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Prehistoric Human Land-use Patterns in the Alvord Basin, Southeastern Oregon

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TWO ideas have inspired more discussion, controversy, and research regarding the prehistory of the Great Basin than any others. These are the Neothermal climatic sequence proposed by Ernst Antevs (1948, 1955) and the Desert Culture, or Desert Archaic, concept of Jesse Jennings (1957, 1964). These proposals, as time-worn as they may now seem, focused on two essential problems of Great Basin prehistory that are as relevant and compelling now as they have ever been: environmental fluctuation and the nature of human cultural adaptation.

The nature of the connection between climatic change and cultural change in the Great Basin has long been argued. The proposition of Antevs (1948), that a period of distinct desiccation (the Altithermal, from 5000 to 2500 B.C.) occurred, led to the suggestion that the Great Basin was abandoned, completely or at least in part, by human populations during that time (Cressman et al. 1942; Cressman et al. 1960; Baumhoff and Heizer 1965; Layton 1972; Bedwell 1973). Opposed to these suggestions were those who argued either that the Altithermal as a dry interval never existed to any appreciable degree, or that its effects were not significant to Great Basin cultures and thus there was no abandonment, or both (Martin 1963; Jennings 1964; Fry and Adovasio 1976; Weide 1976; Grayson 1976). That abandonment of the northern Great Basin did not occur has been strongly suggested by Fagan (1974) in his study of spring sites, but population decline still cannot be ruled out (such population decline is argued for the western Great Basin by Elston [1982:193]).

Currently, the most widely held view appears to follow the suggestion of Bryan and Gruhn (1964) that detailed archaeological studies of particular areas are needed to assess the effects of climatic change on culture. Furthermore, it is now understood that climatic change within the past 10,000 years was much more complex than the simple sequence proposed by Antevs (though he may have been correct at his level of analysis), and that its effects, from both hydrological and anthropological perspectives, must have differed from basin to basin in the desert West (Mehringer 1977; Weide and Weide 1977). This view has stimulated interest in the study of particular basins or other spatially defined areas of the Great Basin, such as Surprise Valley (O'Connell 1975), Warner Valley (Weide 1968), Owens Valley (Bettinger 1975, 1977), Coffeepot Flat (Aikens and Minor 1977), Stinkingwater Pass (Pettigrew 1979), Steens Mountain (Aikens, Grayson and Mehringer 1982), Monitor Valley (Thomas 1983), and the High Rock Country (Layton 1970, 1979).

The recent emphasis on sampling spatially defined areas is a clear advance over the earlier approach of basing archaeological reconstructions on data from individual excavated sites. The picture offered by Steward

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(1938) of scattered people and scattered resources in the Great Basin at the time of contact had a profound effect on the interpretations of prehistorians during the first few decades of archaeological study of the region. Until the 1970s, archaeological evidence, gathered mostly from dry caves where the artifactual density was very high and preservation of perishables was excellent, was widely interpreted to reflect a culture (migratory) and an environment (arid) that had remained stable and mostly unchanged for the past 10,000 years (Cressman et al. 1942; Jennings 1957; Aikens 1970). There was little reason to doubt that the environment during that time had remained dry enough to make the nomadic societies of the ethnographic period the best adaptive model to account for the archaeological record.

Now, however, it is widely recognized that cultural deposits at individual sites are too greatly biased by their specific environmental settings to be used for environmental and cultural reconstructions of broad geographic areas. It is now agreed that the most reasonable and potentially most productive way to approach these problems is to engage in surveys of substantial geographic zones, and to analyze the resulting data in such a way as to determine when and how specific areas within these zones were utilized. Presumably, a recognized shift in the settlement pattern at a specific period of time would signal a change in the adaptive strategy, or an alteration in the environment, or both.

To test paleoenvironmental and paleocultural propositions in the Great Basin, one could use four major criteria to select the ideal geographic area. First, the area should contain an unbroken geo-archaeological record, in which occupational hiatus cannot be explained geomorphically, spanning at least the past 10,000 years. Obviously, a shorter record, or one that is discontinuous, presents problems of interpolation that may weaken the entire reconstruction.

Second, the area should be one where moderate changes in annual precipitation result in very noticeable changes in water availability. This criterion depends on both ecological and hydrological assumptions that are well founded. In any arid temperate region, the availability of water is the most critical factor limiting biotic productivity, so that the more available water becomes on or near the surface the more abundant will become the plants and animals that depend upon it. Water availability depends upon precipitation rates, of course, but also upon factors of hydrology and geology that vary from region to region, but that are nevertheless relatively constant within a given basin. Basins vary in their potential for collecting water and making it available to biota. Those regions that are more efficient in this regard, particularly closed basins, are better candidates for detecting prehistoric climatic change as well as for finding cultural effects of that change.

Third, the area should have a diversity of kinds of water resources: lakes and streams that are available during moist periods, and springs which are the only source of water during dry periods. This criterion is postulated so that changes in water availability will be observable by distinct changes in land-use patterns that can be correlated with the different kinds of water sources. Presumably, lakes and streams will attract human settlement or exploitation during moist periods when they contain water, and the relative intensity of habitation at springs will be greatest during dry periods when the lakes and streams tend to be dry.

Fourth, the ideal study area should include both lowland and upland zones with their different biota. The purpose of this criterion is partly to make it possible to detect changes in the relative use of upland and lowland zones, which not only tend to

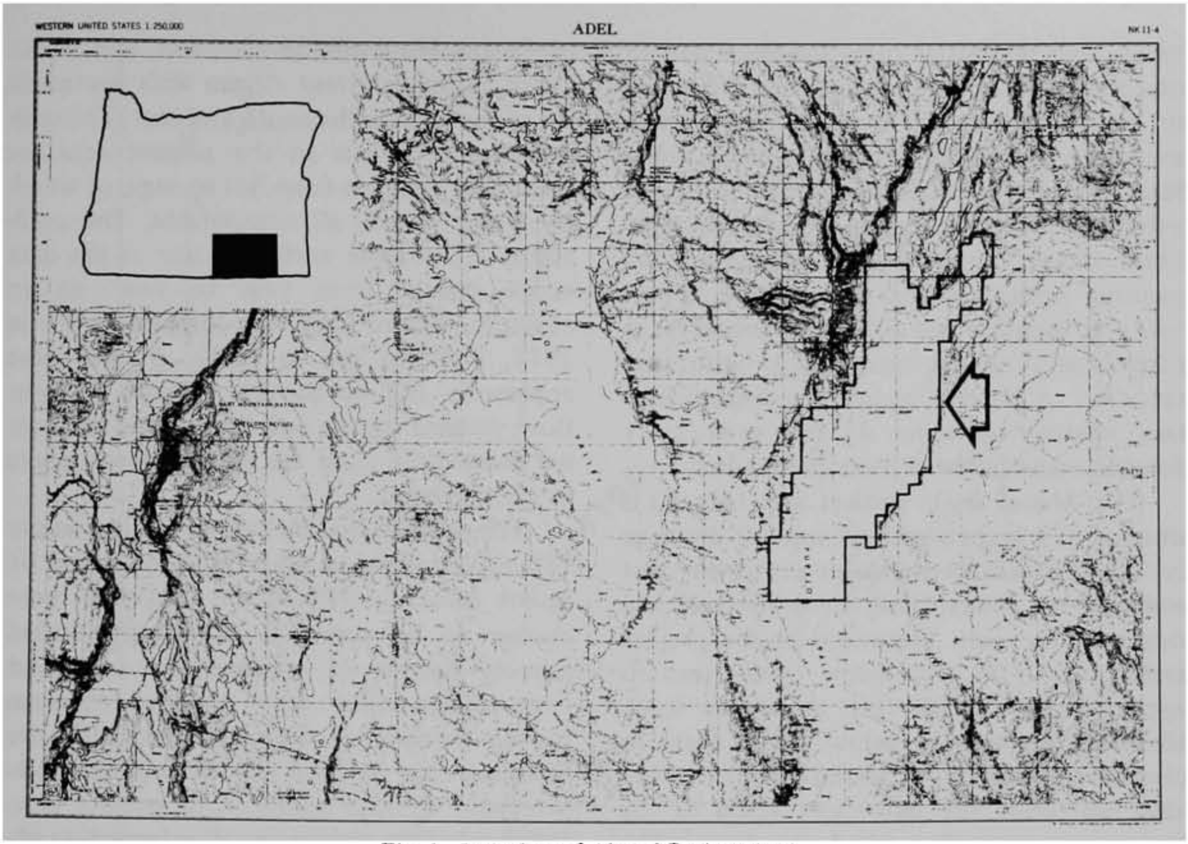

Fig. 1. Location of Alvord Project Area.

have different biota but also tend to have different precipitation rates and different distributional patterns of water sources. Furthermore, the presence of such distinct zonal environments should make it more likely that settlement pattern changes will be noticeable in the survey data, assuming that sites or artifact locations classified by environmental zone will demonstrate differences between zones as reflected in terms of frequencies of those sites or artifacts.

There are actually few areas in the northern Great Basin (Fig. 1) that satisfy this strict set of criteria. Fort Rock Valley (Bedwell 1973) appears to be one of the best candidates, with an apparently long cultural record, but it lacks a significant upland component. The Glass Buttes area (Mack 1975) has upland and lowland areas and a long cultural record, but is limited in its variety of water resources. The Lake Abert area (Pettigrew 1981a, 1985) has a good variety of water resources, and upland and lowland zones, but so far has shown a good cultural record for only about the last 4,000 years; a similar assessment could be made for Surprise Valley (O'Connell 1975) and Warner Valley (Weide 1968). However, a study area that appears to satisfy all the criteria is found in the Alvord Basin.

THE ALVORD BASIN SURVEY

In 1975 the University of Oregon signed a contract with the Bureau of Land Management (BLM) to undertake a cultural resources survey of the Alvord Basin in the southeastern corner of Oregon (Fig. 1). The Alvord Basin contains a cultural record that spans more than 10,000 years, its water resources are varied and responsive to changing rates of precipitation, and the lowland area is flanked by Steens Mountain, one of the highest mountains (9,670 feet) in the northern Great Basin. The BLM requested the archaeological resources survey to comply with federal regulations prior to geothermal leasing, and the resulting project presented a unique opportunity to map site and artifact distributions in a previously almost unexplored basin that promised to provide comprehensive information relating to some of the most hotly debated issues in Great Basin prehistory.

The Alvord Basin project area (Fig. 2) is situated in a graben with an interior drainage system between Steens Mountain to the west and a much lower chain of mountains and ridges to the east. Elevations in the project area range from just below 4,000 feet to approximately 5,000 feet above sea level. Most of the area is below 4,100 feet, an elevation marked by a strand line that probably represents the last major stand of the Pleistocene lake that filled the basin. For purposes of this study, the area above 4,100 feet is defined as the *upland zone* (above the flat bottomland), and that below 4,100 feet as the *lowland zone*. Four major playas are located in the lowlands: Alvord Lake in the south; the Alvord Desert, by far the largest playa, in the middle; a small, unnamed playa northeast of the Alvord Desert; and Mickey Lake in the far northeast. In general, and this is important to remember, the lowlands slope down from south to north; the highest bottomland elevations in the project area are south of Alvord Lake, and the lowest, just below 4,000 feet, are at Mickey Lake. Presumably, then, when the pluvial Lake Alvord dried up, the area of Mickey Lake was the last to be exposed, and the area south of Alvord Lake was the first.

The principal sources of surface water in the project area, outside of the springs, are the intermittent streams that drain the slopes of Steens Mountain to the west, and Trout Creek, an intermittent stream with sources in the mountains to the south and east. The only permanent streams in the project area are those that emanate from hot springs, of which there are several, all non-potable. The availability of potable surface water in the area varies greatly from year to year. As an example, Alvord Lake was completely dry in 1975, but was full in 1979. Alvord Lake apparently fills up enough at times to overflow, judging by the well-defined outlet channel connecting it to the Alvord Desert playa to the northeast.

The project area includes a total of nearly 180 square miles of BLM land, of which 61 square miles, or 34% of the total area, were chosen to be surveyed in a nonstratified random sample of sections. An additional four square miles were surveyed in areas chosen because of their expected high site densities, for a total of 65 square miles surveyed, or 36% of the total project area. Data collection was limited to information obtainable from surface inspection of the sites found, and survey crews were instructed to collect only temporally diagnostic bifaces, particularly projectile points, both at defined sites and as isolates. Other artifacts were recorded but not collected, and a wide range of information about each site was recorded on standard site forms.

A total of 224 sites was found during the survey, as well as 217 classifiable projectile points, recovered both as isolated artifacts and from sites. For the purposes of this report, the sample also includes 109 classifiable projectile points found during a less intensive survey of the same project area the previous winter by a crew from Portland State University. Dr. Tom Newman of Portland State generously loaned that collection for this analysis. The total sample size of projectile points used for this report, then, is 326.

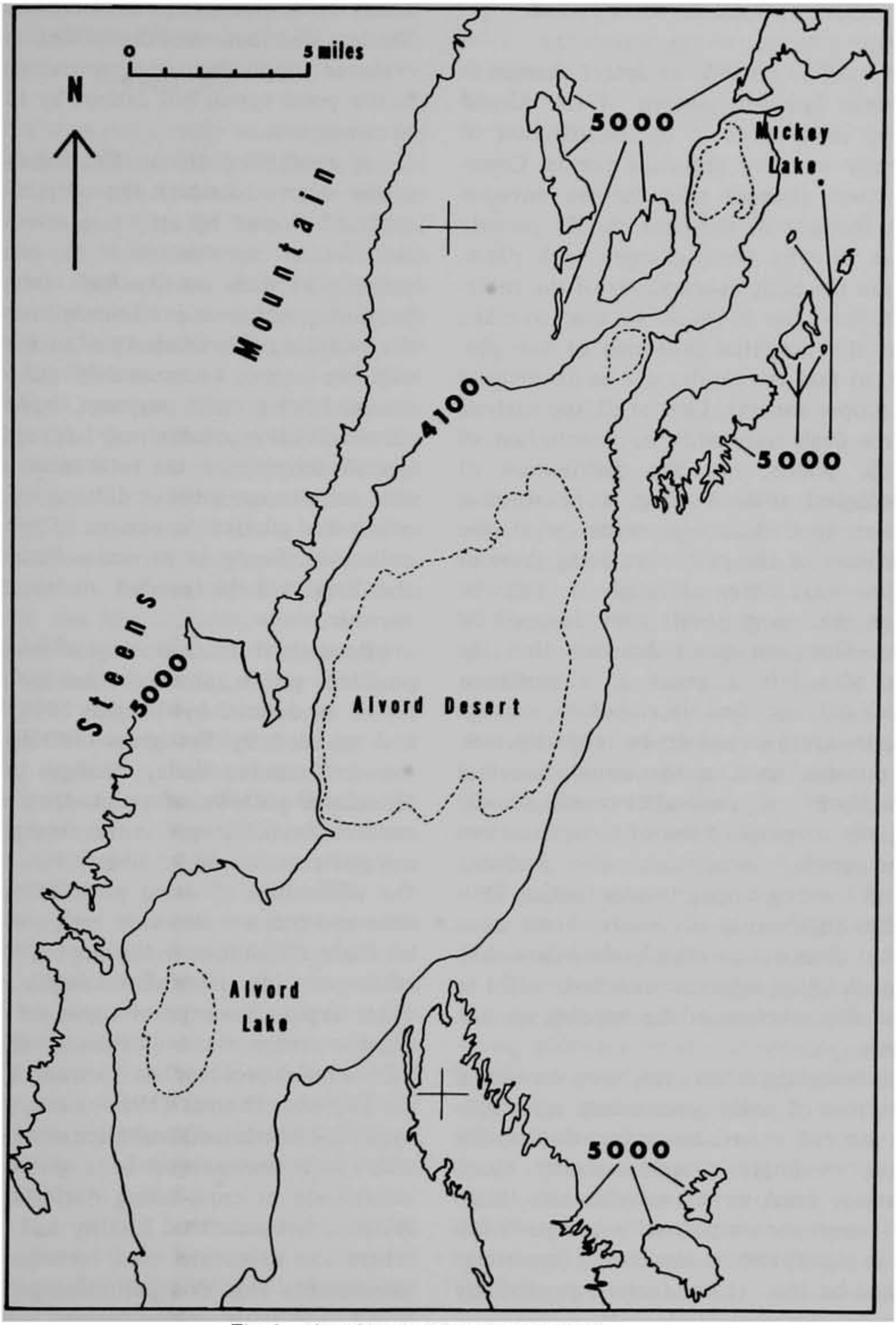

Fig. 2. Alvord Basin (elevations in feet).

ANALYTICAL ASSUMPTIONS

It should be possible to detect changes in the human land-use pattern of the Alvord Basin by an analysis of the distribution of temporally sensitive projectile points. Correlating these changes with known environmental features of the area should provide clues as to why these changes took place. These are the basic assumptions of the analysis to follow, but it would be wise to make explicit the potential problems of the procedure, so that the results will be understood in the proper context. First of all, the analysis to follow deals only with the distribution of projectile points, not the distribution of archaeological sites. Finding a point at a particular spot does not reveal what the original user of the point was doing there or why he was there, although it may be assumed that most points were dropped by hunters. One can never be sure that the person who left a point at a particular location did not find it elsewhere, though such cases are assumed to be relatively rare. What remains, then, is the assumption that the locations of projectile points usually record the unspecified use of those locations by the original depositors, who probably included hunting among their activities. Plotting the distribution of points shows areas used, but does not necessarily show how they were used. Other evidence must be brought to bear on the problem of determining specific land uses.

It is tempting, when comparing the spatial distributions of point types whose age assignments are not secure, to assume that similar distributions imply contemporaneity. Such conclusions must be drawn with care, however. Though contemporaneity is expected to result in distributional similarity, the reverse need not be true. Other factors, particularly similar environmental adaptation and land use, can cause similar spatial patterning of debris on the landscape in different periods. Similar distributions, then, can be strong evidence supporting contemporaneity of projectile point types, but cannot by themselves be conclusive.

A potential problem affecting the sample is the degree to which the project area was surface-collected by artifact hunters prior to the formal surveys. That a considerable amount of such activity had taken place is beyond question—it is common knowledge in the local area. The intensity of such erasure of evidence cannot be accurately assessed. It is assumed for present purposes, however, that prior collection activity may have reduced the overall sample size, the total count of points that were recovered, but did not significantly affect the relative proportion of types in the collection. Study of private collections from the area will be needed to measure this variable.

Because of the chronological sensitivity of projectile points, plotting them by *temporal types,* as defined by Thomas (1981: 13-14) and as used by Pettigrew (1981b) for the Lower Columbia Valley, changes in the distributional patterns of points that may have resulted from changes in the aboriginal land-use patterns should be observable. However, the difficulties of using projectile points as time markers are also very real; not the least of these difficulties is the dependence upon often very imperfect chronological data for point types. Some point types are not very reliable temporal indicators (witness the "Pinto point problem" as discussed by Warren [1980] and Thomas [1981]) and, even with types for which temporal placement is reasonably well documented in a given locality, confidence in cross-dating declines with the distance between that locality and the place where the types are used for chronological assessment. This is a particular problem for the Alvord Basin, where there is still no firm cultural chronology, although good progress has recently been made by the Steens Mountain Project (Wilde 1984).

TYPOLOGY

Rather than rely strictly on the traditional binomial classification of Great Basin projectile points, I chose instead to lump known point types together on the basis of known or suspected contemporaneity in an effort to approximate as closely as possible the desired temporal types. The potential confusion caused by creating numbered types is counterbalanced by the improved temporal utility of the resultant groups. This procedure was followed with the knowledge that chronological placement of point types is beset with uncertainties and is often speculative. The relative degree of error, however, in temporal assignments is reduced when very long occupational periods are under scrutiny. This is the case in the Alvord Basin, where approximately 12,000 years of occupation are represented. Another mitigating factor is that a knowledge of only the *relative* ages of the point types would be sufficient to produce significant indications about changing prehistoric land-use patterns. We can discuss the period when point type "X" was in use without knowing exactly its age in years before present.

Twelve types of points resulted from this process, and the collection inventory is listed by these types in Table 1. One important result of lumping the many Great Basin styles into a typology with a small number of types is the advantage of increasing the sample size per group, so that patterns distinguishing the types become more noticeable, and the numerical differences between them more statistically significant.

Since the criteria for distinguishing small stemmed points from large stemmed points had not been formally defined in the Great Basin until very recently (with the work of Thomas [1981]), I decided to determine

Table 1

ALVORD BASIN PROJECTILE POINT COLLECTION BY TYPE

Type		Count	Percent
1		101	31.0
2		53	16.3
3		21	6.4
4		33	10.1
5		9	2.8
6		31	9.6
7		4	1.2
8		8	2.5
9		19	5.8
10		15	4.6
11		23	7.1
12		9	2.8
	Total	326	100.1

whether neck width could be a useful dimension in standardizing this distinction, as it has been on the Lower Columbia River (Pettigrew 1981b) and elsewhere in the Northwest (e.g., Pettigrew 1982). Plotting the frequency of points by neck width produced some useful results. The separation of modes between narrow-necked and broad-necked points showed up, as expected, but the minimum between the two modes is at 9 mm., as shown by Corliss (1972) for Great Basin points, rather than the 8 mm. expected on the basis of the Lower Columbia data. For purposes of this paper, those points with necks 8 mm. wide or less are narrow-necked, and those 9 mm. and more are broad-necked.

The twelve types of projectile points used for the present analysis are listed in Table 2 along with an estimated chronology and other pertinent information. Without doubt the estimated periods represented by the types are a matter of opinion and controversy. The lively debate about Great Basin projectile point chronologies will probably continue in the future as it has in the past (for a summary, see Thomas [1981]), and new data may improve the accuracy of cross-dating in the northern Great Basin. Recent excavations during the Steens Mountain Prehistory Project

Table 2
PROJECTILE POINT TYPES AS USED IN THIS PAPER

Type	Fig.	Description/Named Types	Period Represented	References
1	3	Desert Side-notched Cottonwood Triangular Rosegate Series	A.D. 1 to historic	Baumhoff and Byrne 1959 Lanning 1963 Heizer and Hester 1978 Thomas 1981
2	4	Elko Corner-notched Elko Eared	1500 B.C.-A.D. 500	Heizer and Baumhoff 1961 Heizer and Hester 1978 Thomas 1981
3	4	Pinto Gatecliff Split-stem	2000 B.C.-A.D. 1	Heizer and Hester 1978 Thomas 1981
4	5	Humboldt Series	4000 to 1000 B.C.	Heizer and Clewlow 1968 Heizer and Hester 1978 Rice 1972
5	5	Northern Side-notched	5000 to 2000 B.C.	Gruhn 1961 Leonhardy and Rice 1970 Hester 1973 Heizer and Hester 1978
6	6	Crescent Great Basin Transverse	9000 to 5000 B.C.	Tadlock 1966 Clewlow 1968 Heizer and Hester 1978
7	6	Willow-leaf "Cascade"	8000 to 4000 B.C.	Weide 1968 Leonhardy and Rice 1970
8	7	square base Eden Scottsbluff Milnesand	9000 to 5000 B.C.	Wormington 1957 Sellards 1955
9	7	tapered toward base Lake Mohave Silver Lake Haskett	9000 to 5000 B.C.	Campbell et al. 1937 Butler 1965 Heizer and Hester 1978
10	7	Windust Lind Coulee	9000 to 6000 B.D.	Daugherty 1956 Rice 1972 Clewlow 1968
11	8	Black Rock Concave Base	9000 to 7000 B.C.	Clewlow 1968
12	8	Clovis	10,000 to 8000 B.C.	Sellards 1952 Hester 1973: 61-62

have produced new data (James Wilde, personal communication 1984) that may make necessary some shift in estimates toward the "long" chronology of the eastern Great Basin (Aikens 1970). Despite these considerations, space limitations preclude a lengthy justification of the temporal estimates used here, which would be a fine subject for another (and quite different) paper. Furthermore, as will be seen, the analysis to come does not depend on the chronology used, although the chronology has an important influence on the interpretation of the analytical results. Therefore, if new evidence or changed opinions cause changes in the temporal estimates, the results of the analysis undertaken in this paper will be as valuable then as they are now.

Some of the temporal types used here deserve further mention. Type 1 includes all of the narrow-necked points. Thomas' (1981)

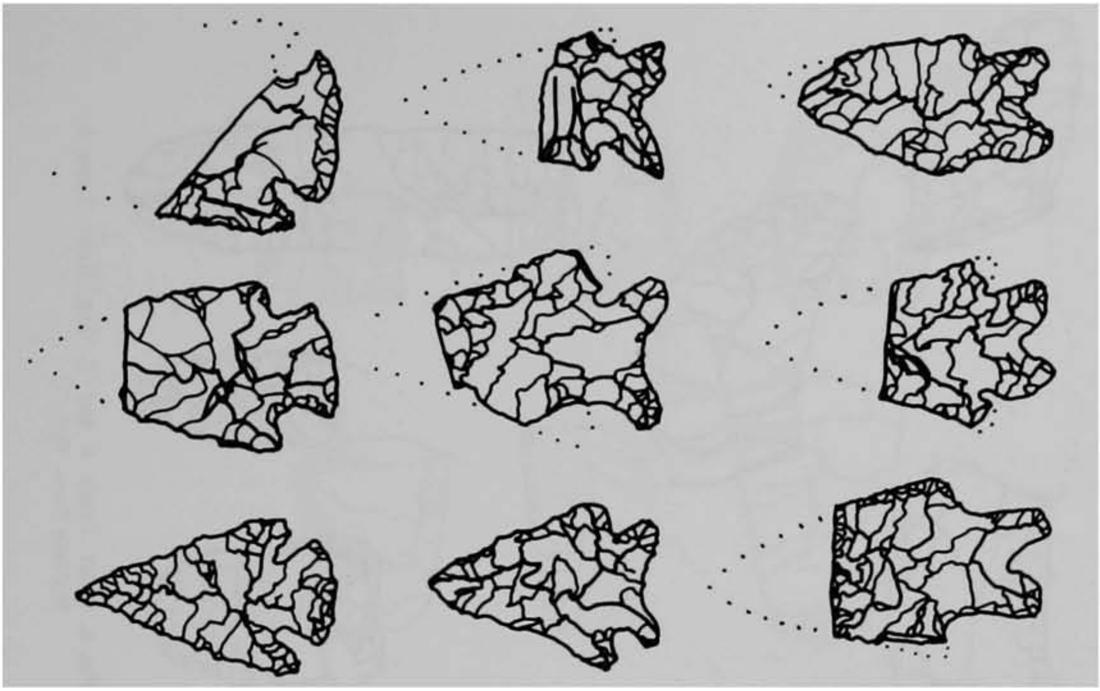

Fig. 4. Point Types 2 and 3. Top and Middle Rows: Type 2; Bottom Row: Type 3.

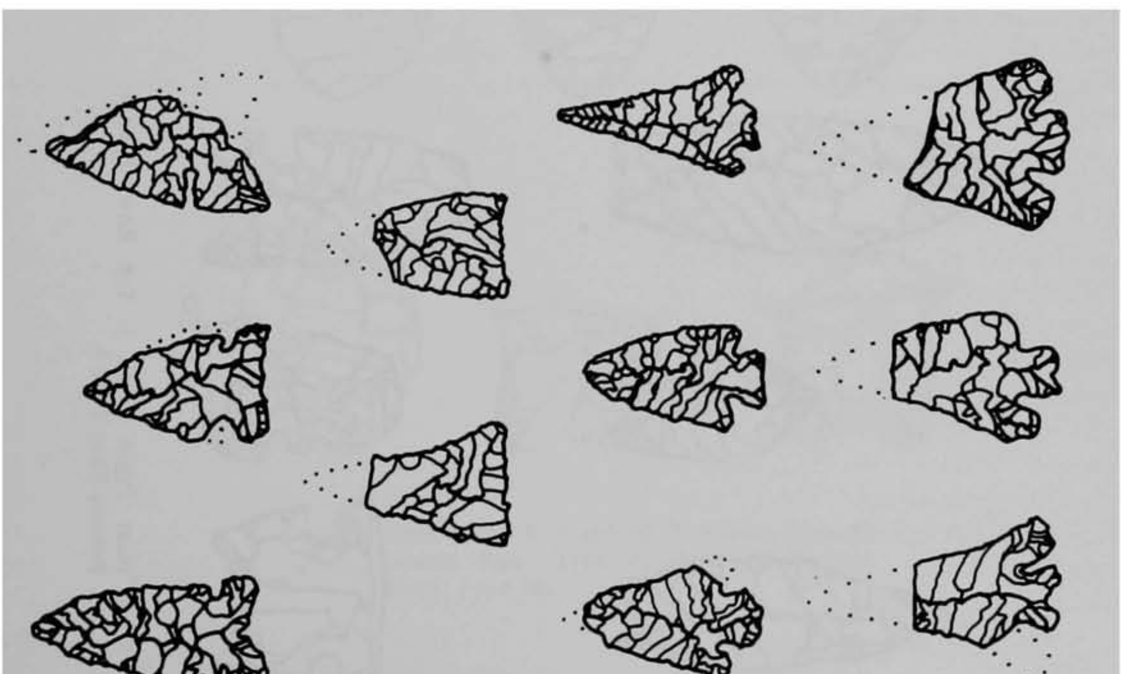

Fig. 3. Point Type 1.

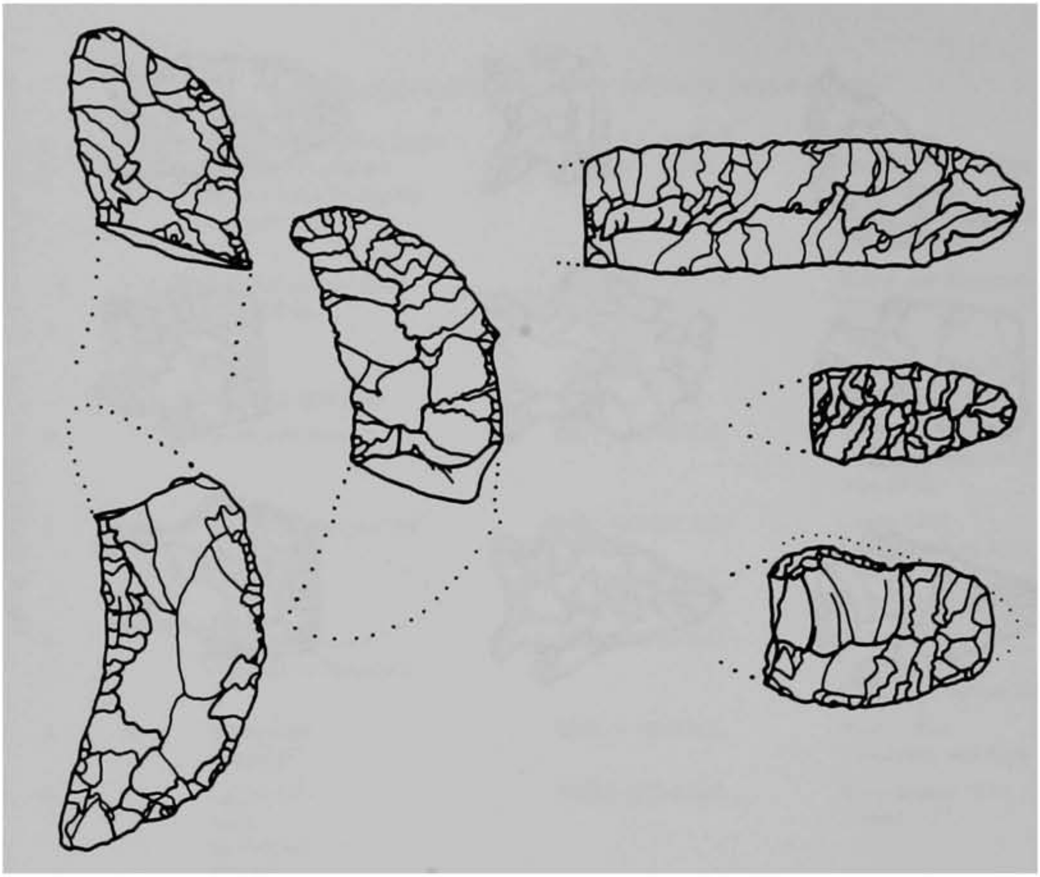

Fig. 6. Point Types 6 and 7. Top Row: Type 6; Bottom Row: Type 7.

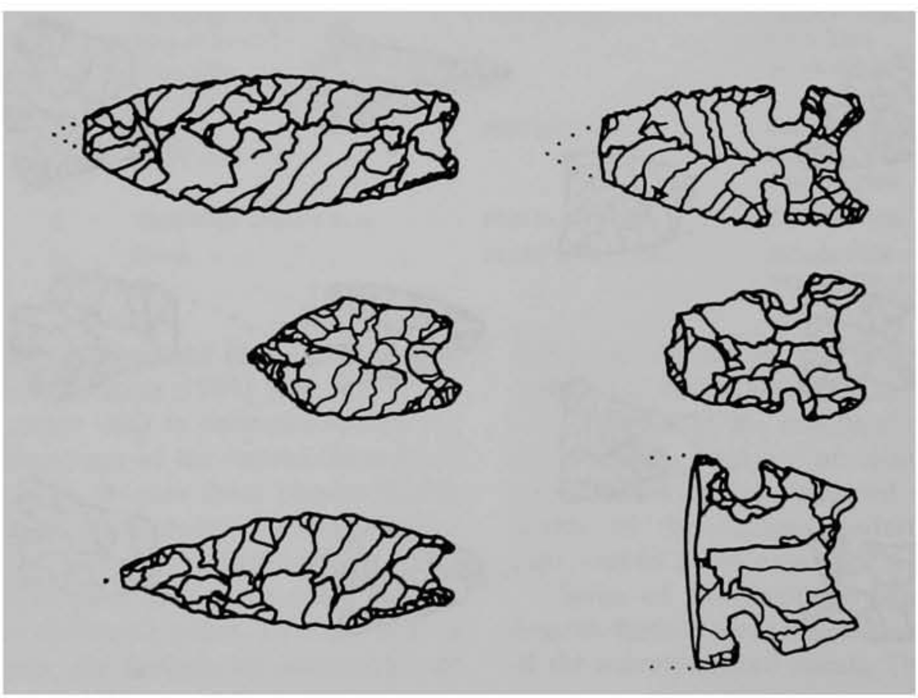

Fig. 5. Point Types 4 and 5. Top Row: Type 4; Bottom Row: Type 5.

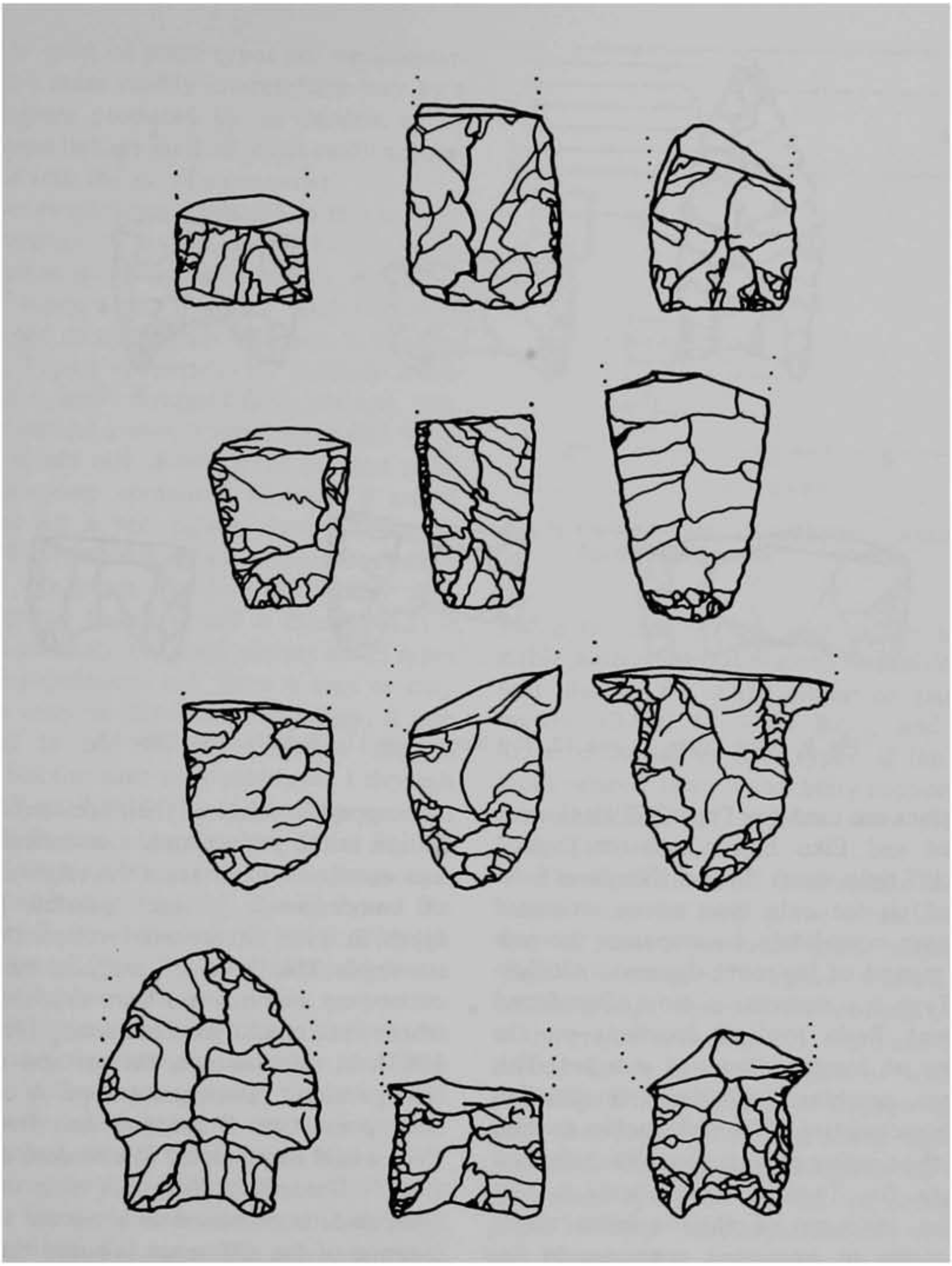

Fig. 7. Point Types 8, 9 and 10. Top Row: Type 8; Second Row: Type 9; Third and Bottom Rows: Type 10.

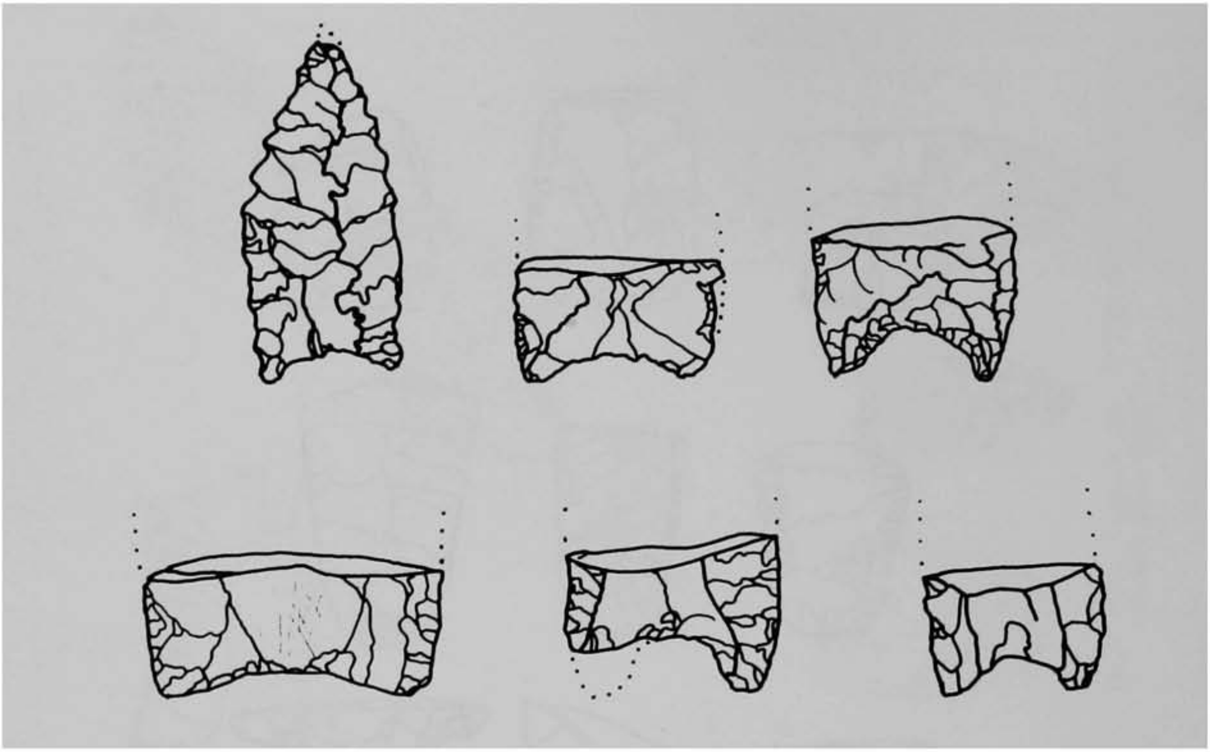

Fig. 8. Point Types 11 and 12. Top Row: Type 11; Bottom Row: Type 12.

definitions are used for Type 2 (Elko Corner-notched and Elko Eared) and for Type 3 (Gatecliff Split-stem). Type 5 (Northern Side-notched) is the only type whose estimated time span completely encompasses the proposed period of the much-discussed Altithermal. Type 6 (crescents) is most often found in Great Basin lowland locations on the margins of former lakes and marshes. This evidence, combined with the distinctive formal characteristics of the style, points to their use in the hunting of waterfowl. The temporal estimate for Type 7 (willow-leaf) is very insecure, because of their relative rarity, particularly in excavated contexts, in the Great Basin. Types 8, 9, and 10 would be included in Layton's (1979) Great Basin Stemmed point series.

HORIZONTAL PATTERNS

To find out how closely the 12 types correspond in terms of their horizontal distribution in the project area, a statistical device was employed to measure the relative degree of co-occurrence of each possible pair of types in each square-mile section that was surveyed. This kind of analysis, called *co-occurrence analysis,* has been described elsewhere in much greater detail (Pettigrew 1983). In this instance, the method answers the question, "Does point type A co-occur with point type B more or less frequently than would be predicted in a random distribution?" The result, for each pair of types compared, is expressed as a z-score that is a measure of the difference between the actual and predicted co-occurrence frequencies, and is also a statement of the probability that point types A and B are randomly associated as well as a measure of the similarity or difference in their distributions. The z-score matrix that results from a comparison of all possible pairs of point types can be summarized in a more readily interpretable way by a dendrogram produced by an iterative or recomputed linkage method, most easily accomplished with the aid of a computer.

The dendrogram produced by this analysis (dendrogram A in Fig. 9) divides the point population into two major groups, one made up of types 1, 2, 5, and 7, and the other composed of the remaining types. In the first group, Type 1 (essentially the probable arrow points) is quite divergent from the rest, and, in the second group, Type 3 (Gatecliff Split-stem) stands out clearly from the rest while the sub-group composed of types 6 and 8 through 12 is very tightly clustered, leaving Type 4 (Humboldt series) somewhat distinct within the group. Because the tightly clustered group (types 6 and 8 through 12) is almost certainly the most ancient set of types in the population, and Type 4 may or may not be early in the local chronology, it was decided to try the co-occurrence analysis again, but this time with only types 1 through 5 and Type 7. With the early group removed the dendrogram (dendrogram B in Fig. 9) divided the population into two major groups, one composed of types 1, 2, and 7, and the other made up of types 3, 4, and 5. With the exception of Type 7, which has a sample size of only 4 specimens and shows no positive values in the z-score matrix (not shown), the first group is certainly younger than the second. In the second group, types 3 and 4 are closely associated and link with Type 5 (large side-notched) at a fairly high value, supporting the view held by Hester (1973:45) that the Humboldt series dates primarily from 4000 to 1000 B.C., generally intermediate in age between large side-notched points and Pinto (here Gatecliff Split-stem or Type 3) points.

The results of the co-occurrence analysis of the horizontal distribution of point types, then, show a tight clustering of early types (6 and 8 through 12) that may reflect a fairly stable settlement and resource utilization pattern during the early Holocene (approximately 10,000 to 5000 B.C.), and much looser clustering of later types (if the Humboldt series is later, a possibility supported by this analysis) that suggests more frequent shifting of settlements.

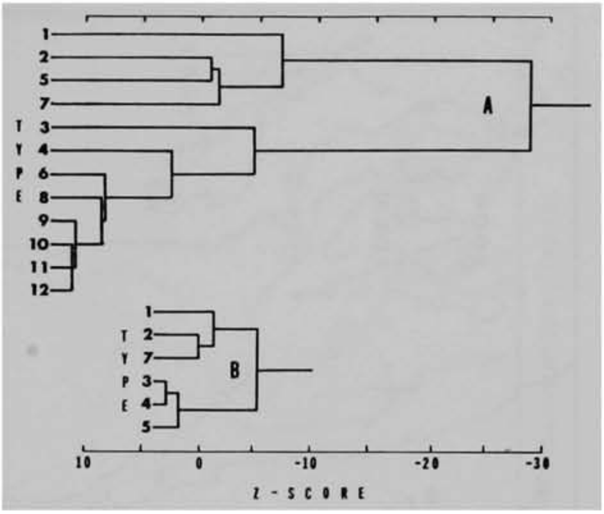

Fig. 9. Co-occurrence Dendrogram, Analysis by Square Mile Section.

The significance of these results becomes clearer when we look at the actual distributions of point types found in the project area (Figs. 10 through 17). Types 11 and 12, the earliest group, cluster in the southern portion of the project area (Fig. 10), south and east of Alvord Lake, on the margins of what was probably a large marsh or shallow lake in early post-Pleistocene time, about 10,000 to 7000 B.C. Only one point of the group was in an upland area, and one of the group was found in the peripheries of the Alvord Desert and Mickey Lake playas, where the distance between the lake bottoms and the surrounding basalt rims is short and was likely covered by water during this period.

Types 8, 9, and 10 form a group that is similar but much more widespread (Fig. 11). The majority of points is still from the

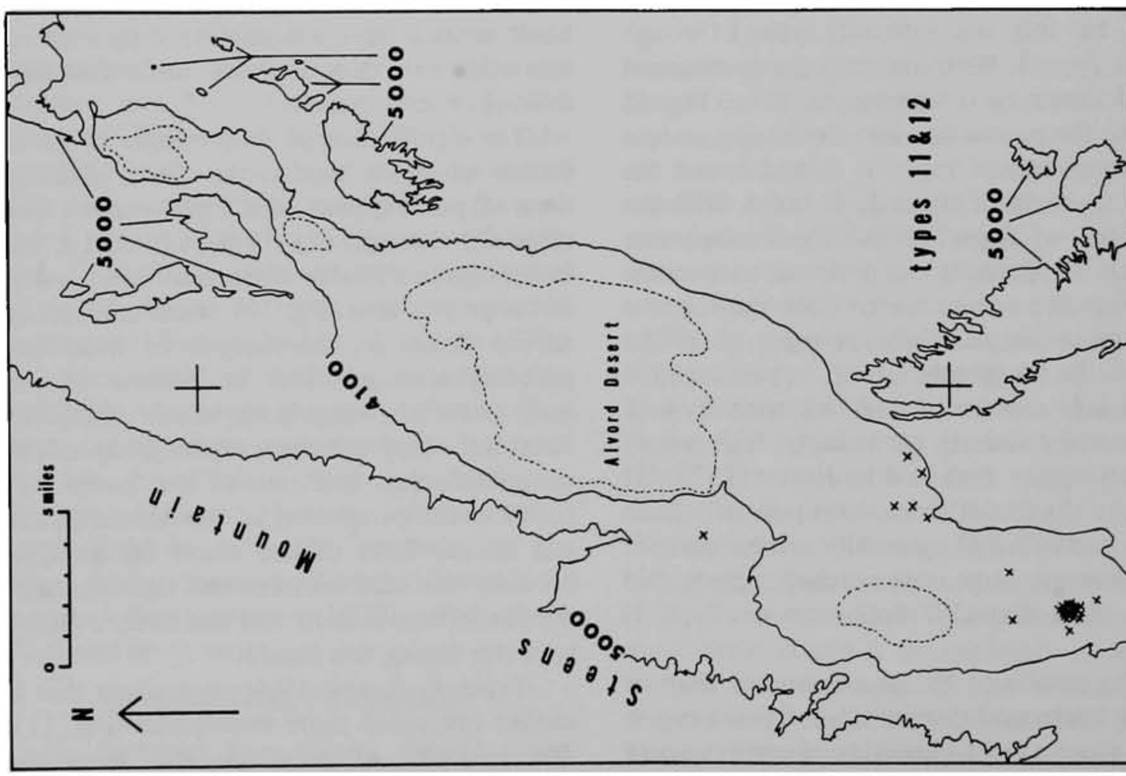

Fig. 10. Distribution of Point Types 11 and 12.

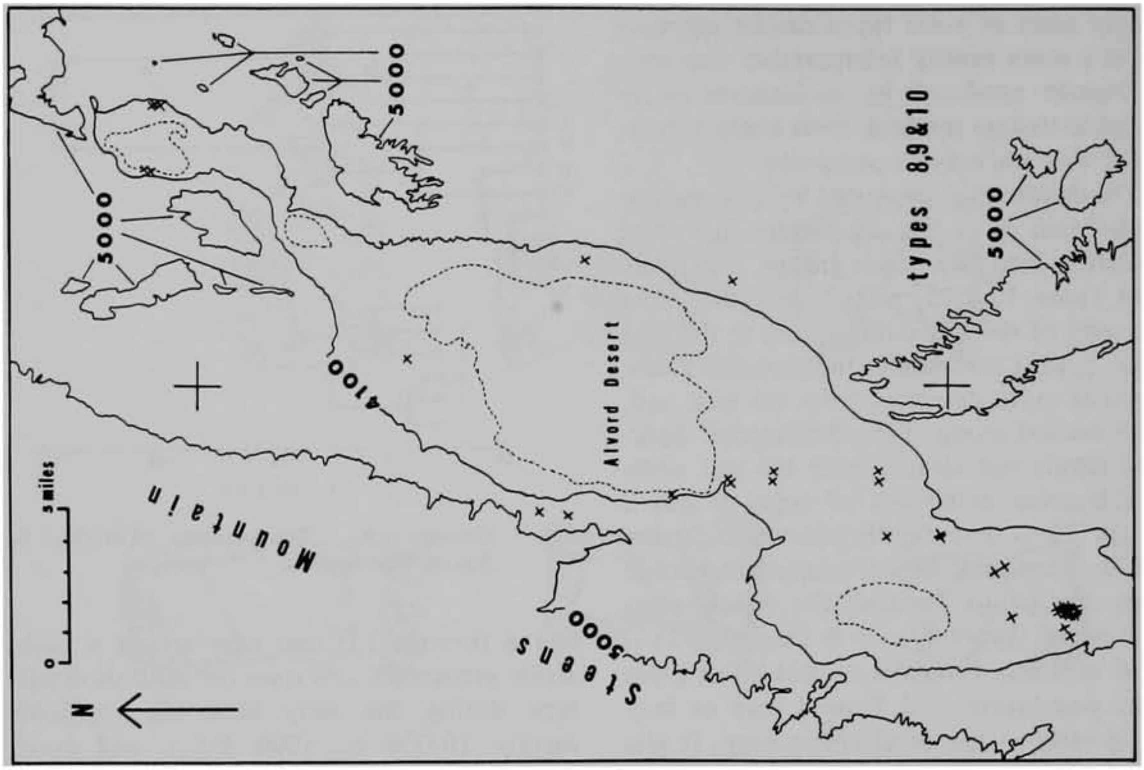

Fig. 11. Distribution of Point Types 8, 9 and 10.

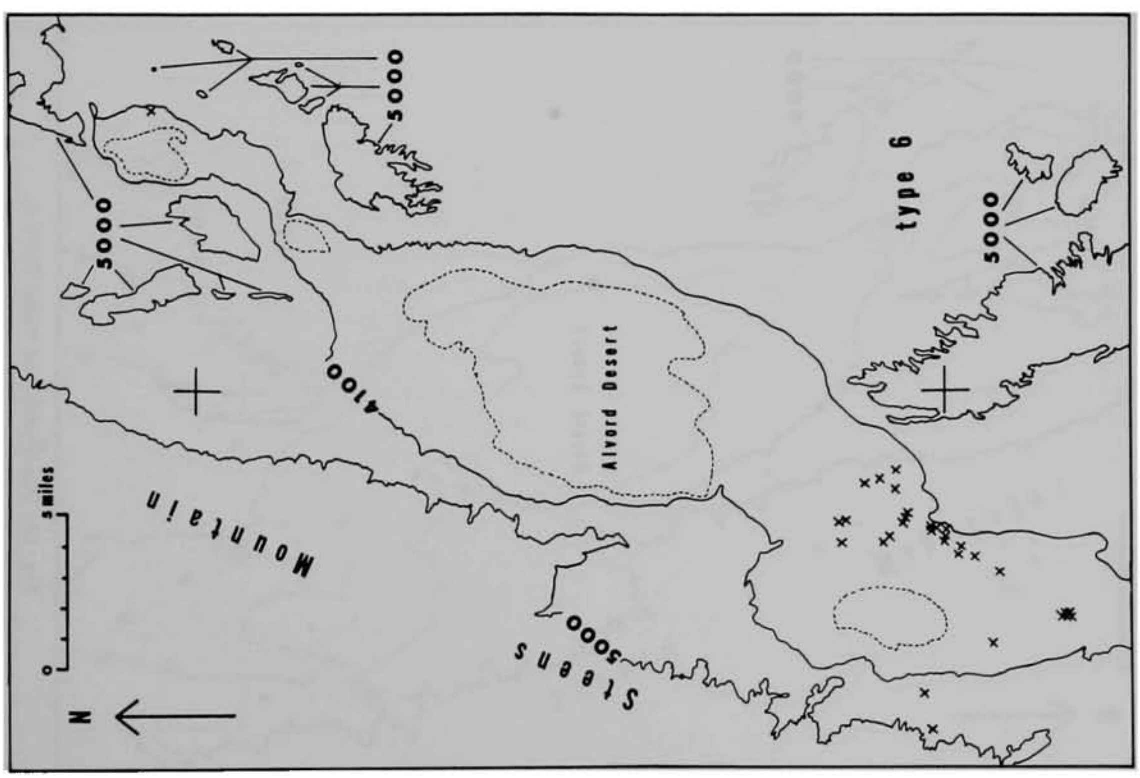

Fig. 12. Distribution of Point Type 6.

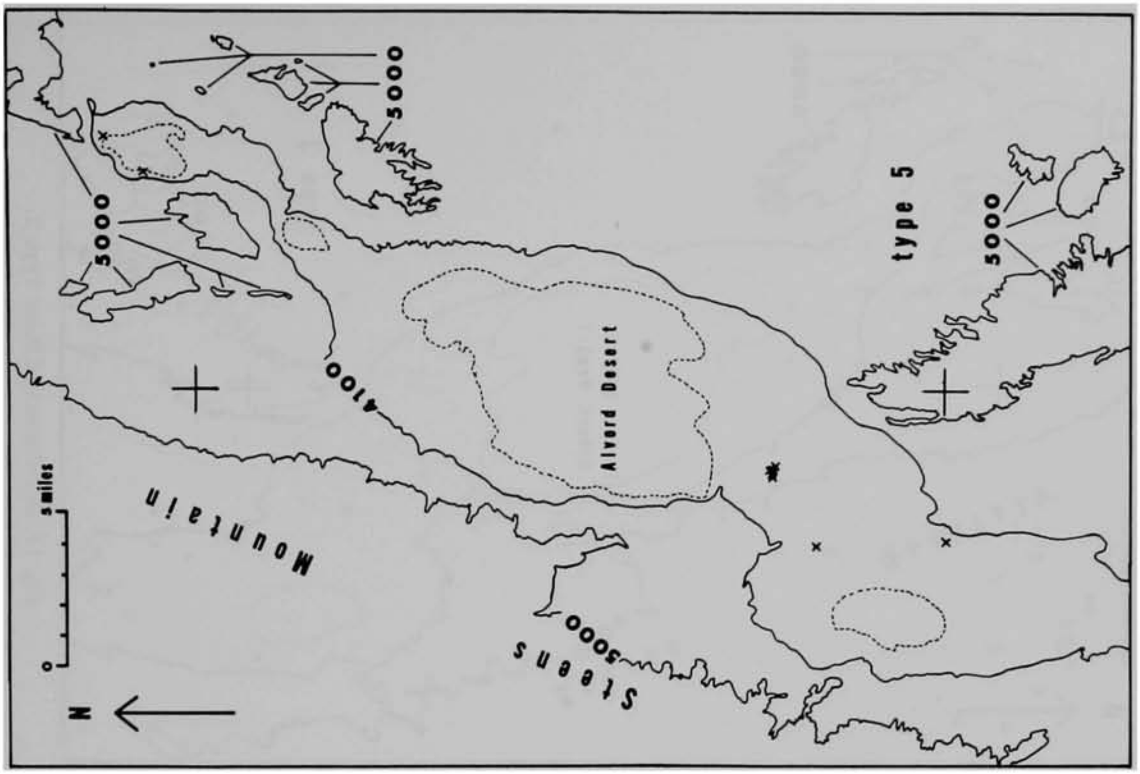

Fig. 13. Distribution of Point Type 5.

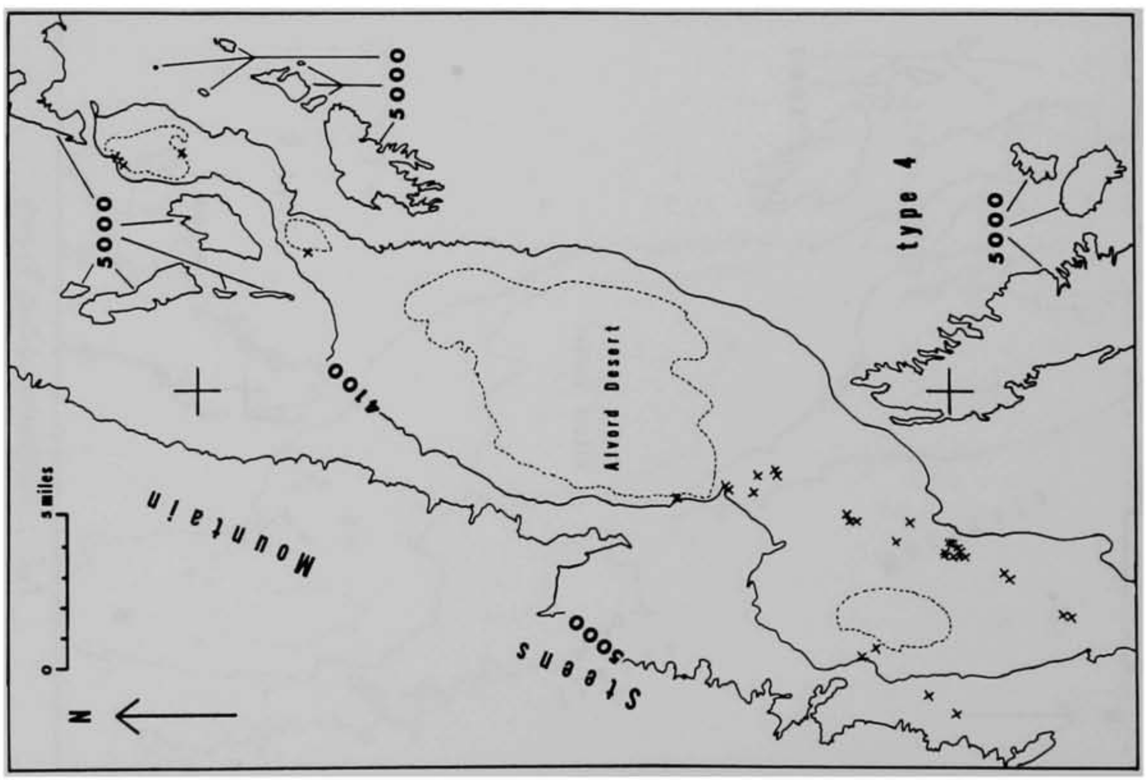

Fig. 14. Distribution of Point Type 4.

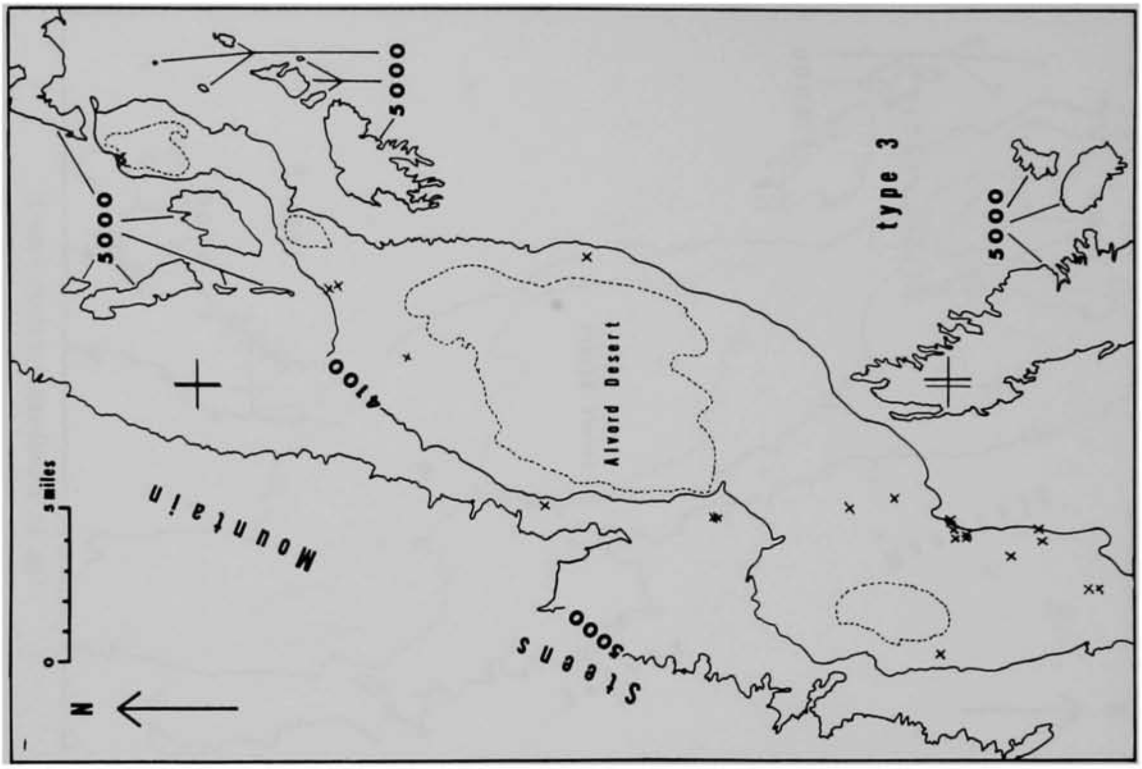

Fig. 15. Distribution of Point Type 3.

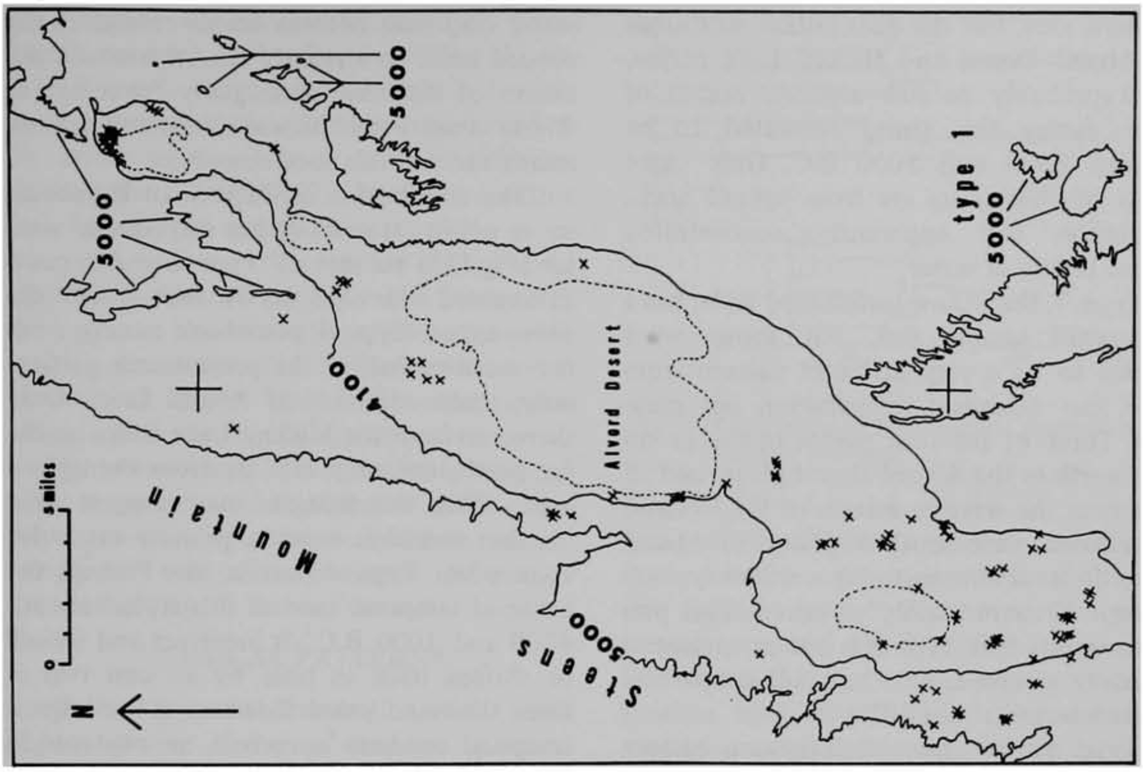

Fig. 17. Distribution of Point Type 1.

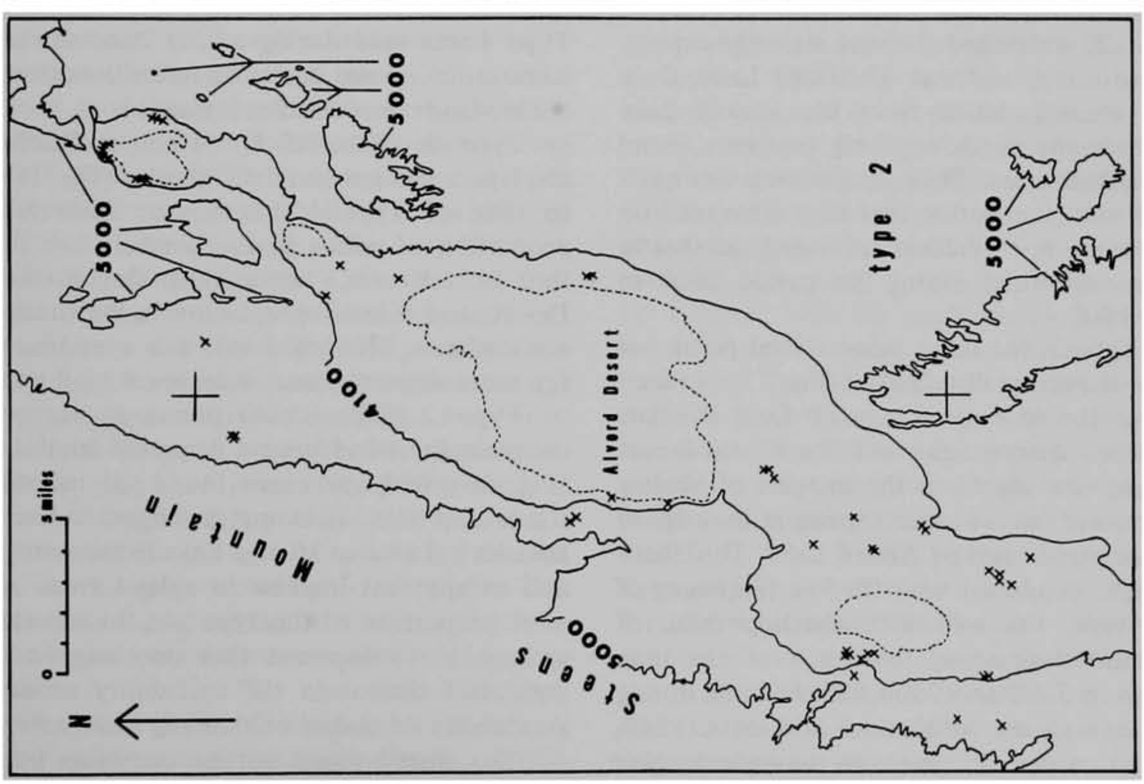

Fig. 16. Distribution of Point Type 2.

southern area, but the distribution surrounds the Alvord Desert and Mickey Lake playas, which probably became separate bodies of water during this time, estimated to be between 8000 and 5000 B.C. Only three points of this group are from upland areas; habitation still apparently concentrated around bodies of water.

Type 7, the willow-leaf-shaped style, has a very small sample size, but shows what appears to be a very different pattern from those just described (distribution not mapped). Three of the four points in this group were north of the Alvord Desert playa, and all were near the western margin of the lowland zone. None were south and east of Alvord Lake, the southernmost playa, where types 8 through 12 were mainly clustered. This pattern suggests that Type 7 is *not* as ancient as originally assumed, but the small sample size makes interpretations difficult.

Type 6, the crescent, follows a pattern (Fig. 12) very similar to that seen for types 11 and 12, which had the vast majority concentrated south and east of Alvord Lake. Only one example came from the Mickey Lake Basin in the north, and only two were found in upland areas. Their distribution fits quite well with the notion that they were used on the margins of shallow lakes and marshes to hunt waterfowl during the period 9000 to 5000 B.C.

Type 5, the large, side-notched point, has a most pecular distribution (Fig. 13) in which six of the nine specimens are from the flats between Alvord Lake and the Alvord Desert playa, two are from the margins of Mickey Lake, and one was near a spring at the edge of the lowlands east of Alvord Lake. This distribution, combined with the low frequency of the type, fits well with the hypothesis of extreme desiccation for much of the time between 5000 and 2000 B.C. At times during this period, the Altithermal of Antevs (1948, 1955), water or resources dependent upon water may have become scarce enough in the Alvord Basin to seriously inhibit human utilization of the area, particularly for a people whose traditional lifeway concentrated on marsh and lakeside food resources.

The distribution of Type 4, or Humboldt series points, appears rather surprisingly similar (Fig. 14) to that of Type 6 and types 8 through 12, the older styles. Just as with the older types, Type 4 points are mostly from the southern half of the project area, particularly south and east of Alvord Lake. Only three are from the Mickey Lake Basin on the far north, and only two are from the upland area. This distribution may suggest that marshes and lakes were the primary extractive zone while Type 4 was in use. Perhaps the assumed temporal span of this style, between 4000 and 1000 B.C., is incorrect and should be shifted back in time by at least two or three thousand years. However, if the original temporal estimate is correct, an explanation for the distributional pattern may be that Type 4 was used during a later stand of the lakes in the Alvord Basin. Whatever the cause, the lowland concentration is marked.

Type 3 (Gatecliff Split-stem or Pinto) displays a pattern generally similar (Fig. 15) to that of Type 4, but has an increased proportion of points in the northern half of the project area, surrounding the Alvord Desert, and a lesser proportion in the southern lowlands. This trend indicates a tendency for more dispersed and widespread land-use.

Type 2 (Elko series) points appear to continue the trend toward dispersed land-use (Fig. 16), with specimens found throughout the project area, including the largest concentrations yet around Mickey Lake in the north, and an apparent increase in upland areas. A large proportion of this type was found near springs, a development that may suggest a continued decline in the availability or dependability of bodies of standing fresh water.

This distributional pattern continues into the period (approximately the last 2,000 years) represented by Type 1 (Fig. 17). As with Type 2, these points, mostly the small, narrow-necked styles generally considered to be arrow points, have a wide distribution (even wider than Type 2). A large proportion was found near springs, a particularly dense concentration was found in the Mickey Lake area, and points of this type were common in the uplands. Newly exploited areas, however, include the alluvial fan at the north edge of the Alvord Desert and the lowland dunes along a line due south of Alvord Lake, the southernmost playa. This distribution apparently represents an adaptation of native populations to an environment similar to current conditions with the aboriginal technology documented at the time of contact.

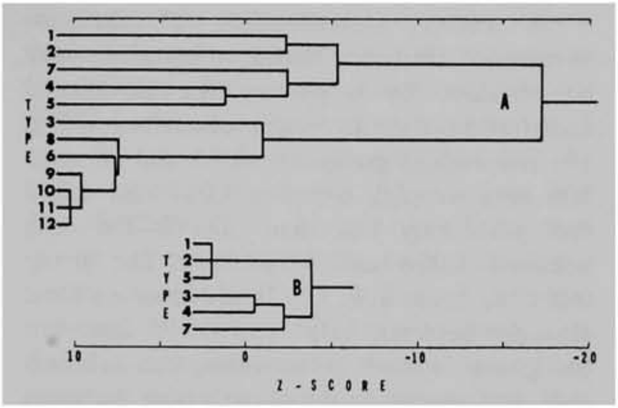

Fig. 18. Co-occurrence Dendrogram, Analysis by Elevational Intervals.

VERTICAL PATTERNS

If the horizontal distribution of the point types shows changing land-use patterns through time, their vertical distribution may be expected to provide complementary information of the same sort. In order to determine how the types varied in their elevational distributions, a co-occurrence analysis was performed using as the co-occurrence units 5-foot intervals between 4000 and 4100 feet, 50-foot intervals from 4101 to 4250 feet, 100-foot intervals from 4251 to 4750 feet, and the open-ended intervals below 4000 feet and above 4750 feet. These expanding intervals were used to maintain comparably large sample sizes and to minimize the number of intervals for analytical ease. The dendrogram (A in Fig. 18) produced by this analysis divides the point population into two major groups, one made up of types 1, 2, 7, 4, and 5, and the other including the remainder. This grouping is very similar to that resulting from the horizontal co-occurrence analysis (dendrogram A in Fig. 9), the only difference being that Type 4 (Humboldt series) is now included with the first group. In the first group of Fig. 18, dendrogram A, the only two types joined on the positive side of the scale are types 4 and 5. In the second group, however, types 6 and 8 through 12 (as in the horizontal analysis) cluster at a very highly positive level, while Type 3 (Gatecliff Split-stem) joins at a slightly negative value.

It is already clear, of course, that the group of types 6 and 8 through 12 is the most ancient of the lot, so the co-occurrence analysis was run again excluding that early group, resulting in Fig. 18, dendrogram B. This new dendrogram, as before, divided the population into two major groups, one composed of types 1, 2, and 5, and the other made up of types 3, 4, and 7. The placement of Type 7, with its small sample size (4), needn't be given much consideration, but the joining of Type 5 (large side-notched) with types 1 and 2 at a rather high level is somewhat unexpected. Inspection of the original z-score matrix from which the dendrogram was constructed (not shown) reveals that Type 5 has a high positive z-score with Type 4 (1.8) as well as with types 1 (1.5) and 2 (1.9), pointing out the major weakness of dendrogram clustering: Type 5 shows tendencies to link with Type 4 as well as with types 1 and 2, but the dendrogram forces it to link with one and not the other.

A better understanding of the co-occurrence clustering based on elevation may be obtained by inspecting the elevational distributions themselves as summarized in Fig. 19. The earliest group, types 11 and 12, clusters very strongly between 4,051 and 4,075 feet with only less than 20% in the next between 4,026 and 4,050 feet. The group including types 8, 9, and 10 also clusters most strongly between 4,051 and 4,075 feet, but the group is much more widespread in elevation, and appears to represent a time, between group is much more widespread in elevation, and appears to represent a time, between 8000 and 5000 B.C., of declining lake and marsh levels. Type 6, the crescent, is contemporaneous with both previous groups, and clusters at a somewhat lower elevation than they do, possibly because of its specialized usage along the margins of lakes and marshes.

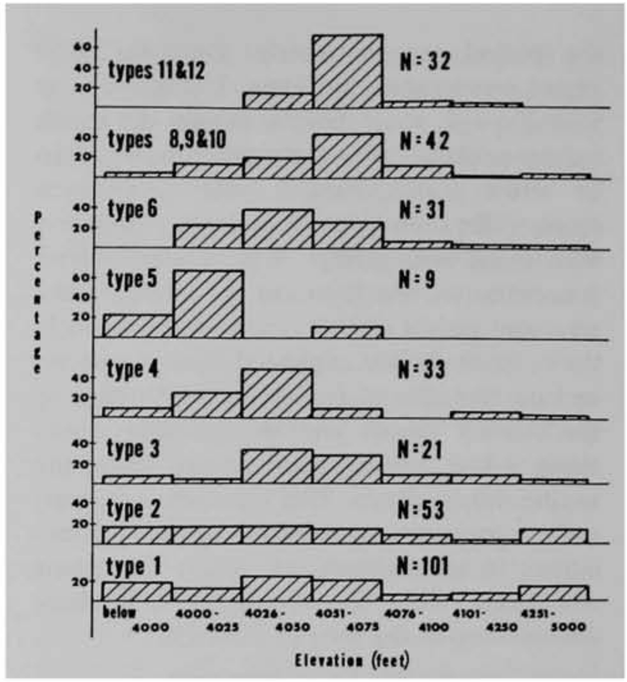

Fig. 19. Frequencies of Point Types by Elevation.

Type 5, the large side-notched point, has the strangest vertical distribution of all, just as its horizontal pattern was aberrant. This may indicate a very limited usage of the Alvord Basin bottomland during the estimated period of the proposed Altithermal, between 5000 and 2000 B.C. That Type 5 showed tendencies to cluster in the dendrogram with both Type 4 and types 1 and 2 results apparently from its substantial proportion from below 4,000 feet (a factor it has in common with types 1 and 2) and its high frequency between 4,000 and 4,025 feet (many Type 4 points are in this interval).

Type 4, the Humboldt series, assumed to date from 4000 to 1000 B.C., has its mode in the same elevation as Type 6, but is generally more widespread in elevation than any of the earlier types. This distribution is congruent with the idea that Type 4 was the last style of point used during the first half of the post-Pleistocene time, when the lakes and marshes had reached their lowest levels before drying up entirely, but also supports the notion that the type was used during a late Holocene filling of the lakes that accompanied a changed way of life and an increase in population density.

The vertical distribution of Type 3 (Gatecliff Split-stem), representing the period 2000 B.C. to A.D. 1, differs somewhat, though not a great deal, from that of Type 4. The most telling difference may be in its increase over Type 4 in proportions above 4,050 feet, beginning a trend, that continues in later types, toward more widespread utilization of the landscape.

Types 1 and 2, representing the past 2,000 years, are remarkably similar in their vertical distributions, differing from the earlier Type 3 in their considerably greater proportions above 4,050 feet and below 4,026 feet. With these two types, elevational diversification reaches its prehistoric maximum, an apparent indicator of maximized economic diversification and the final stage in a long process of adaptational evolution.

DISCUSSION

We cannot, of course, expect these data from the Alvord Basin to inform us on more than some of the details of the prehistoric cultural and climatic sequences. After all, chronological estimates based on cross dating are imprecise, and only a small upland area, all below 5,000 feet, was sampled. Excavations of large, stratified sites would improve our chronological precision, and more sampling of higher elevations, such as that done by Fagan (1974) at spring sites and by the Steens Mountain Project[1] (Aikens, Grayson, and Mehringer 1982), will give us a more complete picture of the seasonal round. Nevertheless, we already have enough information, from the Alvord Basin survey and other sources, to propose a basic model of changing climatic and subsistence patterns for the prehistory of the Alvord Basin and the northern Great Basin.

A very important test of any such model is its ability to explain and encompass the distributional data on the Alvord projectile point types. This criterion will be stressed in the model proposed here. In the following discussions, I shall first present a behavioral model to account for the patterns observed in the survey data, and then propose a more generalized adaptational model to describe the cultural evolution that was fundamental to changing patterns of land-use. Finally, I shall compare the adaptational model to that proposed by Elston (1982) for the western Great Basin, as a way of exploring the potential for a region-wide interpretation of prehistoric cultural change.

Behavioral Model

Though there is little direct evidence yet to support the idea, the first well-recognized cultural tradition in North America, that of the fluted-point big-game hunters, about 10,000 to 9000 B.C., may have had a brief lifespan in the northern Great Basin. This is suggested by the presence of fluted points in the Alvord Basin and elsewhere (Aikens 1978), and paleontological evidence that now-extinct herd animals once roamed the region (Cressman et al. 1942; Heizer and Baumhoff 1970). Each piece of such evidence moves us one step closer to recognizing a continent-wide horizon of late-Pleistocene big-game hunters. This is not to assert that fluted points necessarily imply specialized big-game hunters, but only to suggest that such big-game hunters were the first possessors of such points. I strongly suspect that the first makers of fluted points in the northern Great Basin were skillful big-game hunters; even if so, however, it is likely that their way of life very quickly became adapted to the special conditions of that environment, which was cool and moist, with abundant lakes and marshes that offered a variety of resources such as waterfowl, fish, deer, and edible seeds and tubers. By this reasoning, much of the daily lives of the later fluted-point makers and their descendants was spent on the margins of lakes and marshes, even if elephants, bison, horses, and other large mammals were taken whenever possible. The presence of fluted points in the Alvord Basin in the same areas as later, non-fluted points is the result, then, of rapid adaptation to the local environment.

The first documented cultural tradition in the northern Great Basin, however, is what is aptly called the Western Pluvial Lakes Tradition (Bedwell 1973: 170-171), established possibly as early as 9000 B.C., and marked in the archaeological record by several types of large, lanceolate projectile points and crescents. Birds (possibly hunted with projectiles tipped with crescents), fish, deer, and herds of large mammals, as well as significant vegetal resources (most notably seeds and fruits), were dependable foods that required little seasonal movement, allowing small band terrirories as well as fairly dense human populations where winter game was abundant. Biotic resources that are now found only at high elevations were available at low elevations then, rendering hunting trips into the upland zones less necessary and less frequent than in later times. The distribution of the projectile points of this period (ca. 9000 to 5000 B.C.), particularly the crescents, around the margins of lakes and marshes and only rarely in upland areas, such as at Last Supper Cave and Hanging Rock Shelter in northwestern Nevada (Layton 1979), argues for this kind of lowland adaptation. The success of this way of life may have contributed to its termination, however, by reducing many of the large herd animals, notably the mammoth, horse, camel, and large bison, to extinction. This process may have been quickened by the distinct warming and drying of the climate that appears to have taken place, and that reduced the extent of the lakes and marshes so important to that mode of human adaptation.

Although it would be too simplistic to believe that mid-postglacial times (5000 to 3000 B.C.) were characterized by a single and uninterrupted period of desiccation (the Altithermal of Antevs [1955]), it does appear that this temporal interval witnessed at least one of the most intense, and perhaps the most culturally significant, dry spells of post-Pleistocene time. Even if this period experienced some wet intervals, it appears to have posed a very challenging problem to human societies that had been highly dependent on herd animals and wetland resources. By 5000 B.C., the Western Pluvial Lakes Tradition had become extinct, and human groups were forced to expand their territories to include greater use of the high uplands above 5,000 feet as well as lowland zones, to travel more frequently and for longer distances in their annual subsistence schedule, and to hunt solitary game animals such as deer. Human population density may have dropped significantly in response to a lower environmental carrying capacity. It would not be unreasonable to look for evidence of out-migration to more well-watered locations to the north and west, as suggested many years ago by Cressman et al. (1942). The restricted, distinctive, and exclusively bottomland distribution of Type 5 (large side-notched) points, the only style whose estimated time span completely encompasses this period, is consistent with the reconstruction presented here, in that this distribution clusters at lower elevations than any of the previous styles and in an area of the basin (between the Alvord Desert playa and Alvord Lake) where earlier points are rarely found. In fact, Type 5 points are found at the elevations and locations that in earlier times were probably covered by standing water. The reconstruction proposed here would predict that Type 5 points should also tend to be found at elevations higher than those sampled by the Alvord Survey, and likely at the sites of dependable springs.

Between about 3000 and 2000 B.C., a much moister period began. This period, dubbed the "Neopluvial" by Allison (1982) and by Curry and James (1982), saw the reappearance of some lakes and previously dry or nonexistent lowland springs. By this time the large, side-notched point of the preceding period had probably been replaced by the Humboldt series and then by the barbed, corner-notched point, and during the Neopluvial period the human population increased and adopted a settlement pattern in which all elevational zones, from the basin floor to the highest uplands, were exploited extensively. The broadly based nature of this adaptation is indicated by the increasing diversification of the exploited territory and elevations shown by types 4, 3, and 2 (roughly in chronological order) (Figs. 14, 15, 16, and 19).

By the time the narrow-necked points (all of which fit within Type 1) and, by inference, the bow and arrow arrived on the scene in southeastern Oregon about 2,000 years ago or somewhat less, an extractive system generally similar to that of ethnographic times was firmly established in the Alvord Basin and possibly in other, similarly dry basins. A different way of life, dependent on the lacustrine ecosystem to a greater extent, operated at Lake Abert at this time (Pettigrew 1981a), 1985), however, and may have characterized other basins with substantial lacustrine resources, such as Summer Lake, Warner Valley and the Harney Basin. In the Alvord Basin, however, the distribution of Type 1 projectile points, both vertically (Fig. 19) and horizontally (Fig. 17), shows an undiminished, and in some ways increased diversity of exploited zones compared to previous styles, a pattern that appears to reflect little substantial change in the extractive system. By 2,000 years ago or shortly thereafter, the Neopluvial in its most dramatic manifestations may have terminated, as suggested by Davis (1982: 67) for the Lahontan Basin, with more frequent periods of drought, but there is no clear indication in the Alvord Basin projectile point data of a cultural response to such environmental change. It may be that the cultural system as it had evolved previous to 2000 B.P. in the Alvord Basin was adaptable to climatic fluctuations of the past two millenia, or that the archaeological record as indicated by the survey is not detailed enough to reflect cultural changes that occurred. This latter possibility is the most likely explanation for the lack of an archaeological expression of the ethnic replacement connected with the Numic expansion that probably took place within the last 2,000 years (Bettinger and Baumhoff 1982; Aikens 1982).

Adaptational Model

The Alvord Basin data appear to support the idea that there has been a series of major adaptational shifts over the past 12,000 years of human prehistory. I propose that there have been four *adaptive modes* in the Alvord Basin and perhaps adjacent areas. Each mode was an extractive economic system differing from the other modes in the evolutionary sequence in terms of settlement patterns, preferred foods, scheduling of economic activities, and (to a varying extent) technology. The first adaptive mode was the *Paleo-Indian* (10,000-9000 B.C.) which has long been recognized as an early cultural stage in North America. Evidence for Paleo-Indian occupation of the Alvord Basin is far from overwhelming, as noted above, consisting of fluted points found in the Alvord survey. Nevertheless, it is reasonable to propose that the human groups for which we have any evidence were fully nomadic foragers (Binford 1980, Madsen 1982b) specializing in large herd animals. Their tool kit was related to that of the Upper Paleolithic of the Old World, including large pointed bifaces hafted on spear shafts and used as thrusting weapons as well as cutting tools. Tools for plant processing were not included, though a familiarity with plant foods was probably part of their tradition.

The second adaptive mode was the *Western Pluvial Lakes Tradition* (9000-5000 B.C.), which marks the beginning of what is properly called the Archaic stage by the original definition laid down by Willey and Phillips (1958). This mode, as indicated above, was the first in which the regular use of a wide variety of food resources was practiced. What brought about the end of the Paleo-Indian stage is not clear, though an appeal to evolutionary ecology (O'Connell, Jones, and Simms 1982) suggests that the change was brought about by the decimation of the primary prey of the big-game hunters, who then chose a more reliable and diverse set of resources to exploit. The folk of the Western Pluvial Lake Tradition were collectors (Binford 1980) who concentrated their economic effort on the wet bottomlands, probably maintaining base camps on the margins of lakes and marshes and traveling to seasonal hunting and gathering camps. Upland areas were only sparsely used, since eco-zones were still depressed toward the lower elevations. If there were house structures, they were probably nonpermanent and unsubstantial, perhaps consisting of brush- or hide-covered shelters. Heavy reliance on waterfowl is suggested by the frequency of crescents, though a considerable amount of big-game hunting was practiced with the aid of large projectile points that may still have been hafted to spear shafts. Vegetable foods were doubtless used, though to an unknown degree. Manos and metates may have been introduced during this period, but their degree of use is uncertain. The rather high frequency of occurrence of points from this period in the Alvord Basin suggests that the human population was substantial.

The third adaptive mode was what I call the *Transitional Archaic* (5000-3000 B.C.), which is poorly represented in the Alvord Basin. This mode is hypothesized to have been an attempt by the human population to adapt to a changed environment (notably, without herd animals and substantial low-elevation wetland resources) with a strategy that initially involved a shift to higher elevations to collect the same foods that were used by the people of the Western Pluvial Lakes Tradition. Population density dropped to very low levels, bands occupied large territories and moved more frequently, and people devised innovative techniques to maximize their their subsistence efficiency, including the hunting of solitary game mammals with notched projectile points. This was a time of shifting strategies from an emphasis on animal products to plant foods. By the end of the period, the full-time adoption of the mano and metate for seed processing and possibly the mortar and pestle for root processing (Ames and Marshall 1980-81) had revolutionized the subsistence economy, increasing the carrying capacity of the landscape even in the absence of environmental amelioration. The human population rebounded somewhat, concentrating again in the lowlands.

The fourth and final adaptive mode was the *Full Archaic* (3000 B.C.-contact). The adoption of plant foods (seeds and roots) as the staple created a subsistence strategy that was very adaptable to changing conditions, and less dependent on the fluctuating availability of game. Wintertime food storage was now facilitated, making it advantageous to maintain fixed winter settlements, ideally in the lowlands where milder weather and easier access to game were critical factors. An increase in effective moisture after 3000 B.C. (Madsen 1982a) only furthered the success of this way of life, and the human population increased substantially, reaching a peak between 1000 B.C. and A.D. 1. The economic system was based on a centrally based collection strategy with seasonal camps used by task groups at many localities throughout each group's territory. The degree of sedentism in the Alvord Basin is unknown; no village sites with housepits have been found, though they existed elsewhere in the northern Great Basin, particularly at Lake Abert (Pettigrew 1981a, 1985). Hunting in the Full Archaic continued to be a very important activity, as indicated by the high frequency of projectile points. The adoption of the bow just less than 2,000 years ago may have been an adaptive improvement, but its only effect on the archaeological record seems to be an increase in the frequency of points, probably caused by more frequent re-arming of projectile shafts.

The Numic expansion that probably took place within the last millenium (Bettinger and Baumhoff 1982 with references), whether it was the cause or the result of adaptive change in the northern Great Basin, did not constitute a new adaptive mode. The Full Archaic includes a range of possible adaptive systems (Madsen 1983b: 210-212), from those requiring frequent travel during much of the year (Steward's Shoshonean model) to those with sedentary villages occupied year-round (possibly at Lake Abert). This does not mean that the Numic expansion was not accompanied by significant economic or adaptive change, but simply that the change was probably not as fundamental as earlier shifts in adaptive mode.

COMPARISON AND CONCLUSIONS

The model for prehistoric cultural evolution outlined above is based on data from the Alvord Basin, and is intended for application at that locality. Its validity for the rest of the northern Great Basin is a matter for future investigation. It may be useful, even so, to compare the model with that proposed by Elston (1982) for the western Great Basin, since in my judgment the cultural records for the northern and western Great Basin subareas show a great deal of similarity. Elston would lump my Paleo-Indian and Western Pluvial Lakes Tradition (WPLT) into his "Pre-Archaic" no doubt because of the paucity of Paleo-Indian evidence in the western Great Basin and his belief that the WPLT lifeway was pre-Archaic, i.e., dependent on a few major food resources at the top of the food chain, and thus similar in basic respects to the Paleo-Indian form of adaptation. I, on the other hand, see the WPLT as the earliest Archaic adaptive mode, even in the absence of food-grinding tools. We differ also in our interpretations of population density; Elston (1982: 192) sees a very low density for WPLT peoples, while I interpret the large numbers and spatial concentrations of points from the period in the Alvord Basin as evidence of a fairly large population. Large numbers of early points in the Black Rock Desert, Nevada (Clewlow 1968), south of the Alvord Basin support this idea as well. It would actually work better for Elston's model to have higher population densities for WPLT cultures, because it would help account for the demise of that way of life, as Elston himself (1982: 193) points out.

Though Elston does not name a specific period or stage identical with my Transitional Archaic (7000-5000 B.P.), he does mention the period 8000 to 6000 B.P., that the WPLT terminated by 7000 B.P., and that his "Early Archaic" began after 7000 B.P. A transitional period is implied but not discussed, and no earliest firm date for the Early Archaic is given. Both our models postulate a low population density for this period.

There is general agreement between the two models on the timing and nature of what I call the Full Archaic and he calls the Archaic (Early, Mid-, and Late). Both models propose fairly low populations for the early part of this period, and both attribute the cause of the onset of the adaptive shift more to culturo-technological factors than to environmental improvement. Both models also see a population maximum attained between 3000 and 2000 B.P., but the changes in subsistence and settlement patterns proposed by Elston (1982: 197-199) for the period following 2000 B.P. find no counterparts in the Alvord Desert model or data.

The comparison with the Elston model illustrates a substantial degree of similarity between the cultural records of the Alvord Basin and the western Great Basin, and a convergence of views on the explanatory mechanisms responsible for the cultural change that occurred. Perhaps most importantly, there is agreement that the Full Archaic lifeway did not evolve simply as a response to climatic amelioration following the Altithermal, but rather was initiated during the arid mid-postglacial interval when seed-grinding tools became habitually used.

In summary, the projectile point distributions recorded in the Alvord Basin have led this paper to discussion of patterns and proposals that can be divided into three major categories, ranging from the data-oriented to the theoretical:

1. The distributional analysis of horizontal and vertical patterns, using both co-occurrence analysis and graphical display, divides the projectile point population into groups that appear to show that point distributions, and by inference land-use patterns, changed significantly in the Alvord Basin during the documented span of human occupation. The principal groups are (a) the oldest group, including fluted points and those associated with the WPLT, (b) a middle group, including large side-notched, Humboldt series and Gatecliff Split-stem or Pinto points, and (c) the most recent group, including the Elko series, Rosegate series, and small side-notched as well as other recent point styles.

2. The distributional data combined with the assumed ages of the point styles show a distinct trend from concentrated lowland use, especially around the southern margins of the early Holocene pluvial lake, to a much more widespread and dispersed pattern. This shift is particularly marked in those styles representing post-mid-Holocene time, and is suggested to reflect a growing eclecticism in subsistence and horizontal and vertical expansion of extractive territories as a result of the disappearance of both large herd animals and the formerly extensive lakes and marshes. The distribution of fluted points coincides with that of WPLT tools, suggesting that the fluted-point hunters adopted a WPLT-like way of life very soon after their appearance in the region. No clear evidence of the late Numic expansion is seen at this level of analysis.

3. Four adaptive modes are proposed to encompass the approximately 12,000-year record of aboriginal cultures in the Alvord Basin. The Paleo-Indian (10,000-9000 B.C.) mode was one of fully nomadic foragers specializing in large herd animals. The WPLT (9000-5000 B.C.) mode was characterized by collectors concentrating on the wet bottomlands, depending to a great extent on waterfowl and the remaining species of large herd animals, as well as an undetermined variety of other wetland resources. The Transitional Archaic (5000-3000 B.C.) mode was an initial attempt to adapt to a changed environment without large herd animals and substantial low-elevation wetland resources by shifting the extractive focus to upland areas and plant foods as well as to the increased hunting of solitary game mammals and to the regular use of milling stones. The Full Archaic (3000 B.C.-contact) mode was reached when plant foods had become the staple of the diet, facilitating wintertime food storage as well as fixed winter settlements in the lowlands that were the hub of a centrally based collection strategy with seasonal camps through the extractive territory.

A very important part of this evolutionary reconstruction is the position that the Full Archaic lifeway did not evolve as a response to climatic amelioration following the Altithermal, but instead was brought about during the arid mid-postglacial interval when seed-grinding tools became habitually used. If this is true, then we should expect to find evidence of Full Archaic culture that existed *before* the onset of anything resembling Neopluvial conditions.

The distributional patterns of Alvord Basin projectile points and the explanatory model they have helped to generate represent an important step, but only a step, along the way of explicating the course of cultural change in the Alvord Basin and adjacent regions. Interpretations will no doubt be influenced and to some degree changed by data others will collect and analyze in the years to come.

NOTE

1. Recently reported results of the Steens Mountain Prehistory Project by Charlotte Beck (1984) appeared too late to be included in this paper. Once digested, these new data will no doubt enrich the context of the data reported in this paper and put to the test the proposals made here.

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