Plant Associations within the Interior Valleys of the Umpqua River Basin, Oregon

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Eleven plant associations were identified and characterized according to the frequency, percent cover, and relative dominance of the herbaceous and woody species among the vegetative strata, including stem density, diameter breast height (dbh), and basal area for tree species: *Cynosurus echinatus/Taeniatherum asperum; Bromus mollis/Cynosurus echinatus; Rhus diversiloba/Cynosurus echinatus; Quercus garryana/Rhus diversiloba/Taeniatherum asperum/Cynosurus echinatus; Quercus garryana/Rhus diversiloba/Dactylis glomerata; Pseudotsuga menziesii/Quercus garryana/Rhus diversiloba/Polystichum munitum; Quercus garryana/Arbutus menziesii/Rhus diversiloba/Cynosurus echinatus; Arbutus menziesii/Rhus diversiloba/Festuca arundinacea; Quercus garryana/Fraxinus latifolia/Rosa elganteria/Juncus effusus; Pseudotsuga menziesii/Corylus cornuta/Cynosurus echinatus.* The intensity and duration of recent disturbance distinguished early seral stages which were characterized by a paucity of native shrub and herbaceous species and an abundance of annual invaders in the understory. The primary forces that influenced existing plant assemblages were fire and more recently agricultural practices, especially among grasslands and savannas. Grasslands without recent livestock use exhibited greater species diversity, supporting more species and a more homogeneous distribution of relative abundance among species.

There are very few descriptive data for the vegetation of the Interior Valley Zone of western Oregon (Franklin and Dyrness 1973). The interior valleys of southwestern Oregon represent a climatic and botanical transition zone between the mesic lowlands of the Willamette Valley in central- and north-western Oregon and the more xeric lowlands within the interior valleys of northern California. Several herbaceous and woody plant species characteristic of the respective ecosystems exhibit corresponding northern and southern limits in geographic distribution within the interior valleys of the Umpqua and Rogue River Basins (Hitchcock and Cronquist 1973). The result is a unique assemblage of herbaceous and woody plant species identifiable as distinct plant associations (i.e., communities of similar floristic composition, physiognomy, and uniform habitat conditions [Muller-Dombois and Ellenberg 1974]).

The need for a quantitative ecological approach to range evaluation and management was first espoused by Dyksterhuis (1949); and more detailed description of principles, methodology, and application appeared in subsequent publications (Dyksterhuis 1958a, 1958b). More recently, Gates (1974) has advocated the application of plant succession and other ecological concepts to rangeland resource inventories; he recognized that range evaluation must be based upon "potential vegetation aggregations" (i.e., the condition of the existing plant community with respect to the native seral associations) rather than the potential forage production.

This paper examines data collected during an ecological study within the interior valleys of the North Umpqua River. The overall goal of this endeavor was to quantitatively characterize the identifiable plant associations within the study area. Specific objectives included determining percent cover, frequency of occurrence and relative dominance of the plant species within the 3 vegetative strata.

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Methods and Materials

The study area was situated along the North Umpqua River between Winchester and Glide, Douglas County, Oregon (Fig. 1) and encompassed 2,745 ha. The topography was typical of the Umpqua and Rogue interior valleys with numerous small mountains and rolling foothills producing a mosaic of small valleys and ridges. The elevation ranged from 135 m along the North Umpqua River to 505 m—a ridge crest which formed the southern boundary of the study area (Fig. 1).

Temperatures along the interior Umpqua valleys were moderate; the mean monthly minimum and maximum temperatures were 4.9°C ($s_{\bar{x}}$ = 0.34) in January and 20.2°C ($s_{\bar{x}}$ = 0.27) in August, respectively (U.S. Department of Commerce 1955–1980). The mean annual temperatue (12.2°C, $s_{\bar{x}}$ = 0.24) rarely fluctuates dramatically among years, but annual precipitation may vary considerably (e.g., 55.9 cm in 1978 as compared to 90.4 cm in 1979). Mean annual precipitation was 84.1 cm ($s_{\bar{x}}$ = 3.07) with an average of 67.8 cm falling October–March, producing wet winters and semi-drought summers. Snow cover is uncommon and rarely persists for more than a few days.

A general reconaissance of the study area during the initial field season, May–August 1978, provided the basis for subdividing the existing *Quercus* woodland community into 11 distinct plant associations. Differences in species composition and structure (e.g., absence or presence of one of the vegetative strata) served as the primary criteria for delineating plant assemblages. Botanical nomenclature followed Hitchcock and Cronquist (1973) except for Gramineae where Hitchcock (1971) were consulted. The arcsin transformation was employed with percentage data exhibiting a wide range of values, whereas the square root transformation was used with percentages between 0 to 20 or 80 to 100. A probability level of less than 0.05 was accepted as indicating statistical significance.

Full time field studies resumed May 1979 and continued through September 1979. Whenever possible, 3 replicates of each association were sampled. The number of plots per sample (n = 50 for each replicate) was derived from the existing variation in preliminary samples (Zar 1984:132). A random-systematic sampling scheme was devised such that plots were located along a predefined transect that began at a randomly selected starting point. The distance between plots was adjusted to ensure that the entire replicate site was included in the sampling procedure.

Herbaceous cover (percent crown cover) was estimated for each species occurring within a 2 by 5 dm-plot (Daubenmire 1959). Percent frequency of occurrence and relative dominance (as determined from percent crown cover) of each species were computed. Shrub crown cover was estimated with the line-intercept method (Canfield 1941). Intercept lines were incorporated within the general sampling scheme, extending from each plot site along the transect. The intercept of each shrub species along a 20-m tape was measured to the nearest centimeter. The total amount of intercept was summed for each line; cover, botanical composition

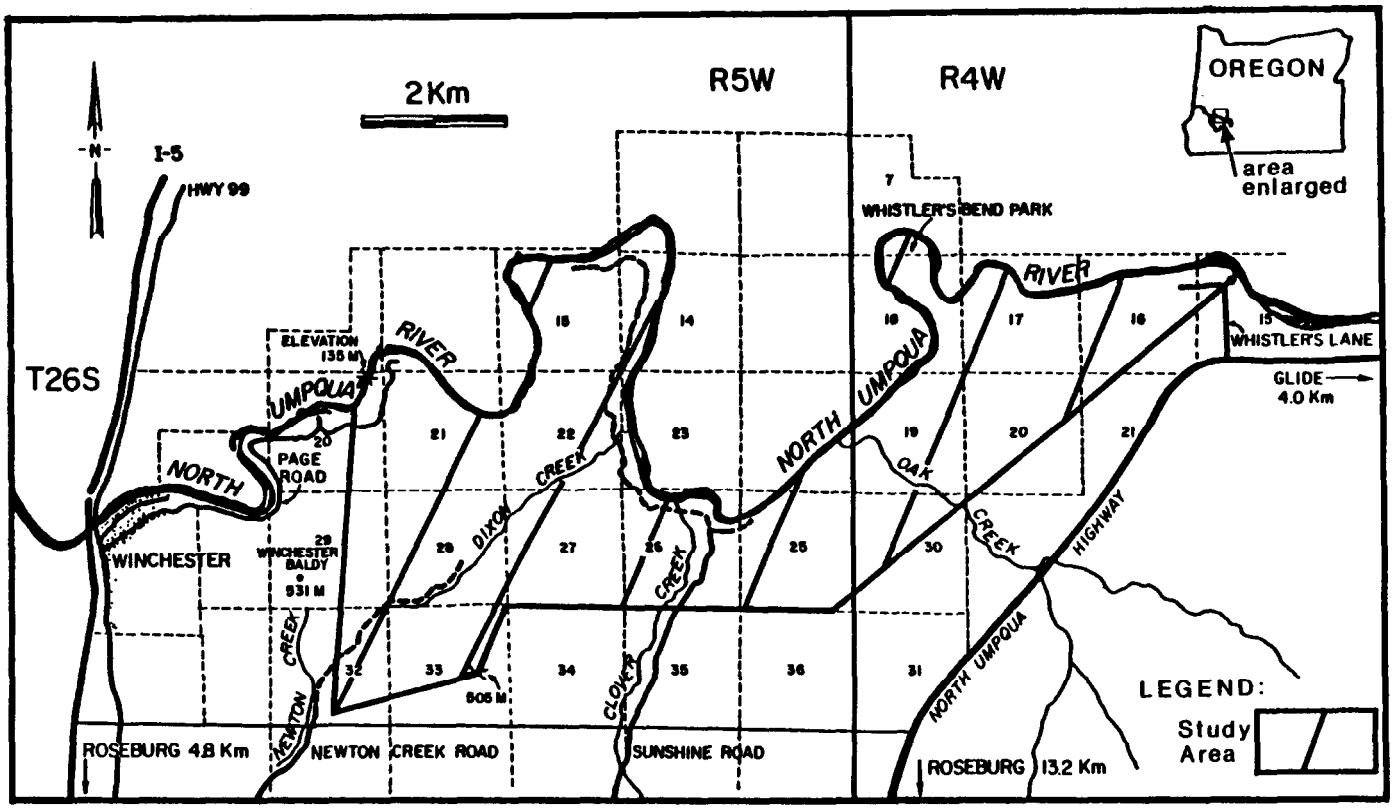

Fig. 1. *The 2,745-hectare study area (hatched region) situated along the North Umpqua River between Winchester and Glide, Ore., May 1978–December 1980.*

and relative dominance were computed accordingly (Pieper 1978).

An estimate of canopy cover was obtained at each of the 50 plots with a forest densiometer (Lemmon 1956). The point-centered quarter method (Cottam and Curtis 1956) was employed to estimate tree density and relative dominance (as determined from basal area); the center of a plot served as the sampling point. The distance (in centimeters) to the nearest tree in each of the 4 quadrats, tree species, and its diameter at breast height (dbh) were recorded.

Vertical density of the vegetation was estimated at each of the 50 plots with a density board (Wight 1938). A reading was taken from a point 20 m beyond each plot along the transect.

Results

Each of the plant associations was named with the scientific names of the dominant and co-dominant plant species occurring within the corresponding vegetative strata. Subsequent references to each of the associations in the text will use only generic names.

Description of Plant Associations

Cynosurus echinatus/ Taeniatherum asperum. Preliminary data indicated discernible differences between pasturelands and grasslands (areas not recently exposed to livestock) and justified separate descriptions of the corresponding plant associations. *Cynosurus/ Taeniatherum* associations were pasturelands experiencing a rotational grazing schedule by cattle and sheep and comprised 29.7% (815 ha) of the study area. The grasses and forbs were distributed uniformly throughout with 94% of 150 plots exhibiting $\geq 62\%$ cover. The mean herbaceous cover was 81.1% ($s_{\bar{x}} = 1.48$) but the mean vertical density index was 20.5 ($s_{\bar{x}} = 0.04$, minimum value = 21), reflecting the general scarcity of tall herbaceous vegetation. Hedgehog dogtail *(Cynosurus echinatus),* medusahead wildrye *(Taeniatherum asperum),* and soft chess brome *(Bromus mollis)* comprised 49.2% of the total herbaceous cover. California oatgrass *(Danthonia californica)* was the only common native grass, occurring in 37% of the plots and representing an average of 5.7% cover. Many of the pasturelands were subjected to periodic controlled burning and seeded to sub-clover *(Trifolium subterraneum),* perennial ryegrass *(Lolium perenne),* and tall fescue *(Festuca arundinacea).*

Bromus mollis/ Cynosurus echinatus. The *Bromus/ Cynosurus* association represented natural prairies, grass balds, and pasturelands that had not experienced recent livestock use. These areas were typically free of disturbance except natural fires, and comprised 3.9% (107 ha) of the study area. The vegetation was comparably dense and homogeneous; 95% of 100 plots demonstrated $\geq 62\%$ cover and the mean index of vertical density was 19.6 ($s_{\bar{x}} = 0.12$). Mean herbaceous cover was 78.1% ($s_{\bar{x}} = 1.69$). Soft chess brome, hedgehog dogtail, and perennial ryegrass accounted for 43.6% of the cover. Native grasses included California oatgrass, pine bluegrass *(Poa scabrella),* Sandberg's bluegrass *(P. sandbergii),* and blue wildrye *(ELymus glaucus).*

Rhus diversiloba/ Cynosurus echinatus. Rhus/ Cynosurus comprised 4.4% (121 ha) of the study area. Typically, these areas supported very few trees and exhibited dense shrub cover $\bar{x} = 34.4\%$, $s_{\bar{x}} = 1.76$). Poison oak *(Rhus diversiloba)* was dominant, occurring in 98% of the sampling points and accounting for 96.2% of the cover. Mean herbaceous cover was 73.1% ($s_{\bar{x}} = 1.77$) and the mean vertical density index was 10.1 ($s_{\bar{x}} = 0.67$). New-growth poison oak was 36.8% of the ground cover; the dominant grass was hedgehog dogtail.

Quercus garryana/ Rhus diversiloba/ Taeniatherum asperum/- Cynosurus echinatus. This association was an oak-woodland/ grassland interspersion with an average tree density of 95.6 stems/ ha ($s_{\bar{x}} = 20.6$) and occupied 13.2% (362 ha) of the study area. Mean dbh was 32.9 cm ($s_{\bar{x}} = 0.87$), and the mean canopy cover was 25.5% ($s_{\bar{x}} = 2.94$). The average shrub cover was 5.9% ($s_{\bar{x}} = 1.33$); poison oak

Table 1. Tree density, mean dbh, mean basal area per ha, vertical density index and mean percent cover of the tree, shrub and herbaceous strata for each of the plant associations on the study area, May-September 1979.

Plant associations	Stand Characteristics						
	Canopy cover	Tree density	DBH	Basal area	Shrub cover	Herbs cover	Vertical density index
	%	stems/ha	cm	m^2/ha	%	%	
Cynosurus echinatus/ Taeniatherum asperum	—	—	—	—	—	81.1d	20.5e
Bromus mollis/ Cynosurus echinatus	—	—	—	—	—	78.1cd	19.6e
Rhus diversiloba/ Cynosurus echinatus	—	—	—	—	34.4d	73.1cd	6.8bc
Quercus garryana/ Rhus diversiloba/ Taeniatherum asperum/ Cynosurus echinatus	25.5a	10a	32.9bc	8.1a	5.9a	76.8cd	18.4de
Quercus garryana/ Rhus diversiloba/ Taeniatherum asperum	69.9b	665b	22.1ab c	25.5b	6.1a	71.3cd	14.2cd e
Quercus garryana/ Rhus diversiloba/ Dactylis glomerata	90.3b	1266c	21.2ab c	44.7d	47.6d	58.4bc d	9.3ab c
Pseudotsuga menziesii/ Quercus garryana/ Rhus diversiloba/ Polystichum munitum	89.7b	1364c	21.3ab c	49.5d	21.2b	30.5ab	5.2b
Quercus garryana Arbutus menziesii/ Rhus diversiloba/ Cynosurus echinatus	78.0b	1283c	15.7ab	24.8b	31.7c	46.5ab c	7.3ab c
Arbutus menziesii/ Rhus diversiloba/ Festuca arundinacea	79.3b	3762d	10.3a	31.4bc	28.4c	25.0a	3.0a
Quercus garryana/ Fraxinus latifolia/ Rosa elganteria/ Juncus effusus	81.5b	622b	28.1ab c	38.6cd	4.6a	69.1cd	10.9cd
Pseudotsuga menziesii/ Corylus cornuta/ Cynosurus echinatus	92.3b	541b	41.8c	74.2d	5.8a	21.4a	12.0de

Within columns, values that share common letters are not different ($P>0.05$; Dunn's multiple comparison test, Daniel 1978).

accounted for 95% of the midstory. Mean herbaceous cover was 76.8% ($s_{\bar{x}}$ = 2.32); medusahead wildrye and hedgehog dogtail were co-dominant. The mean index of vertical density was 1.84 ($s_{\bar{x}}$ = 0.46).

Quercus garryana/ Rhus diversiloba/ Cynosurus echinatus. Quercus/ Rhus/ Cynosurus occupied 17.1% (469 ha) of the study area and represented relatively uniform-aged oak woodlands with a well-developed overstory and understory; the shrub layer was sparse and often absent. Mean canopy cover and herbaceous cover were 69.6% ($s_{\bar{x}}$ = 2.21) and 71.3% ($s_{\bar{x}}$ = 2.38), respectively; shrub cover averaged 6.1% ($s_{\bar{x}}$ = 62.0) while the mean dbh was 22.1 cm ($s_{\bar{x}}$ = 0.59). Oregon white oak *(Quercus garryana)* and California black oak *(Q. kelloggii)* were co-dominant and accounted for 95% of the standing basal area. Poison oak and wild rose *(Rosa elganteria)* averaged 3.7% and 2.3% cover, respectively, and together accounted for 99% of the midstory. Hedgehog dogtail, California oatgrass and perennial ryegrass comprised 53.5% of the understory. The mean index of vertical density was 14.2 ($s_{\bar{x}}$ = 0.61).

Quercus garryana/ Rhus diversiloba/ Dactylis glomerata. Quercus/ Rhus/ Dactylis was an even-aged woodland with 3 well-developed vegetative strata and occupied 8.7% (239 ha) of the study area. The overstory was comparably dense with essentially a continuous canopy. The mean tree density was 1,266 stems/ha ($s_{\bar{x}}$ = 118) while the average canopy cover was 90.3% ($s_{\bar{x}}$ = 1.53). Oregon white oak and California black oak were 69.2% and 24.% of the existing basal area, respectively; mean dbh was 21.2 cm ($s_{\bar{x}}$ = 0.66). Shrub cover averaged 47.6% ($s_{\bar{x}}$ = 3.34); poison oak and wild rose occurred with a frequency of 0.72 and 0.52, respectively, and together were 92% of the midstory cover. New-growth poison oak accounted for 32.2% of the understory cover which averaged 58.4% ($s_{\bar{x}}$ = 2.25); orchardgrass *(Dactylis glomerata)* and hedgehog dogtail were co-dominant grasses. The mean vertical density index was 9.3 ($s_{\bar{x}}$ = 1.01).

Pseudotsuga menziesii/ Quercus garryana/ Rhus diversiloba/ Polystichum munitum. This was a dense mixed oak-conifer stand averaging 1364 stems/ha ($s_{\bar{x}}$ = 136) and occupied 11.3% (310 ha) of the study area. The mean dbh was 21.5 cm ($s_{\bar{x}}$ = 0.78) and the average canopy cover was 89.7% ($s_{\bar{x}}$ = 1.72). Douglas-fir *(Pseudotsuga menziesii)* and Oregon white oak were co-dominant, accounting for 79.1% of the existing basal area. Mean shrub cover was 21.2% ($s_{\bar{x}}$ = 3.20); poison oak was 94.9% of the midstory. Herbaceous cover averaged 30.5% ($s_{\bar{x}}$ = 2.99); newgrowth poison oak and swordfern *(Polystichum munitum)* were 58.3% of the understory while hedgehog dogtail was the dominant grass. The mean vertical density index was 5.15 ($s_{\bar{x}}$ = 0.68).

Quercus garryana/ Arbutus menziesii/ Rhus diversiloba/ Cynosurus echinatus. On more xeric sites, many woodlands (6.1%, 167 ha) were co-dominant stands of Oregon white oak and Pacific madrone *(Arbutus menziesii).* Oak-madrone woodlands averaged 78.4% ($s_{\bar{x}}$ = 2.04) canopy cover and supported a mean density of 1283 stems/ha ($s_{\bar{x}}$ = 81.2). Oregon white oak and Pacific madrone comprised 43.5% and 32.1% of the existing basal area, respectively; mean dbh per stem was 15.7 cm ($s_{\bar{x}}$ = 0.36). The shrub layer averaged 31.7% ($s_{\bar{x}}$ = 2.44) ground cover, poison oak was 90.1% of

the shrub stratum. Mean herbaceous cover was 46.5% ($s_{\bar{x}}$ = 2.59); new-growth poison oak accounted for the largest portion of the understory (37.7%) while hedgehog dogtail was the dominant grass. The mean index of vertical density was 7.32 ($s_{\bar{x}}$ = 0.59).

Arbutus menziesii/ Rhus diversiloba/ Festuca arundinacea. Fourteen percent (38.5 ha) of the study area was occupied by essentially monotypic stands of Pacific madrone. *Arbutus/ Rhus/ Festuca* were dense multi-layered woodlands averaging 3762 stems/ ha ($s_{\bar{x}}$ = 750.0); the mean vertical density index was 3.04 ($s_{\bar{x}}$ = 0.25) and mean canopy cover was 79.3% ($s_{\bar{x}}$ = 2.52). Poison oak occurred with a frequency of 0.71 and accounted for 97.9% of the shrub cover; total shrub cover averaged 28.4% ($s_{\bar{x}}$ = 2.69). Herbaceous cover averaged 25.0% ($s_{\bar{x}}$ = 2.69; tall fescue was dominant and accounted for 38.4% of the understory.

Quercus garryana/ Fraxinus latifolia/ Rosa elganteria/ Juncus effusus. Portions of the study area experienced perennial flooding. These areas together with poorly drained sites supported plant assemblages that were best characterized as a riparian association and comprised 3.1% (85 ha) of the study area. Some of the riparian areas were without an overstory (e.g., seeps, ephemeral streams), but typically *Quercus/ Fraxinus/ Rosa/ Juncus* was a multi-layered woodland. The average tree density was 622 stems/ ha ($s_{\bar{x}}$ = 80.2) while mean dbh was 28.1 cm ($s_{\bar{x}}$ = 0.72). Within woodland sites, the canopy was essentially continuous but the overall mean canopy cover was 81.5% ($s_{\bar{x}}$ = 2.21). Oregon white oak and Oregon ash *(Fraxinus latifolia)* were dominant and together accounted for 98.7% of the standing basal area. Mean shrub cover was 4.63% ($s_{\bar{x}}$ = 0.81); wild rose occurred within 36% of the sites and comprised 41.9% of the midstory. Owing to low-reaching canopies and a tall dense understory, the mean index of vertical density was 10.9 ($s_{\bar{x}}$ = 0.63). Mean herbaceous cover was 69.1% ($s_{\bar{x}}$ = 1.95); common rush *(Juncus effusus)* and tall fescue together accounted for 52.1% of the understory.

Pseudotsuga menziesii/ Corylus cornuta/ Cynosurus echinatus. Mixed conifer woodlands occupied the northern slopes at higher elevations and represented 1.1% (30.1 ha) of the study area. *Pseudotsuga/ Corylus/ Cynosurus* supported a continuous canopy ($\bar{x}$ = 92.3%, $s_{\bar{x}}$ = 1.26) with a sparse shrub layer $\bar{x}$ = 5.8%; $s_{\bar{x}}$ = 1.36) and an intermittent understory $\bar{x}$ = 21.4%, $s_{\bar{x}}$ = 2.49). The average tree density was 541 stems/ ha ($s_{\bar{x}}$ = 50.5) and mean dbh was 41.8 ($s_{\bar{x}}$ 1.00). Douglas-fir was dominant and accounted for 91.0% of the existing basal area. Hazelnut *(Corylus cornuta)* and wild rose occurred most often within the midstory and represented 73.4% of the shrub cover. Hedgehog dogtail was the dominant herb, occurring in 63% of the plots and accounting for 39.5% of the understory. The mean index of vertical density was 12.0 ($s_{\bar{x}}$ = 0.84).

Comparison of Community Parameters

The species diversity of *Cynosurus/ Taeniatherum* (2.66, Shannon Index, Zar 1984) and *Bromus/ Cynosurus* (2.94) were different ($P \leq 0.05$, test for differences between diversity indices, Zar 1984). *Bromus/ Cynosurus* supported more species (n = 43) and exhibited a more uniform distribution of relative abundance among species as compared to *Cynosurus/ Taeniatherum* (n = 39); corresponding homogeneity indices (Zar 1984:34) were 0.781 and 0.721, respectively.

The woodland associations differed ($P \leq 0.05$; Kruskal-Wallis one-way ANOVA ranks test, Zar 1984) with respect to basal area/ha, shrub cover, vertical density, and herbaceous cover (Table 1). *Arbutus/ Rhus/ Festuca* displayed the highest ($P \leq 0.05$) stem density, but *Pseudotsuga/ Corylus/ Cynosurus* supported the greatest ($P \leq 0.05$) standing basal area (Dunn's multiple comparison test, Daniel 1978:212). *Quercus/ Rhus/ Dactylis* supported the densest ($P \leq 0.05$) shrub stratum, but *Arbutus/ Rhus/ Festua* exhibited greater ($P \leq 0.05$) vertical vegetation density (Dunn's multiple comparison test, Daniel 1978).

Discussion

The natural vegetation of the southwestern Oregon interior lowlands was classified as *Quercus* woodland community, typical of the Interior Valley Zone (Franklin and Dyrness 1973). The *Quercus* woodland associations along the interior North Umpqua River valleys represent a diverse array of plant assemblages ranging from largely open, sparsely stemmed savannas, to dense, multi-layered forests. Species composition varied from pure Oregon white oak and California black oak stands to associations with an abundance of other hardwood and conifer associates, resembling the *Quercus* forest types of the Willamette Valley (Thilenius 1968). Differences in species composition probably reflect the typically more xeric nature of the interior Umpqua River Basin (U.S. Department of Commerce 1955–1980). California black oak, for example, was an important component of 3 southwestern Oregon woodland associations (and occurred within all 7 forest types), yet was not reported within any of the 4 oak woodland communities of the western Oregon central valley (Thilenius 1968). Also, Pacific madrone occurred much more frequently within the Umpqua Basin, often occurring in dense monotypic stands on the more xeric sites. Moreover, the oak woodland associations of the interior Umpqua valleys were most similar to the *Quercus/ Rhus* community for the Willamette Valley, which typically occurred on the most xeric sites (Thilenius 1968).

The factors influencing phytosociological characteristics of presettlement southwestern Oregon were probably very similar to those desribed for the Willamette Valley (Thilenius 1968). Fire, both natural and human in origin, maintained oak-savannas in what was typically a forest environment; Indians frequently used fire as a management tool to create forest openings and encourage game (Douglas 1914). Subsequent to European settlement, there was an interruption of ground fires and many of the savannas were converted to young oak forests. Evidence of this phenomenon is provided by the comparable dense small *Quercus* stems that characterize the oak woodland/ oak-savanna ecotone. The dbh of the young oak stems are comparable to *Q. garryana* of the Willamette Valley with a mean age of about 90 years (Thilenius 1968), which corresponds fairly well with early settlement of southwestern Oregon.

Since early settlement, logging, land clearance, grass seeding, controlled burning and livestock use have been very important factors influencing the phytosociology of existing *Quercus* woodland associations. This is particularly true of grasslands, savannas and young woodlands where an abundance of palatable forage and easy access combine to encourage more intense livestock use. This is clearly supported by the fact that important native perennials such as California oatgrass, red fescue *(F. rubra)* and blue wildrye were replaced by the exotic annuals hedgehog dogtail, medusahead wildrye and ripgut brome *(B. rigidus)*, invaders of intensively grazed grasslands. Some of the grasslands have experienced less intensive livestock use and/ or have been released from grazing pressure for a longer period. These pasturelands supported considerably more native herbaceous species and were less often plagued with annual invaders overrunning the entire site. Moreover, the fact that the *Bromus/ Cynosurus* association exhibited a greater diversity and homogeneity of plant species indicates that although livestock use can increase diversity via reducing competition among constituents, intense grazing will result in elimination of important perennials and encourage the establishment of less diverse plant assemblages dominated by annual invaders.

There was evidence that many of the conifer, mixed oak-conifer and older (as determined by dbh) monotypic stands of Pacific madrone were relatively undisturbed. The presence of a well-developed multi-layered stand with an abundance of native shrubs in the midstory and grasses and forbs throughout the understory characterized many older *Quercus* associations. Monotypic stands of Pacific madrone and oak-conifer supported Douglas-fir and ponderosa pine *(Pinus ponderosa)* in the overstory with younger stems in the midstory and recent regeneration. Also, these areas typically excluded or were relatively inaccessible to livestock.

Conversely, *Quercus/Rhus/Cynosurus* and *Rhus/Cynosurus* associations lacked a well-developed shrub stratum and an overstory, respectively, and were maintained at earlier successional stages because of frequent controlled burning and easy access to livestock. Many of the existing oak-madrone and some of the monotypic Pacific madrone stands were apparently established following natural and/or man-induced disturbance. These stands were typically dense with small dbh stems and occurred on steep dry slopes; evidence of substantial recent erosion was also apparent. And as was true of the other disturbed sites, the seral shrub and forest associations supported few native woody and herbaceous species and were characterized by an understory dominated by annual invaders.

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