CAMAS BULBS, THE KALAPUYA, AND GENDER: EXPLORING EVIDENCE OF PLANT FOOD INTENSIFICATION IN THE WILLAMETTE VALLEY OF OREGON

By

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INTRODUCTION

> With regard to the apparent lack of domesticated native root foods in any northern environments, I note first that this question remains to be addressed adequately. Given the limited amount of research that has been devoted to it, the available archaeological data are simply not adequate to conclude that northern geophytes were *never* domesticated (Thoms 1989:181).

The Willamette Valley of Oregon is home to two predominant species of camas, *Camassia quamash* and *Camassia leichtlinii.* The Kalapuya Indians of the Willamette Valley of western Oregon are reported to have relied on the roots of this abundant lily as a staple part of their diet (Clyman 1960; Douglas 1959:105; Thwaites 1905; Zenk 1976, 1990, 1994). This is supported by the archaeological record, where earthen ovens containing charred camas bulbs appear throughout much of the region's 11,500 year long prehistory. The dendrocalibrated radiocarbon ages of numerous excavated camas ovens span from ca. 8000 years B.P. to 140 years B.P. (Cheatham 1988; Tasa et al. n.d.).

The Kalapuya were also reported to have used strategies, such as field burning, to effectively manage various plants, including camas, and animals of the Willamette Valley floor (Boyd 1999). Furthermore, based on the ecological and botanical potential of the camas plant itself, it is conceivable that the Kalapuya were not only using the management technique of burning to enhance camas productivity, but were also selecting larger bulbs and replanting their seeds. If so, the Kalapuya would have been able to produce a larger, more cost effective staple food. And, there is evidence that camas was baked, stored, and traded in bulk (Henry 1992 [1814]; Thwaites 1905; Cheatham 1988). While there are admittedly many features of a root food worth exploiting (e.g., taste, nutrient values, size, cost-to-benefit ratio, ease of regeneration, and others), there is a body of evidence lending support to the idea that in addition to larger-scale crop and field management, Kalapuyans (and other Indian groups in the Pacific Northwest) may have been selecting the seeds of individual bulbs for regeneration (Clyman 1960; Smith 1978; Thwaites 1905; Zenk 1976). One physical attribute of camas worth improving is bulb size (Thoms 1989:153). This issue is directly relevant to the question of whether the Kalapuya were simply hunter-gatherers, or hunter-gatherers who also practiced horticulture or agriculture in the Willamette Valley. This issue is also directly relevant to Thoms (1989:181) question (refer to above quote) as to whether geophytes, in this case, camas, were or were not domesticated. There is also the possibility that larger bulbs were preferred and sought after in the digging process, while not necessarily selectively bred for larger size.

Models of camas intensification (not necessarily confined to the Willamette Valley) have been proposed by Thoms (1989), Peacock (1998), Roulette (1993), and Bowden (1995). I will first outline these models in this paper. A description of the ecology of *Camassia spp.,* its production potential, as well as the ethnographic evidence for intensification, will also be presented. I will then explain my own analysis of charred camas bulbs recovered from three archaeological contexts in the Willamette Valley, at the Mill Creek (35MA7, 35MA9, 35MA12, 35MA70), Hannavan Creek (35LA647), and Lynch (35LIN36) sites. My study involved measuring bulbs from different-aged assemblages to determine if bulb size changed over time. The results do not indicate an increase in bulb size throughout time, therefore I could not demonstrate that the Kalapuya were selecting and manipulating camas bulbs to enhance size, nor that they were selecting bulbs of a certain size range. I will present my results as well as my recommendations for future work of this kind. In addition, I will present and discuss the ethnographic record regarding the presumed sexual division of labor associated with camas harvesting and processing.

Overall, the goal of this project is to integrate the artifactual evidence with the ethnographic and ecological, and to determine whether or not bulb size enhancement or bulb size preference occurred in the Willamette Valley. Despite my results, this approach still has promise if and when larger and more precisely dated archaeological samples become available.

MODELS OF PLANT INTENSIFICATION

Because camas is reported to have been a staple of the Kalapuyan diet, and because camas ovens have a rather high visibility in the archaeological record of the Willamette Valley, several theories or models of intensification have emerged recently (Thoms 1989; Roulette 1993; Bowden 1995). Ames (n.d.:7) observed that archaeologists tend to think about societies as on a continuum from hunting and gathering to agricultural, and that we know little about those economies not situated at either extreme. He also discussed issues surrounding how food production can lend itself to social complexity.

At a minimum, intensification may be defined as "producing more food" (Ames n.d:10). Ames noted that two broad lines of evidence may be employed to examine intensification: evidence of increased labor input, or evidence of an altered product (Ames n.d.:13). Thornton (1999:36) defined "conservation and management" as "effective practices by humans to ensure a sustainable supply of a resource." Activities undertaken in Thornton's definition could encompass both lines of Ames' evidence. In this paper, I will be discussing the latter, which may or may not be a product of the former. First, however, I will outline some models of camas use and intensification for the Willamette Valley, and elsewhere.

Roulette (1993) and Bowden (1995) have proposed that not only was camas an intensified resource, but that by 3000 B.P. camas distribution on the Willamette Valley landscape was almost the sole determinant in settlement location and duration (Bowden 1995:27). Roulette (1993) argued that the abundance of camas enabled human populations to increase in size, which further promoted intensification and ownership of camas plots, and hence influenced settlement location and duration. Both Roulette and Bowden argued that midden sites with camas processing features were not necessarily used exclusively to process camas, but functioned as "home bases." The Kalapuya would have used them in such a manner as to exploit the fullest potential of their staple resource (camas) throughout most of the year, and branch out from these home bases to conduct other hunting, fishing, gathering, and trading expeditions.

Roberta Hall and colleagues (1986) examined prehistoric dental and skeletal materials from central and western Oregon for rates of caries, attrition, abscesses, and other dental pathologies. They reported the highest rate of caries among the individuals from the Willamette Valley. These individuals as a group also had the highest incidence of impacted third molars and the lowest rate of attrition. These factors taken together, along with the presumed dependence on a soft, starchy carbohydrate such as camas, led Hall et al. (1986) to hypothesize that a plant-rich diet is reflected in the dental pathology of prehistoric Willamette Valley residents. The aboriginal groups with much lower rates of caries were the groups with a more diversified hunting-gathering economy or a heavier reliance on meats or fish (e.g., groups inhabiting the lower Columbia Valley, Oregon Coast, and Central Oregon).

In his 1989 dissertation on hunter-gatherer plant intensification, Alston Thoms examined camas ethnographically, botanically, archaeologically, and theoretically. He proposed a model that evaluated the possibility of intense northern geophyte root management (using camas specifically) as a potential form of incipient agriculture. He considered the Willamette Valley in Oregon and the Calispell Valley in Washington as ideal locations to examine his camas intensification theory for two primary reasons: 1) both valleys lack abundant salmon and hence another staple resource was relied upon (Thoms 1989:430), and 2) both valleys have the best documented archaeological evidence for camas exploitation in the Northwest (Thoms 1989:304). This second reason is somewhat alarming, since archaeological studies on camas exploitation in the Willamette Valley are not that abundant. The first reason is also one of several that Thoms regarded as essential for camas intensification to occur. The others are:

1) population circumscription
2) availability of an intensifiable geophyte and raw materials to exploit it
3) population growth of sufficient magnitude to exceed carrying capacity with existing subsistence strategies
4) available technology to exploit the resource efficiently.

These conditions provided a framework for what we might expect to find in ethnographic, ethnohistorical, and archaeological records prior to, and concurrent with, intensification (Thoms 1989:183). Thoms (1989:212) also hypothesized that certain phenomena would occur; increased sedentism near root grounds, increased use of the root grounds, increased frequency of related artifacts and equipment, and an increase in root storage features.

Peacock's (1998) dissertation was also an in-depth model of plant food intensification (including camas) but focused on the British Columbian Plateau. She argued that, in addition to climate change as a primary cause of plant intensification, foraging peoples also would have made choices designed to reduce risk. Peacock outlined three general means of reducing risk:

cognitive, technological, and social. She focused on the technological. The technical strategies included actively managing plants and landscapes, changing food processing procedures to increase food energy, and increasing winter stores to support larger populations. Her emphasis was on increasing efficiency of production, rather than simply producing more. This idea is extremely attractive to me, because one way to increase the efficiency of harvesting camas is to increase bulb size. Further, demonstrating that the Kalapuya were increasing the size of camas bulbs in the Willamette Valley may also be a method for addressing the intensification or domestication question raised by Thoms (1989:181).

While Thoms' and Peacock's models are not all-inclusive, they are good starting points for considering and examining available data. At this time, however, data from the Willamette Valley and from the Mill Creek Site Complex in particular, are not adequate to determine precisely whether one model or the other better explains the Willamette Valley case. This point will be more fully demonstrated in this paper.

CAMAS BULB ECOLOGY

The finer points of camas ecology are not completely understood. Specific research on camas itself has not been prolific (Burbank 1914; Maclay 1928; Leffingwell 1930; Gould 1942; Chance et al. 1977; Jewell 1978; Statham 1982; Turner and Kuhnlein 1983; Watson 1988; Thoms 1989) and much information on bulb size, morphology, and reproduction is extrapolated from literature on the plants and bulbs of the lily family (*Liliaceae*) in general (Rees 1972, 1992; Genders 1973).

The premise of my study is built on two facts concerning bulb size. The first is that a large flower indicates a large bulb (Thoms 1989:139; Watson 1988). Among lilies in general, "[i]t is well known that bulbs below a certain size do not flower" (Rees 1972:101). The second is that ethnographically, there is evidence that larger bulbs were preferred and sought after in the digging process (to be discussed later). My supposition, therefore, is that a person collecting camas would have been aware of the former fact and used it to spend her or his time more efficiently by seeking larger flowers knowing they would have larger bulbs. It is also possible that collectors were deliberately enhancing bulb size for the same benefit. For several additional reasons discussed below, the plant is conducive to intensification, selection, and manipulation, which should be measurable and quantifiable via the archaeological record, if they were occurring.

It is important to recognize that experimental enhancement of the size of camas bulbs has been documented by Luther Burbank (1914) and experimental hybridization to determine genetic relationships between taxa has been documented by Jewell (1978). Burbank, a botanist, was convinced that because of its beautiful flower and its edible bulb, camas was the perfect addition to the vegetable garden, and contemplated the idea that it would replace the potato as a foodstuff. In 1890 he began hybridizing different camas species to produce bulbs of tremendous size. Thoms (1989:199) refers to Burbank's work as selective breeding. However, Burbank's methods were not precisely documented, and I inferred that Burbank first selected certain plants for their better features and then began hybridizing the best specimens of the different species. Included in his report is a photograph of an absurdly large camas bulb, which must be twenty times larger than the wild progenitor sitting next to it (Burbank 1914:250). Thoms (1989:158) astutely observed that though Burbank's idea that camas was worth enlarging to make it a more economic foodstuff was a good one, he seemed to have disregarded the fact that camas seeds take 4-5 years to form a bulb of edible size, while the potato takes only one. However, Burbank's experiments were useful in that he aptly demonstrated it was (and is) possible to increase the size of camas bulbs through manipulation.

The Willamette Valley of Oregon is home to two of five species of camas, *Camassia quamash* and *Camassia leichtlinii.* Four of the five species are indigenous to the Pacific Northwest (Gould 1942). These species flourish well in open, wet meadows and prairies exposed to full sunlight, and that also have distinct wet and dry and warm and cold seasons (Chance et al. 1977:52; Thoms 1989:139).

The bulbs, especially those of *C. quamash*, have been noted to have a wide range of size variability, even within the same meadow (Thoms 1989:152). Camas is also suspected to be a very old species, as their range radiates from the mountains of southwestern Oregon, one of the most ancient land masses in North America (Gould 1942:714).

Statham (1982:49) observed a "possible correlation" between larger fresh bulbs and well-drained soil in the Northern Great Basin. She also noted that bulbs growing in alkaline soils have a larger mean size than those growing in acidic soils. More importantly, she observed that flower colors differed with the pH levels in the soil. The bulbs in her study all grew in soils with a pH value ranging from 4 to 8.5. A marked shift in bulb size occurred when the pH values approached the midpoint of the neutral-to-alkaline range (6 to 8.5) , but the bulbs on both the extreme acidic and the extreme alkaline ends of the spectrum were comparable in size to each other. The larger bulbs, and those growing in alkaline soil, were also blue, rather than purple. Flower color, then, could also be an indicator of a larger bulb. This also may have implications as to how culturally modified soil chemistry may affect bulb growth.

Camas reproduces both vegetatively and by off-sets, but there is disagreement among specialists as to which method is more prevalent in the wild (Genders 1973; Burbank 1914). Genders (1973:220) argues in favor of vegetatively:

> They increase by offsets which will have formed around the mother bulb after several years, or they may seed themselves. They are readily raised from seed sown in a frame or in boxes of sandy loam in spring or summer and will bloom within three to four years of their sowing. Fresh seed will ensure rapid germination and the seedlings will be ready to transplant before the end of summer, to deeper boxes or to a frame where they remain until the following spring.

Others agree that camas grows easily from seed but that bulbs also proliferate when transported whole (Turner and Kuhnlein 1983:205; Tasa 1999, personal communication). In light of this, Thoms (1989:146) observed that any species able to reproduce both vegetatively and by off-setting should be more conducive to intensive exploitation than those that do not. He also observed that any plant producing a large quantity of seeds should be a candidate for intensive exploitation (Thoms 1989:146), and, I will add, manipulation and selection.

C. quamash and *C. leichtlinii* produce the largest seed capsules containing the largest number of seeds of all the *Camassia* species, 15-36 seeds per capsule, with 4-60 capsules per plant for the *C. leichtlinii* and 4-35 capsules per plant for *C. quamash* (Thoms 1989:146). Based on these botanical features and the observation that bulbs with active offshoots account for less than 1% of the camas population, Thoms (1989:146) felt that seed reproduction is almost wholly responsible for the regeneration of the species. This leads me to believe that selective planting of seeds could occur, and a camas oven or the living surface at camas processing sites such as Mill

Creek should contain a large quantity of seeds if the plants were gathered late in the spring when the seed pods were open and losing seeds easily and if, 1) the bulbs were being cooked with the withered but intact flower stalks, or 2) the bulbs were transported from field to processing area with the seed pods still attached. However, if the flowers were broken or cut-off from the bulbs for whatever reason, this may cause a virtual absence of seeds in the record of oven features, especially if the ovens were not immediately adjacent to the fields where the bulbs were harvested. This is a complicated issue, because most oven sites are near the fields where camas blooms (or bloomed), and it is unclear why seeds are entirely absent from the record. I will return to this later.

This leads to another important aspect of camas collecting and cooking: seasonality. What effect might the harvesting of bulbs during different parts of the year have on the archaeological record, and how does the archaeological record inform on seasonality and use? The life cycle of *Camassia quamash* has been examined by Thoms (1989) and Maclay (1928). This is useful since *C. quamash* is one of the two species indigenous to the Willamette Valley and most likely that found at Mill Creek. The bulbs change size over the course of a season, and it appears that the timing of bulb collection and the age of the plant both affect bulb size.

The various parts of the camas bulb are attached to a flat basal callas from which the roots grow (Maclay 1928:6). Dissecting specimens in early February and March, Maclay (1928:6) observed several characteristics occurring simultaneously within each bulb. Not only were the scales of tissue and a flower spike for the upcoming season present, the remnants of the previous year's flower stalk and scales were still extant. Lastly, a central mass of meristematic tissue forming the terminal bud was visible. It is this tissue which will develop the shoot for the following season. Therefore, at certain times of the year, three generations of bulb tissue are present (Thoms 1989:151). The daughter bulb increases in size over the growing season, while the mother bulb decreases. Exactly when the bulb would be at its largest size is unclear. Maclay does not address this issue specifically, and Thoms' descriptions are confusing, but it appears that the bulbs achieve their maximum size in early to mid summer (late May/early June), before the seed pods are fully formed (Thoms 1989:149). If the bulbs were collected then, I propose that there should be no seeds in the archaeological record. It appears, however, that the optimal time for digging a larger bulb and the optimal time for having seeds to collect and replant (presuming this was happening) is not the same time of the year, especially considering the bulbs are harvestable throughout the year while mature seeds are only available for a few weeks (Connolly 2000, pers. comm.).

In light of Burbank's data and the prolific seed production of camas, the size of camas bulbs does appear to be biologically conducive to intensification (Thoms 1989) and manipulation. I will now discuss the ethnographic evidence to support this.

ETHNOGRAPHIC EVIDENCE FOR THE INTENSIFICATION OF CAMAS

> The quawmash (*sic*) is now in blume (*sic*) and from the colour of its bloom at a short distance it resembles lakes of fine clear water, so complete is this deseption (*sic*) that on first sight I could have swoarn (*sic*) it was water.
> --Lewis and Clark, June 12th, 1806, near the falls of the Missouri River. (Thwaites 1905:132)

The Kalapuya Indians of the Willamette Valley relied on the bulbs of the prolific camas lily as a staple of their diet (Clyman 1960; Thwaites 1905; Douglas 1959:105; Zenk 1976; 1990:149; 1994). This appears to be substantiated by the archaeological record as well (Miller

1975; White 1975a; Cordell 1975; Sanford 1975; Pettigrew 1980; Toepel 1985; Cheatham 1988; Minor and Toepel 1995). Beside being a dietary staple, camas was also known as a trade resource, at least during ethnographic times (Henry 1992:664).

Based on similarities of material culture and geographical position, the peoples of the Willamette Valley have been linked with those of the Plateau, California, and the Pacific Coast. Aikens (1993:7-8) described the valley as "geographically and culturally intermediate between the Plateau and California." This is due in part to the fact that the valley is completely surrounded by the other archaeological regions of Oregon, including the Great Basin, the Plateau, the Pacific Coast and the Lower Columbia (Aikens 1993:183). Many recovered artifacts in the valley are nearly identical to those in other areas (Aikens 1993:207).

By contact times, the Kalapuyan-speaking peoples of the valley occupied the area from the Willamette Falls near Oregon City, southward on the valley floor to Cottage Grove, as well as in the mountains near Oakridge (Aikens 1993:185). Each group occupied a sub-basin of the Willamette River (Minor et al. 1982:45), as shown on Figure 1. The 15 or more groups that resided here spoke related languages and interacted with each other, although they are considered to have been separate "bands." The Tualatin, the northern most group, was among the better documented by early ethnographers and explorers. This is probably due to the fact that they occupied the valley near Oregon City, adjacent to Lower Columbian groups such as the Chinook, who came into considerably greater contact with early trappers and explorers due to their proximity to the Columbia River. The Tualatin are known to have practiced some rituals, such as head flattening, that are similar to those customs of their Chinookan neighbors. In addition, digging stick handles found at Fuller and Fanning mounds in the Willamette Valley are identical to those types found on the Columbia Plateau (Aikens 1993:207). Furthermore, because of some confusion on the part of Lewis and Clark in calling the Willamette River residents "Shoshones," both Zenk (1976:9-10) and Bowden (1995:3) suggest that the general cultural similarities of "inland groups" caused the explorers to lump all inland dwelling folks together. Unlike the Lower Columbia and Plateau peoples, however, the Kalapuya were not able to rely as heavily on salmon as a staple food due to the fact that the fish were prevented to some degree from migrating into the upper Willamette by the falls at Oregon City. We now know that several interior valleys in the Pacific Northwest can be characterized by similar resource availability to that of the Willamette, i.e., an abundance of game and vegetal resources but limited fish (Connolly 1986; Thoms 1989).

Despite their similarities and differences with neighboring peoples, the Kalapuyans of the Willamette Valley experienced an especially severe demographic loss in the early 19th century. Introduced European diseases such as smallpox and malaria decimated over 90% of their population in the very short time span of approximately 150 years (Connolly 1999). This, as well as other historical facts, have had specific effects on our understanding of Willamette Valley prehistory. Connolly (1999:3) observed that because most first-person observations as well as deliberate ethnographic documentation of Kalapuya culture occurred only *after* several disease epidemics swept through the valley, the ethnographic record is fraught with several problems. In Connolly's (1999) words, "[i]t is certain that in the face of such precipitous population declines that all things familiar, family relationships, economic structures, and land tenure protocols were entirely abandoned, all before the native condition was documented. It is this reality we must

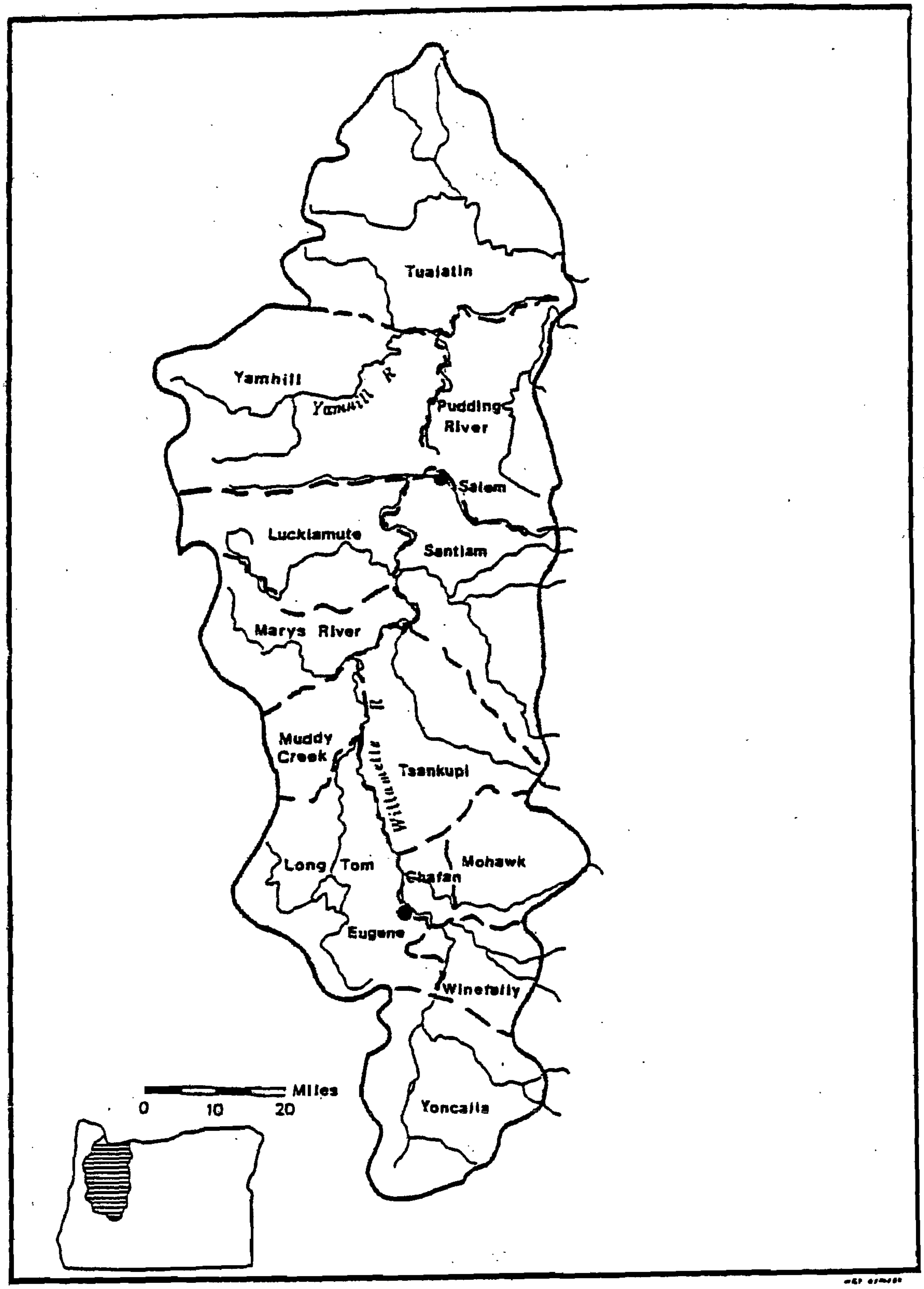


Figure 1. Kalapuya territories of the Willamette Valley of Oregon. From O'Neill 1987:13.

consider in viewing historic documents on the Kalapuya." Therefore, not only are the number of ethnographies for the Kalapuya limited, they are also quite late and considered to be problematic because of their substantial dependence on "memory culture" and their reflection of varying degrees of acculturation (Connolly 1999; Zenk 1994; Fowler 1986). In addition, incidental trapper, trader, explorer and missionary accounts of Kalapuya life also may not be reflective of pre-epidemic lifeways. Nevertheless, these accounts are what we have to use, and they become more valuable when substantiated by archaeological, geological, and geographic data.

In light of Connolly's observations and the similarities Kalapuyans share with other groups, it is useful to explore ethnographic data pertaining to immediately adjacent neighbors as well as those groups more remote. There seems to be a much higher incidence of comments relating to bulb size requirements and/or the replanting of seeds when collecting camas from ethnographic accounts of peoples neighboring the Willamette Valley than there are in the Willamette Valley. There may be more than one reason for this. It may be that peoples in regions such as British Columbia and the Plateau were more aggressively managing their root crops than the Kalapuya, or they were not, and the ethnographic and record for the Kalapuya is simply more fragmented and/or incomplete. A preliminary survey of ethnographic references to camas and other geophyte management provides clues to the level of management and potential intensification that may have been occurring in the Willamette Valley, as well as the greater Pacific Northwest. From his careful scrutiny of linguist Albert Gatschet's original manuscripts, Zenk (1976) reported that there were three distinct camas harvesting periods in a year. His thorough information is worth quoting here:

> Camas was first harvested as soon as its shoots were about one finger high (sometime in March); however, it was not pit-oven roasted until farther along in the season. (Jacobs' Santiam notes [1928-36 #83:135], from Eustace Howard, state that early "fresh" camas, Di'p was gotten in March or early April, often in gopher burrows where quantities of bulbs could sometimes be found; it was boiled at once and eaten, not pit-oven roasted.) Camas was considered fully ripe in June, when it was harvested in quantity, pit-oven roasted, dried for winter, and "pounded" into "a sort of bread" (pressed into cakes?). (Jacobs again has similar information from Howard, who indicates that the Santiam harvested the "large camas," mi·'s, in greatest quantity during June.) The camas harvest went on throughout the summer. There is some evidence that Kalapuyans harvested camas well into the fall (Zenk 1976:53-4).

Zenk (1976:53) also notes two words for camas, one for raw, and one for cooked. It is interesting that there is also a word (mi·'s) for "large camas." This may indicate that the Kalapuya had what equates to different words for the different species, or it may simply reflect a large versus small distinction. Camas' prominent position in the diet of Willamette Valley peoples is reflected to some degree in their language, as described by Zenk (above).

Boyd (1999) has established that burning is one of many ways the Kalapuya managed the valley floor on an annual basis. He reported on many benefits the Kalapuya probably enjoyed as a result of this practice, not all of which were associated with plant management. Circle hunting deer, gathering insects and creating deer habitat (which might have the effect of increasing their population) were all facilitated by burning. In the horticultural domain, gathering tarweed, expanding acorn production, enlarging the size of tobacco leaves, and enriching hazelnut and berry "crops" were the advantages of regular and planned burning. The Kalapuya probably also enjoyed one further peripheral benefit of burning; white travelers were discouraged from camping or grazing their animals in newly burned or smoky areas (Boyd 1999:100-109). Boyd (1999:127) proposed a schedule that places the Kalapuya on the wet prairies and flood plains gathering camas in late spring and early summer, and burning those plains in late summer and early autumn. This is somewhat problematic, however, if we note that David Douglas (1959:215) reported seeing Indians digging camas near the Yamhill and Willamette rivers on October 1, 1826. According to Boyd's (1999:127) burning schedule, most of the burning occurred between July and October, which is after the flower of the camas bulb has withered and gone to seed. While burning at this time would have promoted the following year's growth, it would not make sense to start burning while you were still collecting (see Zenk quote earlier). However, harvesting bulbs from one area could coincide with the burning of prairie in another.

If management of wild edibles was occurring via burning, there is no reason to believe that camas was not one of them. References to burning as a direct influence on camas production or management are less apparent, but some do exist. George Colvocoresses (1852:277) wrote that the Willamette Valley Natives burned the plains "for the purpose of procuring a certain species of root, which forms a principle (*sic*) part of their food" (cited in Boyd 1999:106). Boyd (1999:120) also noted that the Indians were fully aware of the fact that ash encourages plant growth, and there is no reason to doubt that they knew it would encourage camas growth as well, and that fire would also remove competing woody species. James Clyman (1960:153) wrote of the area near Rickreall and the Luckiamute River in May 1845:

> It is remarkable to see the great Quanty (*sic*) of esculent roots that grows (*sic*) in all parts of this vally   Ten or Twelve acres of cammace (*sic*) in one marsh is Quite common and in many instances it will yeild (*sic*) 20 Bushel to the acre. The calapooyas live exclusively on roots but whare (*sic*) hogs are introduced they soon distroy the cammerce fields   these extensive field are allways (*sic*) on wet land and in many places no other vegitable (*sic*) is found to intermix with it (Capitalization and spacing as found in the original).

This description confirms what botanists describe as camas' habit of growing in "large and conspicuous colonies" (Gould 1942:713) and indicates that camas was widespread and may have been a monoculture in some areas. Monocultures may or may not have been a human-induced condition. Gatschet's field notes (in Zenk 1976) indicate that the Tualatin band of the Kalapuya privately owned their tarweed crops, and it is tempting to speculate whether such was the case for camas fields as well (Roulette 1993; Bowden 1995). Private ownership does not necessarily indicate an increased level of management; however, Suttles (1951a:281) remarked that caring for plants, which is necessary for cultivation, seems to be related to patch ownership, at least among the Coast Salish.

Anderson (1997:151-3) reported that root crops were also staples in almost every indigenous Californian society. There, tubers were harvested before and during flowering, as well as during seeding, depending on a family's needs. The Chumash on Santa Rosa Island are reported to have gathered the corms of *Dichelostemma capitatum* (blue dicks), a geophyte that bears a striking resemblance to *Camassia quamash.* After the plants had died back, the Chumash took only the roots and left the seedheads behind, therefore confirming that seeds remained at the site (Timbrook 1993 in Anderson 1997:159). Anderson (1997:149) also noted that ecologists have traditionally tended to ignore Native Americans as an ecological force that actively shaped plant communities, and that Native Californian tillage activities "mimicked natural disturbances with which plants coevolved." The burning cycles of the Kalapuya can clearly fall into this category as well, as mimicry of natural fires, although at more frequent and regularly spaced intervals.

In addition to burning, there are other plant management methods which could further intensification. Some of these methods could also directly affect the size of bulbs in future crops. They include weeding, aerating the soil, and replanting the seeds from superior bulbs. The use of some or all of these methods appear to have been outgrowths of the harvesting process, well understood by Native peoples. Digging camas with a digging stick aerates the soil and damages or destroys other vegetation competing for space. Among the Coast Salish, some argue "the more you dig, the better it grows" (Suttles 1951b:59) (quoted in Thoms 1989:148). Thoms (1989:148) pointed out that digging also creates a seed bed.

Camas was also an important food item for Straits Salish groups in Coastal British Columbia. Turner and Kuhnlein (1983:211) discuss the Salish practice of digging with sharpened sticks, clearing stones, weeds, and brush and practicing controlled burning to enhance productivity. Turner and Kuhnlein (1983:211) also describe a form of selective camas bulb harvesting as follows: "[t]he turf was lifted out systematically in small sections and then replaced after only larger bulbs (3-6 cm across) had been removed. The smaller bulbs were left intact to grow for the next season." Turner and Kuhnlein (1983:211) pointed out that their informants maintained a sustained yield by these types of practices. Stern (1934:42-43) reported that Lummi women of northwest Washington travel to some Puget Sound islands in May to dig camas in this manner, crushing the sod afterwards and planting the seeds broken from the stems in the digging process. Individuals visit the same patch year after year, although exclusive ownership is not delineated. In these gardens, if it were only the seeds of the larger bulbs that were being replanted, the result over time could be plants with larger bulbs.

In his classic study on how the cultivation of the introduced potato relates to the cultivation of indigenous plants (such as camas) among the Coast Salish, Suttles (1951a) hypothesized that potato cultivation may have influenced the use of native plants, or vice versa. He spoke to a Nuwhaha informant who reported that women on Jarman Prairie raised three different native bulbs in privately owned, fenced gardens. Suttles (1951a:282) wrote: "[i]f a woman found good bulbs elsewhere, she brought them to her patch; and when she harvested the roots, she broke off the tops, crumpled them up, and put them back into the holes the roots came from." This quote indicates knowledge of regeneration and how to influence it. However, it is important to mention that when he was interviewed in 1988 by Alston Thoms, Roscoe Watson (1988), a plant pathologist, "expressed doubt" that camas seeds would sprout when planted in a hole as deep as one in which a mature bulb sits, because camas prefers shallow germination depths. In the Willamette Valley, Zenk (1976:56), quoting Clyman (1960), reported a somewhat similar practice among the Kalapuya: "...a portion of earth containing frorm (*sic*) 2 to six roots (*sic*) is taken up the roots being the size of a small onion and much resembling the onion in appearance."

At the Grand Ronde Reservation in April, 1876, Reverend R.W. Summers (1994:32) wrote that his hosts were cooking camas in an earth oven: "[t]wo or three inches of stem are left on the root in the gathering, and a bushel or two is cooked at one time." This is an interesting comment, because if two or three inches of stem are left on the root when *gathering*, the remainder of the stem and the flower would presumably have been left behind in the field. This certainly does not prove the seeds were being replanted, but it is an intriguing statement.

Although the source of her information is not specified, Smith (1978:5) reported that among the Bannock: "[a]fter the bulbs were loosened and the excess dirt shaken back in to the empty hole, the black-skinned bulbs were ready to be cooked." If the plant had already gone to seed, this type of shaking might also cause the seeds to drop. It may have been this activity that was actually occurring, rather than the cleaning off of the bulb, and Smith was unaware of it.

Most accounts presented thus far describe Native peoples utilizing a very particular method of harvesting. These accounts overwhelmingly describe a procedure involving opening the earth with a digging stick, observing several bulbs and removing the choice ones, rather than guessing bulb size based on flower size. This seems to be even more labor intensive than the latter method, although it may be that digging up one bulb is equally as labor intensive as digging up a cluster, and choosing a few. It is also true that the bulbs were harvested for a much longer period than the flowers remained in bloom, and once withered the flower would not be a good indicator of bulb size.

In his dissertation, Thoms (1989) discussed the various factors involved in determining the likelihood that camas was not only intensifiable but intensified. Some of these factors have to do with ethnographic data such as those quoted above, and some factors are much more closely linked with camas morphology and ecology.

In discussing possible intensification methods, Thoms (1989:153) hypothesized, "[s]ince the size of the bulb can be estimated accurately from the size of the aboveground plant, we might expect the digging effort to focus on bulbs in a certain size range." It seems also then that the digging effort can still focus on bulbs of a certain size range even though in the cases quoted above, the sod is removed before the appropriate bulbs are chosen. Thoms (1989:168) estimated a "keeper" bulb to be 2-4 cm in diameter and weighing 5 g. He also noted that the larger the bulb, the deeper in the ground it will be and thus more difficult to retrieve, so collectors might tend to choose the moderately-sized bulbs (which are closer to the surface of the ground) in order to maximize their energy-expenditure/caloric-return ratio (Thoms 1989:153). I do not believe Thoms or anyone else has promoted the idea of digging small bulbs. In Montana, some Flathead people reported not wanting to dig the bulbs on a certain prairie because they were too deep (Thoms 1989:155). In this case, then, assuming these deeper bulbs were bigger than some shallower ones, bulb size importance did not override ease and convenience of harvesting.

Thoms (1989:173) also cited three ethnographic sources (Thwaites 1905; Turner and Kuhnlein 1983; Smith 1986) that "clearly imply" a size threshold was maintained, below which bulbs were not ordinarily harvested. These papers are not related precisely to the Willamette Valley, but to the Plateau, British Columbia, and Washington. Among the Nez Perce, Lewis and Clark (Thwaites 1905:130) observed the following:

> Soon after the seeds are mature the peduncle and foliage of this plant perishes, the ground becomes dry or nearly so and the root increases in size and shortly becomes fit for use; this happens about the middle of July when the nativs (*sic*) begin to collect it for use which they continue untill (*sic*) the leaves of the plant obtain some size in the Spring of the [next?] year.

Although this quote does not make complete sense chronologically, it does seem to indicate that even Lewis and Clark were aware (or had been informed) that the bulbs were bigger at a certain time of the year, and that bigger bulbs were preferred.

At least preliminarily, it seems that camas harvesters chose their plants mindfully. Although it is true that archaeological evidence for some of these activities can be difficult to find, evidence of the results of such endeavors can be teased out of the data. Taken together, ethnographic and botanical data make a plausible, if not somewhat circumstantial case, that camas can be and was being enhanced. Admittedly, most of these ethnographic examples come from other cultural groups and regions, and not the Kalapuya or the Willamette Valley. As explained earlier, this is due at least partially to the fact that the record is incomplete for the Willamette Valley and also unintentionally biased in favor of the Tualatin, rather than any other Kalapuyan group. However, I see no reason to operate under the assumption that the Kalapuya were not able to practice the same type of horticultural or near-horticultural subsistence as their neighbors. Clearly, archaeological evidence is needed to fill in the gaps in the ethnographic and historical records. This is why I am examining the charred camas bulbs from six Willamette Valley archaeological sites for evidence of intensification and size enhancement.

ARCHAEOLOGICAL RESEARCH

There are at least 22 sites in the Willamette Valley of Oregon that have been identified by archaeologists as camas processing sites or as having a camas processing element (Miller 1970; Davis et al. 1973; White 1975a; Cordell 1975; Sanford 1975; Pettigrew 1980; Toepel 1985; O'Neill 1987; Cheatham 1988; Friedel et al. 1989; Thoms 1989; Roulette 1993; Wilson 1993). These sites are usually identified by the presence of an underground, rock-lined oven containing charcoal, fire-cracked rock, and charred camas bulbs. Archaeologists have traditionally reported the mere presence or absence of macrobotanical remains, and the most elaborate published commentaries have been data tables indicating frequency, location, age, and sometimes the weight of recovered camas bulbs. Today, a professional paleoethnobotanist is typically contracted to identify plant remains recovered from Willamette Valley sites. This specialist determines which plants were used as fuel and food, as well as which plants were simply present in the prehistoric environment. Many of the aforementioned reports contain hundreds of pages of lithic tool and debitage analyses and only a few pages on plant processing activities, even if the site apparently existed largely for the latter purpose. Artifacts that likely contributed a limited amount of food to the hunter-gatherer diet are usually analyzed at length; this is true for stone tools associated with hunting. Hunn (1981) has established that the hunter-gatherer diet of the Columbia Plateau was largely plant-based, and approximately 70% of caloric intake was from vegetal sources. Though a similar study has not yet been done for the Willamette Valley in particular, we do know that camas was considered a staple. Nevertheless, on the Plateau as well as the Valley, emphasis has been (for various reasons) placed on the projectile points, their typologies, stages of reduction, sourcing, etc. Very little research attention has been paid to the camas bulbs themselves. In addition to supplying concrete archaeological evidence to address the question of intensive harvesting and manipulation, my study is also an attempt to make use of these valuable ecofacts in a constructive and informative manner. The research design of the Mill Creek Site Complex (Connolly and Hodges 1996) was focused on locating and examining camas ovens and related features. With this project, I also hope to inspire ideas for future research using botanical remains.

Five archaeological sites (35MA7, 35MA9, 35MA12, 35MA63 and 35MA70) comprising the Mill Creek Site Complex were excavated during the summers of 1996 and 1997 by the Oregon State Museum of Anthropology, mitigating the impacts of an Oregon Department of Transportation road improvement project. The archaeological sites are located in and adjacent to the clover-leaf system of off-ramps at the intersection of two major western Oregon roadways, Interstate 5 and the Santiam Highway (Connolly and Hodges 1996). Although there are 11 archaeological sites located in the complex, only five were excavated because 1) they were judged to be significant according to National Register criteria (Minor 1987) and 2) they were located in the impact area of impending highway construction (see Figure 2). This aggregation of sites may have been one large activity area prehistorically, but is now divided by the modern freeway interstate network (Connolly and Hodges 1996). Each of the five sites is situated near present or ancient channels of Mill Creek, a tributary of the Willamette River, near Salem (Connolly and Hodges 1996).

Because the sites were known camas processing sites (Pettigrew 1980; Minor and Toepel 1995), their excavation provided an opportunity to address a variety of research questions involving prehistoric camas resource use and intensification. In addition, excavation of the sites provided an excellent opportunity to test ideas concerning the level of resource use and exploitation throughout time, because the area was occupied and utilized by Willamette Valley peoples throughout the last 6000 years (Connolly et al. 1998).

A total of 74 features was excavated in two field seasons at the Mill Creek Site Complex. Nearly half (34) were rock-lined pit ovens, with the remainder comprised of lenses of bisque and charcoal and/or ash. These lenses were often associated with pit ovens and may represent the dismantling or "rake out" of some of them (Tasa et al. n.d).

The oven features (as well as non-feature units) were excavated in 5 cm levels and the fire-altered rock was weighed in the laboratory. The weights of the oven rock per feature range from 24 kg (52 lbs.) to 1084 kg (2385 lbs.). None of the ovens appeared to be "intact," that is, they all appeared to have had the majority of their contents removed after cooking, as is commonplace for most of the earth ovens excavated in the Willamette Valley thus far (Miller 1970; Davis et al. 1973; White 1975a; Cordell 1975; Sanford 1975; Toepel 1985; O'Neill 1987;

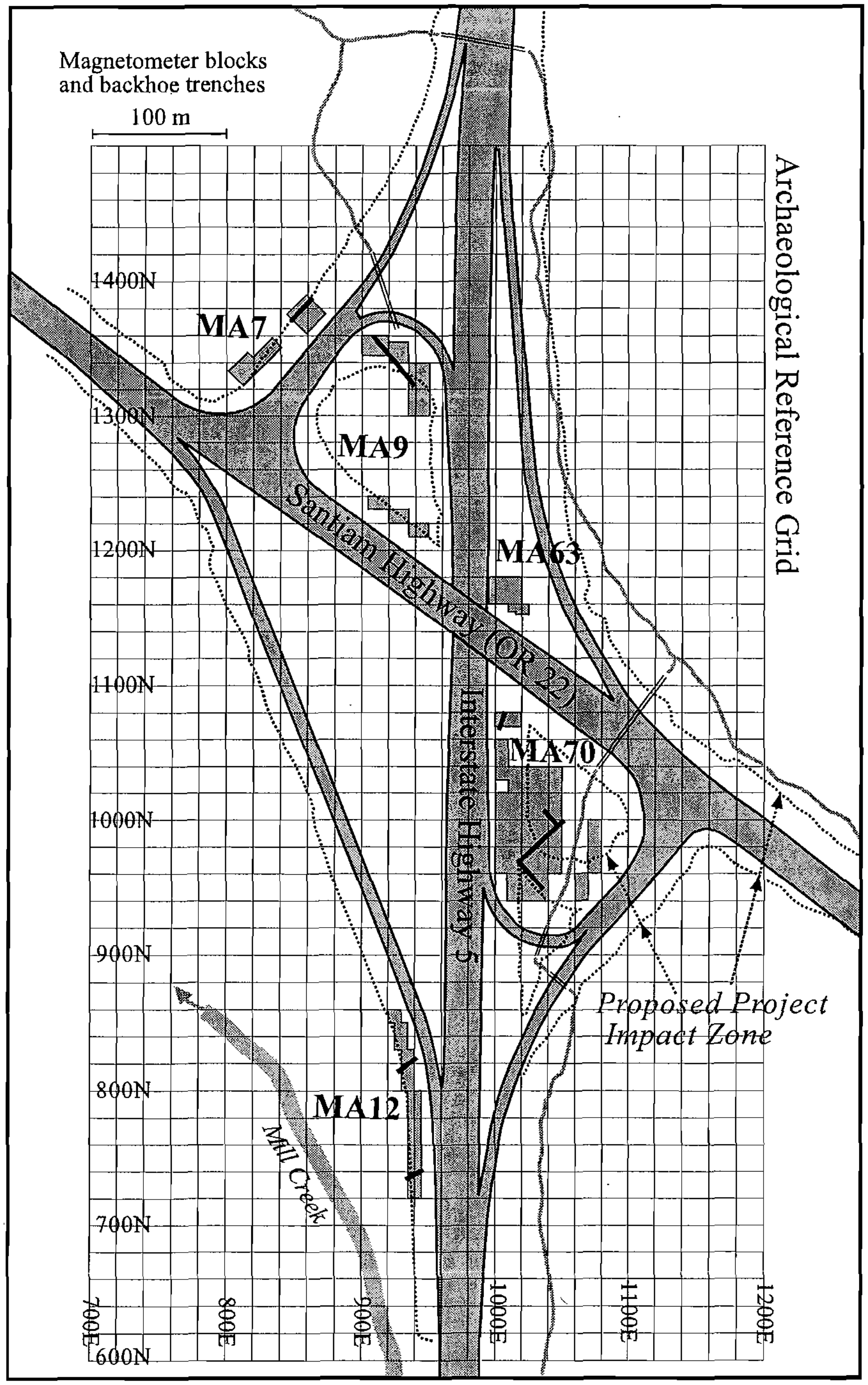


Figure 2. Map of five excavated sites in the Mill Creek Site Complex (from Connolly and Hodges 1996).

Cheatham 1988). Also associated with the ovens were stone tools of basalt, cryptocrystalline silicate, and obsidian in the form of whole and fragmentary projectile points, choppers, battered cobbles, anvils, hammerstones, cores, bifaces, unifaces, utilized flakes, debitage, stone bowls, and pestles. These tools were found either within the ovens or on the living surface surrounding an oven. However, many features, especially the bisque and ash lenses, had no associated stone tools whatsoever. Small fragments of calcined animal bone (Tasa et al. n.d.) and botanical remains were also associated with oven and non-oven features.

As reported by the paleobotanical analysis, charcoal found in the ovens was predominantly *Quercus* (oak), *Fraxinus* (ash) and *Salix* (willow), with *Amelanchier* (serviceberry), *Cornus* (dogwood) and *Betula* (birch) present (Puseman et al. 1999). Probable food remains present in many features included western hazelnut *(Corylus cornuta)* shell fragments and *Camassia.* Also found in many ovens were charred *Galium* (bedstraw) seeds and seed fragments. Bedstraw may have been used as a buffering layer between the camas bulbs and the hot rocks, and the bulbs may have been wrapped in the sticky plant prior to placing them onto the rocks and coals (Puseman et al. 1999). The Kalapuya are known ethnographically to have layered the bulbs with "green grass" in their ovens (Clyman 1960 [1845]:153).[1]

As with the stone tools, not every oven contained associated food remains (i.e., camas bulbs). Some camas bulbs were not associated with discrete ovens, but bisque or ash lenses. Also, camas bulbs, tools, charcoal, fire-altered rock and bisque were found on the living surface of the site 35MA9, which Tasa et al. (n.d.) reported represents an occupational surface that has

[1]Reeve (1986:274-276) presented a comprehensive summary of layering materials used by Plateau peoples in their camas ovens. Although it did not include bedstraw, it does include local grasses, cottonwood bark and leaves, fern, birch branches, willow, and many more plants.

been stable for the past 6000 years. At a minimum, the Kalapuyan peoples used all of these sites for at least three purposes, camas cooking, camas processing and hunting, which is attested to by the assemblage of 250 projectile points and calcined animal bone, the latter presumably from animals cooked on site. Given the fact that camas needs to cook for 2-3 days, people were most likely camping on site and engaging in many other activities as well, such as making stone tools and digging sticks, processing hides and pounding camas.

Whenever possible, charcoal or a camas bulb from each feature was radiocarbon dated, providing a span of dendrocalibrated ages ranging from 140 B.P. to 5740 B.P. (Tasa et al. n.d.). By examining the frequency of ages occurring in discrete ovens, it is clear that there was a time period of heavier use, 4000-5000 years B.P., of camas ovens at Mill Creek (see Table 1). This may simply be a product of sampling, but it could indicate a heavier reliance on camas during this time or a growing population which needed to process more food. One oven was not dated, and one oven returned both a modern age and an age of 2690 B.P. Clearly, the period of time between 4000 and 5000 years ago represents a significant increase in camas processing activity at Mill Creek. It is this time period that may be considered to represent a period of intensification for purposes of further research.

Clearly, the span of camas oven ages from the Mill Creek Site Complex is extensive, and rather old. The Hannavan Creek site (35LA647), located approximately 65 miles south-southwest of the Mill Creek Complex is also quite old. Cheatham (1988:93) described the Hannavan Creek site as a possible winter village. It is situated on the banks of a creek and is a rather large (700 m x 80 m) series of activity areas. Similar to Mill Creek, the artifact assemblage included projectile points, bifaces, scrapers, drills, gravers, spokeshaves, utilized

Table 1. Number of Ovens per Millennium at Mill Creek Site Complex.

Time Period	Number of Dated Ovens
5000-6000 Years B.P.	2
4000-5000 Years B.P.	15
3000-4000 Years B.P.	4
2000-3000 Years B.P.	4
1000-2000 Years B.P.	3
Modern - 1000 Years B.P.	7

flakes, groundstone fragments, hammerstones, anvils, choppers and notched stones (Cheatham 1988:93). As with the Mill Creek Site Complex, no architectural features were found, and the lithic tools occured on a deflated living surface adjacent to sub-surface features. Non-architectural excavated features included multiple fire hearths, five bisque and charcoal concentrations, and two earth ovens. Cheatham (1988:106-7) described one of these features as an intact oven (measuring 150 cm in diameter and 22 cm deep) and dated it twice using *in situ* charred camas bulbs for the first date and water-screened bulbs for the second. The dates, 7750 ± 90 and 6830 ± 100 B.P. do not overlap at one standard deviation, although they do confirm the great antiquity of the oven. Calibrated, these ages are 7669 B.P. and 8520 B.P. Cheatham (1988:107) reported finding over 300 camas bulbs in one quadrant of this oven, leading him to believe that the oven had been abandoned before the contents were removed. Such a large quantity of charred camas bulbs from one quarter of one oven is rather rare in the Willamette Valley. This large sample from a dated feature makes these bulbs good candidates for a comparison study with the bulbs from the Mill Creek Site Complex, and may provide clues to whether a valley-wide phenomenon of intensification was or was not occurring (see below).

The Lynch Site (35LIN36), located approximately 40 miles south of the Mill Creek Site Complex, is much younger in age, its oldest component dating to 1280 B.P. (Sanford 1975:238). This site is located on the banks of Little Muddy Creek, a tributary of Muddy Creek, which flows into the Willamette River. Sanford (1975:271) described it as primarily a camas and meat processing station that also may have been used for tool refinishing. A mass burial of six individuals also was excavated. Like the Hannavan Creek and the Mill Creek Sites, the artifact assemblage included projectile points, scrapers, drills, awls, spokeshaves, choppers, bifaces, debitage, pestles, manos, bowl fragments, abrading stones and faunal remains (Sanford 1975:253-271). Twenty-nine of the 30 features were interpreted as ovens or cooking pits, and the last was a cache of stone tools. Sanford described one of these features as a lens of fire-cracked rock and "hundreds" of burned *Camassia* bulbs, which appear to "spill" into an adjacent pit with more fire-cracked rock and burned bulbs at the bottom (Sanford 1975:241). Some of these carbonized bulbs were radiocarbon dated to 800 ± 80 B.P. (694 B.P. calibrated). This large sample from a more recent, dated feature also makes these bulbs good candidates for a comparison study with the bulbs from the Mill Creek Site Complex (see below).

METHODS

Approximately 350 charred camas bulbs were recovered from ovens and associated units and features during the 1997 field season at the Mill Creek Site Complex. Although five sites were excavated, only four (35MA7, 35MA9, 35MA12, 35MA70) yielded bulbs that were in suitable condition to be measured and numbered 203 (see below). These and other botanical remains are curated at the Museum of Natural History at the University of Oregon. The bulbs are stored in plastic laboratory bags and organized by excavation quadrant and level, as they were recovered in the field. The bulbs have all been identified by Paleo Research Labs (Puseman et al. 1999) as members of the *Camassia* genus.

Approximately 300 charred camas bulbs were recovered from Feature 3E at the Hannavan Creek Site in 1984 (Cheatham 1988:107). One-hundred nine bulbs were in suitable condition to be measured. These are also curated at the Museum of Natural History at the University of Oregon. The bulbs are also stored in plastic laboratory bags but are organized by feature, rather than quad and level. They have been identified by Dr. David Wagner, a botanist at the University of Oregon, as camas bulbs (Cheatham 1988:106).

Approximately 100 charred camas bulbs were recovered from Feature 1 at the Lynch Site in 1971 (Sanford 1975:229), and 38 were in suitable condition to be measured. Many other bulbs were recovered from this site as well, either from other features or not associated with any feature. These are also curated at the Museum of Natural History at the University of Oregon. Most of the bulbs are stored in the original paper field bags, and are organized by field specimen number, and 2 x 2 meter excavation unit number. A large number of the bulbs from Feature 1 (although not 100, as reported) were stored separately in plastic bags, in boxes lined with tissue. It is possible that some of the bulbs that were associated with this feature were excluded from my study due to the unclear nature of the field specimen designations on the paper bags. The paper field bags were not marked by field personnel with a feature number, and in some cases the provenience information was illegible, due to faded ink. Though frustrating, this is not really surprising due to the fact that these bulbs were excavated and curated over 25 years ago, when field methods were somewhat different than those of today. The bulbs from the site have been identified by Sanford as *Camassia* bulbs.

I tried to determine whether the bulbs significantly changed in size over the duration of the occupation of all of the sites, 8095 to 150 B.P. I hypothesize that if the Kalapuya were selecting and harvesting larger bulbs and replanting the seeds, the eventual result would be a measurable increase in bulb size. I expect that bulb size would have increased over time. In addition, the variability of bulb size should decrease inversely with the size increase, as the larger size of the bulbs becomes standardized. I also hypothesize that if the Kalapuya were selecting and harvesting bulbs of a certain size range, this too should be observable in the archaeological record. To determine if this was the case at the Mill Creek Site Complex, the Hannavan Creek site, and the Lynch site, the length, width, and thickness of each recovered bulb was individually measured with a caliper in millimeters. Due to the great age, fragility, and condition of the bulbs, not all were suitable for measurement. To be measured, each bulb had to meet the criteria of being whole, or nearly whole, and of being charred. A bulb was judged to be whole if it appeared tear-drop in shape. Tear-drop shaped bulbs which were missing the stem were noted and measured, recognizing that the length measurement would be slightly shortened. Tear-drop shaped bulbs which had slightly crumbling sides were also noted and measured, recognizing that width accuracy would be somewhat reduced. This was deemed appropriate because many of the bulbs were chipped or crumbling to some extent, and I wished to utilize the largest sample possible. The bulbs were classified as either Whole, Slightly Fragmented, or Fragmented and Unacceptable. The numbers of bulbs in each category are presented in Table 2.

The Unacceptable bulbs from all collections were not measured. As Table 2 illustrates, not all bulbs reported by previous authors were in a condition to be measured, nor did their numbers even add up to the original number reported by the author. There may be more than one reason for this. While some bulbs were sacrificed for radiocarbon dating, I suspect that the number of bulbs was over-reported in these two cases. It is easy to over-estimate the number of camas bulbs present in an oven, as their charred appearance causes them to look a great deal like pieces of charcoal, which are almost always associated with *in situ* bulbs. Although no uncharred camas bulbs were recovered, other uncharred botanical specimens were, so the criteria that the bulbs needed to be charred was added. This was to ensure that contemporary bulbs still growing on the site, or those that had been cached in the many rodent burrows on the site would not be measured.

The length of the bulb was measured stem to base, the width was measured horizontally at the widest part of the bulb, and the thickness was then measured at the thickest part of the bulb perpendicular to the width measurement. Essentially then, a transverse cross-section of the widest part of the bulb was measured. Many bulbs had the appearance of having been flattened so width together with thickness seemed most appropriate. I measured each bulb in exactly the same manner and recorded the measurements in a QuattroPro spreadsheet, along with the associated dendrocalibrated radiocarbon age and condition of the bulb (Measurements are presented in Appendix I). All measurements were taken to the nearest 0.1 mm. For each excavation unit from which any bulb was measured, the Unacceptable bulbs were counted and the number noted. From the 1997 excavation season at Mill Creek, 203 bulbs were in suitable condition to be measured. From the 1984 excavation of the Hannavan Creek site, 109 bulbs were in a suitable condition to be measured. From the 1971 excavation of the Lynch site, 38 were in a

Table 2. Number of bulbs per condition category.

	Whole	Slightly Fragmented	Fragmented	Unacceptable
35MA7	16	14	3	3
35MA9	57	84	20	61
35MA12	1	2	1	5
35MA70	0	3	2	3
35LA647	64	40	5	121
35LIN36	14	18	6	26
Total	152	161	37	219

suitable condition to be measured.

This method is not completely problem-free. An excessive number of bulbs from all sites were unsuitable for measurement. From the Mill Creek Sites, 35% were unsuitable for measurement. Though the large sample from Hannavan Creek was what made it attractive as a comparative sample with the Mill Creek sites, there were only 230 bulbs in the collection that were clearly affiliated with the dated feature. Of these 230, half were too fragmented to be measured. From the Lynch site, forty percent of Feature 1 bulbs were unsuitable for measurement. Many bulbs from all sites were in tiny pieces and some no longer resembled camas tissue except to the trained eyes of a paleobotanist. This damaged state may be due to field screening techniques or the result of post-depositional factors. After all, the burned and fragile bulbs were nestled between river cobbles for several thousand years. Although conscientious efforts were made to retrieve bulbs *in situ*, many of them were subjected to being shaken and battered about in a screen after excavation. Although broken bulb fragments were refitted before measurement whenever possible, most bulb fragments in a bag did not fit together to create a whole bulb.

Another obvious problem in the measurement of camas bulbs is that of shrinkage and water loss through the charring process. Camas bulbs contain a high amount of moisture, approximately 80% (Turner and Kuhnlein 1983:216), much of which would be lost during cooking. The charred bulbs are considerably smaller, quite literally "shrunken," compared to fresh bulbs. It is also conceivable that a bulb's location *within* an oven could impact the water loss to the bulb and the rate of shrinkage. Bulbs nestled closer to a hot heating element (i.e., a cobble) may cook and burn faster or more thoroughly than those nestled up against other bulbs, or those securely wrapped in bedstraw or other layering material.

One final difficulty is that Puseman et al. (1999) were only able to positively identify the camas bulbs to genus and not to species. According to their 1997 report (Puseman et al. 1997) and Linda Scott Cummings (1999, pers. comm.), Puseman et al. presumed it was *Camassia quamash*, because that variety is common in the area, but they cannot actually identify the charred bulbs as such. According to Thoms (1989:137), two species of camas grow in the Willamette Valley, *Camassia quamash* and *Camassia leichtlinii.* These species may have different average-sized bulbs. Burbank (1914:243), who was working with *C. leichtlinii*, *C. cusickii* and *C. esculenta* in his hybridizing experiments, considered *C. leichtlinii* to be the largest of the three species, with *C. esculenta* being quite a bit smaller. The name *C. esculenta* was invalidated by the International Botanical Congress in 1930 (Gould 1942:716), and it is probable that Burbank was using what we now call *C. quamash* in his research. Burbank refers to a common edible "nature" variety as *Camassia esculenta*, while Thoms refers to *Camassia* *quamash* as the common edible. They both describe the size as comparable so I believe they are referring to the same species.

At any rate, this is relevant to the fact that the Mill Creek bulbs (and probably those at Hannavan Creek and Lynch as well) were only identifiable to genus. Because fresh bulb sizes do differ, charred bulb size may differ as well. Burbank (1914:246) describes the C. *esculenta* (cf. *C. quamash*) as "relatively insignificant, usually growing about one-half to three-quarters of an inch in diameter," and though he does not give measurements for *C. leichtlinii*, he indicates it is much larger, and "the finest of the native varieties" (Burbank 1914:242). Thoms (1989:152) states the average size of a fresh juvenile *C. quamash* ranges from 0.75 to 1.75 cm in diameter, which is comparable to Burbank's *C. esculenta* size, although the more mature *C. quamash* can be as large as 2 to 4 cm in diameter. *C. quamash* and *C. leichtlinii* share many attributes and have often been confused with each other, even by botanists (Gould 1942:717). Gould (1942:717) identifies both to several sub-species. If both species were represented in the 1997 collection from Mill Creek (as well as Hannavan Creek and Lynch), this factor alone could have impacted the results of any study using bulb size as a critical variable. Hitchcock (1969:782) notes that *Camassia* is represented by several "races" that are much more easily recognized when fresh than when dried, when many distinguishing features cannot be seen. The charred state of the Mill Creek bulbs would undoubtably further complicate this process. Though there is not an abundance of camas growing at the Mill Creek Site Complex today due to construction impacts, what is growing there is suspected to be *Camassia quamash* (Connolly 2000, pers. comm).

Therefore, I had to make several assumptions at the outset. First, that all bulbs cooked within the same oven should have roughly the same amount of shrinkage, irrespective of their size before cooking, and were equally impacted by the cooking and charring processes. Second, all the bulbs are of the same species and size changes over time are therefore measurable and meaningful. Third, at least some of the damage to bulbs was a result of post-depositional processes such as archaeological screening and was unavoidable. Some damage to bulbs may have also been a result of prehistoric disturbance such as oven rake-out.

RESULTS

In order to compare the size of the bulbs to each other, a composite measure for each bulb was needed. To obtain this, the length, width, and thickness of each bulb were multiplied. This created a "proxy volume" for each individual bulb. Each proxy volume was then matched with the appropriate radiocarbon age for the feature from which the bulb was recovered. For the Mill Creek sites, the dendrocalibrated radiocarbon ages derive from charcoal within the same oven feature as the charred bulbs. The radiocarbon dates for Hannavan Creek were obtained from two charred camas bulbs within feature 3E: 7750 ± 90 and 6830 ± 100 B.P. (Cheatham 1988:106). Since these dates do not overlap at one standard deviation, I have used the mean (8095 B.P.) of the calibrated ages, 7669 B.P. and 8520 B.P., for the purposes of this study. The radiocarbon dates from Feature 1 at the Lynch site were also derived from camas bulbs: 800 ± 80 B.P. (Sanford 1975:238). This is dendrocalibrated to 694 B.P. All of the bulbs from Hannavan Creek and the Lynch sites were from one feature per site.

The ages of the features, the mean proxy volume per feature, the median proxy volume per feature, the standard deviation, and the sample size are recorded in Table 3 and the distribution of bulbs sizes by age are graphed in Figure 3.

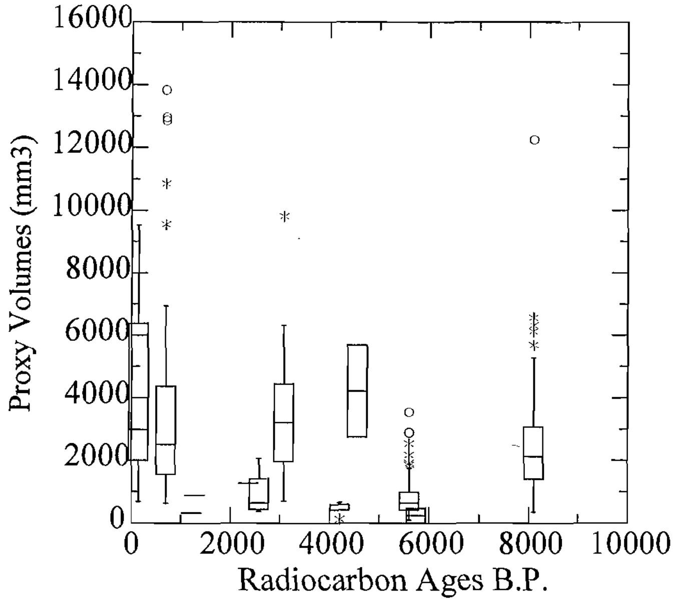
The nature of the ecofact and feature assemblage at the Mill Creek Site Complex set the stage for two "wild cards" to come into play. There are two samples of bulbs from Mill Creek without an associated age. These bulbs could conceivably be from a mixture of many time periods, but they comprised large enough samples to make disregarding them an undesirable option. The first is the living surface at 35MA9, also called Feature 1 (Tasa et al. n.d.). The second is a set of bulbs which were not associated with datable features. Proxy volumes and mean proxy volumes for these two sets were also calculated. These bulbs are designated "Age Unspecified" and "Feature 1" on Tables 3 and 4, and they are graphed separately (Figure 5).

The mean composite bulb sizes were then compared for changes over time using SYSTAT software. Figure 3 charts bulb size against associated radiocarbon age. Each circle on the chart represents the proxy volume of one camas bulb. Figure 5 graphs the "Age Unspecified" and "Feature 1" Bulbs. Figure 6 graphs the means of each feature against radiocarbon age, and Figure 7 graphs the standard deviations of these means.

Most of the sample sizes are too small to be comparable. However, removing them from the graphed results would create the appearance of a trend that does not exist in reality. Admittedly, though, the larger sample sizes do exhibit the tendency to cluster around a certain bulb size, which hints that more significant results might be obtained from using larger sample sizes when available in the future. I will confine most of my discussion to the largest samples, those dated to 694, 3080, 5600, 8095 B.P., and the Age Unspecified and Feature 1 bulbs from Mill Creek. These larger sample sizes are graphed separately in Figure 4. The oldest bulbs are considerably larger (300%) than the next age bracket, 5600 B.P. Once we move into the middle Holocene, the bulb sizes actually begin an upward trend at 3080 B.P. and 694 B.P. When considering only the large sample sizes, the bulb size does appear to increase after 5600 years ago. Considering all sample sizes reveals an alternating, fluctuating effect. In this case, the smaller bulbs (all <2000 mm^3 in volume) are found in ovens dated at 1200 B.P., 2500 B.P., 4200 B.P., and 5600 B.P., and the larger bulbs (>3500 mm^3 in volume) are found in ovens dated at 140 B.P., 694 B.P., 3000 B.P., and 4400 B.P. What is interesting is that the average bulb size seems to fall into two major size categories, 1300 mm^3 or smaller, and 3500 to 4500 mm^3. It is possible

Table 3. ^{14}C ages of features and corresponding mean bulb sizes.

^{14}C age B.P.	Proxy Volume Means per feature mm^3	Median	σ	*n*=
Feature 1	724.1	585.3	439	18
Age Unspecified	840.5	530.6	1268	32
140	4311.7	2985.6	3596	5
694	3813.4	2506.4	3584	38
1210	328.5	328.5	N/A	1
1280	892.3	892.3	N/A	1
2360	1262.7	1262.7	N/A	1
2575	925.7	644.5	769	4
3080	3661.9	3214.8	2760	10
4210	445.6	421.1	205	5
4560	4214.1	4214.1	N/A	2
5600	806.7	644.2	588	122
5740	241.9	241.9	N/A	2
8095	2425.5	2119.4	1622	111



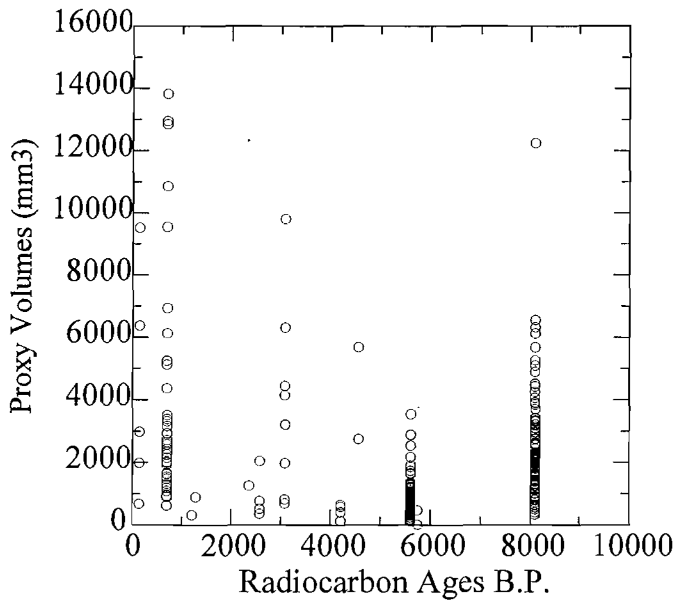


Figure 3. Distribution of Bulb Size (mm^3) over time. The center line on the box and whisker plot represents the median proxy volume.

that these size ranges represent the two species present in the Willamette Valley. At 2425 mm^3, the Hannavan Creek composite mean is an anomaly because it does not fit into either category. This is interesting because the Hannavan Creek bulbs are the only bulbs in the study that are described as being from an "intact" oven (Cheatham 1988), and they are the oldest bulbs recovered in the Willamette Valley to date. Another noticeable trend is that following almost every large bulb mean is at least one small bulb mean, contributing to its fluctuating appearance. The Hannavan Creek bulbs are the oldest bulbs to date recovered from the Willamette Valley. It is tempting to speculate that the large decrease in size from 8095 B.P. to 5600 B.P. is a result of overexploitation occurring after what may be the initial onset of camas use in the valley. However, this is questionable after observing the increase in bulb size at 3080 B.P., during the time of heavier camas usage (based on the increase in radiocarbon ages reported in Table 1). This sample, 3080 B.P., is the smallest of the larger samples, and its range is almost as large as that of Hannavan Creek, which has 10 times more bulbs.

The two sets of bulbs lacking associated ages, Feature 1 and Age Unspecified, have very similar size ranges, and a similar mean: 724 mm^3 vs. 840 mm^3 (Figure 5). Though this is interesting, its significance is difficult to ascertain at this time. Additional radiocarbon ages on these bulbs might prove interesting.

Table 3 also contains a column with the standard deviations for the bulb means. The standard deviations fluctuate considerably. If intensification were indicated, I would expect to see standard deviations decrease over time, exhibiting a selection towards a more standardized bulb size. Even if intensification was not occurring, but a minimal size of bulb was preferred in the digging process, there should still be a more standardized bulb size occurring throughout each sample, rather than the wide range of sizes apparent here. The Spearman's rank correlation is

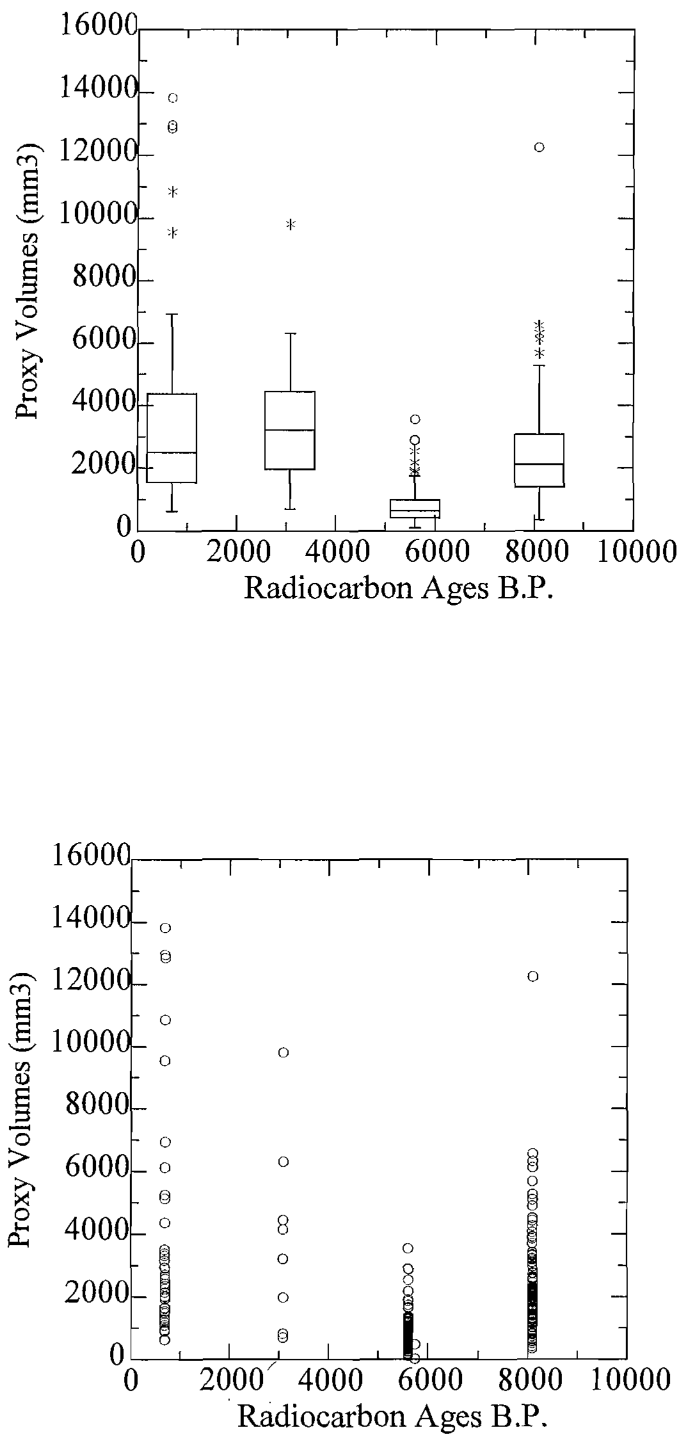


Figure 4. Distribution of Bulb Size (mm^3) over time for large sample sizes. The center line on the box and whisker plot represents the median proxy volume.

0.14, which is not significant.

In addition to fluctuating considerably, some standard deviations are also quite large. This is undoubtably due to the fact that several samples have one or two bulbs whose size is extremely large (refer to Figures 3 and 5). These outliers are increasing the size of the standard deviation within each group of dated bulbs. The standard deviations would become smaller if the outlier data were removed, but the fluctuating appearance of the graph would remain the same.

In order to alleviate any potential problems associated with using data from the Fragmented or Slightly Fragmented bulbs, another test was run using a different measure of bulb size: width x thickness (mm^2), i.e., a cross-sectional area of the two widest parts of the bulb. Many of the Slightly Fragmented bulbs were so classified because they were missing their stems, or the very tip of the bulb from which the shoot emerges. This tip is what gives the bulb its true tear-drop shape, and also its longer length. If the bulb were otherwise whole, the lack of this full length could skew the composite bulb measurement, making some bulbs seem considerably smaller than they were in comparison to the bulbs that were in possession of their stems. Using this cross-sectional area formula, the bulb sizes were then compared as before, against the radiocarbon ages (Table 4, Figure 8). The bulb sizes still do not show a consistent pattern of size change over time. The alternating pattern is nearly identical to the first calculation, supporting the adequacy of the original proxy volume. This graph too shows two distinctive size clusters (150-200 mm^2 and 20-75 mm^2) as well as the pattern of a large bulb mean followed by a small bulb mean. If we discard those measures that are from a sample size of five bulbs or fewer, the pattern is still rather random, but the same as that of the proxy volume measurement, indicating that the length measurement was not skewing the outcome significantly. After a low point at 5600 B.P., the bulbs do increase in size over time. Spearman's rank correlation is 0.18. One possible explanation for the fluctuating bulb sizes over time is a trend of heavy use of a larger bulb crop, which once exhausted, might have still been utilized for its smaller, leftover bulbs. Recall that more features dated to the period 4000-5000 B.P. than during any other millennium, but that recovered bulbs are scarce. Though the sample size of bulbs from this time period is small (n=10), the size is actually rising after the end of this period, 3080 B.P. (Figure 4). Though this may reflect an exhaustion of the camas fields during the intense period of camas oven building at Mill Creek, it must be remembered that each oven age (and hence the bulbs' ages) are

Table 4. ^{14}C ages of features and corresponding mean bulb size (alternate measure).

^{14}C ages B.P.	Cross-sectional mean area of Bulbs in mm^2	Median	σ	n=
Feature 1	49.5	44.4	22	18
Age Unspecified	51.9	41.4	49	32
140	164.9	176.7	98	5
694	176.5	127.6	141	38
1210	30.4	30.4	N/A	1
1280	48.8	48.8	N/A	1
2360	77.5	77.5	N/A	1
2575	62.8	48.0	48	4
3080	154.9	151.3	86	10
4210	31.6	35.9	12	5
4560	194.5	194.5	N/A	2
5600	55.2	47.4	32	122
5740	18.3	18.3	N/A	2
8095	135.4	127.3	67	109

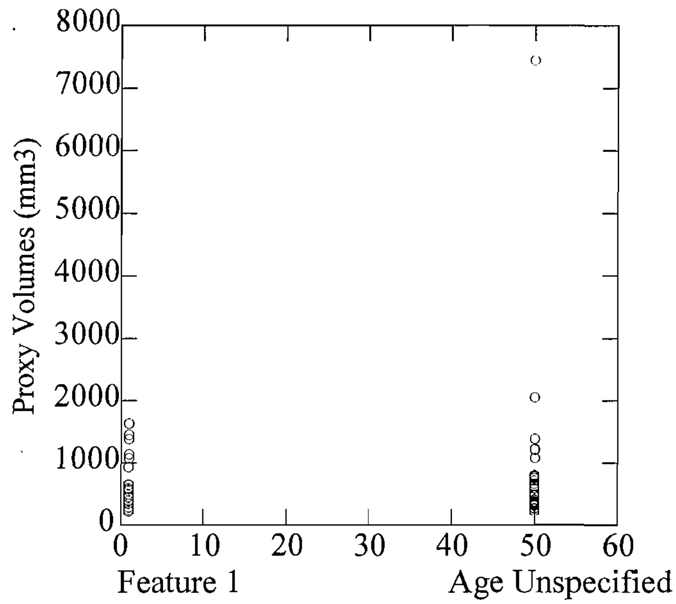


Figure 5. Age Unspecified and Feature 1 Bulbs.

separated by hundreds of years. There are no data on how long it may take a camas field to "bounce back" after years of overuse, but it has been demonstrated that a camas bulb will flower and be edible after only 4 or 5 years, and can live up to 30 or more years (See Camas Bulb Ecology section above). However, Daubenmire (1970:78) quoted in Thoms (1989:148), stated that there is little evidence that the camas plant could be the victim of over-exploitation by the Indians, and Suttles (1951b:59) reported that camas thrives on being heavily exploited. However, this debate is probably better left to studies of camas bulb samples with radiocarbon ages in much closer succession than these.

Finally, Figure 7 is a graph of the standard deviations in mean bulb size from the first data set (mm^3) against the radiocarbon ages. This graph illustrates a somewhat regular increase in standard deviation over time, and is, at least, the most significant measurement thus far. In this case, variability is increasing through time, hence selection of camas bulbs for a larger size or a specific size is not substantiated. Again, I would expect to see selection of larger bulbs (whether by selection or simply choice in field harvesting) resulting in a decreasing standard deviation, as fresh bulb size became more standardized. These data do not support my hypothesis that bulbs were being standardized into a larger size category, but rather the opposite. The Pearson correlation for the standard deviation of all the samples is -0.68, and the Pearson correlation for the standard deviation of the large sample sizes is -0.84, which are somewhat significant.

Finally, there is one detail to observe. Among the larger sample sizes, the most recent bulbs, those dated to 694 B.P., do have a larger mean bulb size that those dated to 3080 B.P., 5600 B.P. and 8095 B.P., in both the proxy volume measurement and the cross-sectional area measurement. The path to this slightly larger mean bulb size is unclear, as evidenced by the fluctuating means. It is also not clear that this is evidence of an increased size in camas bulbs, because another time period (4560 B.P.) exhibits a larger bulb size (4214 mm^3) than that at 694 B.P., although its small sample size (n=2) calls its significance into question. At this time, I am not convinced that complete acceptance of the bulb selection hypothesis is warranted based solely on this data.

DISCUSSION

The results of this study largely indicate that bulb size did not change over time in a systematic manner. Long term selection for a specific bulb size is not clearly evident in the archaeological

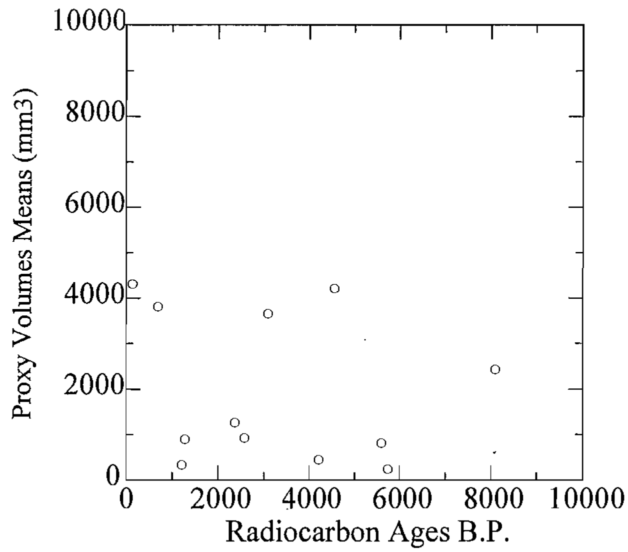


Figure 6. Distribution of bulb size means (mm³) over time.

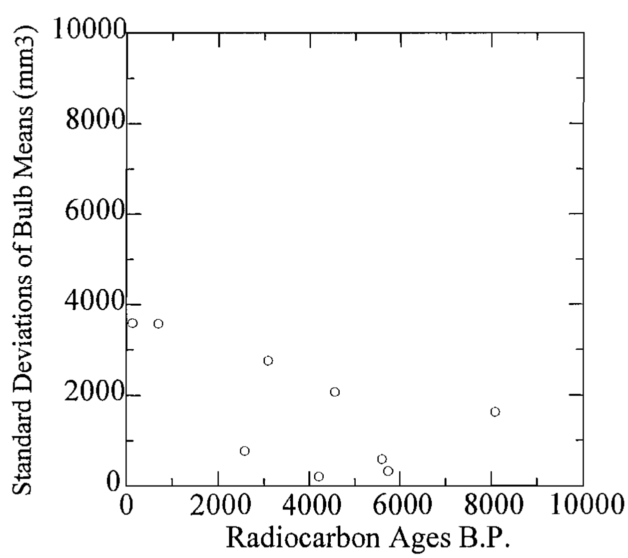
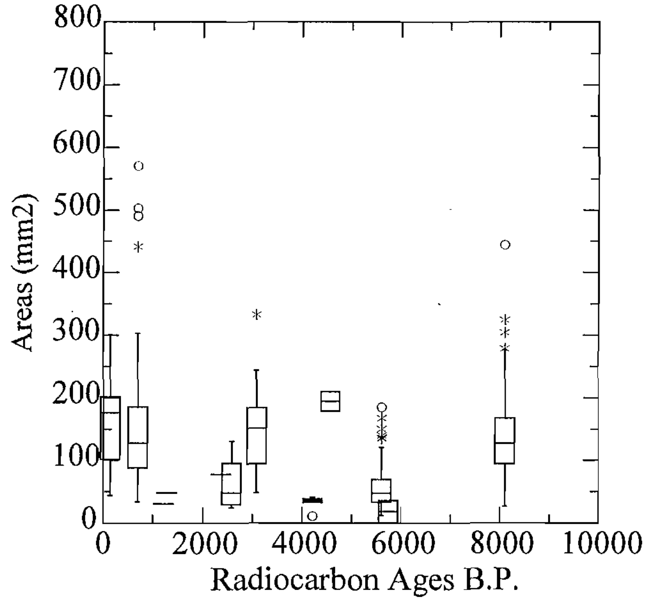


Figure 7. Distribution of Standard Deviations in bulb size over time.



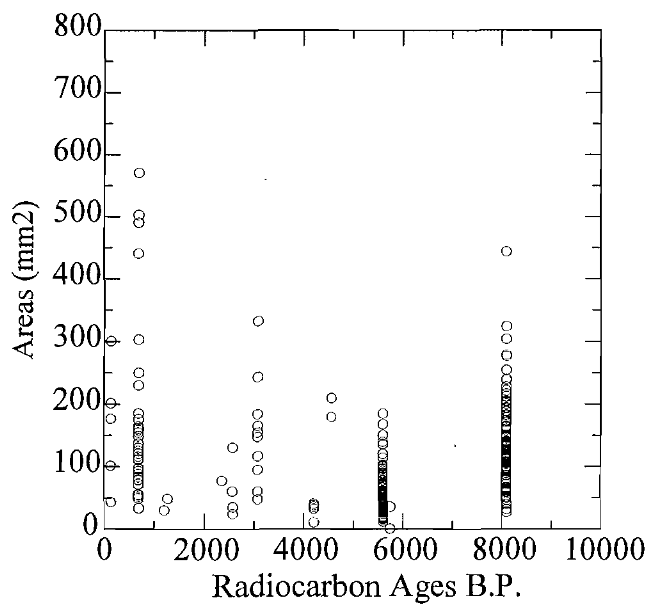


Figure 8. Distribution of bulb sizes (mm^2) over time. The center line on the box and whisker plot represents the median areas.

samples either, although in the very large samples, 8095 B.P., 5600 B.P., and to a lesser extent 694 B.P., the individual bulb sizes do cluster together (see Figure 3, lower graph). This is a clear indication that more large sample sizes would improve this type of study, as well as a study documenting the range of variability in a stand of camas. As stated before, size is only one feature worth manipulating in a food plant, and it remains to be shown whether or not other features may have been enhanced. What we may be viewing, at some point on the 8000 year continuum, is intensification, but certainly not domestication. Based on bulb size, which point in time might we label as a period of intensification? Are the periods of intensification those with a large range of bulb sizes (i.e., when collectors gathered any bulbs regardless of size), such as approximately 700 B.P., or are the periods of intensification those with a fairly standardized bulb size (i.e. collectors gathered bulbs of a certain size to optimize foraging), such as 5600 B.P.? To some degree, the answer depends on our definition of intensification.

There are several caveats to consider before rejecting the size selection hypothesis. It is critical to remember that the bulbs measured here are the leftovers, those not collected from the ovens after baking. There may be several reasons for this. They may have been too charred to collect, or perhaps they had fallen through the cobbles to the lower depths of the ovens and were not retrievable. If the latter is true, did they settle to the lower depths of the ovens precisely because they were the smaller bulbs? Some rather large bulbs were recovered, and it would seem that they would only be left behind because they were overcooked, rather than overlooked or irretrievable.

This question may only be answerable in a case in which every bulb was recovered *in situ*, from within an unopened oven, so exact bulb placement within the oven could be observed. Unopened camas ovens are not often found. The Hannavan Creek bulbs are reported to be from such an oven

(Cheatham 1988:107; 1999, pers. comm.), but in this case only one quadrant of the oven was excavated. Although the bulbs were recovered from within a 40 cm x 40 cm area, some of the bulbs are described in the field notes as being from "outside" or "inside" the concentration, and the precise location of each bulb was not recorded.

Clearly, it is important to remember that these archaeological specimens (with the possible exception of the Hannavan Creek sample) were the "rejects" that no one wanted to eat or retrieve. With this in mind, the size selection hypothesis can still be tested. If bulb size was standardized, this should reveal itself in all of the bulbs, including the "rejects." These rejected bulbs were discarded only after cooking, not at the time of harvest. Whatever criteria were employed in the harvest field (even if it were the minimal criteria that the bulbs *be* camas) theoretically apply to all bulbs in the oven, left behind or not. Therefore, that the bulbs are burned rejects should not affect a study of size manipulation, except with respect to how placement within an oven affects shrinkage of individual bulbs. Even though the burned bulbs probably shrank more than the non-burned bulbs, they should still be comparable due to the fact that they were all collected under the same criteria. This would only be negated or further complicated if it is determined that placement within an oven significantly alters the size and rate of shrinkage of each individual bulb.

Having said this, experimental camas oven building and firing by Wilson and DeLyria (1999) has revealed that temperatures within an oven do differ. In their oven, the lower heating element reached a temperature of 350°C while the pit edge was 150°C. After the oven was covered with its top element and soil, the temperatures in the lower heating element reached 425°C and the matrix above the lower heating element was 100°C (Wilson and DeLyria 1999:82-83). This suggests to me that bulb placement within an oven could affect rates of shrinkage.

Therefore, the three assumptions I had to make initially (refer to Methods section above) may not be warranted. The first was that all bulbs cooked within the same oven should have approximately the same relative amount of shrinkage, irrespective of their size before cooking, and were equally impacted by cooking and charring processes. This may not always be true. Oven temperature clearly varies throughout an oven (Wilson and DeLyria 1999). It may be the case that bulbs in the hotter parts of the oven shrink more, especially upon being burned, and their original dimensions are altered more than those bulbs in the cooler areas of the oven, even if they burn also. Additionally, some bulbs may be better protected from intense heat than others by the thickness of the surrounding foliage added as layering.

The second assumption was that all bulbs represent the same species. This may not be true. Both *C. quamash* and *C. leichtilinii* may be present, and they both have different average-sized fresh bulbs. If they are both present, size changes over time might not be as determinable as initially hoped. I do not know whether it is possible to determine with a high degree of certainty the species of each burned bulb. It may be labor or cost prohibitive to do so. It seems that bulb size change over time should still be measurable, especially with larger sample sizes, which would likely yield more easily interpreted results.

The third assumption, that damage and breakage to the bulbs was a result of post-depositional processes and was unavoidable, remains likely. Most excavations are conducted with limited resources, and rapid excavation is encouraged. However, it would be useful to have larger botanical remains, such as camas bulbs, recovered *in situ* to avoid damage from the screening process. Likewise, careful accessioning in museums to preserve them for future study is imperative, if not obvious. All of the bulbs in this study were preserved remarkably well, considering their fragility. The majority of the bulbs from Feature 1 at the Lynch site (those packed in plastic bags inside tissue lined boxes), were the most carefully packed bulbs of all the sites studied, but were also very disintegrated, no doubt due to their 25+ years above ground. While the charred condition of the bulbs retards spoilage, it also advances pulverization. It seems to me that camas bulbs, even though they are charred, have a short shelf life and any analyses conducted on them should be conducted relatively quickly following excavation.

These problems notwithstanding, there are other implications to consider. One is that climate affected the viability of camas crops. Toepel (1985:152) has already suggested that the warmer and drier climate that occurred between 8000 and 4000 years ago may have limited the extent of camas in the Willamette Valley. In the early Holocene, the climate of the Willamette Valley was warmer and drier than it is today, and through the middle and late Holocene continued (for the most part) to decrease in temperature and increase in precipitation (Pearl et al. n.d.). These climate changes may have affected bulb size as well, although this is not substantiated by my data. It is possible that micro-climatic fluctuations caused some camas yields to be leaner during certain times, and that may be reflected here. People may have been forced to choose smaller bulbs rather than no bulbs at all, or some of the bulbs may have experienced inhibited growth due to the lack of abundant water during certain times.

Ames (n.d.: 35) also discusses two reasons we see varied degrees of camas use in the archaeological record for the Willamette Valley. His first reason is similar to that of Toepel's, that a camas field could experience fluctuation in productivity (and I might add bulb size) due to climatic shifts. His second is that of human overexploitation of the meadows. Particular meadows could become more or less productive at different times. If this was the case at Mill Creek, Hannavan Creek or the Lynch site, the varied results I have produced may reflect the choice by prehistoric peoples to continue using those fields, rather than abandoning them for more productive ones elsewhere. For now, both of these interpretations are largely speculative.

What is apparent, at least with this limited study, is that camas is clearly not showing manipulation on the scale of Eastern Woodland domesticates, such as sumpweed, cucurbita or corn (Cowan 1997:63). However, detailed microscopic study of these bulbs past the point of identification has not been undertaken either, as it has been with the eastern domesticates (Cowan 1997:63). This may be a good topic of further study.

Another possible explanation for the lack of regularity at Mill Creek, Hannavan Creek and the Lynch site, is seasonal variation. Perhaps some bulb samples were dug at different times of the year yielding smaller or larger bulbs, although all bulbs within one oven should be from the same season. The issue of seasonality is currently under review by Tasa et al. (n.d.). It would be hazardous to identify seasonality based on bulb size, because of reasons discussed earlier. As seasonality pertains to seeds in the archaeological record, it must be noted that there were virtually no *Camassia* seeds identified in the ovens and soil samples from Mill Creek (Puseman et al. 1999). I also found very few in the column samples I processed from features (Tasa et al. n.d.). I think this fact may inform either on seasonality or at the very least, cooking processes, if not harvesting ones. Seeds will probably only survive in the record if they are charred in the ovens. Since there were virtually no seeds in the ovens, this may indicate that camas was collected prior to the seed pods becoming fully formed. Conversely, it may indicate that camas was collected after the pods were fully formed, but that the seeds never made it to the ovens. The seeds may have dropped out as they were being carried to the oven activity area, although a 100% loss of the seeds in this manner seems unlikely. Alternatively, they may have been deliberately removed from the bulb. If this is the case, such seeds may or may not have been replanted. Finally, it is possible that seeds in the oven burned so completely that nothing remained. The questions of when the bulbs were being harvested, if the flowers or seed pods were routinely removed, as well as whether or not Willamette Valley residents were replanting seeds remain to be investigated more fully.

Thus far, I have largely focused on ecological or climatic explanations in trying to find an explanation for what appears to be a lack of camas intensification and significant patterns in bulb size changes. Anderson (1997) and Peacock (1998) pointed out the importance of human agency in plant food intensification, and I have hypothesized that people were controlling their camas harvests more than my results have shown to be true. Perhaps the most obvious explanation for the random bulb sizes observed here is that prehistoric residents of the Willamette Valley were not selecting bulbs for large size. It is conceivable that the abundance of camas was sufficient not to require this type of selective harvest. It is also possible that only a limited number of management practices which improved camas' prolificacy (e.g., burning and thinning) were required to sustain a more-than-adequate harvest. It is also conceivable that other social processes were in place that affected camas crops which are not yet measurable in the material record. However, I do not think it would be prudent at this time to dismiss the bulb selection hypothesis outright, especially due to the many variables in this study that may be better controlled in future analyses.

In terms of potential future studies, there are four major avenues to pursue. Measuring all of the camas bulbs ever recovered from archaeological contexts in the Willamette Valley might yield different results, although other collections are also limited in size, and I have already chosen the largest ones available. In addition, most bulb collections are not dated any more precisely than the

Mill Creek, Hannavan Creek, and Lynch bulbs. However, looking at all assemblages in the Willamette Valley may produce more conclusive results. Along that same line, carefully extracting and measuring bulbs from camas ovens excavated in the future, and adding those data to mine may produce a clearer picture of bulb size change over time.

This type of study could also be accomplished for collections from British Columbia, Washington, Montana, and Idaho, where camas was also heavily used. In these areas, there seems to be more clear ethnographic evidence of "selective breeding" (Suttles 1951a; Turner and Kuhnlein 1983; Thoms 1989). The second critical avenue to pursue is that of talking to Native Americans who are camas harvesters, and who may have recollections of the old and new methods of managing and harvesting camas. They may have clear recollections of rules associated with bulb size and/or seed replanting, and the objectives of such actions. Thirdly, in the absence of clear and unquestionable archaeological and ethnographical data on camas bulb selection in the Willamette Valley, studying paleoclimate or water table levels and their effects on camas over time will also be useful. Lastly, more experiments involving actually roasting camas in an underground oven are needed as well, as evidenced by the useful results obtained by Wilson and DeLyria (1999).

In this discussion of intensification, manipulation, horticulture or proto-agriculture, it is valuable to remember the people involved in this process, what they did, and why they did it. To this point I have rarely mentioned *who* was harvesting or processing camas, except to describe it as the work of the Kalapuyans of the Willamette Valley. Now, I will turn to camas processing in a very specific, gendered context.

GENDER STUDIES IN ANTHROPOLOGY AND ARCHAEOLOGY

The formal study of gender within anthropology is relatively new, especially within the subfield of archaeology. An interest in gender in anthropological study can be traced to the second wave of the feminist movement in the United States (the early 1970s), particularly in the cultural and physical subfields (Conkey and Spector 1984; Gilchrist 1999). Archaeology, however, has been described as having experienced a "paradigm lag" (Leone 1972), as it only began to address the issue of formally investigating gender as early as 1984 (Conkey and Spector 1984). Though the formal study of gender in archaeology is a fairly recent development, Brumbach and Jarvenpa (1997:415) have pointed out that "archaeologists have not been silent about women's and men's behavior." In the past, a sexual division of labor was considered a human universal (Brown 1970), and discussions of men's and women's subsistence behavior and roles have since often fallen along these lines, in the tradition of older anthropological models such as "man the hunter/woman the gatherer" (see Lee and Devore 1968). The use of this model has had the effect of implying that 1) men exclusively hunted and women exclusively collected plant foods, 2) women and men created and used different tools, and 3) women and men conformed to two distinct roles which infrequently overlapped and were valued differentially. While interpretations such as these may not be incorrect in some culture areas of the world, it may often be the case that they are rooted less in anthropological data than in long standing stereotypes (see Gero 1994; Moser 1993; Watson and Kennedy 1991; Conkey and Spector 1984 and Zihlman 1981 for in-depth discussions of examples). Additionally, conference papers, books, journals, institutions and cultural horizons have been named in a decidedly androcentric fashion as well (e.g., "Evidence for Megafauna and Man in the Willamette Valley 12,000 YBP" [Stenger 2000]; "Man and Environment in the Great Basin," "National Museum of Man," "Clovis Man").[2]

Feminist and non-feminist scholars have recently put forth successful efforts to deconstruct or revise these types of misinterpretations (e.g., Gero 1991; Hastorf 1991; Watson and Kennedy 1991; Moss 1993; Brumbach and Jarvenpa 1997). In these and other efforts at "engendering" the archaeological record, two primary objectives are accomplished, including 1) critique of androcentric bias in archaeological interpretation and reporting, and 2) research that re-focuses on women and their roles and contributions to their respective cultures. Beyond these two objectives, the benefits of complete incorporation of gender into all archaeological interpretation would lead to better understanding, documenting and explaining gender systems, and how they intersect with other societal systems (Conkey and Spector 1984). Adding the gender variable to the record will enrich and deepen our understanding of prehistory, as it can contribute to explanations of different cultural changes throughout time and place. This is no less an important task to undertake in the Willamette Valley than anywhere else. In time, archaeologists may be able to demonstrate whether or not a sexual division of labor existed in all subsistence matters, and whether or not these practices varied over time and region, and what changes Euroamerican contact contributed to these practices. The final product of understanding these types of social systems would be a better understanding of everyday life, values and subsistence practices in the Willamette Valley.

GENDER STUDIES IN WILLAMETTE VALLEY ARCHAEOLOGY

My goal is to demonstrate that if we explore ethnohistorical and archaeological evidence that

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[2]Androcentric is defined as male-centered. Often the term "man" is used as a default gender, i.e., the term "Early Man" is used when what is actually meant is "Early Human." It is important to recognize that androcentrism is certainly not limited to male scholars.

pertains to sex and gender in the Willamette Valley, we will find evidence to suggest that women's and men's roles in camas gathering and processing do not appear to have followed a rigid division of labor by sex. My goal is also to demonstrate that archaeological studies of all subfields (not just issues concerning paleoethnobotany) within the Willamette Valley would be enhanced if archaeologists ventured to engender the past with empirical data collected in the pursuits of everyday research.

As stated above, before gender can be fully integrated into archaeological interpretation, the two "remedial" tasks of recognizing androcentric bias and conducting research focusing on women in the ethnographic and archaeological records must be accomplished (Conkey and Spector 1984). In the Willamette Valley, this type of research is in its infancy. This may be because Willamette Valley archaeology in general is quite young. Professional investigations began in 1925 and continued until 1951, when a 13 year hiatus occurred. Work began again in 1964 and has continued to the present day (Cheatham 1988:11-15). In sum, there have been 62 years of Willamette Valley archaeology, with 16 years since 1984, when Conkey and Spector introduced gender as a formal study for archaeologists.

Two important directions of research-driven Willamette Valley archaeology have been to understand the relationships of the physical landscapes of the valley environments to different site and settlement types (White 1975b; Cheatham 1988), and to establish a cultural chronology for the valley, including a projectile point typology (Collins 1951; Davis 1973; Henn et al. 1975; Toepel 1985; Tasa et al. n.d.). A more recent attempt has been made to place the cultural sequence of the valley in perspective within the prehistory of the larger Pacific Northwest, and to examine influences of culture change from neighboring regions (Minor et al. 1982). The issues of gender and the sexual division of labor are not usually examined as a matter of course, but see Bowden (1995) and Roulette (1993) for brief mentions pertaining to the Willamette Valley, and Thoms (1989) for mentions in the greater Pacific Northwest. Sanford (1975:270-1) assumed a division of labor by sex to explain the presence of stone tools and camas ovens at the Lynch site, "[c]amas processing was probably the task of women and children. That men were present is indicated by the large number of projectile points found at the site." Olsen (1975:471), in describing pictographs on the wall of Baby Rock Shelter, mentions "men on horseback" but does not indicate how he knew they were men. Generally, however, sex and gender are not frequently mentioned in Willamette Valley archaeology reports.

Why has this been the case? Is it a belief that gender cannot be specified using the archaeological record? Is it because an interest in gender and archaeology is relatively recent within archaeology as a whole? Is it merely a reflection of available technologies and personal interests? Has the issue simply not yet "come up"? Quite possibly all of these reasons are responsible. Perhaps it is *because* camas gathering and processing have been considered ethnographically to have been women's work that a lack of interest in both gender and camas has existed, at least until recently. Within archaeology as a whole, interest in using paleoethnobotanical data has been limited in the past (Gremillion 1997). Watson (1997) described paleoethnobotany as having moved from occupying a peripheral and poverty-stricken status within archaeology to being a central part of the establishment just within the last 20 years. Part of the reason for this was the "artifact-centric" nature of archaeology which until recently had placed faunal and botanical remains on a lower threshold than ceramics and projectile points (Watson 1997). Along these same lines, although camas ovens are frequently uncovered during archaeological excavations, detailed analyses of the ovens and/or their contents have been less of a priority than analyses of stone tools in the Willamette Valley, at least until recently.

To illustrate this point, I have done a survey of the articles in an edited volume on Willamette Valley prehistory (Aikens 1975) that deal with camas ovens and lithic assemblages. I chose this volume because it represents the work of many authors (17) and should provide a window into the interests and foci of local archaeologists. I have not counted articles describing lifeways strictly using ethnographic data. In examining the pages devoted to lithic materials, I counted pages devoted to projectile points and debitage separately from those including scrapers, drills, cores, or groundstone. I found 37 pages devoted to the explanation or mapping of camas ovens, 98 pages devoted to discussions and illustrations of projectile points and debitage, and 62 pages devoted to the other lithics and groundstone. I did not count articles that described sites without camas, or papers that were strictly devoted to the lithic analyses of several sites, although many pages of this 552 page volume constituted such analyses. The contents of this volume reflect the popularity of lithic studies in the valley, and the less-prominent status of camas research, at least in the 1970s.

The Mill Creek project represents a productive and useful change in Willamette Valley archaeological research. Attention to camas ovens and their contents was a large part of the research design (Connolly and Hodges 1996). While documenting geomorphic processes and their relationship to the culture history of the sites was a major element of the design, so too was understanding the functions, structure, and chronology of the camas oven features (Connolly and Hodges 1996). The sites were initially surveyed using a magnetometer to detect magnetic anomalies, and the interiors and exteriors of camas ovens and other features were hand excavated in five centimeter levels. The camas ovens were mapped and measured, and the rock heating elements were weighed in the laboratory. Numerous soil and charcoal samples were collected and analyzed for constituent ratios as well as macrobotanical elements. The recovered camas bulbs were identified by a paleoethnobotanist and measured. The tools associated with the ovens were recorded in an attempt to document distinct activities in close proximity to camas baking operations (Tasa et al. n.d.). As stated above, each feature was radiocarbon dated whenever possible. Even though the Mill Creek project research design did not focus explicitly on gender, the field and lab methods used to document the camas ovens were far more systematic and detailed than that of previous archaeological research in the Willamette Valley. Without these meticulously collected data, my analysis would not have been possible.

These methods yielded important data about Kalapuyan subsistence practices over the past 6000 years (Tasa et al. n.d.). With these valuable data emerging, there are still unanswered questions, such as, which members of the Kalapuya were responsible for building, filling and tending to the many camas ovens excavated and still buried in the valley? One way to get at this, of course, is to examine the ethnographic record. Some may argue that the historical record may only represent customs at contact that do not extend further back into prehistory. One option is to completely avoid ethnographic analogy, and to continue to refer to prehistoric peoples in a rather ambiguous, ageless, genderless fashion. Tringham (1991:94) describes this practice as seeing prehistoric people as "faceless blobs." The other option is to attempt to integrate the archaeological record with the ethnographic, and watch for changes over time and space as we are trained to do.

Here, I will address gender and the sexual division of labor, as it pertains to camas gathering and processing. In the Willamette Valley and elsewhere, camas (and other root) processing has been reported by ethnographers and archaeologists to be the exclusive work of women (Brown 1868; Gatschet 1945; Suttles 1951a:278; Zenk 1976; Reeve 1986; Bowden 1995). Among the Flathead of Montana, the division of labor was so distinct that the presence of men near the baking ovens was taboo (Turney-High 1937:127). That camas harvesting was the domain of women is often implied or stated outright by frequently quoted ethnohistorical journals (Jacobs 1945:18; Summers 1994:33).

Conkey and Gero (1991:12) have criticized the assumption that the products of women's labor (in this case, plant remains and ovens) are less visible in the material record than those of men. Certainly, in the Willamette Valley, camas ovens are very visible. In the "man the hunter/woman the gatherer" model, men are associated with hunting, and projectile points (also very visible archaeologically) are often assumed to have been made and used by them. Even though one objective of the "remedial" research is to find and focus on women and their cultural contributions in prehistory, Conkey and Gero (1991) dislike this path of inquiry (while at the same time recognizing its necessity) on the grounds that no need to "find" men has ever been expressed, by virtue of the fact that men are, by default, always there. Their point is well taken, and as part of my "remedial" research focusing on gender and camas subsistence in the Willamette Valley, I do not sense the need to find women, but to find men, and do (more on this below). A closer examination of our usual and customary ethnographies and ethnohistorical accounts reveals that the division of labor related to camas processing was not as rigid, absolute, or pervasive as may have been surmised.

The primary sources of ethnographic data existing for the Willamette Valley are the linguistic and mythological texts of Albert Gatschet, Leo Frachtenburg, and Melville Jacobs (compiled in one 1945 volume). Gatschet collected his information in 1877, from informants living on the Grand Ronde Indian Reservation for 20 years. His principal informant seems to have been Peter Kinai. The first names of five informants are listed, one is female (Emmy), three are male (Peter, Dave and Kemkid) and one is unknown (Gatschet et al. 1945:155). Additionally, Gatschet's notebooks do not always indicate which informant dictated and translated which text (Gatschet et al. 1945:155). Gatschet presents few translations attributed to female informants. In 1913, Frachtenburg also collected stories from a Mary's River man named William Hartless. He also had the aid of Peter Kinai's son, Louis Kenoyer, who assisted him in translation as well as acting as an informant. Two myth texts are attributed to Mrs. Louisa Selky and Mrs. Grace Wheeler, but they do not mention camas processing (Gatschet et al. 1945:199 & 351). Between 1928 and 1936, Jacobs edited all of the previous manuscripts and conducted his own interviews with a Santiam Kalapuya man named John B. Hudson (Jacobs 1945:5). Although Jacobs reports knowing of a woman who still spoke the Mary's River dialect of Kalapuya, he never mentions interviewing her. In fact, his Santiam Kalapuya Ethnologic Texts (1945:4-81) are solely the result of interviewing John Hudson (Jacobs 1945:6).

It is clear that from the beginning, ethnography of the Willamette Valley was biased towards the male perspective. This may or may not have been intentional. It may be a result of bias on the part of the ethnographers, lack of access by the male researchers to female informants, or a lack of female ethnographers within the field. There may have been more female informants who are simply not clearly identified or relied upon. Whatever the reason, this inherently creates a one-sided ethnography, on many levels. Information could be biased in favor of male activities, and is certainly biased in favor of the activities in which the male ethnographer is interested.

Descriptions of female gendered activities may not be accurately described, or it may be the case that activities were not as dichotomized in practice as an informant reported.

It is interesting that despite texts generated by males, camas harvesting and baking is mentioned and described frequently. If camas gathering and cooking were strictly female activities, we might expect discussions of camas to be absent from this literature due to the fact that these informants and ethnographers were mostly male. However, John Hudson gave a very detailed report on cooking camas in Jacobs (1945:18-19). When describing the digging of the hole, he referred to the diggers as "people" and "they." He then described these people calling in a male shaman to determine whether or not the coals were hot enough to cook camas. The personal pronouns changed to the feminine forms when it was time to layer the camas in the oven, and reverted back to non-gendered forms for the procedure of opening the oven and removing the bulbs (Jacobs 1945:18-19). It is certainly possible that Hudson's command of the English language was not precise, although he is highly praised in Jacob's (1945:9) introduction for his "skill as dictator, translator, and informant...." A closer examination of the Kalapuyan language may shed more light on nuances in the masculine and feminine pronouns in the language. It is also possible that camas cooking was a communal activity, and not restricted solely to women, and this is reflected in Hudson's alternating pronoun genders. In another entry, however, Hudson stated that "in the good old days" (Jacobs 1945:26), men hunted all the time and women always dug camas and gathered tarweed seeds. Hudson did relay a myth to Jacobs, in which five female frogs were digging camas (1945:97). These ambiguous quotes are all from the Santiam Kalapuya texts, and the Santiam are from the geographic area near the Mill Creek sites (see Figure 1).

Some of Gatschet and Frachtenburg's (1945:174) Kalapuya texts are compiled from interviews with Tualatin informants. One unspecified person stated that "Tualatin women dug camas roots, they used a root digger" (Gatschet et al.: 1945:190). Other mentions of camas are very ethereal. One creation myth discussed an infant that dug roots and then turned into a girl (Gatschet et al. 1945:174). Another described a crow coming into a couple's house and telling the man to make bows and arrows and the woman to make a digging stick and to dig camas, carrots, and potatoes (Gatschet et al.: 1945:176). This latter entry is interesting in that it involves a post-contact addition to the valley, potatoes. The myth may have been altered in some way from the original. William Hartless also related a myth in which coyote digs camas (Gatschet et al. 1945:215). Most often Coyote is gendered male, but he is also considered to be a trickster. It may be significant that Coyote is a trickster and by digging camas he is perhaps doing something he is not supposed to be doing.

These ethnographic sources are somewhat ambiguous on the subject of a sexual division of labor, although they seem to favor one in which camas harvesting was, or "should" have been, women's work. Most of the foregoing is memory culture. What the following ethnohistorical accounts will demonstrate are eyewitness accounts of camas harvesting and processing, although they can be just as ambiguous at times.

Alexander Henry was a fur trader for the Northwest Company who kept an extensive journal of his travels through Canada and the Pacific Northwest. He first mentioned camas in the Willamette Valley on a canoe trip up the Willamette River. This passage was written on January 23, 1814, as he was portaging around Willamette Falls. It must have been miserably cold; Henry repeatedly mentions the incessant rain and fog.

> On our arrival at the upper end we met a party of Indians on foot on their way down loaded with bags of raw Cammoss (*sic*). They seem to be an ugly ill formed race, no less than four out of seven had some defect in his eyes. They are of the Yam he las, who dwell on the Yellow River, a branch of the Willamette. They are great rogues but not very numerous. They live in houses. They were most wretchedly clothed in deer skins. Their Quivers were of deers heads and necks. One of them was leading a horse loaded with raw Cammoss. Their women had pettecoats (*sic*) of fringe leather similar to the Chinook women's cedar pettecoats, but reaching only about half way down the thighs. Their scanty deer skins (*sic*) robes were miserable indeed. They had a small round bonnet of wattap on their heads, with a sharp point on the top about three inches high. They are a wild and furious looking people, rather small in size, in a word the most miserable and rascally looking tribe I have seen on this side of the mountains (Henry 1992:658).

This passage is remarkably informative for several reasons. Henry makes several provocative comments which are worth investigating or at least deconstructing: the most interesting being that this mixed gender group of Yamhills was using a horse to transport what sounds like a large amount of camas, unprocessed, in the dead of winter. They were ill, and there were at least seven of them, or seven men.[3] He also asserts that they lived in houses. He later states that shortly thereafter he came across their canoes "hauled on shore" and the "spot where formerly a village stood the remains of their dead are still seen there" (Henry 1992:658).

It is worthwhile to tease out of some of the obscure information in this paragraph. It definitely seems that these folks were either taking their load of camas somewhere to trade it, or moving themselves and taking their winter food stores with them. Since Henry does not mention any trading and later mentions passing a former village, I would support the latter explanation in this

[3]My curiosity regarding whether or not Henry was only counting the males in the party of Yamhills stems from his pronoun usage. He describes how four of seven had a defect "in *his* eyes," and then describes what "*their* women" were wearing [emphasis mine]. This leaves the impression that he may have been counting seven men and "their" women were additional. Though my original point was not to debate whether or not Henry was a chauvinist, but rather to offer that the party of Yamhills may have been larger than seven individuals, this is a good example of how androcentrism can be present but almost invisible in literature of any kind.

case. Some of the details are problematic. The canoes fit with Thoms (1989) intensification model in that these people were using the river to transport themselves, but they were also, perhaps concurrently, using a horse. Additionally, the raw state of the camas is problematic. Was it really raw? Was it really camas? Could it have been stored into January uncooked? Watson (1988) reports that fresh camas bulbs do over-winter well, just as other types of garden bulbs do. If Henry is correct about the Kalapuya having large quantities of raw camas in January and the existence of substantial houses, Thoms' (1989:184) assertion that camas intensification should correlate positively with increased sedentism and storage may be supported by this passage (see page 6).

On the other hand, Henry notes how ill the Yamhills were and the fact that their population was small. These facts do not reinforce the notion of intensification, at least in the early 19th century. This is corroborated by Connolly's (1999) data on disease epidemics and population decline. As with ethnography in general, with the gender issues, too, it is important to remember the effects of the epidemics on the written record. If these descriptions of Native peoples as wretched and scattered cannot be representative of pre-contact conditions (Connolly 1999), the descriptions of sexual divisions of labor may not be entirely accurate either. Connolly's point is well taken, and has the potential to throw all interpretations of Willamette Valley ethnohistorical documentation into question, simply because we know we are examining records that do not reflect accurately the lifeways of the indigenous Kalapuya. It is conceivable that illness and starvation would have caused catastrophic changes to ritual behavior and social structures, so that any behavior one could document could be explained away by claiming that people were sick and desperate, and had tossed aside traditional behaviors in favor of mere survival. Even so, Henry's passage and others like it are worth evaluating because they provide glimpses into the life of Willamette Valley residents. We can ask questions of such passages, and attempt to understand the complexity of historic circumstances with the hope of shedding light on the archaeological record.

Returning to the passage itself, there is still the matter of gender and camas. If this party of Yamhills was relocating itself or its camas stores (rather than traveling somewhere to trade it), any questions validating or refuting a sexual division of labor and camas processing are probably not answerable from this passage alone. We do know that the group Henry encounters included at least seven individuals, unless Henry was only counting the men. It would be highly unusual for a group to be moving their stores and not be mixed gender, therefore, the passage yields no pertinent information on camas processing. However, if the group was not moving but traveling to trade, then clearly both men and women were involved in the trading aspect of camas management.

In March of the same year, Henry seems to have been stationed at the mouth of the Columbia River, trading beaver pelts, sturgeon, salmon and other goods with many different groups of Indians and other Euroamerican trappers. At this time, it was men who were trading camas:

> The Chief of the Calipuyous took under his charge the care of the Buildings, and the four Horses and two Hogs. He appears well inclined towards us. The Yum he las (*sic*) also came there from the Yellow River a few days previous to their departure, about 30 men who brought an abundance of baked Cammoss. These fellows also invited our people to return on the River (Henry 1992:704).

Jesse Applegate, who emigrated in 1843 as a child (almost 30 years after Henry's adventures), reported different experiences with Indians, camas and other plant foods, although he wrote down his memories 67 years after they happened (Rucker 1930a:150). While camping near Salem, he observed the "custom" of the autumn burning of tarweed fields, and notes only women: "squaws, both young and old" collecting the seeds (Rucker 1930a:178). He also mentioned how industrious the female Kalapuya were when it came to food production. He wrote that a typical Kalapuya man was not a working man, but a "sportsman" or "idler" while the "squaws" did "all the work" (Rucker 1930a:200).

He described the "Kalapooyas" in nearly the exact words as Henry, as "not numerous" and living in "miserable hovels." Many died over the winter; Applegate and his family frequently heard funeral services and felt that the Kalapuyas could not be more "degraded morally or more afflicted mentally with demonology" (Rucker 1930a:172). The similarities in these two accounts are remarkable. This could indicate one of two things. Either both of these men have written fairly accurate accounts of the results of dislocation and disease, and we can also trust their accounts of camas and gender, or, the racism and stereotypes of the day were so widespread and pervasive and this caused their accounts to be so similar.

Another Applegate, Lindsay, wrote that in June, 1846, he passed Spencer's Butte where he "discovered Indians digging camas. On perceiving us, most of them secreted themselves in the timber. One of our party succeeded in capturing an old Indian, and representing to him by signs the course we wished to follow, the old fellow preceded us two or three miles, and put us on a dim trail..." (Rucker 1930b:253). This passage is interesting for two reasons. It is one of the few ethnographic accounts we have for the upper Willamette Valley, and it places an elderly male with a party of camas diggers, whose gender is unspecified.

The Reverend R.W. Summers, who was the first Episcopal Priest of McMinnville from 1873-1881, also kept a journal of his frequent and friendly contact with the Indians of the valley. He tells several stories of a man named Yamhill Ilkill and his wife, who demonstrates to Summers how "her" camas oven works. In 1876,

> ... she led us to her camas oven in the yard, where we had seen her yesterday, to explain the

> rest of the cooking process.
>
> Yesterday, in a large, bowl-like excavation on the hillside previously lined by her with flat stones, she had lighted a large fire, keeping it well fed with bark and brush till the stones and surrounding soil were thoroughly heated. In the after part of the day, this being accomplished, she removed the brands, swept the oven clean and filled it with the bulbs. The plant is *Camassia esculenta*, bearing an "onion" about an inch in diameter and found in abundance all over the low grounds of Willamette Valley. Two or three inches of stem are left on the root in the gathering, and a bushel or two is cooked at one time. In this instance more than the average went into the cavity, for Ilkill's family are industrious camas diggers. The camas being properly heaped, leaves were piled on top in a thick layer and mingled coals and ashes spread over the whole, deep enough to keep hot for some days. The pile in its finished state is now several feet in diameter and a cloud smoke ascends from its mound-like surface. In two days, she says, it will be cooked. After that, she will reheat the oven and fill it again.
>
> Ilkill and his family are very fond of this food in winter and she always gets "many sacks" and kegs full of it. When taken out of the oven it is black, a little shrunken in size, sweet and palatable, and it will keep any length of time. Two younger women belonging to the household are out gathering more now.....Only women and girls used these, the young men looking on admiringly while each female strove to excel, for to be a good camas-digger was an accomplishment (Summers 1994:32-33).

This entry is unequivocal in its statement that in the Ilkill family at least, women harvested and processed camas, and were esteemed for it as well. In this case some kind of higher status seems to be associated with heavy camas returns for these women. It would be useful to know if a male could achieve praise or status for this as well, or if camas collecting by men was an emasculating activity, socially speaking. In the following story taking place at the same home, Summers observed a male Indian working with camas:

> This morning, at old Ilkill's, we saw another preparation of *camas*. On a table near the baking-mound was a layer of the fresh roots, while an Indian, a stranger to us, stood gently pounding it. He was using a short, polished, stone pestle, with one end abruptly enlarged and this knob flattened so that the pestle would stand erect. It was held upright and the flattened end was the pounding surface. As these bulbs were pulverized, they were heaped on one end of the table and others took their place. "Thus I pound, pound, pound," said the worker, whom Ilkill addressed as To-yu-sah, white men as Warren, "until it is all very fine. The squaw takes a basket, hugged against herself with her left arm, and holds a stick in the right hand in this way" -- an excellent pantomime accompanying his words about how she

> scraped off the pulverized camas into the basket. "The basket is shallow and not more than half full. Now burn the root, not black, but brown, like coffee, by shaking over the fire. Lay it away then and wait for winter. In the cold months, when needed, take it out of the sack, put in a stone mortar and grind into flour with long stone pestle; and make into a cake, sometimes mixed with dry grass-oppers (*sic*). Cook like bread. Then eat it!"
>
> The aged proprietor we found by his fireside alone. The women had again gone out root-gathering (Summers 1994:38-39).

This interesting account clearly relates that here camas *processing* was a shared project between men and women, but women were still gathering alone. It may be that camas labor was divided in this way by the sexes, but this is not necessarily supported by Lindsay Applegate's observation of a man out with camas diggers (quoted earlier), although that is ambiguous. Also interesting is the fact that Yamhill Ilkill was not grinding the camas, but Warren was. It is tempting to speculate whether Warren was a slave, or a hired worker of some kind, although there is no corroborating evidence for either in the passage. Also, at the late date of 1876, it is probably not likely that he was a slave.

The evidence suggests both men and women ate camas. I know of no restrictions on camas consumption for either sex. Summers (above) remarked that Ilkill and his family are all fond of camas, and Hall et al. (1986:327) reported that the rates of dental caries in Willamette Valley for women and men were virtually the same.

Oftentimes the presence of specific grave goods can indicate the type of work a person did most regularly, as well as much more. From his analysis of the burials and associated grave goods of the Fuller and Fanning mounds in the Willamette Valley, Stepp (1994) concluded that his sample size was too small "to generalize sex differences in grave goods," although he did remark that digging stick handles tended to be found with the females and the obsidian knives tended to be found with the males.

Outside of the Willamette Valley, formal studies of camas processing and gender are still few and incomplete (Reeve 1986), but ethnographic and ethnohistorical sources are more abundant on the subject, if only casually. On the subject of roots in general, Suttles (1951a:281) wrote "a root-gathering tradition implies a division of labor, with some members of the group assigned root-gathering as their regular task." He then explained that the Coast Salish assign root gathering to women, and hunting to men. I do not know why the existence of a root gathering tradition necessarily mandates a division of labor of any kind, but Suttles' statement is typical of anthropologists through the 1970s (see papers in Lee and Devore 1968).

Thoms (1989) extensive research on camas includes many ethnographic and ethnohistorical accounts from outside the Willamette Valley which involve gender and/or the sexual division of labor. While they are too numerous to repeat here, I will give a brief summary. There are several cases of women-only harvesting among the Nez Perce (1989:207), the Nooksack (1989:199), the Queets and Quileute (1989:196), the Shoshoni (1989:192), the Coeur d'Alene (1989:205, 209), unspecified Plateau (1989:205), the Kalispel (1989:212) and the Yakima (1989:212). Women and men are reported to be working together among the Spokane (1989:207), in Discovery Bay, Washington (1989:203), and on southeastern Vancouver Island (1989:198). Furthermore, a description of men collecting firewood and digging the pits while women harvested the bulbs occurs in accounts of the Flathead and Kalispel (1989:208). Apparently, as times changed, missionaries encouraged the male Kalispel to take on the duties of all the "farm" work, which they considered more appropriate for men. By the late 1800s in the Calispell Valley, both men and women are reported to be actively involved in the camas harvest because hunting and fishing were no longer viable (Diomedi 1978:33).

Reeve (1986) credited "female root gathering" with having significant impacts on prehistoric adaptations since perhaps 10,000 B.P. in the Snake River headwaters of northwestern Wyoming. Though his hypothesis involved camas root gathering, the almost complete lack of *Camassia* pollens in his earth ovens did not substantiate which root was responsible for providing the "economic and ideological bases for ceremonialism, trade and political alliance" he wrote about (Reeve 1986:338). Clearly, these examples from Thoms and others give ambiguous data on the sexual division of labor, although the reports, speaking generally, do favor a stronger role in root gathering for women than for men.

In addition to determining gender roles in prehistory, another current debate in archaeology is whether or not specific gender attributions are necessary (Conkey and Gero 1991; Dobres 1993; Costin 1996). Conkey and Gero (1991:11-12) argued that being able to assign activities or material culture to males or females is not the goal of engendering archaeology. To do this would simply be a band-aid approach which would actually limit archaeological understanding of gender systems as a whole. They argued that seeking answers to broader questions such as whether or not there has always been a sexual division of labor, if gender has always existed, or whether the sexual division of labor created gender would be more useful. Costin (1996:112) argued that gender attribution is essential to provide the details of women's and men's lives archaeologists seek; otherwise we have a genderless gender theory. This is an on-going debate within feminist archaeology.

Thoms (1989:429) mentioned the concept of men's and women's tool kits briefly in his dissertation, and this has also been examined by others in different cultural contexts (Brumfiel 1991; Gero 1991). Sahlins (1972:79) wrote that most tasks are completed by individuals, both men and women, from procuring raw materials to fabricating final products, implying that no sharing takes place. Thoms (1989:429) noted that among the various archaeological tool assemblages he examined from the Calispell Valley, expedient tools such as the tabular knife are the most common of all stone tools. He proposed that because these knives are equally represented at both camas processing sites and residential sites, they may be considered women's tools. On the Plateau, where the sexual division of labor may have been more strict than in the Willamette Valley (cf. Turney-High 1937), Thoms might be correct about assigning the tools associated with the camas ovens to women. I have to credit him for even broaching this topic. He assumed that if the site was used primarily by women, the dominant tool must have belonged to women. This is not an unreasonable argument. However, I do not think it is wise to assume that women did all of the food processing at the residential sites, where men were surely present. Thoms (1989:429) noted that "a few hunting related tools" are almost always present. If camas baking was taboo for men, then these tools need to be explained as women's tools also. I disagree with the assumption that women did most of the "food processing and related activities in the home" (Thoms 1989:429), which may be considered a western stereotype. Brisland (1992) has conducted studies on the lithic assemblages at High Prairie in Idaho, and determined that the stone tools found there were not used for root processing, even though there were many earthen ovens present.

At the Mill Creek Site Complex, the stone tool assemblage is diverse (refer to page 29), and many flaked stone tools are found on the living surface, associated with, and/or inside the ovens of various radiocarbon ages (Tasa et al. n.d.). However, two factors affecting the chronology of the Mill Creek sites further complicate our ability to attribute gender to certain activity areas of the site. As described earlier, almost all ovens or other features at the Mill Creek Site Complex were dated using charcoal or camas bulbs directly from that feature. Since many ovens had associated stone tools, the immediate inference is to conclude that users of both the ovens and the stone tools, regardless of gender, were present on the site at the same time. However, the cultural stratum of Mill Creek often contained features and occupations of different ages that were not stratigraphically discernible (Tasa et al. n.d.), and to assume that artifacts and features that are spatially close to one another are chronologically associated without closer scrutiny would be erroneous. To address this, obsidian hydration was employed to date the obsidian tools, although tools of other materials were also present (Tasa et al. n.d.). Fifty-six percent of the projectile points at Mill Creek were obsidian, 43% were cryptocrystalline silicates, and 1% were basalt (Tasa et al. n.d.). Percentages of non-projectile point flaked tools have not yet been calculated, but they are probably similar. Clearly, the following discussion does not take into account the ages of the non-obsidian tools, but skews the discussion in favor of obsidian tools and earth oven features.

The oven (radiocarbon) ages and the obsidian hydration dates are not consistent. More than half of the radiocarbon-dated features are older than 3500 years, but many of the obsidian hydration dates fall between 500 and 1750 years ago (Tasa et al. n.d.). Tasa et al. (n.d.) noted that this could indicate a significant change in obsidian tool use, or site use in general, because the more recent features were more diverse in form (ovens, bisque stains and pits, and living floors), while older features tended to be exclusively rock lined ovens and bisque pits. Tasa et al. (n.d.:10) suggested that these apparently more recent features indicated that "later occupations were less exclusively focused on a narrow set of resource extraction activities (camas collection and processing), and may have been more residential in character, serving as operational bases for a broader range of functions." This makes sense given the fact that more (obsidian) stone tools date to <2000 years B.P. than any other time period. Tasa et al. (n.d.:11) also noted that the stone tools from the later period were predominantly projectile points (63%) rather than utilized flakes (37%), which is a reversal of the pattern for the stone tools of the earlier period, and they interpreted this to further indicate an increasing emphasis on hunting, especially in conjunction with the addition of the bow and arrow to the technologies of the valley. It *may* also indicate that a shift in processors occurred over time. Perhaps women were the primary camas processors in the early Holocene, and the entire family participated or were present later. This might be evidenced in the ethnographic record, for example in John Hudson's statement to Jacobs that "in the good old days" only women harvested camas. However, this interpretation rests on the unproven assumption that men made and used projectile points and women, if they used stone tools at all, were associated with the utilized flakes.

Further detail on the association of tools and ovens, both early and late, is warranted. Ten features described as "ovens" dated within the last 2000 years. Nine of these had associated stone tools from within or near the oven, although the tools ranged in type and raw materials. Groundstone tools, as well as flaked stone tools, are included. Complicating this matter further is the fact that some early ovens were associated with tools that dated several thousand years later (based on obsidian hydration ages). This calls into question either the oven - tool associations or the validity of the obsidian hydration ages. It is possible that the heat from the ovens or the burning of the valley floor on a regular basis was "re-setting" the obsidian hydration "clocks" to zero, causing them to appear much more recent than they actually were. It does remain to be explained how flaked stone tools found their way into the inside of a camas oven at all (Feature 2, site 35MA9). While these data complicate the issue of whether or not flaked obsidian tools were truly associated with the camas processing features, it only confuses the matter of gender and camas processing if we operate under the assumption that only males made and used those tools.

If there were a cultural taboo against men baking camas as among the Flathead (Turney-High 1937), we would have to assign these projectile points to women, and accept that Kalapuya women hunted, or at least manufactured hunting implements. I think it is clear from the ethnographic record that there was no taboo against men being near camas ovens in the Willamette Valley. In fact, if we operate under the assumption that men were the most common makers and users of projectile points, it appears that men were present at the camas processing facilities on Mill Creek, especially during the last 2000 years. The reader may or may not want to make this assumption.

In my view, men were probably present during camas activities in the Willamette Valley because Jacobs' male informants possessed extensive knowledge about camas and oven building (1945:19). Also, Turner and Bell (1971:75) state that on Vancouver Island, harvesting was "usually done by women" although sometimes entire families participated. A male Saanich informant stated that care had to be taken when harvesting camas during the summer not to confuse it with the poisonous camas, *Zigadenus venenosus.* This is something I have read many times, and to me it indicates a level of specialized knowledge about plants. If women were the only harvesters of camas, they might be the sole bearers of this knowledge. However, Turner and Bell's male informant explained how he could tell the difference between the two types (1971:75). It seems clear to me that he had first-hand knowledge of the camas harvest, and the finer points of camas harvesting were not restricted to women. While it is true that a person can have knowledge of something he/she did not do regularly, I argue that if adult camas harvesters took the time to teach their children the differences between the two species, they must have felt a compelling reason to do so. One plant is deadly and one is not. If you have any reason to suspect your child will have occasion to collect bulbs for food, you would teach her or him how to recognize and distinguish them, especially if the stalks are removed in the field and all they return with are the bulbs. Therefore, that these male informants possessed that information is evidence that they were collecting plant foods at some time in their lives. Turner and Kuhnlein (1983:211) described a Saanich man who boasted that his family used to collect 200 to 250 pounds of camas at a single harvest (reported in Babcock, 1967, which is not listed in their bibliography). It is not clear whether this man observed his family collecting the camas or whether he participated as well.

This high level of male knowledge about a supposedly "female" activity is similar to Moss' (1993) study of shellfishing and status on the Northwest Coast. Although shellfish were reported to be a low status food, especially for men or high ranking individuals, Moss' male informants knew a great deal about shellfish, and eventually admitted that they did eat them under certain circumstances. Additionally, the archaeological record indicated that shellfish was a large part of the diet.

Willamette Valley camas harvesting and processing was probably a more cooperative and collaborative effort than the ethnographic record has led us to believe, and archaeologists who have addressed it (Sanford 1975; Thoms 1989; Roulette 1993; Bowden 1995) generally have conceived (Moss n.d.). Wilson and DeLyria (1999:81) conclude that the "industry associated with the procurement and management of fire-cracked rock in the Pacific Northwest required significant quantities of labor and expertise to manage the raw materials and camas roasting byproducts." Camas was the staple resource of the valley's peoples, too important to omit half the population in its procurement and processing. I am not implying that women were incapable of supplying this resource on their own, only that they did not always do it alone. It is not unreasonable to conclude that while women were the primary camas harvesters, males did participate, and there was no taboo against their participation and presence. In this economy, people worked together with one another to get the job done. For the Plateau, Hunn (1981:131) stresses "familial economic cooperation" and discourages the emphasis of one sex over the other or one food over another in seeking to fully understand human foraging. I think this is relevant to the Willamette Valley as well.

CONCLUSION

Ethnographic literature from the Willamette Valley and nearby culture areas suggests that camas harvesters sought camas bulbs of a particular size, and even took pains to relocate better bulbs or the seeds of better bulbs to their own plots. Camas was a staple in the diet of Kalapuyans, and a great deal of time and energy was invested in harvesting and processing camas. I hypothesized that the Kalapuyans were deliberately harvesting bulbs within a certain size range, and that they may have been practicing management techniques that would ensure crops of larger sized bulbs in the future as well. The results of the camas bulb size study indicate that bulb size fluctuated irregularly throughout time, and these changes are not completely explicable at present. Further, the standard deviations in bulb size that may have reflected a stabilization in bulb size actually increased towards contact times, instead of decreasing. Intensification of camas is not indicated by increased or decreased bulb sizes. Although my study of camas bulb size was inconclusive, I believe more studies of this nature are warranted to completely rule out this type of horticulture among the Kalapuya. There are several variables concerning environmental impacts on camas growth and placement within a camas oven that are not completely understood. There are also variables which were not controlled for during archaeological excavation of the camas specimens. Nevertheless, investigating these important ecofacts in archaeological inquiry remains an important research direction.

Additionally, exploring the issue of gender has brought forth contradictory, ambiguous and perhaps surprising ethnographic and archaeological evidence on the subject of a sexual division of labor and camas processing. I think it is substantial enough to encourage archaeologists to view camas related activites in gender-inclusive and gender-conscious terms. For the Willamette Valley, the easy dichotomy man the deer-hunter and woman the camas-harvester is overly reductionist. While "camas related activities" may have been considered primarily women's work, it is clear that men participated in one of more of the associated tasks of the camas harvest, and held a great deal of knowledge about them. These "tasks" included harvesting, processing (pounding, drying, pressing, etc.), storing, oven-building, baking, eating, and trading. At this time, it may be more accurate to characterize processing, baking, and trading as communal, mixed gendered activities, while depicting the actual in-the-field harvest as a female gendered activity frequently carried out primarily by women. It is really too simplistic to talk about camas in general terms at all, without recognizing that camas-related activities comprised a series of differentiated tasks (Spector 1991), even if we do not yet know exactly who carried out which task in precise detail. Although expanding our discussions and descriptions of "the camas harvest" to detailed, differentiated tasks complicates matters, and is more "labor intensive" for the archaeologist, I think it deepens and enriches our understanding of early life in the Willamette Valley. The benefit of examining gender in the Willamette Valley is that when we do determine precisely what occurred here in terms of plant intensification, domestication, and management, we will be better able to fully describe and understand how these horticultural changes affected and were affected by their cultural and social contexts.

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DATE	ACCESSION	LENGTH/m	WIDTH/mm	THICKNESS/	COND.	NOTES	# NOT MEASURED IN SAME BAG
MILL CREEK BULBS							
Feat. 1	9-20D-2-1	14.80	6.00	6.50	WHOLE		
Feat. 1	9-8B-4-1	12.50	12.70	5.90	SLIGHTLY FRAGMENTED		
Feat. 1	9-13D-3-1	12.40	7.90	6.10	WHOLE		1
Feat. 1	9-13D-3-1	13.00	7.00	3.10	FRAGMENTED		
Feat. 1	9-14C-2-1	11.40	8.30	6.90	WHOLE		0
Feat. 1	9-15D-3-1	12.60	7.40	2.40	FRAGMENTED	NO STEM, NO TIP	
Feat. 1	9-8B-3-1	12.20	7.70	5.90	SLIGHTLY FRAGMENTED		
Feat. 1	9-8A-4-1	12.40	9.90	3.20	SLIGHTLY FRAGMENTED		
Feat. 1	9-13C-3-1	18.30	9.80	8.10	FRAGMENTED		1
Feat. 1	9-8A-4-1	11.90	6.90	4.20	SLIGHTLY FRAGMENTED		
Feat. 1	9-8B-3-1	11.40	7.20	5.50	WHOLE		
Feat. 1	9-13D-3-1	17.50	11.20	5.80	FRAGMENTED		
Feat. 1	9-8D-3-1	10.30	6.20	3.90	SLIGHTLY FRAGMENTED		
Feat. 1	9-9D-4-1	18.90	10.80	8.00	WHOLE	NICE BULB!	
Feat. 1	9-18B-2-1	18.20	13.10	5.80	SLIGHTLY FRAGMENTED	SIDE DAMAGED/SHAVED	
Feat. 1	9-9A-4-1	13.70	7.10	6.10	SLIGHTLY FRAGMENTED		
Feat. 1	9-8D-3-1	12.70	7.50	5.20	SLIGHTLY FRAGMENTED		
Feat. 1	9-8D-4-1	14.60	9.00	8.20	SLIGHTLY FRAGMENTED		
140	12-3D-7-1	15.60	7.70	5.70	WHOLE		
140	12-3B-7-2	16.90	14.60	12.10	FRAGMENTED	NO STEM	
140	12-3D-9-1	31.70	19.90	15.10	SLIGHTLY FRAGMENTED	REALLY NICE SPECIMEN	
140	12-3B-7-2	31.60	14.00	14.40	SLIGHTLY FRAGMENTED	REALLY NICE SPECIMEN	
140	12-3B-7-1	19.60	10.70	9.50	SLIGHTLY FRAGMENTED		
1210	9-14A-3-1	10.80	7.80	3.90	WHOLE	NO STEM	0
1280	9-F11-4-1	18.30	9.20	5.30	SLIGHTLY FRAGMENTED	BOTTOM DISINTEGRATING	1
2360	7-4B-9-2	16.30	12.70	6.10	SLIGHTLY FRAGMENTED		
2575	9-22A-4-1	12.70	8.20	7.40	WHOLE		0
2575	9-22C-3-1	14.80	6.80	3.60	WHOLE		0
2575	9-22D-3-1	15.70	10.80	12.10	WHOLE		0
2575	9-22D-4-1	14.70	8.60	4.10	WHOLE		
3080	7-5B-13-1	28.10	16.60	8.90	WHOLE	GREAT SPECIMEN!	
3080	7-5B-13-1	19.40	17.60	9.40	SLIGHTLY FRAGMENTED	NO STEM	
3080	7-5A-15-1	17.50	18.40	10.00	WHOLE		
3080	7-5A-13-2	25.90	19.80	12.30	WHOLE	BIG!	
3080	7-5A-14-1	28.70	17.40	8.90	SLIGHTLY FRAGMENTED	CRUMBLING	
3080	7-5A-15-3	16.80	12.20	9.60	WHOLE		
3080	7-5A-15-2	29.50	26.60	12.50	SLIGHTLY FRAGMENTED	BIG!	
3080	7-5A-15-3	21.00	10.30	9.20	NOT RECORDED		
3080	7-5A-9-1	13.60	8.80	6.90	SLIGHTLY FRAGMENTED		

DATE	ACCESSION	LENGTH/m	WIDTH/mm	THICKNESS/	COND.	NOTES	# NOT MEASURED IN SAME BAG
5600	9-18B-9-1	11.90	9.70	7.70	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-18B-8-5	17.80	9.40	4.80	WHOLE		
5600	9-18B-8-5	14.40	10.20	6.00	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-18B-9-1	15.80	11.30	7.40	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-18B-9-1	17.40	12.80	7.85	WHOLE		
5600	9-18B-9-3	12.70	8.90	5.70	WHOLE		
5600	9-18B-9-3	20.70	9.10	8.70	WHOLE		
5600	9-18C-5-1	13.90	8.30	4.30	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-18B-9-3	12.20	9.00	6.00	WHOLE		
5600	9-18B-9-1	11.10	9.10	4.50	SLIGHTLY FRAGMENTED		
5600	9-18B-9-1	13.60	10.50	6.90	WHOLE		
5600	9-18B-9-2	10.65	8.70	3.80	SLIGHTLY FRAGMENTED	STEM BROKEN	
5600	9-18B-9-1	18.10	16.10	6.40	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-18B-6-2	13.50	9.60	3.10	WHOLE		
5600	9-18B-6-2	16.40	8.50	6.30	WHOLE		
5600	9-18B-7-2	11.70	6.40	4.10	WHOLE		
5600	9-18B-6-2	13.00	5.60	2.30	FRAGMENTED	VERTICALLY "SLICED"	
5600	9-18B-6-1	12.90	6.20	4.50	WHOLE		
5600	9-18B-6-2	15.50	5.90	3.70	SLIGHTLY FRAGMENTED		
5600	9-18B-6-2	14.80	5.70	4.30	FRAGMENTED	VERTICALLY "SLICED"	
5600	9-18B-8-3	21.10	19.30	8.70	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-18B-7-3	13.70	11.20	12.50	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-18B-8-5	11.90	6.60	2.50	WHOLE		
5600	9-18B-8-3	15.00	10.50	6.60	WHOLE		
5600	9-18B-7-3	15.70	6.80	4.80	WHOLE		
5600	9-18B-7-3	13.30	7.40	5.10	SLIGHTLY FRAGMENTED		
5600	9-18B-7-3	16.40	8.60	6.40	WHOLE		
5600	9-18B-7-3	15.80	13.80	5.30	FRAGMENTED		
5600	9-14C-8-1	9.80	9.40	6.50	WHOLE		
5600	9-13D-9-1	22.20	13.00	8.80	FRAGMENTED		0
5600	9-13D-8-1	12.20	6.90	4.90	SLIGHTLY FRAGMENTED		
5600	9-13D-9-2	17.00	9.80	5.60	SLIGHTLY FRAGMENTED		2
5600	9-13D-9-2	16.70	5.80	5.70	FRAGMENTED		
5600	9-13D-8-1	13.20	5.80	3.10	SLIGHTLY FRAGMENTED		3
5600	9-13D-8-1	13.10	6.50	5.20	SLIGHTLY FRAGMENTED		
5600	9-13D-8-1	12.50	6.10	5.70	SLIGHTLY FRAGMENTED		
5600	9-13D-8-1	13.70	9.20	4.90	SLIGHTLY FRAGMENTED		
5600	9-14C-13-1	16.90	8.20	6.60	SLIGHTLY FRAGMENTED		
5600	9-14C-13-1	11.80	12.30	3.80	FRAGMENTED		
5600	9-14C-13-1	14.20	7.20	6.30	SLIGHTLY FRAGMENTED		

DATE	ACCESSION	LENGTH/m	WIDTH/mm	THICKNESS/	COND.	NOTES	# NOT MEASURED IN SAME BAG
5600	9-14C-13-2	14.30	9.10	7.90	SLIGHTLY FRAGMENTED		
5600	9-14C-13-1	13.20	7.80	6.30	SLIGHTLY FRAGMENTED		
5600	9-14C-13-1	13.30	10.30	7.20	SLIGHTLY FRAGMENTED		
5600	9-14C-13-2	18.10	13.10	9.20	SLIGHTLY FRAGMENTED		3
5600	9-14C-13-2	5.50	16.00	9.40	SLIGHTLY FRAGMENTED	NO STEM	
5600	9-14C-13-3	16.60	7.10	5.40	WHOLE		2
5600	9-14C-3-1	15.40	8.70	8.10	SLIGHTLY FRAGMENTED	SOME SIDE DISINTEGRATION	
5600	9-14C-13-3	12.50	10.00	10.20	SLIGHTLY FRAGMENTED		
5600	9-14C-13-3	8.40	6.50	5.50	SLIGHTLY FRAGMENTED		
5600	9-14C-13-3	14.00	10.80	8.00	SLIGHTLY FRAGMENTED	NOSTEM	
5740	70-15C-11-1	16.90	0.96	0.71	FRAGMENTED		2
5740	70-14D-14-1	13.15	6.30	5.70	FRAGMENTED		1
INCID	7-4D-2-1	25.30	16.90	17.40	WHOLE	CRUMBLING	
INCID	9-20A-3-1	13.10	8.30	6.10	SLIGHTLY FRAGMENTED	NO STEM	
INCID	9-23A-4-1	20.20	9.20	6.50	SLIGHTLY FRAGMENTED	SIDE DISINTEGRATING	0
INCID	7-4D-2-1	15.00	5.20	4.90	WHOLE	CRUMBLING	1
INCID	9-20A-3-1	14.00	4.60	4.70	WHOLE		1
INCID	9-15C-5-1	15.10	8.70	8.20	WHOLE		
INCID	9-15B-5-1	14.10	7.80	3.10	FRAGMENTED	BOTTOM CHIPPING OFF	
INCID	9-15B-5-1	11.50	5.70	4.00	WHOLE		
INCID	9-15C-4-1	9.00	6.20	5.80	SLIGHTLY FRAGMENTED		
INCID	9-9D-5-1	14.10	8.10	5.50	SLIGHTLY FRAGMENTED		
INCID	9-9D-5-1	10.20	7.60	6.00	SLIGHTLY FRAGMENTED		
INCID	9-9A-5-1	12.90	8.40	6.60	WHOLE		
INCID	9-9B-5-1	14.60	8.50	6.50	SLIGHTLY FRAGMENTED		
INCID	7-10D-6-1	12.20	5.60	4.60	SLIGHTLY FRAGMENTED		
INCID	9-9D-5-1	11.50	8.20	4.30	SLIGHTLY FRAGMENTED		
INCID	12-4D-14-1	14.60	7.60	6.80	SLIGHTLY FRAGMENTED	NO STEM	4
INCID	12-2D-4-1	15.40	8.70	5.90	SLIGHTLY FRAGMENTED		1
INCID	7-10A-6-1	14.40	9.30	5.80	SLIGHTLY FRAGMENTED		
INCID	9-9D-5-1	12.60	6.30	4.70	SLIGHTLY FRAGMENTED		2
INCID	7-10D-12-1	12.20	7.70	6.60	SLIGHTLY FRAGMENTED		
INCID	7-12B-5-1	10.70	6.30	5.40	FRAGMENTED	BROKEN VERTICALLY	1
INCID	7-1A-13-1	16.00	12.20	10.50	SLIGHTLY FRAGMENTED	INCIDENTAL FIND	
INCID	7-14D-6-1	19.10	10.50	6.10	SLIGHTLY FRAGMENTED		
INCID	7-9D-8-1	14.10	7.10	5.90	WHOLE		
INCID	7-8B-7-2	14.20	8.20	3.00	WHOLE		
INCID	7-14D-5-1	14.70	6.30	6.20	SLIGHTLY FRAGMENTED	VERTICALLY BROKEN	
INCID	7-12B-6-1	18.80	9.10	8.10	WHOLE	NICE!	
INCID	7-13B-7-1	12.10	5.30	4.20	WHOLE		

DATE	PROVENIENCE	LENGTH/mm	WIDTH/mm	THICKNESS/mm	CONDITION	COMMENTS	
HANNAVAN CREEK BULBS			35LA647			Feature 3E: Quad A excavated.	ALL BULBS FROM SAME OVEN; ONLY MEASU
8095	512-82	27.60	22.30	19.90	SLIGHTLY FRA	BIG BULB!	NUMBER NOT MEASURED IN SAME BAG
8095	512-81	23.40	16.10	10.80	WHOLE	EXCELLENT COND; BISQUEY	18
8095	512-81	23.00	15.60	14.20	WHOLE	512-81 IN SITU BULBS	
8095	512-81	19.40	14.10	12.10	WHOLE		
8095	512-81	17.80	12.90	10.00	WHOLE		
8095	512-81	20.40	16.30	11.60	WHOLE		
8095	512-81	16.50	10.30	12.80	WHOLE		
8095	512-81	19.20	12.90	8.80	WHOLE		
8095	512-81	18.90	18.40	17.60	WHOLE		
8095	512-81	19.60	12.50	10.60	SLIGHTLY FRAGMENTED		
8095	512-81	21.30	18.20	11.00	WHOLE		
8095	512-81	19.00	13.30	10.40	SLIGHTLY FRAGMENTED		
8095	512-81	19.20	19.90	9.70	SLIGHTLY FRAGMENTED		
8095	512-81	19.90	13.60	9.50	SLIGHTLY FRAGMENTED		
8095	512-81	12.40	10.40	10.20	WHOLE		
8095	512-81	18.00	15.60	13.90	SLIGHTLY FRAGMENTED		
8095	512-81	14.30	9.90	9.80	WHOLE		
8095	512-81	13.10	11.10	10.30	WHOLE		
8095	512-81	16.60	15.00	12.90	SLIGHTLY FRAGMENTED		
8095	512-81	18.90	13.60	11.80	SLIGHTLY FRAGMENTED		
8095	512-81	15.90	14.80	11.70	FRAGMENTED		
8095	512-81	20.70	16.00	15.90	SLIGHTLY FRAGMENTED		
8095	512-81	14.60	12.10	16.90	SLIGHTLY FRAGMENTED		
8095	512-81	15.30	14.70	10.00	WHOLE		
8095	512-81	14.60	12.00	11.20	WHOLE		
8095	512-81	17.10	12.10	9.70	SLIGHTLY FRAGMENTED		
8095	512-81	18.60	16.90	14.10	SLIGHTLY FRAGMENTED		
8095	512-81	16.40	13.60	11.00	WHOLE		
8095	512-81	15.10	12.10	11.60	WHOLE		
8095	512-81	13.40	9.70	10.10	SLIGHTLY FRAGMENTED		
8095	512-81	15.30	11.50	12.90	WHOLE		
8095	512-81	14.90	14.00	10.70	SLIGHTLY FRAGMENTED		
8095	512-81	19.10	11.50	17.90	SLIGHTLY FRAGMENTED		
8095	512-81	20.80	19.10	15.90	WHOLE		2
8095	512-81	19.50	13.90	12.30	WHOLE		
8095	512-81	18.80	13.30	10.20	WHOLE		
8095	512-81	20.40	18.90	12.70	WHOLE		
8095	512-81	20.40	18.20	15.30	WHOLE		
8095	512-81	18.20	11.00	17.10	WHOLE		
8095	512-81	16.90	13.40	12.20	SLIGHTLY FRAGMENTED		
8095	512-81	15.80	11.10	8.30	WHOLE		
8095	512-81	19.80	14.70	15.50	SLIGHTLY FRAGMENTED		
8095	512-81	16.20	13.20	8.90	SLIGHTLY FRAGMENTED		
8095	512-81	16.80	15.40	13.20	SLIGHTLY FRAGMENTED		
8095	512-81	17.00	12.10	9.60	SLIGHTLY FRAGMENTED		
8095	512-83	23.70	20.80	13.30	WHOLE	512-83=COMPOSITE SAMPLE	
8095	512-83	15.20	9.20	8.40	SLIGHTLY FRA	FROM OVEN	

DATE	PROVENIENCE	LENGTH/mm	WIDTH/mm	THICKNESS/mm	CONDITION	COMMENTS	
8095	5	17.10	15.80	11.50	WHOLE		
8095	6	15.40	14.80	9.40	WHOLE		
8095	7	10.40	9.70	8.90	WHOLE		
8095	8	14.40	10.60	10.90	SLIGHTLY FRAGMENTED		
8095	9	17.80	12.70	9.30	WHOLE		
8095	10	17.60	13.30	13.80	WHOLE		
8095	11	18.90	15.90	11.20	WHOLE		
8095	12	15.60	11.80	9.40	WHOLE		
8095	13	14.80	10.60	8.10	SLIGHTLY FRAGMENTED		
8095	14	17.50	13.00	12.70	SLIGHTLY FRAGMENTED		
8095	15	17.10	9.70	9.90	FRAGMENTED		
8095	16	13.00	10.20	6.10	SLIGHTLY FRAGMENTED		
8095	17	17.90	7.90	5.90	SLIGHTLY FRAGMENTED		
8095	18	21.60	9.50	9.00	SLIGHTLY FRAGMENTED		
8095	19	19.50	10.90	9.90	SLIGHTLY FRAGMENTED		
8095	20	12.60	11.70	14.00	SLIGHTLY FRAGMENTED		

LYNCH SITE BULBS 35LIN36						
DATE	FIELD SPECIMEN NO.	LENGTH/mm	WIDTH/mm	THICKNESS/mm	CONDITION	# NOT MEASURED IN SAME BAG
694	FS111	22.30	14.60	10.20	WHOLE	4
694	FS111	24.60	23.60	18.70	SLIGHTLY FRAGMENTED	
694	FS111	20.50	17.50	14.30	SLIGHTLY FRAGMENTED	
694	FS111	21.30	9.40	12.90	FRAGMENTED	
694	FS111	24.80	16.00	11.00	SLIGHTLY FRAGMENTED	
694	FS111	16.70	12.30	12.90	WHOLE	
694	FS111	17.00	8.60	6.10	WHOLE	15+
694	FS111	28.30	18.90	2.90	SLIGHTLY FRAGMENTED	
694	FS111	17.60	10.30	7.00	SLIGHTLY FRAGMENTED	
694	FS111	17.40	10.70	10.90	SLIGHTLY FRAGMENTED	
694	FS111	19.50	7.80	7.20	SLIGHTLY FRAGMENTED	
694	FS111	26.50	16.50	14.00	SLIGHTLY FRAGMENTED	
694	FS111	15.20	13.00	11.90	SLIGHTLY FRAGMENTED	
694	FS111	26.20	20.80	23.60	FRAGMENTED	
694	FS111	16.80	9.10	9.70	WHOLE	
694	FS111	27.50	23.50	21.40	FRAGMENTED	
694	FS111	16.50	12.70	10.80	SLIGHTLY FRAGMENTED	
694	FS111	19.90	10.30	8.10	WHOLE	
694	FS111	22.90	19.80	15.30	SLIGHTLY FRAGMENTED	
694	FS111	17.50	10.70	8.70	FRAGMENTED	
694	FS111	20.20	11.00	8.80	SLIGHTLY FRAGMENTED	
694	FS111	19.50	21.50	22.80	SLIGHTLY FRAGMENTED	
694	FS111	12.20	10.80	7.30	SLIGHTLY FRAGMENTED	
694	FS111	18.30	14.50	12.80	SLIGHTLY FRAGMENTED	
694	FS111	24.10	13.10	8.60	WHOLE	7
694	FS111	19.40	14.40	7.70	SLIGHTLY FRAGMENTED	
694	FS111	18.20	12.90	12.50	WHOLE	
694	FS111	21.40	13.80	11.90	WHOLE	
694	FS111	16.60	10.70	11.30	WHOLE	
694	FS111	21.50	11.50	11.90	WHOLE	
694	FS111	18.70	14.60	8.90	WHOLE	
694	FS111	25.30	10.80	11.60	SLIGHTLY FRAGMENTED	
694	FS111	16.70	9.70	8.20	WHOLE	
694	FS111	12.20	10.10	9.70	WHOLE	
694	FS111	18.70	6.50	5.20	SLIGHTLY FRAGMENTED	
694	FS111	22.90	15.00	15.30	FRAGMENTED	
694	FS111	22.70	26.80	21.30	FRAGMENTED	
694	FS111	18.60	7.10	7.00	WHOLE	