Impact of Mt. St. Helens Ashfall on Fruit Yield of Mountain Huckleberry, *Vaccinium membranaceum*, Important Native American Food[1]

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Huckleberry plants evaluated at 13 sites in the southern Cascade Mountains of Washington State during August 1980 showed significantly lower fruit yields where subjected to heavy ash deposition following the 18 May 1980 eruption of Mt. St. Helens. High insect pollinator mortality is suspected as the major causal factor. The impact of such effects of volcanic activity on Native American subsistence is discussed.

The current consensus among archaeologists is that the effects of volcanism on Native American culture and population were short term or of small magnitude and scope and thus indistinguishable from the "background noise" of short term climatic variation (Sheets and Grayson, 1979). However, the archaeological data are inadequate to distinguish 2 alternative explanations for this lack of evidence of significant volcanic impact on cultural development. On the one hand, the volcanic effects may not have significantly altered the effective human environment. On the other, there may have been significant effects on resource species, but social and cultural responses mitigated their impact. The research reported here indicates that volcanic activity may dramatically reduce resource yields on which hunter-gatherers depend, but that such reductions are likely to be of short duration and of highly variable impact depending upon the resource affected and the timing of the eruption. Social and cultural means available to mitigate these short term hazards are briefly discussed.

The southern Columbia Plateau of eastern Washington and northern Oregon and Idaho has been inhabited since before the final glacial retreat (Borden, 1979). At first European contact (1805 AD) the Columbia-Fraser basin east of the Cascade-Coast Range barrier supported an estimated 110,000 people on 750,000 km^2 (Ubelaker, 1976). The subsistence economy was based on seasonal movements between riverine fishing stations, dispersed root-digging sites on lithosols and in vernal meadows, and montane berry fields. A wide variety of dried roots, fish, and fruits were stockpiled against 4 mo of winter when fresh food resources were in very limited supply (Hunn, 1981, 1982; Hunn and French, 1981). Although local groups were largely self-sufficient in food production, trading partnerships and interregional and intraregional commodity exchanges through kinship obligations were of considerable cultural significance (Marshall, 1977). These basic economic features are likely constant characteristics of the regional economic pattern for at least the past several millenia.

Volcanism is another constant of human experience in the Columbia Plateau. Over the past 12,000 yr of human occupation, Cascade Range volcanoes are

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estimated to have erupted at least once per century. With prevailing winds to the east, most Cascades tephra will be deposited in the intermontane basin. The cataclysmic eruption of Mt. Mazama, which created Crater Lake in Oregon ca. 7,000 yr ago, is the second largest documented pyroclastic eruption. It ejected 42 km^3 of tephra. The 1980 eruption of Mt. St. Helens is modest by comparison, ejecting 1–2 km^3 of material. Eruptions of this magnitude from Mt. St. Helens occur on average once in 400 yr (Crandell and Mullineaux, 1978; Findley, 1981).

The research reported here focuses on the Indian staple plant-food resource most likely to have been affected by Mt. St. Helens' most recent eruptive episode, the mountain huckleberry (*Vaccinium membranaceum* Dougl. ex Hook., *Hunn 1272 and Norton* (WTU)). Mountain huckleberry was the preferred fruit or a food of major importance to native peoples in the Pacific Northwest with access to elevations above 1,200 m, where it achieves its best growth (Minore, 1972; Minore and Dubrasich, 1978). Such a dietary role is attested for Bella Coola (Turner, 1973), Flathead (Stubbs, 1966), Hoh (Reagan, 1934), Klickitat (Norton et al., 1983), Nez Perce (Marshall, 1977), Okanogan-Colville (Turner et al., 1980), Shuswap (Palmer, 1975), Thompson (Steedman, 1930), Umatilla and Yakima (Hunn, 1981; Hunn and French, 1981). Contemporary Yakima Indians of Washington State distinguish 6 species of *Vaccinium* in their native language, but they single out *V. membranaceum* for special cultural recognition in a thanksgiving celebration held in recent years in August (Hunn, 1981, 1982). Early historical records indicate that a large proportion of the Indian population of the middle Columbia River and Cascade Range slopes decamped in August to the high mountain forest among Mts. Rainier, Adams, and St. Helens, for the primary purpose of harvesting and drying a large supply of these berries (McClellan, 1853; Filloon, 1952). One early observer reported that in 1846 each family resident near The Dalles, Oregon, preserved 4–5 pk (average 39.7 l) of dried huckleberries (Perkins, 1838–1847). Extrapolating from analyses of *V. ovatum* Pursh (Keely et al., 1982), such a supply would provide over 100,000 kcal and 15,000 mg ascorbic acid, or more than 200 kcal/person/day and 30 mg ascorbic acid/person/day through the winter season. (The *V. ovatum* sample analyzed had been dried in a traditional fashion and stored for 1 yr. It contained 24.5% H_2O, 2658 kcal/kg, and 3.85 mg ascorbic acid/g. On the assumption that a liter of dried fruit weighs approximately 1 kg, 39.7 l contains 105,390 kcal and 15,284 mg ascorbic acid, or, for a family of 4, 208 kcal/person/day and 31.5 mg ascorbic acid/person/day throughout the 4-mo winter season.) In short, *V. membranaceum* was a nutritionally-valuable, staple food requiring extensive population movements for its effective exploitation.

PROCEDURES

V. membranaceum fruit production was measured on a sample of 118 plants at 13 sites within 100 km north and east of Mt. St. Helens during August 1980 (Fig. 1, Table 1). At each site 9 plants (10 at site 6) were tagged with colored tape to allow continued monitoring. Each plant was measured horizontally across the longest axis of the crown and perpendicular to that axis. Crown area was estimated by assuming the crown cross-section was elliptical. All fruits within the crown area were counted and classed as either green, ripe, dry, or fallen, with bare pedicels counted as fallen fruit. Since 68% of all fruits counted were not yet ripe (site averages ranged from 100–32% green fruits), we believe our counts closely reflect

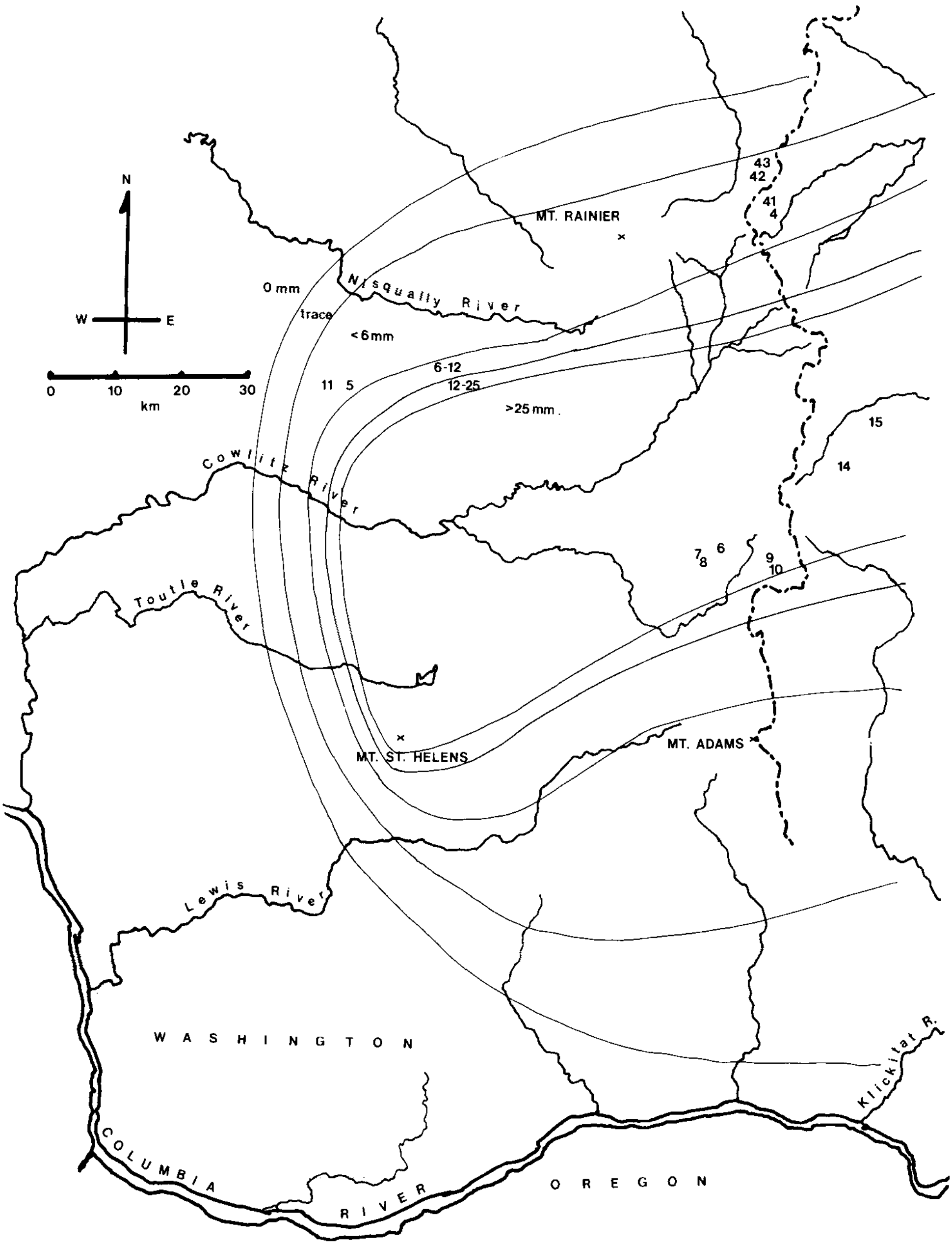

Fig. 1. Location of mountain huckleberry study sites in the southern Washington Cascade Mountains. Site locations are indicated by site numbers (Table 1). Ash-depth contour lines are adapted from a map by J. G. Rigby (Korosec et al., 1980).

actual numbers of fruits produced. Yields were expressed as total fruits/m^2 of crown area. The replicability of counts was checked in 3 instances, when lost data required revisiting sites after a 2-wk interval. Repeated fruit counts were within a margin of 12% error.

At each site a series of 5–12 ash-depth measurements was recorded from an

TABLE 1. SITE CHARACTERISTICS OF MOUNTAIN HUCKLEBERRY PLOTS.

Site (site number)	Ash depth mm	Yield/m²	SIDEDST[a] km	Elevation[b] m	Slope
Ash present					
Bear Mtn. Low (15)	16	12.6	−14.4	1,159	5°
Hugo Lake Flat (7)	38	18.1	+10.0	1,280	6°
Walupt Lake Slope (9)	33	22.3	+6.0	1,247	25°
Bear Mtn. High (14)	30	22.8	−8.9	1,814	15°
Hugo Lake Slope (8)	43	39.7	+10.0	1,280	20°
Chambers Lake (6)	32	43.5	+8.0	1,402	7°
Walupt Lake Flat (10)	33	45.7	+6.0	1,247	5°
$\bar{x}$	32	29.5	+2.5	1,347	12°
Ash absent					
Morse Creek Slope (41)		51.7	−1.5	1,500	16°
Crystal Mtn. Flat (43)		94.9	+1.5	1,433	11°
Crystal Mtn. Slope (42)		141.6	+1.5	1,433	24°
Morse Creek Flat (4)		146.6	−1.5	1,463	8°
Little Rockies East (5)		259.4	+62.4	1,100	23°
Little Rockies West (11)		376.9	+66.0	1,100	28°
$\bar{x}$		178.5	+21.4	1,338	18°
$\bar{x}$ excluding outlier cases		108.7	0.0	1,457	15°

[a] Distance west of the Cascade Mountain Divide measured on an east-west line. Negative values are east of the crest.
[b] Estimated from USGS topographic maps.

undisturbed area of open ground surface, and the depths were averaged for the site. The measurements were taken 79–101 days subsequent to the eruption, thus original deposition is estimated at 3 times the compacted values (Cook et al., 1981). Average ash depths varied from 0–43 mm. Sites fell into 2 groups, those with no measurable compacted ash (6 sites) and those with substantial surface ash (16–43 mm, 7 sites), to define a dichotomous variable, presence or absence of ash (ASHCAT). Other site characteristics were recorded, including elevation and angle of slope (Table 1).

Sites represent a sample of convenience. Sites were chosen with the following considerations in mind: 1) Sites selected should be legally accessible. All sites are on nonrestricted National Forest lands. 2) Sites selected should be known huckleberry harvest sites. Five sites in zones of heavy ash are in areas recommended to huckleberry pickers by the Packwood Ranger District office (sites 6–10). Two sites in trace ash areas were known to be frequented by Indians and non-Indians for harvesting huckleberries (sites 4, 41). 3) Sites selected should represent heavy and trace ash zones, east and west slopes of the Cascades Range divide (and thus a range of average annual precipitation), and a range of elevation and slope.

At each site, plants selected were widely dispersed within an area of approximately 100 m². Plants were selected for measurement without regard for size or apparent quantity of yield. If bias is evident, it is for plants with well-defined borders. Mountain huckleberry typically branches below ground level to emerge as a sprawling mass of intertwined branches. Our sampling units are thus not always single plants, but rather, relatively isolated areas of crown.

RESULTS

Sixty-four plants at the 7 heavy ash sites (average compacted ash depth = 32 mm) produced an average of 29.5 fruits/m^2 crown area. Site averages ranged from 12.6–45.7 fruits/m^2 crown area. Fifty-four plants at the 6 trace ash sites produced an average of 178.5 fruits/m^2 of crown. Site averages ranged from 51.7–376.9/m^2 of crown. The average yield at trace ash sites was thus 6.1 times the average at heavy ash sites, and average site yields did not overlap between heavy and trace ash conditions. The correlation of yield with ash depth (ASHCAT) was statistically significant ($P < .0005$), Pearson's $r^2 = .26$, with 26% of variance in yields attributable to the presence or absence of ash. Since there is no significant correlation of yield with ash depth within the heavy ash sites, it appears there is a threshold of ash deposition at which yield reduction occurs.

Multiple regression was used to evaluate the role of other site factors in interaction with ash depth. This analysis indicated that distance of the site east or west of the Cascade crest (SIDEDST) was more influential than ASHCAT as a predictor of yields ($r^2 = .38$). However, this result is an anomaly produced by 2 outlier sites (5, 11), both highly productive and at an extreme distance west of the crest. The elimination of these sites reduced the correlation of yield with SIDEDST to $r^2 = .00$, but reduced the correlation of yield with ASHCAT only marginally. With outliers eliminated, $N = 100$, $t = -5.60$, $P < .0005$, $r^2 = .25$. Yields at the remaining 36 trace-ash sites average 3.7 times the yields at heavy ash sites. Yield was also significantly correlated with site elevation ($r^2 = .07$) and slope angle ($r^2 = .10$). However, analysis by partial correlation demonstrated that the correlation of yield with ASHCAT is not reduced when these factors are controlled. The partial correlation of yield with ASHCAT controlling for elevation is $r^2 = .25$; controlling for slope angle also is $r^2 = .25$.

DISCUSSION

The data are consistent with an explanation in terms of the effects of tephra on the insects essential for *Vaccinium* pollination. The inverted urceolate flowers of *V. membranaceum* are highly specialized for pollination by long-tongued bees, such as bumblebees (*Bombus*) (Proctor and Yeo, 1972). Native bees were all but eliminated at a study site in Idaho that received heavy ash fall subsequent to the 18 May 1980 eruption (Akre, 1981). Honey bee colonies in the areas of heavy ash deposition were "annihilated" with 80% of colonies destroyed or severely damaged within days of the eruption (Cook et al., 1981). These effects may be expected to recur whenever winds stir up the surface ash, counteracting the high recovery potential of the affected insect populations. This particular eruption closely coincided with the flowering of *V. membranaceum.* A comparable eruption at a different season might have very different consequences for this and other resource species. The total impact on Native American populations of eruptions, such as that of Mt. St. Helens, depends on the nature and scope of the volcanic phenomenon and on the timing of the eruption. Resources are selectively affected; for example, Columbia Plateau peoples relied heavily on the tuberous roots and bulbs of a variety of perennial plants (Hunn, 1981, 1982; Hunn and French, 1981), food resources little affected by a year's disruption of pollination.

Given the selectivity of the effects of volcanism, the diversity of species systematically utilized for food by Columbia Plateau hunter-gatherers provided insurance against such environmental hazards. Specialized market farmers now exploiting the Columbia Plateau environment, by contrast, suffered severe economic dislocations (Cook et al., 1981) as a consequence of the 1980 eruption. Traditional social and economic organization in the Pacific Northwest was characterized by extensive regional networks of cooperative relationships among relatives by marriage and among nonrelated trading partners. Such relations would have facilitated redistribution of surpluses of preserved food from areas less affected to those more heavily damaged by a volcanic catastrophe.

A diverse resource base and widely ramifying networks of social relations requiring generous reciprocal exchanges of food and material wealth are very general features of hunting-gathering societies around the world, with or without volcanic hazards (Lee, 1979: 117–119, 438). R. A. Gould (1982) has argued that such cultural responses are risk-minimizing strategies appropriate to "marginal environments." Such risk-minimizing strategies may thus have provided hunter-gatherers in the Pacific Northwest with an effective set of responses to the additional hazards of volcanism.

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Book Review

Giftpflanzen. Ein Handbuch für Apotheker, Ärzte, Toxicologen und Biologen. Dietrich Frohne und Hans Jürgen Pfänder. 290 pp. illus. Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart, 1982. $136.00.

Superb in every way, this oversize volume provides a broad and intimate view of the notoriously poisonous plants of the temperate zone, many of which are familiar across the northern and central United States, some extending to Florida (*Datura, Phytolacca, Solanum, Cicuta*), and of some subtropical and tropical species grown indoors in the north or outdoors in summertime (*Nerium, Ricinus, Dieffenbachia, Anthurium, Philodendron, Euphorbia, Lantana*)—and even *Abrus precatorius,* the venomous seeds of which may show up in novelties anywhere.

There are 132 excellent color plates, 161 leaf specimens in black-and-white, 61 photomicrographs, and 59 diagrams of chemical structure. English-language literature is well represented in the listing of works on toxic plants on pages 22–23 and in the extensive bibliography occupying fifteen 3-column pages at the end. Paper, printing, and binding are of fine quality.

All botanists, economic botanists, pharmacognists, biologists, and others interested in poisonous plants, whether fluent in German or not, will be delighted to see this book and will derive much from it. The volume is well worth the investment.

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