Glenn M. Hawk

Department of Forest Science
Oregon State University
Corvallis, Oregon 97331

Vegetation Mapping and Community Description of a Small Western Cascade Watershed

Abstract

Watershed 10 is a 10.24 ha watershed previously used as an intensive study site by the Oregon Coniferous Forest Biome project of the US/IBP (International Biological Program). Through the use of an established trail and grid system as well as a stem map of all trees greater than 15 cm dbh, 414 individual map units of plant communities were delimited. These were grouped into seven plant communities and four habitat types. I map and describe structural vegetation characteristics of these communities for the entire watershed.

Introduction

Comprehensive studies of ecosystem processes, such as nutrient and carbon flow and cycling, require thorough basic biological and physical descriptions of the system. The need for the basic surveys or descriptions to provide "state variable" data essential to ecosystem modeling efforts is often unappreciated. Even less understood is the potential use of vegetation or plant communities as a basis of stratifying a study area into environmentally and biologically homogeneous "compartments." Such compartments or subareas can be particularly useful when dealing with a diverse tract such as a mountain watershed. Various processes, such as transpiration or photosynthesis, can be simulated separately for each compartment, eliminating the less desirable approach of developing a single average value for an entire, often highly diverse, watershed.

The basic approach used in describing the plant communities and habitat types of Watershed 10 (WS-10) and the resulting descriptions are the subjects of this paper. Watershed 10 was an intensive study site for the Coniferous Forest Biome project of the US/IBP and is the present site for post-logging perturbation studies. The basic vegetation survey was an essential element in determination of standing crops and in indentifying environmentally homogeneous areas within this diverse watershed.

There are several purposes to this paper: first, to document the approach for others faced with similar tasks; second, to provide a historical record of the original vegetation of this watershed which had been clearcut in 1975 as part of further studies; third, to provide quantitative characterization of the composition and structure of an extensive area of old-growth Douglas-fir (*Pseudotsuga menziesii*) forest; and finally, to alert interested scientists to the availability of an accurate stem map of a large, continuous forest area together with the associated stem data set.

Study Area

Watershed 10 is a 10.24 ha watershed located adjacent to the southwestern tip of the H. J. Andrews Experimental Forest (Fig. 1). Elevations range from 430 m to 670 m. Slopes average about 45 percent, but often exceed 100 percent. Soils are classified as

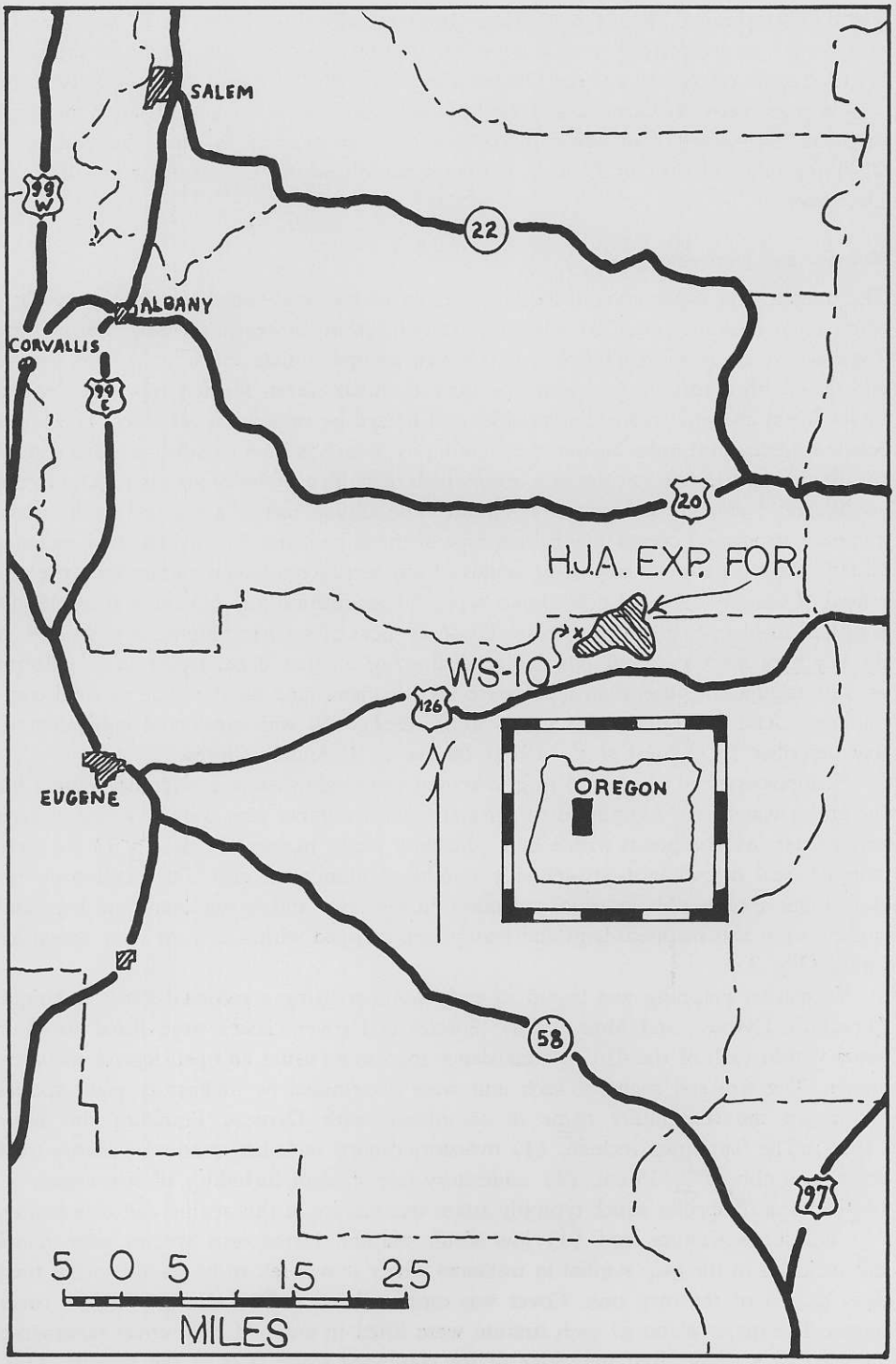

Figure 1. Location of Watershed 10, H. J. Andrews Experimental Forest, central western Cascades of Oregon (Numbers=highway number of highways generally parallel to major rivers).

Typic Dystrochrepts. They typically range from gravelly silty clay loams to very gravelly clay loams, and are derived from volcanic tuff and breccia colluvium parent materials.

Climate is typical of western Oregon Cascades with 2300 mm annual precipitation (75 percent between October and March) and common snow accumulation of short duration. Two years of on-site climatic data show an average daytime temperature of 21°C for July and 0°C for January. Extremes range from 41°C in August to -20° C in December.

Methods and Terminology

Throughout this paper several classification terms are used which need to have their origins and meanings clarified. The classification system presently in use is the Habitat Type system. It is an ecological system which groups similar forest plots into natural and reasonably consistent homogeneous units of climax forest. Habitat types are defined by landform and environmental variables and named by vegetation variables. The lower echelon hierarchical units include the community, which is used as either a general term for discussing different entities or a term which includes a group of stands which are not yet advanced enough to consider as climax. The climax forests are called associations, and each association occurs on a habitat type of the same name. The habitat type includes all land areas capable of supporting stands of any seral stage which demonstrate the potential of developing to a single climax type. A classification key (Dyrness *et al.*, 1974) was used to identify all map units in this study. Several seral communities identified in the key have more than one possible seral direction so that slope, aspect, and landform as well as adjacent vegetation types were used to determine habitat type of seral communities. Seral development of stands in Watershed 10 was considered equivalent to that described by Dyrness *et al.* (1974) for the H. J. Andrews forest.

A slope-corrected 25 m x 25 m grid system was established as a reference system for the entire watershed. Aluminum corner stakes with number tags were installed at each grid corner. All tree stems with a dbh (diameter breast high=1.37 m) $\geq$ 15 cm were mapped, and tagged with sequentially numbered aluminum tags. Data collection included tree species, dbh, location, and notes on the vigor and crown condition. Logs and stumps were also mapped. Logs and stumps are mapped within 2 m of their actual location (Fig. 2).

Vegetation mapping was begun in early summer using a reconnaissance technique (Franklin, Dyrness, and Moir, 1970). Species and cover classes were listed for four strata within each of the 414 reconnaissance map units using an open legend mapping system. The size and shape of each unit were determined by understory plant species and given the community name in accordance with Dyrness, Franklin, and Moir (1974). The four strata include: (1) overstory canopy including mature overstory trees down to a dbh of $\geq$ 15 cm, (2) understory tree stratum including all size classes $<$ 14.9 cm dbh of species which typically attain tree stature in this region and community, (3) tall shrub stratum, and (4) low shrub stratum. Herbaceous species were noted and included in the map symbol in instances where it was felt to be an aid to the final classification of the map unit. Cover was estimated using Daubenmire (1959) cover classes. The major plants of each stratum were listed in order of their cover dominance followed by a single digit indicative of the combined cover class of the stratum. Individual map units were identified and drawn on slope-corrected field maps through the

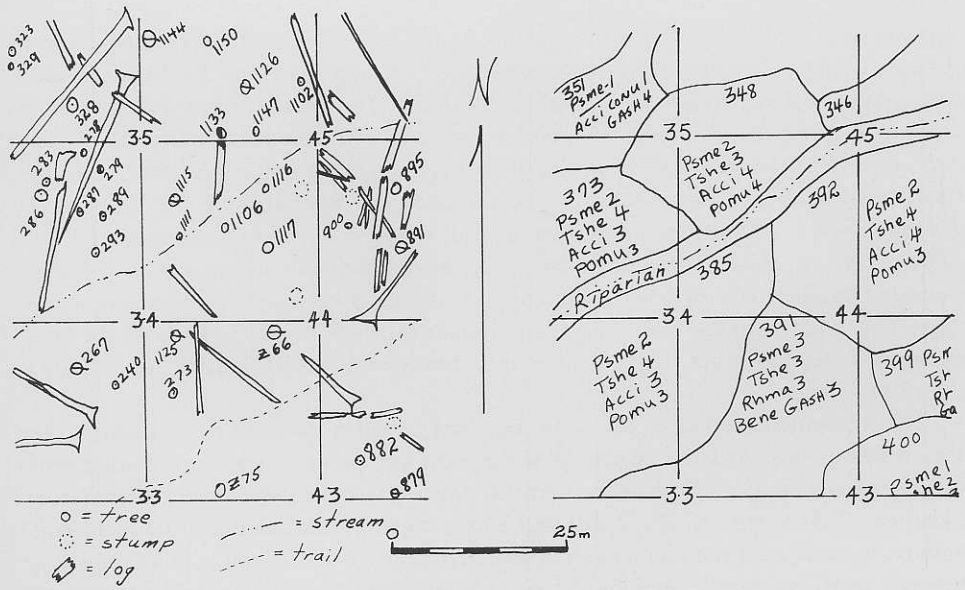

Figure 2. Sample stem map and vegetation unit map of selected grid sections of Watershed 10, H. J. Andrews Experimental Forest.

use of the mapped and tagged trees and the corner post numbers of the grid sections.

The area (in ha) of each of the map units and the percentages of cover within them were calculated with the aid of an electronic grid counting device.

In August 1973, 36 sample plots were established within WS-10 to obtain prelogging data in a study of early succession within habitat types found in the watershed. These successional study plots were placed within previously identified and mapped habitat types in proportion to the percentage of Watershed 10 area occupied by the type. Initial mapping and data from these 36 sample plots have been used as the base data for WS-10 prelogging plant community descriptions.

The sample plots were rectangular, 15 m x 10 m in dimension, slope-corrected, and oriented parallel to contour. Each plot was permanently located by placing metal corner posts referenced to several tree tags and/or numbered grid corner stakes. Data collection included the following: (1) Trees: canopy cover of mature trees ($\geq$15 cm dbh) estimated by species; total density of conifer saplings ($>$1 m tall$<$15 cm dbh), species density; density of conifer seedlings ($>$1 m tall) within representative subsamples of each plot (15 m by 1 m strip above the top, middle, and bottom lines of each plot = 45 m^2); (2) Shrubs: cover and frequency estimated by line intercept along top, middle, and bottom lines of each plot; (3) Herbs: cover and frequency of herb and moss species estimated within 45 microplots (each 2 x 5 dm rectangles) spaced at 1 m intervals adjacent to and below the top and middle plot lines and above the lower plot line; (4) Other: cover of stone, litter, and mineral soil estimated within each of the 45 microplots; lists made of plant species in each plot; photo points established and photos taken in summer and fall at each plot prior to logging; and 16 selected species were measured for leaf area index and biomass data.

Results

The 414 map units were grouped into seven communities: (1) *Tsuga heterophylla/*

Castanopsis chrysophylla (*Tshe/Cach*), (2) *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* (*Tshe/Rhma/Gash*), (3) *Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa* (*Tshe/Rhma/Bene*), (4) *Tsuga heterophylla/Acer circinatum/Polystichum munitum* (*Tshe/Acci/Pomu*), (5) *Pseudotsuga menziesii/Acer circinatum/Berberis nervosa* (*Psme/Acci/Bene*), (6) *Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon* (*Psme/Acci/Gash*), and (7) riparian (Fig. 3). The first six are equivalent to associations and communities of the H. J. Andrews Experimental Forest (Dyrness *et al.*, 1974) and span most of the low-elevation moisture gradient for the western Cascades. The riparian community is in fact a complex of stream-associated vegetation types currently under study (A. Campbell, pers. comm.). Each of the communities or habitat types (HT) is described below and its distribution on WS-10 is shown in Figure 3.

The vegetation map does not show ecotones between communities, although they are present at least to some degree. Observed ecotones between major vegetation types were generally narrow, particularly between the environmentally more extreme communities (*Tshe/Cach* and the *Tshe/Acci/Pomu* communities) and any adjacent community. In some cases the ecotones were several meters wide as in the gradual transitions between seral and climax communities on the same habitat type. Ecotones between the *Tshe/Rhma/Gash* and the *Tshe/Rhma/Bene* habitat types are more subtle than those

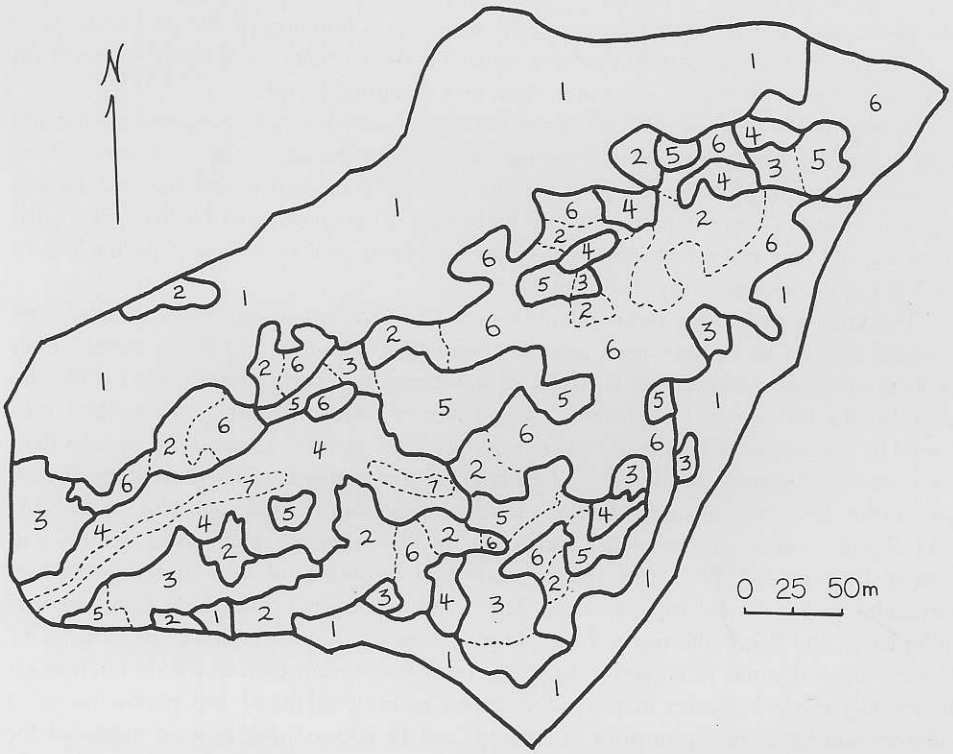

Figure 3. Watershed 10 plant communities (numbered) and Habitat Types (separated by dark lines) (1 = Tshe/Cach; 2 = Tshe/Rhma/Gash; 3 = Tshe/Rhma/Bene; 4 = Tshe/Acci/Pomu; 5 = Psme/Acci/Bene; 6 = Psme/Acci/Gash; and 7 = Riparian communities) (1 = Tshe/Cach HT; 2 + 6 = Tshe/Rhma/Gash HT; 3 +5 = Tshe/Rhma/Bene HT; and 4 + 7 = Tshe/Acci/Pomu HT).

TABLE 1. Diameter size class distribution of trees in Watershed 10 (seedlings and saplings estimated by habitat type subsample).

Size Class (cm)	Species Alpha Code[1] Psme	Tshe	Thpl	Pila	Cade	Cach	Acma	Tabr	Conu	Alru	Arme	Acci
Seedlings (< 1 m tall)	1994	2547	252	448	98	—	—	—	—	—	—	—
Saplings (> 1 m tall < 15 cm dbh)	2596	1965	291	425	5	—	—	—	—	—	—	—
15-30	406	560	65	34	1	518	113	53	26	2	1	1
30-45	94	208	42	11	2	8	15	12	—	1	—	—
45-60	29	64	16	11	2	—	1	—	—	—	—	—
60-75	37	15	8	4	2	—	—	—	—	—	—	—
75-90	53	4	5	3	—	—	—	—	—	—	—	—
90-105	82	4	—	2	2	—	—	—	—	—	—	—
105-120	119	—	2	2	—	—	—	—	—	—	—	—
120-135	88	—	—	2	—	—	—	—	—	—	—	—
135-150	58	—	—	—	—	—	—	—	—	—	—	—
150-165	19	—	—	—	—	—	—	—	—	—	—	—
165+	8	—	—	—	—	—	—	—	—	—	—	—
Total seedlings + saplings	4590	4512	543	873	103	—	—	—	—	—	—	—
Total trees	993	855	138	69	9	526	129	65	26	3	1	1

[1]Psme=**Pseudotsuga menziesii**; Tshe=**Tsuga heterophylla**; Thpl=**Thuja plicata**; Pila=**Pinus lambertiana**; Cade=**Calocedrus decurrens**; Cach=**Castanopsis chrysophylla**; Acma=**Acer macrophyllum**; Tabr=**Taxus brevifolia**; Conu=**Cornus nutallii**; Alru=**Alnus rubra**; Arme=**Arbutus menziesii**; Acci=**Acer circinatum.**

between either of these two communities and the *Tshe/Cach* or the *Tshe/Acci/Pomu* community. Mapping at small scale, the ecotones could easily be drawn on WS-10 maps, but they would be of little use in the context of intended uses of the map.

Basically, WS-10 was a mixture of old-growth and second-growth stands occurring on a mosaic of substrates. This variability in soil depth, slope, and aspect explains in part the mixing of climax communities such as the *Tshe/Cach*, *Tshe/Rhma/Bene*, *Tshe/Rhma/Gash*, and the *Tshe/Acci/Pomu* associations with seral forest stands such as the *Psme/Acci/Gash*, *Psme/Acci/Bene*, and portions of the riparian communities. Fire history has undoubtedly played an important role in the formation and development of plant communities within WS-10, as have bark beetles and windthrow.

Slope and aspect affect plant community development through their effect on stand history; for example, fires, which are known to be a continual source of disturbance in WS-10, tend to be both more likely and more intense on southerly aspects. Fires also have a greater total effect on steep slopes than on gentle slopes. Past disturbance, erosion, and deposition yield differences in soil depth and quality. The result is a watershed with a mosaic of different age classed forests having complex historic involvement in species distribution and structure.

A complete listing of WS-10 trees includes 2815 stems $>$ 15 cm dbh and 12 species as of the summer of 1974 (Table 1). The size class distribution for *Pseudotsuga menziesii* has a biomodal distribution with peaks in the 10 to 40 cm dbh and 80 to 120 cm dbh size class ranges. Factors responsible may include inequalities in growth rates of the trees, slow invasion of WS-10 by *Pseudotsuga*, and periodic creation of small openings by disturbance factors. Disturbance is followed by a gradual successional invasion of *Pseudotsuga*. A preliminary stage structure analysis of WS-10 shows much more age variation than has been suspected for old-growth Douglas-fir forests.

The size class distribution of *Tsuga heterophylla* has the expected J-shaped curve of a climax tree species. The size class distribution of *Thuja plicata* indicates that this species was increasing in numbers in at least some communities and was already an important late seral species. *Acer macrophyllum* apparently does well in earlier stages of secondary succession, but competes poorly with conifers in older stands.

The only other trees which occurred in large numbers in WS-10 were *Castanopsis chrysophylla* and *Pinus lambertiana*. *Castanopsis* is a hardwood that does not generally attain a very large dbh; 518 of 526 trees in WS-10 were in the 15-30 cm dbh category. *Pinus lambertiana* occurred in a variety of size classes in WS-10 and is generally restricted to the more exposed sites. It was frequently found in the *Tshe/Cach* habitat type and other environments supporting numbers of *Pseudotsuga menziesii* in small as well as large size classes.

Reproductive size classes were well represented in WS-10 with an estimated 10,261 stems. The bulk of them (9102) were *Pseudotsuga menziesii* or *Tsuga heterophylla* (Table 2). Table 2 lists reproduction in stems per hectare in order to derive the relative importance of different species in different habitat types. *Pseudotsuga menziesii* is more common in the drier habitats, particularly the *Tsuga heterophylla/Castanopsis chrysophylla* and the *Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon* habitat types. *Tsuga heterophylla* and, to a lesser extent, *Thuja plicata* were relatively more important in the more mesic habitat types.

In general, the distribution of tree species with different ecologic roles strengthens

the vegetation stratification of the watershed. Peculiarities exist in that *Pseudotsuga menziesii* is reproducing in fairly large numbers over a wider range of the hypothesized moisture gradient (Dyrness *et al.*, 1974) than is typical. This apparent anomaly is probably the result of sampling, since study plots were placed (where reproductive size classes were all estimated) within habitat types in order to sample the variation in the canopy cover of each type. Therefore, open stands were sampled in each habitat type. It was the open stands which included large portions of the *Pseudotsuga menziesii* reproductive size classes.

TABLE 2. Conifer reproduction within four habitat types on Watershed 10 (stems per ha).

Habitat type % of WS-10	Area (ha)	Species: Pseudotsuga menziesii Seed.	Pseudotsuga menziesii Sapl.	Tsuga heterophylla Seed.	Tsuga heterophylla Sapl.	Thuja plicata Seed.	Thuja plicata Sapl.	Pinus lambertiana Seed.	Pinus lambertiana Sapl.	Calocedrus decurrens Seed.	Calocedrus decurrens Sapl.[1]
Tsuga heterophylla/ Castanopsis chrysophylla											
39.2	4.02	426	241	190	113	31	26	103	82	5	5
Tsuga heterophylla/ Rhododendron macrophyllum/ Gaultheria shallon											
31.17	3.19	57	419	305	209	10	—	—	19	—	—
Tsuga heterophylla/ Rhododendron macrophyllum/ Berberis nervosa											
17.53	1.79	33	140	306	280	20	93	20	20	—	—
Tsuga heterophylla/ Acer circinatum/ Polystichum munitum											
12.09	1.24	33	33	217	283	50	17	—	—	33	—

[1]Seed=seedlings < 1 m tall; sapl.=saplings > 1 m tall and < 15 cm dbh.

Tsuga heterophylla/Castanopsis chrysophylla associations **(Tshe/Cach)**

This community is the most widespread one on WS-10 (Table 3, Fig. 3). It is generally located on both north and south bounding ridges of WS-10. Westerly and southerly aspects are most common. The overstory tree stratum here is typically quite open relative to other forest types common to the area. Over 43 percent of the 0-cover class in WS-10 occurs in the *Tshe/Cach* habitat type. Most of the *Tshe/Cach* habitat type occurs beneath a very sparse primary tree canopy with 92.1 percent of the community having less than 50 percent cover in this layer.

The canopy of the understory tree stratum is very dense, reflecting the open overstory. Here 31.7 percent of the open understory tree stratum of WS-10 is in the *Tshe/Cach* habitat type. However, a much greater amount of the *Tshe/Cach* habitat type occurs with a denser understory tree cover.

The *Tshe/Cach* habitat type in WS-10 contains 1138 trees $\geq$ 15 cm dbh. Of these, 39 percent are *Castanopsis chrsophylla*, but only eight of them exceed 30 cm dbh. Thirty-three percent of the trees are *Pseudotsuga menziesii*; the species is well represented in the larger size class as well as reproductive classes. It is the dominant tree species and its abundance in the reproductive size classes insures its presence in late seral stages. *Tsuga heterophylla* is another common understory conifer.

A good indicator of the xeric nature of this habitat type is *Pinus lambertiana.* Eighty-two percent of the trees of this species occur within the *Tshe/Cach* habitat type of WS-

10. Some are over 120 cm dbh, although most are considerably smaller. Other less important trees in this habitat type include *Thuja plicata*, *Calocedrus decurrens*, *Acer macrophyllum*, *Taxus brevifolia*, *Cornus nuttallii*, and *Arbutus menziesii*.

Principal understory plant species and their cover values are shown in Table 3. The shrub stratum is dominated by *Rhododendron macrophyllum* followed in importance by *Acer circinatum* in the tall shrubs and *Gaultheria shallon* followed by *Berberis nervosa* in the low shrub layer. The herb layer is poorly developed and is dominated by *Xerophyllum tenax*. *Linnaea borealis* is also a common species. Moss cover is low, but 9 to 12 species are commonly present.

The *Tshe/Cach* habitat type is similar to both the *Psme-Tshe/Cococa* and the *Psme/*

TABLE 3. Percent cover of important plant species within Watershed 10 Habitat Types (from analytic plots) and the riparian zone (pers. comm., A. Campbell). (t=<0.5% cover measured; +=present in plots; M=mature; R=reprod.).

		Community Name				
Layer-Species		**Tshe/Cach**	**Tshe/Rhma-Gash**	**Tshe/Rhma-Bene**	**Tshe/Acci/Pomu**	Riparian
Tree Layer						
Pseudotsuga menziesii	M	18	20	22	11	+
	R	14	23	8	6	+
Tsuga heterophylla	M	15	16	25	43	+
	R	5	18	13	11	+
Thuja plicata	M	1	9	11	1	+
	R	t	—	3	2	+
Acer macrophyllum	M	—	4	4	20	+
	R	t	3	1	t	+
Pinus lambertiana	M	1	1	1	—	-
	R	4	2	1	—	-
Castanopsis crysophylla	M	40	1	2	—	-
Tall Shrub Layer						
Acer circinatum		13	30	29	19	+
Rhododendron macrophyllum		49	23	32	5	+
Cornus nuttallii		8	12	16	8	+
Castanopsis chrysophylla		13	1	1	t	+
Taxus brevifolia		1	7	8	10	+
Corylus cornuta		t	t	2	4	+
Low Shrub Layer						
Gaultheria shallon		45	25	18	3	+
Berberis nervosa		6	4	14	6	+
Herb Layer						
Xerophyllum tenax		13	1	1	t	-
Polystichum munitum		1	5	3	27	+
Linnaea borealis		4	4	4	1	+
Syntheris reniformis		t	1	1	1	+
Coptis laciniata		t	4	4	8	+
Viola sempervirens		t	1	t	t	+
Trillium ovatum		t	t	t	1	+
Vancouveria hexandra		t	t	t	1	+
Whipplea modesta		t	—	1	1	+
Oxalis oregana		—	—	t	1	+
Aralia californica		—	—	—	1	+
Adiantum pedatum		—	—	—	t	+
Blechnum spicant		—	—	—	t	+

Hodi habitat type of Dyrness *et al.* (1974) in its physiographic location, but the extreme development of the shrub layer distinguishes the *Tshe/Cach* habitat type.

Tsuga heterophylla/Rhododendron macrophyllum/Gaultheria shallon association (Tshe/Rhme/Gash)

This habitat type occupies only about 10 percent of WS-10 (Table 3, Fig. 3). It is typically patchy in distribution and located midway between ridgetops and major drainages. It is a more mesic habitat type than the *Tshe/Cach* habitat type (Zobel *et al.*, 1976).

The overstory tree stratum is commonly more dense than that of the *Tshe/Cach* habitat type. Again, the understory tree stratum is commonly denser than the overstory stratum with only 21.1 percent occurring with less than 25 percent cover. The habitat type contains an average of 292 trees larger than 15 cm dbh per ha. Of these, 45 percent are *Pseudotsuga menziesii*, which is found in nearly all size classes. The bimodal distribution of *Pseudotsuga menziesii* in this habitat type is similar to that found for WS-10 as a whole (Table 1). Tree density here is greater than in any other habitat type mapped.

The understory tree stratum is dense and composed of conifers and hardwoods. *Castanopsis chrysophylla* does not play as important a role in the total canopy cover in the *Tshe/Rhma/Gash* habitat type as it does in the *Tshe/Cach* habitat type. It is largely replaced by pole and sapling size classes of *Tsuga heterophylla.* Floristically, the *Tshe/Rhma-Gash* habitat type is similar to the *Tshe/Cach* habitat type. The moderately well developed tree layers do not prevent the development of a fairly dense tall and low shrub layer (Table 3). *Rhododendron macrophyllum* dominates the tall shrubs with *Acer circinatum* a common associate. *Gaultheria shallon* and *Berberis nervosa* dominate the low shrubs. The herb layer is poorly developed. *Linnaea borealis*, *Xerophyllum tenax*, *Chimaphila unbellata*, and *Polystichum munitum* are the most common species, but even these are found in small amounts.

Tsuga heterophylla/Rhododendron macrophyllum/Berberis nervosa association (Tshe/Rhma/Bene)

This habitat type occupies 8.71 percent of WS-10 (Table 3, Fig. 3). It is located primarily on northwest aspects, and occurs on a variety of slopes. It approximates the climatic climax habitat type at low to middle elevations (Dyrness *et al.*, 1974).

On WS-10 the *Tshe/Rhma/Bene* type has between 1 and 50 percent cover in the overstory tree canopy. However, the understory tree stratum is generally quite dense. The *Tshe/Rhma/Bene* habitat type contains 265 trees over 15 cm dbh per ha. Of these, 47 percent are *Tsuga heterophylla.* Most of the *Tsuga* is in small size classes. *Pseudotsuga menziesii* is the next most abundant tree and is the dominant tree as it makes up the total of larger size trees in this habitat type on WS-10. Smaller size classes of *Pseudotsuga menziesii* are also present.

The tall shrub stratum is generally less developed than in the more open *Tshe/Cach* and *Tshe/Rhma-Gash* habitat types. It is dominated by *Rhododendron macrophyllum* and *Acer circinatum. Vaccinium parvifolium* is also common. *Berberis nervosa* and *Gaultheria shallon* dominate a moderately developed low shrub layer. *Linnaea borealis* is the dominant herb (Table 3).

Tsuga heterophylla/Acer circinatum/Polystichum munitum associations **(Tshe/Acci/Pomu)**

This habitat type occupies 11.0 percent of WS-10 (Table 3, Fig. 3), almost all of which is adjacent to the drainage system in the lower portions of the watershed. Two small portions of WS-10, one on a bench and the other in a slight depression, have also been included in this habitat type although they probably more closely resemble a *Tsuga heterophylla/Polystichum munitum* habitat type (Dyrness *et al.*, 1974).

Cover in the overstory tree layer here is generally moderate. The *Tshe/Acci/Pomu* habitat type contains 258 trees over 15 cm dbh per ha in WS-10. Of these, 44 percent are *Tsuga heterophylla.* Again, most of the *Tsuga* are in small sizes. Dominance of *Pseudotsuga menziesii* in the overstory tree layer is still evident. There are, however, fewer large trees per ha in this habitat type.

The tall shrub layer is moderately well developed. *Acer circinatum*, the dominant, is patchy in distribution and low in stature. *Rhododendron macrophyllum*, an occasional associate, is also less robust than that found in other upland communities. The low shrub stratum is dominated by *Berberis nervosa.* The herb stratum is dominated by *Polystichum munitum*, and the moss layer shows greater development than in habitat types discussed above.

The mesic nature of the *Tshe/Acci/Pomu* habitat type is indicated by the dense herb cover and the high number of moist site indicator species such as *Polystichum munitum*, *Oxalis oregana*, *Vancouveria hexandra*, *Viola sempervirens*, and *Blechnum spicant* (Zobel *et al.*, 1976).

Pseudotsuga menziesii/Acer circinatum/Berberis nervosa community **(Psme/Acci/Bene)**

This community occupies 8.8 percent of WS-10 (Fig. 3). The *Psme/Acci/Bene* community occurs adjacent to the *Tshe/Rhma/Bene* community in almost all cases and represents a seral community within the *Tshe/Rhma/Bene* habitat type. The overstory tree layer of the *Psme/Acci/Bene* community is open and patchy in distribution. The overstory tree layer is similar to that in the *Tshe/Rhma/Bene* community in that it has a small percentage of the community occurring beneath cover classes 0 and 1. The *Psme/Acci/Bene* community in WS-10 contains an average of 257 trees larger than 15 cm dbh per ha. Here 45 percent are *Tsuga*, mostly of small size. There is also understory *Pseudotsuga menziesii*, evidence of the open nature of the community. The overstory tree stratum is dominated by scattered old-growth *Pseudotsuga menziesii* with only a few *Tsuga heterophylla* in the large size classes. *Tsuga heterophylla* dominates the understory tree stratum with *Thuja plicata* as a major associate in some areas.

The tall shrub stratum is dominated by *Acer circinatum. Rhododendron macrophyllum* is constant, but with low cover. Low shrubs are dominated by scattered *Berberis nervosa*, though *Gaultheria shallon* is also common. The herb stratum consists of a mixture of plants common to dry to mesic sites which indicate that the community may occupy slightly drier and warmer and more open sites than the climax *Tshe/Rhma/Bene* community. This fact explains in part why *Acer circinatum* dominates the typically less mesic seral stage of the *Tshe/Rhma/Bene* habitat type rather than *Rhododendron macrophyllum.*

Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon community **(Psme/Acci/Gash)**

This community is the second most abundant plant community within WS-10 (Fig. 3).

It occurs on a variety of slopes and aspects. The *Psme/Acci/Gash* community normally occurs downslope of the *Tshe/Rhma/Gash* or *Tshe/Rhma/Bene* communities. Like the *Tshe/Cach* community, the *Psme/Acci/Gash* community has a sparse overstory tree layer cover. Over 81 percent of this community has less than a 25 percent overstory cover. The understory tree layer of the *Psme/Acci/Gash* community is patchy. The total open area in the overstory here is 30 percent of the cover class 0 of WS-10. The understory 0 cover class of this community accounts for 51.1 percent of that class on WS-10.

The *Psme/Acci/Gash* community contains 222 trees over 15 cm dbh per ha. *Tsuga heterophylla* and *Pseudotsuga menziesii* have nearly equal densities (38 percent and 36 percent of the total, respectively). *Pseudotsuga menziesii* dominates in total cover, however. Smaller size classes are well stocked with both *Pseudotsuga menziesii* and *Tsuga heterophylla.*

Acer circinatum dominates the tall shrub layer. This stratum may also contain small amounts of *Rhododendron macrophyllum. Gaultheria shallon* occurs with high cover values and dominates the low shrub layer, occasionally sharing dominance locally with *Berberis nervosa.* Mosses are moderately well developed in the more protected areas but occur with low cover values.

Riparian Community

The riparian community is the most limited of the seven communities in WS-10 (Fig. 3). It occurs mainly along the stream courses at low elevations and adjacent to the *Tshe/Acci/Pomu* community. The overstory and understory tree strata generally have between 25 and 50 percent cover, providing an open appearance. Stem maps show a marked increase in the number of logs on the ground surface within this and the adjacent *Tshe/Acci/Pomu* community compared to other plant communities on WS-10.

The overstory tree stratum of the riparian type is dominated by *Pseudotsuga menziesii* and *Tsuga heterophylla*, with local concentrations of *Acer macrophyllum*, *Thuja plicata*, and *Alnus rubra.* The understory tree stratum is dominated by *Tsuga heterophylla.*

The tall shrub stratum contains *Acer circinatum* and *Vaccinium parvifolium*; *Aralia californica* also occurs and is an indicator of the riparian environment. The sparse low shrub layer has scattered *Gaultheria shallon* and *Berberis nervosa.* The herb stratum is composed of a large number of moisture-loving genera.

Some small areas of less common communities are included in other major communities. One of these occurred often enough to warrant mention, the *Xerophyllum tenax* open (*Xete* open) type. The "*Xete* open" areas occupy 0.73 percent of WS-10, or nearly as much as the riparian community. It usually occurs on open slopes or ridgetops or near rock outcrops where soil development is limited. The *Xete* open type occurs most abundantly (91.1 percent of it) within the *Tshe/Cach* habitat type.

Habitat Types

The seven communities have been combined into four habitat types (HT) for stratification of the physical environment and vegetation during the modeling effort in WS-10. The habitat types are: (1) *Tshe/Cach* HT, consisting of the area occupied by the *Tshe/Cach* community; (2) *Tshe/Rhma/Gash* HT, consisting of the combined areas occupied by the *Tshe/Acci/Gash* and *Tshe/Rhma/Gash* communities; (3) *Tshe/Rhma/Bene* HT, an area occupied by the *Tshe/Rhma/Bene* and the *Psme/Acci/Bene* communities;

and (4) the *Tshe/Acci/Pomu* HT, which combines the areas occupied by the *Tshe/Acci/Pomu* and riparian communities (Fig. 3).

The communities and habitat types represented in WS-10 are similar to stands representative of their respective types on other portions of the H. J. Andrews Experimental Forest and other western Cascade sites in Central Oregon (Franklin *et al.*, 1970; Franklin and Dyrness, 1973; Dyrness *et al.*, 1974; Franklin *et al.*, 1972).

Summary

Watershed 10 is a mosaic of mature and old-growth stands dominated by *Pseudotsuga menziesii*. Communities are those common to low elevations in the *Tsuga heterophylla* Zone. They span most of the range or gradient in temperature and moisture for this zone.

Seven communities were identified and mapped during this study: *Tshe/Cach*, *Tshe/Rhma/Gash*, *Tshe/Rhma/Bene*, *Tshe/Acci/Pomu*, *Psme/Acci/Gash*, and *Psme/Acci/Bene* communities and the riparian vegetation type. These communities are representative of four major habitat types.

Intensive stem and vegetation mapping has yielded numerous data on the structure and composition of plant communities. These data provide a sound base for environmentally and biologically stratifying the watershed for ecosystem modeling projects.

Acknowledgments

The work reported here was supported by National Science Foundation Grant number DEB-74-20744 A02 to the Coniferous Forest Biome, Ecosystems Analysis Studies. This is Coniferous Forest Biome contribution number 181. Office and laboratory space were supplied by the U.S. Forest Service, Forestry Sciences Laboratory, Corvallis.

Literature Cited

Daubenmire, R. 1959. A canopy coverage method of vegetational analysis. Northw. Sci. 33:43-64.

———. 1968. Plant Communities. A Textbook of Plant Synecology. Harper and Row, New York. 300 pp.

Dyrness, 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. Univ. Wash., Seattle. US/IBP Coniferous For. Biome. No. 4, 123 pp.

Franklin, J. F., and C. T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg. USDA For. Serv. Gen. Tech. Rep. PNW-8, 417 pp.

———, ———, and W. H. Moir. 1970. A Reconnaissance Method for Forest Site Classification. Shinrin Richi 12(1), Meguro Tokyo, Japan. 14 pp.

———, F. C. Hall, C. T. Dyrness, and C. Maser. 1972. Federal Research Natural Areas in Oregon and Washington: a guidebook for scientists and educators. USDA For. Serv., Pacific For. and Range Exp. Stn., Portland, Oreg. Miscellaneous pages.

Fredriksen, R. L. 1976. Nitrogen, Phosphorus and Particulate Matter Budgets of Five Coniferous Forest Biosystems in the Western Cascade Range, Oregon. Oreg. State Univ., Corvallis, Ph.D. thesis. 127 pp.

Garrison, G. A., J. M. Skovlin, and C. E. Poulton. 1976. Northwest Plant Names and Symbols for Ecosystem Inventory and Analysis. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg. USDA For. Serv. Gen. Tech. Rep. PNW-46, 263 pp.

Zobel, D. B., W. A. McKee, G. M. Hawk, and C. T. Dyrness. 1976. Relationships of environment to composition, structure, and diversity of forest communities of the central western Cascades of Oregon. Ecol. Mongr. 46:135-156.

Received December 24, 1977
Accepted for publication March 2, 1978