The Paleoindian to Archaic Transition in the Pacific Northwest

*In Situ Development or Ethnic Replacement?*

James C. Chatters, Steven Hackenberger, Anna M. Prentiss, and Jayne-Leigh Thomas

**Introduction**

In many parts of North America, as other chapters in this volume demonstrate, the change from Paleoindian to Archaic lifeways is demonstrably a transformation taking place within a single cultural tradition. In the southern interior of the Pacific Northwest, however, this event is marked by two traditions occurring in sequence. The Western Stemmed Tradition, which is the regional manifestation of Paleoindian, is followed by the Old Cordilleran Tradition, which marks the beginning of the Archaic. The two differ markedly in stone, bone and processing technologies, subsistence, tool and clothing styles, land use, settlement, and even the morphology of the participants themselves. In this paper we present the characteristics of the two traditions, explore their chronological distributions, and offer new information from Beech Creek, a site containing both traditions in an apparently continuous chronological sequence. We then consider possible explanations for this behavioral and morphological disjunction, finding ethnic replacement to be a better explanation than in situ evolution for the entire suite of changes. Both alternatives, to some extent, look to Early Holocene climatic change as a primary driver.

**The Region and Its Changing Environment**

The area addressed in this paper extends along the Northwest Coast of North America from Glacier Bay in Alaska to the Oregon–California border, and includes the interior basins of the Columbia and Fraser Rivers (fig. 3.1). Our discussion also reaches into southeastern Oregon, an area usually considered part of the Great Basin. Topographically, the region is dominated by the north–south trending Coast, Cascade, and Rocky Mountain Ranges, and their intervening valleys. Between the Coast and Cascade Ranges in Washington and Oregon lie the Puget Lowland and Willamette Valley. The Columbia and Fraser Plateaus fill the broad expanse between the Cascades and Rockies.

Unlike most of the regions discussed in this volume, the Northwest is a land of marked topographic, climatic, and ecological variability. Climate is maritime; warm dry summers contrast with cool, wet winters, when moisture-laden clouds flow eastward off the Pacific Ocean and back up against the mountain ranges. The land west of the Cascade and Canadian Coast ranges, therefore, receives most of the precipitation, which supports dense, mixed-conifer forests. This closed canopy restricts terrestrial food resources to shorelines, recovering burns, subalpine and alpine environments, and a few prairies; most of the resources this region had to offer foraging peoples were marine, including hyperabundant, anadromous salmonids. The rain shadow from the western mountains prevents much of the moisture from reaching the interior plateaus, which range from arid in south-central Oregon to subhumid in the northern Fraser Plateau. Conifer forests occupy the uplands, shrub steppe the lowlands. With their more open plant communities, the intermountain plateaus offer better access to terrestrial game, but salmon constituted much of the animal biomass of these drier lands.

During the terminal Pleistocene, Cordilleran and montane glaciers covered all but the southern lowlands of Oregon, Washington, and Idaho. Deglaciation had begun by ca 17,000 cal B.P. (Waitt and Thorsen 1983) and had receded north of the Canadian border by 15,000 cal B.P. By 12,000 cal B.P., all but the highest mountains of Alberta and British Columbia were fully deglaciated.
Chatters, Hackenberger, Prentiss, and Thomas (Clague 1981). Sea levels rose rapidly between 17,000 and 9000 cal B.P. due to a combination of isostatic depression and increased ocean volume (Mann and Hamilton 1995; Fedje et al. 1996). Along the north coast, this led to transgression above modern sea levels, increasing the convolution of the coast, and potentially meaning greater littoral productivity (Moss and Erlandson 1996). Westerly air flow from wasting Laurentide ice, however, reduced upwelling along the southern coast until after ca 9000 cal B.P. (Sancetta et al. 1992). This, along with constantly changing shorelines, meant lower nearshore marine productivity. Although salmon were well established in some parts of the Fraser and Columbia systems by 9000 cal B.P. (Butler and Connor 2004; Matson 1996), they would not be abundant in inland rivers until thousands of years later (Chatters et al. 1995, Butler and Chatters 2003).

In the late Pleistocene and for the first three millennia of deglaciation, a steppe-tundra similar to the Beringian mammoth steppe (Guthrie 1982) occupied exposed land below the ice margins, except in southern Oregon, where conifer woodland and grasslands existed around pluvial lakes. As tempera-
tures increased, a lodgepole pine, spruce, and mountain hemlock woodland akin to Canadian taiga developed in the Puget and Willamette lowlands, to be replaced by open oak and Douglas fir parklands after 10,000 cal B.P. (Barnosky et al. 1987). Denser conifer woodlands and forests could not be found in the southern Cascades below 1000 meters on the west flank and 1500 meters on the east (Chatters 1998a). Dry spruce and pine parklands then occupied the northern Cascades (Heinrichs et al. 2002; Pellatt et al. 1998). Upper timber lines throughout the region stood as much as 300 meters above modern levels (Clague and Mathewes 1989). After 9500 cal B.P., montane forests became more mesic and moved downslope (Barnosky et al. 1987; Hebda 1995), but the Puget Lowland and Willamette Valley remained open or sparsely forested until after 7000 cal B.P. In the intermountain plateaus, conditions became increasingly arid as the Early Holocene progressed (Chatters 1998b). The areas now occupied by shrub steppe supported grassland from 12,000 cal B.P. until between 9500 and 9000 cal B.P., when an arid sagebrush and chenopod steppe became widespread. In the Rockies, true forests were rare throughout the Early Holocene, except in the higher Canadian portions of the range. Much of what is today pine, fir, or cedar–hemlock forest was either unfor-ested or covered in steppe–forest mosaic (Chatters 1996). Animals that inhabited these plant communities included now-extinct megafauna until between 14,000 and 13,000 cal B.P. (Lyman and Livingston 1983), but, except for *Bison antiquus* (Irwin and Moody 1978), only modern fauna survived thereafter (Chatters 1998b). The largest modern herbivores—elk and bison—were common in the Columbia River Basin before 9000 cal B.P., but declined sharply thereafter (Gustafson 1972).

Patterns of vegetation change and weakened nearshore marine upwelling indicate that the climate before 9000 cal B.P. was more continental, with marked seasonality and a more easterly air flow. Higher timber lines are evidence of hotter summers; high frequencies of rockfall in caves and rockshelters on the Columbia Plateau result from colder winters. Patterns of vegetation distribution—the change from xeric to mesic parklands west of the Coast and Cascade ranges, downslope movement of forests in the mountains themselves, a change from grasslands to shrub steppe on the plateaus, and continued high tree lines—show continued warmth but a shift to a more maritime climatic pattern after 9000 cal B.P. (Chatters 1998b).

The change from continental to maritime climate altered the resource potentials on either side of the coastal mountain ranges. Parklands west of the mountains meant higher game and food plant productivity before 9000 cal B.P., at a time marine productivity was reduced along the southern coast. After that time, terrestrial productivity remained high while marine productivity was on the increase. East of the mountains, expanding forests and the loss of grasslands meant a decline in terrestrial productivity, making riverine resources proportionately more important. Change to maritime climate meant promotion of some food species, particularly geophytes, which thrive on winter moisture. These changes had important implications for early hunter-gatherers.

**Paleoindian and Archaic Lifeways**

The archaeological record of the Northwest begins as early as 14,000 cal B.P., if the speared mastodon found at Manis in northwest Washington (Gustafson et al. 1979) and human coprolites from Paisley Caves in south-central Oregon (Gilbert et al. 2008) are taken at face value. A light scattering of isolated Clovis and other fluted projectile points has been reported south of the Canadian border (Carlson 1996a; Moss and Erlandson 1996), but the Richie-Roberts Cache in central Washington (Mehringer 1988) and the Dietz Site in Oregon (Fagan 1988) are the only discrete assemblages of this early material. The earliest well-represented cultural traditions in the Northwest are the Western Stemmed and Old Cordilleran traditions, which were both well established by 12,000 cal B.P. What we know in detail about the behavior of people who left behind the artifacts of these traditions comes primarily from the southern interior of our region, where site records have not been diminished by the
acid soils and extensive bioturbation of conifer forests. In that subregion, the
two traditions occur in sequence: Western Stemmed Tradition (WST) is our
Paleoindian; the Old Cordilleran Tradition (OCT) ushers in the Archaic. They
differ in their tool, food processing, and clothing technologies, land use and
settlement strategies, and subsistence emphases.

Western Stemmed Tradition
Manifestations of the WST are found from Banff in the Northern Rockies to
the northwestern coast of Oregon and extend southward into the Great Basin,
where they have become known as the Paleoarchaic (See Jones and Beck, this
volume). They are known by such chronological labels as the Youngs River
Complex on the Lower Columbia River (Minor 1984), Philipi Phase on the
middle Columbia River (Dumond and Minor 1983), Windust Phase on the
Columbia Plateau (Leonhardy and Rice 1970), the Goatfels Complex on the
upper Kootenai (Choquette 1996), Banff II in southwestern Alberta (Fedje
1996), and Haskett in southern Idaho (Butler 1965). Components attribut-
able to this tradition range from 13,550 cal B.P. at the Cooper’s Ferry Site
in northern Idaho to as late as 9000 cal B.P. (table 3.1). Most date between
13,000 and 9500 cal B.P.

Technologies
Lithic and bone technologies characteristic of the WST are complex. Stone
implements include large, thin, broad-bladed stemmed and lanceolate pro-
jectile points, biface cores that also become projectile or knife forms, large
end and side scrapers produced on large flakes with little edge modification,

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<th>Reference</th>
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<td>Cooper’s Ferry</td>
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<td>Dirty Shame Rockshelter</td>
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<td>Hetrick</td>
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<td>Shoup Rockshelter</td>
<td>8125 ± 230</td>
<td>9398–8727</td>
<td>Swanson and Snead 1966</td>
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<td>Redfish Overhang</td>
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</table>

Table 3.1. Western Stemmed Tradition (Paleoindian) site chronology in the Northwest.

a. One-sigma range, determined using Calib5.
b. Pre-Mazama sediments were arbitrarily divided into components, so separation between Western Stemmed and Old Cordilleran components cannot be made. No upper age limit can be given.
keeled scrapers or scraper-planes, denticulate scrapers, burins, gravers, drills, and a wide array of retouched and utilized flakes (fig. 3.2). Cobble implements, milling stones and manos occur, but infrequently. Two tools that are unique to the WST are chipped stone crescents and finely crafted, egg-sized, plumb bob-shaped stones with longitudinal grooves, known as bola stones. Projectile points, which were produced through bifacial percussion reduction and finished with broad, collateral flakes, appear to have been made long and broad (e.g., Butler 1965; Rice 1972), but were typically resharpened to stemmed stubs while still in the haft. This intensity of reworking and a tendency to exhibit bending fractures at the stem-blade contact are thought to indicate use as knives (Galm and Gough 2008), a common characteristic of Paleoindian technology (e.g., Ahler 1971).

A complex bone technology is also found when conditions allow good preservation. Single-piece and composite bone shafts, unilaterally barbed harpoon points, atlatl spurs, wedges, and other implements have been found at multiple sites (Galm and Gough 2008; Irwin and Moody 1978; Leonhardy 1970; Rice 1972). Bone needles, little larger than modern sewing needles, occur in most early components of this tradition, another link to Paleoindian toolkits continent-wide. Harpoon points, crescents, bolas, atlatl spurs, and multi-piece bone shafts all represent compound tools, indicating a complex technology with a high degree of planning depth (Torrence 1983).

In contrast to the complex toolkit, food processing technology appears to have been quite limited. The presence of a small number of lightly utilized milling stones at such sites as Marmes Rockshelter (Rice 1969; Hicks 2004) and the Vine Site (Lewarch and Benson 1989), and a high frequency of such tools at the Goldendale Site (Warren et al. 1963) provide evidence of what is thought to have been seed processing, although no direct evidence of plant use has yet been obtained. Conspicuous in their absence or rarity are earth ovens and boiling stones. No oven feature has yet been found in association with, or contemporaneous with WST components. Thermally altered rock is rare and, when present, consists of large fragments consistent with cooking by roasting rather than boiling (e.g., Sappington and Schuknecht-McDaniel 2001).

One final aspect of technology is the use of the body as a tool. Only two complete skulls are known from this tradition in the southern interior: Kennewick Man, from eastern Washington (Chatters 2000), and the Buhl woman from southern Idaho (Green et al. 1998). In Kennewick Man, wear on the
lingual surfaces of his lower incisors indicates the front teeth had a paramasticatory grasping function. Buhl, who died as a young woman, also had heavily worn anterior teeth (Green et al. 1998). High anterior dental wear is also found in other Paleoamerican individuals in the western United States (Chatters 2008). This use of the mouth may relate to the lack of food processing technology, a diet of at least partially dried or tough, partially cooked meat, and the evidence that projectiles doubled as knives. It is entirely possible that WST people held tough meat in their teeth to cut it, much as Eskimo peoples are known to have done.

Settlement Strategy

Although it was long believed that WST peoples concentrated their settlements along river corridors (Ames 1988, Ames et al. 1998), it has recently become clear that they made much more extensive use of the entire landscape. Sites like Rock Island Overlook (Valley 1975), Marmes Rockshelter (Rice 1969) and Five-Mile Rapids (Cressman et al. 1960) have indeed been found on the region’s trunk streams, but sites also occur in upland areas adjacent to rivers, as at Sentinel Gap (Galm and Gough 2008) and the Portland (Oregon) Basin; at wetlands in the intermountain plateaus in such sites as Lind Coulee (Daugherty 1956), Willow Lakes, and Bishop Springs (Huckleberry et al. 2003); and well into the Cascade and Rocky Mountains at sites like Judd Peak Rockshelter (Daugherty et al. 1987a), Vine (Lewarch and Benson 1989), and Pilcher Creek (Brauner 1985). Inland wetlands and lakes seem to have been particularly favored. WST isolates and sites have been found at Pend Oreille (Miss and Huson 1987), Palmer (Salo 1987), and Goose lakes. In southeastern Oregon, settlements near Early Holocene lakes are the rule (e.g., Pinson 2004; Connolly and Jenkins 1999a, 199b), which led to their inclusion in Bedwell’s (1973) Western Pluvial Lakes Tradition.

WST sites show a tendency for frequent reuse, as if they were nodes in an annual subsistence round. Lind Coulee was repeatedly used as a hunting camp, from which people focused on bison and elk (Irwin and Moody 1978). The Goldendale Site was a seed gathering camp (Warren et al. 1963), probably used in fall; Five-Mile Rapids and Rock Island Overlook are located at prime locations for harvesting either fish or the birds that fed on their carcasses. Marmes Rockshelter was probably a winter encampment. These sites appear to have been base camps from which foraging forays were made in a logistical-like pattern. In his analysis of early Columbia Plateau assemblages, Ames (1988) found that WST sites could be grouped into those with many tool types and those with few, supporting the notion that both base camps and field camps were utilized. One of the best examples of a field camp is Wewukiyepuh, in northern Idaho (Sappington and Schuknecht-McDaniel 2001), which included remains of a single elk, a hearth, nine tools including two broken projectile points, and a scatter of debitage from producing replacement points out of imported bifaces.

On a regional scale, individual artifact types also show a high degree of patterning, indicative of systematic use of habitats. Crescents, for example, have only been found in upland settings, near wetlands. Although the only reported specimens come from Lind Coulee (Daugherty 1956), collectors have also found them at Willow Lakes and at upland spring sites (Lenz in press). Bolas, conversely, have been found almost exclusively in lowland settings—along rivers and their nearby terraces. Numerous examples have been found at the mouth of Pend Oreille Lake (Weisz 2006), Rock Island Rapids (Valley 1975), Five-Mile Rapids (Cressman et al. 1960), and as isolates on the terraces of the Portland Basin (Petitgrew 1981). The only exception is the Pilcher Creek Site, high in the Blue Mountains of northeast Oregon, where the bola stones appear to have been manufactured (Brauner 1985).

Social groups were small and mobile. On the few occasions where single event camps are found—or can be discerned—as at Lind Coulee (Irwin and Moody 1978) and Sentinel Gap (Galm and Gough 2008), they cover at most a few hundred square meters. Feature and artifact patterning is discrete—evidence of short-term occupancy and, therefore, high residential mobility.
In keeping with high mobility, WST people left few traces of dwellings (but see Connolly 1999a, 1999b). A comparison of the frequencies of expedient stone tools (e.g., utilized and retouched flakes, hammerstones, cobble tools) to curated tools (e.g., projectile points, bifaces, scrapers, gravers, drills), however, indicates that WST social groups in the interior northwest were less mobile than their OCT successors. We compared WST and OCT assemblages from Granite Point and Beech Creek, the two sites that allow clear separation of assemblages from the two traditions. In both cases, the WST assemblages were much more expedient, indicating a lower level of mobility (Hayden et al. 1996).

Subsistence
Although seed use is inferred from the presence of milling stones, only the animal part of the WST diet is known. WST faunal assemblages are highly variable; those in south-central Oregon tend to emphasize rabbits and birds (e.g., Oetting 1994; Pinson 2004), whereas those from more northern contexts tend to be dominated by larger game, while including a range of smaller prey. Deer, elk, and bison rank first or second in NISP in nearly all northern sites with reported faunal assemblages, including Hetrick (Rudolph 1995), Hatwai (Atwell 1989), Wewukiyepuh (Sappington and Schuknecht-McDaniel 2001), Lind Coulee (Irwin and Moody 1978), Sentinel Gap (Gough pers. comm.), Granite Point, Marmes Rockshelter (Gustafson 1972), Windust Caves (Rice 1965), and Wildcat Canyon (Dumond and Minor 1983). Birds and rabbits or marmots often rank in the top four. Fish are not a significant part of any WST assemblage on the Columbia Plateau. There is no sign of food storage, although it is likely that meat was at least partially dried to extend its use life.

Mortuary Practices
Few sets of human remains have been found in association with WST assemblages in the northwest or elsewhere. Only four are known—from Marmes Rockshelter (Krantz 1979), Buhl (Green et al. 1998), and Kennewick (Chatters 2000), and the imprecisely provenienced Stick Man (Chatters et al. 2000). Little patterning is discernible from this group. The Marmes remains, from undoubted WST contexts, appear to have been secondary cremations (Chatters 2010a), deposited repeatedly in the same corner of the rockshelter over a long period of time. As such, they are yet another indicator of WST's patterned use of the landscape beginning as early as 12,000 cal B.P. Buhl, also from before 12,000 cal B.P., was alone and appears to have been abandoned or secondarily deposited. Kennewick Man, whether interred (Huckleberry and Stein 1999) or abandoned (Chatters 2000), was apparently alone. Stick Man was an interment, but it is not possible to know if he was interred with a group. Mortuary practices—secondary interment and usual lack of deposition in a cemetery group—are consistent with high mobility over large geographic ranges (Wallthal 1999).

Characterization
In summary, WST people were mobile foragers who created a diverse array of composite implements to use during a highly patterned but widely ranging subsistence round that emphasized big game. This patterned behavior, their longer residence time in base camps, and use of both residence camps and field camps have earned them the label “collector-like foragers” (Ames 1988; Chatters 1985).

Old Cordilleran Tradition
In this discussion, we treat Carlson’s (1996a, 1998) Pebble Tool and Microblade traditions as manifestations of the same or closely related technologies within Butler’s (1961) “Old Cordilleran” Tradition. Both include foliate bifaces, cobble tools, an assortment of flake tools, and a maritime or riparian focus. Microblades appear as an alternative technology added to the repertoire after around 9900 cal B.P. (see Fedje et al. 2008), although the lack of microblades in the earliest components could also be due to sampling issues
Chatters, Hackenberger, Prentiss, and Thomas (Prentiss and Clarke 2008). Bone implements occur, but typically only as expedient tools. So defined, OCT assemblages have been found throughout the Northwest, extending southward from Glacier Bay, Alaska, and the Fraser-Chilcotin confluence in British Columbia. As we will show later, they first appeared in the north before 10,600 cal B.P., moving progressively southward and inland over a period of 1600 years (table 3.2).

In addition to the tradition name, by which they are known in much of British Columbia, OCT assemblages have been called the Moresby Tradition on Haida Gwaii (Fedje et al. 2008); North Coast Microblade in southeast Alaska (Matson and Coupland 1995); Olcott in western Washington (Butler 1961); and Cascade (Leonhardy and Rice 1970), Vantage (Nelson 1969), and Okanogan phases (Grabert 1968) in eastern Washington, Oregon, and parts of Idaho. Because of broad regional variations in assemblage characteristics, poor site and faunal preservation in heavily forested settings, and interest in contrasting OCT with the WST in a sequence of adaptations, we focus our attention on the characteristics of what we hereafter refer to as the “southern interior” manifestations of this tradition, from the area known as the Columbia Plateau and northwestern Great Basin.

Technologies
OCT lithic and bone technologies are simpler and food processing technologies more complex than in the WST. Lithic assemblages are dominated by foliate projectile points and bifacial knives, drills, small end and side scrapers.

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<td>Box Canyon</td>
<td>6820 ± 70</td>
<td>7703–7586</td>
<td>Burcand 1981</td>
<td>53</td>
</tr>
<tr>
<td>Ash Cave</td>
<td>7940 ± 150</td>
<td>8993–8608</td>
<td>Butler 1962</td>
<td>41</td>
</tr>
<tr>
<td>Kennewick Mar?</td>
<td>8410 ± 40</td>
<td>9489–9417</td>
<td>Chatters 2000</td>
<td>30</td>
</tr>
<tr>
<td>Lagoon Site</td>
<td>7320 ± 90e</td>
<td>8277–8016</td>
<td>Draper 1966a</td>
<td>47</td>
</tr>
<tr>
<td>Plew Site</td>
<td>7730 ± 120c</td>
<td>8633–8394</td>
<td>Draper 1966b</td>
<td>45</td>
</tr>
<tr>
<td>Hangman Creek</td>
<td>7290 ± 60</td>
<td>8156–8027</td>
<td>Stan Gough pers. comm. 2009</td>
<td>49</td>
</tr>
<tr>
<td>Mammes Rockshteler</td>
<td>7840 ± 150e</td>
<td>8971–8458</td>
<td>Rice 1969</td>
<td>3</td>
</tr>
<tr>
<td>45WT 2</td>
<td>7300 ± 180</td>
<td>8314–7966</td>
<td>Nance 1966</td>
<td>48</td>
</tr>
<tr>
<td>Thorn Tricket</td>
<td>7710 ± 180</td>
<td>8766–8336</td>
<td>Sprague and Combes 1966</td>
<td>44</td>
</tr>
<tr>
<td>Stockoff</td>
<td>7660 ± 780</td>
<td>9441–7742</td>
<td>McPherson et al. 1981</td>
<td>43</td>
</tr>
<tr>
<td>10NP453</td>
<td>7980 ± 40</td>
<td>8980–8778</td>
<td>Ridenour 2006</td>
<td>25</td>
</tr>
<tr>
<td>Kirkwood Bar</td>
<td>7100 ± 60f</td>
<td>7980–7856</td>
<td>Reid and Chatters 1997</td>
<td>52</td>
</tr>
<tr>
<td>Bernard Cr. Rockshteler</td>
<td>7250 ± 80</td>
<td>8162–8005</td>
<td>Randolph and Dahlstrom 1977</td>
<td>50</td>
</tr>
<tr>
<td>35E518</td>
<td>7035 ± 56</td>
<td>8016–7979</td>
<td>Schalk 1995</td>
<td>51</td>
</tr>
</tbody>
</table>

a. One-sigma range, determined using Calib5.
b. Dixon (2008) also provides an estimated date of 9200 B.P. for human remains from the site, which is not significantly different from the date given here.
c. Carlson (2008) states that the earliest leaf-shaped projectile point from Namu dates to approximately 9000 radiocarbon B.P., placing this component firmly in the OCT. Earlier dates of up to 9700 rcy B.P. on deposits lacking projectile points or microblades could push the age of the OCT on the Northwest Coast considerably further back in time.
d. Reference here is to the projectile point embedded in the man’s pelvis. It is arguably not culturally associated with him.
e. Shell date.
f. Site dates to the time of the Mt. Mazama eruption, making a younger date of 6740 ± 50 B.P. for the earliest occupation stratum the most likely initial age for the site.
gravers, and cobbles, and microblades and microcores are sometimes found (e.g., Daugherty et al. 1987a, 1987b; Jaehnig 1984; Munsell 1968). Bifaces often far outnumber other tool categories. Despite a bifacial technology, projectile points were often produced by pressure-trimming flake blanks rather than through bifacial percussion reduction. Scrapers and gravers tend to be smaller and more formalized than those of the WST. Tools made from cobbles, including choppers, plane-like unifaces, and large spall knives, account for a much higher proportion of the tool inventories than in the WST. Cobbles, systematically reduced in a manner that often produced polyhedral-like cores, account for a high proportion of the lithic material used by this tradition throughout most of its range. Food-grinding tools, which include manos, milling stones, and edge-ground cobbles, are much more common, being found in most assemblages from the southern interior. In the collection from the Granite Point Site, for example, grinding tools comprise nearly 5% of the total tool assemblage in the early OCT component, but only .02% in the WST component. Cobbles tools (choppers, spalls, scrapers) make up 16% and 1.6%, respectively (see Leonhardy 1970).

Bone implements are less common, less diverse, and take different forms than in the WST assemblages. Usually, only a few simple, splinter awls and antler wedges are found, but Granite Point and the Marmes and Bernard Creek rockshelters produced a broader array (Hicks 2004; Leonhardy 1970; Randolph and Dahlstrom 1977). Needles remain in the inventory, but are much larger and occur along with simple, splinter awls, as if the awls were used to create openings for needles to thread. Small barbs from composite fishhooks were found at Granite Point and Bernard Creek; items the excavators identified as “leisters” came from the latter site. In general, the inventory indicates far fewer composite tools. Those that do occur—the fishhooks and leisters—are associated with fishing.

In addition to milling stones, other food processing technologies were much better developed in the OCT. Earth ovens first appear around 8500 cal B.P. at the Hannavan Creek Site in the southern Willamette Valley (Cheatham 1988), after the OCT was well established in that region (Newman 1966). A “roasting pit” is also reported from site 35JE49 in central Oregon at around 9100 cal B.P. This technology remained a part of the OCT subsistence strategy throughout
Chatters, Hackenberger, Prentiss, and Thomas

its existence (Thoms 1989). A more common food processing method appears to have been stone boiling. Small, thermally altered rocks are common at OCT sites, often appearing in clusters, as they did at the Plew Site, seemingly having been dumped from baskets after being used for cooking (e.g., Draper 1986b). Although foods were more heavily processed during the OCT, there is no evidence, beyond a single grass-lined pit in at Marmes Rockshelter, of food storage as an important component of the resource management strategy (Chatters 1995).

As food processing technologies improved, people stopped using their teeth as tools. The earliest well-preserved human skeletal remains attributable to the OCT, found at the Braden (Harten 1980), Demoss (Pavesic 1985), and Clark Fork River (Pennefeather-Obrien and Strezewski 2002) sites and dating around 6500–7000 cal B.P., lack the extreme anterior tooth wear and wear on the lingual aspect of lower incisors seen in the WST skeletons (notes of the senior author).

Settlement Strategy

OCT sites are confined to mountain ranges and the major river corridors (Chatters and Pokotylo 1998). There is almost no evidence of human activity in the open Columbia Basin during the OCT (Chatters 1982; Greene 1975). Whereas the WST showed a strong tendency for site reuse, the OCT is characterized by small sites seemingly used once for perhaps only a few weeks, then abandoned, never to be revisited. Some sites were repeatedly occupied, but these are the exception. OCT sites can be found scattered along both banks of the Columbia and Snake Rivers, wherever surfaces of a suitable age occur. Consistently, they include small concentrations of thermally altered rock, lenses of mussel shells, small collections of cobble tools and flakes, and a few formed tools (Chatters 1995). Evidence has been found for small dwellings, including small, shallow, semi-subterranean houses at 35JE51B (Schalk 1995) and the Lagoon Site (Draper 1986a), and a surface hut marked by a partial circle of stones at Plew (Draper 1986b). A similar structure-like feature was found in an OCT context at the McCallum site in southern British Columbia (Lepofsky and Lenert 2005). The quasi- logistical strategy seen during the WST disappears. In separate analyses of Columbia Plateau assemblages, Bense (1972) and Ames (1988) found no tendency for sites to cluster functionally. There is also no apparent tendency for seasonal habitation patterns, except perhaps for moves between upland and lowland habitats. OCT people during the time before 7500 cal B.P. were highly residentially mobile and tended to engage in many of the same activities at each residence camp, regardless of location or season.

Subsistence

Plant and animal exploitation underwent major changes between the end of the WST and establishment of the OCT in the southern interior. Increased frequencies of grinding stones and the appearance of roasting ovens are evidence for greater dependence on plant foods. By at least 7000 cal B.P., groups in the Rocky Mountains at the DeMoss and Clark Fork Sites were consuming so much processed carbohydrate that it led to extremely high rates of dental caries and antemortem tooth loss (notes of the senior author; Pennefeather-Obrien and Strezewski 2002).

Faunal exploitation patterns are nearly the reverse of those seen for the WST. Review of faunal assemblages from 13 OCT assemblages dating between 9000 and 7500 cal B.P. shows an emphasis on small mammals, fish, and, often, freshwater mussels. Among vertebrate prey, fish ranked first in NISP at Five-Mile Rapids (Butler and O’Connor 2004), Box Canyon (Burtchard 1981), Bob’s Point (Minor and Toepel 1986), Bernard Creek (Randolph and Dahlstrom 1977), and Kirkwood (Reid and Chatters 1997); second at Ash Cave (Butler 1961) and Plew (Chatters 1986); third at Hat Creek (Shiner 1961); and were important at Judd Peak Rockshelter (Daugherty et al. 1987a). Rabbits and hares were most frequent at 35JE51B (Schalk 1995), Hat Creek, Lagoon (Chatters 1986), and Plew. Deer were the most important animals
only at Marmes (Gustafson 1972), Judd Peak, and Ash Cave—all of them, interestingly, rockshelters. Mussels often far outnumber vertebrate remains at these sites; they are a near-ubiquitous component of OCT archaeofaunas.

The aquatic focus of OCT subsistence is evident from the two sites outside the southern interior that have produced good faunal collections. Indian Sands is a shell midden on the Oregon coast (Moss and Erlandson 1996). Stickleback and salmon dominated the faunal assemblage at the Milliken Site on the Fraser River (Matson 1996).

Mortuary Practices

Burials dating to the earlier OCT have been found at six sites, all of which contain multiple individuals, which may be seen as an indication of a pattern of cemetery establishment characteristic of Archaic cultures. Marmes Rockshelter is the only one of these that predates 7500 cal B.P., however, and the earliest two skeletons at that site (Burials 1 and 2) are the scattered remains of individuals who were not interred. Marmes burials that postdate 7500 cal B.P. are primary interments of adults and children (Breschini 1979; Rice 1969). Clark Fork is an inadvertently discovered pair of skeletons for which context information has been lost (Pennefeather-Obrien and Strezewski 2002). The remaining sites are part of the Western Idaho Archaic Burial complex, in which defleshed and sometimes cremated remains of multiple individuals were interred with caches of outsized and exotic goods during communal burial rituals (Pavesic 1985). While superficially similar to the earliest skeletal remains at Marmes, which date to the early WST, this complex postdates the Marmes cremations by some 5000 years.

Characterization

OCT occupants of the southern interior were highly residentially mobile foragers who lived along major rivers, subsisting primarily on fish, freshwater mussels, small mammals, and plant foods. Although they used both lowlands and montane environments, their record shows no sign of seasonal or geographic variability in behavior. They possessed a more advanced food processing technology, which may have eliminated the need for using their teeth as tools. Despite the heightened mobility, the concentration on plants and small prey, along with evidence in the use of cemeteries of an increased sense of territoriality, is consistent with their inclusion in the Archaic.

The Process of Change from Paleoindian to Archaic

The Archaic OCT replaced the WST in the southern interior of the Pacific Northwest between 9500 and 9000 cal B.P. Regional specialists have long seen the two as ancestor–descendant components of the Pioneer Period (e.g., Ames et al. 1998; Daugherty 1962; Davis 2001; Leonhardy and Rice 1970; Matson and Coupland 1995), but the foregoing review indicates otherwise. The two traditions share many functional types of stone tools and a few bone implements, and sometimes occur in the same sites. Site sizes are small for both, and settlement strategies were mobile. These characteristics, however, can be found in nearly all early traditions in the Americas and across much of Eurasia over a span of tens of thousands of years. The differences, however, far outnumber the similarities, beginning at the most basic level of technology (table 3.3). OCT, throughout its range, shows an emphasis on cobbles as sources of tool material, but also sometimes includes microblades; WST does not. WST projectile tips were bifacially reduced by percussion and did double duty as knives; OCT projectile tips were often pressure flaked on flake blanks. Separate bifaces were prepared as knives. The bone and stone technologies of the WST are more complex than those of the OCT, including many tools—crescents, bolas, bone foreshafts, bone atlatl spurs, and fine needles—that did not persist into the OCT. Most of these are parts of composite implements, indicating a high degree of planning depth that the OCT lacked. WST people were somewhat logistically mobile; mobility during the OCT was strictly residential. WST folk made extensive use of all parts of the landscape in a highly patterned manner; OCT bands clung to rivers and high
mountains, doing much the same thing everywhere they went. WST subsistence, although rich in species, emphasized large game and made little use of plants; fish, shellfish, small mammals, and plant foods were the staples of the OCT. The composite tools the OCT did employ were fishing oriented; absent from the WST, these mark another discontinuity between the traditions. Food processing technology, in addition to making complex starches accessible, freed OCT participants from using their mouths as implements.

The differences are indeed deep, reaching all aspects and levels of behavior, but what stand out most starkly as counter to a culturally genetic relationship (sensu O’Brien and Lyman 2000) are the approaches to lithic reduction and the difference in the complexity of both tool forms and land use. In an ancestor–descendant relationship, we would expect to see continuity at the basic level of technology because it is likely to be learned earliest in life. Here we see no such continuity. A transformation from a complex functional adaptation, with many specialized forms of tools and activities, to a simple one lacking such specializations does not make evolutionary sense. An evolutionary trajectory toward increasing specialization is more likely to continue in the same direction than to abruptly revert to generalized behavior. Faced with environmental stress and a generalized competitor, a specialized form is likely to be selected against. What this sequence seems to indicate is not a transition from one way of life to another, but a replacement of one lifeway by another—an ethnic replacement (using the anthropological, not lay, definition of “ethnic”).

Three other lines of evidence seemingly support this interpretation. These are basketry styles in the northwestern Great Basin, where the WST/OCT sequence can be seen; the physical characteristics of the human beings themselves; and the time–space distribution of components of the two traditions.

**Basketry Styles**

Connolly and Barker (2004) recently conducted a survey of radiocarbon-dated basketry styles in the northern Great Basin, which is the southern extremity of our study region. Looking at designs in twined sandals and basket fragments, they found a distinct break in manufacturing techniques at ca. 9000 cal B.P. Before that date, only simple twined basketry was produced, but a wide array of decorative conventions characterized the basketry thereafter. The change in sandals is even more striking. Except for continuity at the most basic structural levels, all other aspects of sandal design changed abruptly at ca. 9300 cal B.P. Three sandal styles—Fort Rock, Open Twined, and Spiral Weft—are recog-
nized by the region’s specialists (fig. 3.4). Fort Rock style sandals were made with a twined toe flap and open heel; they were held on by cords wrapped around the ankle. Open Twined and Spiral Weft type sandals have heel pockets and were tied on with a cord that ran from the toe to the ankle and was drawn tight through a series of loops that reached from the edge of the sole to the top of the foot. Spiral Weft sandals have an open toe, whereas Open Twined sandals have a toe flap of loose wefts. Fort Rock sandals all date before 9200 cal B.P. Spiral Weft and Open Twined forms only postdate 9400 cal B.P. Noting that, because of its plasticity, basketry style has long been recognized as an indicator of ethnicity in the western United States, Connolly and Barker suggest that 9000 cal B.P., which is a time of widespread cultural changes, may mark a time of “population change” in the northern Great Basin (2004:250).

**Human Characteristics**

A geographic displacement of one ethnic group by another need not be marked by widespread genetic changes, culture being a learned phenomenon rather than an inherited one. That caveat notwithstanding, the few human skeletons that have been dated to the Early to Early–Middle Holocene in the Pacific Northwest do exhibit notable differences in cranial morphology. In the southern interior of the Pacific Northwest, only two individuals predating 9000 cal B.P. are intact enough to provide some information about morphology. These are Kennewick Man (9400 cal B.P.; Chatters 2000; Powell and Rose 1999; Tayor et al. 1998) and Stick Man (9100 cal B.P.; Chatters et al. 2000), both from Washington. The oldest remains from the southern interior that postdate 9000 cal B.P. and are intact enough for comparison come from two multiple interments in Idaho: Braden (6600 cal B.P.; Harten 1980) and DeMoss (6800 cal B.P.; Green et al. 1986). Measurements were all made by the senior author using standard osteometric equipment.

Cranial morphometric data could be obtained from Kennewick, Stick, two males each from Braden and DeMoss, and one female from Braden. To compare the crania, we used four simple measures: cranial index, upper facial index, height index, and facial forwardness index. The first two are standard measures (Bass 1987). Height and facial forwardness measures were devised for this analysis to account for the relative incompleteness of most specimens. The height index is computed as $100 \times$ the bregma radius (Howells 1973) divided by the mean of maximum length and maximum breadth. For the computation of facial forwardness, nasion radius was substituted for bregma radius in the equation. The DeMoss female was excluded from computations of mean cranial index because of obvious tumpline deformation, which gave her an extremely elongated, narrow, saddled neurocranium (cranial index 66.7). Results are presented in table 3.4.
Although the sample is painfully small, WST individuals tend to differ from their OCT counterparts in having longer, narrower, higher neurocrania, and a narrower, more forward-positioned face. The only difference that is significant, however, is the degree of facial forwardness (fig. 3.5), for which mean indices of the two groups do not intersect at 3 standard deviations. Facial forwardness is the most robust, continent-wide difference between Paleoindians and later American peoples (e.g., Chatters 2000; Jantz and Owsley 2001). These differences lend support to the impression that the changes taking place in the southern interior of the Pacific Northwest at around 9000 cal B.P. were the result of a population replacement. They must be viewed with extreme caution, however, and should not by themselves be considered prima facie evidence of such an event. The sample is simply too small and the time elapsed between the two sets of remains too great for this to be considered primary evidence.

### Traditions in Time and Space

The chronology of OCT entry into the Pacific Northwest provides further support for the idea of an ethnic replacement. Figures 3.6a through 3.6c map the distribution of dated WST and OCT sites in the Pacific Northwest at >10,000, 10,000–9000, and after 9000 cal B.P. At 10,000 cal B.P., only WST sites occurred in the southern interior, while OCT assemblages are documented only

<table>
<thead>
<tr>
<th>Measure</th>
<th>WST</th>
<th>OCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial index</td>
<td>72.2 ± 1.9 (2)</td>
<td>75.0 ± 2.7 (4)</td>
</tr>
<tr>
<td>Upper facial index</td>
<td>55.6 (1)</td>
<td>52.6 (1)</td>
</tr>
<tr>
<td>Height index</td>
<td>77.8 ± 4.8 (2)</td>
<td>74.9 ± 3.1 (2)</td>
</tr>
<tr>
<td>Forwardness index</td>
<td>63.0 ± 0.3 (2)</td>
<td>59.5 ± 1.1 (2)</td>
</tr>
</tbody>
</table>

a. Only Kennewick and Braden "unnumbered" skulls could be used for this measure.

Figure 3.5.
Marked difference in facial forwardness between Late Paleoindian (Kennewick) and early Archaic (Braden) skulls, overlain in the Frankfurt plane.
along northern Northwest Coast, south as far as the mouth of the Fraser River. By 9400 cal B.P., OCT could be found in the interior of British Columbia and the Pacific Coast as far south as southern Oregon. It also began to appear at points along the Columbia River in the westernmost part of the southern interior, such as the projectile point embedded in Kennewick Man’s pelvis (Fagan 1999; Chatters 2000). By shortly after 9000 cal B.P., it had displaced the WST in all but the southeasternmost part of its range. This time-transgressive distribution is indicative of a slow expansion of a cultural tradition south from eastern Beringia, millennia after the first peopling of the continent (Chatters 2010b).

**The Evidence from Beech Creek**

Although the record of technological, settlement, land use, and physical anthropological change can be interpreted as the replacement of one culture by another, the limited archaeological record from the time period between 9500 and 8800 cal B.P. (tables 3.1 and 3.2) leaves open the possibility...
that the exchange of ideas and intermarriage between neighboring groups, stretching over the span of a few centuries, could account for the transformation. The issue could be resolved with a larger sample of individual occupations from each tradition dated to this critical time interval or with a continuous, discrete stratigraphic sequence containing assemblages of the two traditions, either with or without transitional forms. In preparing this article, we sought sites that contained both traditions in a clear stratigraphic sequence; unfortunately, the quest was fruitless. All sites that contained both traditions in apparently continuous sequence had significant limitations. Five-Mile Rapids, seemingly one of the best candidates because of deep stratification and rapid deposition, had been excavated before some of the issues discussed here were being considered and was reported in a manner that makes distinguishing individual assemblages extremely difficult (Cressman et al. 1960). High water table prevented recent excavations at the site from reaching strata that predate 9100 cal B.P. (Butler and O’Connor 2004), into the WST levels. Marmes Rockshelter, with a purported continuous sequence (Hicks 2004), was excavated in broad stratigraphic units. The transition between WST and OCT is included in Unit III, which spans the period from around 9500–7500 cal B.P. Not surprisingly, both WST and OCT elements are found in that stratum. Paulina Lake exhibited some of the same problems. The entire pre-7500 cal B.P. deposit was only 50 cm thick and lacked stratigraphic breaks of any kind. Connolly (1999) was, therefore, forced to arbitrarily designate three subunits within this series, the middle of which, this time, contained both WST and OCT elements. Rock Island Overlook was another shallow deposit in which assemblages were commingled; it has never been fully analyzed and reported (Valley 1975). Only Granite Point (Leonhardy 1970), which has been discussed briefly above, contained discrete WST and OCT assemblages predating 7500 cal B.P., but they are widely separated by a fluvial series of seeming long duration. There seemed no suitable candidate for clarifying the Paleoindian–Archaic interface. Then, in the fall of 2007, two of us (Chatters and Prentiss 2010) obtained a contract to analyze lithic artifacts from the Beech Creek Site (45LE415) in western Washington.

The Beech Creek Site

Beech Creek is an open site on the floor of the broad upper Cowlitz River Valley near Packwood, Washington, only 16 kilometers west of the crest of the Cascade Range. Located at an elevation of only 317 meters, it occupies a small, flat-topped ridge or terrace remnant beside deeply incised Beech Creek, overlooking the modern Cowlitz River floodplain. Rick McClure and Cheryl Mack of the Gifford Pinchot National Forest conducted excavations at the site in 1992 and 2006, recovering more than 40,000 stone artifacts.

The site is discretely stratified in a series of very poorly sorted layers of what appear to us to be either colluvium from the adjacent mountain slopes or alluvial fan sediments from Beech Creek, laid down before the stream incised its present-day canyon. Bioturbation, largely from tree roots, is extensive. Artifacts were all found in Stratum IV, a massive layer that averages approximately 120 cm thick and is capped by tephra from the 470 cal B.P. eruption of Mount St. Helens (McClure 1992). Sedimentation during the deposition of Stratum IV appears to have been slow but continuous. Deposition of the stratum ceased long before the recent volcanic eruption. The tool assemblage consists of a wide variety of bifacial and unifacial implements made from cryptocrystalline silicates, microcrystalline volcanics, and obsidians, plus a small number of cobbles implements of mostly volcanic origin. Unfortunately, little bone is preserved and no domestic features were found. Projectile point styles, which include Windust stemmed, Cascade leaf-shaped, and large, corner-notched and barbed specimens resembling tools from British Columbia’s Nesikep Tradition, indicate occupation at the site probably ended before 7500 cal B.P. (Chatters and Prentiss 2010). The vertical distribution of artifacts is more or less even, with some zones of greater or lesser frequency but no patterning of frequency modes. At first look, this assemblage appeared
to be beset by the same problems as Marmes Rockshelter, Rock Island Overlook, and Paulina Lake. Analysis proved otherwise.

Methods of Analysis
Twenty-five 1-meter square units were excavated during 2006 as part of a data recovery effort associated with the planned sale of federal land. McClure and Mack asked us to conduct technological analysis of debitage from the four units with the thickest Stratum IV and largest quantities of lithics. We also conducted stylistic and functional analyses of all 306 tools from the 2006 excavations, including utilized flakes, and a technological analysis of all cores. Debitage analysis included aggregate analysis and simplified reduction stage categorization, both by material. Tools were identified to traditional formal classes; each employable unit (per Knudson 1983) on each tool was analyzed macroscopically and microscopically for wear patterns. Projectile points were classified into regional types based on its plan view, blade cross-section, flaking patterns, and edge treatment.

Once the analysis was complete, we sought evidence for intra-assemblage variability. It is important to note that the above-described analyses were conducted blind, without any information but the lithics themselves and their horizontal and vertical provenience. We submitted the data tables from this analysis to McClure and Mack before seeking any information about sedimentary context that might be used to distinguish vertical or horizontal patterning. After a principal components analysis of the debitage from the four sample units indicated the presence of a zone containing higher frequencies of early-stage core reduction debitage, we asked if there were any horizons in which large stones consistently occurred. In reply, Mack provided data showing there had been such a horizon in all but five of the 25 units. We used this manuport-strewn horizon to divide the assemblage into three analytic zones: I, above the stony horizon; II, the stony horizon itself; and III, all material from below the stony horizon. Looking at the distribution of projectile point styles across these zones, we found that all of the Western Stemmed projectile points but one were from Zone III. The odd point out was from 10–20 cm above the Zone II/III boundary, in Zone II. Conversely, all but one of the Cascade-style points from the OCT came from Zones I and II. The exception was a tiny basal fragment from 20–30 cm below the stony horizon. This separation based on the stony horizon had resulted in discrete WST and OCT components in a site with no apparent hiatus in archaeological deposition.

Comparison of Assemblages
In our comparison of the three assemblages, each of which consisted of between 94 and 113 tools, we sought to determine if the assemblages of the traditions exhibited differences that were comparable with those described in table 3.3 for the region as a whole and to determine if they offered evidence that might support or refute the idea of ethnic replacement. Differences in settlement and mobility patterns, activities performed at the site, use of individual tool classes, and passive style were the foci of our analysis. We found a consistent pattern of difference, often statistically significant, across nearly all variables considered. The only measure that produced a significant difference between Zones I and II was the proportion of early-stage reduction debitage, which was the variable that initiated identification of the zones.

Settlement and Mobility
Consideration of the region-wide record (table 3.3) indicates that WST folk were somewhat logistically mobile and “collector-like” in their mobility strategy, using both residence camps and field camps, whereas OCT people were residually mobile. Core types, intensity of tool utilization and rejuvenation, and levels of expediency, as indicated by the ratio of expedient tools to curated tools in the Beech Creek assemblages, all support this characterization. Cores in Zone III were primarily spent, bipolar cores; those in Zones I and II were nearly all polyhedral-like cobble cores. The difference is statistically significant. Zone III occupants made much more intensive use of their toolkit (table 3.5).
Utilized flakes in Zone III have 18% more employable units (EU) per item than either Zone I or II. Retouched tools have more EU per tool, a higher percentage of them are worn, and bifaces were more heavily worn in Zone III than in the later zones. In Zone III, all Stage 4 bifaces (with pressure retouch) other than projectile points had edge wear; few in the other two zones were worn. Worn tools with their edges showing signs of multiple resharpening episodes were common in Zone III, rare elsewhere. Small debitage, which represents tool finishing and rejuvenation, is significantly more abundant in Zone III than in each of the other two zones. As mentioned earlier in this paper, the WST component of this site showed a higher ratio of expedient tools to curated ones: .98 for Zone III and .79 for Zones I and II. All of these measures bespeak a longer duration of residency each time Zone III people made camp at Beech Creek. It was more of a base camp during the WST occupation, a short-term residence camp when visited by OCT people.

Use of Tool Classes

Tool use frequencies show differences in the function of what we interpret to be the same tool forms, as well as emphasis on different activities between OCT and WST occupations. In Zone III, microscopic wear patterns on utilized flake edges show an emphasis on scraping actions. These flakes and retouched scraping tools were used for working both hard (bone, wood) and soft (skin) materials. Stage 4 bifaces (knives) were used for slicing and chopping both soft and tough materials—that is, for such activities as skinning, meat slicing, and heavy butchering, and perhaps cutting hardened skins. Utilized flakes in Zones I and II were used primarily as cutting tools, perhaps assuming many of the functions held by knives in Zone III. Scraping tools were used primarily on soft materials, mainly for skin working. Knives were used only for slicing tough materials. In general, tools were used for a much wider range of activities during the WST occupation, another indicator of longer, base camp–like residency. OCT folk concentrated on producing tool blanks and processing meat and hides while at the site; WST inhabitants performed a much wider array of activities, including tool finishing and repair, and working wood, bone, and fresh and dried skins.

The most striking difference in tool utilization is seen in the projectile points, which show almost mutually exclusive patterns of edge damage and breakage. All but one blade among the Western Stemmed projectile points exhibits edge rounding and “greasy” edge-and-flake-scar polish of the type produced by slicing meat. All of the worn points have been resharpened over this edge wear, leaving small islands of polish. None of the Cascade Point blades show any edge wear. All of the five broken WST points have bending fractures; none are impact fractured. Of ten non-fire-fractured Cascade points, eight are impact fractured and only two show bending fractures. The WST points were used both as projectiles and as knives; OCT points served only one function.

It is tempting to see a relationship between the use of projectiles as meat-cutting knives and WST peoples’ paramasticatory use of their teeth. Perhaps with limited food processing technology, they ate much in the manner observed among Eskimo and Aleut people, by grasping meat between the teeth and one hand while cutting off a bite with the other.

Passive Style

Ames (2000) makes a distinction between active and passive styles. Active style refers to differences in the form of functionally similar implements, garments, or vessels that we assume to have had conscious social meaning.
Fort Rock sandals were visibly distinct from Spiral Weft sandals, and would thus have been useful signals of social group membership. We assume the large, broad Western Stemmed projectile points and narrow, thick, usually serrated-edged willow leaf Cascade points found at Beech Creek also conveyed such meaning. Passive style refers to differences in manufactured objects that are the result of “rote social learning” (Bettinger et al. 1996). We previously referred to basic tool technology as an indicator of continuity between one broad cultural pattern and its descendant. Such things as flaking patterns, raw material choices, forms of flakes selected for blanks, and sizes of selected and produced implements are considered here to be elements of passive style. Patterns of projectile point use are, we believe, another.

Multiple differences that can be considered discontinuities in passive style are found in the Beech Creek collection. WST occupants preferred microcrystalline volcanic rock over cryptocrystalline silicas for flake blanks. They also preferred hard hammer percussion flakes over biface thinning flakes and chose larger flakes with less acute edge angles than selected by the later, OCT occupants. The blanks they selected were larger, as were bifaces they produced at the site. When they produced side scrapers, they made them with less acute angles than their successors did. OCT people preferred smaller, biface thinning flakes of cryptocrystalline silica and selected more acute edge angles. We have already discussed the extremely different ways they used projectile points. The difference in flake blank preference is significant, as are differences in edge wear and breakage on projectile points. These findings provide support for the replacement hypothesis and refute the idea of an ancestor–descendant relationship between the WST and OCT in the southern interior.

Discussion
The change in the interior Pacific Northwest between the WST (Paleoindian) and OCT (Archaic) entails all aspects of behavior—land use, settlement patterns, mobility strategy, technological content, complexity, and planning depth, and both active and passive style. It entails elements of technology that, within anthropology, are traditionally considered the purview of both men (lithic and bone technology) and women (food processing, basketry). It also is loosely correlated with a change in human craniofacial morphology. We have suggested here that this pattern is consistent with ethnic replacement. There are, however, alternative explanations that could account for many, if not most of the cultural changes we have identified.

Many of the changes might be explained as a response to the increasing aridity and warming winters that occurred between 9500 and 9000 cal B.P. The reorganization of OCT settlement and land use patterns from upland terrestrial environments to the major river corridors, change to fish and shellfish as mainstays of subsistence, and preference for cobble sources of stone might all be accounted for as a response to the change in the balance of resources from the drying uplands to the more stable rivers (Davis’s [2001] oasis effect; see also Lyman 1992). The change in bone technology from hunting implements toward fishhooks and leisters would be a manifestation of that new focus. Increasing emphasis on plants might also be interpretable as a response to the aridity-induced loss of large mammalian prey as a source of carbohydrates, although anadromous fish could have been a sufficient replacement. The abandonment of seasonal differences in subsistence-oriented behavior and the shift from partially logistical to residential mobility might be accounted for as a response to rising effective temperature (sensu Binford 1980) toward the end of the Early Holocene.

Some tool categories—one could say whole technological complexes—were lost at the end of the WST, whereas the OCT ushered in new tools and complexes. We have already mentioned how the introduction of fishing implements could be a response to resource availability, but what of bolas and crescents? Perhaps they were associated with species or habitats that were lost or declined regionally as the environment dried out, but without knowing the tools’ original uses we are hard pressed to identify what those changes might have been. Perhaps the shift away from using teeth as implements has
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a similar explanation: reduction in large ungulate prey and, hence, large packages of tough meat. It could also be a collateral effect of new food processing technologies (Chatters 2008).

Style changes cannot be linked to climatic events, at least in a direct causal sense. Nothing in the shift from upland to riparian land use could account for the replacement of stemmed points and distally broad, leaf-shaped weapon tips by proximally broad, leaf-shaped points. Neither can it explain the replacement of Fort Rock sandals by distinctly different styles. Likewise, it cannot account for the absence of change in both artifact categories for thousands or years before and after the appearance of the OCT.

Physical changes in the human form are also not explained with simple reference to environmental causes. Sampling error due to small sample sizes and genetic drift in small populations (see Powell 2004) could account for the observed differences. Time is also a factor, with compared specimens separated by some 2500–3000 years. Natural selection could have favored less forward faces, or not favored more forward ones as new processing technologies and less-tough meat required lower bite forces in mastication.

The time-space patterning of the OCT in the Northwest is more difficult to explain. The only ways to negate this as a support for ethnic movement are to say that we have either incorrectly lumped multiple distinct technological traditions or that the record is simply too incomplete along the southern Northwest Coast for us to say what technology occupied that area before the OCT is recognized. This alternative is contradicted by the Youngs River Complex variant of the WST near the mouth of the Columbia River and in parts of lowland western Washington.

We acknowledge that there is at least one alternative explanation for many of the changes we have noted between the WST and OCT. Such an accounting, however, requires multiple, often unrelated explanations. Ethnic replacement is a single process that can account for all observed differences. Furthermore, multiple explanations do not account for changes in passive style, which should be immune to environmental influence. Replacement is, therefore, the more elegant and empirically sufficient, hence better explanation for the Paleoindian–Archaic shift in the interior Northwest. The presence of change in both male and female products, particularly changes in style, makes it clear that the entire population was involved in the move; intermarriage and acculturation, although they almost certainly occurred, played little part.

The conclusion that increasing aridity did not bring about the subsistence, technological, settlement, and land use differences between the two traditions does not mean that it was not involved in the change from WST to OCT. In fact, we are certain that environmental change played a pivotal role in this event. It is widely acknowledged (e.g. Carlson 1996a; Fedje et al. 2008) that the OCT, as we have defined it here, was adapted to maritime conditions; the WST, although not averse to consuming fish and shellfish, emphasized terrestrial resources, particularly large ungulates in our region. At 9500 cal B.P., we can envision two neighboring groups in the southern Pacific Northwest: the OCT occupying the coast and the WST entrenched in the interior. By this time, the OCT apparently had developed or adopted stone boiling and earth oven processing methods and, therefore, the ability to use complex plant starches. Over the next 500 years, the terrestrial environment along the coast remained stable, while that of the interior, east of the Cascade Range, became more arid and less productive. At the same time, coastal upwelling was reestablished, increasing nearshore marine productivity, which would have included anadromous fishes that used both coastal and interior streams. Thus conditions improved for marine-adapted coastal peoples, while they deteriorated for their terrestrially adapted interior neighbors. The adaptation to aquatic resources gave the OCT a selective advantage over the now-weakened WST, who were soon displaced.

The southward immigration of the OCT from Alaska into temperate North America between 10,600 and 9000 cal B.P. was secondary to one or more late Pleistocene migrations that constituted the initial peopling of the Americas (Goebel et al. 2008). Such a later peopling event is seemingly contradicted.
by mitochondrial, Y-chromosome, and nuclear DNA evidence that all Native American peoples, past (Gilbert et al. 2008) and present, derive from a single ancestral population (Tamm et al. 2007). Genetic evidence, however, demonstrates not a single founding population for the Americas, but rather a single source population, which was isolated in Beringia for a thousand to more than 10,000 years before budding off one or more groups that became the American founders. Archaeological evidence demonstrates the existence of three distinct stone tool traditions, and thus probably at least three separate ethnic groups and at least as many gene pools, in eastern Beringia prior to the movement of the OCT onto the Northwest Coast. Earlier immigrants, from whom the WST folk descended, may have represented one of those traditions, the OCT apparently represented another. In their summary of evidence for the early peopling of the Americas, Geobel et al. (2008) acknowledge that Clovis might represent a later immigration from the same Beringian source population that gave rise to pre-Clovis peoples. Following this same reasoning, the OCT was apparently a third such event. It is likely that there have been others, the last being the Athabaskan expansion that gave rise to the Apache, Navajo, Tlatskanie, Nikola, Hupa, and other groups less than 2000 years ago.

Conclusion
The Paleoindian–Archaic transition in the Pacific Northwest is an example of a macroevolutionary event in which a maritime-adapted coastal population with advanced fishing and food processing technologies took advantage of weakened terrestrial productivity and improved oceanic conditions, and supplanted their Paleoindian neighbors. The event, recognized archaeologically by the replacement of the Western Stemmed Tradition by the Old Cordilleran Tradition, took place between 9500 and 9000 cal B.P. in the Columbia Plateau and neighboring parts of the Great Basin. It is represented by synchronous changes in land use, settlement patterns, mobility strategies, subsistence emphases, and lithic, bone, basketry, and food processing technology. The fact that this event is accompanied by changes in human morphology, and both active and passive styles of utensils made by women as well as men, makes ethnic replacement the most likely explanation. No other single process can account for such a complex and pervasive transformation. This event represents a secondary expansion of founding peoples out of the Beringian heartland.

Notes
1. This measure is useful only for intrasite comparisons due to differences in analysts' interpretation of tool forms. Ratios for each tradition are, therefore, not expected to be equivalent. The ratio of expedient to curated tools at Granite Point, based on tallies in Leonhardy (1970), is 3.76 for WST and 1.36 for the pre-Mazama OCT assemblage. At Beach Creek the ratios were .98 and .79, respectively (Chatters and Prentiss 2010).
2. Wilson (2008) found a higher frequency of pygmy rabbit bone in Lind Coulee than reported by Irwin and Moody, leading him to infer that this indicates greater emphasis on small prey. Lind Coulee was, however, pygmy rabbit habitat and the presence of this tiny animal at the site cannot be inferred as cultural. It is more elegantly explained as the equivalent of the mouse and ground squirrel remains that also occur in the site.
3. Butler (2004) reports large quantities of nonsalmonid fish bone from the Marmes and Harrison horizons at Marmes Rockshelter. This assemblage was collected from floodplain deposits and using a finer mesh screen than employed at any other site in the region. The bone is more likely to represent fish stranded by floodwaters than food remains. Unfortunately, no non-site control was analyzed to enable this inference to be ruled out.

References Cited


