Early and Middle Holocene Archaeology in the Northern Great Basin: Dynamic Natural and Cultural Ecologies

by Dennis L. Jenkins, Thomas J. Connolly, and C. Melvin Aikens

The primary questions addressed in this chapter—and in the volume as a whole—include: "were humans present in the Northern Great Basin during Terminal Pleistocene times?" and "what is our current understanding of changing cultural and ecological regimes in the Northern Great Basin during Early and Middle Holocene times?" This introductory chapter addresses the first question in methodological terms at the outset, and later we offer in more substantive terms our current understanding of the key issues presented in the following papers. To deal with the second question, which is much broader, we summarize in a general way the contributions of the volume as a whole. It is necessary to begin, however, with preparatory discussions of the radiocarbon dating and obsidian hydration research methods and reporting protocols employed throughout this initial chapter, and throughout the volume as a whole.

Preliminary Notes on Radiocarbon and Obsidian Hydration Dating

Refining culture and environmental history remains a primary archaeological concern in the Northern Great Basin (Figure 1). Without a chronologic framework for each site or set of sites investigated, questions about the nature of settlement and subsistence systems, inter- and intra-regional population movements, trade, and paleoclimatic or paleoecological change cannot be adequately addressed. We must, therefore, begin by clearly stating how we are going to deal with time in our efforts to order the events of the past.

Radiocarbon Dating

The accurate depiction of past lifeways and paleoecological events from the archaeological record requires establishing the relative ages of specimens, features, and strata. The question "how old is it?" strongly affects most aspects of archaeology. If we don't first think about the age of things we cannot begin to address even the most basic issues. Yet, here at the very foundation of our research, archaeologists have often made too little effort to be consistent within the discipline. In this volume, we attempt to add impetus to an important change in the reporting and use of radiocarbon dates in Northern Great Basin research that is long overdue. We advocate the primary use of calibrated radiocarbon ages when discussing time, a convention used throughout this volume, rather than continuing to employ conventional radiocarbon ages.

Radiocarbon dating has undoubtedly been the single most important method of age determination employed in the field of archaeology since its invention in 1950. But in the Northern Great Basin, as elsewhere, the radiocarbon chronology generally employed in regional synthetic and comparative research has lagged well behind important improvements in the dating method itself. Although it has long been clear that "radiocarbon years" do not precisely equal calendar years, many archaeologists have continued to report their findings in terms of radiocarbon years, even though a method for calibrating ages in actual calendar years has been available for some time (e.g., Stuiver and Reimer 1993, 2000). This poses a number of problems, both for the general public that "consumes" archaeological knowledge, and for the professionals who seek to advance and refine that knowledge (cf. Minckley et al., this volume; Skinner 1995a; Bartlein et al. 1995).

Archaeologists' continued discussion of ages expressed in radiocarbon years creates confusion in cases where written histories expressed in terms of the modern Gregorian calendar do not properly match up with archaeological histories. It is also true that the variance of radiocarbon ages from calendar years generally (but unevenly) increases with samples greater than about 3000 years old, so that dates expressed in radiocarbon years may be 1000 to 2000 years or more "too young" for the Terminal Pleistocene/Early Holocene times considered in this volume, as compared to true calendar years. In addition, uncalibrated radiocarbon determinations may

Figure 1. Physiographic features and archaeological sites in the Northern Great Basin.

appear to cluster significantly along a time-line, while in reality the clustering is due to causes such as fluctuating solar activity, variance in the amount of atmospheric insolation from cosmic ray activity, or the so called "atom bomb" effect which caused an artificial enrichment of the earth's atmosphere with radioactive isotopes of carbon after 1945. There are other possible anomalies as well.

It is absolutely vital to employ calibrated ages of radiocarbon dates to the application of the obsidian hydration dating method (see below), as radiocarbon determinations are the means of translating measured thicknesses of obsidian hydration rinds into years. Thus, any investigative reporting involving ages determined by the radiocarbon method should begin with the calibration of the radiocarbon determinations.

The use of dates expressed in radiocarbon years has persisted despite these problems for the very good reason that while new calibration methods were being developed and improved, archaeologists felt it prudent to continue reporting in terms of established methods. For some years therefore, many archaeologists have been careful to specify whether ages they presented were in radiocarbon years before present (RCYBP) or calendar years before present (cal. BP). We believe the time is now upon us to shift the chronological discussion over in a thoroughgoing way to calendar years. At the same time, we recognize the need for many to refer back and forth between the old and new formats.

To this end, therefore, reported radiocarbon dates, sample numbers, the material dated (to species level, if known), sample weights or volumes (if known), and corresponding calibrated ages, are provided in the texts and tables of the following chapters. Calibration has been provided by application of the CALIB computer routine developed by the University of Washington Quaternary Isotope Laboratory Radiocarbon Calibration Program (Stuiver and Reimer 1993; Stuiver et al. 1998). The resulting calibrated ages are designated throughout this volume as "cal. BP." Radiocarbon years are designated "RCYBP." Readers will observe, therefore, somewhat different ages for known events than those commonly seen in older literature. For example, the age of the climactic eruption of Mount Mazama, previously placed about 6850 radiocarbon years before present (RCYBP), is now calculated at about 7600 years ago (cal. BP). The age of the famed Fort Rock type sagebrush sandals, previously placed at about 9000 RCYBP, is now calculated at ca. 10,000 cal. BP. The controversial earliest date of 13,200 RCYBP from Fort Rock Cave is now calculated at ca. 15,800 cal. BP.

Obsidian Hydration Dating

Obsidian hydration is a weathering process, involving the adsorption of molecular water on obsidian surfaces, producing hydration bands that thicken with time. Production of chipped stone tools exposes fresh obsidian surfaces to this process, effectively setting the hydration clock of each specimen. Hydration bands are visible on thin sections cut from chipped obsidian artifacts, then mounted on glass slides, and ground to appropriate thicknesses determined by the degree of specimen translucency. The obsidian hydration measurement, reported in microns of hydration band thickness, is made by optical microscopy with the aid of an ocular scale. The widespread distribution of obsidian toolstone sources in the Northern Great Basin makes this dating technique widely applicable throughout the region, where it has been employed since the early 1970s (Layton 1972a, 1972b).

Indeed, it was at Newberry Volcano on the northwest edge of the Fort Rock Basin that important pioneering efforts were made by Irving Friedman (1968, 1977; Friedman and Long 1976). Friedman and Smith (1960) recognized that establishing reliable rates of obsidian hydration requires prior obsidian source characterization of the dated specimens and a working knowledge of the thermal history of those specimens (Friedman and Long 1976; Friedman and Smith 1960; Friedman and Trembour 1983). Individual volcanic sources exhibit unique chemical compositions which may affect the rate of hydration. Thus, in theory at least, each source hydrates at its own rate. However, it is encouraging to note that regionally clustered *subgroups* of obsidian sources (Hughes 1986:290)—such as those in and around the Fort Rock Basin—apparently hydrate at similar rates. Consequently, with careful documentation of specimen associations, proper application of sampling methods, and appropriate expectations directing the interpretation of the resulting data, it has been possible to develop a robust, broadly applicable, and relatively accurate obsidian hydration dating protocol for particular *subgroups* of obsidian sources in the Northern Great Basin.

Theoretically, obsidian hydration offers a method of directly addressing the age of individual obsidian specimens. The sample of obsidian hydration readings currently available for the Fort Rock Basin offers good evidence that the method works well at many sites, though certainly not all, since some sites seem to generate more than their fair share of incomprehensible hydration measurements. For instance, obsidian hydration measurements taken on specimens recovered from subsurface contexts at two Early Holocene sites located on Buffalo Flat near Fossil Lake in the eastern end of the Fort Rock Basin exhibit hydration thicknesses more typical of post-Mazama Middle Holocene sites (Oetting, this volume). The same is true of some hydration rims on specimens recovered from within the exceptionally dry interiors of the Paisley Caves (Skinner and Thatcher 2003). These variations from the larger pattern may be a function of environmental variables unique to particular locations within these sites.

Obsidian sourcing and hydration analyses have been annually conducted since 1994 by the University of Oregon (UO) archaeological field school's FRBPP (1989-1999) and subsequently re-conceptualized NGBPP (1999-present). These studies, combined with a large sample of tools and debitage (N=357) recovered from Buffalo Flat in Christmas Valley

(Oetting 1993, this volume), have resulted in the geochemical characterization analysis of more than 1600 specimens from 29 archaeological sites in the Fort Rock Basin by the energy-dispersive X-ray fluorescence (EDXRF) method (Skinner et al., this volume). Over 900 of these specimens have also been subjected to obsidian hydration analysis.

The magnitude of this study has only been exceeded in this region by the analysis of 6,595 specimens recovered from 83 sites located along the PGT-PG&E pipeline which passed just west of the Fort Rock Basin on its route from Idaho to California (Skinner 1995a, 1995b). That massive study provided the data from which Pettigrew and Hodges (1995:2-16) proposed a local hydration rate of 3.3F^2/l000 years for a number of prominent obsidian sources in southern Oregon, including the Silver Lake/Sycan Marsh and Spodue Mountain sources, as applied to sites at the approximate latitude and elevation of those considered here.

The UO obsidian sample is unusual not only in its size but also in the level of selection and documentation of environmental settings from which the specimens were recovered. Of particular interest are 333 well-documented specimens obtained from buried contexts in six open, sparsely vegetated, lunette dune sites at elevations ranging between 4310 and 4330 feet, and two cave sites (Connley Caves and Paisley Caves) at somewhat higher elevations of 4450 and 4520 feet, respectively. All of these locations face to the southwest, and each was subjected to a period of rapid sedimentation after the eruption of Mount Mazama some 7600 years ago. Thus, patterns of annual exposure to solar radiation heat were broadly comparable, though individual settings within particular site locations, and individual artifacts, may have experienced somewhat differing depositional histories.

In analyses discussed in this volume relative frequencies of radiocarbon and obsidian hydration dates have been used as a proxy for cultural factors such as population density and activity intensity. The rationale is that sufficiently large samples of dated artifacts and cultural features will reflect population patterns. Periods of higher population, or more intensive settlement activity, should produce relatively more artifacts and features on the landscape, and, all things being equal, archaeological studies should most frequently sample these larger artifact and feature populations. The sample of obsidian hydration measurements (calculated at a rate of 3.3F^2/1000 years; Pettigrew and Hodges 1995:2-16) shows remarkable consistencies with a set of 212 radiocarbon dates from 38 sites in the greater Fort Rock area (Figure 2). As should be expected, the most prominent peaks represent times for which high levels of cultural activity are documented in the Fort Rock-Summer Lake basins, most notably in the multiple dual peaks within the very large number of Middle Holocene samples.

There are some notable differences between the radiocarbon and obsidian hydration samples. The majority of this variation is due to intrinsic differences in the sampling methods between the two types of dating, and some of it is the product of our arbitrary clustering of samples into 250 year increments along the time line. The most obvious difference is the large number of Late Holocene radiocarbon dates forming two peaks to the left side of Figure 2. These represent intensive dating of house floors at the lowland Carlon Village site (Wingard 2001) and a group of contemporary upland habitation sites (Boulder Village, Scott's Village, Teri's House [Jenkins and Brashear 1994], and others [O'Grady 1999]) occupied in connection with intensified early spring root-crop harvesting. Obsidian hydration analysis has also been conducted on hundreds of specimens collected from all these Late Holocene sites, but the samples have not been included in Figure 2 because the sites are located in extremely rocky soil and, in the case of the upland root-ground sites, are typically located more than 1000 feet above the valley floor. These factors locally affect the ambient temperatures that drive the rate of hydration, and hydration results may not be directly comparable to those from lower elevation settings. While the hydration results from these sites are comprehensible, there are variations that require extended discussion more suitably presented elsewhere.

Also in Figure 2, the strong peak in obsidian hydration dates at about 13,250 years ago, is directly supported by only two radiocarbon ages. This peak was generated by a series of obsidian samples from the Lower (below 250 cm) pre-Mazama component at the mouth of Connley Cave #5, which yielded a mean hydration measurement of 6.6F. A radiocarbon age of ca. 13,150 cal. BP (11,200±200 RCYBP) was reported by Bedwell (1970:55-56) from nearby Connley Cave #4. Thus, the obsidian hydration provides a small measure of support for Bedwell's assertion that the Connley Caves were indeed occupied at this early time, although additional supporting evidence is still needed because the radiocarbon date was stratigraphically out of sequence with other radiocarbon samples from neighboring Cave #4. Possibly the most notable matches in Figure 2 occur among the most ancient samples, which exceed 15,000 cal. BP (more than ca. 12,500 RCYBP). The

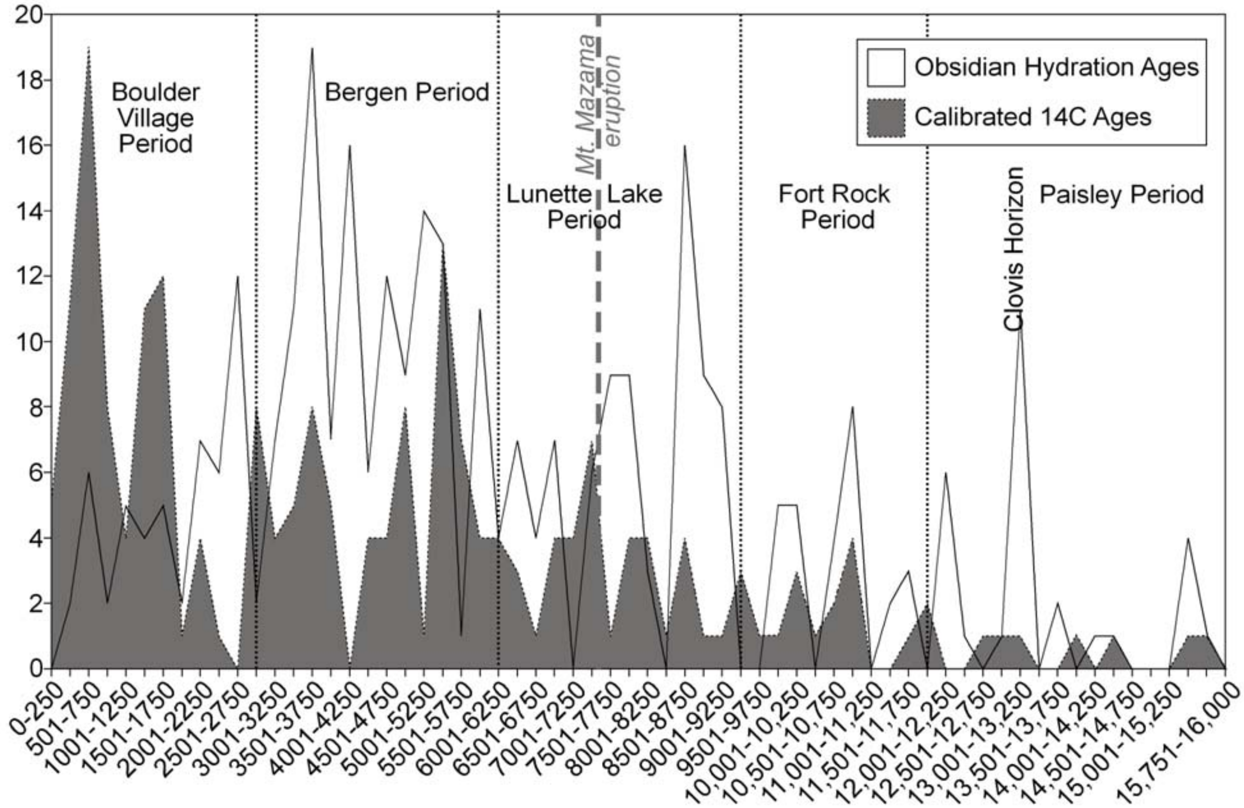

Figure 2. Frequency graph (calibrated radiocarbon ages and obsidian hydration ages) of chronological measures of cultural events in the Fort Rock Basin.

earliest radiocarbon age from Cressman and Bedwell's Fort Rock Cave work (13,200 RCYBP) is well known, but has always been controversial. Figure 2 shows that the early Fort Rock Basin radiocarbon ages are closely matched by hydration ages on cultural obsidian, resurrecting the possibility of a cultural event in the basin as early as ca. 15,800 years ago (see Late Pleistocene discussion, below).

Research History and Methods: Artifact Associations, Dating, and Interpretive Bias

The archaeology of the Northern Great Basin was initially made notable by the demonstration of great time depth in the human occupation of Fort Rock Cave, the Paisley Caves (Cressman and Williams 1940; Cressman 1942; Bedwell 1970, 1973; Bedwell and Cressman 1971), Cougar Mountain Cave (Cowles 1960; Layton 1972a, 1972b), and the Connley Caves (Bedwell 1970, 1973; Cressman 1986:120-123). Since then, other early sites have contributed further evidence (Willig 1988, 1989; Connolly 1999a; Oetting 1993, 1994a; Jenkins 2000). Also notable was the preservation of fragile fiber artifacts of great antiquity at many of them. The archaeological records at these sites are generally the product of many occupation events, some separated by long periods of time. They reflect site functions such as caching, short-term camping, and long-term residence. Activities that included the digging of pit and floor features, cleaning up, and occasionally construction within the confines of the caves—as well as the scavenging of previous artifacts and debris by both humans and animals—created an accumulation of stratigraphic problems for later archaeologists to sort out.

Cressman clearly established the Early Holocene age of human occupations at Fort Rock Cave and the Paisley Caves (Cressman and Williams 1940; Cressman 1942), by finding artifacts buried under volcanic tephra from the eruption of Mount Mazama in the nearby Cascades. He also thought he had demonstrated that human occupations were contemporary with Late Pleistocene lake shores and now-extinct fauna at the Paisley and Roaring Springs caves (Cressman 1986). However, he published extremely brief descriptions of the crucial excavations. The similarly limited field notes and illustrations, as well as published comments (cf. Krieger 1944), engender a lack of confidence in the accuracy of certain asserted associations. Thus, in the case of the Late Pleistocene faunal specimens, it is impossible to unequivocally verify the claimed association of cultural materials with the bones.

Following on this early work, for the last three decades researchers have cited the dissertation (1970) and posthumous publication (1973) of Stephen Bedwell, Cressman's last graduate student. In spite of demonstrated problems with his data (cf. Grayson 1979, 1993), Bedwell's work continues to be cited, primarily to reference his proposed concept of a Western Pluvial Lakes Tradition (ca. 13,000 to 9000 cal. BP [11,000 to 8000 RCYBP]), and to review the surprisingly early 15,800 cal. BP (13,200 RCYBP) date he obtained from charcoal found on Pleistocene beach gravels at Fort Rock Cave. Few other sites in the Northern Great Basin have produced such impressive and widely-cited archaeological records as the Connley and Fort Rock caves. Bedwell proposed that the Western Pluvial Lakes Tradition was supported by a particularly strong reliance on marsh resources (especially waterfowl), resulting in a settlement pattern centered on the shores of now-dry ancient lakes. Bedwell drew inspiration for the original idea from the abundant bones of waterfowl and shore birds in the Connley Caves deposits, and the unexpectedly early radiocarbon date from Fort Rock Cave.

These data in fact failed to demonstrate the pattern he sketched, because in drawing his interpretation Bedwell imprecisely merged the data from the Connley and Fort Rock caves. The bird bones from the Connley Caves were at least three thousand years younger than the Fort Rock Cave date for pluvial lake beach gravels, and no comparably large waterfowl bone assemblage was were found in Fort Rock Cave. Further, the cultural associations Bedwell claimed for the reported 15,800 cal. BP date (13,200 RCYBP) itself at Fort Rock Cave remain undemonstrated because there was no graphic, photographic, or explicit written documentation in either his publications or field notes to show the dated charcoal's relationship to the artifacts he said were associated with it. Vance Haynes (1991) suggested that the radiocarbon determination may indeed date the pluvial lake beach gravels at the bottom of Fort Rock Cave, as Bedwell claimed, but offered the scenario that driftwood from a high-water period, settled in the back of the cave, may have later been collected and burned by site occupants. Haynes was encouraged in this interpretation by the fact that the artifacts said to have been found with the hearth—a heavily reworked Western Stemmed point, a mano, and a few edge-modified flakes (Bedwell 1970:57)—are types consistent with assemblages dated in many western sites to only 12,000-8500 cal. BP (but see Bryan 1988).

Bedwell's sampling strategies also skewed his perception of Fort Rock Basin culture history. In the introduction of his dissertation he outlined that "The purpose of this study is to investigate human prehistory and environmental change in the Fort Rock area of south-central Oregon. . . . The emphasis of this study, however, particularly in regard to relationships between the Fort Rock area and other areas, is primarily on the early periods prior to the onset of Medithermal times around 4,500 years ago (Bedwell 1970:1)." He focused his excavations on cave sites, reasoning that they would best provide data to address issues of climatic reconstruction and corresponding human responses (Bedwell 1970:18-19). In every case, the caves selected for investigation faced to the south-southwest, the direction from which prevalent winds blew waves across Pleistocene Lake Fort Rock to cut caves into the cliffs of the basin, and were situated 50 meters or more above the floor of the basin. In other words, Bedwell skewed his data toward a single site type and ecological setting at the outset of his research. The fact that he relied heavily on artifact collectors to direct him to the caves assured that most of the caves had been previously disturbed before he began his investigations. He ignored the open dune sites of the basin, which have since proven to contain a rich Early and Middle Holocene archaeological record, particularly of periods not well represented in the caves (Aikens and Jenkins 1994b; Jenkins 2000; Jenkins, Aikens, and Cannon 2000; Jenkins, Droz, and Connolly, this volume; Mehringer and Cannon 1994; Oetting 1993, 1994a). Adding to this bias, Bedwell interpreted observed fluctuations of occupational intensity in the caves as reflecting the prehistory and paleoecology of the entire region. In so doing, he failed to recognize the complexity of dynamic regional human demography and settlement-subsistence patterns related to the paleoclimatic, ecological, and cultural changes he sought to reconstruct. As we now know, open sites in the Fort Rock Basin wetlands were commonly occupied during periods when the cave sites were effectively abandoned (Jenkins 2000; Jenkins, Droz, and Connolly, this volume).

Culture History and Ecology in the Northern Great Basin

The culture-history of the region has been molded to a significant degree by climatic and ecological events manifested at regional and subregional levels. Minckley et al. (this volume) provide a current review of the climatic variables and patterns that had a major effect on the colonization of the Northern Great Basin. By modeling boundary conditions—sets of controls that most readily governed global and hemispheric climate—they reconstruct climatic change since the Last Glacial Maximum (21,000 to 16,000 cal. BP).

Pluvial lakes were high and woodlands substantially expanded in response to dramatically increased precipitation during the Last Glacial Maximum. Late Glacial (16,000 to 14,000 cal. BP) conditions saw less effective moisture, possibly due to colder winter temperatures, although more than 120 pluvial lakes continued to fill basins throughout the region until ca. 14,000 cal. BP. Nearly all of these lakes began to simultaneously drop in elevation by ca. 14,000 cal. BP (12,000 RCYBP).

A significant north to south gradient, related to gradually northward-retiring glacially influenced weather patterns which existed across the Late Glacial/Early Holocene boundary, caused some Late Glacial lakes in the Northern Great Basin to briefly rebound between 14,500 and 13,000 cal. BP before resuming their drop toward Holocene levels (see Friedel 2001). Timberlines remained lower than present until ca. 11,000 cal. BP (10,000 RCYBP), when climatic conditions began to approach drier-than-present levels. Late Glacial lakes in the Northern Great Basin may have been relatively lower than those found in the Southern Great Basin due to summer-dominant monsoons in more southerly latitudes. In other words, the transition to drier Holocene conditions appears to have been more unidirectional (and possibly earlier) in the Northern Great Basin than it was farther south. However, brief cyclical interludes of improved climatic conditions undoubtedly continued to occur throughout the Early and Middle Holocene transition between 9000 and 6000 cal. BP (see Jenkins, Droz, and Connolly, this volume, for evidence of lakes in the Fort Rock Basin at the time of the Mt. Mazama eruption ca. 7600 cal. BP).

Evidence for a significant period of maximum summer temperatures resulting in exceptional levels of evapotranspiration between 7000 and 6000 cal. BP is undeniably wide-spread in the West. However, this period occurred at different times and with varied intensity across the region due to variations in local topography and storm patterning (Minckley et al., this volume). Evidence from the Harney (Wigand 1987), Fort Rock (Jenkins 2000), and Klamath (Sampson 1985) basins suggests that a reversal of this extreme thermal trend began about 6000 cal. BP (ca. 5000 RCYBP) in the Northern Great Basin. Middle to Late Holocene climatic trends once again followed a general pattern of amelioration toward increased precipitation, when evidence indicates a rejuvenated lake-marsh system with much more water and biotically richer environments than we have known during the historic period. Again, the specific timing and intensity of events varied by location; geoarchaeological evidence suggests that this period of climatic amelioration involved multiple phases of increased precipitation as well as drought, resulting in varied cultural responses in the Fort Rock Basin (Figures 1 and 2; Jenkins, Droz, and Connolly, this volume).

Though intense climatic events involving unusually hot and cold thermal regimes, flooded marshes, and extended drought had strong effects on the human ecology of the region, they were not the only reasons for cultural change in the Northern Great Basin. By the latter half of the Middle Holocene (ca. 6000-3000 cal. BP) social circumscription of populations appears to have been a limiting factor governing, to some degree, cultural responses to local ecological change. Settlement-subsistence patterns shifted from extreme mobility toward greater sedentism and resource intensification, and trade intensified throughout the region (see chapter on personal ornamentation by Jenkins, L. Largaespada, T. Largaespada, and McDonald, this volume). This shift is also marked by an increasing reliance on upland root crops between 4000 and 3000 cal. BP (Jenkins 2000:104).

Most of the papers in this volume are dedicated to documenting cultural changes that distinguish the Early and Middle Holocene periods. For the sake of contrast and continuity, however, we offer a brief review beginning with what is known of the Late Pleistocene, and carrying through the Late Holocene. At the risk of oversimplification, we present this discussion by named periods for clarity, and in order to bring focus to cultural-ecological themes that dominate each time unit.

Late Pleistocene (Paisley Period, >15,500 to 12,000 cal. BP)

The Late Pleistocene period is begun in this discussion with the earliest radiocarbon date from Fort

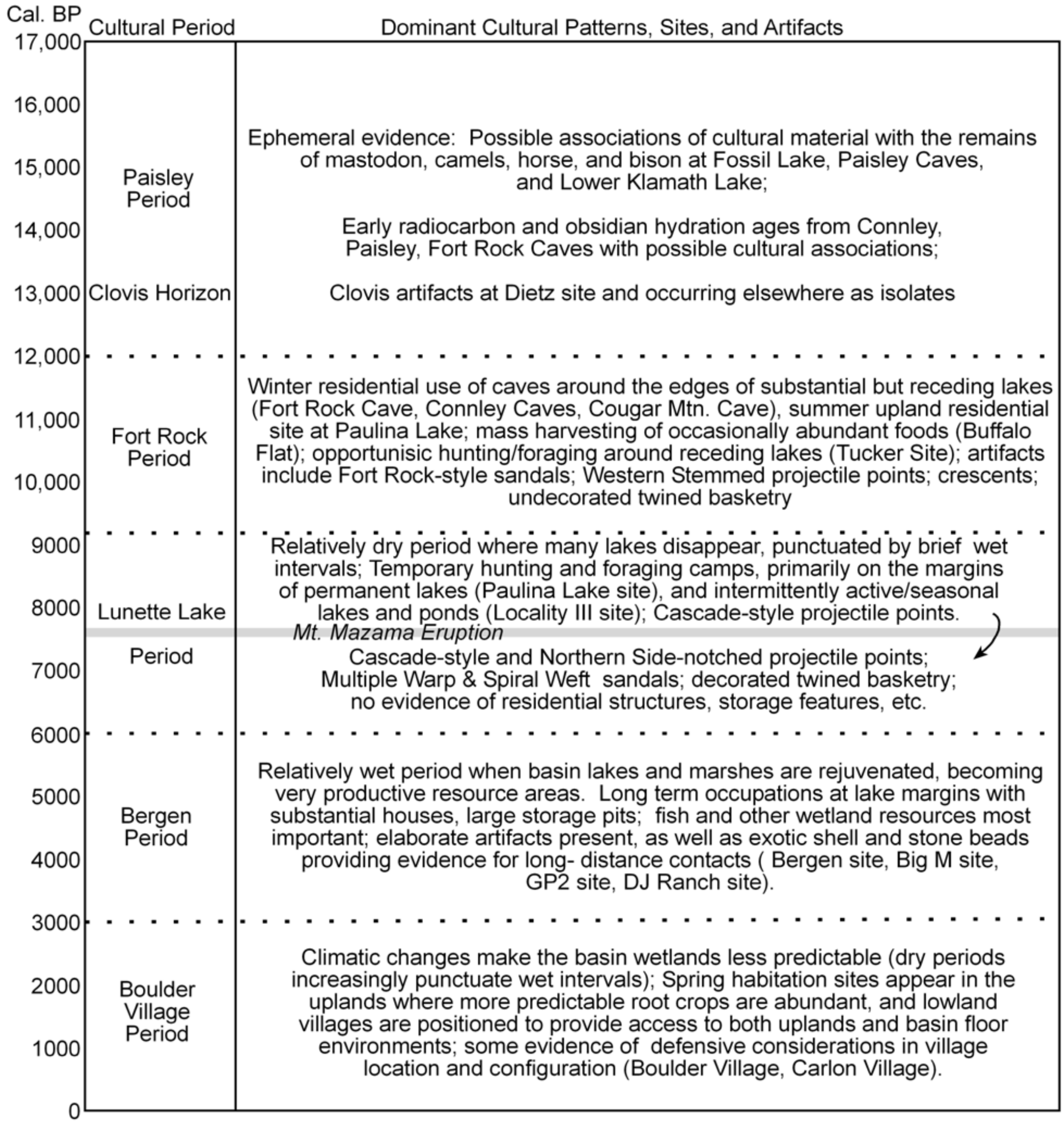

Figure 3. Cultural chronology of the Fort Rock Basin and vicinity.

Rock Cave, and terminated at 12,000 cal. BP (ca. 10,000 RCYBP), the normally accepted beginning of the Holocene. Late Pleistocene populations on the Plains, in the Southwest, and Southeast focused much of their subsistence effort on hunting large game, apparently including mammoths and *Bison antiquus* in their diets (Boldurian and Cotter 1999). There is no unequivocal evidence at present for the hunting of megafauna in the Great Basin, but a number of finds suggest that it may have been a feature of the Late Pleistocene occupation in the Northern Great Basin.

Minor and Spencer (1977) reported the recovery of lanceolate point fragments from the area of the rib cage of a camel found on the surface and in near surface deposits in Christmas Valley, Oregon. Radiocarbon dating of bone collagen produced an unusually late date of ca. 11,300 cal. BP (9955±165 RCYBP [SI-3458]; Minor et al. 1979:32). If this date is correct, it would put the age of the animal well within the period commonly accepted for human occupations in the Great Basin. Cressman (1942:99-100) reported the possible association of lithic artifacts (a scraper and a knife) with the bone and tusk fragments of a mastodon at the Narrows of Lower Klamath Lake, as well as the recovery of Clovis-style bone foreshafts from a bed of blue-gray silt of presumed Terminal Pleistocene age based on the presence of bone from extinct mammals including horse, camel, and proboscidian. At Paisley Cave #3 Cressman (1940a, 1940b) recovered a small assemblage of obsidian artifacts with camel, horse, and bison bones from a space apparently cleared of stones. The discard pattern around the periphery of this space suggested to him that the bones had been tossed out of the living area. While the above evidence is suggestive of megafauna hunting, the associations are not indisputable.

Bedwell (1970, 1973) conducted excavations at the Connley Caves, Fort Rock Cave, Cougar Mountain Cave #2, as well as four other caves or rockshelters in the Fort Rock Basin. He obtained radiocarbon dates of Late Pleistocene age at Fort Rock Cave (ca. 15,800 cal. BP [13,200±720 RCYBP], the large error value on this sample provides a 2-sigma range from 17,600 to 13,810 cal. BP), Cougar Mountain Cave #2 (ca. 13,900 cal. BP [11,950±350 RCYBP]), and the Connley Caves (ca. 13,150 cal. BP [11,200±200 RCYBP). More recently, Beaton (1991) reports a radiocarbon age of ca. 13,500 cal. BP (11,450±340 RCYBP) from a probable hearth in a small Klamath Basin cave near Tule Lake. Though all of these dates have been individually considered questionable, the early ages show a striking consistency from site to site.

The UO archaeological field school conducted excavations at the Paisley Caves during the summers of 2002 and 2003. The bones of camelids, bison, horse, artiodactyls, rabbits, waterfowl, fish, and small vertebrates were recovered from stratified deposits of loosely consolidated rat midden near the floor of Cave #5, which lies adjacent to Cressman's (1940a, 1940b) Cave #3. A radiocarbon date of ca. 14,300 cal. BP (12,300±40 RCYBP; [Beta-172663]) was obtained on the collagen from an astragalus of a large camelid, probably camelops (James Martin, personal communication), and a date of 13,140 cal. BP (11,130±40 RCYBP; [Beta-185942]) was obtained on collagen from a partially charred horse phalanx. Five obsidian artifacts and pieces of debitage recovered at depths between 275 and 300 centimeters, near the same cave floor, exhibited hydration measurements ranging from 6.7 to 7.9F, which produced a mean of 7.3F. Applying the hydration rate noted above, which so reliably matched radiocarbon ages for cultural deposits in the Fort Rock Basin caves, suggests the Paisley Cave #5 artifacts are slightly older than the calibrated radiocarbon age of the camel bone from the same site. Thus, the early radiocarbon ages are now supported by obsidian hydration evidence. However, three tightly twisted threads recovered from the same excavation unit, level, and stratum as the camel bone produced a radiocarbon age of ca. 12,700 cal. BP (10,550±40 RCYBP). The radiocarbon date of these threads, which is later (but not much) than either the date of the camel or horse bones, keeps the correlation between the bone dates and the obsidian hydration age from being considered definitive, though it does fit the broader pattern noted above.

Bedwell (1970:213-220; 1973:157-160) recognized two basic cultural units of pre-Mazama age from his work in the Fort Rock Basin. Unit 3, the Early Pre-Mazama, is divided into two periods, the first attributed an age of ca. 16,000-13,000 cal. BP (ca. 14,000 to 11,000 RCYBP), and the second, which he identified as the Western Pluvial Lakes Tradition (WPLT; defined further below), dating from 13,000 to 8800 cal. BP (11,000 to 8000 RCYBP). Unit 2 was a Late Pre-Mazama "Transitional" period which fell between the WPLT and the Altithermal climatic maximum, dating from ca. 8800 to 7500 cal. BP (ca. 8000 to 7000 RCYBP). Not certain what the tiny assemblages associated with his earliest radiocarbon dates might mean, Bedwell postulated an Early Hunter period when populations would have been very small and highly mobile. The recovery of ground stone with the early (15,800 cal. BP) hearth at Fort Rock Cave implied processing of small seeds, and the recovery of fish from Cougar Mountain Cave #2 suggested to him that these hunters were at least opportunistic fishers as well. This view is quite consistent with a recent review of the evidence for Terminal Pleistocene occupations in the Great Basin generally (Beck and Jones 2003:465-466), which suggests that people probably did not colonize the Great Basin until sometime after ca. 15,500 cal. BP (ca. 13,000 RCYBP), and that they arrived with a generalist adaptation exploiting a broad range of resources around biotically rich, shallow water marshes.

Geomorphological investigations of Pleistocene lake levels in the Summer-Chewaucan-Abert lake basins (Pluvial Lake Chewaucan) also suggest a favorable setting for Late Pleistocene hunters. By ca. 16,500 cal. BP, following Pleistocene high stands, the level of pluvial Lake Chewaucan dropped (Allison 1982), producing Winter Lake in the Summer Lake basin and ZX Lake in the Lake Abert-Chewaucan basins. Winter Lake fell rapidly after the two hydrologic systems separated, but ZX Lake, fed by the Chewaucan River, fell more slowly. A resurgence in ZX Lake between 14,350 and 13,500 cal. BP (ca. 12,400 and 11,600 RCYBP), caused a small river to overflow north into Winter Lake, across the broad plain now seen near the Paisley Caves (Friedel 2001). Water budget models suggest that local precipitation may have increased by at least 60% and stream flow by 240%, while evapotranspiration decreased by 20% during the period of this flow (Friedel 2001, 1998). If this model is accurate, the plain between the two lakes should have been covered with better forage for large mammals than the marginal pasturage that exists there today. Small herds of large game such as camels, horses, bison, deer, antelope, and elk would have been visible for a good distance from the Paisley Caves, making the caves attractive for temporary use by hunters at this time.

The earliest well-documented cultural horizon in North America is associated with the distinctive Clovis complex, thought to date primarily between ca. 13,500 and 12,500 cal. BP. Only one possibly fluted point, excavated from near the bottom of Connley Cave #5 by Bedwell, has been recovered from stratified deposits in eastern Oregon. The specimen itself is securely dated by both radiocarbon and obsidian hydration to about 10,500 cal. BP (9540 RCYBP), but whether it is actually fluted is debated (Musil, this volume; Beck et al., this volume). Musil, comparing the specimen with a sizable number of points recovered as surface finds from the Lake Abert and Alvord Desert subregions, contends that it is not fluted, but rather basally thinned, which is a common characteristic among the Western Stemmed projectile points of the Early Holocene. Beck et al. argue that this specimen is indeed fluted, based on their comparison with fluted points from the Sunshine Locality in northern Nevada, and that it is representative of a late phase of Early Holocene fluting technology in the Great Basin, analogous to that of the Dalton phase in the Southeast. Their argument is similar to that of Basgall (1988) who reported fluted points apparently dating to some time around 9000 RCYBP at the Komodo site in California.

The Dietz site, located in a small sub-basin at the north end of Alkali Lake basin, which lies some 40 miles east of the Fort Rock area, has produced an assemblage of more than 60 fluted points and 52 otherwise diagnostic Clovis period artifacts. Also found were at least 31 Western Stemmed points (representing a more clearly defined variant of Bedwell's WPLT concept) and 17 Middle Holocene side- and corner-notched projectile points (Elko, Northern Side-notched, Humboldt, and Pinto). Extensive controlled surface survey, backhoe trenching, and limited testing, was conducted over a large area at and around the original locus where Clovis points were discovered lying on the surface. Based on this work, Willig (1988: Figs 33, 36; 1989) showed that most of the discovered fluted points from the Dietz site lay below 1315 m. elevation, associated with a small and shallow (ca. 30-50 cm deep) marshy lake or pond (Lake Koko) on the currently arid basin floor. No Clovis artifacts were found in buried context, although flakes weathering from silica-cemented sediments in backhoe trench walls suggested that buried cultural deposits of possible Clovis age could exist at the site. In contrast, Western Stemmed artifacts were found on surfaces above 1315 m., and they extended above 1320 m. More will be said about this aspect of the Dietz research below.

Based on these elevations, and apparent shoreline features, Willig saw Western Stemmed occupation as associated with post-Clovis, relatively higher water levels in the northern Alkali basin. The differential distributions of point types and their associated artifact assemblages suggested that stratified subsurface deposits might be encountered at points of overlap between these distributions. Subsurface testing at the Tucker site, at the edge of a ridge marking the far eastern shore of the Dietz sub-basin, revealed a buried paleosol dated at ca. 11,000 cal. BP (9610 RCYBP) between 1317 and 1318 m. elevation. Eroding out of this soil were found large bifaces, blanks, cores, flaking debris, and ground stone tools. No diagnostic points were found, but Willig believed the Tucker site paleosol placed it well within the Western Stemmed time range.

Obsidian source characterization studies indicate that the Dietz site's Clovis occupants had traveled long distances to reach this location (Fagan 1990). Many of the fluted points found on site were worn out, discarded, and replaced tools, or production failures related to the replacement process. Large end and domed scrapers, crescents, gravers, bifaces, cores, and core tools comprised the majority of the tool assemblage. The obsidian of which many of the discarded specimens came from distant sources, including Glass Buttes, Beaty's Butte, Silver Lake/Sycan Marsh, and others, while knapping debris found at the site was of obsidian obtained from the very nearby Horse Mountain source (Willig 1988, 1989). From these and comparative observations across the West, Willig (1988; Willig and Aikens 1988: 26-31) defined the site as one of a finite number of "sweet spots" on a Clovis-age "Paleo-Archaic" landscape. These locations offered water and concentrated subsistence resources, including both terrestrial and lacustrine plants and animals, which "tethered" sparse early fluted point users to an annual round of dependable sites in a flexible, far-ranging, broad-spectrum strategy of subsistence and settlement that presaged the Desert Archaic pattern seen by Jennings (1957, 1964) as emerging in the Early Holocene.

Early Holocene (ca. 12,000-7600 cal. BP)

Early Pre-Mazama Period (Fort Rock Period, ca. 12,000-9000 cal. BP). It was in the pre-Mazama deposits of the Fort Rock caves (particularly the latter part of the Early pre-Mazama occupations associated with the WPLT, ca. 13,000-8500 cal. BP) that Bedwell (1970, 1973) encountered the richest cultural assemblages. These Early Holocene deposits theoretically reflected a gradual climatic drying trend during which shallow-water marshes with fringing grasslands replaced the vast Pleistocene lakes. The most notable characteristic of the Early Holocene assemblages recovered from the Connley Caves are the large numbers of waterfowl bones mixed with terrestrial fauna including rabbit, pika, small mammals, deer, elk, pronghorn, mountain sheep, and bison (Grayson 1979). The Early Holocene stone tool assemblages recovered from the Fort Rock caves include Western Stemmed, Windust, lanceolate, and foliate projectile points, as well as crescents, large scrapers, bifaces, gravers, choppers, cobblestone tools, manos, and bone awls. Textiles included Fort Rock type sagebrush sandals (Bedwell 1970, 1973).

Comparing the Early Holocene assemblages of the Fort Rock Basin to those of similar age from further south in the Western Great Basin (Sadmat, Hathaway Beach, Coleman) and southern California (San Dieguito and Lake Mojave), Bedwell (1970:227-228) found strong similarities in projectile point styles and the consistent presence of large numbers and types of scrapers made of fine-grained metavolcanic materials such as dacite, andesite, felsite, and rhyolite. Sites were generally located in lacustrine settings throughout the basin bottoms of the western Great Basin. This led him to postulate the existence of a wide-spread Early Holocene (13,000 to 8500 cal. BP) cultural system he termed the Western Pluvial Lakes Tradition (WPLT). This tradition was most strongly characterized by the intensive exploitation of shallow-water marsh resources, particularly waterfowl.

Paulina Marsh, the location of the Connley Caves in the Fort Rock Basin, sustains resident and migratory populations of waterfowl throughout the winters. Mule deer and elk migrate out of the higher elevations surrounding the basin to winter around Paulina Marsh and in the timber-covered Connley Hills, and it is likely that deer, elk, pronghorn, and bison may have done the same in ancient times as well. Lagomorphs, on the other hand, do not migrate long distances and are locally more susceptible to annual depletion of numbers when intensively exploited by sedentary human populations. These seasonal patterns relate to the archaeological record for the Connley Caves. Grayson (1979:446), noting normal sage grouse sex ratios (i.e. of non-breeding, dispersed populations) and a general lack of immature birds in the early assemblages at the Connley Caves, suggests that the data might best fit a late fall to late spring predation pattern. Connolly (1995:16) notes that the increased use of grouse and waterfowl in the 11,000 to 8000 cal. BP period in these assemblages is primarily at the expense of lagomorphs. Bedwell (1970:191) suggests in a footnote that the dramatic increase in scraper types and numbers in his early WPLT assemblages may well indicate both the increased processing of hides and more intensive winter occupation of the caves. In sum, considering both faunal and artifact assemblages, the Connley Caves appear to be good candidates as late fall-winter base camps during what we have called the Fort Rock Period (cf. Bedwell's WPLT period).

Cougar Mountain Cave, situated in a small volcanic dome 20 km northeast of Fort Rock at about 1334 m (4446 ft.) elevation, was excavated to bedrock in 1958 by John Cowles, an avid artifact collector, who reportedly kept track of approximate artifact proveniences by one foot levels (Cowles 1960). The cave was filled to a depth of two meters (6.5 ft.) with rich cultural deposits. Cowles reported the exclusive recovery of large lanceolate, foliate, and Western Stemmed (including Windust) points, and one crescent in the lowest two feet (60 cm) of deposits. Bison bones (dated no later than ca. 8900 cal. BP at the Connley Caves) also occurred only in the lower two feet of deposits at Cougar Mountain Cave. Other artifacts included well-made ovate knives, scrapers, abraders and manos, stone drills, pipes, bone awls, bone atlatl spurs, bone needles, pressure flakers, bone beads, shell beads, basketry, twine, sandals, matting, leather, and wooden artifacts. Sandals, which were fairly common, were frequently muddy (see Connolly and Barker, this volume, for recent radiocarbon dating of Fort Rock-style sandals). This rich assemblage, including artifacts generally found more commonly in later assemblages (e.g. pipes, pressure flakers, and bone beads), undoubtedly contains materials stratigraphically out of context. Still, all indications are that the Cougar Mountain Cave was a winter base camp, in some ways similar to that of Connley Caves.

Investigations at the Paulina Lake site (35DS34), some 40 kilometers northwest of Fort Rock in the Newberry Volcano, identified three Early Holocene cultural components below Mazama tephra, which ranged from 11,000 to 7500 cal. BP. Component 1, the initial occupation of the site, dates to about 11,000 cal. BP; Component 2 dates from roughly 10,500 to 8500 cal. BP, and Component 3 dates from 8500 to 7500 cal. BP (Connolly and Jenkins 1999). Evidence of small structures and storage pits, preserved below thick layers of volcanic tephra, make this site unique. The storage pit, identified with Component 1, was roughly one meter in diameter and 45 cm deep. Grass pollen and starch granules suggest that it may have been grass-lined; other pollens included mock orange (*Philadelphus*) and willowweed (*Onagraceae*) (Connolly and Jenkins 1999:103). Near the pit, circular spaces cleared of stone suggest the possible presence of small structures, but no additional evidence exists to support this tantalizing possibility. Tools in Component 1 include Windust and foliate points, bifaces, flake tools, and an end scraper.

Component 2 comprised the majority of cultural deposits from the site. Excavations clearly defined the circumference of a small elongated wickiup or tepee-like structure with a well defined hearth near the center. The structure was roughly five meters long and four meters wide. It was surrounded by stout posts up to 20 cm in diameter but does not appear to have had an excavated floor. Radiocarbon determinations on three of these posts indicate the structure was built ca. 9500 cal. BP. Macrobotanical and pollen analysis identified chokecherry (*Prunus* cf. *emarginata*), bulrush (*Scirpus* sp.), sedge (Cyperaceae family), an unidentified nutlet, possible edible tissue, hazelnut (*Coylus*), salmonberry or blackberry (*Rubus*), lomatium (*Apiaceae*), and a variety of herbs. Beside the usual projectile points (Windust and foliate types, many with ground stems) and bifaces, the assemblage is distinguished by a rich cobblestone tool assemblage including ground, battered, striated and pecked abraders, hammerstones, mauls, girdled stones, a plummet stone, handstones and grinding slabs. Blood residues (rabbit, bison, bear, deer, and possibly mountain sheep) were detected on chipped stone tools (Williams and Fagan 1999).

Component 2 clearly represents a summer residential base camp, at which a broad range of subsistence resources were processed. The environment appears to have been both biotically rich and diverse. The artifact assemblage is like-wise fairly rich and diverse. Though the site is located in a caldera well-known for obsidian quarrying activities, quarrying was conducted only as a secondary activity necessary to replacement of exhausted chipped stone tools and does not appear to have been the primary reason for occupation of the site. Most of the exotic obsidian tool stone came from sources to the south, primarily in the Fort Rock Basin. Notably, the summer residential use of Newberry Caldera is contemporary with the hypothesized winter-residential use of the Fort Rock Basin caves. Together these sites suggest a relatively stable resident population in the area, contrasting with the typical characterization of highly mobile and dispersed foragers commonly associated with the Early Holocene.

Four sites on Buffalo Flat, located at the east end of the Fort Rock Basin (Oetting 1994a), also yielded cultural remains ranging in age from ca. 11,500 to 8900 cal. BP. Two of these sites (35LK1881 and 35LK2076) produced discrete, datable pit features filled with charcoal and rabbit bone, and ranging in size from small (<50 cm) to very large (250 cm x 300 cm). Radiocarbon dates associated with these cooking pits produced ages from ca. 10,500 to 9000 cal. BP. Sparse lithic assemblages associated with these dates include Western Stemmed projectile points, bifaces, cores, utilized flakes, ground stone (mano and metate fragments), and grooved abraders. More than 14,000 bones or fragments were recovered from one site, 10,000 from inside a single large pit and the remaining 4,000 from deposits surrounding it. At least 98% of these bones are from jackrabbits.

The Buffalo Flat sites appear to represent processing locations resulting from large scale, organized rabbit drives during the Early Holocene (Oetting 1993:673). Although Grayson and Cannon (1999:150) caution that the faunal assemblages merely indicate that rabbits were abundant, and say nothing about the method of rabbit capture, the bone abundance and concentration does suggest a communal mass-harvesting strategy.

Late Pre-Mazama (Lunette Lake Period, 9000 to 7600 cal. BP). Researchers throughout the region have long recognized distinctive cultural patterns for the pre-Mazama period. On the Columbia Plateau, the sequent Windust and Cascade phases are differentiated by distinctive material assemblages, and according to Ames (1988:356), by "clear evidence for different residential patterns." Based on their cave excavations, Bedwell (1973) and Cressman (1986) similarly recognized two sequent pre-Mazama cultural periods in the Fort Rock Basin. The WPLT assemblages of the early pre-Mazama cultural period were characterized by Cressman (1986:122) as "the climax of cultural development in the Fort Rock Basin." Bedwell (1973:159) observed of the Late pre-Mazama period (ca. 9000 to 7500 cal. BP), that "change is undeniable in terms of artifact form and flaking, a greater emphasis on the use of obsidian, the greater use of unretouched flakes, and the addition of new tools."

A distinction is also noted at the Paulina Lake site, where Component 3 (ca. 8500-7500 cal. BP) provides no evidence of domestic features or pits, and offers a markedly less diverse tool assemblage. Projectile points are predominantly foliates lacking grinding on the stem margins. Projectile points, point fragments, and unfinished points increase in number, as do the numbers of bifaces in general and ovate bifaces. Ground and pecked stone tools continue, though in substantially reduced numbers.

UO field school excavations at the Locality III site, buried in a lunette dune in the Fort Rock Valley, exposed a dense concentration of small hearths averaging ca. 60 cm in diameter and 15 cm in depth (Jenkins 2000). These features produced radiocarbon dates ranging from ca. 8600 to 6300 cal. BP (7880 to 5550 RCYBP). The Early Holocene cultural and faunal assemblages are nearly identical to those of the Buffalo Flats sites. Rabbits form the major portion of the faunal assemblages, which also include waterfowl and their eggs. Fish seldom appear in cultural assemblages, and then only in minute quantities. Macrobotanical assemblages include both marsh and upland plants. The low density and diversity of all these assemblages suggests a settlement-subsistence mode of extreme mobility, even in the relatively rich, more biotically diverse environs of the marsh-grasslands ecotone at Locality III. Individual site occupations were extremely short-term, perhaps lasting only a few days at a time. Although a few Olivella shell beads were recovered from the cultural deposits, there are no structures or storage facilities currently known, though large hearth features like those found on Buffalo Flat probably also exist in the Fort Rock Valley sub-basin (Jenkins, this volume).

Clearly, the large cultural assemblages of Early Holocene components at the Paulina Lake site vary substantially from the tiny assemblages found in the Fort Rock Basin. However, projectile points, bifaces, abraders, and expedient flake tools are common in all of these assemblages, and actually appear to increase slightly in number during the latter portion of the period (8300 to 7500 cal. BP). Ground and pecked stone artifacts occur in reduced numbers in the late pre-Mazama Component 3 at Paulina Lake and are present in small numbers in nearly all components of similar age in the Fort Rock Basin. Large game hunting clearly remains important at Paulina Lake, despite—or perhaps because of—the increasing environmental homogeneity and reduced biotic diversity of the area caused by the massive Mazama ashfall about 7600 cal. BP. In the open dunes of the Fort Rock Basin, projectile points, point fragments, and preforms make up a major portion of the known assemblages, even though the faunal remains recovered at these sites are predominantly rabbits and waterfowl, which are most efficiently taken with nets. It seems entirely possible that projectile points were serving as both points and cutting implements, as suggested by Beck and Jones (1997) for other Great Basin Early Holocene assemblages.

Best known as the location of the Dietz Clovis site (35LK1529), the Alkali Basin to the east of Fort Rock also contains a substantial number of Early Holocene sites (Fagan 1986a, 1988; Pinson 1996, 1998, 1999; Willig 1988, 1989). Situated at the base of an east facing ridge located at the extreme northwest end of the Alkali Basin, the Dietz site is a large multi-component lithic scatter one kilometer in length. As mentioned earlier, it incorporates a low-elevation Clovis component on the valley floor and a Western Stemmed component slightly higher on Dietz Hill. As also mentioned earlier, no subsurface deposits have been definitively identified at the Dietz site, and while the Early Holocene assemblage is large and diverse the site contained no subsistence information beyond what could be inferred from the site setting as reconstructed from geoarchaeological data. Consequently, the primary contribution of Willig (1988, 1989), and later Pinson (1999, this volume), was the geoarchaeological interpretation of stratigraphic sequences exposed in backhoe trenches cut at the Dietz and Tucker (35LK1529) sites. Pinson reopened and extended most of Willig's earlier backhoe trenches (see Pinson, this volume). Pinson's (1999) investigations led her to some significant differences with regard to Willig's geomorphic interpretations, but also produced significant confirmation of key cultural fundamentals.

Willig envisioned the Terminal Pleistocene-Early Holocene boundary as a cool-wet period, and hypothesized the existence of four lake stands related to human occupations: Lake Koko, a shallow, marshy lake or pond associated with the Clovis occupation, Sand Ridge Lake, dated from early Western Stemmed times (ca. 11,500-10,700 cal. BP [10,000 to 9500 RCYBP]); a shallower late Western Stemmed period Lake Delaine (ca. 9500-8900 cal. BP [8500 to 8000 RCYBP]), and a deep though short-lived Big-Cut lake, dating sometime between 7600 and 5700 cal. BP (6850-5000 RCYBP). Evidence that paleo Lake Beasley in the Fort Rock Basin was also filled at this time is reported by Jenkins, Droz, and Connolly (this volume). Willig questioned the efficacy of a predominantly large game hunting strategy in the Great Basin during the Western Clovis period and suggested the Clovis occupation at the Dietz site was related to a broad-spectrum foraging pattern not unlike that of later groups. Willig emphasized the fact that though Western Stemmed sites were generally found near streams, marshes, and lakes they did not represent a specialization on lacustrine resources as proposed by Bedwell (1970). Alternatively, she characterized the Western Stemmed adaptation to the Northern Great Basin as one that was "tethered" to mesic environments she referred to as "sweet spots" because they provided reliable resources during times of environmental stress (Willig 1989:276).

Pinson resumed geoarchaeological excavations and mapping in the Alkali Basin in 1995 with the intention of testing Willig's "Four Lake Model" (Pinson 1996). She reexamined the 12 skip trenches left open by Willig, excavated another backhoe trench, manually excavated three test units (one 1x1 m, one 1x4 m, and one 4x4 m) at the Dietz site, and conducted further surface collections of artifacts in strips and blocks around the site. Pinson (1999:154) concluded,

> the stratigraphic record sequence along Dietz Hill records just two separate lake stands. The higher, earlier [Pleistocene] lake is represented by the Qb1 and Qbe1 deposits. The lake stood at or near 1322 m elevation and may have had a depth exceeding 6 m- 10 m depending on how much sedimentation and erosion has since occurred across the basin. A second shallower, younger lake, represented by the Qb2 and Ql2 deposits, may represent either a recessional still stand of the older lake or the formation of a new lake following substantial lowering or desiccation of the Qb1 lake. This lake had a surface elevation of approximately 1318 m and may have had a depth on the order of 2 to 4 meters, placing it at the boundary between lake and pond in the classification of Currey (1994b).

Pinson thus agrees with Willig that both a higher and a lower lake stand were evident at the Clovis locality, but she considered that the Lake Koko bed and shoreline, where the Clovis artifacts were mainly found, was later than the higher beach line, which she considered to represent an older, earlier lake. Willig's interpretation, on the other hand, was that numerous Western Stemmed points, almost all of which were found along the Dietz Hill above Lake Koko and extending to an elevation above 1320 m, implied a post-Clovis date for the higher beach line.

Willig's subsurface testing at the Tucker site (35LK1529), opposite Dietz on the eastern edge of the sub-basin, had revealed a buried paleosol between 1317 and 1318 m. elevation. An accelerator date of ca. 10,900 cal. BP (9610±100 RCYBP; Willig 1989:217) was returned on a charcoal fleck at 166 cm from the surface, which was evidently from Stratum Qe3a as later defined by Pinson (1999). Eroding out of the old soil were found large bifaces, blanks, cores, flaking debris, and ground stone tools. Willig found no diagnostic points but she believed the Tucker site to belong to the Western Stemmed horizon because she saw the assemblage as otherwise identical to those she had found at some 30 other Western Stemmed sites in the surrounding area. Also, the date of the Tucker site paleosol placed it well within the Western Stemmed time range.

Pinson conducted much more intensive investigations at the Tucker site, ultimately excavating four more backhoe trenches and manually excavating 24 m². Radiocarbon dates ranging from ca. 11,000 to 10,300 cal. BP (9160, 9480, 9520, and 9540 RCYBP) are reported by Pinson (1999:169) for the Tucker site Western Stemmed occupation, which she identified as occurring in a lunette dune (Stratum Qe3a) that had formed on the edge of an ephemeral marsh. Pinson (1999, this volume) favors the drying of the last shallow (ca. two meters deep) Early Holocene lake in the Dietz sub-basin by ca. 10,800 cal. BP (9600 RCYBP), followed by more xeric wet-meadow conditions. Thus, Pinson disagrees with Willig's belief that a post-Clovis lake overtopped Clovis-age Lake Koko, contending there has been no deep water in the Alkali Basin since the end of the Pleistocene. On the other hand, her results have confirmed Willig's Western Stemmed attribution and dating for the

Tucker site. Pinson finds no evidence to support Willig's concept of a mid-Holocene Big Cut Lake, instead interpreting her putative "shoreline" as a Late Holocene eolian blowout that was preserved by subsequent dune formation. This new mid-Holocene dating, however, has little relevance to the Early Holocene cultural periods under discussion here.

Pinson offers an interpretation much like Willig's in addressing the cultural implications of the Dietz and Tucker sites, contending that the subsistence focus of the Western Stemmed period was on small mammals and waterfowl, an adaptation that was related to "a risk-sensitive, variance-minimizing foraging strategy" which was a response to "tremendous ecological changes of the Initial Archaic" (1999:218). This strategy continued through the Middle Holocene until about 6000 cal. BP when, Pinson suggests, a return to more mesic conditions allowed the development of a relatively risk-indifferent foraging pattern including the pursuit of more large game.

The data for the Early Holocene in the greater Fort Rock region suggest at least three basic site types. Two of them, residential bases and temporary foraging camps, have been identified in and around marsh and lacustrine settings. Base camps, perhaps late fall and winter occupations, have been identified at the Connley Caves near Paulina Marsh, at Cougar Mountain Cave, and possibly Fort Rock Cave. The latter two sites are both within a few miles of the northernmost arm of the Fort Rock Valley marsh, which follows a channel system running north and west from Silver Lake around the Connley Hills to paleo Lake Beasley. Fort Rock Period components 1 and 2 at the Paulina Lake site appear to be summer residential occupations by people who also visited—or were perhaps centered in—the Fort Rock Basin (Connolly 1999b). Temporary foraging camps (Locality III and the Tucker site), were used very briefly in spring and summer while local resources were harvested. The third site type is the resource processing location, examples of which are found on Buffalo Flat in the arid eastern end of the Fort Rock Basin.

Fort Rock Period (12,000-9000 cal. BP) residential sites and base camps are characterized by substantial artifact, macro-botanical, and faunal assemblage sizes and diversities, reflecting at least seasonal sedentism and a corresponding breadth of camp maintenance activities. Basic tool classes present at all three types of sites include projectile points (Western Stemmed, lanceolate, and foliate), ovate bifaces, expedient flake stone tools, abraders and manos. These multi-function tools bespeak high mobility and broad application to a variety of tasks. In addition to significant quantities of these tools, residential bases are also characterized by numerous cobble tools, steeply retouched end scrapers, and gravers, suggesting that large game hunting and the processing of animal hide and bone were common activities in such sites. In addition to hunting, plant processing is also consistently indicated, though it was undoubtedly somewhat less important at this time than it was during the latter part of the Middle Holocene.

Pinson (this volume, 1999) suggests that there is evidence of variance in game procurement patterns between the Early and Middle Holocene periods. She proposes an Early Holocene specialization in small animal procurement systems designed to reduce starvation risk by consistently pursuing those animals least susceptible to changing—and often more xeric—climatic conditions. Thus, in her reconstruction, artiodactyl procurement during the Early Holocene Fort Rock Period was less frequent than it became during the wetter late Mid-Holocene Bergen Period.

The procurement of rabbits was probably the most consistently pursued hunting activity conducted throughout the Northern Great Basin over thousands of years, and is well attested for the Early Holocene at the Tucker, Buffalo Flat, and Locality III sites. However, the quantity and type of faunal remains at other sites varies significantly, apparently in relation to the locations of particular sites and their seasons of occupation. For instance, major Early Holocene use of waterfowl at the Connley Caves is surely a reflection of the site's close proximity to Paulina Marsh, where resident and migratory waterfowl provided a fresh food resource available throughout the year. In fact, the Early Holocene occupations of all the Fort Rock Basin cave sites seem to reflect intervals when waterfowl and large game (deer, elk, pronghorn, and bison) provided annually replenished (migratory) fresh food resources through the late fall, winter, and early spring seasons. It is notable that in modern times a very large deer herd winters in the western end of the Fort Rock Basin, near the Connley, Cougar Mountain, and Fort Rock Caves (see O'Grady, this volume), and this may well have been true in earlier times also. In contrast, there is currently little evidence from the open sites of the Fort Rock Basin for intensive waterfowl exploitation. Instead, these sites tend to contain egg shells and immature rabbit and waterfowl remains that suggest spring and early summer occupations. While waterfowl are present in most Early and Middle Holocene marsh-side sites, they generally appear in small numbers unless they are accompanied by quantities of large game and other indicators of more intensive occupation. There is inconsistent evidence in the greater Fort Rock Basin for the specialized Early Holocene waterfowl procurement strategy (WPLT) proposed by Bedwell (1973, 1970). The abundance of bird bones that Bedwell found in the Connley Caves has not been duplicated in other Fort Rock Basin sites, or in the Tucker site farther east. Edge-damage analysis of crescents, once thought to be a type of bird point (Tadlock 1966; Clewlow 1968), has recently shown that these uniquely shaped artifacts are more likely to have been used as cutting and scraping implements (cf. Beck and Jones 1997:207-208). The use of nets and snares to capture waterfowl—but also rabbits—is well documented among historic Northern Great Basin (Fowler and Liljeblad 1986) and Klamath Basin (Voegelin 1942) groups, and traces of cordage that may be fragments of netting have been found in the Fort Rock caves. However, cordage had many uses, and by itself is not clear evidence of a specialized tool kit related to waterfowl or rabbit procurement.

In sum, a broad-spectrum predation pattern is generally evident throughout the Fort Rock Period settlement-subsistence system in the Northern Great Basin, with occasional evidence of specialized harvesting/processing locations such as the Buffalo Flat rabbit processing sites or the Connley Caves, where waterfowl were abundant. Though storage of plants is suggested at the Paulina Lake site, storage has yet to be verified for this period anywhere else in the Northern Great Basin. Over-wintering sites generally appear to have been situated in biotically heterogeneous ecotonal settings, which maximized access to both local and migratory waterfowl, and probably migratory big game herds. Shelter, southern exposures, and the availability of firewood also appear to have been important considerations in the location of winter residential bases.

This conclusion is consistent with the results of the PGT-PG&E Pipeline Expansion Project (Schalk et al. 1995:9-27, 9-28), which traverses the Deschutes River and Klamath basins, passinga immediately to the west-northwest of the Fort Rock Basin. It also fits well with Ames' (1988) assessment of broad-spectrum settlement-subsistence patterns for the Pioneer Period (Windust and Early Cascade phases) on the Southern Columbia Plateau to the north. Thus, there is considerable support for the conclusion that during the Early Holocene in the Northern Great Basin, summer and winter residential site selections were directed toward procurement of plentiful but differing animal resources, primarily big game in some locations and smaller game (birds and rabbits) in others. Roots, seeds, and fruits were exploited, though they generally seem to have contributed less to the diet than they would during subsequent periods.

Middle Holocene (Lunette Lake and Bergen Periods, 7600 to 3000 cal. BP)

The Middle Holocene (7600 to 3000 cal. BP) is generally characterized by two distinctly different climatic phases. The first half of the Middle Holocene (Lunette Lake Period, ca. 7600 to 6000 cal. BP) is a continuation of the trend toward increasing aridity which began near the end of the Early Holocene. The second half (Bergen Period) is a moister period—characterized by expanded and more stable marshes throughout the region—that began in different basins between 6000 and 5500 cal. BP (see Minckley et al., this volume; Jenkins, Droz, and Connolly, this volume).

Bedwell (1970, 1973) reported that occupation in the Connley Caves was greatly reduced during much of this period, and may have ceased altogether between roughly 8000 cal. BP and 5500 cal. BP (7240 to 4720 RCYBP). This break in occupations is bracketed at the Connley Caves by obsidian hydration measurements of 4.3F to 5.3F (ca. 5600 to 8500 cal. BP; Jenkins et al. 2002:26). Recent excavations at the Paisley Caves indicate a similar hiatus in occupations there. The caves of the region were seldom occupied, but intense, sporadic exploitation of marsh and grassland resources continued throughout this period in nearby lowland dune sites such as Locality III (Jenkins 2000), Bowling Dune (Jenkins, this volume), Kelly's Site and Locality I (Mehringer and Cannon 1994), all of which are located not far from Fort Rock Basin caves. Changing plant communities may have begun to exhibit greater homogeneity across broader areas, requiring an increase in human mobility to achieve the levels of subsistence reliability that had been more easily obtained from fewer locations during the previous period (Fort Rock Period). The caves, located in distinctive situations some 50 meters above the valley floors, may have simply been in the wrong places to accommodate settlement-subsistence needs during the Lunette Lake Period.

Bedwell (1973) presumed that the climactic eruption of Mount Mazama had disastrous effects on human occupation in the Fort Rock Basin, but this has been debated (Grayson 1979). There is little evidence in the lunette dunes that the marshes were seriously impacted by the deposition of ca. 50 cm of Mazama tephra at about 7600 cal. BP. Radiocarbon dates and obsidian hydration readings from occupation sites bound this eruptive event closely, indicating that if the area was abandoned by its usual occupants, they were back again after a relatively short time, perhaps less than 100 years (cf. Mehringer and Cannon 1994:323). Though subsequent individual site occupations were short, they continued sporadically throughout the warm-dry Middle Holocene Lunette Lake Period. Populations apparently fluctuated with available marsh/grassland resources and trended, in general, toward the low end of the demographic scale.

At Newberry Caldera, and in much of the Deschutes and Klamath river basin, however, the pollen and archaeological records indicate significant environmental and cultural use-pattern changes (Scott-Cummings 1999; Connolly 1999a; Schalk et al. 1995). Much of this area, which prevailing winds left with a thicker layer of Mazama ash than the Fort Rock Basin, became a "pumice desert" in which shrubs and lodge-pole pine became dominant, reducing biotic diversity and productivity. This effect caused a massive area bordering the Fort Rock Basin to the west, one which probably formed a major node of the Early Holocene settlement-subsistence pattern, to be seriously altered. However, because archaeological data from the region are limited (probably deeply buried by Mazama tephra), the local response can only be hypothesized to have changed to some degree. Projectile points appear in some known sites to have *increased* somewhat in number, suggesting that the human response was to begin using the area in an even more ephemeral and specialized pattern than previously, involving highly mobile hunting excursions for large game (Schalk et al. 1995; Connolly 1999b).

On the other hand, at sites like Locality III in the Fort Rock Basin marshes, there is no obvious evidence for a dramatic shift in settlement-subsistence patterns at the time marked by the eruption of Mount Mazama. People apparently used the caves only rarely, but continued to use the marshes whenever biotic productivity warranted. Water inflow, while undoubtedly reduced on average, was still occasionally altered by short-term, unusually intense wet periods that were of sufficient duration for fish and marsh plants to reestablish themselves. In fact, one of the most intense–if perhaps short-term–post-Pleistocene flood events apparently occurred in the Fort Rock Basin just before or during the climactic eruption of Mount Mazama, filling the Silver Lake/Fort Rock (SL/FR) channel system with water that reached to within one kilometer of the modern village of Fort Rock (Jenkins, Droz, and Connolly, this volume). Exploitation of the marshes continued to be a regular spring-time event, as evidenced by the presence of waterfowl egg shell in most archaeological deposits of this time. Some evidence of inter-regional trade or travel is found in the presence of *Olivella* shell beads, which appear in small numbers by 9200 cal. BP and continue throughout this period (Jenkins, L. Largaespada, T. Largaespada, and McDonald, this volume).

Sites like Locality III, situated in the occasionally rich wetlands/grasslands ecotone of the Fort Rock Basin, are examples of temporary foraging campsites common to the transitional period (Lunette Lake Period) which spanned the end of the Early Holocene (ca. 9000 to 7600 cal. BP) and early part of the Middle Holocene (ca. 7600 to 6000 cal. BP). Settlement-subsistence patterns show increasing mobility in the Fort Rock region during the Lunette Lake Period, characterized by artifact assemblages that generally exhibit little diversity, low density distributions, and multiple-use tools rather than specialized single-use tools.

The evidence suggests that tiny, highly mobile (family?) groups spent very short periods of time at temporary foraging sites exploiting local resources (rabbits, waterfowl, and waterfowl eggs) near each site for a few days, and moving frequently to offset increasing costs and decreasing benefits as local resources were depleted (cf. Charnov 1976). Cultural assemblages continue to be numerically small and exhibit predictable eveness (i.e. limited diversity). Projectile points for most of the period continue to be predominantly foliate types.

The inception of Side-notched projectile point types in the Fort Rock Basin is most commonly dated by obsidian hydration to about 7500 cal. BP (ca. 6800 RCYBP). Manos and metates are consistently present in these tiny cultural assemblages but continue to be primarily expedient, unformed types, which generally comprise relatively small portions of the cultural assemblage. Plant remains recovered from cultural contexts include scattered occurrences of chenopodia, bulrush, wada, knotweed, and grass seeds, along with sagebrush and juniper charcoal. Bifaces, expedient flake tools, and abraders continue as portions of the non-specialized tool assemblage, indicating continued high levels of mobility and low levels of tool/task specialization (Jenkins 2000). Occupations apparently continued to be extremely transient until approximately 6000 cal. BP (5000 RCYBP) when some evidence of caching behavior in the caves began to appear, along with more sedentary occupations on “living floors” in marsh-side sites.

Dramatic differences exist between the earliest Middle Holocene assemblages (Lunette Lake Period, 7600 to 6000 cal. BP) and the later Middle Holocene assemblages (Bergen Period, 6000 to 3000 cal. BP) in the Fort Rock Basin. For example, few tui chub bones (*Gila bicolor*) are present in faunal assemblages of the Lunete Lake Period at Locality III (but see Mehringer and Cannon 1994 for Early Holocene fish consumption at this site) and the Bowling Dune site (O'Grady, this volume; Singer, this volume; Jenkins 2000). Yet, tui chubs are common in Bergen Period assemblages dated after ca. 6000 cal. BP at the Bergen, Big M, DJ Ranch, Claim A1, and Bowling Dune sites (Greenspan 1994; Helzer, this volume; Jenkins 1994c; Moessner, this volume; O'Grady, this volume).

Evidence for a shift in residential patterns at about 6000 cal. BP is found in the varying density of lithic debitage and faunal remains at different sites. Lithic debris and bone fragments were recovered at very low quantities of 127 and 305 pieces per m^3, respectively, from the Lunette Lake Period deposits of Component 2 at Locality III. These recovery rates are comparable to those of pre-Mazama deposits at the Bowling Dune site. There, totals of 1,754 flakes and 973 fragments of bone were recovered from an area of 20 m^2 with an excavated volume of 5.5 m^3, producing means of 319 flakes and 177 bone fragments per m^3 (Jenkins, this volume). In contrast, excavations in Bergen Period deposits at the DJ Ranch site covered an area of 54 m^2 and removed 47.2 m^3, producing means of 563 flakes and 1,192 bone fragments per cubic meter. Faunal assemblage diversity increases proportionately, with mule deer, mountain sheep, pronghorn, elk, rabbits and hares, canids, mustelids, many kinds of waterfowl, and fish present in varying quantities (O'Grady, this volume; Singer, this volume).

By 6000 cal. BP increased sedentism was developing as an alternative method of exploiting the rich marsh-grasslands ecotone of the Fort Rock Basin, and by 5600 cal. BP houses and large storage pits were common in site locations that offered easy access to abundant lowland subsistence resources, including fish, seeds, and small animals. Upland roots were probably exploited as early as 10,000 cal. BP (Connolly and Jenkins 1999:102) but do not appear to have formed as large a part of the diet as lowland resources until sometime after 4000 to 3000 cal. BP. Artiodactyls were hunted in both the uplands and lowlands, and bones indicate whole carcasses were brought back to house sites, hamlets, and villages.

There is a strong correlation between the construction of houses and storage pits in the open sites of the Fort Rock Basin, and increased diversity and richness in artifact and faunal assemblages. This indicates that the period over which a site was occupied had been extended, providing more time for a greater variety of items to accumulate. Resource intensification in fishing and small seed production systems correlates well with the appearance of large volume storage pits (Jenkins 2000, this volume). Sedentism, with all of its risks and costs in labor and social organization, was apparently unnecessary prior to about 6000 cal. BP, most likely because human populations were low and residential mobility levels relatively high. After that time, however, sedentism in the Fort Rock Basin reached unusually intense levels suggesting that human populations were relatively high during at least two periods between 6000 and 3000 cal. BP—5700-5400 cal. BP and 3900-3500 cal. BP (Jenkins, Droz, and Connolly, this volume).

Local settlement-subsistence patterns are best conceived as segments of larger regional and inter-regional patterns. Local population increases do not have to be the direct result of local increases in birth rates (Jenkins 1994a). Middle Holocene populations undoubtedly fluctuated in and between various local basins within the Northern Great Basin, as subsistence resource productivity and reliability fluctuated in response to climatic and ecological changes. One of the possible effects of Middle Holocene circumscription of populations might have been to dramatically increase Fort Rock Basin populations when resources were abundant locally, and scarce extra-locally, such as when there was too much water or snow in surrounding regions. Previously dispersed populations surrounding the Fort Rock Basin (e.g. Klamath Marsh, Sycan Marsh, Deschutes River Basin, and Harney Basin) apparently gravitated toward it due to these kinds of local environmental stresses. Once residential population levels in the Fort Rock Basin were increased beyond previously attained levels, changes in local settlement-subsistence patterns, accompanied by at least moderate adaptations in social organization, would have been necessary (Aikens and Witherspoon 1986; Connolly 1999a).

Resource intensification in small seeds and fish, combined with increased sedentism are plausible alternative methods of resource allocation and exploitation which may have been necessary to accommodate substantially increased populations that had gravitated to more dependable resources in expanded marshes of the Fort Rock Basin during the Bergen Period. Large volume storage of seasonally abundant lower-ranked resources like minnows, chenopodia, amaranth, wada, and bulrush seeds was a necessary component of this kind of regional population adjustment. Exploitation of migratory game animals, waterfowl, mule deer, pronghorn, and elk, provided important fresh foods to winter diets. However, not all sites were equally well-suited to take advantage of these resources. Some, like the Bergen site (O'Grady, this volume), were located nearer sheltering woodlands and over-wintering sites for herds of large game at the northwest end of the basin while others like the Big M site were located near more stable marshes at the southwest end of the basin where specialization in fish and waterfowl exploitation would have been more practical. Trade, gift exchange, and gambling probably played important parts in redistributing "patchy" resources between intra- and inter-basin populations. The expansion in types and quantities of trade and artistically embellished artifacts–beads, carved bone tools, pipes, mauls, and stone balls for instance–provide evidence of both resource redistribution and increasing social complexity during the Middle Holocene Bergen Period (Jenkins, L. Largaespada, T. Largaespada, and McDonald, this volume).

This increased sedentism within the Fort Rock marshes was reduced after 3500 cal. BP, and appears to have ended by about 2900 cal. BP (Jenkins, Droz, and Connolly, this volume). An intense regional drought ca. 2950 cal. BP (Wigand 1987) undoubtedly had something to do with this, but local and regional settlement-subsistence patterns had already begun to change prior to this time (Jenkins et al. 2000). Jenkins, Droz, and Connolly (this volume) note,

> At Nightfire Island, in the Lower Klamath Basin southwest of the Fort Rock Basin, occupants built an artificial island of basalt and earth for their pithouse village in a rising lake at about 5600 cal. BP. Pithouses were abandoned there about 3100 cal. BP and replaced by more ephemeral above-ground structures. Sampson (1985:511-513), noting correlations in stratigraphic, faunal, and archaeological assemblage changes, suggests that the post-3100 cal. BP period was characterized by reduced marshes, reduced sedentism, and increased residential mobility. As noted above, sedentism in marshes was substantially reduced in the Fort Rock Basin sometime after 3500 cal. BP and ended by 2900 cal. BP. . .This final shift of residence out of the marshes may have initially been a response to reduced reliability of marsh resources brought on by drought (Wigand 1987), but the reason sedentism within the marshes was not reestablished at previous levels after this drought probably has more to do with increasing dependence on upland root crops after 4000 cal. BP.

Late Holocene (Boulder Village Period, 3000 cal. BP to Historic Contact)

Marsh resources remained very important to growing local populations, as they were for the Northern Paiute (Fowler and Liljeblad 1986), Klamath (Spier 1930), and Modoc (Ray 1963) of the Historic period, but these resources were generally harvested from more temporary camp locations within the marshes after 2900 cal. BP. Rather than being sited within the marshes, winter villages in the Fort Rock-Summer Lake-Lake Abert region were most often located at the edge of marshes, nearer the foothills, after that time. Stone house ring and pithouse villages were built on low prominences on the edge of marshes and lakes of the Fort Rock, Chewaucan-Lake Abert, and Warner basins (Wingard 2001; Eiseldt 1998; Oetting 1989; Pettigrew 1985), reflecting intensifying agglomeration of local populations and increasing reliance on upland root crops. In contrast, in the Harney Basin where geomorphology and ecological settings varied, sedentism apparently continued in the lakes and marshes throughout the Late Holocene (Oetting 1990, 1999; Carter and Dugas 1994; Musil 1995). Even so, human skeletal evidence from that basin suggests that entire families were much more mobile than contemporary populations of Stillwater Marsh in Nevada (Bettinger 1999:329), traveling long distances together to hunting and root grounds (Hemphill 1999). Fort Rock populations apparently situated late fall/winter sites at ecotonal settings near both marshes and upland root-grounds.

While the Late Holocene is not a major focus of this volume, a substantial recent monograph based on NGBPP research (Wingard 2001) presents a major data set and discussion of the Late Holocene in the Fort Rock Basin, and for the sake of linking the coverage of the present volume to recent developments in Late Holocene research, the main elements of Wingard's study are summarized here. The Carlon Village site, located on a low ridge at Silver Lake, is the best known example of a Late Holocene settlement (Wingard 2001). This impressive site was sporadically occupied from the Early Holocene into the Historic era, but domestic structures included eight large stone ring houses (several exceeding six meters in diameter) made of huge boulders built after ca.

2350 cal. BP. The primary supports of the superstructures appear to have been pine brought from distant forested ridgelines. Bulrush matting and/or grass bundles probably served as roofing materials. Extremely rich and complex artifact and faunal assemblages indicate this was a long-term occupation site exhibiting possible evidence of social complexity in the presence of varying house types segregated at the top (stone rings) and bottom (shallow earthen house floors) of the ridge. Subsistence data include typical marsh resources such as fish, waterfowl, wada, bulrush, grasses, and chenopodia. Upland resources are represented by fruity tissues, processed edible tissues, charred roots, and imported fuel wood and structural materials (Wingard 2001).

Obsidian source data suggest that residents of Carlon Village also occupied the well-studied Boulder Village site, located in the upland root grounds east of Silver Lake, by about 1400 cal. BP (Jenkins and Brashear 1994; Wingard 2001:137). Boulder Village is a large site composed of more than 120 structures and 50 large cache pits. Tool and faunal assemblages are limited in quantity and diversity, clear evidence of the temporary and generally short-term nature of occupations related to the intensive exploitation of spring time upland root-crops (Jenkins and Brashear 1994). Smaller outlying hamlets and isolated house sites in the upland root grounds exhibit obsidian source signatures that are much different than those of Boulder Village and Carlon Village (O'Grady 1999; Jenkins et al. 1999). These smaller, more ephemeral habitation sites generally have more obsidian originating from sources in and around the Harney Basin. Paired in the typical two village settlement pattern common historically for Plateau populations and the Klamath/Modoc, the Carlon and Boulder village sites provide new and detailed insight into the social organization and subsistence-settlement patterns which developed, at least partially, in response to an increasing reliance on upland root crops during the Middle Holocene Bergen Period.

In sum, Late Holocene populations in theNorthern Great Basin appear to have been numerous and much more agglomerated—perhaps as a measure of protection—than in previous times. While people continued to rely heavily on lowland resources such as fish, waterfowl, rabbits, and small seed crops, they had developed a new degree of reliance on upland root-crops that annually appear when food—cached or fresh—is scarcest (early spring). Settlement patterns clearly reflect this shift in subsistence dependence throughout the Fort Rock region (Jenkins 1994a; Jenkins and Connolly 2000; Oetting 1989; Pettigrew 1985). Projectile point assemblages from uplands surveys similarly reflect the gradually intensifying use of upland resources throughout the region by the latter part of the Bergen Period (ca. 4000 to 3000 cal. BP (Brashear 1994; Byram 1994), a pattern which continued and intensified through the early (post-3000 cal. BP) part of the Late Holocene. By ca. 1400 cal. BP people were building temporary stone ring habitation shelters near stored food supplies (dried roots) in the uplands. The location of these sites in hard-to-reach settings suggests that safety of the occupants from surprise attack may have been a concern then, as it was in historic times throughout the region (Spier 1930; Ray 1963; Oetting 1989; Bettinger 1999:330). Populations expanding from areas to the south and east may have presented a threat to which local populations responded by living in larger groups, both in the lowlands where they over-wintered and in the upland root-grounds occupied in the early spring.