

HOLOCENE SUBSISTENCE AND SETTLEMENT PATTERNS: MOUNT RAINIER AND THE MONTANE PACIFIC NORTHWEST

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ABSTRACT

The last two decades have witnessed increased interest regarding the role of mountain landscapes in regional subsistence and settlement systems, and the manner in which those systems changed through time. The 1998 report (revised 2003) Environment, Prehistory and Archaeology of Mount Rainier National Park, Washington deals with these issues as they apply to Mount Rainier, with implications for the Cascades generally. This paper extracts key arguments from that report, updated and refined through recent research, to address long-term land-use processes as they apply to Mount Rainier and Cascade landscapes; and to consider the capacity of the archaeological record to improve our understanding of these processes. This paper first introduces Mount Rainier's basic environmental characteristics, and addresses the capacity of this, and other mountain landscapes, to attract and sustain precontact hunters and gatherers. Sections that follow discuss the forager to collector continuum as it applies to the Pacific Northwest, and employs these principles to develop a Holocene subsistence and settlement model designed to fit Mount Rainier patterns into larger regional land-use systems.

INTRODUCTION

Mount Rainier's upper elevation landscapes have been used seasonally by hunting and gathering people for most of the 8,500 to 9,500 years that the mountain has been free of Pleistocene glacial ice. The importance of Mount Rainier, and other mountain

landscapes, to prehistoric people, however, has only recently become widely recognized in the Pacific Northwest. Perhaps because of elevation, unpredictable weather and rugged terrain, places like Mount Rainier have been regarded by many as marginal to subsistence and settlement strategies that focused instead on lowland settings east and west of the Cascades.

The mountain locally known as *Takhoma*¹ was renamed Mount Rainier by George Vancouver during his Puget Sound explorations (Morgan 1979:8). It is the highest and most massive of the stratovolcanos that form the eastern spine of the Cascade Range, which extend from Mt. Baker in northern Washington to Mt. Lassen in northern California. For at least the last 75,000 years (Harris 1988:240), Rainier has loomed above the surrounding western Cascade peaks, dominating the landscape from the Puget Trough to the Cowlitz River valley on the west, and from the Kittitas to Yakima valleys on the east. Owing to the combined effects of elevation, mass, latitude and position relative to Pacific westerlies, Mount Rainier sustains the single largest glacier system in the 48 contiguous states (Harris 1988:231). These glaciers are the source of several major Northwest rivers — the Nisqually, Mowich-Puyallup, Carbon, and White Rivers draining into Puget Sound; and the Ohanapecosh-Cowlitz system emptying into the Columbia River at Longview north of Portland.

Mount Rainier National Park forms an approximately square 235,612 acre box around the mountain's base; including the

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geologically older Tatoosh pluton peaks on its northern and southern flanks, and the Cascade crest to the east (Figure 1). Environmental characteristics vary with elevation, aspect, and landform. Over the years, different taxonomic systems have been employed to group these characteristics in the form of floral, principally forest, composition (e.g., Brockman 1947; Franklin and Dyrness 1973; Moir 1989). For our purposes, it is useful to modify these systems slightly to accommodate vegetation-resource zones of differential value to prehistoric people. For Mount Rainier, this can be accomplished in a four-part system that includes 1) low to mid-elevation closed forest associations (here referred to as the Northwest maritime forest) and associated river floodplains, 2) patchy subalpine parklands, 3) alpine tundra above tree-line, and 4) perpetual snowfields and glaciers.

Mount Rainier's environmental characteristics are important because they play a critical role in conditioning the manner in which its landscapes were used during the prehistoric past. Arguably, seasonal availability of economically important subsistence resources constitutes the primary reason that people used Mount Rainier during precontact times.² The most useful of these resources (e.g., mountain goats, elk, deer, marmots, bears, game birds, and huckleberries) tend to co-occur in greatest abundance in subalpine, alpine, and other early- to mid-seral stage habitats wherever they occur. Accordingly, it is reasonable to expect precontact hunter-gatherers to have favored these environments over more heavily forested, relatively resource-impoverished lower elevation slopes; at least within the fishery-poor boundaries of Mount Rainier National Park.

Because upper elevation subalpine and other early seral stage environments tend to be large, non-isolated, and widespread above 5,500 feet—especially on its drier northeastern

side-- (see Figure 2), Mount Rainier should have been a particularly valuable resource procurement destination throughout much of the time that people have occupied the region. Assuming these resources did indeed attract precontact people, Mount Rainier's archaeological record should preserve evidence of that use, distributed in greatest abundance in its more productive subalpine, alpine and other early to mid seral stage environments.

The seasonal resource richness of upper elevation landscapes has not always been appreciated. Perhaps because mountains appear to be remote, difficult-to-access places with severe winters, many have assumed that they were poorly suited to precontact human use in other than a cursory manner, or as barriers to be crossed on the way to somewhere else (cf., Mierendorf 1999:14-15). Ethnographic evidence to the contrary (Smith 2006), presumed unimportance of high elevation landscapes was implicit in the river valley emphasis of Mount Rainier's first formal archaeological survey (Daugherty 1963), and lingered into the mid-1970s as witnessed by statements alluding to the park's limited potential for archaeological remains (Bohannon 1974, 1975).

Since that time, the count of precontact archaeological site locations at Mount Rainier, and in other mountain settings across the Pacific Northwest, has climbed steadily. By 2008, almost 100 site and isolated finds had been documented in Mount Rainier National Park (Figure 3) despite widespread presence of artifact -obscuring ground cover, repeated volcanic deposits, and limited survey effort. Consistent with patterned resource abundance on the mountain, most of these archaeological properties are located in upper elevation forest, subalpine and alpine settings.

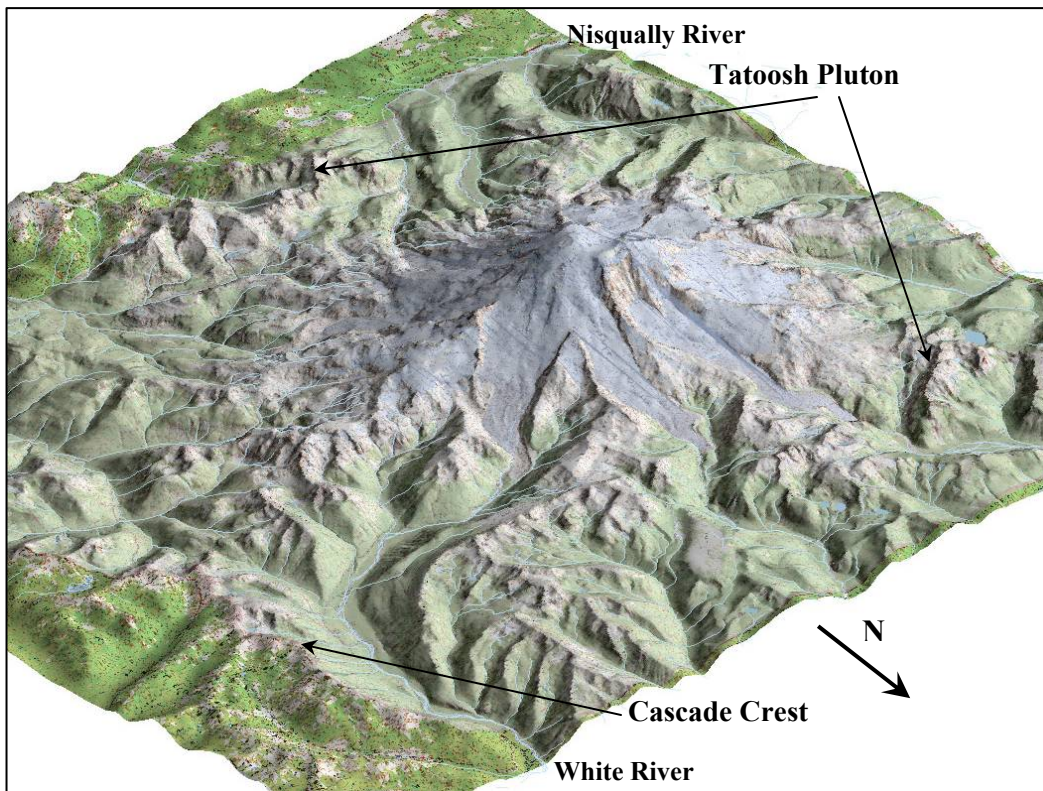


Figure 1. Mount Rainier viewed from the northeast. Base map generated by Mount Rainier National Park GIS Office.



Figure 2. Mount Rainier and sub-alpine parklands in Spray Park. Photo by author.

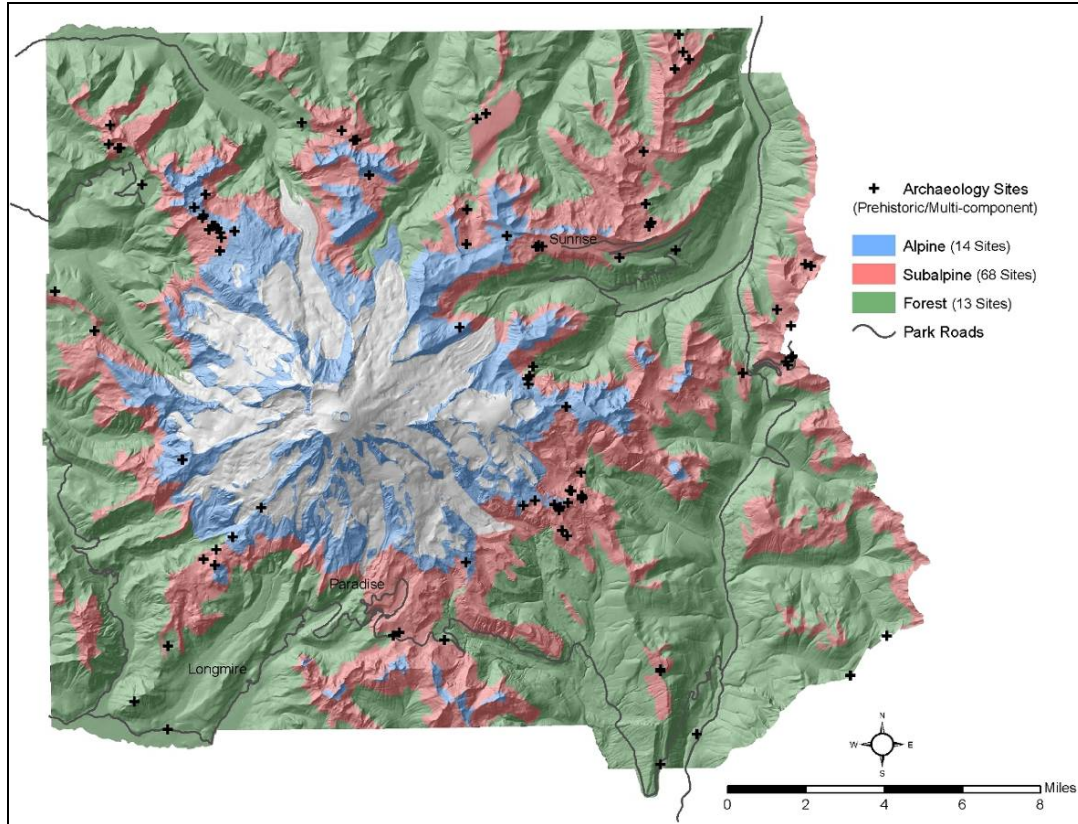


Figure 3. 2008 Documented precontact Sites and environmental zones in Mount Rainier National Park. Map generated by Mount Rainier National Park GIS office.

FORAGERS, COLLECTORS, AND MOUNTAINS

If we had better understood the resource qualities of mountain environments, and the economies of early Holocene hunter-gatherers, the archaeological community might not have ignored the importance of mountains to precontact people for so long. In order to better understand these issues, it is useful to consider the manner in which precontact societies were organized and how they changed during the last 12,000 years or so.

Lewis Binford (1980) developed basic elements of the forager-collector model to explain spatial variation in hunter-gatherer subsistence and settlement patterns in tropical environments. Schalk and Cleveland (1983) extended these principles to the Pacific Northwest; applying them to change through

time as well as variation across space. In the years since, many archaeologists have come to accept basic tenets of the forager-collector model as modified and elaborated to accommodate organizational change through time in patchy, temperate environments. In essence, the model anticipates that, for terminal Pleistocene and early Holocene colonizing populations, the most effective economic strategy was one dominated by small, highly mobile foraging groups whose movement was determined largely by seasonal availability and productivity of locally obtainable subsistence and maintenance resources. Human population density and competition for available food resources were low. The relatively few foraging groups in the region were relatively unencumbered in their capacity to move to new hunting and gathering places (including mountains) in accordance with seasonal, or other, changes in

the availability and abundance of their most important resources. Storage needs were minimal and residential moves could be made by the entire social unit. It is reasonable to expect use of high elevation landscapes by early Holocene foragers assuming the mountains' economic opportunities were sufficient to outweigh travel and weather difficulties inherent in their use.

During the mid to late Holocene, the economic draw of montane habitats became more complicated. Assuming increasing regional population density and elevated resource competition, unfettered use of upland (and other) habitats by small, autonomous groups should have become increasingly unreliable. With or without environmental change, a time had to come when there simply were too many people competing for too few resources in too little space. Such conditions provided economic stimulus for more intensive use of subsistence resources wherever they could be found and sustained, accompanied by heightened reliance on mass harvest and in-place storage (salmon, camas, and a few other mass-harvestable resources) to bridge seasonal shortfalls. Settlement sizes became larger and movement restricted by labor and storage requirements of the new economy. In essence, mobile foragers became semi-sedentary collectors with harvest responsibilities focused, to a large extent, on lowland rivers or exceptionally productive camas meadows.

It is important to note that strict application of forager to collector principles strongly implies that the way in which the region's mountain landscapes were linked to lowland populations changed dramatically from early to late Holocene. However, the manner in which these changes are mirrored by corresponding variation in the character of archaeological assemblages has yet to be demonstrated. The intent here is to use forager-collector

principles to lay the groundwork for anticipating the nature of social and archaeological changes by drawing attention to 1) basic shifts in regional and montane land-use practices through time, and 2) implications, if any, for the archaeological record of the Washington Cascades as represented in Mount Rainier National Park.

ORIGINS OF THE FORAGER TO COLLECTOR CONTINUUM

To evaluate the strengths and weaknesses of the forager to collector principles in regard to modeling regional land-use systems, it is useful to understand how these concepts were developed, and how they came to be used to characterize temporal variation in subsistence and settlement systems in the Pacific Northwest.

Though anticipated in *Nunamiut Ethnoarchaeology* (Binford 1978), Lewis Binford (1980, 1983) formally presented his forager to collector ideas in the *Willow Smoke* article. Binford's interest in that article lay not in addressing change through time, but rather in explaining a fundamental organizational contrast between low and high latitude hunter-gatherers. His two-part model contrasts settlement systems adapted to regions lacking marked seasonal or spatial variation in critical resource abundance with those characterized by highly seasonal or extremely patchy environments. All else being equal, more temporally and spatially uniform environments tend to be located in non-desert, equatorial settings. Resource seasonality –what Binford terms *temporal incongruity* or *phasing*– generally increases with latitude north and south. *Spatial incongruity* may occur at any latitude where critical resources are widely separate.

Simply put, Binford argues that the most viable subsistence strategy in uniform

environments is a *foraging mode of production* in which consumers maintain high residential mobility, moving to new resource procurement areas as local productivity declines. Accordingly, forager settlement systems are characterized by frequent, relatively short distance residential moves with negligible storage at any of the residential bases. Due to relatively short duration stays, bulk resource input and processing tends to be minimal at any specific point.

Redundancy in land-use practices from place to place tends to limit forager site type variability. Binford suggests that forager sites could be collapsed into two basic kinds – residential bases and resource acquisition locations. Binford (1983:343) sees a residential base as the “hub of subsistence activities, the locus out of which foraging parties originate and where most processing, manufacturing and maintenance activities take place.” Locations are places where extractive tasks are carried out. Use limitations are expected to affect the character of the archaeological record of these places. Binford (1983:343) notes that:

Since foragers generally do not stockpile foods or other raw materials, such locations are generally ‘low bulk’ procurement sites. That is to say only limited quantities are procured there during a given episode, and therefore the site is occupied for only a very short period of time. In addition, since bulk procurement [for storage] is rare, the use, exhaustion, and abandonment of tools is at a very low rate. In fact, few if any tools may be expected to remain at such places.

In contrast, a *logistic* or *collecting mode of production* is the most viable strategy for groups residing in environments with a

temporally or spatially incongruous resource base. Because food resources tend to be unavailable for an extended winter period and/or too distant to be accessed by repeated short-distance, short-duration moves, the most practical strategy tends to be one in which goods are moved to consumers by logistically organized food procurement groups. Collector residential bases tend to be situated in places that optimize access to resources or at places where particularly critical resources are abundant. Residential moves are infrequent. Rather than shifting primary residence to multiple procurement areas, collected goods tend to be returned to the center for storage and redistribution. Because of more intricate organizational requirements, collector systems tend to be more socially complex than foragers. While not addressed in the *Willow Smoke* article, collector systems generally are capable of supporting higher population densities than foraging systems (when not in severely resource limited environments), and I maintain, typically require elevated population levels simply to meet labor requirements of the logistic system itself.

Inter-site variation is greater among collector populations because of greater functional variation in the use of space. Binford attempts to accommodate this variability by adding field camps, stations and caches to the residential bases and locations common to all hunter-gatherers. He (Binford 1983) defines field camps as places where hunting parties are maintained while away from the residential base –essentially short-term, task-specific (or limited-task) residences in which only a portion of the larger group resides. Stations or observation sites are used for information collection on game presence or movement. Caches are temporary storage places. Locations are used by foragers, but among collectors may be tethered either to residential bases or to field camps.

FORAGERS AND COLLECTORS: SPATIAL VARIATION VERSUS TEMPORAL CHANGE

The power of Binford's forager-collector model lies in its capacity to subsume much of the basic organizational variability in ethnographically documented hunter-gatherer populations world-wide; and does so by relying on pan-cultural causal principles that facilitate empirical examination of archaeological expectations. The utility of these ideas notwithstanding, there are two obvious problems involved in applying the dichotomy to *temporal* shifts in hunter-gatherer settlement and subsistence systems in the Pacific Northwest. First, the model originally was developed to explain patterned variation in hunter-gatherer populations in the ethnographic present; it was not intended to address change through time. Second, casual application of the model's arguments imply that *only collectors*, not foragers, would fit the seasonal environmental constraints of the Pacific Northwest. Each of these issues warrants brief comment.

Even though Binford's ideas address organizational variation from simple (foragers) to complex (collectors) across space rather than through time, the capacity of the model to address temporal variation in this regard need not be so limited. I suggest that autonomous, small group foraging economies tend to function poorly in a context of high population density and resource competition. Assuming increasing population density and resource competition over time, at some point foraging groups, in order to sustain themselves, must either emigrate to new areas, find ways to arrest population density at sustainable levels, or develop means to squeeze more food energy out of existing space. The latter option involves adopting more intensive and complex resource acquisition, storage, and distribution

strategies. To do so in a seasonal environment, hunter-gatherers must develop subsistence practices centered on seasonally abundant staple resources that can be mass harvested for storage and redistribution without collapsing from overly intensive use.

In the Pacific Northwest, subsistence resources that can sustain intense exploitation are few –anadromous fish, marine resources, camas, wapato, lomatium and perhaps a few others. I suggest that the mid-Holocene shift toward intensive use of these resources and development of aggregated, semi-sedentary communities across the region is most parsimoniously explained by regional population density elevated beyond carrying capacity sustainable with a forager based economy (cf., Schalk 1988:10-12; Mierendorf 1996; Burtchard 1987, 1990:14-25, and 1998:124-155). This is due, I believe, to the inability of less labor-intensive, high return, unmanaged plant and animal resources to support increasing human predation pressure; ultimately forcing region-wide logistic reorientation toward reliance on alternative resources capable of withstanding intensive exploitation over the long-term. Across most of the non-coastal Pacific Northwest, this means salmon.

Some of the above considerations also apply to the second issue (i.e., that a foraging mode of production would not be expected in regions with marked winter seasonality). Indeed, this is the point of view taken by Aikens et al. (1986) in their *Affluent Collectors* article. This certainly was so in the ethnographic record that figures in Binford's (1980) and Schalk's (1978) early ideas. The ethnographic pattern, however, lacks time depth. There is compelling reason to believe that early Holocene land-use patterns differed fundamentally from those of the late Holocene in the Pacific Northwest. There is little doubt, for example, that early Holocene group sizes

were smaller, residential mobility was higher and assemblages less complex than during the late Holocene. In any case, even if early Holocene, winter season mobility was reduced somewhat relative to summer, such restriction did not approach the level of sedentism and logistical organization common to later collectors.

Utility of the forager-collector model notwithstanding, it is important to recognize that the pattern should not be expected to occur as a simple dichotomy, or to be everywhere uniform (see Kelly 1995). Binford (1983:355) himself warns that “logistical and residential variability are not to be viewed as opposing principles ...but as organizational alternatives which may be employed in varying mixes in different settings.” Across the greater Pacific Northwest, a settlement and subsistence pattern characterized by high residential mobility, low bulk processing and negligible storage appears to have sustained the early Holocene’s low density (foraging) populations, while a relatively abrupt regional change toward restricted residential mobility with high bulk procurement and storage of anadromous fish (collecting) took place about 5,000 to 4,000 years ago (cf., Ames 1985; Ames and Mashner 1999:93-94; Burtchard 1990:6-25, 180-183, 1998:124-149, 161-165; Mierendorf 1986:50-63; Mierendorf et al. 1998:35-3; Schalk 1988: 7-15, 107-121; Thoms 1989:27-43, 353-357; Thoms and Burtchard 1987:222). This shift was most plausibly to accommodate increased population demands for limited subsistence resources. Accordingly, despite differences in focus from Binford’s original intent, the forager-collector model remains a useful tool to characterize subsistence and settlement systems of early versus mid to late Holocene hunter-gatherers in the Pacific Northwest.

HUMANS AND ECOSYSTEMS: A FEW ASSUMPTIONS

Foraging and collecting principles, and the model offered here, are rooted in ecological theory. I assume that, to function successfully in the long-term, human organizational systems must fit the constraints of larger environmental systems of which they are a part. Over time, human groups organize their use of space and adjust resource procurement patterns in response to environmental variables in a cause and effect manner comparable to other organisms. While language, culture and the technological capacity that flows from them confer substantial competitive advantage, they do not free humans from ecological constraints. Rather, the primary effect of language and culture is to *increase the range* of potential human responses and dramatically *enhance the speed* at which those responses can be made. Human group behavior patterns constitute cultural traits that can respond quickly when factors inducing change are severe. Because cultural traits are subject to rapid change, attempts to explain subsistence and settlement practices by reference to culturally-based phenomena such as group mind-sets, expectations, linguistic differences, and so on are inherently tautological. Such attempts cannot reach to more basic causes of the cultural phenomena themselves and, hence, cannot come to grips with processes that take place over very long periods of time.

It is more productive, I believe, to view variation in regional cultural patterns in their broader environmental context. Dominant cultural patterns at any given point in time and place reflect dynamic system states rooted in complex and ongoing feedback relationships between humans and the environments within which they strive to survive and reproduce (cf., Leonard and Reed 1993:649-650). Cultural systems –including settlement and

subsistence systems of primary interest here—can be expected to remain relatively stable so long as they function well enough to sustain most of their members most of the time. Systems can be expected to change, perhaps rapidly, when critical shortfalls become widespread and chronic. The explanation for relative stability versus change, then, does not lie in the cultural system itself, or even in introduction of new cultural systems or ideas into a region, but rather in the selective context through which some ideas are adopted and transmitted, while others are ignored or fall into disuse. It is this focus on selective context that underlies the long-term land-use approaches and allows them to predict basic settlement and subsistence patterns well beyond the shallow temporal depth of ethnohistoric models. Equally important, archaeological predictions derived through application of ecological models provide direction and interpretive context for research efforts, and permit rejection or refinement of ideas as new data become available.

Please note that these considerations do not imply that all cultural manifestations are adaptive; or that cultural systems cannot act, for a time, in ways that are actively maladaptive (i.e., that serve to reduce the fitness of its members) in the face of environmental pressure to the contrary. I suggest simply that cultural traits respond to external stimuli, and that the relative stability of these traits through time may be understood by reference to cause and effect relationships. In essence, traits serving to enhance the fitness of the members (or that are at least selectively neutral) tend to be differentially replicated and perpetuated through time. Traits that reduce fitness tend to be lost.

POPULATION DENSITY, RESOURCE AVAILABILITY AND LAND-USE INTENSIFICATION

Implications of population and resource processes in the Northwest have been discussed in some detail by Schalk (1988:10-12), Burtchard (1987, 1990:15-16, 1998:111-155), and Schalk and Atwell (1994:[5]1-42). All of these approaches assume that resource distribution and abundance relative to population density is fundamental to determining the basic form and relative stability of regional settlement and subsistence systems. Stability, however, is difficult to maintain. The biological tendency toward increasing population density among successful species—particularly pronounced among colonizing species such as early Holocene humans in North America—will, over time, result in resource instability, even in the absence of environmental change. In essence, these processes create a natural distinction between economies of 1) colonizing systems functioning in a context of low population density and relative resource abundance, versus 2) regionally packed systems forced to develop mechanisms to support higher population density in a context of heightened competition for limited critical resources.

Though the process is most easily understood in terms of polar extremes (here foragers versus collectors), it should be borne in mind that actual circumstances at different times and places lead to variable responses. The common thread, however, is a tendency toward more intensive exploitation of the landscape as population density increases and/or critical resources become limiting. *Intensification*, or the process of extracting increasing amounts of energy from finite land area (Schalk and Atwell 1994:[5]15; cf., Boserup 1965:43-44), is the heart of changing land-use strategies and the forager to collector

shift as it is applied to land-use systems in the Pacific Northwest.

We should also recognize that the manner in which humans organize use of the landscape at any point in time reflects feedback relationships between established practices rooted in the past and the practical need to maintain a stable supply of critical resources in the present and predictable future. Because these feedback relationships are complex, because solutions to resource problems are generally experimental and multifaceted, and because of lag time between individual recognition of the need for change (stimuli) and the general adoption of modified land-use practices (response), there is no reason to expect any land-use system to be truly optimal when viewed only in a narrow time frame.

Despite this complexity, the most viable, and hence successful, groups over the long-term are those whose land-use systems are best fit to local resource constraints. Accordingly, while recognizing that the fit will not be perfect, over the long-term hunter-gatherers should 1) exhibit regularities in the ways subsistence and settlement practices accommodate resource abundance and distribution patterns, and 2) tend to optimize return of critical resources (particularly staple food supplies, clothing, shelter and implement materials) for labor investment.

Successful groups must routinely adjust subsistence and settlement strategies as members strive to maintain a stable resource base in the face of variable climate and rising population density. During periods in which resources are stable and abundant relative to demand (e.g., the early Holocene) it is reasonable to expect relatively simple land-use systems, minimal inter-group contact, and stability in land-use practices through time. Times of acute shortfalls should narrow the range of successful subsistence strategies.

Social responses to chronic shortfalls (ostensibly in the mid-Holocene) should include increased competition and punctuated change in the form of emigration, development of social mechanisms such as territorial boundaries and trade networks to buttress resource supply, increased labor investment relative to return, and/or focused management or exploitation of lower return resources and those most responsive to intense exploitation (e.g., increased reliance on domesticates, or intensively exploitable non-domesticates such as salmon or camas).

The general manner in which resource-population processes play out through time will vary with the capacity of regional resources to sustain intensive use without collapse. In essence, regions with edible resources amenable to domestication, and/or capable of sustaining intense exploitation, will tend to develop settlement and subsistence systems oriented toward them (e.g., horticulture or salmon acquisition). Regions lacking intensively exploitable commodities cannot sustain comparable changes and will instead tend toward mechanisms such as emigration and population control to cope with chronic resource pressure within the basic *status quo anti*.

In the Pacific Northwest, we can expect development of a series of resource-related mid-Holocene subsistence and settlement changes; all leading toward more intensive use of the landscape and elevated social complexity. Expected responses include: a punctuated shift toward greater reliance on anadromous fish along productive river systems, increased reliance on storable staples such as camas or wapato in appropriate habitats, increased reliance on marine resources and lower return resources such as smaller body size game and marginal plant resources, and increased efforts to improve

ungulate habitat with fire (cf., Schalk 1988:11-12).

To accommodate more people to a more spatially constrained resource base, mid-Holocene processes also selected for aggregated settlement in places that optimized access to mass harvested and stored staples. Exploitation of resources at logistically challenging places like Mount Rainier should continue, or even expand, but would be obliged to accommodate scheduling and labor demands of more critical lowland commodities such as salmon. Accordingly, at a broad scale, we can expect land-use practices to have become logistically tethered to lowland villages.³ The change from mobile, small group foraging economies to such logistically constrained collector strategies is central to the forager-collector continuum applied to Pacific Northwest hunter-gatherers, and is an essential element of the Mount Rainier model outlined below.

AN INTENSIFICATION MODEL FOR MOUNT RAINIER AND THE MONTANE PACIFIC NORTHWEST

To this point, discussion has focused on theoretical background linking human and environmental systems with particular emphasis on basic causes of organizational change in subsistence and settlement systems through time. I have given particular attention to implications of human population density relative to the distribution, density and seasonality of critical resources –particularly ungulates and anadromous fish. I suggest that chronic shortfalls in availability of key resources induced primarily by increasing regional population density and/or resource degradation have, over the long-term, been met by increasingly intensive use of the landscape. That is, as the Holocene progressed, population and resource variables

interacted to create selective contexts favoring development and continuance of land-use systems capable of extracting and distributing increasing resource output from fixed or declining territory.

I focus on forager-collector ideas as the foundation for these approaches not so much because these ideas can be applied uncritically, but because of 1) their capacity to subsume critical organizational elements at both ends of the hunter-gatherer continuum, 2) their predictive power for basic site type and distribution patterns, and 3) their acceptance as a baseline approach, with established application to regional prehistory. Figure 4 summarizes several regional models that, except for the general period reference on the far left, incorporate these concepts.

The Mount Rainier model shown on Figure 4, and described in greater detail below, predicts patterned change in subsistence and settlement systems from early Holocene foragers moving between resource patches as small, residential groups with minimal reliance on bulk procurement and storage; to late Holocene collectors obliged to reside, at least seasonally, in sedentary villages reliant on winter storage and relatively complex resource procurement and distribution strategies tethered to the village centers. The model is organized into six temporal stages; each of which summarizes basic subsistence and settlement characteristics expected to dominate Mount Rainier, the Cascades, Olympics, and much of the Pacific Northwest more widely; and offers several implications for the archaeological record.

The model simplifies a more complex reality in order to draw attention to basic causes and consequences of changing land-use systems through time. Links to objectively observable phenomena allow us to more effectively use the archaeological record to test and refine

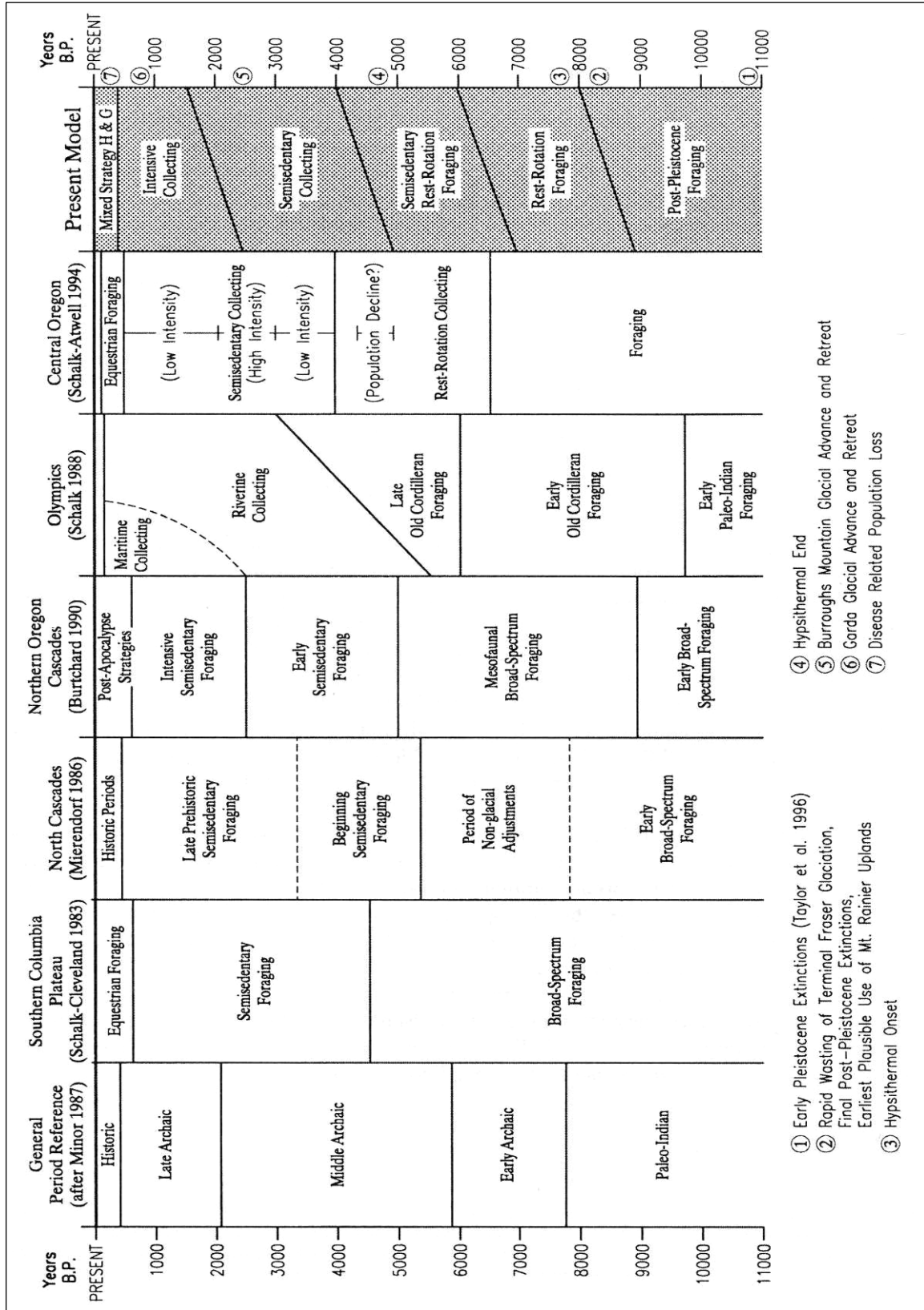


Figure 4. Selected Northwest land-use intensification models. (Ages expressed as ¹⁴C yr BP.)

proposed land-use patterns. Please note that because of the variety of sources that make up age estimates in archaeological, paleontological, and geological literature, I use radiocarbon years before present (^{14}C yr BP) as a standard measure. Paleoclimatic inferences are based on plant macrofossil and pollen data, and interpretive summaries from Mount Rainier, the Cascades, and the Pacific Northwest region (e.g., Dunwiddie 1986; Heusser 1977; Sea and Whitlock 1995; Tweiten 2007; Whitlock 1992); and on synchronous North Cascade and Mount Rainier glacial advance-retreat patterns (Crandell and Miller 1974; Heine 1998; Hekkers and Fountain 2008; Porter 1976).

Post-Pleistocene Foraging: Environment

Post-Pleistocene foraging extends from more than 11,000 to ca. 8000 ^{14}C yr BP. Terminal Pleistocene floral and faunal patterns across much of northern North America were regionally variable and dynamic. On the Columbia Plateau east of the Cascades, the climate was cooler and drier than present. The region supported a variety of large bodied fauna including mastodon, bison and caribou which, along with a variety of smaller species sharing similar habitat requirements, declined to extinction as the climate warmed and human predation began (see Schalk and Atwell 1994 and Gustafson et al. 1979). Initial extinctions appear to have begun about 11,000 ^{14}C yr BP with full transition from Rancholabrean to modern fauna taking place between 8,000 and 7,000 ^{14}C yr BP with the passing of now extinct forms of bison — the last vestige of Pleistocene megafauna (Taylor et al. 1996:516).

Abundance of these animals in the Pacific Northwest and their capacity to sustain human predation, are difficult to establish. However, given the tendency of the region's bunch grass prairies to degrade under heavy grazing

pressure (Mack and Thompson 1982), it is reasonable to assume that density of these megafaunal grazers was more limited here than on the Great Plains further east. Even so, scattered distribution of large fluted Clovis-style lance points typically associated with exploitation of these animals suggests human presence in the Columbia Plateau and eastern Cascades foothills (Waters and Stafford 2007), probably focused on exploitation of early post-Pleistocene megafauna and other habitat-sharing species.

West of the Cascades, plant and animal communities appear to have dispersed into previously ice mantled areas of the Puget Trough and Olympic Peninsula during the Everson Interstadial circa 13,500 to 11,000 ^{14}C yr BP (Heine 1998; Whitlock 1992:15). This period may also have witnessed colonization by some Pleistocene megafauna. It is plausible that the mastodon excavated at the Manis Site near Sequim on the drier east flank of the Olympics (Gustafson et al. 1979) is part of a population established during this time period. Glacial ice advanced again during the Sumas Stade about 10,500 to 9500 ^{14}C yr BP (Crandell and Miller 1974; Porter 1976), pushing megafauna habitat further south into the southern Puget Trough. The ice retreated rapidly after about 9,500 ^{14}C yr BP, allowing rapid development of dense lodgepole pine forest succeeded by more nearly modern floral associations.

In the Cascades, Cordilleran ice retreated dramatically during the Everson interglacial; opening lower elevation passes such as Snoqualmie north of Mount Rainier. On Mount Rainier, McNeely drift (Sumas Stade in the Puget Trough) ice advanced down the major river valleys, lowering the snowline to about 5,900 ft (Crandell and Miller 1974:36-38). At this elevation, most of Mount Rainier's larger mid-elevation landforms would have lain under perpetual snowpack or

been subject to vegetation depleting impact of extended snowpack and frost heaving. It is likely that near-modern floral associations became established briefly during the Everson Interglacial, retreated during the Sumas (McNeely) advance, and returned again following Sumas retreat about 8500 ¹⁴C yr BP.

Post-Pleistocene Foraging: Land Use

The first colonizing populations in North America probably penetrated the continent south of Alaska during the Everson Interstadial circa 13,500 to 11,500 ¹⁴C yr BP following movement of Pleistocene megafauna south through an ice-free seam between Cordilleran and continental ice masses east of the Canadian Rockies. While some controversy remains as to timing of initial colonization, a selected suite of 20 firmly dated and calibrated Clovis and Folsom assemblages scattered across the continental United States (Taylor et al. 1996) is consistent with this time frame. Waters and Stafford's (2007) more recent study of 87 radiocarbon dates from 30 Clovis and Clovis-age sites in North and South America also supports this range. There is little doubt that some of these colonizing populations spread into the Pacific Northwest during terminal Pleistocene and very early Holocene times. Human activity, however, was most likely focused on large-bodied, Rancholabrean faunal habitats on either side of the mountain—particularly the Columbia Plateau.

Schalk and Atwell (1994:[5]88) argue that no securely dated cultural remains in the Northwest predate 11,000 ¹⁴C yr BP (cf., Waters and Stafford 2007). Presence of Rancholabrean fauna and early fluted points, however, provide some evidence of an early post-Pleistocene human presence in the vicinity of the Cascades. While lacking stratigraphic context, a privately collected

Clovis point near Cle Elum, Northeast of Mount Rainier, suggests human presence in the general Snoqualmie Pass area some time in the early Holocene (Hollenbeck and Carter 1986:26, Zweifel and Reed 1991:11-13).

The suite of large Clovis points recovered from subsurface context from the well-publicized East Wenatchee Clovis Site (45DO482) also suggests early Holocene activity just east the Cascades. Waters and Stafford (2007:1124) attribute a somewhat ambiguous age of $<11,125 \pm 130$ ¹⁴C yr BP to this site based on traces of Glacier Peak, Layer G, tephra on the underside of some of the artifacts (cf., Mehringer and Foit 1990). Unfortunately, Gramly's (1991, 1993, 1996) contention that the artifacts were cached in pit features emanating from an unspecified surface of unknown age, and associated with artifactual bone dated to only 5215 ± 90 ¹⁴C yr BP, cast doubt on the site's stratigraphic integrity and on the value of the chronometric ages (see arguments by Gramly (1996, 1998), and Mierendorf (1997)). As with the Cle Elum find, however, the clearly Clovis style of the collected artifacts suggests an early Holocene time-frame.

On Mount Rainier itself, open forest-tundra habitats probably became established as early as 12,000 ¹⁴C yr BP on its lower to mid-elevation slopes. These habitats would have retreated downslope during McNeely Drift times, and moved upslope again as ice retreated circa 9000 to 8000 ¹⁴C yr BP (Heine 1998:1146). Most economically important post-Rancholabrean Holocene fauna probably became established on the mountain during this time frame. Indeed, radiocarbon dated woody charcoal recovered from a deep sediment profile at 6,200 feet on Sunrise Ridge indicates that trees were growing (with, I assume, associated fauna) at this elevation at least by 7800 ± 80 ¹⁴C yr BP [Beta 151857]. It is possible that earliest human use of

comparable habitats on Mount Rainier date about this time as well. Use of lower Cascade passes and habitats probably began somewhat earlier in the post-Pleistocene period.

The possibility of human use of upper elevation Cascade landscapes by end of the early post-Pleistocene period notwithstanding, most foragers probably focused on more productive and easily accessed habitats east, and to a lesser extent west, of the Cascades. Montane game density would have been too low and exploitation costs too high relative to the lowlands to have attracted significant use by the few human groups entering the region during early post-Pleistocene times. The probability of human forays into the midst of the Cascades and onto the mid to upper elevation flanks of Mount Rainier increases with glacial retreat and establishment of modern plant and animal communities at the close of the period.

Post-Pleistocene Foraging: Archaeological Record

For the Washington Cascades, archaeological evidence of human occupation should be minimal and restricted to lower elevation passes. To date, the Cle Elum Clovis find is the only very early fluted point form plausibly linked to montane landforms in this region. Because of its surface context, the age and even location of original use cannot be determined unambiguously. Even so, its location near Snoqualmie Pass is consistent with post-Pleistocene foraging in the eastern Cascades foothills and/or with cross-Cascades travel at an early date.

Extant radiocarbon data are consistent with these expectations. The earliest, plausibly culturally related, radiocarbon age presently known in the Washington Cascades is a circa 8500 ¹⁴C yr BP date recorded near the Cedar River north of the park (Samuels 1993).

Mierendorf and Foit (2008) report an essentially identical age from stratified cultural deposit in the North Cascades. It is likely that continuing work at this site will push the earliest known date in the Cascades to the 9000s ¹⁴C yrs BP (Robert Mierendorf, personal communication, 2008). Cultural deposits radiocarbon dated to the mid 6000s ¹⁴C yr BP are more common, firmly establishing human presence in the Washington Cascades by this time (see McClure 1998:72-75). Currently, the oldest known site on Mount Rainier proper is the Buck Lake site (45PI438), containing lithic artifacts in pre-Mazama stratigraphic context dated to 7173 ± 49 ¹⁴C yr BP [Waikato 15981]. Because of glacial ice, cultural remains on Mount Rainier are not expected to date to terminal Pleistocene or very early Holocene times prior to about 9000 ¹⁴C yr BP.

Rest-Rotation Foraging: Environment

Rest-Rotation Foraging extends from about 9000 to 6000 ¹⁴C yr BP. Environmental parameters for the period have been anticipated above. During these three millennia, the earth rebounded from its long Pleistocene glacial episode (albeit with interglacial breaks) and entered a protracted period in which general climatic conditions were warmer and drier than present—generally referred to as the *Altithermal* or *Hypsithermal Interval*. In lowlands like the Puget Trough, forest succession was arrested or reversed as an increasingly xeric climate selected for brushier, more open forest stands. In the Cascades, tree-line crept further upslope, plausibly reducing the size of subalpine habitats as permanent snowline moved upslope and growing season lengthened. Assuming fire frequency remained stable, ungulate habitat would have improved in the lowlands and Cascade foothills, while it became more restricted at higher elevations.

The onset of the period is keyed to extinction of the last of the Pleistocene megafauna and full development of characteristic Holocene plant and animal communities in the Pacific Northwest. In the high Cascades, Cascade foothills and surrounding lowlands, near modern floral and faunal patterns became well established except as affected by Hypsithermal warming. Included are resources believed to be of particular economic importance for hunters and gatherers now deprived of larger megafaunal alternatives; including elk, deer, mountain goat, bear, marmot, game birds, camas, huckleberries, and so on. Anadromous fish populations are expected to have become reestablished in most Northwest watersheds.

On Mount Rainier, recent evidence from stratified deposits at 6,200 feet on Sunrise Ridge, indicate that near modern floral, and probably faunal, associations were established to at least this elevation by about 8000 ¹⁴C yr BP (Burtchard 2001). Assuming these plant and animal associations were of value to foraging populations, it is reasonable to expect some level of human use of comparable mid to upper elevation habitats as well.

Rest-Rotation Foraging: Land Use

I expect human population density to have increased across the Pacific Northwest, but to have remained at relatively low levels during the early Holocene. With extinction of Rancholabrean (late Pleistocene) fauna, resource productivity on the Columbia Plateau may have declined substantially. Even at low population density, extinction of these large animals should have induced increased use of a broader resource spectrum focused particularly on the habitats of the most productive surviving ungulates—ostensibly elk and deer—and other habitat sharing plant and animal species. Assuming that the densest distributions of these ungulates were biased

toward Cascade foothills and surrounding lowland landscapes, it is reasonable to expect their human predators to have increased their presence in these areas as well. Because of the loss of Rancholabrean fauna and presence of somewhat smaller body-size alternatives in foothill and valley settings on both sides of the Cascades, we should expect Pleistocene extinctions to have been associated with an increase in hunter-gatherer activity in these settings with at least limited use of higher elevation landscapes, both as cross-mountain travel routes and resource acquisition destinations.

I emphasize lowlands and Cascades foothills to a greater extent than higher mountain landscapes because of the presumed impact of the Hypsithermal climate on forest structure. If ungulate habitat became more productive in the western lowlands and eastern foothills due to forest recession, and simultaneously less productive in the uplands due to forest encroachment, then it is reasonable to expect human populations to focus attention on low to moderate elevation landscapes, perhaps with less resource-related attention to high elevation places. Given the combination of relatively low human predation pressure (due to continuing low population density), productive lowland habitats, and tendency of game to aggregate in mountain foothills (Schalk 1988:90-91), hunter-gatherers may have emphasized use of valley and foothill environments throughout the period (also see Daugherty 1993:3-4).

Between 9000 to 6000 ¹⁴C yr BP, continuing high game density relative to demand and tendency for ungulates to aggregate in open lowland and foothill habitats, should have made it possible to sustain a foraging strategy with relatively short distance residential moves and minimal dependence on bulk processing and storage. Foraging may have focused on a broader spectrum of resources

relative to the immediate post-Pleistocene period, but plants and animals selected are expected to be dictated by seasonal availability and proximity to ungulate hunting areas. *Rest rotation* (after Schalk and Atwell 1994) refers to the capacity of groups to move to new foraging areas as hunting productivity declines, thereby allowing predation-free time for game density to regenerate naturally. Ability to do so depends on abundant open space with minimal inter-group resource competition. The pattern is of key importance to maintaining a forager strategy, because it insures resource stability without sophisticated logistic strategies or inter-group coordination. In an environment like that of the Pacific Northwest, I believe that it is only practical in a context of very low population density and high resource abundance.

Rest-Rotation Foraging: Archaeological Record

Currently at Mount Rainier, only one site has been documented that dates to the 9000 to 6000 ¹⁴C yr BP period. Site 45PI438, situated at 5,400 feet in the park's northeastern quadrant, produced a micro-blade core *in situ* atop a paleosol predating the 6800 ¹⁴C yr BP Mt. Mazama eruption. Stratified deposits indicate continued use of the site at 5500 ¹⁴C yr BP, and an apparent sharp increase in use intensity closely following the Mt. Saint Helens Yn eruption about 3500 ¹⁴C yr BP (Crandell 1987; Mullineaux 1974; Vallance 2001). Continuing research will clarify use of this landscape further in the next few years.

It is unreasonable to believe that 45PI438 is the *only* early to early-mid Holocene site preserved at comparable elevation on the mountain. Indeed, a few other sites of comparable age and elevation have been documented elsewhere in the Washington Cascades. Rick McClure (1989, 1998) reports a ca. 6250 ¹⁴C yr BP radiocarbon date from an

obsidian quarry (45LE285) in alpine context at Elk Pass; and Mierendorf's recent work at Cascade Pass (45CH221) in the North Cascades has produced micro-blades and micro-blade cores in stratigraphic context dating to approximately 8000 ¹⁴C yr BP (Mierendorf and Foit 2008). Given the resources to search and test, others almost certainly will be located. Strict application of the present model, however, suggests that such sites may be relatively rare compared to the later Holocene. Without intentional burning to enhance upland forage (considered unnecessary in the low population-abundant resource context of the early Holocene), foraging activity should have emphasized lower elevation foothill and valley landforms. These sites should be limited in size but contain a functionally varied array of artifact classes consistent with residential use. Additional research geared toward developing a larger set of dated upland sites in firm stratigraphic context will be useful for determining the extent to which land-use emphasized lower elevation landscapes as predicted here or routinely incorporated subalpine habitats.

Semisedentary Rest-Rotation Foraging: Environment

Semisedentary Rest-Rotation Foraging extends from about 7000 to 4000 ¹⁴C yr BP. Present data suggest that the Hypsithermal Interval gave way to a period of generally cooler and moister conditions about 5000 to 4500 ¹⁴C yr BP — conditions that persist with shorter-term perturbations to the present (Crandell and Miller 1974:44-50; Heusser 1977:298-302). Termination of the Hypsithermal had significant, but opposite, effects on lowland versus upper montane forest structure. In lowland valleys and foothills, forest cover became more uniform and began to approach more nearly closed canopy cover. That is, forest cover advanced

toward the mid to late seral-stage maritime forest pattern that now dominates the region. At low to moderate elevation, ungulate forage should have been restricted by the shrinking size and number of productive early seral-stage grassland and brushy habitats.

In the mountains, where upper elevation forest cover is controlled more by persistent snow burden, saturated ground and growing season than by moisture (Franklin et al., 1988:127; Moir 1989:5), forest cover should have retreated downslope to approximately present elevations (Burtchard & Swinney 2004). Increasing expanses of alpine tundra, and subalpine parklands should have attracted correspondingly increased numbers of elk, deer and associated species during the late summer months when forage was at its peak. Coincident degradation of forage in the lowlands with seasonal improvement in the uplands, overlain by increasing regional population density, should have contributed to punctuated increase in human use of places like Mount Rainier during this time frame.

Mid-Holocene volcanic events may also have affected land-use patterns in the Cascades. Clearly, Mount Rainier's summit collapse about 5500 ¹⁴C yr BP, the Osceola Lahar (Harris 1988:242-245; Pringle 2008:36-37; Vallance 2001), and subsequent smaller debris flows were catastrophic events that destroyed plants, animals and people unfortunate enough to be caught in their path. Except for the Osceola Lahar, however, effects of debris flows on Mount Rainier were spatially limited, and probably of little enduring consequence. While the massive Osceola lahar undoubtedly had serious consequence for resource distribution and population density northeast of the mountain, I suggest that these effects gradually subsided as forest cover returned. Indeed the primary long-term effect of even the Osceola event probably relates more to climatic implications of the loss of 1,000 to

2,000 feet of summit height, than to direct impact of the lahar *per se*.

Volcanic tephra deposits from several less destructive Mount Rainier eruptions during the period likewise were of little environmental consequence. Early succession processes involving growth of rapidly reproducing grasses and brushy plants most valuable as ungulate forage generally would have begun immediately following these events. It is likely that habitat destruction was short-lived and followed quickly a slightly longer period of ungulate habitat improvement due to forest smothering (see Tweiten 2007). Accordingly, I assume that these events, while dramatic, did not significantly affect (and certainly did not reduce) forager use of the uplands or major lowland river valley in the long-term scale with which we are dealing.

Semisedentary Rest-Rotation Foraging: Land Use

To accommodate low but gradually increasing population density and loss of lowland and foothills ungulate habitat at the end of the Hypsithermal Interval, human groups should have increased exploitation of a wider range of variably productive habitats, including higher elevation montane landscapes. Consequent changes in foraging strategies are expected include limited sedentism and storage to bridge winter food shortages. It is reasonable to expect, however, that competitive resource pressure was not yet high enough to cause loss of at least two options central to forager production: 1) continued existence of enough uncontested territory to maintain rest rotation movement; and 2) ability to move to most resource patches as full residential units rather than as task-limited groups tethered to larger central villages. In essence, the model assumes that mobility became restricted somewhat by incorporation of limited bulk harvest and

storage activities, but not enough to lose rest-rotation and full residential movement options.

As noted above, forage should have become more productive in the uplands as forests retreated downslope to near modern elevations. Accordingly, use of subalpine and alpine zones on Mount Rainier and the Washington Cascades is expected to increase between 7000 and 4000 ^{14}C yr BP as a direct consequence of their increased foraging value.

In short, the most salient aspects of the forager strategy (e.g., small group size, relatively frequent residential moves, minimal bulk processing and storage, limited inter-site variability) should have continued throughout the period. However, combined population and environmental circumstances are expected to have operated to cause 1) settlement in less optimal habitats, 2) increased variability in foraging strategies, 3) short-term bulk processing and storage, and 4) punctuated increase in use of upland habitats coincident with environmental cooling at the end of the Hypsithermal Interval.

Semisedentary Rest-Rotation Foraging: Archaeological Record

Site types should remain roughly comparable to those from the early Holocene, but with 1) a higher site density consistent with increased regional population density, 2) dispersal into a wider range of habitats on both sides of the mountains, 3) increased representation in montane uplands, and 4) a fraction of larger, more complex sites in lowland settings with evidence of storage facilities or use of resources such as anadromous fish, camas and/or other storable plants and animals. Site density in Mount Rainier subalpine and alpine zones should increase abruptly, particularly as the Hypsithermal climate weakened in the second half of the period.

An increased number of radiocarbon aged sites in the southern Washington Cascades dating between about 5500 and 6500 BP is consistent with these expectations (McClure 1998; McCutcheon *et al.* 2008), as are data from the Buck Lake site (45PI438) which suggest heightened use of Mount Rainier's subalpine zone relative to the pre-Mazama component. Unfortunately, too few sites have been documented in subalpine context to address the expectation of punctuated increase in use of high elevation settings in a meaningful fashion. Because of its growing number of documented sites and substantial subalpine and alpine habitat, however, Mount Rainier offers an unusual opportunity to investigate environmental and land-use changes. Environmental patterns could be addressed through pollen core extraction and paleo-environmental reconstruction such as at Buck Lake (Tweiten 2007). Land-use changes can be examined through test or data recovery excavation at a set of upper elevation site locations.⁴

Semisedentary Collecting: Environment

Semisedentary Collecting extends from about 5000 to 1500 ^{14}C yr BP. The second half of the Holocene epoch saw full termination of Hypsithermal warming followed by oscillating, but generally cooler and moister climatic conditions. Forest density in the lowlands and western foothills, if not modified by fire, should have advanced to higher seral stages with concomitant reduction of ungulate forage. Subalpine to alpine plant and animal communities should have remained at approximately modern levels. Indeed, both uplands and lowlands probably appeared essentially as they do at present, except as modified by fire, volcanic deposits, and short-term climate oscillations.

The Osceola Lahar and summit collapse lowered Mount Rainier's peak and altered

upper elevation landscapes and major river valleys about 5500 ¹⁴C yr BP. About 2500 ¹⁴C yr BP, a second volcanic cycle rebuilt the summit to its present height (Harris 1988:245-247). The second event also deposited from one to eight inches of Mount Rainier series C tephra (MR-C) over much of the mountain's northern and eastern flanks (Crandell 1987:14-15). About a thousand years prior to this summit rebuilding eruption, at 3500 ¹⁴C yr BP, Mt. Saint Helens series Yn (MSH-Yn) eruptions deposited a dense layer of sand-sized tephra across much of the mountain's mid to upper elevation landscapes (Pringle 2008:34-39). This event appears to have smothered fir and hemlock forests, and contributed to more open pine-dominated associations for several hundred years (Tweiten 2007). Long-term vegetation alteration and land-use implications of these events appear to have been insignificant (cf., Dunwiddie 1986), or in the case of MSH-Yn, improved ungulate habitat temporarily.

In general, there is no indication that mid-Holocene environmental circumstances improved the regional resource-population equation in the long-term. Subalpine habitats, because they are limited in total area, are not likely to have compensated for lost winter forage in the lowlands and foothills. In a natural state, ungulate population density, particularly on the wetter westerns slope, should have decreased overall.

From a human standpoint, lost ungulate habitat in the lowlands probably was not critical so long as population density remained low relative to abundance. By about 4000 ¹⁴C yr BP, however, it is likely that demands on available resources reached a point beyond which they could be reliably met with previous hunting and gathering strategies carried out by small autonomous forager groups. I suggest that combined impact of rising human population density and restricted

ungulate habitat created an environmental context favoring 1) increased use of fire to expand ungulate habitat, particularly in lowland and foothill settings; 2) loss of rest-rotation options; 3) more intensive reliance on mass harvested and stored anadromous fish and other storable commodities; 4) loss of residential mobility; and 5) logistic reorganization consistent with intensive land-use requirements.

Semisedentary Collecting: Forager to Collector Land Use Changes

A shift to winter reliance on mass harvested and stored anadromous fish underlies a shift from the high mobility foraging pattern to the limited mobility collector pattern that dominated northwest hunter-gatherer economies in the latter part of the Holocene. The model assumes that between about 4500 and 3500 ¹⁴C yr BP, elevated population density and declining ungulate habitat reached a point at which competition for available resources was too high to reliably sustain rest-rotation foraging practices. Loss of rest-rotation recovery options set up a positive feedback response, quickly leading to over-predation and precipitous decline in game abundance. In this context, foraging land-use systems, critically dependent on closely spaced resource patches and high game abundance became untenable, causing a rapid shift toward logistically organized subsistence and settlement strategies centered on major salmon bearing rivers and streams (cf., Schalk 1988:99-104).

There are only a few Pacific Northwest subsistence staples that can meet bulk acquisition and storage requirements required to bridge winter shortfalls, and are capable of withstanding continuous intensive use without collapse. Foremost among these are anadromous fishes because they offer the highest return for effort of the available

options. Salmon bearing streams are widely distributed across the region, the oceanic growth cycle supports very large populations, runs are predictable in place and time, and food return per harvest event can be high if labor is sufficient. Other subsistence resources potentially meeting mass harvest requirements include winter collected marine resources, camas in very productive habitats, and perhaps wapato and biscuit root in places where they grow best.

Despite its desirable qualities, there is compelling reason *not to expect* mass harvest and storage of anadromous fish before being forced to do so. Large-scale procurement and storage is a labor intensive undertaking entailing loss of residential mobility through an extended harvest and storage period. As a central feature of a collector economy, it also involves a host of subsistence and social adjustments. Schalk (1988:98-99) describes costs and risks of dependence on mass harvested salmon as follows:

The costs of food storage in this environment are quite high... Due to the high precipitation and humidity as well as the mild winter season temperatures, effective storage of fish through desiccation or through freezing is impractical. Saturation of fish flesh and oils with the phenols in wood smoke (Schalk 1984) was essential to effective storage of oily fish like salmon. To effectively store salmon in this environment for winter consumption requires technology for mass harvest, appropriate structures for smoking the fish, containers and sheltered space for storing it, and large inputs of human labor spanning the entire interval from the time the fish are caught until eaten months later.

There are also *risks* involved in dependence upon stored foods to survive productive lows. Poor runs or even run failures occur naturally and, even if very infrequent, would have necessitated fall-back strategies. Perhaps a greater risk though is the potential that fish successfully stored may not be successfully consumed. Spoilage, loss to predators and scavengers and even loss to other human groups are some of the more obvious sources for this kind of risk.

Costs and risks such as these made reliance on mass harvest and storage of anadromous fish undesirable prior to onset of chronic resource related needs to do so. Intensive use of marine resources entails even greater liabilities. According to Schalk (1988:109):

...the more productive marine resources are only seasonally available and tend to be restricted in abundance or entirely unavailable during the winter months. Added to this are ...accessibility problems... The weather can be stormy for days on end making travel by watercraft difficult or impossible. Many shellfish are only available at low tide and ...during the winter months [the tides] are not as low as during the spring and early summer and they occur at night time.

Plants do not fare any better than marine life as over-winter stored staples. Suitably productive habitats, while locally important in the absence of anadromous fish, are too few and far between to sustain a region-wide forager to collector shift. Camas, arguably the most valuable of the plant staples, entails high harvest and preparation costs and requires a long storage period (see Thoms 1989, 2008:121-127). I suggest that bulk storage of plant products generally entails greater labor

and storage costs due to the need to collect, process and store larger quantities than their salmonid equivalents. Furthermore, because of intensive harvest needs, other than in exceptionally productive areas, non-horticultural plants cannot sustain intensive long-term use in the absence of alternative resource supplements.

Largely due to widespread availability and sustainable productivity, anadromous fish were therefore most plausibly the earliest resources relied upon for over-winter mass storage in the Pacific Northwest. Schalk (1988:110) suggests that initial settlement should have been geared toward larger rivers providing stable fisheries in areas that also maximized continued access to ungulate procurement places. Through time, we should see progressive expansion onto less productive streams, followed by adoption of lower return resources as intensification pressure continued to increase.

Once required to change to primary subsistence reliance on mass processed and stored fish, remaining characteristics that define collector systems fall into place. Perhaps the most important change is to nearly sedentary residence in relatively large aggregated villages. With a fishing dominated economy, residence is restricted to riverine settings from autumn through winter by the extended procurement and storage needs that anadromous fish entail. Group size increases to accommodate higher regional density overall and meet elevated labor requirements. Indeed, *increased* population density may be expected to closely follow a shift to collector (or agricultural) strategies, in part, to meet these new labor demands (cf., Schalk 1988:111).

Because of large group size and scheduling requirements related to reliance on anadromous fish, collectors forfeited the

capacity to move freely across the landscape as a residential unit at times optimal for procurement of non-salmonid resources. Late summer to fall use of subalpine habitats, for example, conflicts directly with salmon harvest and storage in the lowlands. In short, sedentism, bulk storage, group size, scheduling requirements and degraded game habitat combine to force a shift to a full collector system in which relatively few resources become the central focus of attention and supplemental resources are either sought by limited-task groups tethered to the residential hub or are supplied by trade. There is no middle ground. Even social complexity must increase to regulate the more involved tasks required to sustain larger groups in limited territory.

Semisedentary Collecting: Land Use

Widespread adoption of riverine collector strategies implies primary settlement and subsistence focus on lowland and foothill settings through most of the year. Due to presence of upstream barriers, productive salmon runs seldom penetrate deeply into high elevation landforms, and almost never in close proximity to subalpine habitats. Due to downstream barriers, anadromous fish were probably never an important mass-harvested resource within the boundaries of Mount Rainier National Park. Subsistence-related use of upper elevation subalpine to alpine habitats should have become logistically challenging to people whose effective resource gathering territories were increasingly tethered to lowland villages. Transportation difficulties always inherent in using upland habitats may have increased, or at least have become more logistically complex in a context of depleted game by collectors charged with transporting resources back to residential bases.

In his Olympic Peninsula study, Schalk argues for declining use of the uplands during the late Holocene (Schalk 1988:150; zone titles added):

Early in the ...project it was postulated that subalpine areas were likely to have been used more intensively during the early and mid-Holocene than after the emergence of semi-sedentism in the region (Schalk 1985). This expectation derives from the fundamental differences between land use systems that emphasize residential mobility versus those which emphasize logistic mobility. The implication ...is that native usage of the Olympic mountains prior to the appearance of the riverine and maritime collecting systems involved systematic exploitation of resources in Zone IV [*Subalpine and Arctic*]. After the appearance of the collector systems, however, the focus of exploitation shifted downward in elevation onto the ungulate winter ranges that are generally below 2,000 ft in Zone II [*River Valleys and Lowlands*].

As compelling as these arguments may be, they are not consistent with archaeological data from Mount Rainier, or the Washington Cascades generally. While excavations at 45PI438 (Buck Lake) indicate early to mid-Holocene human presence on Mount Rainier, data from this and other excavated locations on the mountain, widespread presence of cultural debris atop 3500 MSH-Yn and 2300 ¹⁴C yr BP MR-C tephra, and preponderance of mid to late Holocene radiocarbon dated sites in the southern Washington Cascades (McCutcheon *et al* 2008) leave little doubt that upper elevation Cascade landscapes continued to be used throughout the Holocene coincident with full development of collector strategies in the lowlands.

In line with Schalk's argument, it is possible that, relative to now-elevated regional population density, use of high elevation places decreased on a per capita basis in the late Holocene. However, continuing use of subalpine and alpine landscapes must be expected for one or all of at least three reasons: 1) uplands could not be left as unregulated pasture-land in a population packed region without being further degraded by "cheaters", and/or 2) marginal populations continued low intensity forager practices on the fringes of increasingly centralized lowland society, and/or 3) limited task groups tethered to lowland villages acquired high return commodities not available in the lowlands.

Garrett Hardin, who developed much of the competition theory imbedded here, also advanced explanations as to why unmanaged resources tend to degrade to crisis levels when used in common by people lacking clearly defined mutual obligations. In *Tragedy of the Commons*, Hardin (1968) uses the example of pasture land commons in Britain to argue, in essence, that unregulated resources always serve to the selective benefit of over-users. That is, "as long as a pasture [or any other resource] is considered to be unlimited and for common use by everybody without constraints, then ...overuse is inevitable since the individual gains a temporary advantage by overstocking [or overuse] and only at some later time ...begin[s] to suffer the collective consequences of overuse" (Odum 1971:245). In this light, all early Holocene resource foraging areas –highlands, lowlands, rivers and more– may be considered commons; unregulated use of which could continue only so long as the resource base reliably sustained common use in the face of increasing population density. Ultimately however, competition for limited resources necessarily reached a point at which some form of use-limiting, exclusionary, or cooperative regulatory mechanism(s) had to be developed

in order to protect the resource base from collapse—earlier in bounded, smaller, or less-productive resource patches; later in broader, or more productive places.

In the mountains, and specifically at Mount Rainier, the expectation that subalpine “pastures” would be left untouched by linguistically and socially distinct groups on all sides of the mountain with, at best, marginal obligations to one another is unreasonable. Despite its degrading state, it is more reasonable to expect that a) marginal groups would continue to exploit remnant resources at a low level; and/or b) groups dependent on winter hunting would establish territorial rights over critical portions of the uplands and protect them from overuse. In the latter case, limited task groups may have been dispatched to the mountains less to collect and return stores to lowland centers, than to insure that ungulate resources return to the lowlands with the onset of winter.

In addition to protecting montane resources from exploitation by marginal foragers on the fringes of collector-dominated society, it is possible that late Holocene collecting in the uplands focused less on ungulates and more on alternative high value resources such as mountain goats (wool), mountain beaver (fur), marmots (fat), or huckleberries (dried berries) not available in comparable abundance in the lowlands. Because they are durable, and their value can be amortized over a number of years, goat wool and fur may have been particularly important mountain commodities compared to food resources which typically are consumed within the year. Because of transportation difficulties and scheduling conflicts noted above, it may be impractical to expect food resources to be taken in abundance unless affiliated with other land-use needs as outlined below or prior to transportation enhancing introduction of the horse.

I suggest that a combined explanation is most plausible for late Holocene land-use practices. It is likely that early in the Semisedentary Collecting period, mixed upland hunting and gathering continued to be carried out by a decreasing number of marginal forager groups. As resource pressure mounted, lowland groups extended territorial rights over critical watersheds and upland summer game habitats. Ultimately, the benefit of protecting upland resources became great enough to warrant the cost of dispatching limited-task groups to protect territorial resource rights during the critical late summer months. To be effective, it would have been necessary to extend protection over a period of about two months. Accordingly, such groups would have been obliged to establish residential base camps (very likely much the same as foragers), carry out low-level maintenance hunting while in upland residence, and ultimately return to the lowland center in late autumn with the highest value for weight commodity(ies) available on the mountain – perhaps goat wool and fur.

In short, it is reasonable, indeed expectable, for human use of the mountains to continue throughout the Holocene, albeit on a restricted per capita basis and oriented to fill different social-economic needs. Rather than use dominated by mobile mixed sex and age residential groups, the mountains became tied into more complex land-use practices ancillary to intensive use of riverine resources in the lowlands. Changing mountain land-use practices were part of a regional shift in settlement and subsistence practices from forager-dominated systems (fit to a context of low population density relative to terrestrial game abundance) to collector systems better able to cope with increasing demand and restricted availability of wild terrestrial resources.

Semisedentary Collecting: Archaeological Record

The archaeological record of Mount Rainier and the Cascades leaves little doubt that human use of the uplands continued throughout the Holocene. What remains is not to debate the fact of continuing uplands use, but rather to address how land-use practices may have changed and how those changes affected the archaeological record. Interestingly, it is possible, perhaps probable, that site type and distribution patterns in the mountains may not appear to be substantially different if forager to collector land-use practices evolved as outlined above. Due to the need to maintain upland residence during the subalpine to alpine summer, factors affecting site selection and use may have been much the same throughout the Holocene. Because of occupation length, both foragers and collectors would have been obliged to establish residential base camps in settings fit to unpredictable high elevation weather patterns. Both foragers and collectors probably operated out of these camps through a series of task-specific resource acquisition locations or information stations. Differences between the two systems may lie largely in 1) the social composition of the groups, 2) the suite of upland resources sought, and 3) the composition of tool kits and features employed in carrying out these tasks.

Due largely to the need to maintain extended residence, archaeologically recognizable differences between early and late Holocene sites may be subtle. Each of the three areas of variation noted above may be detectable in the archeological record given directed research and a large enough sample size. For example, the expectation of differences in social composition assumes that earlier forager groups would have a gender and age range reflecting the full social unit in residence on the mountain. Collector residence is more

likely to consist of a subset of the larger population, the remainder of which would have been occupied by lowland tasks in the late summer. Unfortunately, because maintenance and food preparation tasks may have been varied in both cases and because both may have selected similar base camp settings (e.g., the upper forest-subalpine ecotone), forager-collector archaeological signatures may be quite similar. Indeed, it is possible that mixed sex and age groups may have used the mountain through time, even if representing a social subset in later times. Archaeological variation, if any, must be the subject of empirical investigation. It is likely that most robust early to late Holocene changes will lie in other archaeologically observable domains.

The greatest single source of variation between early and late sites may lie in the relative proportions of game animals sought, and, in principle, preserved in the archeological record. All else being equal, early Holocene deposits should contain a high fraction of large ungulate remains (principally elk and deer) within a broad spectrum of exploitable species. Late Holocene collector components should show broad mix as well, especially in residential locations, but we should also see a higher fraction of smaller animals, including particularly a higher fraction of remains linked to potentially high value transportable commodities —mountain goat, mountain beaver, and perhaps marmot remains.

Potential change in artifact and feature complexity associated with early versus late Holocene land-use practices reflects the need to maintain high residential mobility with relatively low site reuse among foragers, versus greater potential for redundant site use and exploitation of a somewhat broader range of resources among collector groups. To accommodate high residential mobility,

forager tool kits should be small, portable and suited to multi-functional applications centered on the need to kill and butcher large body-sized animals. Such needs may characterize later Holocene use as well, but modified by incorporation of a higher fraction of small body-sized game, greater functional variability among site types, and enhanced potential to reuse site locations and thereby lessen transportation weight by caching tools. With lessened weight restrictions and a potentially greater number of tasks to be performed (at least at base camp settings), tool kits should be more complex and contain implements such as arrows, darts and distinct butchering tools suited for extraction of wider size ranges without as pressing a need for multi-functional portability. Overall feature variability may increase in the later Holocene as well; particularly if goat hunting (high elevation blinds) and huckleberry processing (fire drying features) become integrated into the range of upland tasks.

At Mount Rainier, most of the approximately 100 presently documented precontact sites are found in subalpine context atop mid to late Holocene volcanic deposits. These survey data alone suggest widespread use of upper elevation habitats during late Holocene (collector) times. Excavation data sufficient to address temporal variation in forager versus collector assemblages are more limited. Even so, preliminary results from two tested rockshelter sites and two large sites in open, ostensibly base camp, settings display qualities consistent with the general tenor of the land-use continuum. Goat, marmot, mountain beaver, and (less certainly) deer remains at Fryingpan Rockshelter (45PI043) excavated from sediments circa 1000 ¹⁴C yr BP (Lubinski and Burtchard 2005) are consistent with small body-size game, and transportable resource (goat wool, marmot fur) expectations associated with village-linked collector populations. Lithic remains

dating to the last 1200 ¹⁴C yr BP at another rockshelter in Berkeley Park (45PI303) are dominated by late-stage pressure bifacial reduction of arrow-sized performs of non-local material types. Also present is limited amounts of debitage reflecting the bipolar reduction of locally available jasper. The relatively uniform character of the Berkeley assemblage is consistent with hunting and hunting-related maintenance activities (Bradford Andrews, personal communication 2008). Unfortunately, faunal remains were not preserved in Berkeley's relatively open setting which is exposed to greater chemical weathering than the more sheltered Fryingpan setting.

The density and relatively high diversity of artifacts recovered from the 2300 to 3400 ¹⁴C yr BP Sunrise Ridge Borrow Pit site (45PI408) are consistent with residential base camp expectations; and include a ground stone hammer and trade goods not expected in portable forager assemblages (Burtchard 1998:112-113; Dampf 2002; McCutcheon 1999:12). Horizontally stratified remains at Buck Lake in the park's northeast quadrant span a range of at least 7000 ¹⁴C yr BP to the present. The site (45PI438) is the most clearly and deeply stratified site presently known on the mountain, with cultural content that should address temporal variation in assemblage composition once excavation and analyses are complete. Preliminary results suggest a marked increase in artifact diversity and density immediately atop 3500 ¹⁴C yr BP MSH-Yn tephra deposits compared with earlier deposits. Results also show substantial artifact diversity including both dart and arrow sized projectile points (introduced in the late Holocene), suggesting a mixed hunting strategy continuing late in the Holocene, but with increased reliance on smaller, faster fauna best taken with a bow.

Pending completion of analyses of recovered assemblages, and in light of the low number of early to early middle Holocene components against which to compare later Holocene materials, Mount Rainier archaeological data remain too limited to rigorously test of many of the expectations offered here. Ongoing research at 45PI438, 45PI408 and several other localities such as Tipsoo Lake (45PI406) should begin to address these issues more thoroughly in the next few years. With currently available information, however, it is clear that extensive use of Mount Rainier's subalpine to alpine habitats can be dated to the last 3500 ¹⁴C yr BP. We also know that use extended back at least to 7000 ¹⁴C yr BP and probably further. Currently available test results are consistent with general expectations for the Semisedentary Collecting period. I expect refinement of these ideas in light of concrete archaeological data to emerge soon as ongoing research is completed.

Intensive Collecting: Environment

Intensive Collecting extends from about 2500 to 400 ¹⁴C yr BP. On Mount Rainier, late Holocene climatic conditions remained relatively cool and included an acute glacial advance between about 600 and 150 years ago (the Little Ice Age Garda Stade; Crandell and Miller 1974:49-50). The extent to which this advance influenced resource patterns is difficult to determine. All else being equal, high elevation ungulate forage should have been improved by forest cover snow suppression, while low elevation forests expanded in response to increased moisture overall. On strictly environmental grounds, there is reason to expect seasonal hunter-gatherer use of high elevation landscapes to have continued throughout the period unless upland hunting was restricted to maintain elk and deer populations as proposed by Schalk (1988). In the lowlands, cool and moist

conditions would have further exacerbated problems related to increased forest cover (and reduced ungulate habitat) operative since the close of the Hypsithermal interval. Such resource limitations, probably further heightened by elevated population density, should have selected for efforts to intensify resource acquisition through a variety of mechanisms, including 1) fire-based forest suppression to promote more productive early seral-stage communities in both lowland and upland settings, 2) greater use of anadromous fish and intensively exploitable plant resources such as camas and wapato, and 3) increased reliance on marine resources.

Intensive Collecting: Land Use

Most implications for increasing land-use intensity have been addressed in the preceding section. Considerable attention has been given to causes and effects of the forager to collector transition because such land-use changes entail substantially different organization of resources, territory and labor. Intensive Collecting assumes mounting population pressure on available resources countered by incorporation of additional social mechanisms to increase food output and buffer resource shortfalls. Expected changes include an incremental shift toward 1) incorporation of a higher fraction of lower return mass harvestable resources, 2) expansion into marginal habitats, 3) extension of trade networks and development of alternative mechanisms to extend resource capture, 4) more tightly defined and defended territorial boundaries, and 5) increased inter-group competition and conflict.

Away from Mount Rainier, perhaps most obvious of the regional changes is development of maritime economies in coastal settings with productive off-shore waters. For the Olympic Peninsula, Schalk (1988:111-116) discusses the energy requirements of a

shift to primary dependence on marine resources, providing compelling arguments for progressive incorporation of this resource base as population demands increase. Nearer Mount Rainier, we may expect settlement on less productive salmon-bearing rivers and streams further inland. Collector settlements can also be expected to incorporate lower return bulk commodities such as camas, wapato and biscuit root in moderately productive habitats, particularly where they occur near salmon streams. Huckleberries may also be incorporated as a stored resource if procurement and processing costs are minimized by proximity to other less labor intensive resources. In fact, I suggest that use of huckleberries as a storable resource increased in importance during the Intensive Collecting period after 2500 ¹⁴C yr BP, particularly where productive berry grounds were situated in close proximity to winter village locations. Because of high labor and transportation costs relative to return, use is expected to be restricted by the limits of pedestrian transport so long as alternative food options remained viable.

Use of montane uplands on Mount Rainier itself is not expected to change perceptibly from Semisedentary Collecting to Intensive Collecting periods. It is plausible that competitive pressures for extending territorial boundaries to protect critical upland habitats became more acute. If so, human use of subalpine and alpine zones should have involved increasingly regular dispatch of limited-task groups to protect summer ungulate herds, probably returning with high value alternative resources as described earlier. In any case, the period ended abruptly with precipitous population losses and social dislocation associated with introduced Old World diseases 400 years ago or less.

Intensive Collecting: Archaeological Record

Most dated prehistoric remains on Mount Rainier date to the latter part of the Semisedentary Collecting period or to the Intensive Collecting period as structured here. Because of the predominance of 2300 ¹⁴C yr BP MR-C surface tephra on the eastern and northeastern slopes of the mountain, and 3500 ¹⁴C yr BP MSH-Yn on the northwestern side, most of the currently documented surface sites and isolates date to after 3500 ¹⁴C yr BP. Only two firmly dated subsurface components have yet been documented from this period: Berkeley Rockshelter (45PI303) and Fryingpan Rockshelter (45PI043) as described above.

Mixed Strategy Hunting and Gathering: Environment

Mixed Strategy Hunting and Gathering extends from about 400 ¹⁴C yr BP to near present. All but about 150 years of this period falls within the "Little Ice Age" that lowered temperatures world-wide from between approximately 1350 to 1850 C.E. (Fagan 2000). Circumstances initiating the period and its dramatic land-use changes, however, had less to do with climatic events than with the impact of diseases, and interaction with expanding Russian, British and American economies. Basic changes expected for Mount Rainier and the southern Washington Cascades are outlined below.

Mixed Strategy Hunting and Gathering: Land Use

The time since America's discovery and colonization by European states has been marked by devastating change to Indian populations. While sources of change have been many, among the most dramatic are abrupt population losses and social dislocation

due to introduction of old-world epidemic diseases, substantially expanded transportation and mobility made possible by introduction of the horse, and ultimately land-use and social changes resulting from overwhelming competition with the expanding American agricultural-industrial system.

The Pacific Northwest was not free of these processes. Epidemic losses, particularly among larger aggregated village populations, were dramatic (see Boyd 1985, 1990). Lewis and Clark, for example, visited the nearly deserted remnants of *Nechacole*—the location of a 226 ft long multi-compartment plank house and ruins of associated buildings on the south shore of the Columbia River east of Portland—in April of 1806 (Coues 1893:926-927). Remaining inhabitants attributed the village demise to a smallpox epidemic circa 30 years earlier. It is plausible that population-reducing epidemics swept through the region earlier still. The period's 400 year initiation date was set to anticipate that epidemic losses could date to as early as 1520 to 1600 C.E., related to overland transmission of diseases from central Mexico. Boyd (1992) believes that disease introduction post-dates direct Euroamerican contact in 1774—a time that correlates closely with Clark's observation at *Nechacole*. The precise date of the actual onset is less important than the extent of the impact on indigenous people, social organization and land-use practices.

Effects of rapid population loss on Northwest settlement and subsistence practices were almost certainly catastrophic. A conservative estimate of 60% decline (Boyd [1992:135] believes that 80% losses are likely) would have altered the population-resource equation and brought on sudden and severe stress to the structure of social and land-use systems. My earlier Cascades land-use model developed for Mt. Hood National Forest, anticipates the

general character of these events (Burtchard 1990:24):

Rapid population decline, while superficially appearing to ease resource stress, would result in the inability to provide organizational or labor support needed to maintain systems as previously structured. Massive short-term stress should have occurred as a function of inadequate labor to continue previous intensive food acquisition practices, and short-term lag in the regeneration of alternative hunted game to support the remnant population. People could not simply return to a broad-spectrum foraging pattern because game abundance would have been suppressed by previously heavy exploitation. We should expect, rather that surviving populations would again aggregate into composite groups attempting to maintain the *status quo ante*. Initially, at least, we should continue to see semisedentary settlements and seasonal upland foraging sites, though in substantially reduced number. Surviving settlement locations should tend to be those situated at optimal access points for camas, wapato, salmon and/or big game. In relatively short order, mesofaunal game densities should have begun to recover due to reduced human predation pressure. As herds increased, we may expect to see defections from the cold season village centers, as sub-groups split off to reform more mobile foraging adaptations.

It is possible, perhaps probable, that the expected re-emergence of foraging land-use practices may have been cut short by extension of the fur trade into the Pacific

Northwest, accelerating immigration, and repeated epidemic outbreaks. This is particularly likely if Boyd (1992) is correct about the relatively late date for regional introduction of epidemic diseases. At least since the mid-1800s, it is more likely that Indian populations maintained themselves at the margins of Euroamerican society, responding in various ways—including montane foraging and collecting—in an attempt to maintain viable existence in the face of severely disruptive pressures on their indigenous lifestyle.

While hardly as debilitating as diseases, introduction of horses at about the same time had a locally significant impact on indigenous land-use practices. Development of the plains equestrian “bison cultures” are among the most dramatic and best known examples. In the Northwest, impact of the horse was mixed. Clearly, horses altered transportation options and became an important part of some Northwest land-use systems—particularly in basin and range environments east of the Cascades. Other groups appear to have been affected very little. Schalk and Atwell (1994:[5]23) suggest that for groups situated between major resource foci, equestrian transportation may have been adopted in support of a role as middlemen in long distance trade (e.g., The Dalles fisheries-trade center on the Columbia and bison hunting grounds further inland). In the mountains, the horse’s value is not as clear. So long as ungulates remained important to upland use, and long distance transport was not critical to maintaining newly formed composite collector or split off forager systems, the horse may have represented an undesirable competitor for available forage. Availability of canoes in the west side and Columbia River lowlands further reduced the transportation value of the horse in these areas (Burtchard 1990:24).

Horses, however, may have played a more important role in late prehistoric and early historical use of the Cascades and Mount Rainier for huckleberry mass harvest and transport. Indeed such use may have been particularly intense on eastern and southeastern slopes, where villages linked to equestrian based economies—like the Yakama—were relatively close to historically productive berry fields. Availability of equestrian transportation may have been an important element underlying the apparently intensive use of huckleberries reported in the ethnographic record (see Smith 2006:106-122)—both for packing storage containers and ancillary equipment in and dried huckleberries out. Allan Smith’s (2006:107) allusion to huckleberries as “the primary attraction of the [Mount Rainier] mountain slope,” while probably true, was a relatively young phenomenon resulting from the acquisition of the horse, in marked contrast to earlier land-use patterns dominating early to mid-Holocene times.

Ultimately, indigenous land-use systems were effectively overwhelmed by expansion of the American agricultural-industrial system into the Pacific Northwest. Indeed, the Lewis and Clark expedition was the first overland extension of this system. President Jefferson funded the expedition, in part, to find the “most direct and practical water communication across the continent, for the purpose of commerce” (Parsons and Shiach 1902:8). The inland water route was not found, of course, but commerce did indeed follow. By the mid to late 1800s, the region was filling with settlers, miners, entrepreneurs and others with little concern for the welfare of indigenous populations—people already suffering the consequences of epidemics, and severe social and economic dislocation. Elsewhere (Burtchard 1990:24-25), I have summarized the general impact as follows:

Reforming indigenous economic systems could not long compete with the intrusion of a complex state with very different, and generally conflicting land-use requirements. The Euroamerican industrial system relies on the extension and maintenance of very long distance supply lines for critical resources. Even in the mid 1800s, fossil fuel subsidized industry and transportation made possible the exploitation of regions that had heretofore been too remote for effective integration into the larger system. Settlers established farms, logging, fishing and industrial operations in areas that previously supported the indigenous economy. Eventually, surviving Indian populations were congregated [in most cases] into confederated reservations at places that represented minimal intrusion on the new land-use system. To partially ameliorate the effects of social disruption and relegation to marginal habitats, the new sub-systems were, and continue to be, subsidized by the new industrial state. The continuing development of water, rail, highway and air transport has tied the regional economy into the larger national and international system. Presently, the economy of the Northwest is critically tied to events emanating far beyond the spatial limits operative in the past.

On *Takhoma*, human use shifted from the berrying and limited hunting activities that lingered on through the 1800s, to primary use as the recreation and wilderness preserve known now as Mount Rainier National Park.

Mixed Strategy Hunting and Gathering: Archaeological Record

Presently, there are no sites definitively dated to the terminal precontact period documented in Mount Rainier National Park. Combined effects of population loss and reorientation around the newly emerging agricultural-industrial land-use systems can be expected to have reduced and redirected use of upper elevation landscapes. Clearly, however, use of montane landscapes did not stop altogether. Indian familiarity with various parts of Mount Rainier and the Cascades is indicated in accounts by early explorers and adventurers in the region. Early historic period use of Mount Rainier is discussed in passing by Schmoer (see 1925 and 1967), in detail by Allan Smith (2006), and implied by Marian Smith (1940) in her Puyallup-Nisqually ethnography. These accounts indicate a continuing interest in hunting and particularly huckleberry gathering directed to subalpine and alpine habitats on all sides of the mountain. Allan Smith (2006:120-122) also describes characteristic fired berry drying features. For both theoretical and ethnographic reasons, then, we should expect to see at least a limited number of residential base camp and task specific locations on Mount Rainier dating to very late prehistoric and early historic times. The latest of these locations should contain some European trade goods and utensils.

In addition to residential base camp and hunting location remains, we should be sensitive to characteristic signatures of huckleberry processing features –which may or may not be directly associated with base camps. Allan Smith's informants allude to two general procedures for drying berries: 1) on mats stretched between poles and suspended several feet above small fires; and 2) on a low linear mound opposite a burning log. A number of these latter type features have been found in the Gifford Pinchot

Table 1. Mount Rainier Environment, Land-Use and Archaeological Record Summary

Land-Use Period	Environment	Land-Use Expectations	Archaeological Expectations	Rainier & WA Cascades Data
Post-Pleistocene Foraging (ca. 11,000-8000 ¹⁴ C yr BP)	Mount Rainier glaciated early retreating rapidly near period end; modern habitats est-ablished near period end. Megafauna present in Puget Trough during Everson Interglacial; extinct by period end.	Very low population density; foragers east of Cascades focus on megafauna habitats. Limited use of Puget Trough and Cascade foothills. Increased use of Cascade foothills with megafauna extinctions at period end. Earliest plausible use of Mount Rainier (not expected).	No archaeological remains expected for Rainier during the period, except at the close ca 8000 years ¹⁴ C yr BP.. Earliest use of Washington Cascade foothills and lowlands during the period.	Extant: No remains dating to earliest Holocene. 45PI438 dates to ca. 7300 14C yr BP. Clovis point near Cle Elum may indicate use of foothills or low elevation passes earlier. Recommend: Additional samples from deeply stratified cultural deposits. Mazama tephra provides good 6800 ¹⁴ C yr BP temporal marker.
Rest-Rotation Foraging (ca. 9000-6000 ¹⁴ C yr BP)	Full onset of Hypsithermal. Lowland forest density decreases –ungulate habitat improves; upland forest density increases –ungulate habitat restricted.	Low population density; mobile foraging strategies emphasizing ungulate habitat in lowlands and Cascade foothills. Limited use of Mount Rainier uplands begins	Small residential and hunting camp sites in lowland and foothill settings. Low site density on Mount Rainier.	Extant: Modest number of dated sites in foothill to moderate elevation settings. 45PI438 documents earliest known use of Mount Rainier. Recommend: As above, concerted effort to locate and sample deeply stratified cultural deposits.
Semisedentary Rest-Rotation Foraging (ca. 7000-4000 ¹⁴ C yr BP)	Hypsithermal climate cools near period end. Ungulate habitat degrades in lowlands, improves in uplands. Volcanic collapse of Mount Rainier summit; Paradise-Greenwater-Osceola lahars.	Slightly elevated population density. Short-term winter sedentism and storage. Other aspects of mobile foraging strategies continue. Punctuated increase in use of upland early seral-stage habitats.	Site density in lowlands increases with similar site types. Limited evidence of storage features. Site density on Mount Rainier rises sharply. Patterned distribution of base camps at upper forest ecotone, hunting locations in sub-alpine to alpine settings.	Extant: Modest number of dated sites in the Cascades. Distinct 45PI438 component establishes presence on Mount Rainier, stratigraphy at 45PI408 suggests use 4500-2300 ¹⁴ C yr BP. Recommend: Near term data recovery at 45PI408. Survey and test rock-shelter locations to gain assemblage, resource and temporal data. Survey and test subset of base camp and limited-task locations.
Semisedentary Collecting (ca. 5000-1500 ¹⁴ C yr BP)	Climate cools to near modern conditions. Limited glacial advance ca. 2400 ¹⁴ C yr BP. Closed lowland forests, open uplands. Mount Rainier C eruptions rebuild summit to present height.	Elevated population, degrading ungulate habitat; unstable resource balance with forager system. Shift to river oriented logistic strategies. Use of fire to improve ungulate habitat. Extension of territorial claims to uplands; montane use continues with focus on habitat protection and use of alternative resources.	Increased site density in lowlands with sharp increase in aggregated settlement on salmon streams. Site density increases on Mount Rainier reflecting elevated regional population density. Base camps at upper forest ecotone; increased site variety. Increased use of small game and alternative durable, easily transportable resources.	Extant: Village complexes in lowlands. Stratigraphic, artifact and ¹⁴ C evidence for use of Mount Rainier upper forest to alpine habitats. Recommend: Site survey with subsurface tests to expand database and improve temporal representation. Test-data recovery at subset of sites stratified by type to improve view of temporal and site distribution issues.

Land-Use Period	Environment	Land-Use Expectations	Archaeological Expectations	Rainier & WA Cascades Data
Intensive Collecting (ca. 2500-400 ¹⁴ C yr BP)	Early mountain rebuilding vulcanism. Variable climate. "Little Climatic Optimum" followed by "Little Ice Age" glacial advance near the end of the period. Dense maritime forests in lowlands, open subalpine associations in uplands.	Peak prehistoric regional population density. Collector systems fully established. Increasing use of fire. Territorial claims vigorously enforced. Extension of trade and other inter-group ties. Increased social complexity. Elevated inter-group conflict. Exploitation of lower return storable resources, increasing use of inland valleys and foothills; high elevation use continues, focusing on habitat protection and use of alternative durable, easily transportable resources.	Maximum lowland site density and dispersal into varied habitats. Largest aggregated settlements in marine and riverine context. Storage features and elevated artifact complexity. Higher fraction of ritual and status goods. Higher fraction of tools for capture of smaller bodied animals. Montane site density and type remains largely constant. Due to logistic difficulty, mass huckleberry harvest for lowland storage not expected prior to introduction of the horse.	Extant: Highest regional site density with largest aggregated villages in lowland settings. General Cascade site density increases sharply. Upland Mount Rainier use evident by ¹⁴ C, stratigraphic, and artifact remains. Recommend: Survey and test procedures as above. Efforts to identify and date huckleberry processing features. Obtain pollen profiles for paleoenvironmental reconstruction and examination of carbon frequency-fire data.
Mixed Strategy Hunting & Gathering (ca. 400 ¹⁴ C yr BP.- Present)	Essentially modern climatic conditions except as modified by Little Ice Age global cooling circa 1350-1850 C.E. (Garda Stade on Mount Rainier). Lowland and upland forest patterns near modern levels.	Rapid population loss to epidemic diseases. Abandonment of villages in marginal habitats with re-aggregation as composite groups in optimal habitats. Increased inter-group variability in land-use systems. Equestrian transport and emergence of long distance overland collecting and trade, particularly on east slope. Increased mass huckleberry harvest. Partial integration into Euroamerican economy ultimately breaks predominance of forager-collector land-use strategies.	Punctuated drop in site density overall. Continuing but decreasing number of large lowland villages. Possible short-term reemergence of small forager residential camps. Increased fraction of European trade goods and utensils. Use declines then increases with primary focus on mass huckleberry harvest and supplemental hunting. Indigenous use for economic purposes declines in late 1800s- early 1900s.	Extant: Decreased lowland site total. Some large maritime and riverine villages continue. The Dalles trade fairs. Mount Rainier huckleberry-hunting use ethnographically documented. Early historical use suggested at several sites, but data ambiguous. No huckleberry processing features currently documented. Recommend: Survey efforts geared to expand and categorize sample of early historical remains. Survey test procedures to document huckleberry processing features. Test procedures at most probable traditional prehistoric-historic sites

National Forest and a few have been excavated (Mack and McClure 1996; 2002). On the modern surface, features tend to appear as low linear mounds. Excavation reveals elongated charcoal deposits opposite a sloping mound, often in association with fire cracked and unbroken rock (Mack and McClure 2002:50-51). Deposits also should produce *Vaccinium* remains in macro-botanical samples. Efforts to identify and document such remains should be included as part of the larger continuing effort to develop a clearer understanding of the mountain's broader cultural resource base and Mount Rainier's place in long-term processes of human use of montane environments in the Pacific Northwest.

SUMMARY

We now know that Mount Rainier, and other Pacific Northwest mountains, have attracted humans to their high elevation landscapes for thousands of years. Current data suggest that use began over 8,500 y¹⁴C yr BP, increased in intensity about 3,500 ¹⁴C yr BP, and continued until effectively terminated by extensive population loss and social dislocation about 200 years ago. On Mount Rainier, I have argued that differential resource productivity of low seral-stage subalpine and alpine habitats provides economic benefits sufficient to attract hunters and gatherers throughout most of the Holocene epoch that the mountain has been largely free of glacial ice. I believe that Mount Rainier has been particularly important as a resource destination in this regard because of the large expanse and linked character of these upper elevation communities. Similar considerations apply to the moist Cascade and Olympic Mountains generally, but with patterns fit to the unique configuration of comparable low-seral stage habitats in these Pacific Northwest massifs.

In this paper, I have given considerable attention to origins and uses of the forager to collector continuum first proposed by Binford (1980), and subsequently applied to temporal changes in subsistence and settlement patterns in the Pacific Northwest (e.g., Schalk and Cleveland 1983). Despite its tendency to focus our attention on polar extremes, I believe that the forager-collector model provides an effective means to contrast the economies of early Holocene colonizing populations with later Holocene populations forced to fit elevated population density into a context of heightened competition for finite resources.

The paper also offers a six-part intensification model based on forager to collector principles (see Table 1). The model simplifies and draws attention to basic Holocene subsistence and settlement processes as they apply to Mount Rainier with implications for the Pacific Northwest generally. Consistent with forager-collector expectations, I (and many others cited here) suggest that, in general, land-use practices across the Pacific Northwest have shifted from mobile foraging economies with minimal reliance on mass harvest and over winter storage, to more logistically oriented acquisition of food resources by limited task groups tethered to village centers. Because these processes are played out by real people adjusting as best they can to real-world circumstances, I have given substantial attention to outlining ecological processes that I believe play critical roles in determining the manner subsistence and settlement systems develop and change over time.

The full paper, of course, discusses environmental and land-use expectations at substantially greater length than possible in Table 1. I encourage readers to consider the concepts and arguments presented. Most importantly, I hope that the effort stimulates

interest in, and debate regarding, long-term subsistence and settlement processes; and helps to contribute to the development of more sophisticated concepts than those offered here.

NOTES

¹ *Takhoma* is employed here as a proxy for a wide variety of similar names pronounced somewhat differently by the region's Sahaptin and Salishan speaking Indian groups (see Smith 2006:24).

² This is not meant to imply that *all* precontact use of Mount Rainier was economically driven; but rather, that *most* prehistoric use, *most* of the time was geared toward extraction of subsistence and maintenance resources available in sufficient abundance to attract interest.

³ The closest ethnographically reported villages to Mount Rainier were located in the Nisqually and Puyallup-Carbon River drainages about 17 to 25 miles from present park boundaries (see Smith 1940:8; Smith 2006:80-81)

⁴ Ongoing palynological and archaeological research at Buck Lake (45PI438) on Mount Rainier are intended to address these questions.

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