HUCKLEBERRY ABUNDANCE, STAND CONDITIONS, AND USE IN WESTERN OREGON: EVALUATING THE ROLE OF FOREST MANAGEMENT[1]

BECKY K. KERNS, SUSAN J. ALEXANDER, AND JOHN D. BAILEY

Kerns, Becky K. *(Pacific Northwest Research Station, USDA Forest Service, 3200 Jefferson Way, Corvallis, OR 97331, USA; e-mail: bkerns@fs.fed.us),* **Susan J. Alexander** *(Pacific Northwest Research Station, USDA Forest Service, 3200 Jefferson Way, Corvallis, OR 97331, USA),* **and John D. Bailey** *(School of Forestry, College of Ecosystem Science and Management, Northern Arizona University, Box 15018, Flagstaff, AZ 86011, USA).* HUCKLEBERRY ABUNDANCE, STAND CONDITIONS, AND USE IN WESTERN OREGON: EVALUATING THE ROLE OF FOREST MANAGEMENT. *Economic Botany 58(4):668–678, 2004. Huckleberries are major components of the understory vegetation in coniferous Pacific Northwest forests of the United States.* Vaccinium *species also have a long history of human use. However, little research has been done to ascertain how they respond to common forest management practices. We used data obtained from old-growth, young thinned, and young unthinned Douglas-fir stands in western Oregon to evaluate how forest management could potentially influence species abundance and product supply. Our analysis focused on three species:* Vaccinium ovatum, V. parvifolium, *and* V. membranaceum. *Results were variable, but indicate that overstory stand conditions and forest management can affect huckleberry species abundance. However, to assess fully the effects of forest management on these species, studies specifically designed to target areas where people harvest these products are needed. Measuring relevant product attributes such as commercial productivity is also critical.*

Key Words: Huckleberries, understory species, NTFPs, forest management, stand thinning, Pacific Northwest.

Understory species such as huckleberries (species in the genus *Vaccinium*) are important ecosystem components of forest communities in the Pacific Northwest (Oregon and Washington in the United States, and British Columbia, Canada). Forest understory species contribute to biological diversity and long-term ecosystem productivity (Alaback and Herman 1988; Halpern and Spies 1995), are well correlated with mammalian and avian abundance (Carey 1995; Carey and Johnson 1995; Morrison 1982), and are important for wildlife, contributing browse, berries, and cover (Tirmenstein 1990). Often overlooked, however, is long-standing and extensive use by humans, generating nontimber forest products (NTFPs). Current use of huckleberry plants in the Pacific Northwest in the floral market, as wild food, medicinals, and landscaping provides economic opportunities for individuals, families, and communities. In 1950, NTFPs contributed about $5 million to Oregon's economy (Cronemiller et al. 1951; Shaw 1949). The floral and Christmas greens market alone in the Pacific Northwest was estimated at $128.5 million in 1989 (Schlosser, Blatner, and Chapman 1991) and $106.8 million in 1994 (Blatner and Schlosser 1997). In some areas, extensive floral industries, in place for almost a century, depend entirely on coniferous boughs and understory plants harvested from public and private forests (M. Savage pers. comm.). These species also have a long tradition of use, and have important associated cultural and recreational value.

Forest managers are increasingly called upon to provide a wide range of ecological goods and services, including NTFPs, from public forests. Harvesters, managers, researchers, and the general public have expressed concern about the short- and long-term effects of forest management practices, such as clear-cut logging, intensive site preparation, and stand thinning (partial

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removal of the overstory canopy) on understory forest species. Many NTFP species are common in *Pseudotsuga menziesii* (Mirbel) Franco (Douglas-fir) forests that have been intensively managed for timber production. Until recently, timber activities in these areas focused on even-aged management, which consisted of clear-cut logging, intensive site preparation, tree replanting, and periodic stand thinning to maintain vigorous, evenly spaced crop trees (Hansen et al. 1991). Federal lands in this region are presently managed under the Northwest Forest Plan (USDA and USDI 1994), which has a combination of land allocations including areas that are managed primarily to protect and enhance habitat for late-successional and old-growth forest related species. Although some old-growth areas are specifically reserved, land managers are developing and using silvicultural treatments such as stand thinning in other areas to promote late-successional characteristics in younger stands (Curtis and Carey 1996; Muir et al. 2002). Regardless of management objectives, the fate of understory plant communities is frequently a function of overstory forest management practices.

Despite the known extensive human use of huckleberries, little is known about how species abundance patterns are related to common forest management practices and stand conditions. In general, understory species respond to stand thinning by increased biomass and cover, particularly for clonal species and woody shrubs (Alaback and Herman 1988; Bailey et al. 1998; Huffman, Tappeiner, and Zasada 1994; Klinka et al. 1996; Tappeiner et al. 1991; Thomas et al. 1999). Removal of canopy trees increases light, water, nutrient availability, and soil temperature. Stand thinning therefore favors species that can rapidly expand into newly available resources and tolerate lighter and warmer conditions (Covington et al. 1997; Grime 1979; Klinka et al. 1996). Alaback and Herman (1988) note that most understory species that colonized thinned plots at Cascade Head in the central Coast Range of Oregon were shade-tolerant, with animal-dispersed seeds such as fleshy berries. In western Oregon huckleberry fields where conifers have invaded, berry production increased when overstory reduction methods did the least amount of damage to understory species (Minore 1984). Understory dynamics in mature and late-successional *P. menziesii* forests are less well understood, but these stands are frequently characterized by a dynamic mosaic of patches created by old trees that have died and young trees, herbs, and shrubs that fill the gaps (Franklin and Spies 1991; Carey et al. 1999).

To evaluate how stand thinning and maintaining late-successional (old-growth) reserves could influence huckleberry species abundance and product supply, we analyzed an existing data set that had been collected from old-growth, young thinned, and young unthinned Douglas-fir stands in western Oregon. We focused on three species that have a known history of human use and were common enough in our data set for statistical analysis: *Vaccinium ovatum* Pursh (evergreen or California huckleberry), *Vaccinium parvifolium* Smith (red huckleberry), and *Vaccinium membranaceum* Dougl. (thin-leaf huckleberry).

Huckleberry Characteristics, Uses, and Markets

Huckleberries are ericaceous (Ericaceae or Heath family) shrubs that have fleshy edible berries and are common in Pacific Northwest forest plant communities (Pojar and MacKinnon 1994:57). Human use has been widely reported in the literature, which we review briefly here. We also discuss information gained from our informal conversations with harvesters, buyers, business owners, and managers, and summarize price and product information from these conversations in Table 1.

Vaccinium ovatum

Vaccinium ovatum occurs along the Pacific Coast from British Columbia to central California (Tirmenstein 1990). It is rare in the Cascade Range but grows as an understory dominant or codominant along the western coast of Oregon and is found frequently near beaches in the salt spray zone (Pojar and MacKinnon 1994:59; Tirmenstein 1990; USDA and NRCS 2000). It is erect and generally slow growing but can grow rapidly in moist, shady conditions, is long-lived, 0.5–3 m in height, and very shade-tolerant (Schlosser et al. 1992; USDA and NRCS 2000).

Native Americans have traditionally collected *V. ovatum* berries and used the leaves medicinally (Moore 1993:83; Pojar and MacKinnon 1994:59; USDA and NRCS 2000). People also collect and use the leaves and stems for personal and commercial medicinal use (Table 1), but one

TABLE 1. USES, MARKETS AND PRICES PAID TO HARVESTERS FOR THREE WILD-HARVESTED HUCKLEBERRY SPECIES.[1]

Species	Product name(s)	Plant part harvested	Product type	Use	Prices paid to harvesters (U.S.$)	Product unit[2]
Vaccinium ovatum	Evergreen huckleberry	Stems, green leaves	Floral, tip	Commercial	.60–65 (.55–.90)[3]	0.34 kg (0.75 lb), 36–41 cm (14–16 in.)
			Floral, spray	Commercial	.70	0.68 kg (1.5 lb), 61 cm (24 in)
	Red huckleberry, red-huck	Stems, red leaves	Floral	Commercial	.60–.65 (.55–.90)[3]	0.34 kg (0.75 lb), 36–41 cm (14–16 in.)
	Huckleberries	Berries	Food	Both	2.00–4.00	0.45 kg (1 lb)
	Not specified	Leaves, stems	Medicinal	Both	2.00	0.45 kg (1 lb)
	Evergreen huckleberry	Whole plant	Transplant	Commercial	Unknown[4]	1 plant
Vaccinium parvifolium	Deciduous huckleberry, sweet huck, winterbud	Stems, no leaves	Floral	Commercial	.75	0.45 kg (1 lb), length unspecified
	Not specified	Stems	Craft[5]	Both	Unknown	Unknown
	Huckleberries	Berries	Food	Personal	NA[6]	NA
	Not specified	Leaves	Medicinal	Both	Unknown	Unknown
	Not specified	Whole plant	Transplant	Both	Unknown	Unknown
Vaccinium membranaceum	Huckleberries	Berries	Food	Both	3.5	0.45 kg (1 lb)
	Huckleberry	Leaves, berries	Medicinal	Both	Unknown	Unknown

[1] Data are compiled from discussions with harvesters, buyers, and businesses in Oregon and Washington, in 2000–2001. Initial contacts were selected from referrals from the USDA Forest Service and knowledgeable people in the various industries. In total, 23 people were consulted.
[2] English units are reported parenthetically to provide industry standards.
[3] Reported range in prices 1999–2001.
[4] One private landowner charged $.50/plant for permits.
[5] Basketmaking.
[6] Not applicable.

source said that European imports of *V. myrtillus* compromised the vast majority of medicinal use of huckleberry leaves. Although Breakey (1960) reported that one company alone was shipping 500–1000 tons per year of *V. ovatum* berries from the Puget Sound area in the late 1950s, we found only two wild-food buyers that now purchase the berries for domestic sales.

Fresh aerial stems of *V. ovatum* are used in the floral market for structure and accent, and to provide a long-lasting background in flower arrangements (Blatner and Alexander 1998; Schlosser, Blatner, and Zamora 1992; Schlosser et al. 1992) (Table 1). Stems with green leaves are marketed as evergreen huckleberry, and stems with red leaves (when grown in direct sunlight the foliage turns red) are marketed as ''red huckleberry'' or ''red-huck'' (Douglass 1975; Schlosser et al. 1992). Douglass (1975) indicated that 99% of the *V. ovatum* floral market is for the fresh green foliage, which is harvested as sprays with spreading branches or as tips. Stem lengths for sprays and tips that we encountered were shorter than what others have reported in the literature (Schlosser et al. 1992); however, one business was trying to market a third type of floral product, which was a long bouquet grade (stems 60 cm and longer). Greenleaved evergreen huckleberry still composes the vast majority of the fresh floral market for this species. The red-leaved variety has a small but consistent seasonal market (fall, Christmas, Valentine's Day, and Mother's Day). We only encountered this product fresh and one source noted that it does not preserve well.

Floral harvesters collect fresh *V. ovatum* stems at low elevation, near the coast and in forests they describe as having ''not too many trees to shade it out but enough shade so that it is still dark green.'' Plants to be sold as transplants are collected from upland areas where floral stem harvesters do not pick. ''Red-huck'' is only found in open and clear-cut areas from before Christmas until about April 15th. The time frame for harvesting is based partially on market demand; however a business owner said that the foliage also has the highest quality when days are short and temperatures low. One 20-year veteran harvester picks *V. ovatum* berries in near-beach and coastal areas for commercial sale.

The floral market for *V. ovatum* is primarily domestic (some export to Europe) and of relatively minor importance compared with the major understory species used in the fresh floral market in this region, salal (*Gaultheria shallon* Pursh). *Vaccinium ovatum* stems once rivaled *G. shallon* in the Pacific Northwest fresh floral market (Douglass 1975). In 1958, the evergreen huckleberry floral market was worth $1 million annually in western Washington (Breakey 1960). The fresh floral market started shifting from *V. ovatum* to *G. shallon* in the early 1970s, and demand for *V. ovatum* decreased sharply in the early 1990s when a European species replaced its market in Europe. Although *V. ovatum* is still important in the floral market, we estimate that only about 20% of the total wild-harvested floral market in the Pacific Northwest is currently *V. ovatum* and approximately two-thirds is *G. shallon.* Likewise, the berry market for this species has declined considerably and, although there still is a small consistent market, it is likely that extensive domestication and hybridization of eastern blueberries such as *V. angustfolium* has affected the *V. ovatum* wild-harvested berry market. *Vaccinium ovatum* has also recently been planted by a large food processor with the goal of producing fruit for processed huckleberry products (C. Finn pers. comm.).

VACCINIUM PARVIFOLIUM

Vaccinium parvifolium grows from southeastern Alaska southward to central California, though only west of the Cascades and Sierra Nevada. It is the dominant huckleberry in the Oregon Coast Ranges and an important understory component in the *Tsuga heterophylla* (Raf.) Sarg. (western hemlock) zone (Franklin and Dyrness 1973:77; Pojar and MacKinnon 1994:57). It is an erect, slow-growing deciduous shrub, 1–4 m in height.

Commercial uses of *V. parvifolium* are considered minor, but coastal Native Americans collect and eat the berries and use the leaves medicinally (Pojar and MacKinnon 1994:57) (Table 1). Although there had been no previously reported floral use of this species in the literature, we encountered several uses and trade names, reflecting its recent emergence as a floral product in the Pacific Northwest 7–10 years ago (Table 1). At present, the market is small. Stems with no leaves are collected before spring regrowth and are sold as a substitute for baby's breath (*Gypsophila paniculata* L.), to use as a base for wreaths, and for basket making. For one Oregon business, this species represented about 3% of their annual purchase of forest products. In southern Oregon, harvesters collect *V. parvifolium* from clumps 5–15 ft in diameter that are located on serpentine and near-serpentine soils.

Minore (1972) noted that the small berries of *V. parvifolium* are not produced in sufficient quantity for commercial harvest, and we talked to only one commercial berry harvester. Some people collect the berries for personal use, particularly for jams or jellies. These harvesters noted that the berries ripen early in the season and are located at accessible low elevations.

VACCINIUM MEMBRANACEUM

This species occurs from Alaska south to California and eastward to Wyoming, South Dakota, Minnesota, and northern Michigan. It is common at mid to high elevations in the Cascade Mountain Range of Oregon and Washington (USDA and NRCS 2000). It is a semi-erect, long-lived shrub with moderate growth rates, usually less than 1.5 m in height. Growth rates can be rapid in moist, shady conditions.

There is no reported floral use of *V. membranaceum* stems in the literature, nor did we encounter any such use. However, the berries are considered the tastiest of the western huckleberries and have been extensively harvested by Native Americans for thousands of years and by many other people for personal use and for sale (Fisher 1997; Hunn and Norton 1984; Minore 1972; Turner, Bouchard, and Kennedy 1980) (Table 1). There has been extensive discussion in the literature about who picks huckleberries and why (Carroll, Blatner, and Cohn n.d.; Chaney 1990; Findley, Carroll, and Blatner 2000; Stark and Baker 1992) and about commercial uses and markets (Minore, Smart, and Dubrasich 1979; Schlosser et al. 1995). Minore and Dubrasich (1978) estimated that berry production in test plots on the Gifford Pinchot National Forest for this species would have been worth almost $2000/ha annually. Carroll, Blatner, and Cohn (n.d.) note that the social ecology surrounding harvest and use of huckleberries is as complex as the biological ecology.

Harvesters sell their berries to local processors and exporters in Oregon, Washington, and Montana. Historically, most berries picked were dried, and although some people still dry them, now they are mostly consumed fresh, frozen, or canned (Fisher 1997; Turner, Bouchard, and Kennedy 1980). Herbal medicine manufacturers buy leaves and berries and sell them freeze-dried in capsules, in flavored botanicals, and as extracts. Most berries collected are for the domestic market, although wild huckleberries (which includes several species) are exported from the Seattle and San Francisco customs districts to Europe and Asia (Blatner and Alexander 1998). Harvesters collect berries in open-canopy conditions and in fields where berry production is prolific.

Forest Management Effects on Huckleberry Species

To evaluate huckleberry species abundance from different stand conditions, we used field plot data collected in 1993 and 1994 from sites in young and old-growth Douglas-fir forests of the Coast and Cascade Ranges of western Oregon (Bailey et al. 1998; Bailey and Tappeiner 1998).

Study Area

Dominating much of western Oregon, coniferous forests have some of the highest productivity rates of any forests in the world (Barbour et al. 1998:590). Data from our study are from the extensive *T. heterophylla* zone, where *P. menziesii* is frequently dominant (Franklin and Dyrness 1988:70). Two major provinces make up much of the forested area in western Oregon: the Coast Range and the more interior Cascade Range (Franklin and Dyrness 1988:6). The climate is maritime, with wet, mild winters and cool, relatively dry summers, and a long frost-free period (Franklin and Dyrness 1988:42). Diurnal fluctuations are narrow (6–10°C). Annual precipitation averages 170–300 cm, occurring mainly in the winter. There is widespread variation in temperature and precipitation in relation to latitude, elevation, and topography.

Methods

The data set consisted of sites consisting of either a triad (with a young thinned, young unthinned, and associated old-growth stand) or a thinned/unthinned pair. For our analysis, the *Vaccinium* species of interest had to be present in all stand types, although occasionally they did not occur on individual sample plots. On the basis of this criterion, we selected three triad sites from the Coast Range for *V. ovatum.* For *V. parvifolium,* we selected seven triad sites and one thinned/unthinned pair from the Coast Range, and four triads and six thinned/unthinned pair sites from the Cascade Range. Only one triad site for *V. membranaceum* in the Cascade Range met our criteria.

All young thinned and unthinned stands were similar (in, for example, slope and aspect), 50–120 years old, with operational thinnings having been conducted 10–25 years before our study. These stands regenerated naturally between 1880 and 1930, typically after timber cutting and burning. No additional treatments, such as fertilization, were conducted in either stand. Adjacent old-growth stands exhibited old-growth structure, and trees were 200 years or more old. Elevation of the sites ranged from 250 to 800 m.

At each stand, 6–12 sample points were established systematically on a grid with 50- to 75-m intervals between points, depending on stand size. At each sample point, a series of nested plots was established. Understory shrubs were measured on a nested subplot with a 2.37-m radius. For sampling purposes, understory plants were divided into height-based strata. The three species of interest for this study were most common in the tall shrub layer (>1.5 m); thus we report data sampled only from the tall shrub layer. Leaf area index (LAI, m^2 of leaf area per m^2 of ground area) was estimated for the overstory canopy at each subplot center with a LAI-2000 (LI-COR, Lincoln, NE). Additional sampling details are found in Bailey et al. (1998) and Bailey and Tappeiner (1998).

We analyzed data at three nested spatial scales: local (individual site), province (Coast or Cascades), and, for *V. parvifolium*, region (western Oregon, Coast, and Cascades). Because data were not distributed normally (skewed by the high proportion of zero values and unequal variance), we used Kruskall–Wallis rank tests to determine differences for triads. If significant, pairwise comparisons were done using Wilcoxon signed tests. Wilcoxon signed tests were also used to examine thinned/unthinned pairs. The Kruskall–Wallis rank test is distribution-free and analogous to an analysis of variance; the Wilcoxon rank test is analogous to the Student's *t*-test. These procedures test whether or not the samples are drawn from the same population; however, they are sensitive to differences in central tendency, particularly the median (Howell 1992:610). Accordingly, we present medians with the 10th, 25th, 75th, and 90th percentiles. *Vaccinium parvifolium* occurred on enough sites (n = 18) to allow examination of correlations between shrub frequency and density and such site-level variables as overstory tree density, basal area, and average overstory canopy LAI. For thinned stands only, correlations were examined between shrub frequency and density, and years since thinning and percentage volume removed. Results are reported as statistically significant ($P < 0.05$) or marginally significant ($P < 0.10$).

Results

Significant differences in median *V. ovatum* frequency and density were found for the different stand types in two out of three sites examined in the Coast Range (Fig. 1). For site 1, both frequency and density of *V. ovatum* were greater in the old-growth stand than in thinned and unthinned stands. For this location, the unthinned stand had no *V. ovatum* on the subplots sampled, although the species was present within the stand. For site 2, *V. ovatum* density was greater in the unthinned stand than in thinned and old-growth stands; frequency results were similar. Data combined at the regional scale (n = 3) showed no statistically significant differences among the stand types for median frequency or density.

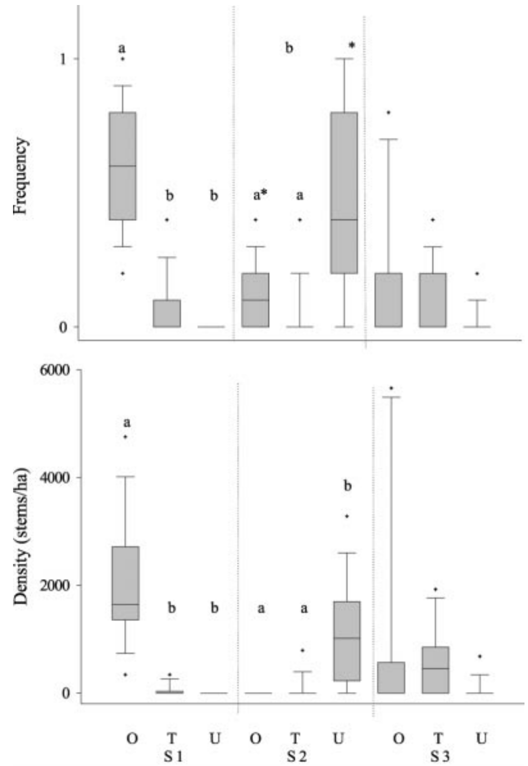

Fig. 1. *Vaccinium ovatum* frequency and density results by stand type from three Oregon Coast Range sites (O = old-growth, T = thinned, U = unthinned, S = site). Box plots show the median line, 10th, 25th, 75th, 90th percentiles and outliers. Within each site, different lowercase letters denote statistically significant differences ($P < 0.05$), and asterisks denote marginally significant results ($0.10 > P > 0.05$).

For the Coast Range, significant differences among stand types for median *V. parvifolium* frequency and density were found for five out of the eight sites examined (Fig. 2). Although results were variable, three of these five sites showed greater frequency and density of *V. parvifolium* in thinned stands (sites 1, 6, 9). Data combined at the regional scale (n = 7) showed no statistically significant trends among the three stand types for frequency or density. Correlations for median *V. parvifolium* frequency and density and overstory tree density (trees/ha), basal area, and average canopy LAI were not statistically significant. Analysis of solely thinned stands revealed no significant correla-

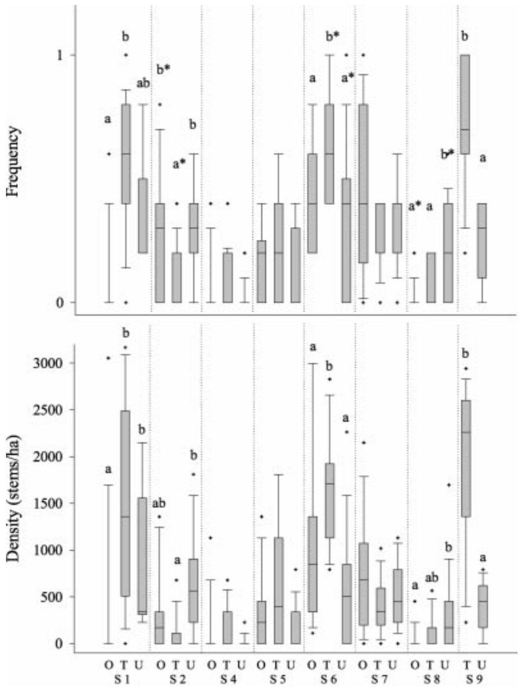

Fig. 2. *Vaccinium parvifolium* frequency and density results by stand type from eight sites in the Oregon Coast Range (O = old-growth, T = thinned, U = unthinned, S = site). Box plots show the median line, 10th, 25th, 75th, 90th percentiles and outliers. Within each site, different lowercase letters denote statistically significant differences ($P < 0.05$), and asterisks denote marginally significant results ($0.10 > P > 0.05$).

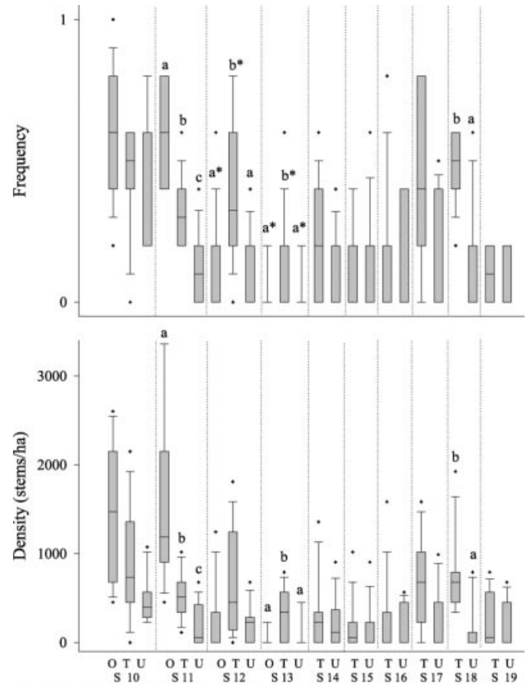

Fig. 3. *Vaccinium parvifolium* frequency and density results by stand type from 10 sites in the Oregon Cascades (O = old-growth, T = thinned, U = unthinned, S = site). Box plots show the median line, 10th, 25th, 75th, 90th percentiles and outliers. Within each site, different lowercase letters denote statistically significant differences ($P < 0.05$), and asterisks denote marginally significant results ($0.10 > P > 0.05$).

tion between shrub frequency or density and years since thinning or percentage volume removed.

For the Cascades, statistically significant differences for median *V. parvifolium* frequency among the stand types were found for four out of the ten sites examined (Fig. 3). Three of these sites were also significant for density. Only one site (site 11) showed greater *V. parvifolium* frequency and density on old-growth stands compared with thinned and unthinned stands. Three sites (sites 11, 13, 18) showed greater *V. parvifolium* frequency and density on thinned compared with unthinned stands. Data combined at the regional scale were not significant for frequency or density for triads ($n = 4$). For thinned/unthinned pairs, frequency was not significant ($n = 6$), but thinned stands had significantly higher density compared with unthinned stands ($n = 6$). *Vaccinium parvifolium* density showed a marginally significant negative correlation with overstory tree density (trees/ha), but not basal area or average canopy LAI. Analysis of thinned stands showed a significant correlation between both shrub frequency and density and years since thinning ($n = 10$, frequency $r^2 = 0.56$; density $r^2 = 0.46$). Shrub density showed a marginally significant correlation with percentage volume removed ($r^2 = 0.35$).

For the western Oregon region (Coast and Cascade data combined), no significant differences were detected for median *V. parvifolium* frequency and density among stand types for the triads ($n = 11$). Thinned stands had significantly greater *V. parvifolium* density compared with unthinned stands ($n = 7$). Correlations for *V. parvifolium* density and overstory tree density (trees/ha), basal area, and average canopy LAI were not statistically significant. Analysis of solely thinned stands showed a significant correlation between shrub frequency and density

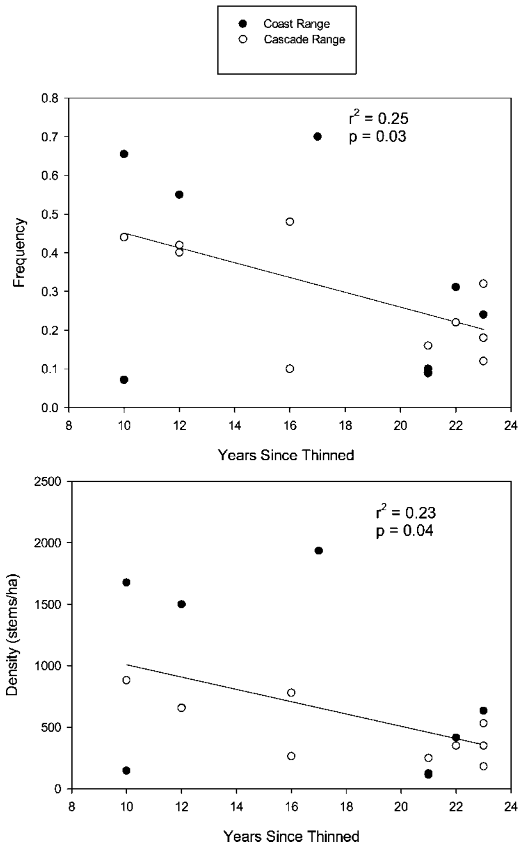

Fig. 4. Mean *Vaccinium parvifolium* frequency and density in relation to years since thinning for thinned stands. Data include all sites from western Oregon (n = 18). Note that the relationship is stronger for Cascade province sites.

and years since thinning (Fig. 4), but not percentage volume removed (n = 18).

Although *V. membranaceum* was present in three of our Cascade Range sites, analysis was limited to only one site where the shrub occurred on all stand types. At this location, *V. membranaceum* was more frequent in the old-growth and unthinned stand compared with the thinned stand (median frequency, old-growth = 0.70; unthinned = 0.40; thinned = 0.0). This shrub was also more dense in the old-growth compared with the thinned stand and marginally more dense in the old-growth compared with the unthinned stands (median density, stems/ha, old-growth = 1753.5; unthinned = 848.4; thinned = 0.0). For the two other sites not in the analysis, this shrub was present in old-growth stands only (median densities of 1423.9 and 264 stems/ha), supporting the results observed earlier.

Discussion

Our results indicate that forest management can potentially influence huckleberry species abundance and product supply. *Vaccinium ovatum* was associated with old-growth and unthinned stands, and stand thinning might not increase the frequency or density of this shrub. Pabst and Spies (1999) noted that *V. ovatum* abundance corresponded with more closed rather than open canopies for coastal Oregon riparian forests. This shrub is a slow-growing, very shade-tolerant species (USDA and NRCS 2000) that does not spread quickly, is considered to lack rhizomatous growth (Westman and Whittaker 1975), and might not be able to spread rapidly and compete for new resources created by stand thinning. Douglass (1975) notes that *V. ovatum* does not compete successfully with more aggressive understory species.

Our results indicate that in young stands, overstory stand thinning could increase the abundance of *V. parvifolium*. Across the western Oregon region, *V. parvifolium* density was significantly greater in young thinned stands than in young unthinned stands. For more recently thinned stands, this trend was more pronounced, particularly in the Cascades. In the Cascades, *V. parvifolium* density was also related to intensity of thinning. These results are consistent with those of Thomas et al. (1999), who reported a positive response to stand thinning for *V. parvifolium* cover in western Washington. Differences in our results between Coast and Cascade sites could be associated with differences in thinning operations, plant resource limitations, and competitive interactions related to each of these provinces.

Our results suggest that *V. membranaceum* can be associated with old-growth stands. Although we had only one site, these results are consistent with those of Halpern and Spies (1995). These authors reported that frequency and cover for *V. membranaceum* were significantly higher within old-growth or mature forest stands compared with young stands in the Cascade Range of Washington. Although *V. membranaceum* may be more abundant in the older stands we examined, berry production tends to decline in closed-canopy forests; however, production can be high in certain years (Minore

1984). Minore (1972) expressed concern about declines in *V. membranaceum* berry production due to conifer encroachment. Our discussions with harvesters, buyers, business owners, and managers confirmed that this is still an important concern for many people.

Although we found significant differences in species frequency and abundance related to stand conditions, results were quite variable. Influences such as site history and conditions, and location can be important in explaining huckleberry species distribution and abundance. For example, light conditions at the gap scale and particularly substrate availability (for example, downed woody material; J. Tappeiner pers. comm.) rather than stand type, may be important. Although relationships between understory species and overstory conditions are frequently generalized, site-specific predictions cannot usually be made from broad general theory, and specific recommendations about understory management are often quite complex. Harrington et al. (2002) point out that managers may have to accept a lower level of certainty or invest more in research and monitoring when managing for components of forest stands other than overstory trees.

Implications for Forest Management

Some suggest light commercial thinning to increase *V. ovatum* supply as a floral product (Schlosser, Blatner, and Zamora 1992; Schlosser et al. 1992). Heavy thinning could reduce the amount of dark green foliage. Although our data indicate that *V. ovatum* was more abundant in old-growth and unthinned stands, we were unable to determine a relationship between stand condition and commercial floral foliage quality and fruiting patterns. Vance et al. (2001:119) note that huckleberry flowering and fruiting increases in openings or after fire. However, we see little present market motivation for forest managers to apply treatments to increase supply of this species.

Our analysis showed that forest management could play an important role in increasing the supply of *V. parvifolium,* because stand thinning probably increases abundance. Unlike *V. ovatum,* heavy stand thinning would not adversely affect foliage characteristics of this species, because leafless stems were used in the floral market. We found little market motivation for increasing supply; however, because this market is just emerging, future demand may change. In contrast, *V. membranaceum* remains in high demand for Native Americans and others who collect the berries for nutritional, cultural, and recreational purposes. Although our data indicate that this species is associated with old-growth stands, it is unclear, and improbable from our discussions with harvesters, that these stands would be prolific berry production sites.

Our study suggests that overstory stand conditions and forest management can have an effect on understory species abundance. Although we were able to infer linkages between silvicultural practices and huckleberry species abundance, our results provide limited quantitative information about product yield and quality. At the stand scale, only a small percentage of the species present will be of sufficient quality for commercial harvest. Information gathered through discussions with NTFP harvesters and sellers revealed that the sites at which our data were obtained would probably not be primary targets for harvesters. This important contextual information indicated that the most productive sites for these species were near beach areas, serpentine soils, and open meadows. Therefore, specifically designed studies are needed to target areas where people harvest these products. Measurement of important product attributes such as commercial productivity is also critical. If such studies were done, models could be used to develop to linkages between biological abundance and product attributes. These models could then be applied to existing data sets, including extensive forest inventory data that are useful for landscape analysis.

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