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Pacific Northwest Forest Lands Potential for Floral Greenery Production

Abstract

This study was undertaken to determine the management potential of forest plant zones in the Pacific Northwest for floral greenery production. The special forest products industry, based primarily on the utilization of understory plants found in Northwest forests, employs thousands of part-time and full-time people. To date, little information has been published concerning the special forest products industry (Schlosser *et al.* 1991). This paper describes the forest zones and selected plant associations of the region which have the greatest potential for floral greens management.

Plant association guides completed by the U.S. Forest Service and other research groups have been used to identify specific forest associations across five forest zones in the region. The occurrence, in terms of constancy and coverage, of each species in a number of these associations is given. Harvest levels of each product are discussed while specific associations are recommended for floral greens management.

The special forest products industry leases harvest rights from forest landowners. The leases typically generate annual revenues which can continue during the entire life of the forest stand. The increasing importance of generating revenues from Northwest forests places increased emphasis on the proper management of floral greens for harvest.

Introduction

The coniferous forests common to western Washington, western Oregon, and coastal British Columbia contain sites rich in understory vegetation. Many understory plants of this region have characteristics desired by the floral greens industry. Forest plants have been harvested from Northwest forests over the past fifty years by a group of businesses known as the special forest products industry. The portion of the industry dealing with understory plants is known as the floral greens industry, with individual buyers/processors referred to as producers.

Most plant parts purchased by floral greens producers are used to accent floral arrangements and provide long lasting backings and fillers for colorful flowers. Waxy leaved evergreen plants, such as salal (*Gaultheria shallon*)[2] and evergreen huckleberry (*Vaccinium ovatum*) are harvested, processed, and marketed extensively. Plants with similar properties, such as dwarf Oregon-grape (*Berberis nervosa*) are also in high demand as floral greens. Sword fern (*Polystichum munitum*) and deer fern (*Blechnum spicant*) are desired for their flexible fronds and unique form. Beargrass (*Xerophyllum tenax*) is harvested, dried and dyed for use in eastern United States and European floral markets. These and other plants are common to several forest associations found across the Pacific Northwest.

The special forest products industry also purchases a wide array of other plant materials such as cones, evergreen boughs, mushrooms, and mosses. In 1989, the special forest products industry generated an estimated $47.7 million in raw product purchases for an estimated $128.5 million in finished product sales and employed over 10,000 persons in seasonal and permanent positions (Schlosser *et al.* 1991).

The special forest products industry is concentrated in western Oregon, western Washington, and southwestern British Columbia. Many of these businesses extend their procurement efforts hundreds of miles. Forest landowners of the region have the opportunity to enter into harvest lease agreements with the producers and harvesters of the products. The harvesting process typically removes only a portion of the plant, and allows for harvest annually or in alternate years.

Many public and private forest managers are becoming more interested in special forest products because of the revenue potential associated with the sale of harvest leases. As a result, methods are being sought to manage for the production of special forest products in combination with other more traditional forest outputs. Public land managers in the U.S. Forest Service, the Washington State Department of Natural Resources and the Oregon Department of Forestry have recognized the monetary potential associated with leasing harvest rights to special forest products producers. Additionally, numerous private forest landowners (industrial and nonindustrial) have offered special forest product harvest leases.

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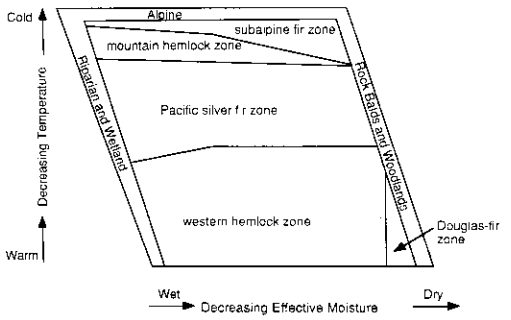
[2]All scientific and most common names are defined according to "Flora of the Pacific Northwest" (Hitchcock and Cronquist 1981). Some common names used may reflect specialized usage by the floral greens industry.

This paper provides a preliminary assessment of the potential for producing selected floral greens within the subalpine fir, mountain hemlock, Pacific silver fir, western hemlock and Douglas-fir forest zones. Management options are also discussed for the joint production of the floral greens and other forest uses.

Methodology

Plant association guides have been completed for most of the forested part of the Pacific Northwest by the U.S. Forest Service and others. These guides present the characteristics of forest associations with discussions of management, soils, microsites, and species composition. The guides were used in this study to identify forest associations supporting species desired by floral greens buyers.

Forest communities from each geographic area represented in the guides were arrayed by forest zone. The classification of western Washington, western Oregon and coastal British Columbia into forest zones generally appears in the ecological literature as a two-dimensional aggregate reflecting a temperature regime and a moisture gradient (Topik *et al.* 1988, Halverson *et al.* 1986, Brockway *et al.* 1983) (Figure 1). The moisture and temperature axes are arranged to reflect elevation and aspect-related climatic information. To facilitate information processing, the zones were ordered in a linear fashion. The ordering represented a moisture/temperature gradient which moved from cold/wet at one extreme, to warm/dry at the other extreme.



Linearized ordering of the forest zones from the moisture/temperature distribution:

Cool-Wet				Warm-Dry
subalpine fir zone	mountain hemlock zone	Pacific silver fir zone	western hemlock zone	Douglas-fir zone

Figure 1. Idealized distribution of forest zones within a temperature and moisture gradient, adapted from Topik *et al.* (1986) and Halverson *et al.* (1986).

In each zone, plant associations were ordered and recorded using the same linear criteria used for ordering the zones. For example, the western-hemlock zone supports numerous plant associations. On the Gifford Pinchot National Forest, western hemlock communities tend to exist in the geographic areas exhibiting the combinations of moisture and temperature evidenced in Figure 2 (Halverson *et al.* 1986, Topik *et al.* 1986). From this idealized two-dimensional distribution, specific associations were grouped in the general temperature/moisture combinations shown in Table 2. From these general groups, associations were ordered from cold/wet to warm/dry extremes.

Many plant associations are found throughout the region. Because of subtle differences in the floristic composition of various national forests and study areas, not all plant associations represented in one forest are represented in another forest. In cases where specific plant associations were not represented in each national forest, the association was ordered according to the temperature/moisture gradient in the forest zone in which it occurred.

Plant association guides present tables of individual plant constancy and coverage values for each forest association. Constancy, expressed as a whole number percent, represents the presence of a plant species within an association with no emphasis on either size or numbers (Kovalchik 1987). Coverage denotes the average percentage, expressed as a whole number, of canopy coverage for each plant species within a plant association (Clausnitzer and Zamora 1987). Eight of the most economically important floral greenery species were identified in a survey of special forest products producers (Table 2) (Schlosser *et al.* 1991). By recording the constancy and coverage values for each of the floral greens species by forest association, a summary of the relative degree of plant coverage and occurrence was obtained.

Plant association guides also discuss microclimate, floristic successional stages, soil characteristics, animal use and management considerations by plant association. By synthesizing this information, management concerns are highlighted to aid in the identification of lands with the potential for joint production of special forest products and other forest uses.

Background

General Product Quality Considerations

The ecological requirements of the floral greens are as diverse as the habitats in which they grow.

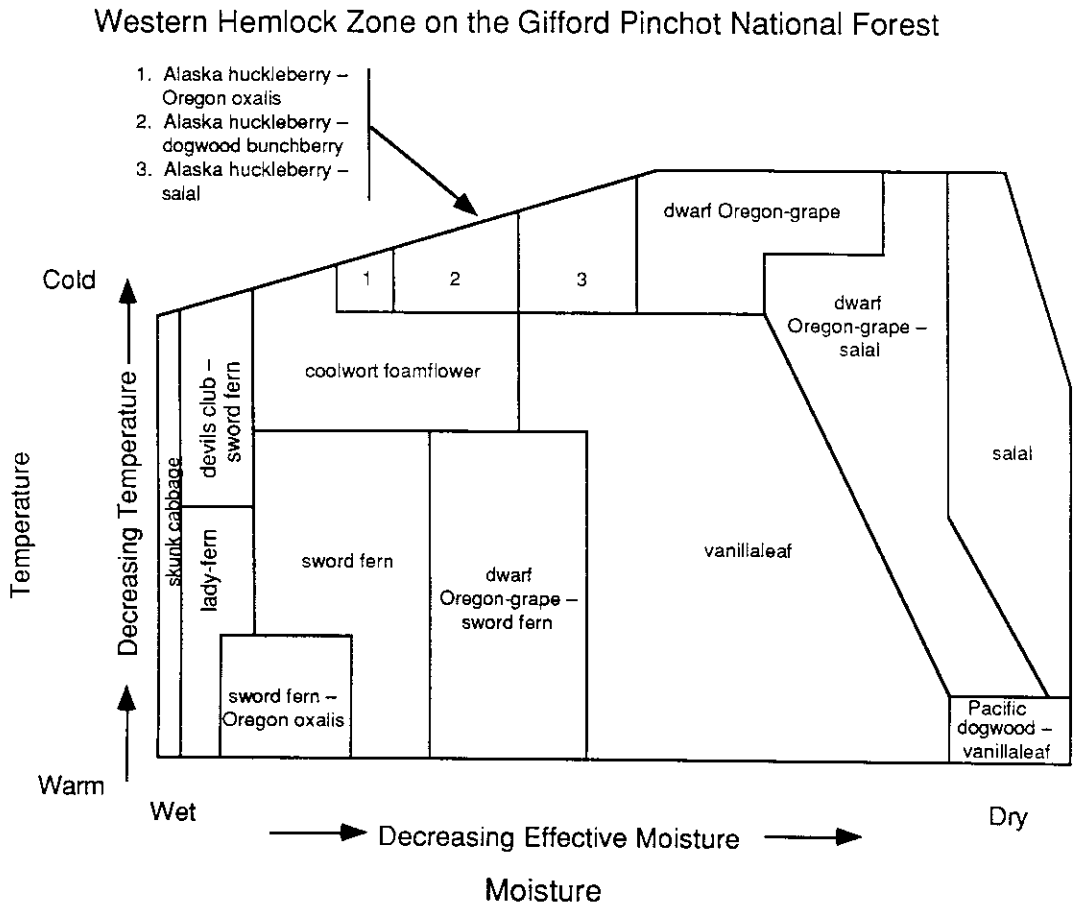


Figure 2. Predominant understory plant locations as evidenced by a temperature and moisture gradient common in the western hemlock zone. See Table 2 for general groupings of these associations and scientific names. Adapted from Topik *et al.* (1986) and Halverson *et al.* (1986).

Most of the floral greens species require partial shade provided by overstory forests to meet product quality requirements. Salal, evergreen huckleberry, dwarf Oregon-grape, deer fern, sword fern and Oregon-boxwood (*Pachistima myrsinites*) require a partially closed forest canopy to grow in forms acceptable for commercial harvest. Although most of these plants grow under other conditions, only plants growing under partial shade develop the deep green, broad spreading leaves or fronds desired by floral greens producers.

Forest site disturbances, such as fire and timber harvesting, often create early seral conditions favoring other floral greens species. Beargrass, grown in the open, produces long, bluish-green leaves which retain strength and color after harvest. Scotch broom (*Cytisus scoparius*), an introduced species, grows tall and straight in openings with deep green color. Red-evergreen huckleberry (*Vaccinium ovatum*)[3] grown in direct sunlight, develops long spikes with leaves arranged spirally along the stem. In direct sunlight these leaves turn bright red, thus giving it the alternate vernacular of "red-huck."

Salal appears in early successional stages on many sites but it is seldom of harvestable quality until it has developed under a partial canopy of

[3]Note evergreen huckleberry and red-evergreen huckleberry (red-huck) are both *Vaccinium ovatum*. The different common (trade) names reflect differences in plant coloring and are important in the floral greens trade. The red tips associated with *Vaccinium ovatum* grown in direct sunlight (red-huck) are marketed and used in different ways than *Vaccinium ovatum* grown under shade.

TABLE 1. Examples of the forest associations found in the western hemlock zone on the Gifford Pinchot National Forest.

PLANT ASSOCIATIONS WITHIN THE WESTERN HEMLOCK ZONE*			
WET GROUP	MOIST GROUP	MESIC GROUP	DRY GROUP
skunk cabbage *Lysichitum americanum* lady-fern *Athyrium filix-femina* devils club *Oplopanax horridum*- sword fern *Polystichum munitum*	sword fern *Polystichum munitum*- Oregon oxalis *Oxalis oregana* Alaska huckleberry *Vaccinium alaskaense*- Oregon oxalis *Oxalis oregana* coolwort foamflower *Tiarella trifoliata* sword fern *Polystichum munitum*	dwarf Oregon-grape *Berberis nervosa*- sword fern *Polystichum munitum* Alaska huckleberry *Vaccinium alaskaense*- dogwood bunchberry *Cornus canadensis* Alaska huckleberry *Vaccinium alaskaense*- salal *Gaultheria shallon* vanillaleaf *Achlys triphylla* dwarf Oregon-grape *Berberis nervosa* dwarf Oregon-grape *Berberis nervosa*- salal *Gaultheria shallon*	salal *Gaultheria shallon* Pacific dogwood *Cornus nuttallii*- vanillaleaf *Achlys triphylla*

*Adapted from *Plant Association and Management Guide for the Western Hemlock Zone* (Topik *et al.* 1986).

TABLE 2. Common and scientific names of the species most widely utilized as floral greens.

COMMON NAME	SCIENTIFIC NAME
dwarf Oregon-grape	*Berberis nervosa* Pursh
deer fern	*Blechnum spicant* (L.) Roth
scotch broom	*Cytisus scoparius* (L.) Link
salal	*Gaultheria shallon* Pursh
Oregon-boxwood	*Pachistima myrsinites* (Pursh) Raf.
sword fern	*Polystichum munitum* (Kaulf.) Presl
evergreen huckleberry	*Vaccinium ovatum* Pursh
beargrass	*Xerophyllum tenax* (Pursh) Nutt.

trees. Salal products grow best under partial shade, but growth and vigor increases as canopy shading approaches complete closure (Sabhasri 1961, Haeussler and Coates 1986, Emmingham and Hanley 1986). Although sword fern, dwarf Oregon-grape, Oregon-boxwood and deer fern also grow in openings, these species require shaded environments to develop characteristics desired by floral greens producers. During the period from crown closure to forest maturity, these plants compete among themselves and with other plants. During this period the floral greens species meet product quality standards.

As forest communities mature, many understory plant species become scarce or totally absent. Depending on the forest zone, evergreen huckleberry and Oregon-boxwood generally have low representation in successionally advanced communities. Management practices to increase constancy and coverage of specific understory plants are best applied during early to mid stages of forest succession. By combining specific management practices for floral greens with the characteristics of specific forest associations, management practices may be used which allow for joint production of understory floral greens and other forest uses.

Forest Zones

A forest zone, as used here, represents areas in which the climate over time, favors the dominance of one forest tree species (Figure 1). The subalpine fir zone is found where cold conditions and

high elevations combine to produce short growing seasons. Where precipitation levels are slightly higher, usually in the form of deep snow packs, the mountain hemlock zone is prevalent. The Pacific silver fir zone predominates where precipitation levels are slightly higher than in the subalpine fir zone and the mountain hemlock zone, but temperatures are warmer usually due to lower elevations accompanied sometimes by south and/or west aspects. As growing seasons and temperatures increase, the western hemlock zone becomes predominant. As moisture availability decreases, the Douglas-fir zone is predominant, usually at lower elevations (Figure 1).

Results

Subalpine Fir Zone

A distinct subalpine fir zone has not been classified on all the national forests in the study region. This zone on the Olympic National Forest (Henderson *et al.* 1989) contains four recognizable subalpine fir associations. The area exhibits a continental climate with wide seasonal temperature extremes. The zone is used as summer range for big game. Late snow melt allows watershed management practices designed to increase delayed water yield. Soils in this zone are well drained and shallow while forest productivity is relatively low. Due to physical constraints and the remoteness of this zone, it is not well suited to intensive forest management.

Floral Greens Production Potential

Shrub and herb populations typically have low constancy and coverage values throughout the subalpine fir zone. The only harvestable floral greens plants present are beargrass, dwarf Oregon-grape and Oregon-boxwood. On the wet/cold sites, beargrass has constancy values ranging from 30 to 50 perent with coverage values ranging from 13 to 44 percent. Conversely, dwarf Oregon-grape has medium constancy values with only 1 percent coverage (Table 3).

Management Considerations

Management for floral greens harvest in this zone will most likely occur on associations which are exceptionally productive; average sites probably will not produce at levels necessary to sustain harvest at commercial levels. Where understory plant products exist, deer and elk often browse the new growth, reducing the quality of the product. Combining poor accessibility and dry location characteristics, intensive floral greenery management is not practical.

Mountain Hemlock Zone

The mountain hemlock zone is found at high elevations, with short growing seasons (Figure 1). It occurs at elevations above 1000 m (3300 feet) in areas receiving precipitation exceeding 2540 mm (100 inches) (Henderson and Peter 1985). Most of the precipitation falls as snow, usually accumulating snowpacks of about 3.3 m (10 feet) (Henderson *et al.* 1989, Henderson and Peter 1985). The biological productivity of this zone is very low due to excessively short growing seasons caused primarily by short frost-free periods (Henderson *et al.* 1989). The forest canopy is generally continuous but interspersed with small openings. This zone is a favorite of recreationists interested in panoramic views and of watershed managers interested in mid summer water flow. This zone is also important to big game management, as summer range for deer and elk.

Floral Greens Production Potential

Because of the short growing season of this zone, only a few floral greens species have suitable growth. Deer fern and beargrass are present on most sites. Beargrass typically grows on all sites except the wettest where devils club (*Oplopanax horridum*) predominates, or on the driest where rhododendron (*Rhododendron* spp.) predominates. Despite beargrass constancy values generally exceeding 50 percent, harvestable populations are scattered with coverage values between 2 and 65 percent (Table 3). Deer fern is not as tolerant of the cold-wet climates as beargrass, but it does occur in the Alaska huckleberry (*Vaccinium alaskaense*) association, becoming scarce in the rhododendron associations. Dwarf Oregon-grape and sword fern are present on some sites, but not in amounts needed for commercial harvesting.

Management Considerations

Due to the remoteness of this zone and its low timber productivity, much of the zone remains unroaded. In those areas which are roaded and where wildlife management is not adversely affected by

TABLE 3. Average coverage and constancy values for some floral greens plant species by selected forest associations [1] (Note: not all forest associations in the region are in this table).

Forest Association	AVERAGE COVERAGE/AVERAGE CONSTANCY[2]					
	dwarf Oregon-grape	deer fern	beargrass	salal	sword fern	evergreen huckleberry
Subalpine Fir Zone:						
Pacific rhododendron[3]	1/20	–	13/30	–	–	–
big huckleberry	–	–	44/50	–	–	–
Mountain Hemlock Zone:						
Alaska huckleberry	–	1/62	2/20	–	1/10	–
big huckleberry - Alaska huckleberry[4]	–	1/16	8/83	–	–	–
Alaska huckleberry - beargrass	–	2/50	15/100	–	–	–
big huckleberry	–	1/3	20/85	–	–	–
big huckleberry - beargrass	3/12	–	41/98	–	–	–
Pacific Silver Fir Zone:						
skunk cabbage	–	3/100	5/50	15/100	1/50	–
sword fern	3/65	7/94	1/62	3/50	21/100	–
salal - Oregon oxalis	12/85	5/100	4/42	19/100	5/85	–
Alaska huckleberry/Oregon oxalis	3/10	3/100	2/24	2/31	3/68	–
salal - deer fern	5/30	4/100	30/7	23/100	2/61	–
Western Hemlock Zone:						
vine maple/vanilllaleaf	25/100	–	–	2/8	9/100	–
Pacific dogwood/vine maple	22/100	8/5	2/10	17/13	4/73	–
salal	6/80	3/24	2/17	50/100	7/53	4/17
sword fern	4/74	2/45	1/7	3/47	37/100	3/50
sword fern - coolwort foamflower	7/63	3/60	–	3/71	39/100	5/26
dwarf Oregon-grape - sword fern	18/100	2/20	2/33	3/53	26/100	–
sword fern - salal	10/87	2/31	1/5	31/100	20/100	–
vine maple - salal	11/65	2/21	2/31	35/100	15/93	12/46
Pacific rhododendron - sword fern	7/89	2/32	1/23	22/55	22/82	5/56
Pacific rhododendron - dwarf Oregon-grape	15/100	1/11	2/31	4/66	10/70	7/75
Pacific rhododendron - salal	10/90	2/25	4/39	40/99	7/60	6/75
Pacific rhododendron	7/67	2/11	2/23	9/50	9/82	41/100
salal - evergreen huckleberry	3/100	–	–	68/100	4/100	9/100
evergreen huckleberry	6/43	2/39	–	9/87	43/100	21/100
salal - dwarf Oregon-grape	23/100	2/12	2/9	42/100	11/84	23/17
Douglas-fir Zone:						
salal	17/93	–	2/51	46/100	3/78	–
salal - oceanspray	19/100	–	2/31	35/100	2/85	–
oceanspray - dwarf Oregon-grape	26/100	–	–	3/25	2/78	–
oceanspray - baldhip rose	10/94	–	2/25	4/43	3/76	–

[1]Data for this table were derived from all of the plant association guides and other sources included in the references section of this paper.

[2]Values for constancy and coverage represent a simple average of all research areas classifying the specific plant association.

[3]Scientific names for the plant species representing the individual associations are presented in the text.

[4]A "/" is used to separate layers between species, while a "-" is used to separate species in the same layer. However, readers should be aware that the plant association guides for western Washington and western Oregon have not been standardized and hence some inconsistencies exist.

the increased use during the spring and summer months, beargrass may be commercially harvested.

Beargrass is generally found in stands of all ages. It resprouts quicker following fire than following disturbances from harvesting equipment (Henderson *et al.* 1989, Wright and Bailey 1982). Unfortunately, fire also accelerates Alaska huckleberry and big huckleberry (*Vaccinium membranaceum*) repopulation, which commonly excludes tree regeneration. As a result, the use of fire to increase harvestable beargrass populations should be avoided where deciduous huckleberry species are well-represented and tree regeneration is desired.

Pacific Silver Fir Zone

The Pacific silver fir zone occupies mid- and upper-slopes above 900 m (2970 ft.) in wet climates and 1480 m (4900 ft.) in the driest environments (Figure 1). Both winter temperature and snow fall are moderate with the snowpack melting by late-spring to mid-summer. Precipitation ranges from 2120 mm (80 in.) in drier areas to amounts above 5300 mm (200 in.) in wetter areas. This zone characteristically has cool, moist, shallow soils.

Floral Greens Production Potential

The Pacific silver fir zone is the cold extreme for many of the floral greens plant species. Constancy and coverage values are low for many, but not all floral greens species.

Dwarf Oregon-grape constancy values are highly variable ranging from 3 to 85 percent, with coverage values consistently below 10 percent. Dwarf Oregon-grape production is maximized in the cool-moist associations, but its constancy values remain moderate on sites which support warm-dry associations.

Deer fern is moderately well represented, as measured by constancy, on all but the driest sites. Values normally exceed 40 percent and exceed 90 percent in 5 associations (Pacific silver fir zone/: skunk cabbage (*Lysichitum americanum*); sword fern; salal - Oregon oxalis (*Oxalis oregana*)[4]; Alaska huckleberry / Oregon oxalis; and salal - deer fern associations) (Table 3). Although coverage values are generally near 5 percent, this value represents economically feasible harvest levels because of the dense, overlapping fronds of the plant. Deer fern population numbers decrease sharply on the warm-dry sites and is generally absent on extreme warm-dry locations.

Salal is well-represented across most of the environmental gradient present in the Pacific silver fir zone. In moist climates, where sword fern is predominant, it has constancy values up to 50 percent, with coverage values below 10 percent. At the drier extreme, salal also has very high constancy values with coverage values scattered between 3 and 35 percent. Salal typically requires only sporadic openings in the forest canopy to achieve highest product quality.

Sword fern is well suited to the moist and wet climates found in the Pacific silver fir zone. Where it is predominant, it has 100 percent constancy with up to 28 percent coverage. Like deer fern, sword fern has overlapping fronds and single plants are often spaced well apart. Thus, even low coverage values often signal acceptable harvest levels. In the drier-warm sites sword fern is less common and generally considered unharvestable for commercial purposes.

Beargrass is represented in almost all plant associations in the Pacific silver fir zone, but its highest potential for commercial utilization is found where it is either a dominant or co-dominant understory species. Where it attains this dominance it has constancy values between 85 and 100 percent with coverage values from 20 to 64 percent (e.g. Pacific silver fir zone/: Alaska huckleberry / beargrass; big huckleberry / beargrass; white rhododendron (*Rhododendron albiflorum*) / beargrass; Pacific rhododendron (*Rhododendron macrophyllum*) / beargrass; and beargrass associations). Beargrass is sporadically found at harvestable levels across other associations, such as the Pacific silver fir / salal - deer fern association on the Olympic National Forest, where coverage is 30 percent with a constancy of 7 percent (Henderson *et al.* 1989).

Management Considerations

Most of the Pacific silver fir zone is classified as ecologically fragile due primarily to soil characteristics (Henderson *et al.* 1989). Many regeneration prescriptions strongly recommend shelterwood regeneration techniques to maintain soil stability

[4]A "/" is used to separate layers between species, while a "-" is used to separate species in the same layer. However, readers should be aware that the plant association guides for western Washington and western Oregon have not been standardized and hence some inconsistencies exist. A ";" is used to separate the different associations within each example.

and soil nutrients while reducing erosion (Brockway *et al.* 1983). Forest management prescriptions designed to protect soil and organic matter are strongly recommended for this zone (Henderson *et al.* 1989).

On moist and wet sites (e.g. Pacific silver fir zone/: skunk cabbage; devils club; devils club - Alaska huckleberry; sword fern; and sword fern - Oregon oxalis associations), management practices such as shelterwood regeneration harvests with minimal disruptions to understory communities are complementary to deer fern, salal and sword fern populations.

On mesic to dry sites (e.g., Pacific silver fir zone/: white rhododendron; white rhododendron/ beargrass; Pacific rhododendron - Alaska huckleberry; Pacific rhododendron / dwarf Oregon-grape; Pacific rhododendron / salal; Pacific rhododendron; Pacific rhododendron / beargrass; and beargrass associations) commercial management for beargrass, salal and dwarf Oregon-grape is preferred. Although maintenance of organic matter is a concern on these sites, prescribed burning is acceptable (Brockway *et al.* 1983, Hemstrom *et al.* 1982). In shelterwoods with low residual basal area, salal competition tends to reduce tree regeneration. Where it is present in the association, salal will regenerate from roots, rhizomes and seeds stored deep in the forest floor, especially on drier sites (Feller 1988). Salal will not be of suitable quality for extended time periods following shelterwood regeneration treatments due to stunted growth from excess sunlight and droughty conditions (Sabhasri 1961). Where salal is the understory-dominant, burning is often used to control heavy concentrations of salal so that tree regeneration has a better chance of success (Brockway *et al.* 1983). Fire stimulates salal sprouting from roots and stem bases, but regrowth is slowed for five to ten years, compared with pre-burn levels (Haeussler and Coates 1986, Sabhasri 1961). Beargrass, dwarf Oregon-grape and sword fern tend to resprout following fire (Haeussler and Coates 1986), but only beargrass thrives and is harvestable in the open environment created. As forest trees grow to near crown closure, both salal and dwarf Oregon-grape become harvestable.

Western Hemlock Zone

The western hemlock zone has high floristic diversity and aesthetic appeal. It is characterized by precipitation levels less than 4000 mm (150 in.) but above 800 mm (30 in.), with brief summer droughts (Henderson *et al.* 1989). Most precipitation falls as rain, fog or cloud drip, with minimal snow accumulations. In wetter environments it occurs up to 300 m (1000 ft.) elevation, but in dry climates it extends to 1212 m (4000 ft.) (Henderson *et al.* 1989) (Figure 1). Soils are moderately moist and deep. Forest productivity is comparatively high and understory plant species thrive in this climate. Big game species use this zone for summer range at the upper elevations and for winter range elsewhere.

Floral Greens Production Potential

Many floral greens species are found in this zone. Dwarf Oregon-grape, salal and sword fern are all present. Evergreen huckleberry is plentiful, but beargrass and deer fern are not abundant.

Dwarf Oregon-grape is well-represented in most western hemlock associations. It is best represented in the vine maple (*Acer circinatum*) / vanillaleaf (*Achlys triphylla*) and the Pacific dogwood (*Cornus nuttallii*) / vine maple associations of this zone (Table 3). It is well-represented where it is dominant to co-dominant in the understory of this zone (e.g. western hemlock zone/: dwarf Oregon-grape/sword fern; dwarf Oregon-grape - Oregon oxalis; dwarf Oregon-grape; and salal - dwarf Oregon-grape associations). Constancy and coverage values remain sufficiently high for commercial harvest opportunities throughout most of this zone, except on the coolest/wet and warmest/dry sites.

Deer fern is less abundant in this zone compared to the Pacific silver fir zone, due to decreased precipitation and brief summer droughts. Deer fern is an indicator of moist to wet environments and is found in the cool-wet to warm-moist associations (e.g. western hemlock zone/: sword fern - Oregon oxalis; Alaska huckleberry - devils club; and Alaska huckleberry / Oregon oxalis associations). On microsites where miosture is excessive and sunlight is highly filtered, deer fern is of harvestable quality, but cannot always be harvested at commercial levels or for extended periods of time. The western hemlock zone is the warm-dry extreme of deer fern occurrence.

Salal is very common in the mesic to dry western hemlock associations. It grows on only a few of the cool-wet sites. Overall, the best salal for use as floral greens is harvested from plant communities

found in this zone. Moderate soil productivity, available soil nutrients, filtered sunlight and lengthened growing season allows salal to develop under near optimal growing conditions. Salal grows at near optimal levels where elevation averages 617 m (2025 ft.) (Henderson and Peter 1985), and precipitation levels are moderately low (Topik *et al.* 1986). On these sites, salal has 100 percent constancy with coverage between 34 and 64 percent. Where salal grows exceptionally well (e.g., western hemlock zone/: salal - dwarf Oregon-grape; salal - oceanspray (*Holodiscus discolor*); salal / Oregon oxalis; salal - evergreen huckleberry; salal / beargrass; and vine maple - salal associations) constancy approaches 100 percent with coverage values of 20 to 60 percent.

Sword fern quality and quantity increase in the western hemlock zone and surpass sword fern production in most other zones. On the Mount Baker Ranger District, the sword fern association is the most common association, representing 40 percent of the western hemlock zone (Henderson and Peter 1985). On cold-wet sites sword fern is often prevalent, attaining 100 percent constancy on many associations (e.g., western hemlock zone/: sword fern; sword fern - coolwort foamflower (*Tiarella trifoliata*); dwarf Oregon-grape - sword fern; and sword fern - salal associations) (Table 3). On drier western hemlock sites, where Pacific rhododendron and salal are dominant or co-dominant understory species, sword fern attains a constancy of over 60 percent, with moderate to low coverage values (e.g., western hemlock zone/: vine maple / salal; Pacific rhododendron - sword fern; Pacific rhododendron - dwarf Oregon-grape; Pacific rhododendron / salal; and Pacific rhododendron associations). In these associations, fronds can grow more than 150 cm (59 in.) in length with a deep green color (Haeussler and Coates 1986).

Evergreen huckleberry occurs in cool-moist to cool-dry environments in this zone. In three associations (western hemlock zone/: Pacific rhododendron; salal - evergreen huckleberry; and evergreen huckleberry associations), evergreen huckleberry has 100 percent constancy (Table 3). Evergreen huckleberry prefers the dry sites in the western hemlock zone.

Beargrass is not well adapted to the western hemlock zone. In the wettest climates, beargrass is rarely abundant enough for harvesting at commercial levels. Only on the extreme cool-dry sites of the western hemlock zone does beargrass attain adequate abundance for harvest. It attains harvestable levels generally where it is dominant to co-dominant in the understory layer (e.g., western hemlock zone/: Alaska huckleberry / beargrass; salal / beargrass; Pacific rhododendron / beargrass; and beargrass associations).

Management Considerations

The western hemlock zone includes some of the most productive forest land in the region (Topik *et al.* 1986, Halverson *et al.* 1986). Specific associations such as those possessing sword fern, devils club and Alaska huckleberry as indicators of the association, are more productive than others, but non-harvestable brush species cause competition problems (Henderson and Peter 1985). As discussed, this zone accommodates a wide variety of harvestable floral greens. The seral stage and the successional status dictates the floral greens harvest level. The best floral greens products, from a commercial perspective, are found in maturing forests with semi-closed canopies.

In some western hemlock associations, salal is represented in all stages of forest development, while evergreen huckleberry is present only in early to mid stages of forest succession. Commercially harvestable levels of both salal and evergreen huckleberry occur only during mid-successional stages of forest development. By maintaining forest conditions at or near the mid-successional stage of development, both products will remain harvestable.

Both sword fern and dwarf Oregon-grape occur in selected associations at all forest stand ages. But, the highest quality products are found growing in forests of mid to late successional status. When sword fern is subjected to increased amounts of direct sunlight by overstory removal, fronds decrease in quality and become dwarfed (Haeussler and Coates 1986). Like the salal and evergreen huckleberry example, maintenance of the forest site in the preferred successional status increases product quality and harvest quantity. Harvest treatments which retain a slightly higher canopy coverage than normally practiced allows for dual product management.

Certain forest associations within the western hemlock zone allow for forest management practices which provide acceptable conditions for salal, evergreen huckleberry, sword fern and dwarf

Oregon-grape. Use of the harvest technique described previously allows multiple product management, if regeneration sources remain viable. For example, consider the western hemlock/ salal - dwarf Oregon-grape association. This specific association is recognized on the Olympic National forest (Henderson *et al.* 1989), the Mt. Hood National Forest (Halverson *et al.* 1986), the Willamette National Forest (Hemstrom *et al.* 1987), and the Siuslaw National Forest (Hemstrom and Logan 1986), while similar associations are identified on the Gifford Pinchot National Forest (Topik *et al.* 1986), the Mount Baker-Snoqualmie National Forest (Henderson and Peter 1985), in the southern Oregon coast range (Bailey 1966, Bailey and Hines 1971), and in the central portion of the western Cascades in Oregon (Dyrness *et al.* 1976). This association is characterized by mesic habitats with moderate timber productivity. There are two general successional pathways, one dominated by Douglas-fir and the other dominated by western hemlock (Henderson *et al.* 1989). The successional tendencies of this association include both salal and dwarf Oregon-grape at all stages of development. Evergreen huckleberry is abundant in early to mid development while mid to late herb layer development is dominated by large populations of sword fern (Hemstrom and Logan 1986). Forest management considerations often include enhancement of soil nutrients, organic matter and controlling brush competition (Henderson *et al.* 1989).

Floral greens occur in various amounts in the western hemlock / salal - dwarf Oregon-grape association (Table 3). Dwarf Oregon-grape coverage values span 10 to 29 percent, with 100 percent constancy. Salal also attains 100 percent constancy, but has higher coverage values ranging from 31 to 63 percent. Sword fern is usually well represented with constancy ranging between 62 and 100 percent and coverage up to 24 percent. Evergreen huckleberry is usually less represented, with constancy values averaging 17 percent and coverage averaging 23 percent (Table 3).

As tree crown shading increases, dwarf Oregon-grape and evergreen huckleberry should become harvestable. However, if the canopy layer becomes too dense, it will tend to limit understory plant species. A moderate precommercial thinning will allow understory growth to increase coverage levels for a period of years. Following thinning, salal populations tend to increase in size and product quality improves.

As the forest stand matures, evergreen huckleberry occurrence decreases and sword fern populations increase. At forest stand maturity, salal, dwarf Oregon-grape, sword fern and small amounts of evergreen huckleberry are harvestable. Before evergreen huckleberry becomes scarce, a commercial thinning to simulate earlier seral conditions can maintain or increase evergreen huckleberry populations for several years.

Douglas-fir Zone

The Douglas-fir zone usually occupies south-facing slopes at mid to low elevations in the northern range and all except north facing slopes in the southern range of the western Cascades (Henderson *et al.* 1989). The environment is characterized as warm-dry with precipitation generally less than 1000 mm (40 in.) with frequent summer droughts (Figure 1). Snow accumulations tend to be minimal. Forest productivity is low compared to other forest zones of the region.

Special Forest Products Potential

Only dwarf Oregon-grape and salal appear harvestable in this zone. The salal association (Douglas-fir / salal) on the Olympic National Forest contains salal at 100 percent constancy and 56 percent coverage (Henderson *et al.* 1989). Dwarf Oregon-grape averages 85 percent constancy with only 15 percent coverage. A similar but drier association recognized in the central portion of the western Cascades in Oregon describes a salal - oceanspray association which includes dwarf Oregon-grape at 100 percent constancy and 19 percent coverage (Dyrness *et al.* 1976). Salal also has 100 percent constancy with 35 percent coverage (Table 3). The Willamette National Forest characterizes an oceanspray - dwarf Oregon-grape association on which dwarf Oregon-grape has 100 percent constancy and 26 percent coverage (Hemstrom *et al.* 1987). Both salal and sword fern are present with low constancy levels (Table 3). The Olympic National Forest has a drier oceanspray - baldhip rose (*Rosa gymnocarpa*) association (Henderson *et al.* 1989), which is similar in many respects to the oceanspray association identified in the western Cascades in Oregon (Dyrness *et al.* 1976). Dwarf Oregon-grape ranges in constancy from 88 to 100 percent, with corresponding coverage values of 4 and 16 percent. Salal constancy ranges from 23 to 62 percent, but coverage is very low, averaging below 5 percent (Table 3). In each Douglas-fir association,

sword fern and beargrass are represented with moderate constancy and low coverage values.

Management Considerations

Floral greens management on the Douglas-fir zone is primarily limited to considerations for salal and dwarf Oregon-grape. Because many of these sites are slightly mesic to dry, often on steep southern slopes, problems arise because of soil stability and erosion. Often soil erosion and soil instability concerns preclude commercial thinnings as a management option (Henderson *et al.* 1989). Floral greens management is primarily limited to mature and overmature stands which possess the desired product(s) at acceptable levels. Management activities are limited to product identification, inventory and monitoring of harvest.

Discussion

The western hemlock zone is not only the most accessible and most productive, but also possesses the highest potential for floral greens production. Salal, evergreen huckleberry, sword fern and dwarf Oregon-grape all flourish at near optimal growing conditions. This zone is also utilized extensively for timber production, which can easily be matched with floral greens production. The Pacific silver fir zone is not as productive overall as the western hemlock zone, but it is better suited to production of beargrass and deer fern. The mountain hemlock zone has the most productive beargrass sites, but accessibility is a limiting factor to intense management.

Certain steps are necessary to ensure proper management of floral greens. First, an identification of the forest site as it pertains to forest zones and specific plant associations is necessary. This identification allows characterization of typical management concerns, while helping to identify the floral greens products available on the site.

Second, forest land managers should consider the use of longer-term rather than shorter-term leases. Nearly half of the harvest leases in 1989 lasted only one year or less. The short-term nature of these leases was partially explained by the policies of the public agencies in the region (Schlosser *et al.* 1991). Conversely, many harvesters and producers are willing to enter long-term agreements with land owners/managers. Such long-term agreements are more desirable than short-term contracts because the incentive to overharvest in a given year is reduced.

Third, the lease should be advertised and offered to as many producers and harvesters as possible. The region has about 60 producers and over 5,400 harvesters. The Washington State Department of Natural Resources has offered at least some special forest product leases which are as long as 10 years in duration and are publicly auctioned (Schlosser *et al.* 1991). This process attracts many producers and harvesters and potentially higher lease revenues.

Finally, monitoring of floral greens populations should be conducted periodically to assess the effects of the harvest process. Little is currently known about the environmental impact of removing various amounts of understory biomass yearly or every other year.

Floral greens management is a relatively new consideration to land managers in the Pacific Northwest. By entering into floral greens harvest leases, net revenues can increase significantly. Opportunities exist for improved production and utilization of the resource.

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