SECOND ANNUAL REPORT TO NATIONAL PARK SERVICE ON STUDIES OF FOREST ECOSYSTEMS AT MOUNT RAINIER NATIONAL PARK

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by

Jerry F. Franklin
William H. Moir
Sarah Lewis
Miles Hemstrom

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INTRODUCTION

This project was initiated in the spring of 1975 to provide a basic description of the forest ecosystems at Mount Rainier National Park (MORA), classify and map them, and develop data (on past disturbances and trends) for prediction of successional trends. These data are to provide managers with key information on location and characteristics of existing forests and how (direction and rate) they are are changing.

Several subobjectives have been incorporated in the study, largely in response to needs expressed by MORA staff. These include development of basic data on soils, development and evaluation of criteria for selection of back country sites, selection and establishment of a series of permanent sample areas, and analysis of the effect of management of adjacent lands on MORA forests.

Substantial progress was made toward these objectives during the period of June 1976 through May 1977 and are briefly reported here. More extensive reports have been and will continue to be prepared in which results are fully presented (see section on Products). In addition three maps have been prepared: MORA Forests Potentially Affected by Accelerated Windthrow; Mark I Version of MORA Forest Age Class and Disturbance Map; and Forest Communities of Ohanapecosh Drainage. The latter two currently exist only as single copies.

Personnel involved during the second year in addition to the project leader, Jerry F. Franklin, have been William H. Moir, Miles Hemstrom, and Sarah G. Lewis. Dr. Moir was leader of the summer field crew as well as of t-e community analysis and classification effort. The classification of forest communities and key for their field identification are largely his products. Miles Hemstrom assisted during the field season and has subsequently analyzed disturbance data (e.g., fire history) and planned the detailed studies to be carried out in Year 3. Sarah Lewis assisted during the summer and has since led in mapping from aerial photographs and field data; the Mark I forest age and community maps are largely her effort. Dr. Jan Henderson (Utah State University), Dr. Henry Smith (Washington State University), and Mr. Donald Hobson (Washington State University) also contributed to the project.

FOREST ECOSYSTEM CLASSIFICATION

The classification of forest ecosystems at MORA was essentially completed during the second year of the project. During 1975 data on composition and structure of 242 forest stands, mostly old-growth,

had been collected from throughout the Park. These data were subjected to manual association analysis and a preliminary classification presented in last years annual report (Moir and Franklin 1976) and at the New Orleans Science Conference (Moir et al. 1976). In 1976 data were collected from 158 additional stands, mostly in younger forests. The complete data set (400 stands)was keypunched and (with substantial tedium) cleaned up prior to analysis. The data were then subjected to several computer analyses (similarity-ordination and principal component analysis procedures) as well as standard (manual) association analysis procedures.

Twenty-one forest ecosystem types are recognized in the classification (table 1) not counting the several phases of the widespread Pacific Silver Fir/Alaska Huckleberry (ABAM/VAAL) type. The elevational and geographic distribution of plots belonging to each type is shown in table 2. Sixteen of these can be charcterized as mature forest types and are named after the hypothetical climax dominants. Five of the ecosystem types are early successional forests: three Douglas-fir communities as well as one each dominated by Subalpine Fir and Red Alder.

A key for the field identification of these ecosystem types is included as Appendix I.

Complete descriptions of each type along with management interpretations will be provided in a monographic report of the forest types to be prepared in Year 3. Some environmental groupings are obvious (tables 1 and 2). For example, analyses show that the types on dry, wet, and high-elevation sites are closely related. Hence, the dry types, wet types, and high types groupings. The fourth major grouping consists mainly of the very widespread ABAM/VAAL type which occupies the modal or "average" site throughout MORA.

Several computerized catalogs and summaries are available including stand tables for each association (includes listing for individual stand assigned to a given association as well as averaged values using all stands.

DISTURBANCE ANALYSIS

We have felt from the initiation of the project that the key to a basic ecological inventory is a thorough understanding of the direction and rate of successional change. This gives the manager his ability to predict changes in the current resource to be expected as a consequence of human or natural events.

Table 1. Forest Ecosystems of Mount Rainier National Park.

Group	No.	Forest Ecosystem Type	Abbreviation
Model Types	1	*Abies amabilis/Vaccinium alaskaense* Pacific Silver Fir/Alaska Huckleberry *Vaccinium alaskaense* (VAAL) phase *Vaccinium parvifolium* (VAPA) phase *Rubus pedatus* (RUPE) phase *Chamaecyparis* (CHNDO) *nootkatensis* phase *Berberis nervosa* (BSNE) phase	ABAM/VAAL
	2	*Abies amabilis/Tiarella unifoliata* Pacific Silver Fir/Western Coolwort	ABAM/TIUN
	3	*Tsuga heterophylla/Gaultheria shallon* Western Hemlock/Salal	TSHE/GASH
	4	*Tsuga heterophylla-Abies amabilis/Gaultheria Shallon/Xerophyllum tenax* Western Hemlock-Pacific Silver Fir/Salal/Beargrass	TSHE-ABAM/GASH-XETE
Dry Types	5	*Tsuga heterophylla-Abies amabilis/Berberis nervosa* Western Hemlock-Pacific Silver Fir/Oregongrape	TSHE/ABAM/BEHE
	6	*Tsuga heterophylla/Achlys triphylla* Western Hemlock/Vanillaleaf	TSHE/ACTR
	7	*Pseudotsuga menziesii/Arctostaphylos uva-ursi* Douglas-fir/Bearberry	PSME/ARUV
	8	*Pseudotsuga menziesii/Xerophyllum tenax* Douglas-fir/Beargrass	PSME/XETE
	9	*Pseudotsuga menziesii/Viola sempervirens* Douglas-fir/Evergreen Violet	PSME/VISE
	10	*Tsuga heterophylla/Polystichum munitum* Western Hemlock/Swordfern	TSHE/POMU
Wet Types	11	*Tsuga heterophylla/Oplopanax horridum* Western Hemlock/Devilsclub	TSHE/OPHO
	12	*Abies amabilis/Oplopanax horridum* Pacific Silver Fir/Devilsclub	ABAM/OPHO
	13	*Abies amabilis-Tsuga heterophylla/Polystichum munitum* Pacific Silver Fir-Western Hemlock/Swordfern	ABAM-TSHE/POMU
	14	*Alnus rubra/Rubus spectabilis* Red Alder/Salmonberry	ALRU/RUSP

Table 1. (cont.)

Group	No.	Forest Ecosystem Type	Abbreviation
High Types	15	Abies amabilis/Menziesia ferruginea Pacific Silver Fir/Rusty	ABAM/MEFE
	16	Chamaecyparis nootkatensis/Vaccinium ovalifolium Rubus pedalus Alaska-Cedar/Ovalleaf Huckleberry/Strawberry-leaf Blackberry	CHNO/VAOV/RUPE
	17	Abies amabilis/Rhododendron albiflorum Pacific Silver Fir/Cascades Azalea	ABAM/RHAL
	18	Abies amabilis/Vaccinium membranaceum/Erythronium montanum Pacific Silver Fir/Big Huckleberry/Avalanche Fawnlily	ABAM/VAME/ERMO
	19	Abies amabilis/Vaccinium membranaceum/Rubus lasiococcus Pacific Silver Fir/Big Huckleberry/Dwarf Blackberry	ABAM/VAME/RULA
	20	Abies lasiocarpa/Vaccinium membranaceum/Rubus lasiococcus Subalpine Fir/Big Huckleberry/Dwarf Blackberry	ABLA/VAME/RULA
	21	Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax Pacific Silver Fir/Big Huckleberry/Beargrass	ABAM/VAME/XETE

Table 2. Elevation and Geographic Distribution of Sample Plots for Forest Ecosystem Types at Mount Rainier National Park

Ecosystem Type	Elevational Range (m)	Number of Plots 1/ OH	WH	CA	PU	NI	TOTAL
ABAM/VAAL (all)	(630-1390)	(22)	(17)	(15)	(7)	(11)	(72)
VAAL phase	670-1350	11	7	1	2	8	29
VAPA phase	630-1180	6	2	3	-	1	12
RUPE phase	850-1390	1	2	9	3	-	15
CHNDOphase	940-1260	2	-	1	1	1	5
BENE phase	940-1060	1	3	-	-	-	4
Other	940-1170	1	3	1	1	1	7
ABAM/TIUN	840-1490	10	3	4	1	2	20
TSHE/GASH	560-1010	10	-	2	-	3	15
TSHE/ABAM/GASH/XETE	1010-1310	-	-	5	4	5	14
TSHE-ABAM/BENE	780-1430	10	15	2	1	1	29
TSHE/ACTR	560-700	6	-	-	-	-	6
PSME/ARUV	870-1070	5	-	-	-	-	5
PSME/XETE	880-1370	4	2	-	-	1	7
PSME/VISE	730-1080	12	-	-	-	-	12
TSHE/POMU	520-1110	-	1	6	1	2	10
TSHE/OPHO	480-980	3	4	7	-	9	23
ABAM/OPHO (all)	(660-1470)	(11)	(8)	(11)	(1)	(4)	(35)
Valleys and benches	660-1190	4	5	10	-	3	22
Slopes	820-1470	7	3	1	1	1	13
ABAM-TSHE/POMU	680-1110	-	-	6	-	-	6
ALRU/RUSP	760-810	2	-	-	-	1	3
ABAM/MEFE	1090-1490	6	7	3	1	2	19
CHNO/NAOV/RUPE	1220-1490	5	2	6	1	1	15
ABAM/RHAL	1220-1630	5	4	6	-	3	18
ABAM/VAME/ERMO	1340-1660	5	-	4	2	6	17
ABAM/VAME/RULA	1310-1760	3	9	-	-	-	12
ABLA/VAME/RULA	1470-1720	3	8	-	-	-	11
ABAM/VAME/XETE	1150-1630	3	2	6	-	8	19
TOTALS		125	82	83	19	59	368

1/ OH = Ohannapecosh and Cowlitz River drainages, WH = White River drainage, CA = Carbon and Mowich River drainages, PU = Payallup River drainage, and NI = Nisqually River and Butter Creek drainages.

Our initialinvestigation of successional dynamics is an analysis of forest disturbances during the past thousand years. Specifically we are documenting frequency, intensity, and extent of forest destruction by fire, avalanche, and mudflow--the major catastrophic agents at Mount Rainier. Pre- and post-settlement fire histories are of special interest. During the second year over 400 living trees were aged throughout MORA.

Forest ages indicate major differences in fire history in the various drainages (fig. 1). The bulk of the Cowlitz River drainage burned about 75 years ago although smaller areas of forest 175, 650±, and 1000 years old are also present. In the Ohanapecosh River drainage peaks in ages suggest major disturbances around 260, 650 to 750, and 1000 years ago. White River drainage shows a whole series of disturbances between 75 and 250 years ago as well as peaks in tree ages at 475 and 775 years.

It is notable that trees and forests 1000 years or more in age are found in all drainages. Some 1000-year-old+ specimens of Douglas-fir are found in Cougar Rock campground.

Also discovered during year 2 of our studies was the fact that some of the forests at MORA which appear to be the result of wildfire may, in fact, be first generation forests on mudflows despite their normal appearance.

MAPPING

Color infra-red photographs were taken of the Ohanapecosh River drainage during 1976 by the Oregon Air National Guard at our request. These photographs are in the form of 5" square transparencies with the scale of around 1:24,000.

These transparencies and USGS black and white photographs were combined with ground truth to produce our first versions (Mark I) of a forest age class and disturbance map of MORA and a more detailed forest ecosystem map of Ohanapecosh drainage. We were disappointed by the amount of information on forest age classes that could be gathered off of the photographs (both type). Consequently only one copy of each map was produced. We feel that extensive on-the-ground data is critical to accurate mapping and will concentrate on obtaining much more of it in Year 3; good photography helps but cannot substitute for gound traverses, especially in heavily timbered country.

A map showing boundary areas of MORA potentially subject to accelerated windthrow is included in the report by Franklin (1977).

OTHER ACTIVITIES

During Year 2 of our studies we carried out a variety of other activities. The first set of permanent plots was established by an Experiment Station crew (visually-obvious) young noble fir stand on Sunrise Ridge. This consisted of five 1000 m^2 circular plots systematically located within the stand. An establishment report with full information on the initial conditions in these plots has been provided the Park and should be securely filed. A second copy is being kept in the Forestry Sciences Laboratory in Corvallis. The design of these plots is different than the design that will normally be used in "reference stands"; the reference stands will typically be single hectare (1000 x 1000 m) plots but since productivity and changes in forest structure and composition was of special interest in the young noble fir stand the series of circular plots was used.

Project personnel collaborated with Stan Schlegel and other MORA staff in developing and testing a system for rating potential back-country campsites (Moir, Lewis, and Hobson 1977).

Project personnel visited all of the Wiesbrod small mammal study sites, sampled them, and identified their "type" according to the forest ecosystem classification.

Franklin (1977) identified windthrow problem areas along the boundaries of MORA.

PLANS FOR YEAR 3

Our minimal objectives of the forest ecosystem studies at Mount Rainier for June 1, 1977 to May 31, 1979 are in the contract. We will try to confine this brief discussion to our expectations during Year 3.

Now that the classification is essentially complete our objective is to get it into formal publication form. We intend to prepare two manuscripts. The first will be a technical report possible for publication in the National Park Service Science Monograph series. The second will be popularized lay-level booklet on the forests of MORA. This is as requested by Superintendent Tobin which was based on Moir's narrative description of the forests included in the first year report.

The disturbance or successional analysis of MORA will go ahead on several fronts. First of all, substantial work will be done on identifying boundaries of different fires and/or forest age classes. Although many data on ages were collected during Year 2 of the study these were not always effectively related to the area of an age class and/or the dominant age class present

(in multi-aged stands). Also, the photographs failed to be of much assistance in differentiating various age-classes of old-growth. Therefore, substantial effort will go into ground mapping and additional aging.

Ms. Martha Cushman, a Ph.D student at University of Washington, will begin her studies of avalanche communities in Butter Creek. Although not officially part of this project we will assist Ms. Cushman as much as possible since her work will contribute to our overall goals.

The work on aging and five boundaries is obviously going to contribute significantly to progress in mapping the forest ecosystems of the Park. Our objective is to prepare a map of the forested portion of the Park showing both habitat types and existing vegetation during the next two years. Ground examinations will be the most important part of this work but, fortunately, will serve both the disturbance analysis and mapping effort.

During Year 3 the first permanent sample plots/reference stands will be established. The two-year objective is 20 of these representing each of the major ecosystem types. Thermographs will be installed in several of these to provide data on soil and air temperature.

A plan for rehabilitation of a portion of the Ohanapecosh Campground will be developed during 1977. This will include a map, tabulations of required materials, and report on desired methods for handling and caring for transplanted materials. Objectives will be to develop a plan which will: (1) provide for regeneration of the forest trees; (2) provide screening between campsites; (3) be functional; and (4) be attractive. Extensive use of rotten logs as seedbeds, travel barrers, transplant protectors, and sources of soil organic material is anticipated. This project was developed specifically at the request of MORA staff.

A soil/geological monolith will be collected from the well-known Williwakas Creek site for use by MORA in the interpretive program.

PRODUCTS

Franklin, Jerry F.
1977. Windthrow problem areas in peripheral forests at Mount Rainier National Park. Typewritten report, 6 p. + maps.

Hobson, Frank D.
1976. Classification system for the soils of Mount Rainier National Park. 47 p., illus. M.S. thesis, Washington State Univ., Pullman, WA.

Moir, W. H., F. D. Hobson, M. Hemstrom, and J. F. Franklin.
1977. Forest ecosystems of Mount Rainier National Park. (20 p.) Submitted for publication in Proc. First Conf. on Sci. Res. in the National Parks.

Moir, W. H., Sarah Lewis, and F. D. Hobson.
(1977) Evaluation of some backcountry campsites, Mount Rainier National Park. Typewritten report, 12 p.

Moir, William, and Jerry F. Franklin.
1976. First year report to National Park Service on studies of forest ecosystems at Mount Rainier National Park. Typewritten report, 33 p. + map.

APPENDIX

KEY TO COMMON FOREST TYPES OF MOUNT RAINIER NATIONAL PARK

(Using Abbreviated Scientific Names)

1. Forests of upland rolling slopes or flats, above 1100 m (3600 ft) elevation, usually just below the subalpine parkland zone. Characteristic trees are ABAM, ABLA, TSME, CHNO, occasionally ABPR or TSHE. PSME absent or rare. OPHO absent or rare. ...A

1. Forests of lower elevations on various sites. Common dominant or codominant trees include TSHE, PSME, THPL, ABAM, CHNO, ABPR. ...2

2. Forests of valleys, toeslopes, or wet sideslopes and benches. OPHO and/or ferns (POMU, BLSP, GYDR, ATFI) common. ...B

2. Forests of dry or mesic (but not wet) sideslopes, ridges, or benches. OPHO absent or rare. ...3

3. Forests of dry slopes and exposures. Dominant trees are PSME, TSHE, THPL, sometimes PIMO. ...C

3. Forests of mesic slopes and benches. Dominant trees are PSME, TSHE, ABAM, ABPR, sometimes CHNO. ...D

A. HIGH ELEVATION FORESTS (Tsuga mertensiana Zone)

1. Understory strongly herbaceous with TIUM, RUPE, STRO, ACTR, and other species, but not XETE or ERMO; shrubs minor, or if conspicuous, then mainly VAOV or VAAL. ...3

1. Understory either not strongly herbaceous (except possibly with XETE or ERMO), or else conspicuously shrubby. ...2

2. ERMO ≥ 5 percent cover. ...6

2. ERMO absent or < 2 percent cover. ...10

3. Shrub cover considerably less than the rather profuse herbaceous cover. ABAM/TIUN

3. Shrubs (especially VAOV or VAAL) as abundant as herbs. ...4

4. CHNO rather minor or absent in overstory. ABAM/VAAL, RUPE

4. CHNO often codominant in overstory. ...5

5. VAAL minor at best; RUPE and TIUN conspicuous. CHNO/VAOV/RUPE

5. VAAL common. ABAM/VAAL, CHNO

6. CHNO common; several shrub species codominant. ...7

6. CHNO minor or infrequent; VAME clearly the leading shrub. ...9

7. VAOV cover > MEFE; RHAL <5 percent. CHNO/VAOV/RUPE

7. MEFE cover >VAOV, or RHAL ≥ 5 percent. ...8

8. RHAL ≥ MEFE. ABAM/RHAL

8. MEFE > RHAL. ABAM/MEFE

9. ABLA common; RULA cover > ERMO cover. ABLA/VAME/RULA

9. ABLA infrequent or absent; ERMO usually exceeds RULA cover. ABAM/VAME/ERMO

10. VAME the leading shrub, other shrub species minor. ...11

10. Several species of shrubs common. ...8

11. XETE common and RULA < 10 percent cover. ABAM/VAME/XETE

11. XETE at best minor, or RULA > 10 percent cover. ...12

12. ABLA dominant or codominant. ABLA/VAME/RULA

12. ABLA minor or absent. ABAM/VAME/RULA

B. FORESTS OF WET SITES

1. ABAM regeneration minor or absent, considerably less than other tree species. ...2
1. ABAM regeneration light to heavy, more abundant than any other tree species (except sometimes TSHE). ...6

2. ALRU with 20% or more of dominant canopy cover. ALRU/RUSP
2. ALRU absent or less than 20% overstory canopy. ...3

3. OPHO with at least 1% cover (sometimes reduced by browsing but then GYDR conspicuous); PISI, when present, is diagnostic. TSHE/OPHO
3. OPHO absent or only trace cover; never PISI. ...4

4. Ferns (especially POMU or BLSP) dominant in the herb layer. ...5
4. Angiosperms (especially ACTR and VISE) dominant. TSHE/ACTR

5. BLSP minor. TSHE/POMU
5. BLSP common; Carbon and Mowich drainages. TSHE-ABAM/POMU

6. Understory excluding ACCI and TABR dominated mostly by herbs. ...7
6. Understory excluding ACCI and TABR either very shrubby or the shrubs and herbs have about equal coverage. ...8

7. BLSP $\geq$ POMU cover; Carbon and Mowich drainages. TSHE-ABAM/POMU
7. BLSP $<$ POMU, or both absent or minor. ABAM/TIUN

8. Herb assemblage diverse and profuse, more coverage than provided by shrubs. Dominants may include GYDR, TIUN, ACTR, RUPE, STRO, COSC, or other species. ...9
8. Herb assemblage less profuse and usually with less (or about equal) cover than shrubs. Common herbs include LIBO, CLUN, ACTR, RUPE, RULA, COCA, or others; OPHO absent. ...10

9. OPHO present; CHNO present or absent. ABAM/OPHO
9. OPHO usually absent; CHNO abundant. CHNO/VAOV/RUPE

10. VAAL cover > VAOV. ...11
10. VAOV > VAAL. Riparian (usually) variants of ABAM/VAAL

11. VAPA absent or minor; herb cover usually exceeding 20% with dominant species including RUPE, CLUN, STRO, and TIUN (TITR). ...13
11. VAPA absent to subdominant; total herb cover < 20%. ...12

12. VAOV absent or minor, VAPA cover up to 20% and BENE usually with 1% cover or more. ABAM/VAAL, VAPA or BENE phases
12. VAOV cover various; VAPA usually < 5% cover and BENE minor or absent (sometimes to 3% cover). ABAM/VAAL, typical

13. CHNO common or abundant. ABAM/VAAL, CHNO phase
13. CHNO infrequent. ABAM/VAAL, RUPE phase

C. FORESTS OR HOT, DRY SLOPES AND EXPSOURES, LOW- TO MID-ELEVATIONS.

1. Seral forests under 250 years age, with some PSME regeneration and canopies dominated mostly by PSME poles. PTAQ common in understory. ...2

1. Forests older than 250 years or, if younger, then PSME regeneration uncommon or absent. PTAQ usually uncommon or absent. ...4

2. Ceanothus velutinus present; Ohanapecosh drainge. PSME/ARUV
2. Ceanothus velutinus present. ...3

3. XETE < 10% cover; VISE ≥ 1% cover. PSME/VISE-LIBO
3. XETE > 10% cover; VISE ≤ 1% cover. PSME/XETE

4. ABAM regeneration absent or minor. ...5
4. ABAM regeneration common, or if uncommon, at least as abundant as other tree species. ...8

5. GASH absent or minor. ...6
5. GASH dominant or codominant. ...7

6. Forests strongly herbaceous with ACTR, COCA, VISE, but BENE ≤ 5% and CHUM < 1%. TSHE/ACTR

6. Forests with BENE and/or CHUM (and sometimes LIBO) the leading dominants of the herbaceous layer. TSHE-ABAM/BENE

7. XETE ≤ 3%; intergrades with the next. TSHE/GASH
7. XETE usually > 3%; higher elevations than the proceeding. TSHE-ABAM/GASH-XETE

8. GASH common. TSHE-ABAM/GASH/XETE
8. GASH absent or rare. ...9

9. VAAL < 2% cover; VAME < 2% cover. TSHE-ABAM/BENE
9. VAAL or VAME with more than 2% cover. ...10

10. VAPA absent or rare; XETE common. ABAM/VAME/XETE
10. VAPA common (often more than 2% cover); XETE absent or less than about 2% cover. ABAM/VAAL, VAPA phase

D. FORESTS OF MESIC SLOPES AND BENCHES, WITHOUT OPHO

1.	ABAM regeneration absent or rare.	...2
1.	ABAM regeneration common and abundant.	...4
2.	At least 30% of the overstory contains ABPR.	ABAM/TIUM
2.	Less than 30% of the overstory contains ABPR.	...3
3.	PTAQ usually over about 2% cover, young PSME (<2dm dbh) common to occasional.	PSME/VISE-LIBO
3.	PTAQ < 2% cover; young PSME absent or rare.	TSHE/ACTR
4.	Species of Vaccinium abundant. ABAM/VAAL and phases.	...5
4.	Species of Vaccinium infrequent; herb dominated forests.	ABAM/TIUN

5. The following phases of ABAM/VAAL can be recognized:

5a.	VAPA common; no CHNO.	VAPA phase
5b.	BENE >7-8% cover; no CHNO.	BENE phase
5c.	CHNO common.	CHNO phase
5d.	CHNO present or absent; very strong herbaceous codominance (RUPE, STRO, TIUN, etc.).	RUPE phase
5e.	VAOV abundant.	VAOV phase (usually riparian)
5f.	Not clearly any of the above.	VAAL phase

KEY TO COMMON FOREST TYPES OF MOUNT RAINIER NATIONAL PARK

(Using Common Names)

1. Forests of upland rolling slopes or flats, above 1100 m (3600 ft) elevation, usually just below the subalpine parkland zone. Characteristic trees are Pacific silver fir, subalpine fir, mountain hemlock, Alaska-cedar, occasionally noble fir or western hemlock. Douglas-fir and devilsclub absent or rare. ...A

1. Forests of lower elevations on various sites. Common dominant or codominant trees include western hemlock, Douglas-fir, western redcedar, Pacific silver fir, Alaska-cedar, and noble fir. ...2

2. Forests of valleys, toeslopes or wet sideslopes and benches. Devilsclub and/or ferns (swordfern, deerfern, oakfern, ladyfern) common. ...B

2. Forests of dry or mesic (but not wet) sideslopes, ridges, or benches. Devilsclub absent or rare. ...3

3. Forests of dry slopes and exposures. Dominant trees are Douglas-fir, western hemlock, western redcedar, sometimes western white pine. ...C

3. Forests of mesic slopes and benches. Dominant trees are Douglas-fir, western hemlock, Pacific silver fir, noble fir, sometimes Alaska-cedar. ...D

A. HIGH ELEVATION FORESTS (MOUNTAIN HEMLOCK ZONE)

1. Understory strongly herbaceous with western coolwort, strawberry-leaf blackberry, purple twistedstalk, vanillaleaf, and other species but not beargrass or avalanche fawnlily. Shrubs comparatively minor or if conspicuous, then dominated by ovalleaf or Alaska huckleberry. ...3

1. Understory either not strongly herbaceous (except possibly with beargrass or avalanche fawnlily), or else conspicuously shrubby. ...2

2. Avalanche fawnlily ≥5% cover. ...6

2. Avalanche fawnlily absent or under 2% cover. ...10

3. Shrub cover considerably less than the rather profuse herbaceous cover. Pacific Silver Fir/ Western Coolwort

3. Shrubs (especially ovalleaf or Alaska huckleberry) codominant with herbs. ...4

4. Alaska-cedar rather minor or absent in canopy stratum. Strawberry-Leaf Blackberry (RUPE) phase, Pacific Silver Fir/Alaska Huckleberry

4. Alaska-cedar often codominant in canopy stratum. ...5

5. Alaska huckleberry minor or absent, strawberry-leaf blackberry and western coolwort conspicuous. Alaska-Cedar/Ovalleaf Huckleberry/Strawberry-Leaf Blackberry

5. Alaska huckleberry common. Alaska-Cedar (CHNO) phase Pacific Silver Fir/Alaska Huckleberry

6. Alaska-cedar common; several shrub species codominant. ...7

6. Alaska-cedar minor or infrequent; big huckleberry leading shrub. ...9

7. Ovalleaf huckleberry cover greater than that of rustyleaf; Cascades azalea <5% cover. Alaska-Cedar/Ovalleaf Huckleberry/Strawberry-Leaf Blackberry

7. Rustyleaf cover greater than ovalleaf huckleberry, or Cascades azalea ≥5% cover. ...8

A. HIGH ELEVATION FORESTS (Cont.)

8. Cascades azalea cover ≥ rustyleaf cover. — Pacific Silver Fir/ Cascades Azalea

8. Cascades azalea cover < rustyleaf cover. — Pacific Silver Fir/ Rustyleaf

9. Subalpine fir common; dwarf huckleberry cover >avalanche fawnlily cover. — Subalpine Fir/Big Huckleberry Dwarf Blackberry

9. Subalpine fir infrequent or absent; Avalanche fawnlily cover usually >dwarf blackberry cover. — Pacific Silver Fir/Big Huckleberry Avalanche Fawnlily

10. Big huckleberry the leading shrub, other shrub species minor. — ...11

10. Several species of shrub common. — ...8

11. Beargrass common and dwarf blackberry <10% cover . — Pacific Silver Fir/ Big Huckleberry/Beargrass

11. Beargrass minor or absent, or dwarf blackberry cover >10%. — ...12

12. Subalpine fir dominant or codominant. — Subalpine Fir/ Big Huckleberry/Dwarf Blackberry

12. Subalpine fir minor or absent. — Pacific Silver Fir/ Big Huckleberry/Dwarf Blackberry

B. FORESTS OF WET SITES

1. Pacific silver fir regeneration minor or absent, considerably less than other tree species. ...2

1. Pacific silver fir regeneration light to heavy, more abundant than any other tree species (except, occasionally, western hemlock). ...6

2. Red alder with 20% or more of the dominant canopy cover. Red Alder/Salmonberry

2. Red alder absent or <20% of dominant canopy cover. ...3

3. Devilsclub with at least 1% cover (sometimes reduced by elk browsing but then oakfern conspicuous); Sitka spruce is diagnostic if present. Western Hemlock/ Devilsclub

3. Devilsclub absent or only trace cover; Sitka spruce never present. ...4

4. Ferns (especially swordfern or deerfern) dominant in shrub layer. ...5

4. Angiosperms (such as vanillaleaf and evergreen violet), not ferns, dominant in herb layer. Western Hemlock/ Vanillaleaf

5. Deerfern minor. Western Hemlock/Swordfern

5. Deerfern common; Carbon and Mowich drainages. Western Hemlock-Pacific Silver Fir/ Swordfern

6. Understory, excluding vine maple and western yew, dominanted mostly by herbs. ...7

6. Understory, excluding vine maple and western yew, either very shrubby or with shrubs and herbs of about equal coverage. ...8

7. Deerfern ≥Swordfern cover; Carbon and Mowich drainages. Western Hemlock-Pacific Silver Fir/ Swordfern

7. Deerfern <Swordfern, or both absent or minor. Pacific Silver Fir/Western Coolwort

B. FORESTS OF WET SITES (cont.)

8. Herb assemblage diverse and profuse, more coverage of herbs than shrubs; dominants may include oakfern, western coolwort, vanillaleaf, strawberry-leaf blackberry, purple twistedstalk and dutchman's breeches. ...9

8. Herb assemblage less profuse and usually herb cover less than or equal to shrub cover; common herbs include twinflower, bunchberry dogwood, queencup beadlily, vanillaleaf, strawberry-leaf blackberry, and dwarf blackberry; devilsclub absent. ...10

9. Devilsclub present; Alaska-cedar present or absent. Pacific Silver Fir/Devilsclub

9. Devilsclub usually absent; Alaska-cedar abundant. Alaska-Cedar/Ovalleaf Huckleberry/Strawberry-Leaf Blackberry

10. Alaska huckleberry cover exceeds ovalleaf huckleberry cover. ...11

10. Ovalleaf huckleberry cover exceeds Alaska huckleberry cover. Riparian variants of Pacific Silver Fir/Alaska Huckleberry

11. Red huckleberry absent or minor; herb cover usually >20% with dominant species including strawberry-leaf blackberry, queencup beadlily, purple twistedstalk, and coolworts. ...13

11. Red huckleberry absent to subdominant; total herb cover <20%. ...12

12. Ovalleaf huckleberry absent or minor; red huckleberry cover up to 20% and Oregongrape usually with 1% cover or more. Pacific Silver Fir/Alaska Huckleberry, Red Huckleberry or Oregongrape phases

12. Ovalleaf huckleberry cover various; red huckleberry usually <5% cover and Oregongrape minor or absent. Pacific Silver Fir/Alaska Huckleberry, typical phase

13. Alaska-cedar common or abundant. Pacific Silver Fir/Alaska Huckleberry/Alaska-Cedar phase

13. Alaska-cedar infrequent. Pacific Silver Fir/Alaska Huckleberry, Strawberry-Leaf Blackberry phase

C. FORESTS OF HOT, DRY SLOPES AND EXPOSURES, LOW- TO MID-ELEVATIONS

1. Seral forests under 250 years age, with some Douglas-fir regeneration and canopies dominated mostly by Douglas-fir poles; bracken fern common in understory. ...2
1. Forests older than 250 years or, if younger, then Douglas-fir uncommon or absent; bracken fern usually uncommon or absent. ...4

2. Snowbrush present; Ohanapecosh drainage. Douglas-Fir/Bearberry
2. Snowbrush absent. ...3

3. Beargrass <10% cover; evergreen violet ≥1% cover. Douglas-Fir/Evergreen Violet-Twinflower
3. Beargrass >10% cover; evergreen violet ≤1% cover. Douglas-Fir/Beargrass

4. Pacific silver fir regeneration absent or minor. ...5
4. Pacific silver fir regeneration common or at least as abundant as regeneration of other tree species. ...8

5. Salal absent or minor. ...6
5. Salal dominant or codminant. ...7

6. Forests strongly herbaceous with vanillaleaf, bunchberry dogwood, and evergreen violet, but Oregongrape ≤5% and prince's pine <1%. Western Hemlock/Vanillaleaf
6. Forests with Oregongrape and/or prince's pine (and sometimes twinflower) the leading dominants of the herbaceous layer. Western Hemlock-Pacific Silver Fir/Oregongrape

7. Beargrass ≤3%; intergrades with the next. Western Hemlock/Salal
7. Beargrass usually >3%; higher elevations than preceeding. Western Hemlock-Pacific Silver Fir/Salal/Beargrass

C. FORESTS OF HOT, DRY SLOPES AND EXPOSURES (Cont.)

8.	Salal common.	Western Hemlock-Pacific Silver Fir/Salal/Beargrass
8.	Salal absent or rare.	...9
9.	Both Alaska and big huckleberry <2% cover.	Western Hemlock-Pacific Silver Fir/Oregongrape
9.	Alaska or big huckleberry both >2% cover.	...10
10.	Red huckleberry absent or rare; beargrass common.	Pacific Silver Fir/Big Huckleberry/Beargrass
10.	Red huckleberry common (often >2% cover); beargrass absent or <2% cover.	Pacific Silver Fir/ Alaska Huckleberry, Red Huckleberry phase

D. FORESTS OF MESIC SLOPES AND BENCHES, WITHOUT DEVILSCLUB

1. Pacific silver fir regeneration absent or rare. ...2
1. Pacific silver fir regeneration common to abundant. ...4

2. Noble fir 30% of overstory. Pacific Silver Fir/Western Coolwort
2. Noble fir <30% of overstory. ...3

3. Bracken fern usually >2% cover; young Douglas-fir (<8 inches in diameter) common to occasional. Douglas-fir/Evergreen Violet-Twinflower
3. Bracken fern <2% cover; young Douglas-fir absent or rare. Western Hemlock/Vanillaleaf

4. Species of huckleberry abundant; Pacific silver fir/Alaska huckleberry and phases. ...5
4. Species of huckleberry infrequent; herb dominanted forests. Pacific Silver Fir/Western Coolwort

5. The following phases of Pacific Silver Fir/Alaska Huckleberry can be recognized:

   5a. Red huckleberry common; no Alaska-cedar — Red Huckleberry phase

   5b. Oregongrape >7-8% cover; no Alaska-cedar — Oregongrape phase

   5c. Alaska-cedar common — Alaska-Cedar phase

   5d. Alaska-cedar present or absent; very strong herbaceous codominance (Strawberry-leaf blackberry, twistedstalk, coolwort, etc.) — Strawberry-Leaf Blackberry phase

   5e. Ovalleaf huckleberry abundant. — Ovalleaf Huckleberry phase

   5f. Not clearly any of above. — Typical