BERRY PRODUCTION IN THREE WHITEBARK PINE FOREST TYPES

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ABSTRACT

In the whitebark pine /whortleberry (Pinus albicaulis/ Vaccinium scoparium) *habitat type of southwestern Montana, whortleberry plants produced seven to 69 berries / m² x yr in 1974. In subalpine fir* (Abies lasiocarpa) *habitat types of northwestern Montana, huckleberry plants* (Vaccinium globulare) *may produce from 13 to 228 berries / m² x yr. While removal of competing trees increases production, thinning the understory apparently reduces berry production in direct proportion to the shrubs removed; there is no compensatory production indicative of shrub-shrub competition in fully vegetated plots. Fifty- to 100-fold variation in production among years in* Vaccinium globulare *berry production is attributed to variation in weather conditions.*

INTRODUCTION

Vaccinium species are common associates of whitebark pine (*Pinus albicaulis*). Whortleberry (*Vaccinium scoparium*) dominates the understories of relatively dry high-altitude forests in which whitebark pine is either climax (*Pinus albicaulis/Vaccinium scoparium* and *Abies lasiocarpa-Pinus albicaulis/Vaccinium scoparium* HT's) or seral (*Abies lasiocarpa/Vaccinium scoparium* HT). Lower in whitebark pine's altitudinal range, and especially on relatively moist sites near the Canadian border, one also finds huckleberry (*Vaccinium globulare*) in communities including *Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare* HT (Martin 1979). Habitat type (HT) and plant association names follow Pfister and others 1977.

Vaccinium berries are important foods of bears (black and grizzly), birds (Clark's nutcracker, Cassin's finch, flickers, ravens, and robins), small mammals (squirrels, redbacked voles, and deer mice), and humans; and their production is therefore of interest to wildlife managers. This note summarizes our observations on the variation in berry production with changes in habitat type, overstory cover, shrub cover, and year.

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METHODS

Two independent studies were conducted, one in the Madison Range of southwestern Montana near Bozeman, and the other in the Glacier National Park and Whitefish Range in northwestern Montana.

Whortleberry fruit densities in the understories of five *Pinus albicaulis/Vaccinium scoparium* forests in the Madison Range study were determined by counting the berries in m² quadrats placed at alternate meters along the center line of 10- by 30-m plots sampled in a study of forest productivity (Forcella 1977; Forcella and Weaver 1977). Berry density was also recorded in a clearcut ski-run between the two forest stands measured on Lone Mountain (Madison Range near Bozeman, MT). All berry counts were made during August of 1974.

Huckleberry fruit densities were measured in relatively young forests on *Abies lasiocarpa-Pinus albicaulis/ Vaccinium scoparium* and *Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare* habitat types in the Rocky Mountains of Glacier National Park and in the adjacent Whitefish Range. Whitebark comprised relatively low percentages (4 to 40 percent) of the forest canopies, both because whitebark pine is being eliminated from the stands by white pine blister rust (Hoff and Hagle, this proceedings; Kendall and Arno, this proceedings) and because whitebark is never fully dominant in the relatively moist climate of the area (Arno and Weaver, this proceedings). Annual counts (1983-88) were made in seven forests; 20- by 20-cm plots were placed at 50 points located by pacing from permanent stakes along specified compass lines. While *Vaccinium scoparium* was present in some of these plots, its berries were never counted.

AVERAGE BERRY PRODUCTION IN WHITEBARK PINE STANDS

Average whortleberry production ranged from seven to 69 berries/m² in five closed *Pinus albicaulis/Vaccinium scoparium* stands observed in southwestern Montana during the summer of 1974 (table 1). Because July-August precipitation in 1974 was 132 percent of normal and precipitation in the preceding August was 119 percent of normal (USDC 1973-1989), these yields are probably average or above average. The average whortleberry weighed (dry) 0.0075 g.

During the 1983-88 period, huckleberry production averaged 45 to 228 berries/m² in three *Abies lasiocarpa-Pinus albicaulis/Vaccinium scoparium* stands and 13 to

Table 1—*Vaccinium* berry production (berries/m²) in three habitat types

Environmental type (HT)[1]	Location[2]		Year	Arboreal cover	Wortleberry Cover	Wortleberry Berries	Huckleberry Cover	Huckleberry Berries
				Percent	*Percent*	*Per m²*	*Percent*	*Per m²*
PIAL/VASC[3]	Madison	1LM	1974	73	42 ± 3	68 ± 9	none	present
	Madison	1-2	1974	0	48 ± 4	372 ± 47	–	–
	Madison	2LM	1974	97	44 ± 4	52 ± 9	–	–
	Gravelly	10MM	1974	52	31 ± 3	69 ± 10	–	–
	Elkhorn	11	1974	40	21 ± 2	7 ± 2	–	–
	Tobacco Rt	14	1974	56	50 ± 3	15 ± 4	–	–
ABLA-PIAL/VASC[3]	Lewis	2DF	1983-1988	4	0	not	60	135 ± 65
	Lewis	3MB	1983-1988	22	26	counted	30	45 ± 15
	Apgar	6HM	1983-1988	0	30	–	35	228 ± 141
ABLA/XETE-VAGL[4]	Whitefish	1MO	1983-1988	24	35	–	50	34 ± 7
	Whitefish	2MO	1983-1988	44	60	–	35	13 ± 5
	Lewis	1MB	1983-1988	16	35	–	52	64 ± 14
	Lewis	1TM	1983-1988	42	0	–	70	33 ± 7

[1]Habitat types are *Pinus albicaulis/Vaccinium scoparium*, *Abies lasiocarpa-Pinus albicaulis/Vaccinium scoparium*, and *Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare* (Pfister and others 1977).
[2]Locations are given by mountain range and site number. PIAL/VASC sites are described in more detail by Forcella 1977.
[3]*Vaccinium scoparium* (VASC) standard errors represent quadrat to quadrat variance, $n = 15$.
[4]*Vaccinium globulare* (VAGL) standard errors represent year to year variance, $n = 50$.

64 berries/m² in four *Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare* stands in northwestern Montana. Huckleberry weights (dry) range from 0.02 to 0.11 g and average 0.06 g (Stark 1990).

OVERSTORY-UNDERSTORY COMPETITION

Removal of the whitebark canopy in an area between stands 1LM and 2LM resulted in a sixfold increase in whortleberry fruit production (table 1). Regression of huckleberry production against overstory cover indicates exponential decreases in berry production with increases in overstory cover; the equation [berries/m² = 214 e (– 0.075 canopy cover)] explains 96 percent of the variance in the berry production data ($r^2 = 0.96$) and has a probability of 0.001. Removal of the tree canopy also increased huckleberry production in nonwhitebark forests (Minore 1972; Zager and others 1980).

The inhibition of berry production by tree canopies is often attributed to lack of light energy (Dahlgreen 1984; Martin 1983). Other hypotheses seem equally good. Since the failure of tree seedlings in closed forests is sometimes due to lack of water or nutrients rather than lack of light (Watt and Fraser 1933; Weaver 1974), and since the failure of seedlings in whitebark forests appears to be more likely due to edaphic than light factors (Weaver and others, this proceedings), berry production might also be limited by an edaphic factor. An additional possibility is that berry production might decrease with increases in canopy cover if lack of light inhibited pollinators or promoted flower- or fruit-attacking fungi.

COMPETITION AMONG SHRUBS

If berry plants compete, one expects the production per unit area covered to fall with increases in percent of shrub cover. The hypothesis of strong within-species competition among whortleberry plants is negated by the linear rise in berry production with increases in *Vaccinium* cover both in closed stands (berries/m² = 0.65 cover + 18.75, $r^2 = 0.56$) and in logged stands (berries/m² = 9.85 cover – 102, $r^2 = 0.66$, $p = 0.0$). In huckleberry stands neither we nor Martin (1983) found any correlation between shrub cover and berry production.

WEATHER AFFECTS HUCKLEBERRY PRODUCTION

Huckleberry fruit production varied considerably among years with notable lows across most stands in 1984 and 1987 (table 2). Year-to-year variance surely depends on a succession of weather-condition effects on flower initiation, pollination, winter kill, plant carbohydrate stores, and photosynthesis during the berry-filling period. The poor production observed across all stands in 1984 and 1987 suggests a common meteorological cause. We (1) hypothesize that water was the factor most likely responsible, (2) eliminate rainfall in the bearing season as a factor because, while 1984 was dry, 1987 was wet, and (3) speculate that the failed crops were due to drought during the flower bud initiation season, because the Augusts preceding both 1984 and 1987 were very dry (table 3).

Table 2—Annual variation in huckleberry berry production (in percent of maximum berry count/m^2)

Site	Max/m^2	1983	1984	1985	1986	1987	1988
2DF	410	60	15	11	100	0	11
3MB	95	48	19	89	34	0	100
6HM	512	100	18	99	29	0	21
1MO	58	86	21	48	45	47	100
2MO	29	86	3	31	14	31	100
1MB	95	77	57	100	88	3	771
1TM	51	86	10	94	100	55	47
Berry index[1]		17	36	19	21	36	20

[1]Berry yields were recorded in seven stands for 6 years. Yields were ranked across years by giving the high production a 1, the low production a 6. Ranks were summed across stands to index the productivity of each year. Productivities were similar in all years except 1984 and 1987 when high scores indicate poor crops.

Table 3—Precipitation (inches) in West Glacier, MT. Months with less then half of normal precipitation are asterisked

Month	Year: Berry Index[1]:	1982	1983 17	1984 36	1985 19	1986 21	1987 36	1988 20	Normal
May		1.40	0.96*	3.54	3.00	2.55	1.96	3.27	2.51
June		2.48	4.41	2.83	1.77	3.44	2.05	1.58*	3.42
July		2.58	4.70	.42*	.09*	3.02	3.32	1.56	1.44
August		.89	.52*	.73*	2.08	.54*	2.20	.36*	1.49
September		2.12	1.43	3.61	4.83	3.49	.33*	1.83	2.25

[1]High berry yield indices from table 2 indicate low yields in 1984 and 1987. While one summer was dry (1984) and the other one was wet (1987), both were preceded by dry Augusts.

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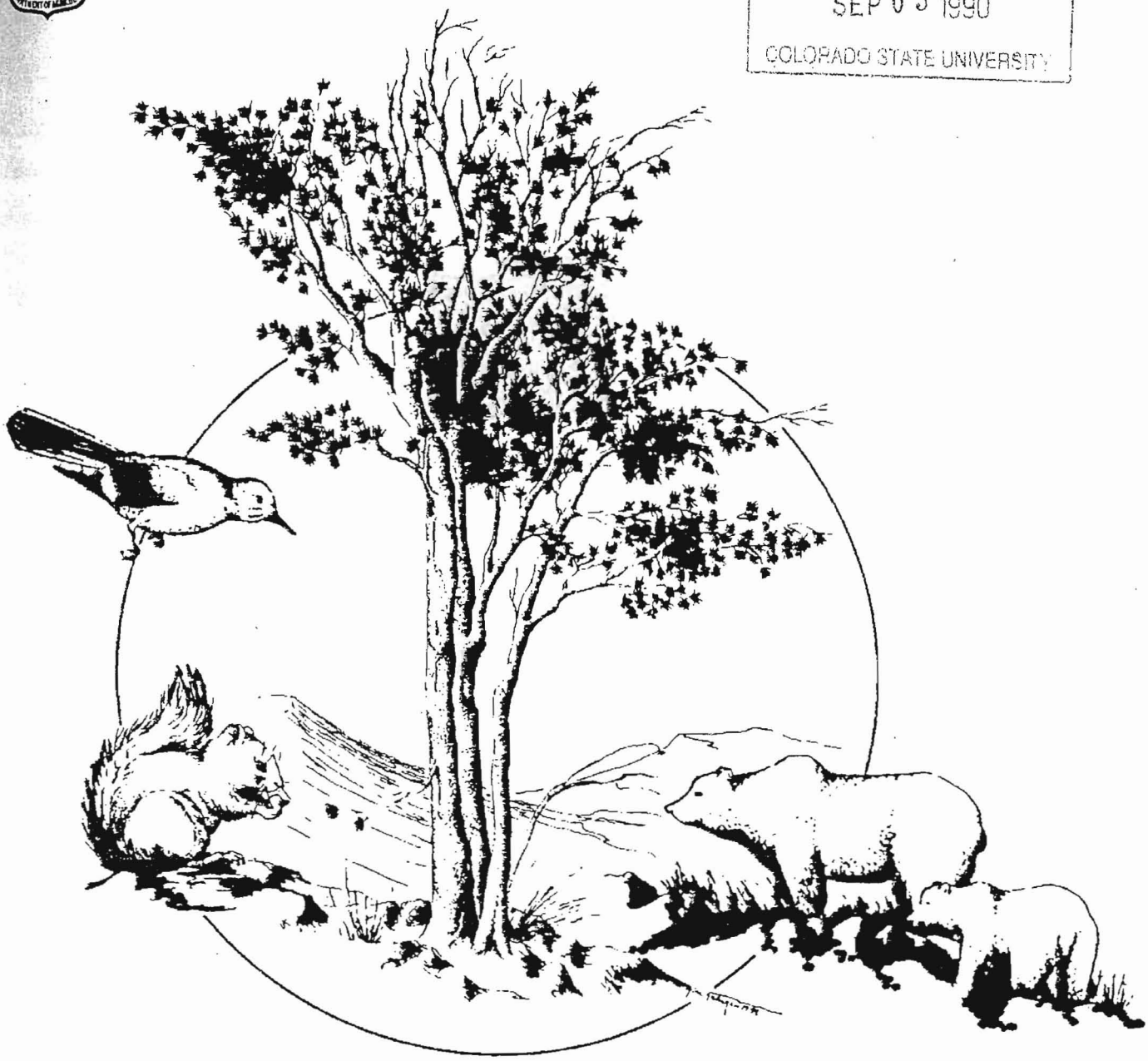
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