientalis	latifolia			western starflower
TROV1	Y	Y	Trillium	ovatum			trillium, white trillium
TSHE1	Y	Y	Tsuga	heterophylla			western hemlock
TSME1	Y	Y	Tsuga	mertensiana			mountain hemplock
UNKN4	N	N	Unknown grass				
VAHE1	Y	Y	Vancouveria	hexandra			inside-out flower
VAME1	Y	Y	Vaccinium	membranaceum			big-leaf huckleberry
VAOV1	Y	Y	Vaccinium	ovalifolium			oval-leaved huckleberry
VAPA1	Y	Y	Vaccinium	parvifolium			red huckleberry
VASC1	Y	Y	Vaccinium	scoparium			grouse huckleberry
VASI1	Y	Y	Valeriana	sitchensis			Sitka valerian
VIAM1	Y	Y	Vicia	americana			American vetch
VIGL1	Y	Y	Viola	glabella			stream violet, pioneer
VISP1	Y	Y	Viburnum	speciosa			viburnum
WATE1	--	--	*WATER				
WOOD1	--	--	*WOODY DEBRIS				
WYAM1	Y	Y	Wyethia	amplexicaulis			mule's ears
XETE1	Y	Y	Xerophyllum	tenax			beargrass
XXXX5	N	N	Graminae	unk.			unknown grass
ZIVE1	Y	Y	Zigadenus	venenosus			death camas

End of data

APPENDIX B. Plot Averages For Each Monitoring Type

FMH Fire Monitoring Handbook Data Analysis - P09
Downed Fuel Inventory

List of menu selections for this output:
- Burn plots
- Preburn (most recent)
- Select from list of monitoring types
- Average all plots within each selected type

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

Type:FPSME1T08 B/C:B Stat:PRE - 8 plots averaged

Size (in)	Const	n * (c)	d sq.	s	a	Nl	Tons / Acre
0 - 1/4	11.64	481.121	0.0114	0.581	1.033	192	0.196
1/4 - 1	11.64	114.709	0.2171	0.577	1.020	192	0.888
1 - 3	11.64	99.535	1.9674	0.570	1.021	384	3.448
		sum D sq.					
3+sound	11.64	2236.120		0.490	1.000	1600	7.546
3+rotten	11.64	5389.950		0.360	1.000	1600	14.116
Sum 3+							21.662
Woody							26.194

	sum	obs	avg	Density lb/^3	Const	
3+sound	310.8	73.495	4.23			
3+rotten	517.0	71.458	7.24			
Litter	111.1	324	0.34			
Duff	273.4	324	0.84	6.2	1.815	9.653
Total						35.847

-------Time Lag Fuel Moisture Classes--------

Species	1	10	100	1000s	1000r
PICO1	27.2%	19.2%	35.6%	50.1%	21.0%
PIMO1	0.9%	0.8%	0.9%	0.7%	0.6%
PSME1	60.5%	63.9%	55.6%	42.7%	61.1%
THPL1	7.1%	10.0%	4.9%	4.0%	10.7%
TSHE1	4.4%	6.1%	3.0%	2.6%	6.6%

Species not found in Downed Fuel Load Constants file and ignored:
ABGR1

Type:FTSHE1T10 B/C:B Stat:PRE - 7 plots averaged

Size (in)	Const	n * (c)	d sq.	s	a	Nl	Tons / Acre
0 - 1/4	11.64	430.539	0.0076	0.653	1.040	168	0.154
1/4 - 1	11.64	137.510	0.2222	0.640	1.020	168	1.383
1 - 3	11.64	75.387	2.0461	0.610	1.022	336	3.334
		sum D sq.					
3+sound	11.64	3727.600		0.568	1.000	1400	17.554
3+rotten	11.64	3907.930		0.360	1.000	1400	11.697
Sum 3+							29.251
Woody							34.121

	sum	obs	avg	Density lb/^3	Const	
3+sound	504.4	93.414	5.40			
3+rotten	386.6	56.269	6.87			
Litter	153.6	279	0.55			
Duff	524.1	279	1.88	7.4	1.815	25.491
Total						59.613

-------Time Lag Fuel Moisture Classes--------

Species	1	10	100	1000s	1000r
PIMO1	1.8%	1.8%	1.6%	1.7%	1.8%
PSME1	24.8%	26.4%	23.8%	27.6%	22.7%
THPL1	22.5%	21.7%	22.0%	20.9%	22.8%
TSHE1	50.5%	49.9%	52.3%	49.7%	52.4%
TSME1	0.3%	0.2%	0.4%	0.2%	0.3%

Species not found in Downed Fuel Load Constants file and ignored:
TABR1 ABAM1

End of file

Fire Monitoring Handbook Data Analysis - P09
Overstory Tree Density and Average Diameter by 15.0cm (5.9") DBH Classes

List of menu selections for this output:
- By 15.0cm (5.9") DBH size classes
- Burn plots
- Preburn (most recent)
- Select from list of monitoring types
- Average all plots within each selected type

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

-------------------[Type:FPSME1T08 B/C:B Stat:PRE Size:0.800ha Plots:8]-------------------

#	SPECIES	NATIVE	CLASS	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	1	178	38.2	222.5	90.1	21.2
2	Pinus contorta.	Y	1	153	32.8	191.3	77.4	19.5
3	Pseudotsuga menziesii	Y	2	37	7.9	46.3	18.7	36.2
4	Thuja plicata	Y	1	22	4.7	27.5	11.1	21.2
5	Pseudotsuga menziesii	Y	3	21	4.5	26.3	10.6	52.5
6	Tsuga heterophylla.	Y	1	16	3.4	20.0	8.1	20.9
7	Thuja plicata	Y	2	11	2.4	13.8	5.6	34.6
8	Pseudotsuga menziesii	Y	4	9	1.9	11.3	4.6	67.5
9	Pinus contorta.	Y	2	5	1.1	6.3	2.5	33.9
10	Pseudotsuga menziesii	Y	5	4	0.9	5.0	2.0	81.2
11	Tsuga heterophylla.	Y	2	4	0.9	5.0	2.0	37.6
12	Pinus monticola	Y	1	2	0.4	2.5	1.0	17.8
13	Abies grandis	Y	1	1	0.2	1.3	0.5	17.8
14	Pinus monticola	Y	2	1	0.2	1.3	0.5	44.2
15	Thuja plicata	Y	3	1	0.2	1.3	0.5	54.9
16	Tsuga heterophylla.	Y	4	1	0.2	1.3	0.5	66.8
Total				466		582.5	235.8	25.4

Nat. species = 466 of 466 plants (100.0%)

-------------------[Type:FTSHE1T10 B/C:B Stat:PRE Size:0.700ha Plots:7]-------------------

#	SPECIES	NATIVE	CLASS	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla.	Y	1	318	55.0	454.3	183.9	20.8
2	Tsuga heterophylla.	Y	2	64	11.1	91.4	37.0	35.1
3	Thuja plicata	Y	1	36	6.2	51.4	20.8	21.9
4	Pseudotsuga menziesii	Y	3	33	5.7	47.1	19.1	52.5
5	Pseudotsuga menziesii	Y	2	21	3.6	30.0	12.1	36.7
6	Thuja plicata	Y	2	17	2.9	24.3	9.8	36.5
7	Thuja plicata	Y	3	14	2.4	20.0	8.1	54.3
8	Pseudotsuga menziesii	Y	4	12	2.1	17.1	6.9	66.0
9	Pseudotsuga menziesii	Y	5	12	2.1	17.1	6.9	83.6
10	Pseudotsuga menziesii	Y	1	11	1.9	15.7	6.4	23.7
11	Thuja plicata	Y	4	8	1.4	11.4	4.6	66.3
12	Thuja plicata	Y	5	7	1.2	10.0	4.0	80.1
13	Tsuga heterophylla.	Y	3	5	0.9	7.1	2.9	51.3
14	Taxus brevifolia.	Y	1	3	0.5	4.3	1.7	19.6
15	Pinus monticola	Y	1	2	0.3	2.9	1.2	16.8
16	Thuja plicata	Y	6	2	0.3	2.9	1.2	93.8
17	Thuja plicata	Y	7	2	0.3	2.9	1.2	110.8
18	Tsuga heterophylla.	Y	5	2	0.3	2.9	1.2	78.5
19	Abies amabilis.	Y	1	1	0.2	1.4	0.6	27.9

#	SPECIES	NATIVE	CLASS	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
20	Abies amabilis.	Y	3	1	0.2	1.4	0.6	50.8
21	Pinus monticola	Y	2	1	0.2	1.4	0.6	36.1
22	Pinus monticola	Y	3	1	0.2	1.4	0.6	53.8
23	Pinus monticola	Y	4	1	0.2	1.4	0.6	70.4
24	Pinus monticola	Y	5	1	0.2	1.4	0.6	75.2
25	Pseudotsuga menziesii	Y	7	1	0.2	1.4	0.6	114.3
26	Tsuga heterophylla.	Y	6	1	0.2	1.4	0.6	91.7
27	Tsuga mertensiana	Y	3	1	0.2	1.4	0.6	48.5
Total				578		825.7	334.3	31.4

Nat. species = 578 of 578 plants (100.0%)

End of file

Fire Monitoring Handbook Data Analysis - P09
Pole Tree Density and Average Diameter

List of menu selections for this output:
- All size classes lumped
- Burn plots
- Preburn (most recent)
- Select from list of monitoring types
- Average all plots within each selected type

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

----------------[Type:FPSME1T08 B/C:B Stat:PRE Size:0.200ha Plots:8]----------------

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Pseudotsuga menziesii	Y	180	64.1	900.0	364.4	7.5
2	Pinus contorta	Y	47	16.7	235.0	95.1	12.6
3	Thuja plicata	Y	31	11.0	155.0	62.8	7.6
4	Tsuga heterophylla	Y	9	3.2	45.0	18.2	6.6
5	Pinus monticola	Y	5	1.8	25.0	10.1	4.9
6	Salix scouleriana	Y	4	1.4	20.0	8.1	8.3
7	Abies grandis	Y	3	1.1	15.0	6.1	10.4
8	Prunus emarginata	Y	2	0.7	10.0	4.0	6.7
Total			281		1405.0	568.8	8.3

Avg. height class = 7.4, Nat. species = 281 of 281 plants (100.0%)

----------------[Type:FTSHE1T10 B/C:B Stat:PRE Size:0.175ha Plots:7]----------------

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE	AVG DBH
1	Tsuga heterophylla	Y	172	72.6	982.9	397.9	8.7
2	Thuja plicata	Y	60	25.3	342.9	138.8	6.7
3	Acer circinatum	Y	3	1.3	17.1	6.9	5.4
4	Taxus brevifolia	Y	2	0.8	11.4	4.6	9.6
Total			237		1354.3	548.3	8.1

Avg. height class = 8.4, Nat. species = 237 of 237 plants (100.0%)

End of file

FMH Fire Monitoring Handbook Data Analysis - P09
Seedling Tree Density

List of menu selections for this output:
- All size classes lumped
- Burn plots
- Preburn (most recent)
- Select from list of monitoring types
- Average all plots within each selected type

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

-----------[Type:FPSME1T08 B/C:B Stat:PRE Size:0.275ha Plots:8]-----------

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Pseudotsuga menziesii	Y	5434	37.2	19760.0	8000.0
2	Tsuga heterophylla	Y	3119	21.3	11341.8	4591.8
3	Abies grandis	Y	2024	13.8	7360.0	2979.8
4	Thuja plicata	Y	1942	13.3	7061.8	2859.0
5	Acer circinatum	Y	1176	8.0	4276.4	1731.3
6	Pinus monticola	Y	531	3.6	1930.9	781.7
7	Alnus sinuata	Y	199	1.4	723.6	293.0
8	Taxus brevifolia	Y	80	0.5	290.9	117.8
9	Pinus contorta	Y	62	0.4	225.5	91.3
10	Abies amabilis	Y	38	0.3	138.2	55.9
11	Salix scouleriana	Y	22	0.2	80.0	32.4
Total			14627		53189.1	21534.0

Avg. height class = 2.7, Nat. species = 14627 of 14627 plants (100.0%)
Dead seedlings recorded and ignored = 154

-----------[Type:FTSHE1T10 B/C:B Stat:PRE Size:0.185ha Plots:7]-----------

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Thuja plicata	Y	2308	39.0	12475.7	5050.9
2	Tsuga heterophylla	Y	1873	31.7	10124.3	4098.9
3	Acer circinatum	Y	1268	21.4	6854.1	2774.9
4	Taxus brevifolia	Y	293	5.0	1583.8	641.2
5	Pinus monticola	Y	65	1.1	351.4	142.2
6	Salix scouleriana	Y	54	0.9	291.9	118.2
7	Abies grandis	Y	52	0.9	281.1	113.8
Total			5913		31962.2	12940.1

Avg. height class = 2.5, Nat. species = 5913 of 5913 plants (100.0%)
Dead seedlings recorded and ignored = 83

End of file

FMH Fire Monitoring Handbook Data Analysis - P09
Forest Transect Vegetation Frequency and Relative Cover

List of menu selections for this output:
- Live perennials & all annuals, lump others
- By species
- Burn plots
- Preburn (most recent)
- Select from list of monitoring types
- Average all plots within each selected type

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

----------------[Type:FPSME1T08 B/C:B Stat:PRE Plots:8]----------------

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Moss species	Y	48.86	23.87	51.97
2	Non-plant	-	48.73	40.33	-
3	Berberis nervosa	Y	13.05	11.37	13.89
4	Chimaphila umbellata	Y	6.03	4.22	6.42
5	Arctostaphylos uva-ursi	Y	5.73	5.08	6.10
6	Pachistima myrsinites	Y	5.60	4.39	5.96
7	Vaccinium membranaceum	Y	2.97	2.41	3.16
8	Linnaea borealis	Y	1.46	0.56	1.56
9	Lonicera ciliosa	Y	1.42	1.08	1.51
10	Cladonia bellidiflora	Y	1.03	0.99	1.10
11	Lichen species	Y	1.03	0.26	1.10
12	Spireas betulifolia	Y	1.03	0.78	1.10
13	Vaccinium parvifolium	Y	0.95	0.95	1.01
14	Rosa gymnocarpa	Y	0.82	0.73	0.87
15	Hieraceum albiflorum	Y	0.47	0.26	0.50
16	Graminae specieosa	Y	0.39	0.34	0.41
17	Cornus canadensis	Y	0.34	0.26	0.37
18	Almelanchier alnifolia	Y	0.30	0.22	0.32
19	Castileja spp.	Y	0.30	0.22	0.32
20	Goodyera oblongifolia	Y	0.26	0.13	0.27
21	Pseudotsuga menziesii	Y	0.26	0.09	0.27
22	Clintonia uniflora	Y	0.22	0.22	0.23
23	Shepardia canadensis	Y	0.22	0.22	0.23
24	Gaultheria ovatifolia	Y	0.17	0.09	0.18
25	Pyrola asarifolia	Y	0.17	0.17	0.18
26	Graminae unk.	N	0.17	0.17	0.18
27	Acer circinatum	Y	0.13	0.09	0.14
28	Fragaria vesca	Y	0.13	0.09	0.14
29	Pinus monticola	Y	0.09	0.09	0.09
30	Pyrola picta	Y	0.09	0.09	0.09
31	Salix scouleriana	Y	0.09	0.09	0.09
32	Viburnum speciosa	Y	0.09	0.04	0.09
33	Dead perennials	-	0.04	0.04	-
34	Hieraceum scouleri	Y	0.04	0.04	0.05
35	Holodiscus discolor	Y	0.04	0.04	0.05
36	Trientalis latifolia	Y	0.04	0.00	0.05

Total # points = 2321, Avg. species/point = 1.5, Avg. height = 0.101m
Nat. species = 2182 of 2186 plants (99.8%)

----------------[Type:FTSHE1T10 B/C:B Stat:PRE Plots:7]----------------

#	SPECIES	NATIVE	% FREQ	% AS TALLEST	% COVER
1	Non-plant	-	58.55	45.93	-
2	Moss species.	Y	46.57	31.35	63.57
3	Berberis nervosa.	Y	9.23	8.27	12.60
4	Tiarella trifoliata	Y	3.47	3.02	4.74
5	Chimaphila umbellata.	Y	2.97	2.29	4.05
6	Vaccinium membranaceum.	Y	1.65	1.46	2.25
7	Pachistima myrsinites	Y	1.60	1.33	2.18
8	Clintonia uniflora.	Y	1.46	1.05	2.00
9	Linnaea borealis.	Y	1.05	0.91	1.43
10	Cornus canadensis	Y	0.96	0.82	1.31
11	Pyrola asarifolia	Y	0.96	0.91	1.31
12	Vaccinium parvifolium	Y	0.50	0.37	0.69
13	Acer circinatum	Y	0.37	0.37	0.50
14	Dead perennials	-	0.27	0.14	-
15	Goodyera oblongifolia	Y	0.27	0.14	0.37
16	Rhibes lacustre	Y	0.27	0.27	0.37
17	Vaccinium ovalifolium	Y	0.23	0.23	0.31
18	Viburnum speciosa	Y	0.23	0.00	0.31
19	Gymnocarpium dryopteris	Y	0.18	0.14	0.25
20	Rosa gymnocarpa	Y	0.18	0.14	0.25
21	Lonicera ciliosa.	Y	0.14	0.09	0.19
22	Oplonanax horridum.	Y	0.14	0.09	0.19
23	Pseudotsuga menziesii	Y	0.14	0.14	0.19
24	Galium species.	Y	0.09	0.09	0.12
25	Pteridium aquilinum	Y	0.09	0.09	0.12
26	Pyrola picta.	Y	0.09	0.05	0.12
27	Thuja plicata	Y	0.09	0.09	0.12
28	Tsuga heterophylla.	Y	0.09	0.05	0.12
29	Athyrium filix-femina	Y	0.05	0.05	0.06
30	Chimaphila menziesii.	Y	0.05	0.05	0.06
31	Gaultheria ovatifolia	Y	0.05	0.00	0.06
32	Osmorhiza chilensis	Y	0.05	0.05	0.06
33	Streptopus amplexifolius.	Y	0.05	0.05	0.06

Total # points = 2188, Avg. species/point = 1.4, Avg. height = 0.092m
Nat. species = 1607 of 1607 plants (100.0%)

End of file

FMH Fire Monitoring Handbook Data Analysis - P09
Forest Plot Brush Belt Density

List of menu selections for this output:
- Live perennials & all annuals, lump others
- All ages lumped
- Burn plots
- Preburn (most recent)
- Select from list of monitoring types
- Average all plots within each selected type

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

-----------[Type:FPSME1T08 B/C:B Stat:PRE Size:0.080ha Plots:8]-----------

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Chimaphila umbellata.	Y	2906	32.1	36325.0	14706.5
2	Berberis nervosa.	Y	2131	23.6	26637.5	10784.4
3	Pachistima myrsinites	Y	1434	15.9	17925.0	7257.1
4	Vaccinium membranaceum.	Y	1173	13.0	14662.5	5936.2
5	Lonicera ciliosa.	Y	477	5.3	5962.5	2414.0
6	Spireas betulifolia	Y	385	4.3	4812.5	1948.4
7	Rosa gymnocarpa	Y	194	2.1	2425.0	981.8
8	Almelanchier alnifolia.	Y	141	1.6	1762.5	713.6
9	Vaccinium parvifolium	Y	52	0.6	650.0	263.2
10	Pseudotsuga menziesii	Y	43	0.5	537.5	217.6
11	Shepardia canadensis.	Y	30	0.3	375.0	151.8
12	Clintonia uniflora.	Y	21	0.2	262.5	106.3
13	Gaultheria ovatifolia	Y	21	0.2	262.5	106.3
14	Acer circinatum	Y	5	0.1	62.5	25.3
15	Holodiscus discolor	Y	4	0.0	50.0	20.2
16	Non-plant	-	4	0.0	50.0	20.2
17	Salix scouleriana	Y	4	0.0	50.0	20.2
18	Thuja plicata	Y	4	0.0	50.0	20.2
19	Pinus contorta.	Y	3	0.0	37.5	15.2
20	Sorbus sitchensis	Y	3	0.0	37.5	15.2
21	Sorbus speciocia.	N	3	0.0	37.5	15.2
22	Abies grandis	Y	2	0.0	25.0	10.1
23	Pinus monticola	Y	1	0.0	12.5	5.1
24	Vaccinium ovalifolium	Y	1	0.0	12.5	5.1
	Total		9042		113025.0	45759.1

Nat. species = 9035 of 9038 plants (100.0%)

-----------[Type:FTSHE1T10 B/C:B Stat:PRE   Size:0.070ha Plots:7]-----------

#	SPECIES	NATIVE	COUNT	%FREQ	#/HECTARE	#/ACRE
1	Chimaphila umbellata.	Y	1279	34.9	18271.4	7397.3
2	Berberis nervosa.	Y	1080	29.5	15428.6	6246.4
3	Vaccinium membranaceum.	Y	490	13.4	7000.0	2834.0
4	Pachistima myrsinites	Y	334	9.1	4771.4	1931.8
5	Vaccinium parvifolium	Y	140	3.8	2000.0	809.7
6	Tsuga heterophylla.	Y	105	2.9	1500.0	607.3
7	Rosa gymnocarpa	Y	56	1.5	800.0	323.9
8	Vaccinium ovalifolium	Y	54	1.5	771.4	312.3
9	Rhibes lacustre	Y	21	0.6	300.0	121.5
10	Oplonanax horridum.	Y	15	0.4	214.3	86.8
11	Almelanchier alnifolia.	Y	14	0.4	200.0	81.0
12	Pseudotsuga menziesii	Y	14	0.4	200.0	81.0
13	Lonicera ciliosa.	Y	13	0.4	185.7	75.2
14	Menziesia ferruginea.	Y	8	0.2	114.3	46.3
15	Gaultheria ovatifolia	Y	7	0.2	100.0	40.5
16	Dead perennials	-	6	0.2	85.7	34.7
17	Thuja plicata	Y	5	0.1	71.4	28.9
18	Alnus rubra	Y	3	0.1	42.9	17.4
19	Taxus brevifolia.	Y	3	0.1	42.9	17.4
20	Acer circinatum	Y	2	0.1	28.6	11.6
21	Polystichum munitum	Y	2	0.1	28.6	11.6
22	Rubus parviflorus	Y	2	0.1	28.6	11.6
23	Spireas betulifolia	Y	2	0.1	28.6	11.6
24	Abies grandis	Y	1	0.0	14.3	5.8
25	Non-plant	-	1	0.0	14.3	5.8
26	Pinus monticola	Y	1	0.0	14.3	5.8
27	Prunus emarginata	Y	1	0.0	14.3	5.8
28	Pteridium aquilinum	Y	1	0.0	14.3	5.8
29	Adiantum pedatum.	Y	0	0.0	0.0	0.0
Total			3660		52285.7	21168.3

Nat. species = 3653 of 3653 plants (100.0%)

End of file

APPENDIX C. Minimum Plot Estimates

FMH Fire Monitoring Handbook Data Analysis - P09
Downed Fuel Inventory Minimum Plots - Tons per Acre

List of menu selections for this output:
Burn plots
Select from list of monitoring types

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

------[TONS PER ACRE--Type:FPSME1T08 B/C:B Stat:PRE --8 plot(s)]-------
percent confidence = 0.80, t value = 1.415

FUEL TYPE	MIN (R=20)	MIN (R=25)	STD DEV	MEAN
1 hr.	24	16	0.135	0.196
10 hr	30	20	0.685	0.888
100 hr.	24	16	2.367	3.448
1000s	63	41	8.432	7.546
1000r	65	42	16.011	14.116
sum 3+.	29	19	16.486	21.662
Woody	20	13	16.532	26.194
Duff.	17	11	5.571	9.653
Duff depth.	17	11	0.487	0.849
Litter depth. . . .	61	39	0.381	0.346
Total Tons/Acre . .	16	10	19.894	35.847

------[TONS PER ACRE--Type:FTSHE1T10 B/C:B Stat:PRE --7 plot(s)]-------
percent confidence = 0.80, t value = 1.440

FUEL TYPE	MIN (R=20)	MIN (R=25)	STD DEV	MEAN
1 hr.	10	6	0.065	0.154
10 hr	13	8	0.669	1.383
100 hr.	12	8	1.580	3.334
1000s	12	8	8.349	17.554
1000r	44	28	10.719	11.697
sum 3+.	15	10	15.414	29.251
Woody	12	8	15.948	34.121
Duff.	22	14	16.503	25.491
Duff depth.	20	13	1.149	1.875
Litter depth. . . .	27	18	0.395	0.549
Total Tons/Acre . .	14	9	30.808	59.613

End of file

FMH Fire Monitoring Handbook Data Analysis - P09
Downed Fuel Inventory Minimum Plots - Tons per Acre

List of menu selections for this output:
Burn plots
Select from list of monitoring types

List of types output:

Indexcode	Stat
FPSME1T08	PRE
FTSHE1T10	PRE

------[TONS PER ACRE--Type:FPSME1T08 B/C:B Stat:PRE --8 plot(s)]-------
percent confidence = 0.95, t value = 2.365

FUEL TYPE	MIN (R=20)	MIN (R=25)	STD DEV	MEAN
1 hr.	66	43	0.135	0.196
10 hr	84	54	0.685	0.888
100 hr.	66	43	2.367	3.448
1000s	175	112	8.432	7.546
1000r	180	116	16.011	14.116
sum 3+.	81	52	16.486	21.662
Woody	56	36	16.532	26.194
Duff.	47	30	5.571	9.653
Duff depth.	47	30	0.487	0.849
Litter depth. . . .	170	109	0.381	0.346
Total Tons/Acre . .	44	28	19.894	35.847

------[TONS PER ACRE--Type:FTSHE1T10 B/C:B Stat:PRE --7 plot(s)]-------
percent confidence = 0.95, t value = 2.447

FUEL TYPE	MIN (R=20)	MIN (R=25)	STD DEV	MEAN
1 hr.	27	18	0.065	0.154
10 hr	36	23	0.669	1.383
100 hr.	34	22	1.580	3.334
1000s	34	22	8.349	17.554
1000r	126	81	10.719	11.697
sum 3+.	42	27	15.414	29.251
Woody	33	21	15.948	34.121
Duff.	63	41	16.503	25.491
Duff depth.	57	36	1.149	1.875
Litter depth. . . .	78	50	0.395	0.549
Total Tons/Acre . .	40	26	30.808	59.613

End of file

APPENDIX D. Rare Vascular Plants of the Skagit Valley, B.C.
(Excerpt from Rare Vascular Plants of the Skagit Valley British Columbia. R.T. Ogilvie and A.Ceska, 1990.)

RARE PLANTS

Allium acuminatum Taper-tip Onion R4
Ponderosa pine Eco-reserve (ER 22) rock outcrops.

Carex inops Long-stolon Sedge R3
ER 22.

Castilleja rupicola Cliff Paintbrush R4
Finlayson Peak, Wright Peak, McNaught Ridge, alpine.

Cryptogramma cascadensis Cascade Parsley Fern
Whitworth Peak, alpine, moist talus. This is a newly described species (Alverson, 1989), with its centre of distribution in the Cascade Mountains from southern B.C. to California, and also occurring in the Selkirk Mountains of B.C. southward to northern Oregon. There is a single locality of it in the southern Coast Mountains of B.C., and it is suspected to occur in the Olympic Mountains of Washington (Alverson, 1989).

Dicentra uniflora Steer's-head R1
ER 22 rock outcrops. On species list in Eco-reserve's files, no voucher specimens seen.

Elmera racemosa Elmera R1
Whitworth Peak, Finlayson Peak, alpine talus.

Hydrophyllum fendleri Fendler's Waterleaf R4
Upper Skagit Eco-reserve No. 89, Whitworth Peak, Wright Peak, Wright Ridge.

Lloydia serotina Alp Lily R4
McNaught Ridge, Finlayson Peak, Wright Peak, Wright Ridge, alpine cliffs and ledges.

Mimulus alsinoides Chickweed Mimulus R4
ER 22 seepage.

Penstemon ovatus Broad-leaved Penstemon R4
Antimony Creek; Skagit east-slope cliff.

Platanthera elegans Elegant Rein-orchid R4
ER 22.

Polypodium amorphum Pacific Polypody Fern R3
Whitworth Peak, Finlayson Peak, Wright Peak.

Polystichum imbricans Imbricate Swordfern R1
Upper Skagit scree.

Polystichum kruckebergii Kruckeberg's Swordfern R1

Whitworth Peak, Finlayson Peak, alpine talus and rubble.

Rhododendron macrophyllum Pacific Rhododendron R2
From near the north end of the Skagit Trail down valley to within 4.5 km of the U.S. border; in Eco-reserves Nos. 21 and 106. On coarse, well-drained river terraces under dry Douglas fir / lodgepole pine stands. Additional discussion of the distribution and ecology of these stands is given in a separate section of the report.

Rubus lasiococcus Dwarf Bramble R2
Listed for Skagit Valley by Straley et al (1985); no voucher specimens seen.

Senecio elmeri Elmer's Ragwort R4
Wright Peak, Whitworth Peak, Finlayson Peak, alpine.

Smelowskia ovalis Cascade Smelowskia R1
McNaught Ridge, alpine talus.

Spiraea densiflora Subalpine Spiraea R4
ER 106.

The Rarity rating is based on: Straley, G.B., R.L. Taylor, & G.W. Douglas. 1985. The rare vascular plants of British Columbia. National Museum of Canada, Syllogeus No. 59, 165 pp.
Degree of Rareness: R1 - single or few small populations, restricted distribution. R2 - few, large populations, restricted distribution. R3 - small populations, scattered widespread distribution. R4 - narrowly restricted distribution, large populations.