SPECIES: Vaccinium membranaceum

INTRODUCTORY

Photo courtesy of Virginia Tech, Department of Forestry

Photo courtesy of Virginia Tech, Department of Forestry

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ABBREVIATION:
VACMEM

SYNONYMS:
Vaccinium globulare Rybd. [75]
Vaccinium membranaceum Hook [74]

NRCS PLANT CODE [156]:

VAME

COMMON NAMES:
big huckleberry
blue huckleberry

TAXONOMY:
The currently accepted scientific name of big huckleberry is *Vaccinium membranaceum* Dougl. (Ericaceae) [40,60,76,159,162].

LIFE FORM:
Shrub

FEDERAL LEGAL STATUS:
No special status

OTHER STATUS:
Big huckleberry is listed as imperiled in South Dakota [136].

DISTRIBUTION AND OCCURRENCE

SPECIES: Vaccinium membranaceum

GENERAL DISTRIBUTION:
Big huckleberry is found in Alaska and British Columbia south through the Cascade and Olympic mountains to California and east to Ontario, Wyoming, South Dakota, and Minnesota [12,40,60,75,76,159,162]. Populations also occur in 3 counties of the Upper Peninsula of Michigan on the east side of Lake Superior [159]. The Plants database provides a distributional map of big huckleberry in the United States.

ECOSYSTEMS [56]:
FRES11 Spruce-fir
FRES20 Douglas-fir
FRES21 Ponderosa pine

FRES22 Western white pine
FRES23 Fir-spruce
FRES24 Hemlock-Sitka spruce
FRES25 Larch
FRES26 Lodgepole pine
FRES27 Redwood
FRES28 Western hardwoods
FRES37 Mountain meadows
FRES44 Alpine

STATES:

AK	CA	CO	ID	MT	MI
OR	SD	UT	WA	WY	
AB	BC	ON	MB	SK	YK

BLM PHYSIOGRAPHIC REGIONS [16]:
1 Northern Pacific Border
2 Cascade Mountains
4 Sierra Mountains
5 Columbia Plateau
8 Northern Rocky Mountains
9 Middle Rocky Mountains
10 Wyoming Basin
12 Colorado Plateau

KUCHLER [90] PLANT ASSOCIATIONS:
K001 Spruce-cedar-hemlock forest
K002 Cedar-hemlock-Douglas-fir forest
K003 Silver fir-Douglas-fir forest
K004 Fir-hemlock forest
K005 Mixed conifer forest
K008 Lodgepole pine-subalpine forest
K010 Ponderosa shrub forest
K011 Western ponderosa forest
K012 Douglas-fir forest
K013 Cedar-hemlock-pine forest
K014 Grand fir-Douglas-fir forest
K015 Western spruce-fir forest
K017 Black Hills pine forest
K018 Pine-Douglas-fir forest
K020 Spruce-fir-Douglas-fir forest
K052 Alpine meadows and barren
K093 Great Lakes spruce-fir forest

SAF COVER TYPES [47]:
12 Black spruce
22 White pine-hemlock
201 White spruce
205 Mountain hemlock
206 Engelmann spruce-subalpine fir
207 Red fir
208 Whitebark pine
209 Bristlecone pine
210 Interior Douglas-fir
211 White fir
212 Western larch
213 Grand fir
215 Western white pine
217 Aspen
218 Lodgepole pine
219 Limber pine
224 Western hemlock
225 Western hemlock-Sitka spruce
226 Coastal true fir-hemlock
227 Western redcedar-western hemlock
228 Western redcedar
229 Pacific Douglas-fir
230 Douglas-fir-western hemlock
232 Redwood
237 Interior ponderosa pine
244 Pacific ponderosa pine-Douglas-fir
243 Sierra Nevada mixed conifer
245 Pacific ponderosa pine

SRM (RANGELAND) COVER TYPES [134]:
109 Ponderosa pine shrubland
110 Ponderosa pine-grassland
409 Tall forb
410 Alpine rangeland

HABITAT TYPES AND PLANT COMMUNITIES:
Depending upon environmental constraints/conditions, big huckleberry may occur as a dominant understory species with Engelmann spruce (*Picea engelmannii*), western larch (*Larix occidentalis*), limber pine (*Pinus flexilis*), ponderosa pine (*P. ponderosa*), lodgepole pine (*P. contorta*) [9,123], western white pine (*P. monticola*), western hemlock (*Tsuga heterophylla*) [123], and mountain hemlock (*T. mertensiana*) [51]. Pacific silver fir (*Abies amabilis*), subalpine fir (*A. lasiocarpa*), noble fir (*A. procera*), white fir (*A. concolor*), grand fir (*A. grandis*), Douglas-fir (*Pseudotsuga menziesii*), and western redcedar (*Thuja plicata*) [163] and are also dominant overstory species [49,63].

Common shrub associates include sticky flowering currant (*Ribes viscosissimum*), mountain snowberry (*Symphoricarpos oreophilus*) [9,24], common snowberry (*S. albus*), grouse whortleberry (*Vaccinium scoparium*), Cascade bilberry (*V. deliciosum*), red huckleberry (*V. parvifolium*) [20], Utah honeysuckle (*Lonicera utahensis*), bearberry (*Arctostaphylos uva-ursi*) [9], fool's huckleberry (*Menziesia ferruginea*) [9,42]. Other common shrub associates include white spirea (*Spirea betulifolia*) [123,142], whiteveined wintergreen (*Pyrola picta*) [20], pink mountainheath (*Phyllodoce empetriformis*), Cascade azalea (*Rhododendron albiflorum*), Sitka mountain-ash (*Sorbus sitchensis*), western moss-heather (*Cassiope mertensiana*), strawberryleaf raspberry (*Rubus pedatus*), roughfruit berry (*R. lasiococcus*) [42], little prince's pine (*Chimaphila menziesii*) [11], Rocky Mountain maple (*Acer glabrum*) [46,89], Pacific dogwood (*Cornus nuttallii*) [120], and Oregon-grape (*Mahonia repens*) [11].

Forb associates include common beargrass (*Xerophyllum tenax*) [9,20,24], Brewer's aster (*Chrysopsis breweri*) [9,24], pinewoods lousewort (*Pedicularis semibarbata*) [24], fireweed (*Epilobium angustifolium*), Sitka valerian (*Valeriana sitchensis*) [42], queencup beadlily (*Clintonia uniflora*) [20], twinflower (*Linnaea borealis*), lupine (*Lupinus* spp.) [3], Pacific trillium (*Trillium ovatum*), and threeleaf foamflower (*Tiarella trifoliata*) [20].

Pacific Northwest: Big huckleberry is well represented in subalpine habitats [14,53,112]. In mesic subalpine communities, big huckleberry is a common understory associate of Pacific silver fir and mountain hemlock [51]. Big huckleberry is an important understory component of subalpine fir forests in the eastern Olympic Mountains, Washington [50]. Within the Cascades of Oregon and Washington, big huckleberry frequently occurs on dry subalpine sites with beargrass [53,112].

Big huckleberry is a dominant species within fir/hemlock (*Abies* spp/*Tsuga* spp) stands in the Cascade Mountains, understory to Pacific silver fir, noble fir, mountain hemlock, Douglas-fir, western white pine, and western redcedar [163]. Within fir/hemlock (*Tsuga* spp) understory communities in the Cascades of southern Washington, big huckleberry is often codominant with common beargrass [53].

Big huckleberry is associated with cool western hemlock zones in the Mount Hood National Forest, Oregon. It occupies a dominant understory status in the coldest, driest portions of the western hemlock zone. When overstories are dominated by Douglas-fir and western hemlock, common associates include little prince's pine and Oregon-grape [66].

Stewart [149] compared understory composition of Douglas-fir and western hemlock stands in the west-central Cascade Range. Both stands were found on a southeast aspect at 3,740 feet (1,140 m) with a 15% slope. Fire history, mean tree age, and mean tree height were similar. Differences were in frequency of canopy gaps: Douglas-fir at 9.3% and western hemlock at 1.3%. Big huckleberry was more frequent and had greater coverage ($p<0.05$) in Douglas-fir stands:

	Western hemlock	Douglas-fir
Frequency	18	44

(%)		
Cover (%)	< 1	3.3

Rocky Mountain Region: Big huckleberry is a dominant shrub species in subalpine fir forests of northern Utah. Subalpine fir/big huckleberry habitat types are also described for south-central and southwestern Montana, eastern Idaho, and western Wyoming [100].

In Montana big huckleberry is a major undergrowth component in pole stage or older stands of Douglas-fir and subalpine fir [9]. Big huckleberry is an understory component of mountain hemlock communities in western Montana, in association with common beargrass, grouse whortleberry and fool's huckleberry [61].

Big huckleberry is an important shrub species in climax Douglas-fir/ninebark (*Physocarpus* spp.) habitat type, ponderosa pine phase in west-central Idaho, and in the Rocky Mountain maple phase of Douglas-fir/Rocky Mountain maple habitat types [146].

Big huckleberry is a frequently occurring understory species within the grand fir mosaic of northern Idaho [49]. Big huckleberry is uncommon in grand fir/Douglas-fir stands in Montana and Idaho below 3,937 feet (1,200 m) and common in higher elevations. Big huckleberry is a major understory species for grand fir/western redcedar stands when grand fir is dominant, and almost unrepresented below where western redcedar is dominant. Big huckleberry is common in intermediate aged stands of subalpine fir and limber pine on open slopes and within mature stands on mesic sites [63].

In general, big huckleberry is dominant to grouse whortleberry at lower-elevation subalpine fir habitats. At mid- and higher elevations, big huckleberry is generally subordinate to grouse whortleberry, although representation is sometimes about equal [96].

Published classifications listing big huckleberry as an indicator or dominant species are listed below:

Forest types of the North Cascades National Park Service Complex [3]
Preliminary plant associations of the southern Oregon Cascade Mountain Province [10]
Preliminary plant associations of the Siskiyou Mountain Province [11]
Plant association and management guide for the Pacific silver fir zone: Gifford Pinchot National Forest [20]
Forest habitat types of northern Idaho: a second approximation [29]
Classification of montane forest community types in Cedar River Drainage of western Washington, USA [36]
Subalpine plant communities of western North Cascades, Washington [41]
The forest communities of Mount Rainier National Park [52]
Natural vegetation of Oregon and Washington [51]
Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington [65]
Plant association and management guide for the western hemlock zone: Mount Hood [67]
Plant association and management guide: Willamette National Forest [72]
Forested plant associations of the Olympic National Forest [73]

Plant associations of the Walloma-Snake Province: Walloma-Whitman National Forest[94]
Forest habitat types of Montana [123]
Climax vegetation of Montana based on soils and climate [129]
Forest habitat types of eastern Idaho-western Wyoming [143]
The grand fir/blue huckleberry habitat type in central Idaho: succession and management [144]
Forest habitat types of central Idaho [147]
Plant association and management guide for the grand fir zone, Gifford Pinchot National Forest [155]

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Vaccinium membranaceum

GENERAL BOTANICAL CHARACTERISTICS:
Big huckleberry is a native, rhizomatous, frost-tolerant [20] shrub with stems ranging from 12 to 47 inches (30-120 cm) in height [64,74,106,162]. Leaves are alternate, elliptic to oblong [79], and small, ranging from 0.7 to 2.75 inches (1.8-7 cm) long [74,162]. Roots may penetrate to 39.4 inches (100 cm) of soil. Rhizomes are usually found within the 3.15 to 11.8 inch (8-30 cm) range of a soil profile [109]. Largent and others [91] observed a minor occurrence of mycorrhizal symbiosis.

RAUNKIAER [126] LIFE FORM:
Phanerophyte
Geophyte

REGENERATION PROCESSES:
Big huckleberry may reproduce through seed or by vegetative production from adventitious buds on rhizomes [80,140] and root crown [1]. Reproduction through seed is rare under natural conditions. Populations are usually maintained through lateral expansion of vegetative clones [80,140].

Seed: Flowers are pollinated by bees [79,99] with each stem node having the capacity to produce 1 berry [32]. A typical berry carries 47 seeds. Mean germination is around 42% [138].

Fruit production is not halted during dry summers. Fructification may occur after 4 to 6 months void of rain [33]. In the southern Washington, Cascade Mountain region, individual stems are capable of producing fruit for 14 years [32]. Although berry production is moderately tolerant of

moisture deficits, successful germination and subsequent establishment is extremely reduced or eliminated by water stress. Cool spring temperatures also negatively affect seed germination [140].

Establishment through seed is not heavily relied upon after disturbance. Number of seedlings emerging from soil blocks collected from a western hemlock/Pacific rhododendron (*Rhododendron macrophyllum*)/dwarf Oregon-grape community was monitored after experimentally applied disturbance. Big huckleberry showed no regeneration from seed after burning and mechanical mixing of soil layers [80].

Big huckleberry offers a relatively minor contribution to soil seed banks. Viable seed most often occurs within the 1st 2 inches (5cm) of soil. Kramer and Johnson [89] evaluated the soil seed banks of Douglas-fir/ninebark habitat type; grand-fir/Rocky Mountain maple habitat type; and grand-fir/big huckleberry habitat types in central Idaho. The constancy (%) of viable, buried, big huckleberry seed, by habitat type is summarized below:

Douglas-fir/ninebark	Grand fir/Rocky Mountain maple	Grand fir/big huckleberry
6	31	25

Vegetative: Big huckleberry possesses an extensive system of rhizomes [64,106], with adventitious buds distributed evenly along the length of the rhizome [106]. Vegetative production is relied upon highly for regeneration after disturbance [80]. Fruit productivity is more sensitive to solar radiation than vegetative production [32].

SITE CHARACTERISTICS:
Big huckleberry has wide ecological amplitude [108], occupying moist, moderately deep, well-drained soils [64,120]. Big huckleberry is found on moderate slopes or benches, rocky hillsides, and avalanche chutes [65,98,122,148]. Big huckleberry is rarely found in valley bottoms [82]. As an understory species, big huckleberry can grow beneath a partially closed forest canopy, or in sunny openings [54,64]. Big huckleberry has greatest potential on cool mesic sites with minimal overstory [32].

Soils: Big huckleberry prefers soils with a pH around 5.5 [111]. Clay and silt content are usually low (under 40%) leaving soil with a fine, loamy texture [138]. Relatively low concentrations of essential elements are required to sustain growth. Mesic and drier sites are preferred, although big huckleberry may inhabit soils with a wide range of available moisture [64].

In Montana, Goldin And Nimlos [58] evaluated big huckleberry presence in the Garnet Mountains in relation to soil physical properties. Big huckleberry prefers quartzite and granitic soils to limestone-derived soils possessing similar pH and gravel content. Quartzite soils resulted in the greatest coverage of big huckleberry, compared to granite and limestone derived soils:

	Relative Cover (%)
Limestone	1
Granite	9
Quartzite	16

	Quartzite	Limestone	Granite
Average organic horizon thickness (cm)	4.0	2.3	4.0
Soil texture	loam	silty loam	sandy loam
Gravel content	very gravelly	gravelly to very gravelly	slightly gravelly
pH	5.7-6.9	6.5-8.0	5.5-6.5
Calcareousness	none at surface, slight to strong at depth	slight to strong on surface, strong at depth	none

Within sites, big huckleberry grew under Douglas-fir on limestone, limber pine on quartzite and subalpine fir on granite.

Aspect/Slope: Big huckleberry prefers northern aspects [92] although populations may exist on all aspects [99]. Martin [99] observed big huckleberry to prefer moderate to steep slopes (25-40%). Gentle slopes were found to allow greater competition from other plant species.

Elevation: Elevation by geographic area is :

California [74]	3,609 to 7,217 feet (1,100-2,200 m)
Montana	3,000 to 9,650 feet (914-2,930 m)
Oregon and Washington [138]	3,000 feet (914 m) to high mountains
Utah [162]	8,202 to 10,318 feet (2,500-3,145 m)

SUCCESSIONAL STATUS:
Big huckleberry may occur in early or late seral stages [32,69,99]. It generally shows greatest productivity within sites that experienced disturbance about 50 years previously [99]. Hamilton and Yearsley [69] describe big huckleberry as a "fairly shade-tolerant" species.

Fields dominated by big huckleberry are seral.

Decline of big huckleberry as forests move toward climax status is inevitable, especially in areas of crown closure [32]. Without disturbance, big huckleberry will gradually decrease in dominance, crowded out by trees [108].

Early seral: In spruce-fir forests big huckleberry may have a significant presence within 1 to 5 postdisturbance years [22]. Response varies greatly with intensity of disturbance. In a spruce-fir forest in Idaho, big huckleberry was not a dominant shrub until 40-79 years after clear cutting, sharing understory dominance with wild ginger (*Asarum caudatum*) in sites undisturbed for 80 years or longer [133].

Habeck [62] observed big huckleberry as a common understory component of pioneer and seral communities within cedar-hemlock habitats of Glacier National Park, Montana. Big huckleberry is also an early seral species in western redcedar-western hemlock forests of northern Idaho [150].

In grand fir habitats of north-central Idaho, big huckleberry may occupy an important role in early seral stages at high elevations on north slopes [167]. Big huckleberry decreases as a major understory species of developing grand fir/Douglas-fir stands above 3,937 feet (1,200 m) in the Selway-Bitteroot Wilderness of Montana and Idaho as stands move toward maturity [63]. Big huckleberry is well represented throughout all seral stages in grand fir/big huckleberry habitat types. Steele [142] presents a detailed model of succession in the grand-fir/big huckleberry habitat type.

In subalpine prairies of the Mount Hood area, Oregon, big huckleberry is an early seral plant species [118]. Big huckleberry is greater in frequency and coverage in open stands of mountain hemlock and Pacific silver fir associations and decreases as stands close [42].

Late seral: Big huckleberry is a widespread understory dominant in late seral and climax communities in subalpine forests [4]. Within Montana, northern Idaho, and eastern Washington habitat types, big huckleberry generally shows a slow recovery increasing toward a peak at 20 to 30 postdisturbance years [92].

SEASONAL DEVELOPMENT:
Growth of big huckleberry is fixed. Leaf primordia are initiated prior to spring bud break. Seasonal growth involves shoot extension through internode elongation [59].

Throughout big huckleberry's range in Montana, flowering begins the 1st week of June with total floret development requiring 4 months (mid-July to October) [59]. Gough [59] observed vegetative and reproductive development in the Lee Metcalf Wilderness, Montana, at 6,562 feet (2,000 m) with an 80-day growing season. Shoot growth from vegetative buds on stems began in mid-May. Buds on plants where the soil was still frozen showed no bud break. Vegetative buds on shoots greater than 0.08 inches (2 mm) diameter swell before buds on thinner, less vigorous shoots. Shoot elongation occurs until mid- to late June. Seasonal shoot growth is generally completed within a 4-week period [59].

Drew [44] mapped the phenology of big huckleberry within the cedar/hemlock zone of Idaho. Onset of leaf fall was directly related to limitations in soil moisture availability. Bud burst occurred early to mid-April followed by leafing out (beginning of May) and stem elongation (May-beginning of July). Leaf fall is initiated in mid-August [44].

FIRE ECOLOGY

SPECIES: Vaccinium membranaceum

FIRE ECOLOGY OR ADAPTATIONS:
Foliage of big huckleberry is of low flammability, allowing for survival after low severity fires, with top-kill resulting from higher severity fires. Top-killed plants resprout from rhizomes.

The clonal habit of big huckleberry favors ecotypic variation among populations. Plants subjected to regular fire intervals may be better suited to surviving fire than individuals developed under fire suppression [32]. Plants are consumed by fire only when adequate fuels are present to dry and preheat stems and foliage. Seed is not an important postfire recolonization method and is rarely found in postfire areas [106].

Historically, burning of big huckleberry patches by Native Americans was a regular activity in the subalpine zone of the Cascade and Pacific ranges. To enhance production, fires were set in autumn after berry harvest. Fires reduced invasion of shrubs and trees [17]. Fields of big huckleberry in the Pacific Northwest are considered a product of uncontrolled wildfires occurring before effective fire suppression [111].

FIRE REGIMES:
Western Montana: Cool habitats dominated by lodgepole pine, with big huckleberry as a plentiful understory species, showed high severity (stand replacing) fire return intervals of 150 to 250 years in past centuries [55]. Lower subalpine stands in the Bitterroot National Forest, including stands in the Douglas-fir/big huckleberry habitat type, common beargrass phase, showed mean intervals between surface fires ranging from 17 to 28 years with a range of 3 to 67 years. At lower elevations, on montane slopes including stands in the Douglas-fir/big huckleberry habitat type, mean fire return intervals ranged from 7 to 19 years with a range of 2 to 48 years [6]. About 60% of mature subalpine fir/common beargrass stands in western Montana show evidence of surface fire [7].

Northern Idaho: Dry, lower subalpine fir habitat types where big huckleberry occurs show historic intervals between low to moderate severity fires averaging 35 years. Stand replacing fires occurred at average intervals >217 years. Severe fires occurred at intervals of 60 to 70 years in cold, dry grand fir habitats where big huckleberry is a dominant species [135].

Mixed conifer forests of the grand fir series within the Elkhorn Mountains of Oregon showed historic fire return intervals of 50-200 years on sites where big huckleberry is the dominant understory species [2]. The Douglas-fir forests of the eastern Cascade Range possess longer fire return intervals and higher fire intensities where big huckleberry is present than where big huckleberry does not occur [164].

The following table provides some fire-reutrn intervals where big huckleberry is found. Find further fire regime information for the plant communities in which this species may occur by entering the species name in the FEIS home page under "Find Fire Regimes".

Community or Ecosystem	Dominant Species	Fire Return Interval Range (years)
silver fir-Douglas-fir	*Abies amabilis-Pseudotsuga menziesii* var. *menziesii*	> 200
grand fir	*Abies grandis*	35-200
western larch	*Larix occidentalis*	25-100
Engelmann spruce-subalpine fir	*Picea engelmannii-Abies lasiocarpa*	35 to > 200
whitebark pine*	*Pinus albicaulis*	50-200
Sierra lodgepole pine*	*Pinus contorta* var. *murrayana*	35-200
Pacific ponderosa pine*	*Pinus ponderosa* var. *ponderosa*	1-47
Rocky Mountain ponderosa pine*	*Pinus ponderosa* var. *scopulorum*	2-10
Rocky Mountain Douglas-fir*	*Pseudotsuga menziesii* var. *glauca*	25-100 [21]
coastal Douglas-fir*	*Pseudotsuga menziesii* var. *menziesii*	40-240 [8,114,128]
California mixed evergreen	*Pseudotsuga menziesii* var. *menziesii-Lithocarpus densiflorus-Arbutus menziesii*	35
western redcedar-western hemlock	*Thuja plicata-Tsuga heterophylla*	> 200
western hemlock-Sitka spruce	*Tsuga heterophylla-Picea sitchensis*	> 200
mountain hemlock*	*Tsuga mertensiana*	35 to > 200 [21]

*Fire-return interval varies widely; trends in variation are noted in the Species Review.

POSTFIRE REGENERATION STRATEGY [152]:
Rhizomatous shrub, rhizome in soil

FIRE EFFECTS

SPECIES: Vaccinium membranaceum

IMMEDIATE FIRE EFFECT ON PLANT:
Big huckleberry foliage is of low flammability. Individuals may survive low intensity fires [106] with top-kill occurring on more intense fires.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:
No entry

PLANT RESPONSE TO FIRE:
Big huckleberry is adapted to sprout after fire and is efficient in storing nutrients released from burning [139]. Big huckleberry sprouts after fire from shallow and deep rhizomes [30,106] or root crown [1]. Heat penetration into soil layers where rhizomes occur will affect big huckleberry's ability to produce postfire, vegetative sprouts [106].

In preferred habitats, big huckleberry will generally survive low to moderately severe fires, attaining prefire coverage within 3 to 7 years [19,25], with stem number and density increasing. High severity burns may result in moderate to high mortality [39] or greatly reduced sprouting [71]. Moderate to severe fires on coarse textured soil or areas with a thin organic layer kill underground rhizomes, resulting in heavy mortality [25,130]. Strong decreases occur after severe broadcast burning and wildfire with recovery generally occurring within 15 to 20 years [9]. Overall, low severity burns result in heavy sprouting from rhizomes [39].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:
Low to moderate severity fire: Big huckleberry showed good vegetative response in lightly burned areas of western larch/Douglas-fir forests in western Montana. The same result was seen in moderate fires top-killing the majority of shrubs and consuming up to half of the litter [141].

A comparison of postfire big huckleberry sprouts was made after spring (May-June) and fall (September-October) fires at the University of Montana's Lubrecht Experimental Forest. The number of stems present before burns was closely related to the number of stems postburn. Spring burns produced a lower mortality of adventitious buds on rhizomes than fall burns. Moist duff and soil present during spring burns served as a heat shield. Spring burns causing rhizome mortality occurred only in areas with duff and soil of low moisture content. Results summarizing the average stem number/meter^2 on 9 sites are presented below [106]:

Spring Fires:

Before Fire (1973)	1974 (yr 1)	1975 (yr 2)	1973-1974 change in stem # (%)	1973-1975 change in stem # (%)
49.54	61.62	66.23	24.38	33.69
28.15	39.65	50.58	40.85	79.68
23.08	28.77	39.08	24.65	69.32
45.77	62.85	83.27	37.3	81.93
43.08	46.65	53.85	8.29	25.00
3.35	35.50	23.08	959.7	589.96
18.54	32.15	40.69	73.41	119.47
27.38	39.00	47.58	42.44	73.78
30.19	35.46	39.88	17.46	32.10

Fall Fires:

Before Fire (1973)	1974	1975	1973-1974 change in stem # (%)	1973-1975 change in stem # (%)
16.85	5.69	14.35	-66.23	-14.84
33.19	29.85	33.81	-10.06	1.87
18.73	37.54	46.62	100.43	148.91
34.65	38.08	47.35	9.90	36.65
97.96	92.96	117.54	-5.10	19.99
26.08	26.31	49.73	0.88	90.68
16.42	23.88	31.58	45.43	92.33
12.42	4.54	11.46	-63.45	-7.73
15.73	38.00	42.31	141.58	168.98

Moderate to high severity fire: Doyle and others [43] evaluated plant species richness 17 years after the July 17, 1974, Waterfalls Canyon Fire, in Grand Teton National Park, Wyoming. Big huckleberry dominated (30-36% coverage) the understory of adjacent unburned areas with greatly reduced coverage (approximately 7%) in moderately burned areas and almost no coverage in severely burned areas. Big huckleberry populations were greatly reduced the 1st

growing season following a high intensity fire in the Payette River drainage near, Lowman, Idaho [145].

Big huckleberry showed no postfire re-establishment through seed after the Sundance fire of 1967, a severe burn in northern Idaho [151].

In general, big huckleberry is slow to recover from moderate to high severity fire. After stand replacing fire in upland Douglas-fir/big huckleberry sites in Pattee Canyon, west-central Montana, big huckleberry showed "slow" recovery. In severely burned ravines, big huckleberry sprouted from rhizomes at depths of 3.5 to 6 inches (9 to 15 cm). Before effective fire exclusion began in the early 1900s, fire return intervals in the area averaged 15.8 years [30].

Vegetation recovery for big huckleberry after an August wildfire in Sleeping Child Creek, Bitterroot Valley, Montana was slow; density and crown volume showed little recovery after 4 postfire years [97]:

	Before burn	1	2	3	4
Plants/1,000 feet^2	113	--	2.2	18.4	28.3
	Before burn	1	2	3	4
Crown volume feet^3/1,000 feet^2	96.9	--	1.2	2.5	5.4

For further information on big huckleberry response to fire, see Fire Case Studies. Hamilton's Research Papers (Hamilton 2006a, Hamilton 2006b) and the following Research Project Summaries also provide information on prescribed fire use and postfire response of plant community species including big huckleberry:

- Revegetation in a subalpine fir forest after logging and fire in central British Columbia
- Vegetation response to restoration treatments in ponderosa pine-Douglas-fir forests of western Montana

FIRE MANAGEMENT CONSIDERATIONS:
In most areas, fire exclusion reduces big huckleberry populations over time. In Washington, a big huckleberry field of 8,000 acres (3,238 ha) within an old burn has diminished to 2,500 acres (1,012 ha), replaced by trees and brush after 40 years of fire exclusion [107]. Repeated low severity burns may control competing vegetation, enhancing big huckleberry vigor [109]. Franklin and Dyrness [51] attribute occurrence of widespread big huckleberry fields within the southern Washington Cascades to large and repeated wildfire.

The Gitxsan and Wet'suwet'en people of northwestern British Columbia used fire to manage big huckleberry fields. Burning typically occurred in the early fall, late August, and September. Late fall burns were specifically chosen to reduce fire severity and spread since fall frontal storm systems were likely to bring precipitation. Elders (women) decided burning time and scheduled fires during times they felt were prior to rainfall. Intervals between burns varied [82]. Sahaptin

and Chinook Native Americans started fires in the fall (end of huckleberry season) during periods when winter rains had begun [54].

In habitat types were big huckleberry is dominant, fires conducted when duff is relatively moist and not completely consumed result in heavy resprouts from rhizomes [39,118,127]. Low severity burning may stimulate lateral bud growth similar to pruning and assist in eradication of parasites [118]. Burning that consumes large amounts of duff is most harmful to big huckleberry regeneration [106]. Quantity of heat released by fire and relative amounts of duff and soil moisture are controlling factors [105].

In western Montana, spring burning is recommended to increase big huckleberry density within the Douglas-fir/western larch habitat type, except when lower duff and soil are dry [106]. In moist Douglas-fir habitat types of Montana, where ponderosa pine and lodgepole pine are seral components, low severity burning in the early spring stimulates big huckleberry, increasing shoot density [153]. In the Lolo National Forest, low and moderate severity surface fires increase density and nutrient content of big huckleberry in moist Douglas-fir and cool, dry Douglas-fir habitat types [35]. In the Douglas-fir/big huckleberry habitat type, spring fires and moderate amounts of shade may enhance production of big huckleberry [18].

In the grand fir series of the eastern Cascade Range, 2 consecutive fires in short intervals favor big huckleberry over grand fir, and big huckleberry may share dominance with lodgepole pine after intense fires on moist sites [1]. Dense stands of big huckleberry may not burn if fuels are limited, due to low flammability of big huckleberry foliage [106]. Density of big huckleberry may be increased by low severity surface fires in subalpine fir/big huckleberry habitat type in northern Utah [100].

In sub-boreal spruce zones of British Columbia, postfire sprouting of big huckleberry occurs almost exclusively through rhizomes. Postfire recovery is slow in the 1st 10 years postfire [69]. Likewise, in mesic and drier sites of the sub-boreal spruce zone in Canada, big huckleberry recovers slowly after fire [68].

FIRE CASE STUDIES

SPECIES: Vaccinium membranaceum

- 1st FIRE CASE STUDY:

  Underburning effects on big huckleberry in a Douglas-fir/big huckleberry community on the Lubrecht Experimental Forest, Montana

- 2nd FIRE CASE STUDY:

  Effects of fall burning on a big huckleberry shrubfield near Mount Adams, Washington

1st FIRE CASE STUDY:

Underburning effects on big huckleberry in a Douglas-fir/big huckleberry community on the Lubrecht Experimental Forest, Montana

FIRE CASE STUDY CITATION:
Tirmenstein, D., compiler. 1990. Underburning effects on big huckleberry in a Douglas-fir/big huckleberry community on the Lubrecht Experimental Forest, Montana. In: Vaccinium membranaceum. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/plants/shrub/vacmem/all.html#1stCaseStudy [2016, September 22].

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Miller, Melanie. 1977. Response of blue huckleberry to prescribed fires in a western Montana larch-fir forest. Gen. Tech. Rep. INT-188. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 33 p. [106].

SEASON/SEVERITY CLASSIFICATION:
Spring (May 11 to June 29, 1973)/light
Fall (September 11 to October 11 1973)/light

STUDY LOCATION:
The study site is located approximately 35 miles (56 km) northeast of Missoula, Montana, on the Lubrecht Experimental Forest.

PREFIRE VEGETATIVE COMMUNITY:
Most of the study area was identified as a Douglas-fir/big huckleberry-kinnikinnick (*Pseudotsuga menziesii/Vaccinium membranaceum-Arctostaphylos uva-ursi*) habitat type,

although several plots were transitional to a Douglas-fir/common beargrass (*Xerophyllum tenax*)-kinnikinnick habitat type stocked by Douglas-fir, western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*) and scattered ponderosa pine (*P. ponderosa*). Common shrubs included white spirea (*Spirea betulifolia*), and fool's huckleberry (*Menziesia ferruginea*).

TARGET SPECIES PHENOLOGICAL STATE:
Not reported

SITE DESCRIPTION:

Elevation	4,800 feet (1,460 m)
Aspect	northwest to northeast
Slope	15 to 45%
Soils	sandy, thin, and poorly developed

FIRE DESCRIPTION:
Drip torches were used to ignite strip headfires at 16-foot (5-m) intervals. Dead and down woody fuel loadings averaged 6 to 51 tons per acre (1.4-11.4 kg/m^2). Fuel and burning conditions were:

	Spring	Fall
Prefire Fuel Weight (kg/m^2):		
0-1/4 inch (0-0.635 cm)	0.7	0.10
1/4-1 inch (0.635-2.54 cm)	0.14	0.15
1-3 inch (2.54-7.62 cm)	0.43	0.57
rotten, > 3 inch (7.62 cm)	5.84	4.10
sound, > 3 inch	1.11	0.65
total, > 3 inch	6.95	4.75
Prefire duff depth (cm)	7.59	5.57
Prefire dead fuel depth (cm)	16.59	16.15
Prefire herbaceous vegetation weight (kg/m^2)	0.09	0.07
Burning Conditions:		
Windspeed (mph)	2.56	2.64
Slope (average %)	35	37
Fuel moisture (%)		
0-1/4 inch (0-0.635 cm)	10.74	20.38

1/4-1 inch (0.635-2.54 cm)	11.46	23.24
Soil moisture content (%)	29.09	12.51
Relative humidity (%)	37.44	39.45
Understory foliage moisture (%)	259.00	128.31
Ambient air temperature (°F)	68.56	59.91
Fuel reduction weight (kg/m^2)		
0-1/4 inch (0-0.635 cm)	0.02	0.04
1/4-1 inch (0.635-2.54 cm)	0.06	0.08
0-1 inch (0-2.54 cm)	0.09	0.12
1-3 inch (2.54-7.62 cm)	0.08	0.28
Total > 3 inch (7.62 cm)	4.38	3.36
Total fuel reduction	4.63	3.88
Mean duff reduction (cm)	1.74	3.85
Duff reduction (%)	24.41	53.41
Heat release ($kcal/sec/m^2$)	103.07	71.68
Average mineral soil temperature (°F)	143.56	232.73
Average duff surface temperature (°F)	252.4	359.27
Average temperature (°F) at 2.5 (cm) below duff surface	191.00	320.27
Average temperature (°F) at 5.0 (cm) below duff surface	163.89	299.27
Average temperature (°F) at 7.5 (cm) below duff surface	141.78	263.91

FIRE EFFECTS ON TARGET SPECIES:
The fire was patchy, and dense big huckleberry stands in forest openings did not burn due to lack of fuels. At the end of the 1st growing season, big huckleberry stem numbers exceeded prefire

levels on all plots. On 33% of the spring-burned plots, big huckleberry stem numbers increased 80 to 120%. On 1 plot, increases of 900% were noted, although 33% died by the following year.

On fall-burned plots, postburn year 1 stem numbers exceeded preburn levels on only 55% of the plots. The majority of plants sprouted during the 1st growing season, although some additional sprouting occurred during the 2nd year. These later sprouting plants presumably originated from deeper rhizomes. On parts of some fall-burned plots, plant density increased but elsewhere all rhizomes were killed.

Sprouting was primarily related to depth of heat penetration rather than to specific phenological development. Sprouting was common on fall-burned plots where heat penetration was slight. Maximum soil temperatures were recorded on microsites with high fuel concentrations and/or low soil moisture. High soil moisture tended to limit rhizome heating. Influence of moisture level on big huckleberry regeneration was:

	Promote big huckleberry regeneration	Inhibit big huckleberry regeneration
Lower duff moisture content	> 100%	< 70%
Soil moisture content	> 30%	< 19%
Large fuel moisture	high	low

Stem densities were also significantly related to the number of stems present prior to the burn.

FIRE MANAGEMENT IMPLICATIONS:
Fire treatment most beneficial to big huckleberry results in damage to senescent stems but does little damage to rhizomes. These conditions are often met by spring burns that occur when soil and duff are still somewhat moist. Spring burning can increase density of big huckleberry in Douglas-fir-western larch forests. For optimal increases, burning should not be attempted when lower duff and soil are dry.

Fall burns generally produce greater heat penetration than spring burns and probability of mortality is increased. Fall burns can effectively reduce big huckleberry, particularly where duff reduction is complete.

2nd FIRE CASE STUDY:

Effects of fall burning on a big huckleberry shrubfield near Mount Adams, Washington

FIRE CASE STUDY CITATION:
Simonin, Kevin, compiler. 2000. Effects of fall burning on a big huckleberry shrubfield near Mount Adams, Washington. In: Vaccinium membranaceum. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/plants/shrub/vacmem/all.html#2ndCaseStudy [2016, September 22].

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SEASON/SEVERITY CLASSIFICATION:
Cut and Burn: Fall/low
Burn: Fall/low

STUDY LOCATION:
Experimental plots were established 13 miles west of Mount Adams, Washington.

PREFIRE VEGETATIVE COMMUNITY:
The prefire vegetation community consisted of a big huckleberry (*Vaccinium membranaceum*) dominated understory followed in dominance by common beargrass, lupine (*Lupinus* spp.) and a minor grass component. Lodgepole pine (*Pinus contorta*), western white pine (*P. monticola*), subalpine fir (*Abies lasiocarpa*), Douglas-fir (*Pseudotsuga menziesii*), mountain hemlock (*Tsuga mertensiana*), and Engelmann spruce (*Picea engelmannii*) made up the invading forest canopy. Forest canopy trees were immature, short, and poorly formed, often showing considerable snow damage. Within cut and burn treatments all invading tree species were felled by chainsaw in the 2nd week of August. Lodgepole pine dominated the overstory canopy in the burned treatment followed by western white pine, mountain hemlock, subalpine fir, willow (*Salix* spp.), Engelmann spruce and Douglas-fir:

	Lodgepole	Western	Mountain	Subalpine	Willow	Engelmann	Douglas-	Total

	pine	white pine	hemlock	fir		spruce	fir	overstory
Average overstory cover	11.8	2.6	1.7	1.3	1.0	0.4	0.3	19.1

TARGET SPECIES PHENOLOGICAL STATE:
Not reported

SITE DESCRIPTION:
Experimental treatments occurred at 4,000 feet (1,219 m) on a gently sloping, west by southwest aspect. Soils were shallow and low in nutrients, with a gravelly coarse texture. Specific soil properties are summarized below:

Property	0-15 (cm)	16-30 (cm)	31-46 (cm)
pH	5.6	5.6	5.8
CEC* (meq/100 g)	13.19	13.10	11.66
N (%)	0.11	0.07	0.05
P (ppm)	14.00	6.00	3.00
K (ppm)	28.40	16.40	11.20
Ca (meq/100 g)	1.04	0.70	0.39
Mg (meq/100 g)	0.08	0.07	0.05
Na (meq/100 g)	0.02	0.02	0.03
Boron (ppm)	0.22	0.22	0.20
Acetate extractable Fe (ppm)	42.00	53.00	168.00

* CEC (cation exchange capacity)

FIRE DESCRIPTION:
Burns were conducted the 1st week of October, 5 days after a 4-inch (10 cm) snow that fell on 25 September and then melted. Meteorological measurements at the time of burn were recorded from a weather station 5 miles away at the same elevation:

Average temperature	66 degrees Fahrenheit (19 °C)
Relative Humidity	35%
Wind	dry, east, 7 miles/hour (11 km/hr)

Flamethrowers and diesel fuel were used to initiate burns.

Cut and Burn: Although slash would not carry fire, plots were burned applying flamethrowers over the entire area. Fine fuels and herbaceous vegetation were consumed.

Burn: Little understory fuel was present and fire could not be kindled or spread. Diesel fuel and flamethrowers were used to deliberately burn herbaceous vegetation and lower tree branches. Fine fuels and herbaceous vegetation were consumed. Coarse fuels and duff were blackened. Most trees were killed immediately; others were severely injured.

FIRE EFFECTS ON TARGET SPECIES:
Cut and Burn: Big huckleberry leaves were consumed with stems blackened but not consumed.

Burn: Big huckleberry leaves were consumed with a few stems surviving.

Berry production (kg/ha) was severely reduced on both cut and burn, and burn treatments:

	Preburn (1972)	1973[1]	1974	1975	1977[2]
Cut and burn	--	0	0	0.27	0.15
Burn	83.01	0	0.03	1.81	4.90
Control	99.30	0	132.15	137.53	35.06

[1] Destroyed by spring frost
[2] Majority of berries destroyed by severe August hailstorm

Average overstory cover for 4 postburn growing seasons:

	Big huckleberry	Lodgepole pine [1,2]	Western white pine [1,2]	Total competing species [3]
Preburn (1972):				
Cut and Burn	--	--	--	--
Burn	18.4	9.7	2.7	65.6
Control	22.1	9.3	4.9	58.8
1973:				
Cut and Burn	4.1	0	0	36.5
Burn	5.7	0.2	0.1	38.9

Control	18.2 *	7.3	4.1	53.5
1974:				
Cut and Burn	8.8	0	0	42.9
Burn	15.1	0.6	0	40.7
Control	22.5 *	6.6	3.0	47.2
1975:				
Cut and Burn	6.7	0	0	23.3
Burn	18.1	0.6	0.1	33.1
Control	22.6 *	8.1	3.8	44.1
1977:				
Cut and Burn	11.6	0.1	0	54.5
Burn	18.8	0.7	0.1	59.4
Control	24.4	5.5	2.4	57.2

[1] Major overstory tree species, original reference documents coverage data for all plant species present.
[2] Represents coverage above 3.28 feet (1 m); below was recorded within total competing species coverage.
[3] Includes standing trees, tree regeneration, shrubs and herbs
* $p<0.05$ between control and treatments

FIRE MANAGEMENT IMPLICATIONS:
Fire treatments most beneficial to big huckleberry occur during relatively moist conditions. Damage to rhizomes is reduced when soil and duff are relatively moist. Burning may increase density of big huckleberry when conditions conducive to low heat transfer throughout the soil are present.

MANAGEMENT CONSIDERATIONS

SPECIES: Vaccinium membranaceum

- OTHER MANAGEMENT CONSIDERATIONS

IMPORTANCE TO LIVESTOCK AND WILDLIFE:
Big game: Big huckleberry is a good food source for grizzly bears and black bears [34,161] and is a key food item for bears in Montana [117]. Bears feed upon berries, leaves, stems [5], and roots [84]. Big huckleberry is the dominant huckleberry species consumed by grizzly and black bears of Glacier National Park, Montana [84] and a major shrub food item in Yellowstone National Park [88]. Bears may begin feeding upon big huckleberry berries in mid-July at lower elevations 3,000 to 3,937 feet (900-1,200 m) of Glacier National Park [161].

Big huckleberry is a minor component in the summer diet of western Montana elk [45]. Elk feed on big huckleberry when leaves are young and tender [165]. Big huckleberry also provides browse for moose in north-central Idaho [124].

Big huckleberry is an important species for white-tailed deer in grand fir and western redcedar forests of northern Idaho, with greatest use occurring in the fall [86].

Avian: Although not preferred, big huckleberry provides a fall food source for blue grouse in Oregon [31] and is an important food source for ruffed grouse [77].

PALATABILITY:
Overall palatability of big huckleberry has been rated as [38,87,99,144,165]:

	ID	MT	Eastern OR	WA	WY
Cattle	----	poor	----	----	----
Domestic sheep	good	fair	good	good	----
Horses	----	poor	----	----	----
Pronghorn	----	----	----	----	poor
Elk	fair to good	----	----	good	----
Mule deer	good	fair	----	----	good
White-tailed deer	good	----	----	----	good
Small mammals	----	----	----	----	good
Small nongame birds	----	----	----	----	good
Upland game birds	-----	----	----	----	good
Waterfowl	----	----	----	----	poor
Grizzly bear	----	good	----	----	good
Black bear	good	good	good	good	good

NUTRITIONAL VALUE:
Nutritional value of big huckleberry has been rated for Wyoming as [87]:

Elk	good
Mule deer	good
White-tailed deer	good
Antelope	poor
Upland game bird	good
Waterfowl	poor
Small non-game bird	good
Small mammals	good

Light intensity (litter temperature of 150 degrees Fahrenheit (66 °C) at 1.9 inches (5 cm)) slash burning, after a clearcut in subalpine fir/queencup beadlily habitat type composed largely of Douglas-fir and western larch, had no significant effect ($p > 0.05$) on big huckleberry nutritional value [137].

COVER VALUE:
Big huckleberry provides hiding or resting cover for several wildlife species. Dense thickets provide good cover for many smaller birds and mammals. Cover value of big huckleberry has been rated as follows for Wyoming [87]:

Pronghorn	poor
Elk	fair
Mule deer	fair
White-tailed deer	fair
Small mammals	good
Small nongame birds	good
Upland game birds	good
Waterfowl	poor

VALUE FOR REHABILITATION OF DISTURBED SITES:
The Wind River Nursery [70] in Carson, Washington, provides suggestions for successful big huckleberry propagation. Initial planting is recommended in flats with subsequent transplanting of germinants to individual pots. Flats should be covered with glass or plexiglass to reduce soil moisture loss and placed in a cool location (large refrigerator or unheated greenhouse) to provide cool moist stratification. After stratification, flats should be transferred directly to heated greenhouse for germination. Seedlings should be hand transplanted to pots.

Propagati	Seed	Seed	Stratificati	Seed	Seedlin	Seedling media	Other

on method	collection	extraction	on	planting	g container		treatment
seed	summer	mash fruit with water, separate	short/cool	tray	10-15 cm pot	Perlite/vermiculite/peat moss or Perlite/vermiculite/barkdust	inoculation with mycorrhizae

Flowering by new seedlings usually requires 3 growing seasons [113].

OTHER USES AND VALUES:
Big huckleberry is historically an important food item in the diet of many Pacific Northwest Native Americans [78,82,84,93,118].

Big huckleberry may hybridize with *Vaccinium* cultivars, producing drought-resistant cultivars for the West Coast [33].

OTHER MANAGEMENT CONSIDERATIONS:
Silviculture: Postlogging treatments are the most influential variables on big huckleberry productivity [99]. Initial decreases of big huckleberry in logged areas are common.

Big huckleberry decreases after clearcutting without site preparation or slash treatment, clearcutting followed by broadcast burning, and clearcutting with mechanical scarification (dozer piling and burning) within Douglas-fir/ninebark, Douglas-fir/big huckleberry, subalpine fir/common beargrass, and subalpine fir/fool's huckleberry habitat types of western Montana.

Douglas-fir forests: Within the Douglas-fir/big huckleberry habitat type, strong decreases in big huckleberry occur after disturbance. Big huckleberry is drastically reduced after overstory removal in the Douglas-fir/big huckleberry habitat type of west-central Montana. [9].

Subalpine fir forests: Moderate decreases in big huckleberry after clearcutting without site preparation or slash treatment are associated with subalpine fir/common beargrass habitat type, big huckleberry phase. Strong decreases in big huckleberry occur after clearcutting followed by broadcast burning or stand replacing wild fire. Stand replacing wildfires without clearcutting have the quickest recovery. Within the subalpine fir/fool's huckleberry habitat type little or no decrease occurs after clearcutting without site preparation or slash treatment, and light to moderate broadcast burning [9].

Depending upon moisture regimes, clearcut logging that leaves the understory intact could decrease productivity of big huckleberry fields. Removal of forest cover on dry, south-facing slopes exposes big huckleberry to sun, wind, and frost, or winter desiccation damage. Big huckleberry shows a greater tolerance of overstory removal, clearcutting, and wildfire within subalpine fir/common beargrass habitat type in north-west Montana, than in dry west-central Montana [9].

Plant species composition was evaluated in a moist Engelmann spruce-subalpine fir forest in southeastern British Columbia. The area was logged during summer using conventional ground skidding. Two years later a broadcast burn was implemented on 27 August. Engelmann spruce seedlings were planted in the area during September at 648 trees/acre (1,600 trees/ha). Five years later, big huckleberry had a greater frequency of occurrence within slash burned areas than in the sidecast (shown in the paper as the downhill, filled edge of the skid trail), mid-trail, and cutbank areas of skid trails [121]:

	Slash burn	Sidecast	Mid-trail	Cutbank
Frequency (%)	60	20	16	8
Cover (%)	11.5	1.6	2.3	0.4

Big huckleberry was slow to develop even in slash burn areas, showing 3% coverage at 3 postburn years, 6.7% coverage at 4 postburn years, and 11.5% coverage at 5 postburn years [121].

Soil scarification through mechanical means (bulldozing) does not promote big huckleberry growth [130].

Laursen [92] provides detailed models for predicting height and cover of big huckleberry following management disturbance. Model equations were generated following observations in the Douglas-fir to mountain hemlock zones throughout northern Idaho, eastern Washington and western Montana.

Martin [99] provides specific management recommendations for big huckleberry within subalpine fir/common beargrass-big huckleberry habitat type; subalpine fir/queencup beadlily-menziesia habitat type; subalpine fir/queencup beadlily-common beargrass habitat type; and subalpine fir/menziesia habitat type.

Coates [25] provides a general description of big huckleberry response to a variety of silvicultural treatments in British Columbia :

Treatment	Big huckleberry response
Overstory removal	Berry production increases, with population numbers increasing slowly.
Manual cutting	Sprouting and suckering occurs but recovery is slow and may take 3 to 7 years to regain pretreatment levels. Increases in number and density of stems are common.
Mechanical site prep	Likely to reduce frequency and cover for several years.
Chemical	Tolerant to very tolerant to glyphosate; 2,4-D as early foliar spray

treatments	kills aerial parts with sprouting occurring the following season.

Recreation Management: Cole and Trull [28] evaluated big huckleberry response to recreational disturbance (human trampling) on the east slopes of the North Cascades. Big huckleberry was not tolerant of trampling. Decreases in vigor occurred after trampling, with little recovery the following growing season. Results from trampling experiments (a one-way walk at a natural gait by a 154 lb (70 kg) trampler in lug-soled boots) in subalpine fir stands are summarized below:

Number of passes	Cover (%): after trampling	Cover (%): 1 year recovery
25	93	69
75	54	46
200	6	44
500	0	40
700	--	--

Similar results of low resistance and low recovery potential to summer trampling were seen in the Bob Marshall Wilderness, Montana, [27].

Berry Production: Several abiotic and biotic factors determine the extent of fructification by big huckleberry. Greater berry production occurs in soils high in organic matter. Soil moisture availability will affect quality and quantity of berry production within a growing season [138].

Pruning can significantly ($p < 0.05$) increase vegetative production of big huckleberry through increased lateral bud development. Bud elongation usually begins within a few weeks of stem clipping, with buds nearest to point of stem removal developing 1st. Pruning date has no direct effect upon amount of lateral bud break if conducted before early July. Pruning after July may suppress lateral bud swelling and elongation through initiation of fall dormancy. Mid-June and early July pruning produced significantly less ($p<0.05$) lateral bud growth than earlier pruning [107]:

Treatment date	Mean # lateral shoots developing	Mean shoot growth (mm)
19 May	2.97	92.67
1 June	2.63	59.20
15 June	2.70	19.67
8 July	2.20	17.93
4 August	1.47	3.07
Control	0.30	2.43

Berry production usually decreases with increased forest overstory [110]. In Montana, aspect has the greatest effect upon berry production. Fruit decreases from optimum northwest aspects to north, northeast, then from east to west. Canopy cover is inversely related to berry production; however, south or west aspects show no inverse relation. On south and west aspects, canopy removal may decrease population due to subsequent moisture stress [99].

According to Martin [99], in disturbed sites berry production is generally delayed at least 5 years. Berry production increases 15 to 20 years after wildfire on mesic north or east aspects and 5 to 10 years if sites are clearcut and broadcast burned.

Although coverage of big huckleberry may have a positive response to fire disturbance, berry production is usually delayed. Overstory removal with minimal huckleberry disturbance is recommended to increase berry production. Frilling (2,4-D applied to frills cut in trees) and girdling are 2 methods that effectively remove an overstory with minimal disturbance [113]. Fields of big huckleberry, productive for huckleberry picking, have developed after fires within some areas of mountain hemlock-subalpine fir forests in Washington and Oregon [95].

Herbicide application (2,4-D) along with cut and burn treatments were evaluated to monitor effect on big huckleberry berry production within a Pacific silver fir forest zone in Oregon. Frill treatments (herbicide 2,4-D and water) applied to stem incisions, were carried out on overstory trees larger than 2 inches (5 cm) d.b.h. in July. Spraying of 2,4-D in late July on all vegetation below 9.8 feet (3 m) was also implemented. The cut and burn treatment consisted of overstory removal followed by an August broadcast slash burn which killed, but did not consume, shoots. Berry production in kg/ha, 5 and 7 posttreatment years, is summarized below [110]:

Treatment	5 post-treatment years	7 post-treatment years
Frill	200.1	122.6
Cut and burn	76.7	51.7
Spray	57.2	38.5
Control	108	29.9

Girdling is suggested as a nonchemical approach to achieve results produced by the frill treatment [110].

Indirect application of herbicides may have a profound negative effect on big huckleberry, producing high mortality. Glyphosate may provide minor control of big huckleberry [101]. Top-kill and prevention of subsequent growing season resprouts maybe obtained through use of 2,4-D [104] and triclopyr [102,104]. Miller [103] provides a summary of herbicide control within the inland Northwest.

Within subalpine fir/big huckleberry habitats of northern Utah, berry production is increased when the relative amount of direct sunlight received is increased [100]. Overstory shading has no effect on berry sweetness [112].

Stark and Baker [138] provide information on ecology and culture of big huckleberry for those interested in cultivation or more intensive field management.

Vaccinium membranaceum: References

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