POSSIBLE CORRELATIONS BETWEEN ENVIRONMENTAL FLUCTUATIONS AND OBSIDIAN USE AT FIVE MONO COUNTY SITES

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ABSTRACT

Studies along Highway 395 in Mono County have identified several prehistoric sites, five of which were recently excavated. In this paper, it is assumed that the environment had an effect on site formation processes, particularly with respect to subsistence strategies. It is proposed that examination of obsidian hydration, sourcing, and paleoclimatic data may help identify certain patterns between these variables. This and other hypotheses are being tested through a phased research program. Preliminary findings are reported here.

INTRODUCTION/METHODS

In the last 13 years several workers (Mehringer 1977; Bettinger and Baumhoff 1982; Elston 1982; Hall 1983) have constructed paleoenvironmental models for central-eastern California. These models are based on the synthesis of dated events in geology, palynology, dendrochronology, and hydrology. Similar to the analytical framework used by Bettinger and Elston, the model constructed here uses climate-related shifts in vegetation type and productivity to make archaeological predictions. The environmental record and archaeological predictions are then compared to archaeological data generated by the excavation of 5 sites in the Bridgeport vicinity (Figure 1). Cross-dating of the more temporally diagnostic tools coupled with obsidian hydration measurement profiles are used to identify possible correlations between the archaeological and environmental records.

This model is specifically applicable to a high elevation location, such as Bridgeport, where growing seasons are short and resources are widely dispersed. The underlying postulate is that dependence on direct procurement of dispersed resources produces pronounced reactions to environmental fluctuations.

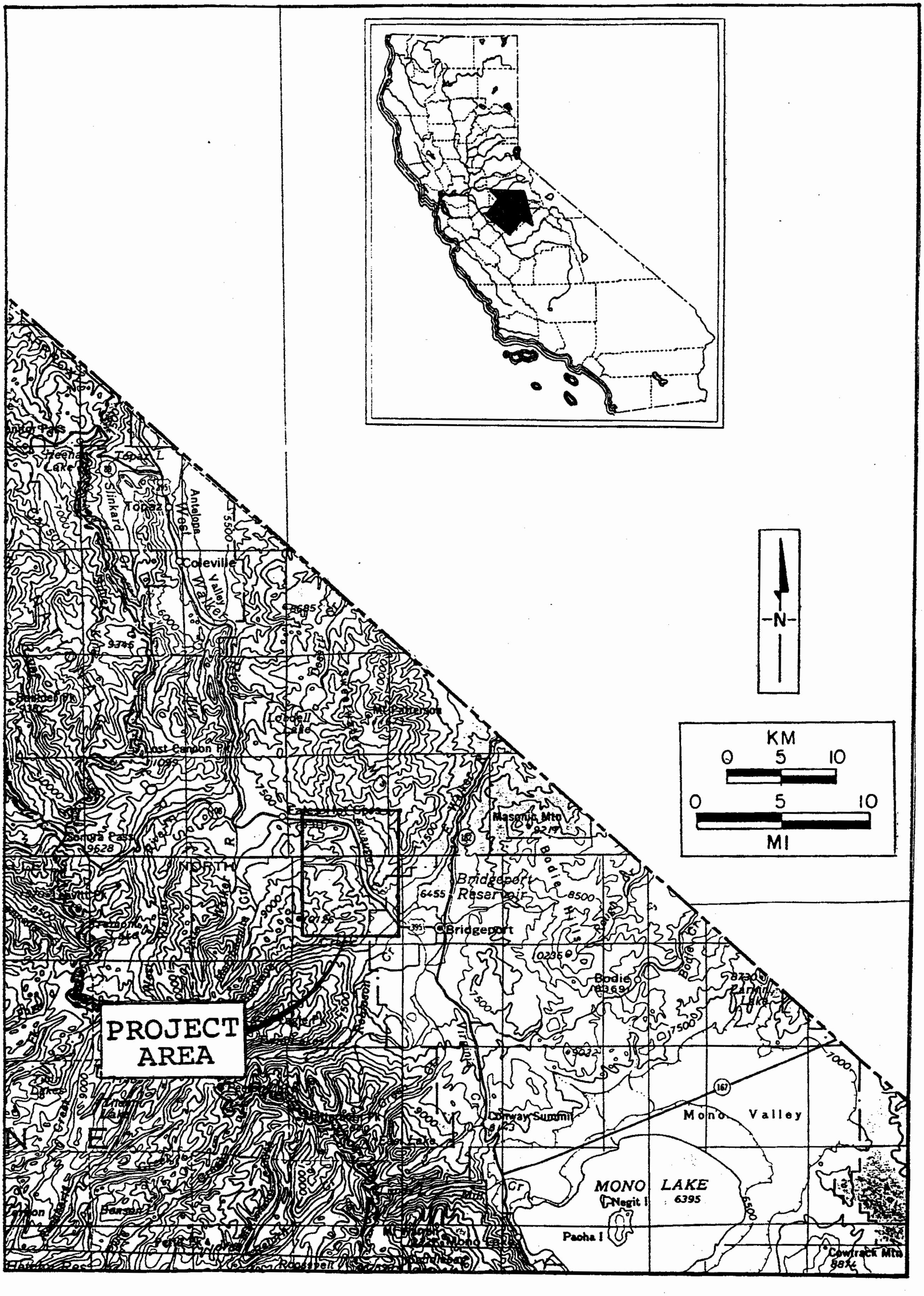


Figure 1. Project Location.

PHYSIOGRAPHIC SETTING

Bridgeport's environment has certain physiographic variables affecting its potential for human exploitation: 1) It is located along a geographic corridor between 6000 and 7000 feet; 2) It has a dependable watercourse and riparian corridor within 65 feet of the archaeological sites; 3) Its vegetation consists of Jeffrey pine, pinyon juniper, and sagebrush/desert scrub communities; and 4) It has a nearby obsidian source - Bodie Hills, 20 miles to the southeast.

LATE PLEISTOCENE

Climatic data indicate parts of the Sierra Nevada were probably quite habitable on a short-term seasonal basis between 13,000 and 11,000 years ago at the end of the Pleistocene.

Eastern Sierra pollen and microfossil records indicate a cool, dry climate with summer drought and mean annual precipitation similar to today (Anderson et al. 1985; Adam 1967). Climatic calculations indicate that late Pleistocene summers were March-like (Moran 1972), or around 53 degrees Fahrenheit in Bridgeport. Jeffrey pine probably moved downslope and became the dominant late Pleistocene vegetation (Figure 2). The fauna would have consisted of large and small mammals such as Inyo mule deer, black bear, and porcupine as well as birds and an aboriginally important insect, the Pandora moth, which inhabits the Jeffrey pine.

Jeffrey pine forests and 53 degree temperatures would have been conducive to summer hunting although the short season and low human population could have mitigated against it. Artifact assemblages would reflect an emphasis on hunting.

EARLY HOLOCENE

Moving from the Pleistocene to the Holocene there was a general warming trend. Throughout the Holocene, small glacial events alternated with warm, dry periods.

High percentages of pine pollen (Adam 1967; Batchelder 1980; Anderson et al. 1985; Davis et al. 1985; Mackey et al. 1976; McCarten and Van Devender 1988), as well as geologic data (Porter 1978:40) indicate that in the early Holocene, the eastern Sierra climate was somewhat warmer and wetter than the late Pleistocene. Vegetation zones previously dominated by Jeffrey pine were probably invaded by pinyon (McCarten 1990) and juniper as well as sagebrush moving upslope (Figure 3). Although there is ongoing debate concerning the earliest migration of pinyon pine, the early Holocene is accepted here.

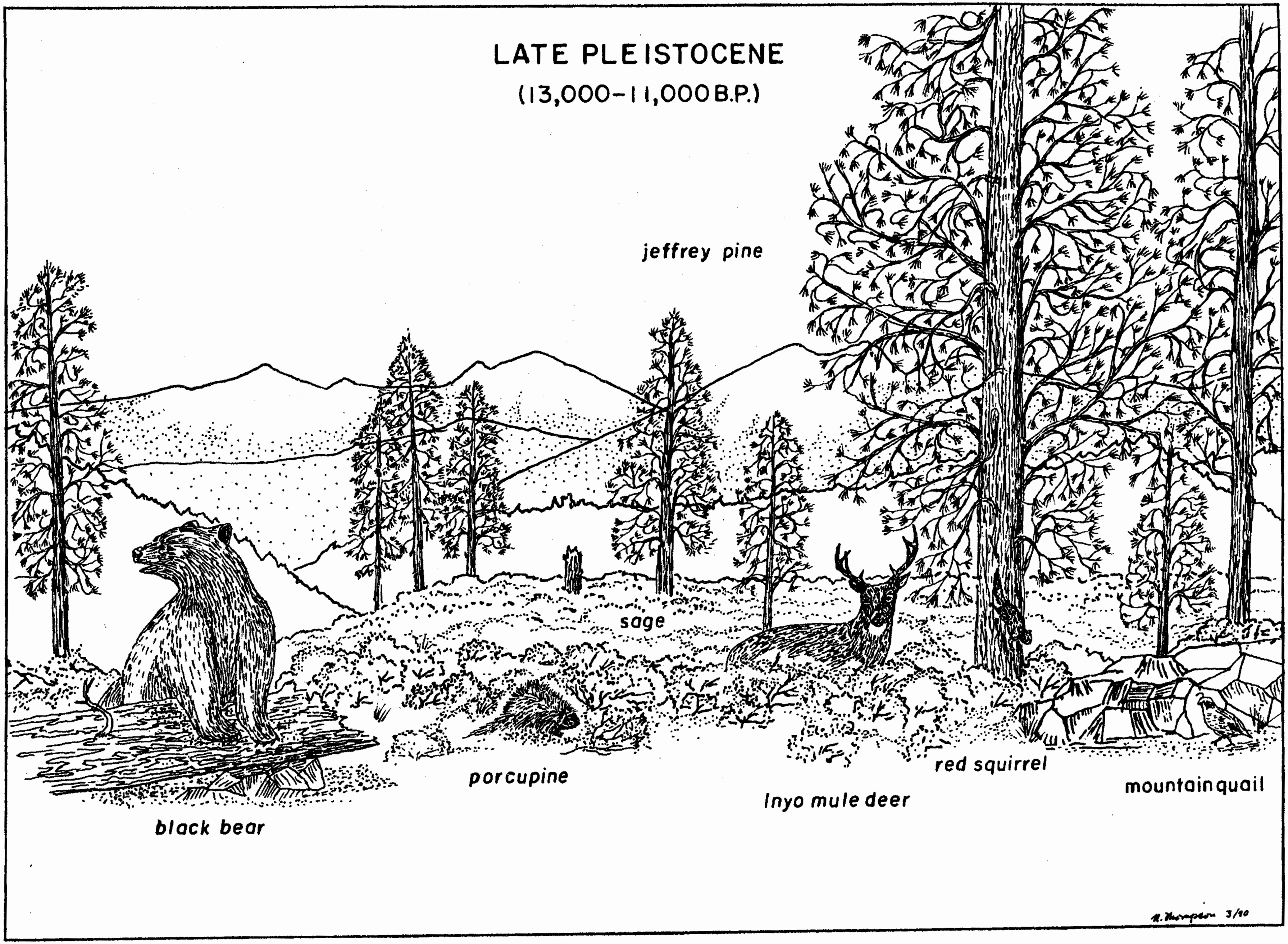


Figure 2. Late Pleistocene.

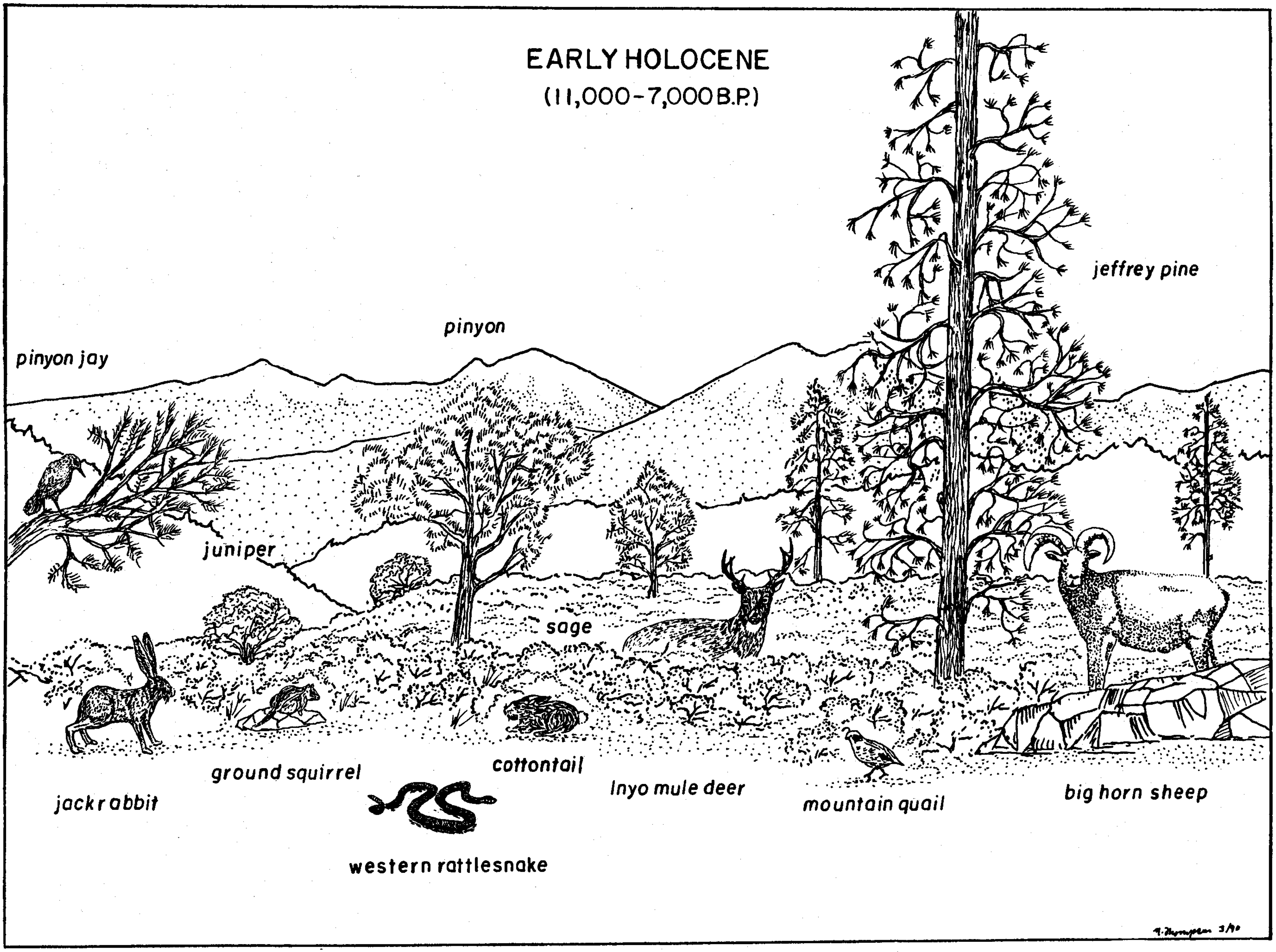


Figure 3. Early Holocene.

These changes indicate a significant increase in animal fodder and the pinyon woodland that contained the Western Great Basin protohistoric staple - the pinyon nut.

Pinyon woodland fauna would have included among other seasonal species, Inyo mule deer, desert bighorn sheep, and mountain quail. Maurice Crawford, Native American advisor for the project, pointed out that heavily used deer trails currently run along drainages and natural corridors within the project area.

Sagebrush probably co-occurred with pinyon-juniper, which would have supported a wide variety of large and small mammals. Pronghorn antelope inhabited the sagebrush community year-round and Inyo mule deer, Sierra bighorn, and desert bighorn used it as winter rangeland.

Tool assemblages would not necessarily have been notably different from previous assemblages. Hunting could have intensified at this time because of the increased faunal habitats.

Seasonal summer hunting would remain the focus, with a tool-kit designed for capturing a variety of prey. Nut and seed harvesting could have gained significance but may not be evident in the archaeological record. Even with the increased edible biomass, it is predicted that the short growing season, and low overall human population density would have kept use of the Bridgeport area to a minimum.

MIDDLE HOLOCENE

Several studies indicate that during the <u>middle</u> Holocene an extremely warm/dry period, the Altithermal, extended from around 7000 to 4000 years ago (Antevs 1948, 1953; Benson 1977; Jones 1925; Russell 1885). Davis (1982) suggests this lower precipitation was occurring primarily in the summer. For vegetation species adapted to the summer precipitation, drought conditions would have forced them upslope. Sagebrush was being replaced by desert scrub in many parts of the Great Basin (Van Devender et al. 1987:343) and temperatures were considerably warmer (Axelrod 1981; LaMarche 1973; Scuderi 1987). The desert scrub fauna is very similar to that of the sagebrush community outlined above (Figure 4).

Because of a decrease in faunal habitats and annual rainfall lower than the current 10.5 inches, it seems unlikely that people would have stayed long in the proposed desert scrub community with its paucity of water. Drought conditions over a span of around 3000 years would have produced a cumulative decrease in vegetation resulting in a marked decrease in carrying capacity. Although the area was likely less productive, Bridgeport's

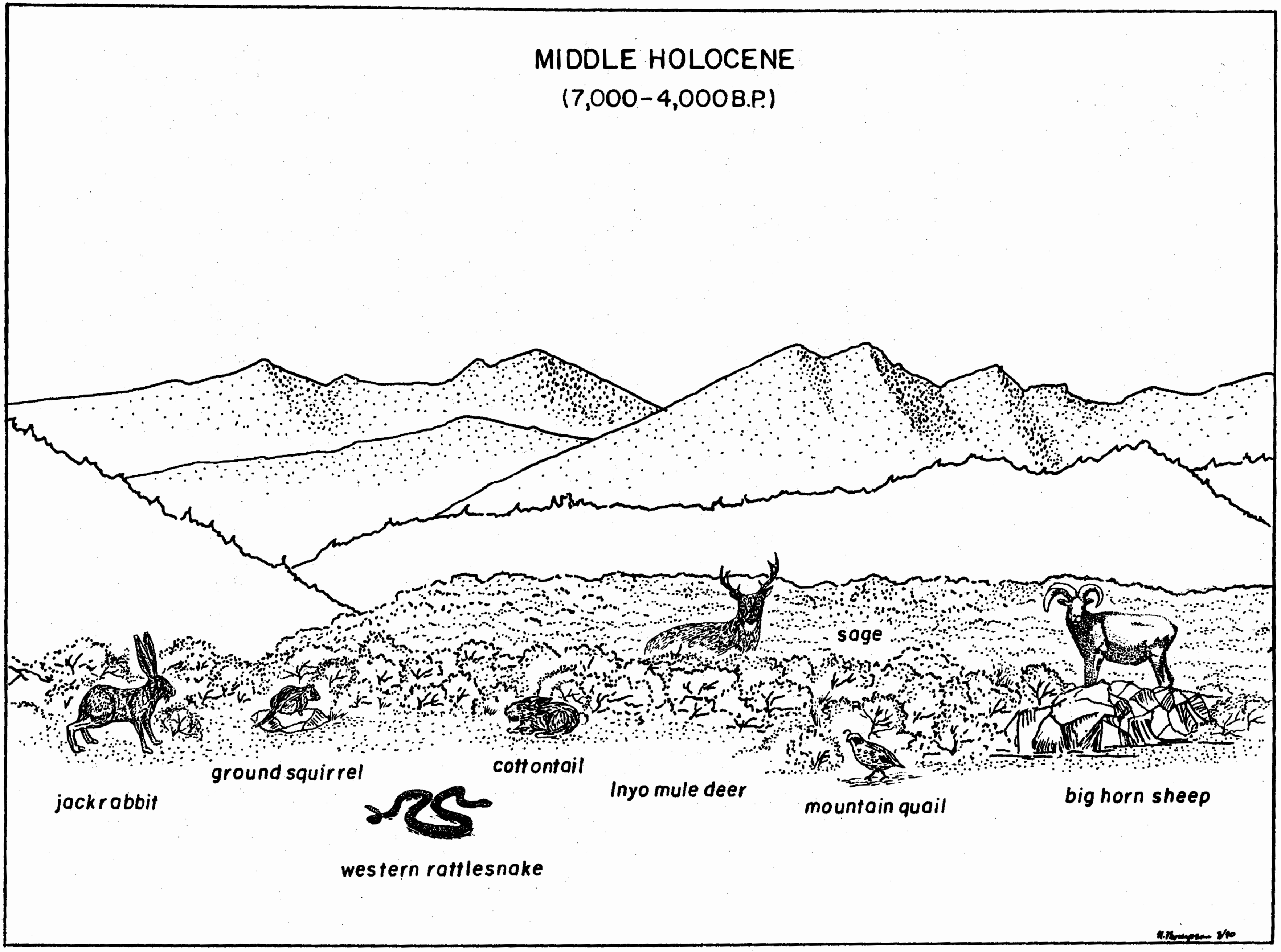


Figure 4. Middle Holocene.

proximity to the mountains kept it near drainages carrying snowmelt (Anderson 1990). Short term forays during particularly wet years could be predicted. Like humans, migratory game may have traveled to the area for peak oscillations in vegetation and water. Thus, the area was probably abandoned for long spans of time, punctuated by short spurts of hunting and collecting. Sites would have been small, widely dispersed, and located along drainages. Like the previous two scenarios, the expected toolkit would primarily be focused on hunting.

LATE HOLOCENE

Turning to the late Holocene, pollen data and other sources indicate a cooler, moister climate in the first part of the late Holocene that lasted from 3500 to 2000 years ago. Summer precipitation was waning while winter precipitation became dominant. Overall temperature was comparatively low and summer cooling began (Adam 1967; LaMarche 1973; Scuderi 1987; Davis 1982:67; Vasek and Thorne 1977:809). These cooler climatic conditions caused a treeline elevation drop for several species (LaMarche 1973) which suggests cooler and/or wetter conditions and according to Davis (1982) initiation of modern vegetation associations in the eastern Sierras. In Bridgeport, Jeffrey and pinyon pine probably moved back downslope into areas including their current locations (Figure 5).

This was probably the most biologically abundant period in the eastern Sierras. Since Swauger Creek has never desiccated in modern times (Frye 1990), increased moisture probably made this a perennially flowing watercourse.

Increased moisture and cooler conditions would have increased vegetation density promoting an increase in available game. With staples of deer, pinyon nuts, juniper berries, various seeds and roots, an overall increase in plant productivity, and a dependable water source, the resources in Bridgeport would have been relatively stable and predictable.

As noted by Bettinger (1975), Elston (1971, 1982), McGuire and Garfinkel (1980), and Hall (1983), an increase in eastern Sierran and Great Basin cultural activity occurred. The greatest degree of site distribution patterning and site density at Bridgeport likely would have occurred at this time. Seasonally rich microenvironments and predictable seasonality of plant and animal resources may have fostered the concentration of larger groups of people. In good years, perhaps during the months of August and September when deer migrations and pinyon harvests coincided, different groups may have gathered to use the same resources. This clustering of resources, which in turn created a clustering of activity areas, was the most likely time that the development of more intensive exchange relationships could have developed.

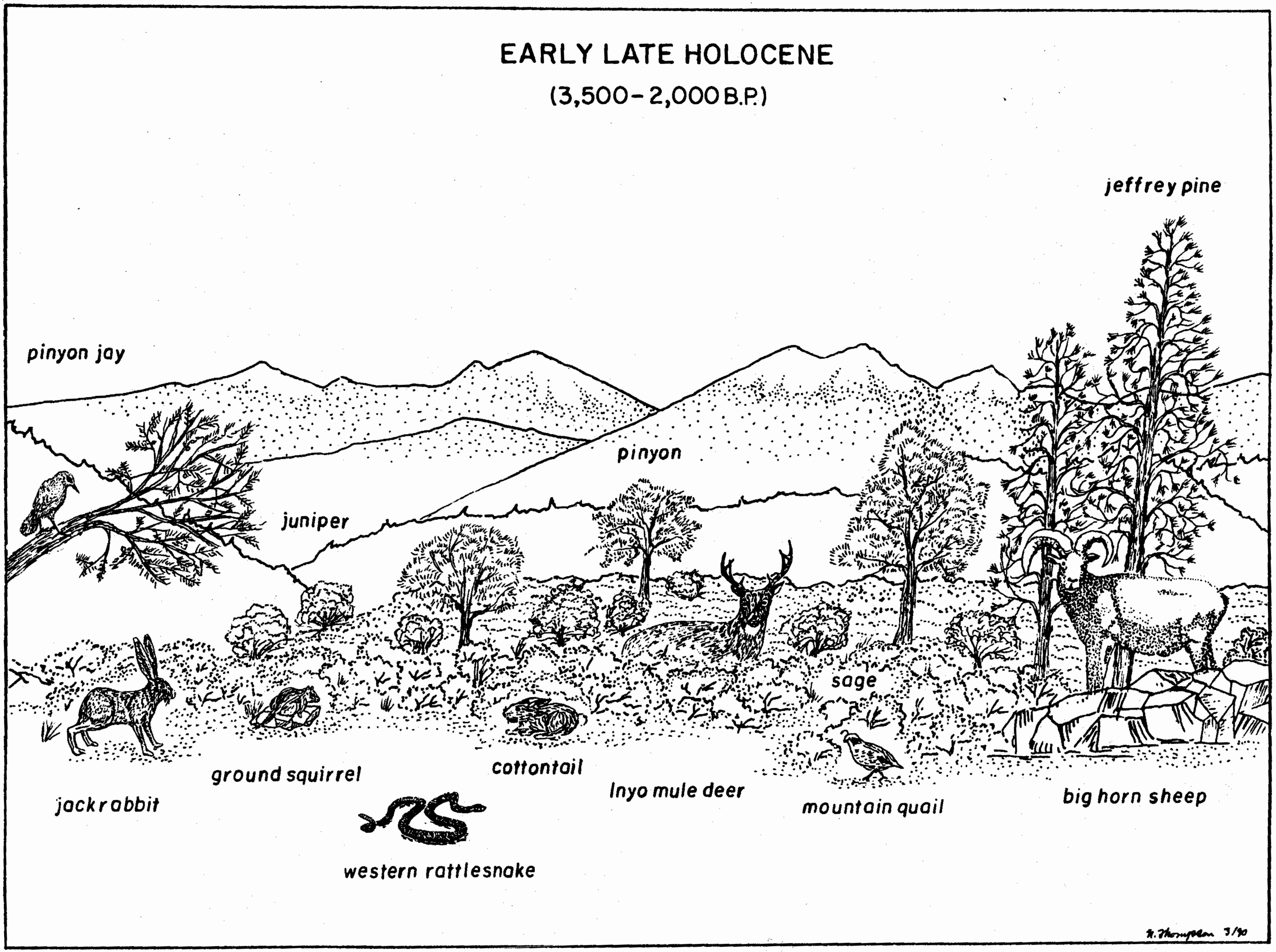


Figure 5. Early Late Holocene.

Following Elston (1982:195), the archaeological materials expected for this period would probably have consisted of a greater quantity and diversity of items than previous periods.

The next 500 years was a warm, dry period similar to modern times (Born 1972; Davis 1978:88-92, 1982; Pippin 1980). According to Hall (1983:30), this time also marked the initiation of several volcanic episodes at nearby Mono Craters. No direct evidence of past volcanism was found in the Bridgeport soils (Anderson 1990; Stewart et al. 1982) and it is not clear whether this volcanism could have affected occupation at Bridgeport.

Since warm/dry climatic conditions during this interval were comparable to modern ones, it is assumed that vegetation and faunal communities were also. Vegetation productivity probably decreased and human activities may have contracted for about 500 years. A decrease in overall site use could be expected (Figure 6).

Finally, the latest glacial advance oscillated throughout the last several hundred years (Birman 1964; Curry 1969, 1971; Wood 1977; Yount et al. 1979; Burke and Birkeland 1983; LaMarche 1973; Scuderi 1987); the climate was wetter than today, and dominated by winter precipitation (Davis 1982).

More than 500 years of renewed wetter conditions probably created the second-most optimal time for vegetation and faunal development (Figure 7). Although modern plant communities were already developed, their productivity was probably more pronounced than the warm dry periods before or after. Similar to what occurred in the previous abundant time, cooler conditions and increased precipitation may have expanded subsistence bases. However, precipitation and temperature in the later period changed every 100 to 200 years which probably kept vegetation and faunal productivity down. Thus, the climate and environment were cool and wet between 1000 to 150 years ago, but not as consistent as they were earlier.

The human response to fairly productive, dependable resources during good decades or centuries may not have dramatically affected site locations. Because the subsistence bases may have been the same as those in the previous abundant time, sites were probably distributed on or near earlier sites. Fluctuating resource productivity may have caused decreased intensity of site use, or expansion in diversity of activities.

Finally, evidence indicates that the twentieth century is considerably dryer than the period prior to 150 years ago and may be similar to the interval 2000 to 1500 years ago (Davis 1982; Matthes 1940; LaMarche 1973; Scuderi 1987).

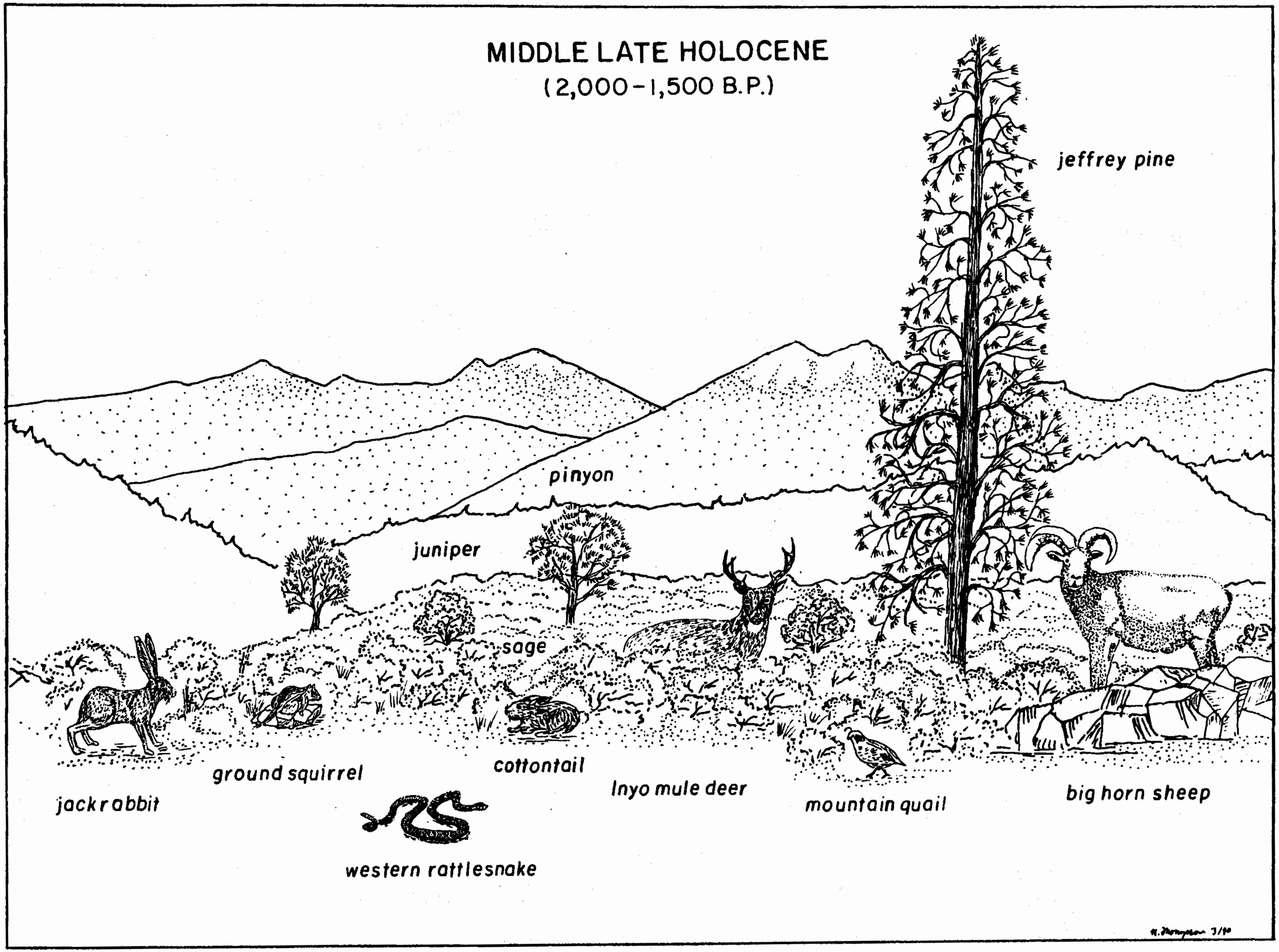


Figure 6. Middle Late Holocene.

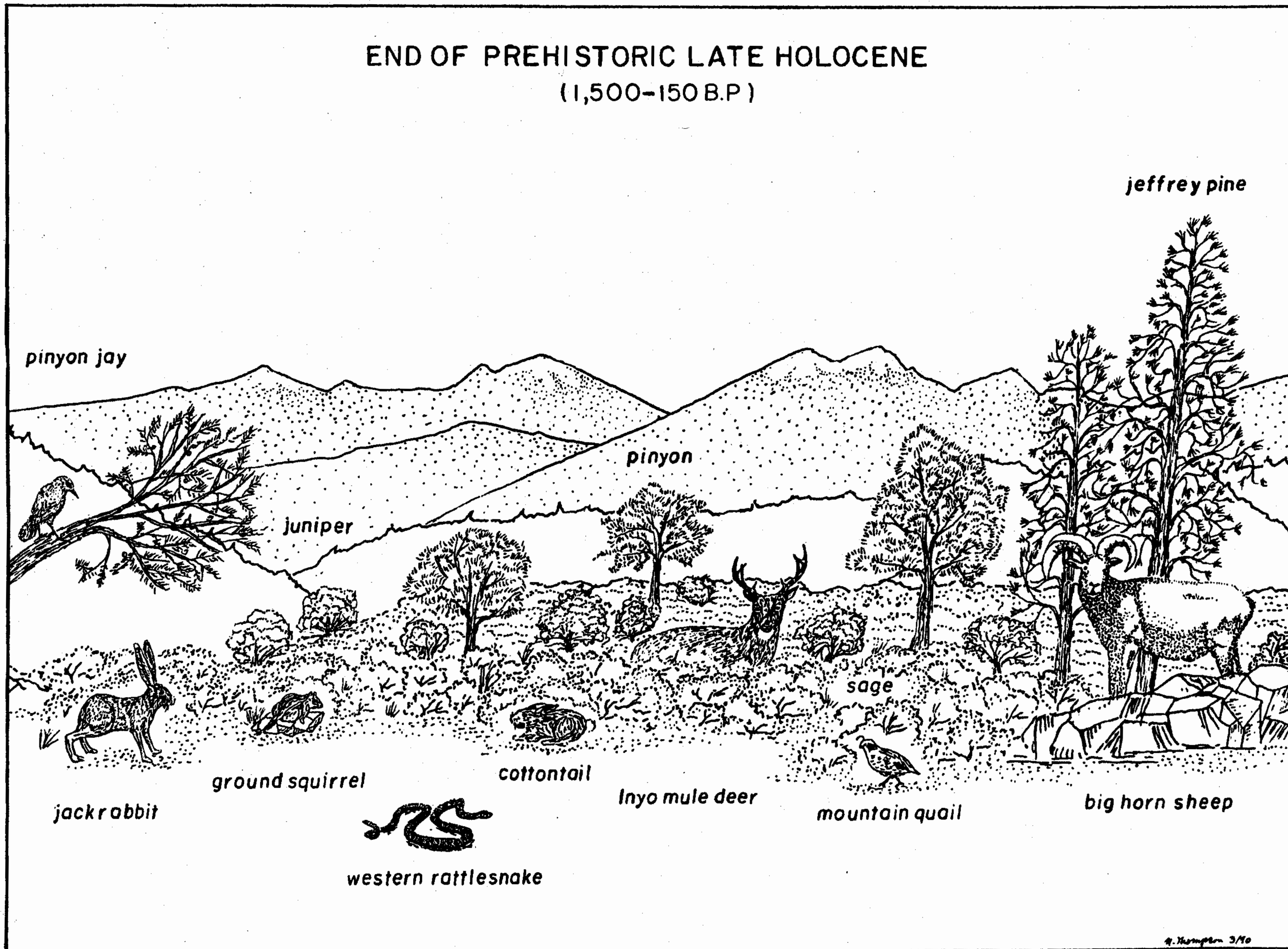


Figure 7. End of Prehistoric Late Period.

ARCHAEOLOGICAL PREDICTIONS COMPARED TO ARCHAEOLOGICAL DATA

The results compare the environmental record to the archaeological record from the five Bridgeport sites. In the beginning of this paper, it was suggested that eastern Sierra inhabitants could have hunted seasonally in Bridgeport's Jeffrey pine forests during the late Pleistocene but the cost may not have been worth the benefit.

The warmer early Holocene catalyzed the upslope movement of vegetation. Although pinyon pine, sagebrush, and browsing herbivores were present, low human population density probably kept activity at Bridgeport to a minimum. Nothing was found at Bridgeport to suggest that the sites were used in the late Pleistocene or early Holocene (Jackson 1985:52-54; Basgall n.d.).

The middle Holocene, 7000 to 4000 years ago, was a hot, dry period that catalyzed more upslope movement of vegetation and the area was probably dominated by sagebrush and desert scrub. In the Bridgeport archaeological collection possible Little Lake projectile points with micron readings between 4.6 and 7.0, and collective micron readings from points, bifaces, and debitage greater than 5.5 may support the hypothesis that Bridgeport was occupied sporadically during the Altithermal. Interesting enough, 2 sites at the southern end of the project overlooking the Bridgeport Valley exhibit the majority of obsidian hydration readings for this period (Figure 8).

At the beginning of the late Holocene, 3500 to 2000 years ago, Bridgeport was characterized by cooler and wetter conditions with winter precipitation, and was probably dominated by pinyon pine and sagebrush. It was probably a period of abundance, stability, and thus maximum site occupation. The Bridgeport collection at this time is dominated by Gatecliff, Elko, and Humboldt points with an expansion in obsidian deposition. With micron readings between 5.5 and 2.6 microns, the activity at the two sites overlooking the valley continues, but in addition two sites located more within the pine-sagebrush association contain the majority of micron readings (Figure 8).

The following period, around 2000 to 1500 years ago, was characterized by a warm, less productive, dry climate similar to today. One of Hall's proposed volcanic eruptions also occurred at this time. These environmental variables might be related to less intensive site use but there is not enough environmental or archaeological data to test this. However, there is an overall marked decline in rim readings between 2.6 and 1.7 microns (Figure 9).

Finally, between 1500 and 150 years ago, for the second time, oscillating glacial advances probably increased available water and, thus, site use. This occupation may have lasted for several hundred years and was probably similar to, but not as

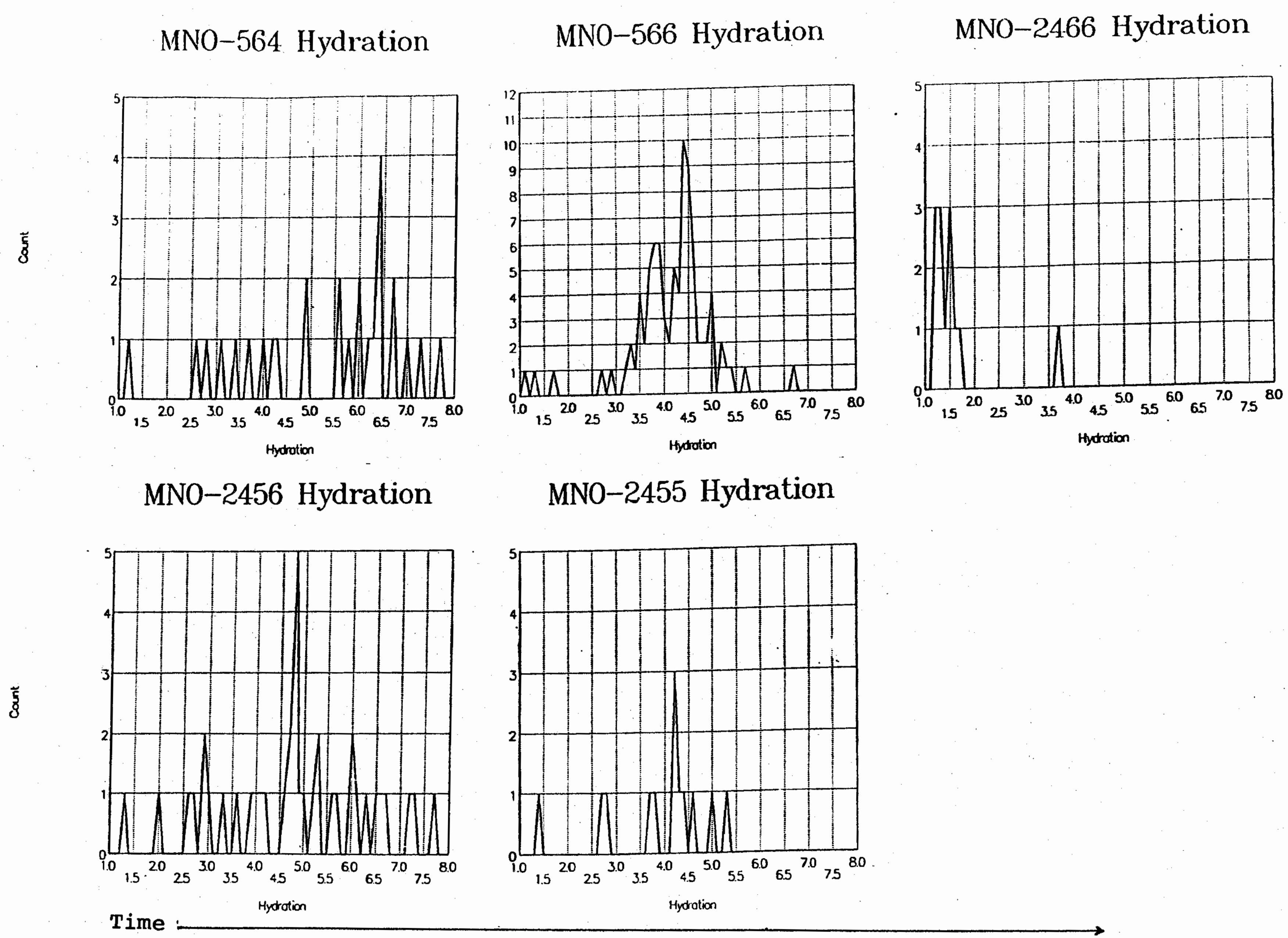
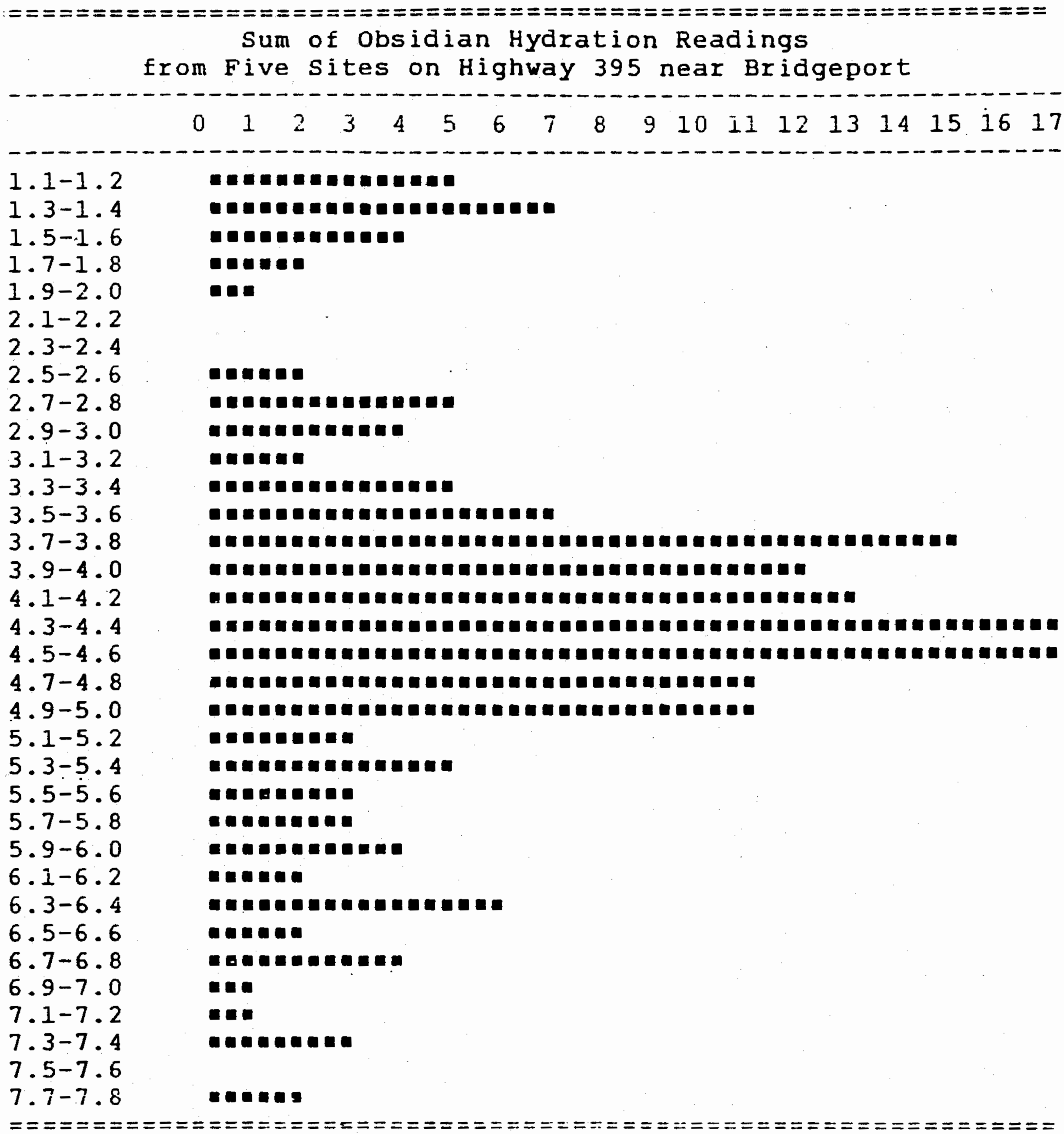


Figure 8. Obsidian Hydration Reading Profiles
from Five Bridgeport Area Sites.



n=178

Figure 9. Summary of Obsidian Hydration Readings.

N = 89 of the 178 obsidian hydration samples underwent x-ray fluorescence analysis. N = 83 of the sourced samples conform to the Bodie Hills trace element "signature".

intense as the previous expanded occupation. Obsidian hydration shows that very few rim readings occur at the four above-mentioned sites during this period. However, the occurrence of bedrock mortars at three of the sites is suggestive of late use. Furthermore, the northernmost site of the project is a discrete deposit occurring only after 1.7 microns. Though very scant, these data support the hypothesis of late period activity diversity (Figure 8).

SUMMARY AND SUGGESTIONS FOR FURTHER RESEARCH

In summary, the archaeological record at Bridgeport seems to provisionally correlate with the environmental record. Prior to 7000 years ago it was suggested that the short growing season and low population inhibited site occupation even though the area was seasonally habitable. After 7000 years ago, the archaeological record may reflect the environmental record, showing a shift in locations of obsidian deposition before and after this time, with a remarkable abundance of flaked materials. This is consistent with the findings of Jackson (1985:83), Basgall (1983:128, 1984:83), and Hall (1983:200-202) further south in Long Valley.

Recapping the findings of this paper a few statements and suggestions for future research can be made: Possible correlations between the environmental and archaeological records may suggest that the people at the Bridgeport sites were using direct procurement strategies without much buffering such as exchange or storage. Considering the subfreezing Bridgeport winters, it seems unlikely that it would be worth the effort to develop buffering mechanisms for occupation beyond seasonal stays. Further work focused on season of use and range of activities at such high elevation locations is needed to test this hypothesis.

Climate-related shifts in vegetation type and productivity might temporally correlate with two possible shifts in location of obsidian deposition. Further work is needed whereby paleoenvironmental vegetation and fauna are quantified and carrying capacity through time can be estimated. These results can then be compared to the archaeological record to test whether there is a causal relationship between the vegetation and archaeological shifts hypothesized in this paper.

REFERENCES CITED

Adam, David P.
1967 Late Pleistocene and Recent Palynology in the Central Sierra Nevada, California. IN: Quaternary Paleoecology, E.J. Cushing and H.E. Wright, Jr., eds., pp. 207-302. Yale University Press, New Haven, CT.

Anderson, R.S., O.K. Davis, and P.L. Fall
1985 Late Glacial and Holocene Vegetation and Climate in the Sierra Nevada of California, with Particular Reference to the Balsam Meadow Site. IN: Late Quaternary Vegetation and Climates of the American Southwest, B.F. Jacobs, ed., pp. 127-140. AASP Contribution Series 16. Department of Geosciences, University of Arizona, Tucson.

Anderson, T.
1990 Personal communication. Sonoma State University, Rohnert Park, CA.

Antevs, Ernst
1948 Climatic Changes and Pre-White Man. University of Utah Bulletin 38(20), Biological Series 10(7):167-191. Salt Lake City.

1953 The Postpluvial or Neothermal. University of California Archaeological Survey Reports 22:9-23. Berkeley.

Axelrod, D.I.
1981 Holocene Climatic Changes in Relation to Vegetation Disjunctions and Speciation. The American Naturalist 17(6):847-870.

Basgall, Mark E.
1983 Archaeology of the Forest Service Forty Site (CA-Mno-529), Mono County, California. MS on file, Inyo National Forest, Bishop, CA.

1984 The Archaeology of Mno-1529: A Secondary Reduction Site in Mammoth Lakes, Mono County, California. MS on file, Inyo National Forest, Bishop, CA.

n.d. Obsidian Acquisition and Use in Prehistoric Central-eastern California: A Preliminary Assessment. Obsidian Studies in California, R.E. Hughes, ed. Contributions of the University of California Archaeological Research Facility, Berkeley (in press).

Batchelder, George L.
1980 A Late Wisconsin and Early Holocene Lacustrine Stratigraphy and Pollen Record from the West Slope of the Sierra Nevada, California. Sixth AMQUA Abstracts and Programs 13.

Benson, Larry V.
1977 Fluctuation in the Level of Pluvial Lake Lahontan During the Last 40,000 Years. Quaternary Research 9:300-318.

Bettinger, Robert L.
1975 _The Surface Archaeology of Owens Valley, Eastern California: Prehistoric Man-Land Relationships in the Great Basin_. Ph.D. dissertation, Department of Anthropology, University of California, Riverside.

Bettinger, Robert L., and Martin A. Baumhoff
1982 The Numic Spread: Great Basin Cultures in Competition. _American Antiquity_ 47:485-503.

Birman, J.H.
1964 Glacial Geology Across the Crest of the Sierra Nevada, California. _Geological Society of America Special Report_ 75.

Born, Stephen M.
1972 Late Quaternary Historic, Deltaic Sedimentation, and Mudlump Formation at Pyramid Lake, Nevada. Center for Water Resources Research, Desert Research Institute, University of Nevada, Reno.

Burke, R.M., and P.W. Birkeland
1983 Holocene Glaciation in the Mountain Ranges of the Western United States. IN: _Late-Quaternary Environments of the United States_, Volume II, pp. 3-11.

Curry, R.R.
1969 Holocene Climatic and Glacial History of the Central Sierra Nevada, California. _Geological Society of America Special Paper_ 123.

1971 Glacial and Pleistocene History of the Mammoth Lakes Sierra, California: A Geologic Guidebook. _University of Montana Department of Geology Geological Series Publication_ 11.

Dalrymple, G.B., R.M. Burke, and P.W. Birkeland
1982 Concerning K-Ar Dating of a Basalt Flow from the Tahoe-Tioga Interglaciation, Saw Mill Canyon, Southeastern Sierra Nevada, California. _Quaternary Research_ 17:120-122.

Davis, Jonathan O.
1978 Quaternary Tephrochronology of the Lake Lahonton Area, Nevada and California. _Nevada Archaeological Society Research Paper_ 7. Reno.

1982 Bits and Pieces: The Last 35,000 Years in the Lahontan Area. IN: Man and Environment in the Great Basin, D.B. Madsen and J.F. O'Connell, eds., pp. 53-75. _Society for American Archaeology Papers_ 2.

Davis, O.K., R. S. Anderson, P.L. Fall, M.K. O'Rourke, and R.S. Thompson
1985 Palynological Evidence for Early Holocene Aridity in the Southern Sierra Nevada. Quaternary Research 24:322-323.

Elston Robert G.
1971 A Contribution to Washo Prehistory. Nevada Archaeological Survey Research Paper 2.

1982 Good Times, Hard Times: Prehistoric Culture Change in the Western Great Basin. IN: Man and Environment in the Great Basin, D.B. Madsen and J.F. O'Connell, eds., pp. 186-206. Society for American Archaeology Papers 2.

Frye, W.
1990 Personal communication. Bridgeport Ranger Station, Bridgeport, CA.

Hall, Matthew C.
1983 Late Holocene Hunter-Gatherers and Volcanism in the Long Valley-Mono Basin Region: Prehistoric Culture Change in the Eastern Sierra Nevada. Ph.D. dissertation, University California, Riverside.

Jackson, Robert
1985 An Archaeological Survey of the Wet, Antelope, Railroad, and Ford Timber Sale Compartments in the Inyo National Forest. MS on file, Inyo National Forest, Bishop,. CA.

Jones, J.C.
1925 The Geologic History of Lake Lahonton. Carnegie Institute of Washington Publications 325.

LaMarche, Valmore C., Jr.
1973 Holocene Climatic Variations Inferred from Treeline Fluctuations in the White Mountains of California. Quaternary Research 3(4):632-660.

Mackey, E.M. and D.G. Sullivan
1976 A 10,000 Year Palynological and Stratigraphic Record from Gabbott Lake, Alpine County, California. American Quaternary Association, Program and Abstracts of the 9th Biennial Meeting, 2-4 June 1986. University of Illinois, Champaign - Urbana.

Matthes, F.E. (chairman)
1940 Report of the Committee on Glaciers. American Geophysical Union Transactions 21:396-406.

McCarten, N.
1990 Personal communication. Department of Biology, San Francisco State University.

McCarten, N., and T.R. Van Devender
1988 Late Wisconsin Vegetation of Robber's Roost in the Western Mojave Desert, California. Madrono 35(3):226-237.

McGuire, Kelly R., and Alan P. Garfinkel
1980 Archaeological Investigations in the Southern Sierra Nevada: The Bear Mountain Segment of the Pacific Crest Trail. MS on file, Bureau of Land Management, Bakersfield, CA.

Mehringer, Peter J., Jr.
1977 Great Basin Late Quaternary Environments and Chronology. IN: Models and Great Basin Prehistory: A Symposium, D.D. Fowler, ed., pp. 113-167. Desert Research Institute Publications in the Social Sciences, University of Nevada, Reno.

Moran, J.M.
1972 An Analysis of Periglacial Climatic Indicators of Late Glacial Time in North America. Ph.D. dissertation, University of Wisconsin, Madison.

Pippin, Lonnie C.
1980 Prehistoric and Historic Patterns of Lower Pinyon-Juniper Woodland Ecotone Exploitation at Borealis, Mineral County, Nevada. University of Nevada, Desert Research Institute, Social Sciences Center Technical Report 17. Reno.

Russell, Israel C.
1885 Geological History of Lake Lahonton, a Quaternary Lake of Northwestern Nevada. United States Geological Survey Monograph 11. Washington, D.C.

Scuderi, L.A.
1987 Late-Holocene Upper Timberline Variation in the Southern Sierra Nevada. Nature 325:242-244.

Stewart, J.H., J.E. Carlson, and D.C. Johannessen
1982 Geologic Map of the Walker Lake 1 and 2 Quadrangle, California and Nevada. USGS Miscellaneous Field Studies Map MF-1382-A.

Van Devender, T.R., R.S. Thompson, and J.L. Betancourt
1987 Vegetation History of the Southwest: The Nature and Timing of the Late Wisconsin-Holocene Transition. IN: North America and Adjacent Oceans During the Last Deglaciation, W.F. Ruddiman and H.E. Wright, eds., pp. 323-352. Geological Society of America, Boulder, CO.

Vasek F.C.,and Robert F. Thorne
1977 Transmontain Coniferous Vegetation. IN: Terrestrial Vegetation of California, M.G. Barbour and J. Major, eds., pp.797-834. University of California, Davis.

Wood, S.H.
1977 Holocene Stratigraphy and Chronology of Mountain Meadows, Sierra Nevada, California. Ph.D. dissertation, California Institute of Technology, Pasadena.

Yount, J.C., P.W. Birkeland, and R.M. Burke
1979 Glacial and Periglacial Deposits of the Mono Creek Recesses, West-central Sierra Nevada, California: Measurements of Age-dependent Properties of the Deposits. Field Guide to Relative Dating Methods Applied to Glacial Deposits in the Third and Fourth Recesses and Along the Eastern Sierra Nevada, California, with Supplementary Notes on Other Sierra Nevada Localities, R.M. Burke and P.W. Birkeland, eds. Field Trip Guidebook for the Friends of the Pleistocene, Pacific Cell.