FOREST ECOSYSTEMS OF MOUNT RAINIER NATIONAL PARK

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INTRODUCTION

We began studies of forest ecosystems at Mount Rainier National Park (MRNP) in the summer of 1975. Our objectives were to identify and describe the different forest types, characterize their environmental features and patterns of occurrence within the Park, and determine causes and rates of succession. The initial forest classification presented here is based on data from 242 plots distributed over all the major drainage systems. During our second summer (1976) we sampled an additional 158 plots, mostly younger forests. This paper reports the major forest types resolved from these data, some generalized patterns of occurrence of these types in selected landscapes at MRNP, the major soil types, and important factors initiating succession. We also give forest age spectra for three drainages and compositional chronosequences in three of the forest types.

METHODS

Most data were obtained by the reconnaissance method for forest classification (Franklin et al. 1970). The usual procedure for the field crew would be to travel a slope, trail, road segment, or whatever path through a forested landscape and establish a string of sampled plots that revealed both the typical and changing forest patterns along that path. In 1975 we sought stands from late seral to climax condition, i.e., old-growth relatively free of recent disturbances; in 1976 we focused mostly upon forests of early to middle seral condition.

Circular plots mostly 500 or 1,000 m^2 (depending on mature tree density) were our sample units. Understory vascular plant cover was recorded as described by Franklin et al. (1970) and Dyrness et al. (1974). All tree stems exceeding 1.4 m in height were tallied by species and diameter. Tree regeneration (<1.4 m in height) was subsampled in a 50 m^2 circular plot either at the center of the larger plot (1975) or at four 12.5 m^2 circular plots, one in each quadrant of the larger plot. We also made field description of soils, and recorded elevation, exposure, slope, degree of canopy closure, landform, position in the landscape (lower, middle, upper slope, ridge, draw, bench) and location on topographic map. Supplemental notes included disturbance evidence (fire, biotic, windthrow, etc.) and inclusions or mosaics of other forest types.

The classification was obtained by subjectively sorting releve or stand table data from late seral to climax plots into subsets based upon general similarities in dominance within each of the tree, shrub, and herb strata. The technique is described by Dyrness et al. (1974) and Shimwell (1971, p. 188 ff).

Stand ages were measured from increment cores of dominant specimens of *Pseudotsuga manziesii*, *Abies procera*, or other trees judged to have been among the first wave of regeneration after disturbance. We sought the oldest specimens of a seral cohort to set a time limit on whatever disturbance event gave opportunity to establish that cohort. Cored trees were aged by counting rings in the field and adding to that age corrections for center and age to core height. For large specimens these corrections were sometimes a source of considerable sample error.

MAJOR FOREST TYPES

We can recognize four broad elevational zones of forests at MRNP. At highest elevations (generally over 1,620 m) are subalpine parklands where mosaics of tree copses and meadow communities occur. These communities and environments have been previously described (Franklin and Mitchell 1967, Franklin et al. 1971) and are not the subject of this study. Below about 1,620 m elevation are mostly closed canopy forests. The *Tsuga mertensiana* zone occurs at the highest elevations with *Abies lasiocarpa, Tsuga mertensiana, Chamaecyparis nootkatensis,* and *Abies amabilis* as characteristic trees. At mid-elevations *Abies procera, Pseudotsuga menziesii, Tsuga heterophylla,* and *Thuja plicata* are important canopy dominants. These forests are within the *Abies amabilis* zone generally between 730 and 1,475 m elevation at MRNP. We have provisionally recognized 3 high-elevation and 9 mid-elevation forst types at MRNP (Table 1). Below about 730 m elevation are four forest types of the *Tsuga heterophylla* zone (Franklin and Dyrness 1973). Such forests are more extensive outside the Park, but reach their upper elevational limits in valleys and south-facing slopes near Park boundaries. *Pseudotsuga menziesii, Tsuga heterophylla, Thuja plicata, Abies grandis,* and *Picea sitchensis* are trees of these lowest elevations.

The forests of MRNP can also be divided into mature and immature types. The classification of Table 1 is based upon mature forests that are generally about 250 years or older and well stocked. Immature

Table 1. Major forest types at Mount Rainier.

Forest Type	Dominant Trees[1] Overstory	 Regeneration	Important Understory Species
I. LOW ELEVATION (< 730 m)			
Western hemlock/Salal	PSME, TSHE	TSHE	*Gaultheria shallon*, *Vaccinium parvifolium*, *Berberis nervosa*
Western hemlock/Vanillaleaf	PSME, TSHE, THPL	TSHE	*Acer circinatum*, *Achlys triphylla*, *Viola sempervirens*
Western hemlock/Swordfern	PSME, TSHE, THPL	TSHE	*Acer circinatum*, *Polystichum munitum*, *Berberis nervosa*
Western hemlock/Devil's club	PSME, TSHE, THPL	TSHE	*Oplopanax horridum*, *Athyrium filix-femina*, *Gymnocarpium dryopteris*
II. INTERMEDIATE ELEVATION			
W. hemlock-Silver Fir/Oregongrape	PSME, TSHE	TSHE, ABAM	*Acer circinatum*, *Berberis nervosa*, *Achlys triphylla*, *Vaccinium parvifolium*
W. hemlock-Silver Fir/Swordfern-Deerfern	PSME, TSHE, THPL	TSHE, ABAM	*Polystichum munitum*, *Blechnum spicant*, *Berberis nervosa*
Silver Fir/Salal	PSME, TSHE, THPL	TSHE, ABAM	*Gaultheria shallon*, *Xerophyllum tenax*, *Berberis nervosa*
Silver Fir/Alaska huckleberry	TSHE, ABAM	ABAM	*Vaccinium alaskaense*, *Linnaea borealis*, *Rubus lasiococcus*
Silver Fir/Alaska huckleberry-Trailing raspberry	TSHE, ABAM	ABAM	*Vaccinium alaskaense*, *Vaccinium ovalifolium*, *Rubus pedatus*
Silver Fir/Foam flower	PSME, ABPR, TSHE	ABAM	*Tiarella unifoliata*, *Achlys triphylla* *Streptopus roseus*, *Clintonia uniflora*
Silver Fir/Devil's club	TSHE, ABAM, CHNO	ABAM	*Oplopanax horridum*, *Gymnocarpium dryopteris*, *Tiarella unifoliata*
Silver Fir/Devil's club/Trefoil foamflower	TSHE, ABAM, CHNO	ABAM	*Oplopanax horridum*, *Vaccinium* spp., *Gymnocarpium*, *Rubus pedatus*, *Tiarella trifoliata*
Silver Fir/Huckleberry/Beargrass	TSHE, PSME, ABAM	ABAM, TSHE	*Vaccinium membranaceum*, *Xerophyllum tenax*
Silver Fir-Yellow cedar/Oval-leaf huckleberry	TSHE, CHNO	ABAM	*Vaccinium ovalifolium*, *Tiarella unifoliata*, *Gymnocarpium dryopteris*
III. HIGH ELEVATION (> 1300 m)			
Silver Fir/Huckleberry/Herb	TSHE, ABAM, CHNO, TSME	ABAM	*Vaccinium membranaceum*, *Erythronium montanum*, *Rubus pedatus*
Silver Fir/Rusty leaf	TSHE, ABAM, CHNO, TSME	ABAM	*Rhododendron albiflorum*, *Menziesia ferruginea*, *Vaccinium ovalifolium*

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[1] PSME = *Pseudotsuga menziesii*, TSHE = *Tsuga heterophylla*, TSME = *T. mertensiana*, ABAM = *Abies amabilis*, ABPR = *A. procera*, CHNO = *Chamaecyparis nootkatensis*, THPL = *Thuja plicata*

Immature stands are either well below stocking potential or less than about 250 years old. Seral forest types (or community types) include *Abies lasiocarpa* forests at high elevations, *Pseudotsuga menziesii/Pteridium aquilinum* community types at intermediate elevations, and red alder (*Alnus rubra)* communities of lower slopes and valley bottoms.

VEGETATION-LANDSCAPE PROFILES

Moisture and temperature gradients are major environmental complexes affecting forest patterns. For each drainage system at MRNP these complexes can be delimited by elevation, relief, and position in the landscape. Thus each forest type embraces a relatively narrow environmental span illustrated by the profiles of Figures 1-3.

White River. Our profile (Fig. 1) extends from Clover Lake to Sunrise road in the White River Valley, an elevational range of 740 m (2,430 ft). The road to Sunrise Visitor Center crosses the entirety of this sequence of forest types. Subalpine parkland is common along Sunrise Ridge and in the upper Sunrise Creek basin along the trail to Clover Lake (elevations generally over 1,620 m). A small finger of Silver fir/Rusty leaf forest type occurs along Sunrise Creek below Clover Lake. Elsewhere on steep slopes between 1,500 to 1,620 m are closed subalpine fir forests, as, for example, along Sunrise Road. The Silver fir/Foam flower forest type centered around 1,500 m elevation. The boundary is visually apparent because subalpine fir (dark greenish canopies) suddenly yield dominance to noble fir (bluish canopy). At 1,280 m is a narrow, wet bench on which occurs the Silver fir-Alaska yellow cedar/Oval-leaf huckleberry type. Below this the Western hemlock-

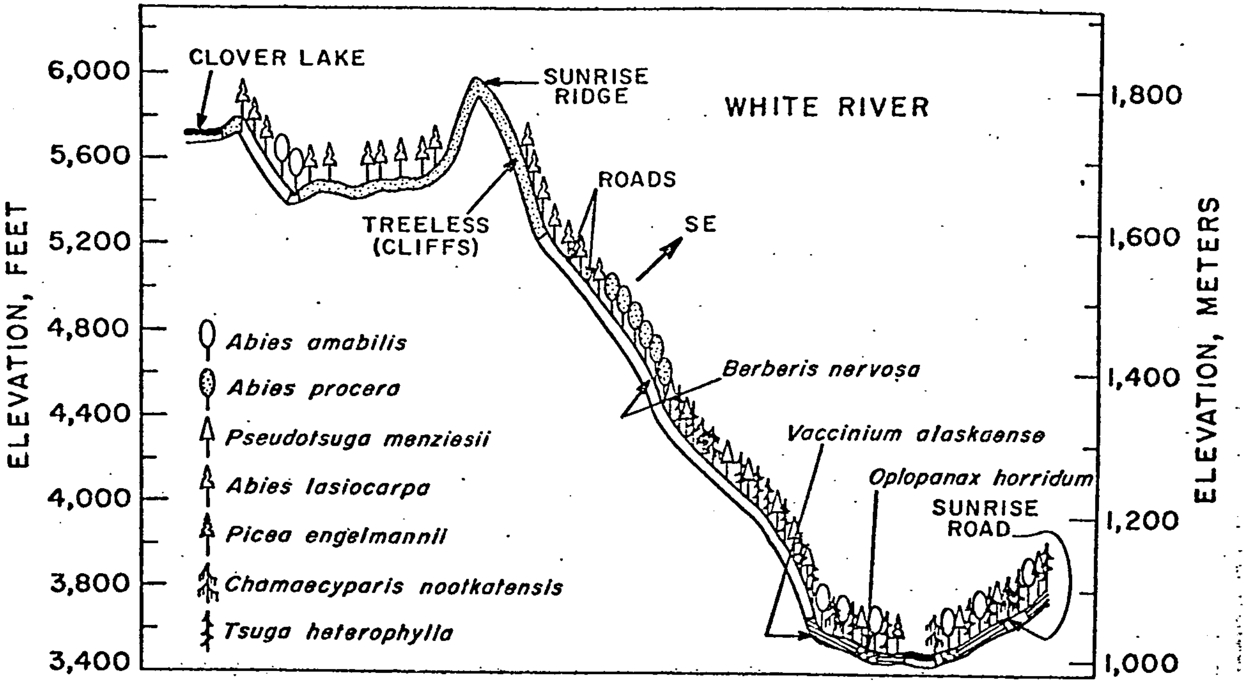

Figure 1. Generalized vegetation cross-section across Sunrise Ridge from Clover Lake to the White River Valley.

Silver fir/Oregongrape forest extends along middle and lower slopes. The lower slopes and valley bottoms along the White River have forests of Silver fir/Alaska huckleberry type, with Silver fir/Devil's club type in seep and smaller drainage areas. Occasional Engelmann spruce and Alaska yellow cedar along the White River may indicate cold airflow and other environmental features of this major valley drainage.

Ohanapecosh River. The southeastern sector of Mount Rainier is the driest of the Park's drainages -- the rain shadow of Pacific westerlies swirling around the volcanic cone. Our profile (Fig. 2) extends from Cowlitz Divide, across the steep, narrow Ohanapecosh Valley to the southeast boundary of the Park on the ridge of the Ohanapecosh rock formation. The Steven's Canyon road crosses the east-facing slope of this profile and offers a bird's eye view of forests across the valley. The ridge forming the Park's east boundary has forests of the Silver fir/ Foam flower and Silver fir/Rusty leaf types. Below 1,300 m and extending all the way to the valley floor are forests dominated almost entirely by Douglas fir and western hemlock along west-facing slopes. At higher elevations are forests of Western hemlock-Silver fir/Oregongrape type; lower slopes are Western hemlock/Salal type. The Ohanapecosh River valley contains forest mosaics of Western hemlock/Salal, Western hemlock/Vanilla-leaf, and Western Hemlock/Devil's club. The very steep canyon sideslopes leading up to Cowlitz Divide generally mirror the zonation pattern of the opposite slope. Cliffs and rocky talus, however, frequently interrupt the forests. Shallow, cobbly soil between the cliffs and ledges may exhibit xeric variations of Western hemlock/Salal and Western hemlock-Silver fir/

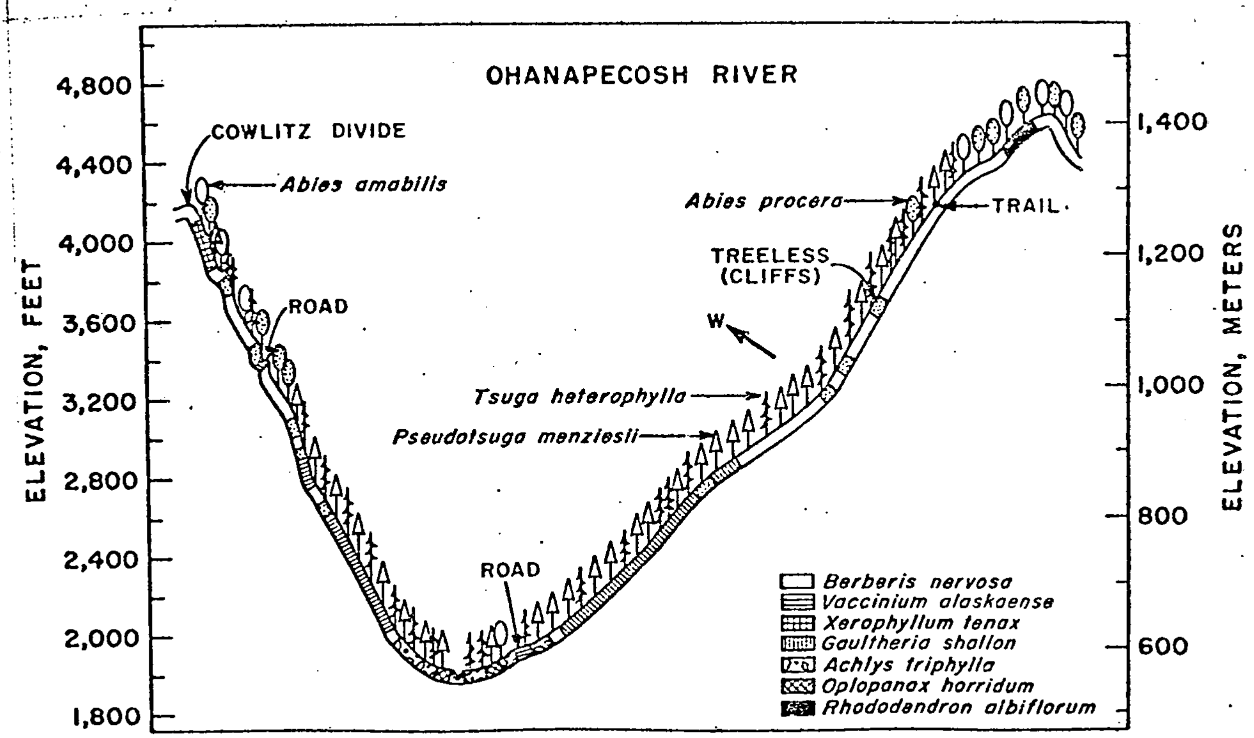

Figure 2. Generalized vegetation cross-section of the Ohanapecosh Valley near the ranger station and campground.

Oregongrape forests. But Silver fir/Foam flower forest type can be found on more stable slopes with deep tephra soils (Fig. 2 just below the road). The ridges and upper slopes of Cowlitz Divide have forests of Silver fir/Huckleberry/Beargrass and Western hemlock-Silver fir/Oregongrape with the former on more exposed sites.

Mowich River. This westerly trending drainage system is (together with the Carbon River drainage) the wettest of the Park's watersheds. Figure 3, Paul Peak to the Golden Lakes upland, shows great variation of forest pattern from south-facing to north-facing slopes. Forest sequences along slopes of Paul Peak are not unlike the west-facing slopes of the Ohanapecosh River (Fig. 2). The lower slopes along Mowich River, however, contain stands of the Western hemlock/Swordfern type. The Mowich River bottomlands are mantled primarily by forests of Silver fir/Devil's club/Trefoil foamflower. Colluvial lower slopes and draws with northerly aspect

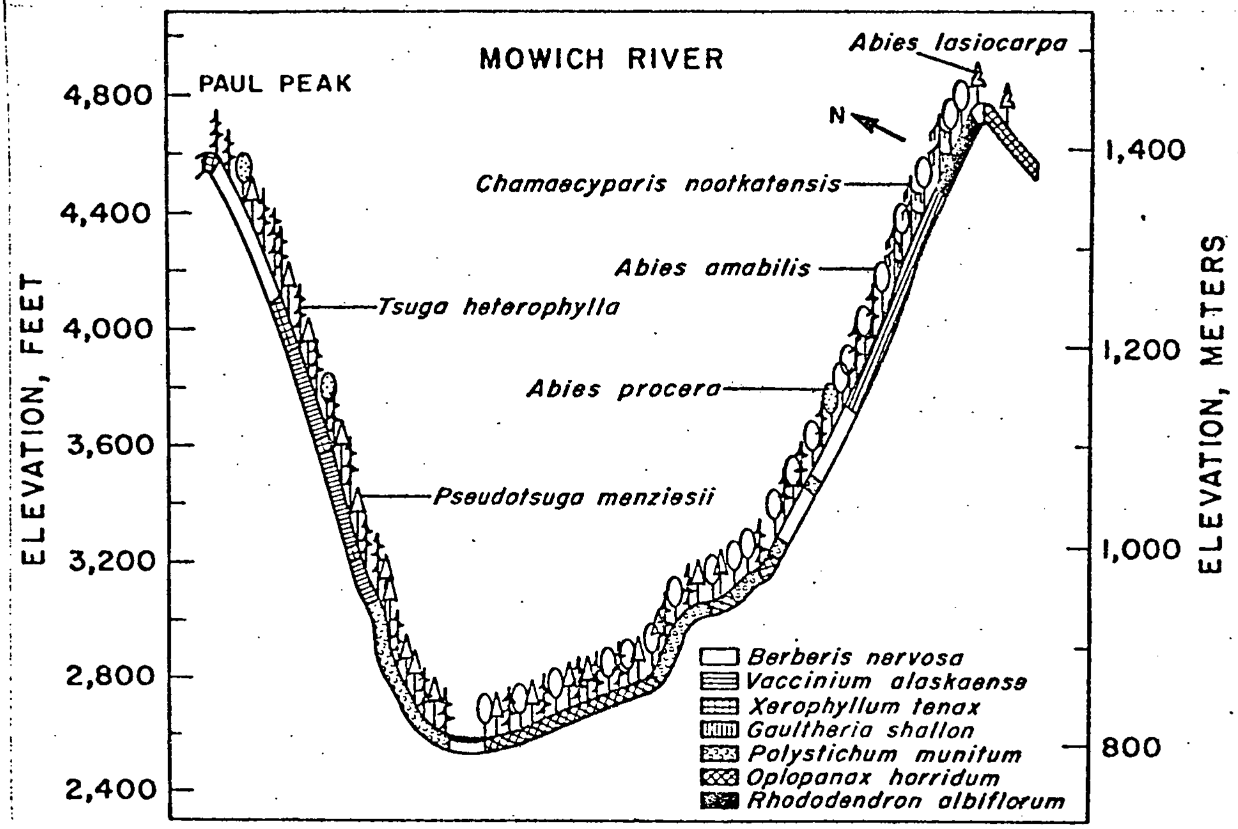

Figure 3. Generalized vegetation cross-section of the Mowich River Valley.

feature the Silver fir/Swordfern-Deerfern forest type. Around 1,100 m elevation the trail to Golden Lakes passes through stands dominated by western hemlock and silver fir, but with a very depauperate, sterile appearing understory. Infrequent deerfern or huckleberry give only faint suggestion of the Silver fir/Swordfern-Deerfern or Silver fir/Alaska huckleberry forest types. The latter is better defined as understory flora becomes more diverse and abundant upslope (ca 1,200 m elevation). The uppermost north-facing slopes are forested with the Silver fir/Rusty leaf type. The ridgetop and upper slopes of the Golden Lakes basin area contain open, fire-derived forests of the Silver fir/Huckleberry/Beargrass type with occasional subalpine fir among early successional trees.

SOILS

The forest soils at MRNP are extremely variable and grade from one kind of soil to another. Major soil-forming activities are accumulation of forest floor organic matter and development of iron pans. Podzolization may sometimes be indicated by very weak to moderately-developed spodic horizons. Four basic parent materials (Hobson 1976) are pyroclastic deposits (tephra), mudflow, colluvium, and alluvium. Tephras, alluvial, laharic, and glacial materials have periodically been deposited during the history of forest vegetation at MRNP (Mullineaux 1974, Crandell 1971, 1967), and most parent materials of the rooting zone are of Holocene age. Differences in soil mineralogy and depths of various parent materials within the profile generally seem to have little influence upon the composition of forest vegetation. But soils considered in the broader context of landform, internal drainage, and position in the landscape

(Table 2) can affect vegetation. For example, the colluvial soils of steep midslopes may be physiologically drier than deeper, finer-textured tephra soils of midslope benches.

DISTURBANCES

Fire is the most extensive forest disturbance and its evidence is found in the majority of our sample plots. Fires appear to have influenced the composition of wetter valley forests as well as those of drier ridges and upper slopes. Plummer (1899, p. 133) observed that "ancient burns, of which traces still remain in the standing timber, cover probably 40 to 50 percent of the [Mount Rainier Forest] reserve, but being restocked with trees of large size cannot be called burns." We are not yet prepared to relate fire frequency or burning characteristics to the various forest types. Evidence for multiple fires can be found in most drainages at MRNP. In the Ohanapecosh Valley, for instance, fires evidently took place about 260, 450, and 670 years ago, as suggested by three widely occurring age classes of *Pseudotsuga menziesii.* Charred bark on survivors of 450 age class can be attributed to the fire about 200 years later. Evidence of repeated fires can also be found in places where charcoal occurs *in situ* both above and below the tephra W, a pyroclastic deposit about 450 years ago (Mullineaux 1974). Many younger stands were initiated by white man's fires. The Sheepherder Burn of the White River (oldest trees dating about 118 years) is a good example. The Cowlitz Valley appears to be the most extensively burned within the last 150 to 200 years. Plummer (1899) reported "great burns" of the Cowlitz (possibly outside the Park boundaries) in 1841 and 1856 and reburns at intervals around 1889-1899.

Table 2. Modal soil profiles of forests at Mount Rainier National Park. (after Hobson 1976).

1. Tephra-Slope-No Iron Pan		
01	6-4 cm	Litter
02	6-0 cm	Duff; abundant medium and fine roots; smooth, abrupt boundary to
A21	0-3 cm	Dark gray (moist) fine sand (post-W tephra); loose; fine and medium roots abundant; smooth, abrupt boundary to
IIA22	3-9 cm	Mixed brown and gray (dry) coarse sand (tephra W); loose grained; fine and medium roots common; occasional subangular cobbles; wavy, clear boundary to
IIIBir	9-25 cm	Brown (moist) loamy sand (tephra C) with fine distinct areas of dark gray fine sand; massive breaking to loose weak, moderate subangular blocks, very friable; few roots; 5 percent lapilli, occasional subangular cobble; smooth clear boundary to
IVC1	25-32 cm	Dark gray sand (moist) with common fine distince brown mottles; massive breaking to loose and very weak subangular block, very friable; few roots; 10 percent lapilli; smooth abrupt boundary to
IVC2	32-68 cm	Mixed brown, dark gray, and yellowish brown very coarse sand (tephra Y); loose; very few roots to none; occasional cobble
2. Tephra-Bench-Strong Iron Pan		
01	6-4 cm	Litter
02	4-0 cm	Duff; saturated; abundant roots
A2	0-7 cm	Gray (wet) very coarse sand (tephra Y); loose; roots abundant, more so at 02/A2 boundary; smooth clear boundary to
B1	7-18 cm	Mixed light brownish gray and dark yellow brown (wet) very coarse sand; loose grain; roots common; smooth gradual boundary to
B2ir	18-36 cm	Dark brown (wet) very coarse sand; massive breaks to structureless, friable becoming firm with depth; very few to no roots.
3. Colluvial		
01	9-7 cm	Litter
02	7-0 cm	Duff; roots common
A21	0-2 cm	Dark gray (moist) fine sand (post-W tephra); loose; roots common; smooth abrupt boundary to
IIA22	2-5 cm	Mixed gray and yellowish brown (moist) coarse sand (tephra W); single grain; roots common; irregular abrupt boundary to
IIIB	5-60 cm	Yellowish brown (moist) gravelly sand; 25 percent lapilli and angular gravels increasing with depth; loose; roots abundant to 40 cm grade to few.
4. Alluvial		
01	3-2 cm	Litter
02	2-0 cm	Duff; fine roots abundant
A1	0-3 cm	Very dark grayish brown (moist) fine sand; massive breaks to moderate medium crumb, friable; fine roots common; smooth clear boundary to
B	3-14 cm	Dark yellowish brown (moist) fine sand; massive breaks to moderate coarse subangular block, very friable; fine roots common; smooth clear boundary to
IIC	14-63 cm	Dark gray (moist) sand; massive breaks to single grain; few fine and medium roots.

Avalanches are another common disturbance, affecting forests at mostly high and intermediate elevations (Table 1). Their extent is particularly apparent on air photographs. The start zone, trimline, and runout zone can be contrasted to more irregular patterns produced by fire. The aerial extent of successional vegetation of avalanche paths is not proportionately reflected in our sample of 400 plots. Vegetation composition of avalanche areas has been studied in the North Cascades by Cushman (1976). She found species of *Alnus, Acer circinatum,* and *Pteridium aquilinum* to be important dominants on south-facing tracks.

Lahars (Crandell 1971) are another widespread agent of disturbance. The 1947 Kautz lahar is a conspicuous example of almost primary succession on newly deposited surface. Root burial produced total mortality of the tree overstory. Dominant seral shrubs and herbs include *Alnus rubra, A. sitchensis* (at higher elevation), *Salix, Pteridium aquilinum, Epilobium angustifolium,* and *Anaphalis margaritacea.* Another lahar surface adjoining the 1947 lahar but older than 450 years has forest of the Silver fir/ Alaska huckleberry type that we aged at about 590 years. As we were unable to find any charcoal residues that might have indicated a fire history, the forest might be first generation primary succession. The surface might correlate to the Electron lahar about 600 years age (Crandell 1971). This forest differs little from stands of Silver fir/Alaska huckleberry in the Ohanapecosh Valley of about the same age but evidently fire-originated. Lahar deposits as soil material differ little from recent alluvium, pyroclastic deposits, or colluvium in affecting old-growth vegetation composition.

Alluvial and glacial processes also cause forest succession. A common tree invader of new river bars is *Populus trichocarpa*. Glacial outwash torrents and meltwater deposits destroy old banks and cause primary succession on new surfaces. Our plot 356 (Table 3) thus originated. Glacial advances create forest disturbance, and recessions initiate succession on primary surfaces (Sigafoos and Hendricks 1972). Strong trimlines can be seen along the Nisqually River near the highway bridge. Plot 375 (Table 3) below that trimline occurs on morainal drift exposed around 1840 (Crandell 1969).

Windthrow was extensive enough in several of our plots to qualify as a major disturbance. But we could not ascertain whether the blowdown itself was the immediate agent of succession or followed upon another event such as root rot, tree kill by insects, or fire.

Biotic influences on forest succession at MRNP are important and varied. Effects can be local or widespread. Examples include beetle kill of *Pinus monticola* during the 1960s, beaver impoundments creating red alder communities, pockets of root rot (*Phellinus weirii*), tree girdling by foraging bears, and feeding behavior of large herds of elk. Elk activities are apparent in many of our plots in the Ohanapecosh, Cowlitz, and Mowich River sectors. The migrating herds have seasonal impacts in several of the forest types. Recurrent usage of the same areas by elk could result in significant shifts of vegetation dominance. For example the greater abundance of devil's club (*Oplopanax horridum*) in the Carbon River (no elk) than at Ohanapecosh Valley (numerous elk) may reflect both climatic and elk-use factors, since this is a favorite browse plant.

FOREST AGE PATTERNS

Figure 4 shows the distribution of tree ages in samples from Cowlitz, White, and Ohanapecosh River drainage systems. Our selection of trees for age determination was intended to provide an estimate of time since disturbance, so that the histograms are a sample of only the older, seral trees. Douglas fir was usually present in most disturbed forests at low and intermediate elevations. Other seral species included noble fir and western white pine. At higher elevations we sometimes had to resort to mountain hemlock, Alaska yellow cedar or silver fir, recognizing that these could be early- to mid-seral as well as late-seral or climax.

These age patterns reflect a variety of disturbances discussed above, but principally fire. The histogram for the Ohanapecosh drainage shows three modes. Peaks occur at 225, 675, and 975 years. As seedling establishment can lag many years after the disturbance event, it is not unreasonable to speculate major disturbance periods at about 275-300, 750-800, and 1000 or more years ago. Of course other times of forest disturbance are likely too (e.g., specimens of Douglas fir aged at 450 years or noble fir at 310 years), and possibly our sample has not adequately revealed these periods.

The Cowlitz drainage has been heavily burned in the past two centuries. Our histogram shows major modes at 75 and 175 and minor peaks at 675 and 1000 years. The 75-year peak may reflect Plummer's (1899) burns of 1896 and earlier. Yet another sequence is apparent in the White River drainage. Ages of seral trees there show maxima at 75, 475, and 775 years. The youngest peak probably again reveals fires contemporaneous with white man's activity, especially the so-called "Sheepherder Burn" on Crystal Mountain. The older peaks may show periods of "ancient burns" mentioned by Plummer (1899).

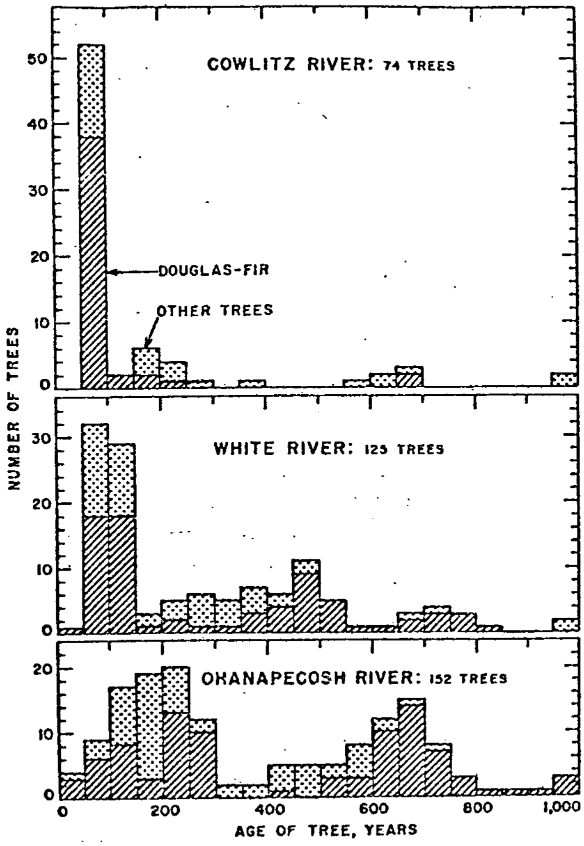

Figure 4. Sampled age distribution of oldest trees from various forest stands in three river drainages.

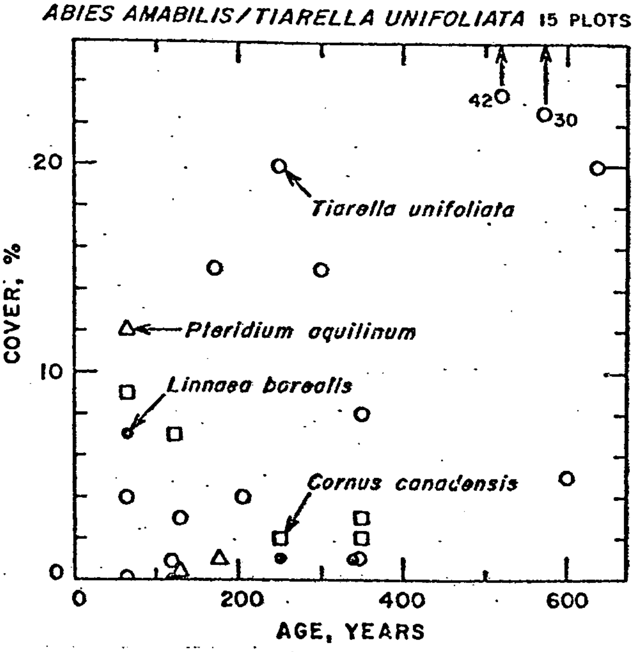

Figure 5. Cover of selected herbs in relation to plot age, Silver fir/ Foamflower forest type.

Regard Figure 4 as only a first approximation to disturbance periodicity in forests at MRNP. The samples are not necessarily proportionate to the actual aerial extent of the various disturbance types and periods within forest populations. As stands mature and mortality reduces the old tree record, the probability of sampling the oldest trees of the earliest seral cohort diminishes. Multiple disturbances long ago may also be impossible to resolve from sparse records of the old-growth survivors.

CHRONOSEQUENCES

Figures 5 and 6 were made by arranging by age plots of the Silver fir/ Foamflower and Western hemlock-Silver fir/Oregongrape forest types. One problem making chronosequences is recognition of early members when continuously intergrading samples up to old-growth climax do not exist. Our samples had a gap in the record about 400-500 years ago. But the plots before and after this gap were floristically similar enough to reasonably assign to the appropriate chronosequence.

We detect some rather uncertain understory trends in the Silver fir/Foam flower forest type (Fig. 5). Foam flower (*Tiarella unifoliata*) itself is rather variable, but has higher cover percentages in plots over 500 years than those younger than 400 years. Bracken fern does not persist after about 200 years. Similarly both twinflower (*Linnaea borealis*) and bunchberry (*Cornus canadensis*) seem more associated with younger plots of the noble fir successional stage. In the Western hemlock-Silver fir/Oregongrape forest only bracken fern revealed any trend: it occurred (from 1 to 10 percent cover) in only four plots under 125 years of age.

Rapid understory recovery after disturbance in two of the wetter forest types is also suggested in Table 3. Plots within each type were compared by calculating percentage similarity from 14 dominant understory species. Comparisons included young plots (secondary succession after fire and primary succession on new geological substrates) with old-growth. We regard vegetation between plots to be similar if calculated similarities exceed about 25 percent. Similarities of each plot with others of the same forest type often exceeded 25 percent regardless of forest age or disturbance type. We discerned no striking or consistent difference in dominant understory vegetation whether 100 or 500 years after the disturbance.

Tree composition (Fig. 6) is the most indicative state of the sere. Noble fir usually dominates the Silver fir/Foam flower habitat during the

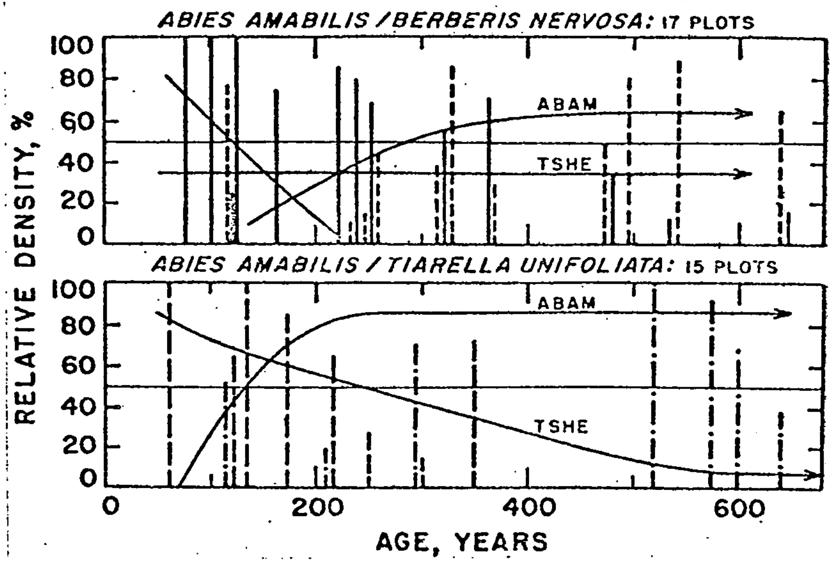

Figure 6. Tree chronosequences in two forest types. Canopy dominants are Douglas fir (solid bars), western hemlock (short dashes), noble fir (long dashes), and silver fir (dash-dot bars). Regeneration is silver fir (ABAM), western hemlock (TSHE), and Douglas fir (unlabelled curve).

Table 3. Comparison of dominant understory composition (computed as percentage similarities) between young and old-growth forests in two forest types.

Forest Type	Plot	Age (Years BP)	Geology[1]	Disturbance	Similarity[2] (%)
TSHE/OPHO	356	135	QA	New substrate	34, 18, 21
	45	146	QA	Fire	34, 44, 45
	127	>500	QA		18, 44, 42
	131	>500	QA		21, 45, 42
ABAM/OPHO	273	119	QO	Fire	21, 30, 39
	375	120	QG	New substrate	21, 57, 27
	263	660	TBR		30, 57, 30
	389	900	TBR		39, 27, 30

[1] QA = Quaternary alluvium, QO = Osceola mudflow, QG = Garda drift TBR = Tertiary volcanic rock.

[2] Each plot compared to others of the same forest type sequenced from top to bottom of column 2.

first several centuries after fire. (All plots of figure 6 were apparently fire initiated.) Alaska yellow cedar, western hemlock, Douglas fir, and silver fir may also be seral, however. But after 500 years silver fir is usually the leading and sometimes the exclusive dominant. By contrast western hemlock or Douglas fir are seral dominants after fire in the Western hemlock-Silver fir/Oregongrape type. The proportion of Douglas fir gradually declines, with replacement by the hemlock. Silver fir achieves very small share of the canopy dominance only in the oldest plot. Tree regeneration patterns differ in the two forest types. Western hemlock has continuous regeneration pressure throughout the time span of the Western hemlock-Silver fir/Oregongrape chronosequence, but decays to minor status in old growth of the Silver fir/Foamflower type. In both chronosequences silver fir is the eventual (after about 200 years) regeneration dominant.

We feel that the first few decades after disturbance is the period of greatest vegetation contrast between young and old stands. After about 100 years in mesic forest types of valleys, draws, or lower slopes the sere has assumed most of the attributes of climax. Successional trends seem slower, however, on drier or more exposed sites such as Backbone Ridge or upper elevations at Sunset Park where forest closure and stabilized understory composition may require centuries.

CURRENT STUDIES

We have summarized much of our present state-of-knowledge concerning forest ecosystems at MRNP. Our efforts are now directed to better resolving the mature forest types with computer help and mapping these and their seral derivatives from air photo information. More analysis of succession is needed in some of our hot, dry as well as high elevation forest types. We need better resolution of the frequency, extent, and nature of natural and man-caused forest disturbances at MRNP. These studies should help provide park managers some insights into ecological processes that have brought about in past centuries the complex forest mosaics existing at Mount Rainier today. Land use practices both within MRNP and outside the Park may or may not disrupt or modify certain of those processes. The ability to predict forest responses on both short and long term should give management necessary perspectives for the job of both utilizing and preserving the forest ecosystems.

LITERATURE CITED

Crandell, D.R. 1970. Postglacial lahars from Mount Rainier Volcano, Washington. Geol. Surv. Prof. Paper 677, iv, 75 p., map

_______. 1969. Surficial geology of Mount Rainier National Park, Washington. Geol. Surv. Bul. 1288, vi, 41 p., map

Cushman, Martha J. 1976. Vegetation composition as a predictor of major avalanche cycles, North Cascades, Washington. M.S. thesis, Univ. Washington, Seattle, vii, 99 p.

Dryness, C.T., J.F. Franklin, and W.H. Moir. 1974. A preliminary classification of forest communities in the central portion of the western Cascades in Oregon. US/IBP Coniferous For. Biome, Bul. 4, viii, 123 p., Univ. Washington-AR-10, Seattle.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Serv. Gen. Tech. Rep. PNW-8, viii, 417 p.

_______, W.H. Moir, G.W. Douglas, and C. Wiberg. 1971. Invasion of subalpine meadows by trees in the Cascade Range, Washington and Oregon. Arctic & Alpine Res. 3: 215-224.

_______, C.T. Dyrness, and W.H. Moir. 1970. A reconnaissance method for forest site classification. Shinrin Richi XII: 1-12.

_______ and R.G. Mitchell. 1967. Successional status of subalpine fir in the Cascade Range. USDA Forest Serv. Res. Paper PNW-46, 16 p.

Hobson, F.D. 1976. Classification system for the soils of Mount Rainier National Park. M.S. thesis, Wash. State Univ., Pullman, 79 p.

Mullineaux, D.R. 1974. Pumice and other pyroclastic deposits in Mount Rainier National Park, Washington. Geol. Surv. Bul. 1326, viii, 83 p.

Plummer, F.G. 1899. Mount Rainier Forest Reserve, Washington. Geol. Surv. 21st Rep. 1900[1901], Pt. 5: 81-143.

Shimwell, D.W. 1971. The description and classification of vegetation. Univ. Wash. Press, Seattle, xiv, 322 p.

Sigafoos, R.S. and E.L. Hendricks. 1972. Recent activity of glaciers of Mount Rainier, Washington. Geol. Surv. Prof. Paper 387-B, vi, 24 p., 6 maps.