The Development of Pinyon Exploitation in Central Eastern California

ROBERT L. BETTINGER

THE aboriginal human ecology of the Great Basin has been a topic of much interest and debate among archaeologists over the last 20 years. One positive result of this research has been the refinement of research design and field techniques permitting the detailed reconstruction of prehistoric annual subsistence-settlement systems in some localities (e.g., Thomas 1973; O'Connell 1972). At the same time, against the background of such highly sophisticated projects, it is becoming apparent that many widely-accepted ideas about prehistoric man-land relationships are assertions, or at best hypotheses, which require further testing before they can be assigned any validity by archaeologists.

A case in point concerns inferences about the prehistoric use of nuts of the pinyon pine (*Pinus monophylla*) in central eastern California. It has been almost axiomatic among investigators working in this region that pinyon was an important aboriginal resource over the last few millenia at the very least (Meighan 1955; Lanning 1963; Davis 1963, 1964, 1970). Surprisingly little evidence is cited in support of this proposition, however. The notion apparently stems from observation of extensive, but usually undated, evidence of prehistoric use of upland pinenut groves (Meighan 1955), and from the direct application to prehistoric contexts of ethnographic accounts which document the intensive use of pinyon in historic subsistence systems (Lanning 1963; Davis 1963). The difficulty in demonstrating prehistoric pinyon exploitation lies in a number of circumstances which include: (1) the tendency of pinyon settlements to be surface scatters of artifacts, and therefore difficult to date by standard methods (e.g., radiocarbon); (2) confusion about the dating of time-sensitive projectile points which occur at these sites (cf. Bettinger and Taylor 1974); (3) lack of attempts to recover plant macrofossils from stratified sites; and (4) lack of adequate survey data upon which such a reconstruction could be legitimately based. These limitations are not insurmountable, but they make it obvious that if the study of prehistoric human ecology in eastern California is to proceed beyond the level of speculation, then all components of the aboriginal subsistence procurement systems (including that of the pinyon nut) will require more explicit study than has been the case in the past.

In addition, because pinyon exploitation is inextricably linked to the historic dietary patterns of eastern California, its time depth is relevant to a current controversy regarding the application of ethnographic models to Great Basin prehistory. Specifically, Jennings (1957, 1964, 1968) has argued that from 8000 B.C. to the historic period the human ecology of the

Great Basin was based on the intensive, but unspecialized, exploitation of all available resources and essentially comparable to the historic adaptation described by Steward (1938). This pattern is said to have been unaffected by climatic fluctuations. On the other hand, Heizer (1956), Baumhoff and Heizer (1965), Napton (1969), Davis (1966), and others (Cowan 1967; Ambro 1967) have suggested that Great Basin subsistence adaptations were highly variable through time and space, being affected by climatic changes, which altered the availability of subsistence resources, and by regional variations in environment, which led to diverse subsistence strategies. It is further proposed that in certain favorable localities, resource specializations developed in which certain potential food sources, including pinyon, were entirely ignored. In addition, Service (1964:94-99) and Cowan (1967) have contended that the historic adaptations recognized by Steward represent an essentially post-contact pattern developed in response to post-contact changes in the environment.

The test implications of these positions for pinyon exploitation in eastern California are clear. If Jennings is correct, then archaeological evidence should show that once prehistoric groups are well established in a locality, pinyon is incorporated in the subsistence pattern on a regular basis. If Heizer and others are correct, then the use of pinyon might be altogether lacking during some phases of prehistoric occupation, although the absence of such evidence would not necessarily refute their position. A more subtle implication of this hypothesis might involve cyclical fluctuations in the use of pinenuts that can be traced to the effect of climatic changes on the availability of other regularly-used resources or on pinyon itself.

Recent research in Owens Valley, central eastern California, has shed light on the prehistoric use of pinyon, and hence on the general applicability of Steward's ethnographic accounts to prehistoric situations.

OWENS VALLEY

Environment

Owens Valley is a block-faulted trough about 70 miles long and 15 miles wide, located in eastern California (Fig. 1). Two mountain ranges, the Sierra Nevada on the west, and the Inyo-White Range on the east, form the major boundaries of the valley; both have peaks reaching in excess of 14,000 feet. The valley floor lies between 4000 to 5000 feet above sea level, and the average vertical relief between the valley floor and mountain crests is about 7000 feet. The area receives little rainfall, but runoff from Sierran storms is discharged into groundwater banks and a number of streams on the eastern slope of the Sierra which coalesce to form the Owens River. The little moisture which reaches the Inyo-White mountains is quickly absorbed as groundwater, and no surface streams are present.

The natural environment of the valley can be divided into a series of major biotic communities, each identified by a distinct set of plants and animals (Fig. 2). Four of these were important to aboriginal subsistence.

The first of these is the *riverine community*, which occurs along the margins of the Owens River in the center of the valley floor. The vegetation in these well-watered areas consists of dense growths of tule (*Scirpus* sp.), cattail (*Typha* sp.), and other hydrophytes. The more important faunal resources include molluscs, fish, and migrant waterfowl.

The area between the riverine community and the lower boundaries of coniferous woodlands in the foothills on either side of the valley floor is characterized by a *desert scrub community*. This is an arid association dominated by low shrubs and seed-bearing grasses. The resident fauna of the zone consists chiefly of small rodents, but pronghorn antelope (*Antilocapra americana*) inhabit the community throughout the year, and deer (*Odocoileus hemionus*) and mountain sheep (*Ovis canadensis*) use the desert scrub as winter rangeland.

The third important community is the *pinyon woodland*, which is largely restricted to elevations above 6500 feet in the Inyo-White mountains east of the valley floor. The zone is dominated by dense growths of pinyon pine which produce annual crops of cones bearing edible nuts. Large ungulates also use the community as summer rangeland.

The final community relevant to aboriginal settlement and subsistence patterns is the *upper sagebrush zone*, which occurs in open meadows and depressions within the pinyon woodland. The edible plant resources of this community are limited. On the other hand, a major potential food source in this zone is the large ungulates, principally deer, mountain sheep, and pronghorn antelope, which use the area as summer rangeland and as a migration route in the early fall.

Three other biotic communities—the *limberpine-bristlecone forest* of the Inyo-White Range, and the *Sierra meadowland* and *Sierran conifer zone* of the Sierra Nevada—contain relatively few subsistence resources, and were largely ignored by aboriginal groups (Steward 1933:Map 2).

Ethnography

In historic times, Owens Valley was occupied by two linguistic groups. Shoshoni-speakers inhabited a relatively small area at the southern end of the valley; Northern Paiute groups used the much larger region to the north. Despite this linguistic dichotomy, the region showed essentially uniform patterns of settlement, subsistence, and social organization. The ethnographic accounts of Steward (1933, 1934, 1938) and others (Chalfant 1933; Parcher 1930) permit the following reconstruction of historic subsistence-settlement patterns. The aboriginal population numbered between 1000 to 3000 individuals, or about 0.4 to 1.2 individuals per square mile, and was centered at several lowland occupation sites situated in the desert scrub community on the valley floor throughout the spring, summer, and early fall. Major activities in this interval included the procurement, processing, and storage of a variety of desert scrub seeds and roots and, to a lesser degree, riverine roots and seeds, both of which could be obtained in large quantities within a two-hour walk of the lowland occupation sites. Moreover, the growth of some root crops was encouraged by irrigation in plots near these base camps. Trips for plant resources available at some distance from occupation sites involved the use of temporary camps in the riverine and desert scrub communities as collecting stations by family-sized groups. In addition, some riverine temporary camps were used for communal fishing in the spring and for communal jackrabbit and antelope drives in the fall. Small hunting parties pursued large game in upland communities in the summer and early fall months, where they occupied temporary camps.

When a harvestable nut crop occurred, small groups of from one to three families travelled to productive pinyon groves in order to harvest this resource in the fall. In years with unusually large harvests, habitation at pinyon camps persisted throughout the winter, during which pinyon nuts provided most of the food intake. These groups returned to lowland occupation sites in the early spring. In years of low yield, pinyon camps were abandoned immediately after the harvest was complete, and the winter was spent at lowland occupation sites. On these occasions, stored seeds, roots, and pinyon nuts constituted the bulk of the food consumed.

Although Steward (1933:241) indicates that pinenuts were the most important single plant species to the Paiute, his plant lists show that a combination of desert scrub seeds and roots provided the bulk of historic aboriginal subsistence intake (Steward 1933:242-246).[1] These were followed in importance by riparian roots and seeds; pinenuts probably ranked no higher than third in terms of overall contribution to the diet. Animal foods were

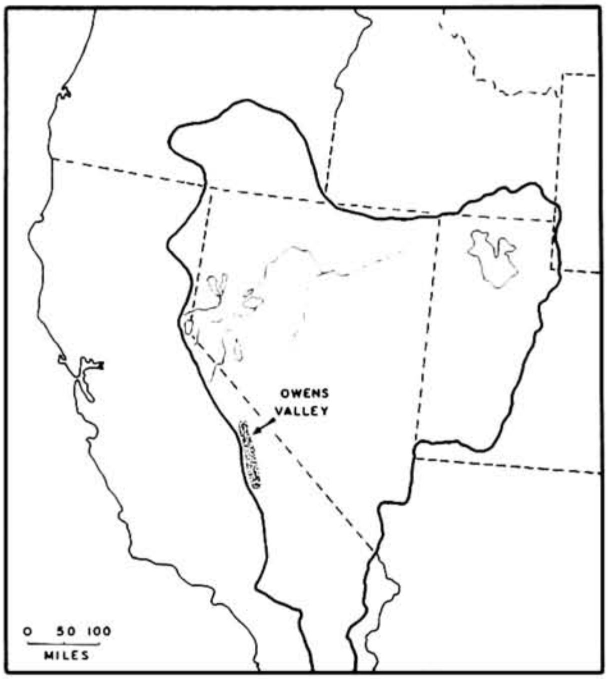

Fig. 1. Map showing location of Owens Valley and the boundaries of the Great Basin.

substantially less important than plant foods, and large game less important than small game.

THE EVIDENCE

Fieldwork

Intensive archaeological fieldwork was carried out in Owens Valley in 1972 and 1973. The intent of this research was to reconstruct local prehistoric settlement and subsistence patterns in detail and define potential changes in these patterns through time. The field procedure involved the surface survey of a series of 500 m. x 500 m. tracts selected at random from a grid system of 3920 such tracts superimposed over a 42 x 27 km. transect of land centering on the modern town of Big Pine, California (Fig. 3). Tracts in the grid system were initially stratified according to the dominant biotic community in each. Tracts

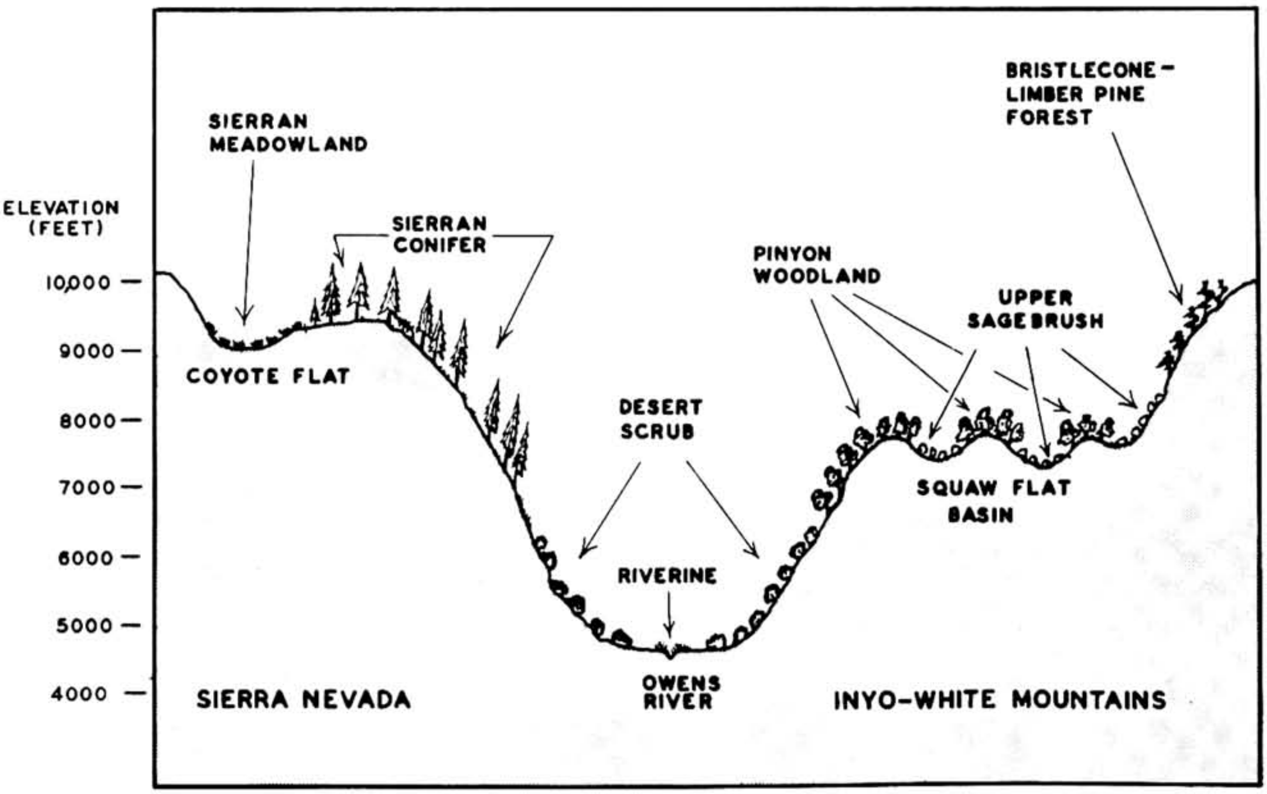

Fig. 2. Cross section of Owens Valley showing the horizontal and vertical distributions of the major biotic communities. View is to the north.

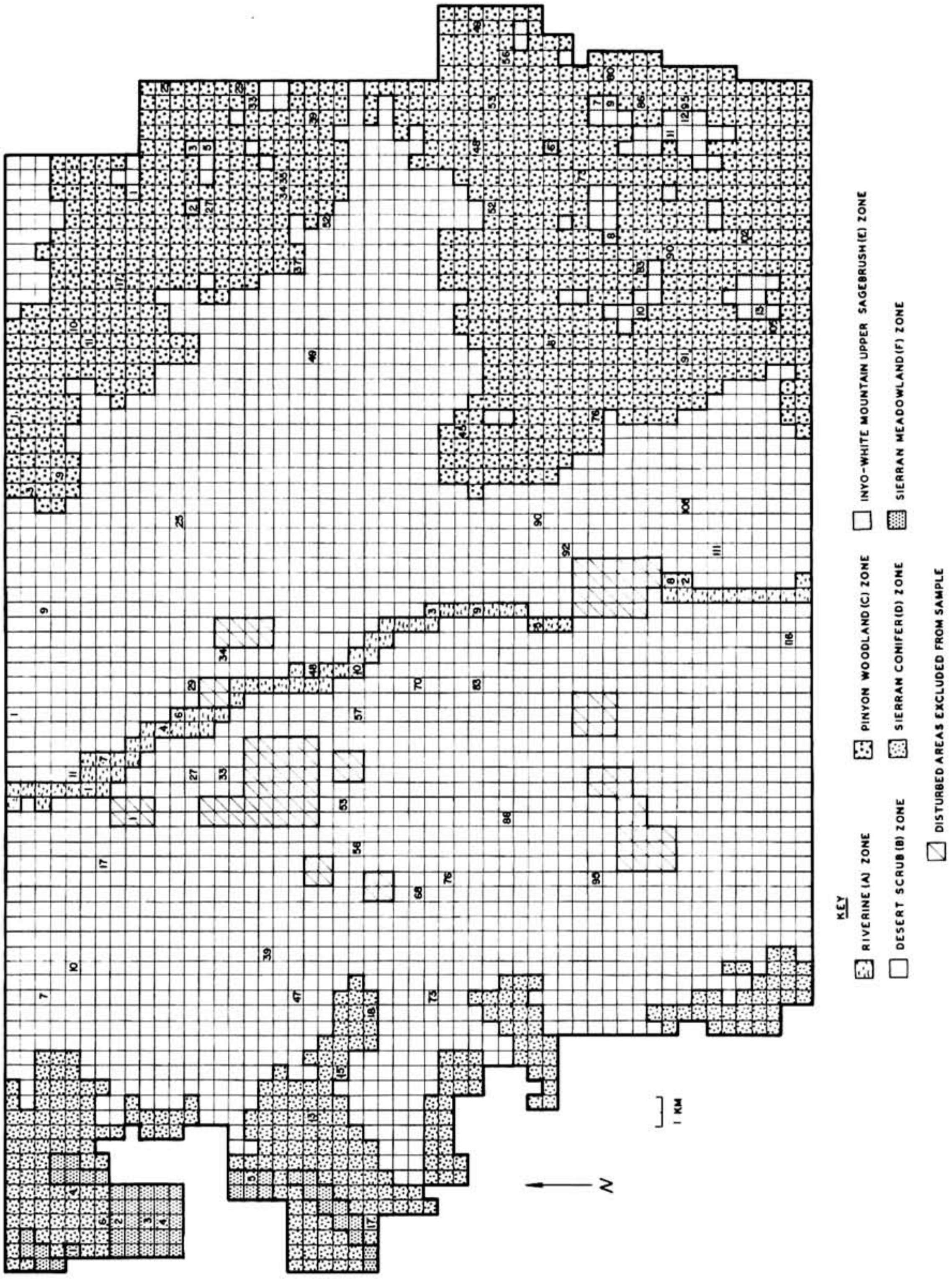

Fig. 3. Owens Valley sampling grid system, stratified by biotic communities. Numbered tracts were surveyed.

selected for investigation were surveyed over their entire surface; all sites and isolated artifacts were recorded, time-sensitive artifacts—mainly projectile points, bifaces, and ceramics—were retrieved, and samples of other portable artifacts were collected. A total of 95 such tracts was surveyed in this manner. Table 1 indicates the distribution of sample tracts among the varous biotic communities, the relative size of each community, and the percentage of the community sampled.

Analysis

Data obtained in the survey were analyzed in two ways. The first was a statistical comparison of the actual distribution of certain functional artifact categories against a hypothetical set of artifact distributions based on ethnographic accounts. This procedure is discussed in detail elsewhere (Bettinger 1975) and will not be reviewed here. The second type of analysis involved the establishment of a functional taxonomy of archaeological site categories encountered in sampled tracts following a procedure similar to that described by Struever (1968) and O'Connell (1972). Inferences about the use of each site category were based on the archaeological assemblages, that is, the features, tools, and debris, found at these sites, and their settings with respect to potential food resources. More precisely, site setting is defined here in terms of the area, or catchment (Vita-Finzi and Higgs 1970), around a site which can be exploited on a regular basis, and which, as a rule, provides the bulk of food resources consumed at the site. Ethnographic evidence (Lee 1969; Steward 1938) shows that hunter-gatherers tend to restrict their daily movements to a catchment, the outer margins of which are no more than a two-hour walk from the base camp, and this figure was used in the analysis. Within such a catchment, ethnographic evidence also shows that hunter-gatherers tend to situate themselves closest to the most important resource under exploitation. In establishing site categories, an effort was made, wherever possible, to duplicate the settlement types recognized from ethnographic accounts so that archaeological inferences could be augmented by direct historical analogy. On this basis, five categories of settlements were identified: *lowland occupation sites*, *pinyon camps*, *riverine temporary camps*, *desert scrub temporary camps*, and *upland temporary camps*. Pinyon camps provide the bulk of direct evidence of pinyon exploitation, and the following discussion is confined to this site category.

Pinyon Camps

In all, 21 sites were identified as pinyon camps. A diverse archaeological inventory was represented at these sites (Table 2), which included circular, stone-ringed floors interpreted as dwellings and storage facilities, seed-grinding tools consisting of basin and slab millingstones, and manos, along with fiber-, hide-, and wood-working tools in the form of bifacially flaked knives and unifacially flaked planes and scrapers. Stone-working gear, represented as cores, roughouts or blanks, and debitage, and hunting equipment—largely projectile points and bifaces—were also common.

The catchments of these sites contain large areas of pinyon woodland and smaller areas of upper sagebrush meadowlands. That all these sites are located within pinyon groves, together with the large number of millingstones and pinyon caches (circular floors) commonly found at them, suggests that pinyon collecting and processing was the most important activity at these sites. It is inferred that the use of pinyon camps is analogous to that observed in historic times, being occupied by small groups of from 1 to 3 families or from 6 to 15 individuals during the fall pinyon harvest. The latter notion is consistent with the size of these sites ($\overline{X}$=2770 m.^{2}), which are substantially smaller than lowland occupation sites ($\overline{X}$= 66,200 m.^{2}). The latter were occupied by from

Table 1

COMPOSITION OF THE BIG PINE TRANSECT AND ARCHAEOLOGICAL SAMPLE

	Stratum "A" Riverine	Stratum "B" Desert Scrub	Stratum "C" Pinyon Woodland	Stratum "D" Sierran Conifer	Stratum "E" Inyo Mountain Upper Sagebrush	Stratum "F" Sierran Meadowland	Stratum "G" Bristlecone-Limberpine Forest	Stratum "X" Withdrawn and Special Areas	Total	Percent of Transect
Transect tracts	68	2328	908	276	108	48	65	119	3920	100
Percent of transect	1.7	59.3	23.1	7.0	2.7	1.2	1.6	3.0	—	—
Potential tracts	10	118	113	27	12	5	6	1	292	7.4
Percent of community	14.9	5.0	12.4	9.8	11.1	10.4	9.2	0.8	—	—
Surveyed tracts	10	31	31	6	12	5	—	1	96	2.4
Percent of community	14.9	1.3	3.4	2.2	11.1	10.4	—	0.8	—	—

50 to 200 individuals. In years when the crop was sufficiently large, pinyon camps were probably used as winter camps. In years with smaller harvests, some of the crop was likely transported back to lowland occupation sites for winter consumption and the remainder cached on the spot (Steward 1938:52-53). At least 9 pinyon camps exhibit limited artifact assemblages (see Table 2), and it is inferred that these were used only as temporary collecting and processing stations; the remaining 12 examples were probably used both as temporary collecting stations and winter camps.

The large number of projectile points, bifaces, and stone-working items—the latter principally roughouts—found at pinyon camps can in part be attributed to their production during the winter months, but it is likely that these sites were also used as a base for hunting activities. Pinyon camps, situated as they are on steep ridges and isolated promontories in the pinyon community, are not particularly well-suited as hunting camps, which would be best located along trails or on grazing land (although not so close that game would be disturbed by camp activities). It is therefore likely that what hunting did occur at pinyon camps coincided with the fall harvest, when families were already occupying these sites, and the effort involved in establishing separate hunting camps was not justified by the advantages they afforded.

Dating

Sites in the sample tracts were dated on the basis of the time-sensitive projectile points they contained. The dating and attributes of these point types has been previously discussed by Bettinger and Taylor (1974). Four temporal phases have been recognized in Owens Valley; their time-markers and time spans are summarized in Table 3.

To clarify the following discussion of the dating of pinyon camps, the term *component* will refer to a phase manifestation at an

Table 2

CHARACTERISTICS OF PINYON CAMPS

Camp Designation	Circular Floors	Millingstones	Ceramics	Projectile Points	Bifaces	Roughouts	Unifaces	Cores	Flakes	Clyde Phase Projectile Points	Cowhorn Phase Projectile Points	Baker Phase Projectile Points	Klondike Phase Projectile Points	Dart Fragments	Arrow Fragments	Area (X $100m^2$)
C— 1/1	+			+	+	+			+			1	1			29.0
C— 9/1	+	+		+	+	+	+		+			4	2			18.0
C— 9/2	+	+		+	+	+	+	+	+			3				19.3
C— 10/1	+	+		+	+	+	+	+	+			1	3			108.0
C— 11/1	+	+			+		+	+	+							22.5
C— 11/2	+	+		+	+	+	+	+	+				2			120.0
C— 25/2	+	+		+	+	+	+		+				6		1	47.3
C— 29/2	+	+		+	+			+	+				1		1	12.0
C— 35/2		+														0.3
C— 39/1	+	+							+							0.2
C— 56/2	+	+		+	+				+						1	6.0
C— 56/5	+	+		+	+				+				6			12.0
C— 56/7	+			+	+				+				2			15.0
C— 67/2	+								+							0.1
C— 67/7	+				+	+			+							0.1
C— 67/9	+				+											0.1
C— 83/2		+			+		+		+							1.5
C— 91/2		+			+											0.2
C— 95/2	+	+	+	+	+	+	+	+	+		1	8	5			131.3
C— 105/1	+	+		+		+	+	+	+				2			12.0
Total projectile points by phase										0	1	17	30	0	3	

+= Artifacts Present

individual site. For further convenience, and because of small sample size, the Clyde and Cowhorn phases have been combined.

Sixteen dated components were recognized at pinyon camps: 1 is of Clyde-Cowhorn age, 5 are of Baker age, and 10 are of Klondike age. The general pattern recognized is a marked increase in the use of pinyon camps through time. Of a total of 48 time-sensitive projectile points recovered at pinyon camps, only 1 could be attributed to the Clyde-Cowhorn phase. Points of this phase comprised 30.0% of the total sample of 113 time-sensitive projectile points found at all sites in the sample transect. Under random conditions, the probability of such an extremely small representation of Clyde-Cowhorn phase points at pinyon camps is $p=.0003$ (see Siegel

Table 3

SUMMARY OF ARCHAEOLOGICAL PHASES IN OWENS VALLEY, THEIR TIME SPANS, AND TIME MARKER PROJECTILE POINTS

Phase	Time Span	Time Marker Projectile Points
Clyde	3500 B.C. — 1200 B.C.	Little Lake Series
Cowhorn	1200 B.C. — A.D. 600	Elko Series
Baker	A.D. 600 — A.D. 1300	Rose Spring Series/Eastgate Series
Klondike	A.D. 1300 — A.D. 1850	Cottonwood Series/Desert Side-Notched Series

1956:binomial test), a value so small that it suggests that the use of these settlements in the Clyde-Cowhorn phase was negligible and that the single Clyde-Cowhorn projectile point represents a stray lost by a hunter; this interpretation is followed here. Therefore, present evidence indicates that the occupation of pinyon camps in the Clyde-Cowhorn phase, or prior to about A.D. 600, was for the most part nonexistent, but it became increasingly intensive beginning in the Baker phase (A.D. 600-1300) and in the succeeding Klondike phase (A.D. 1300-1850). It is difficult to set a precise date for the inception of pinyon collection within the Baker phase, but the comparatively large number of components of this phase at pinyon camps leads me to conclude that it must have been early in the phase, probably sometime between A.D. 600 and A.D. 1000.

Discussion

The above data show that Owens Valley was occupied for perhaps as long as 5500 years, but that pinyon exploitation was a component of the subsistence system only during the last 1000 years. An initial conclusion which can be drawn from this is that there have been important changes in the cultural ecology of the Great Basin, the late shift to pinyon exploitation in Owens Valley being one of these. Taken as a test case of the Desert Culture, the Owens Valley data tend to refute Jennings' contention that the subsistence economy of the Great Basin was based on the intensive exploitation of all potential resources throughout the period of human occupation and that it showed no basic changes through time. On the other hand, it tends to support the views of those investigators who suspected that substantial changes in man-land relationships might have occurred. Given that this is so, it remains to be explained why such a subsistence change should occur in Owens Valley. The following discussion is based on the premise that the fundamental reason for subsistence shifts lies in imbalances between local populations and their subsistence resources (cf. Birdsell 1968). Such imbalances are typically envisioned as being negative—i.e., over-population or resource depletion—but logically they might also be positive, for example, a climatically induced *increase* in local resources. Several explanations of this nature might conceivably account for the inception of pinyon exploitation in Owens Valley, but the alternatives explored below seem more likely.

Archaeological evidence indicates that the inception of pinyon collecting sometime between A.D. 600 and A.D. 1000 was apparently not accompanied by a decrease in the exploitation of any other resource; thus, it marks a broadening of the total subsistence base by increasing the number of species exploited for food. One explanation for this might be that the existing subsistence base, i.e., the complex of resources other than pinenuts, was reduced by some climatic change. Other evidence too detailed to present here shows that this subsistence base consisted largely of desert scrub and riparian roots and seeds. The climatic factor most likely to upset such a procurement system would be a decrease in available moisture, either through a decrease in precipitation or an increase in evaporation, which reduced the productivity of these riparian and desert scrub plant resources to the point that new resources were required.

The climatic data from central eastern California are consistent with the notion of a trend toward drier and probably warmer conditions at this time. Based on glacial features dated by lichen growths and dendroclimatic evidence, Curry (1971) interprets the interval from A.D. 600 to A.D. 1000 as warm and dry relative to the long-term regional norms. Dendroclimatic data from high-altitude pines lead LaMarche (1974) to reconstruct dry conditions beginning at least as early as A.D. 800 and persisting to A.D. 1000, but both LaMarche and Adam (1967)—who relies on palynological evidence—interpret the period from A.D. 800 to A.D. 1000 as relatively cool. Since Curry has the advantage of a more diverse data base, his temperature reconstruction seems stronger at this point. Whether these inferred warm and dry conditions were sufficiently severe to effect the observed changes in subsistence and settlement patterns is unknown at this time; however, the hypothesis is at least not refuted by the present evidence.

Perhaps some climatic change increased cone production by pinyon trees, making them a more abundant resource than in earlier periods. This would probably require an increase in rainfall or a decrease in temperature, but, as already noted, the present climatic data would seem to suggest that this is not the case. Even if a trend toward cooler and moister conditions could be shown to have occurred, it is likely that such a shift would have increased the productivity of desert scrub plants, thus eliminating the need to exploit pinenuts at all.

A third possible explanation for the inception of pinyon collecting at this time is a population increase through local recruitment or immigration which raised the local population to levels near the carrying capacity of the existing subsistence base. The hypothesis that local growth rates were responsible for a population increase is reasonable given the inherent potential for such growth among hunter-gatherers (Birdsell 1968). Furthermore, it need not be assumed that such a population increase reflects an increase in the growth rate itself; a more parsimonious explanation would be that by about A.D. 600, the cumulative effect of a constant growth rate brought Owens Valley population to levels approaching the capacity of the extant subsistence base. Although time-sensitive artifacts do appear to increase through time in Owens Valley, as would be expected if population were increasing, the archaeological data are insufficiently understood to permit reliable inferences about population size. Thus, the hypothesis that local population growth was responsible for the inception of pinyon exploitation cannot be evaluated at present. Similar limitations prevent archaeological evaluation of the hypothesis that the population increase was due to immigration. In this case, however, linguistic evidence provides the hypothesis partial confirmation. The prevailing theory among a number of scholars is that the aboriginal groups occupying the Great Basin at the time of white contact had reached their observed distribution only recently (Lamb 1958; Miller 1966; for an alternative view see Goss 1975). The linguists suggest that the predecessors of these groups began a rapid expansion out of southeastern California around A.D. 1000, travelling northward and eastward to their historic positions. Some investigators have pointed to a contemporaneous proliferation of archaeological sites in at least some parts of the Great Basin, which is consistent with this hypothesis (Wallace 1962:177-178; Rogers 1939:73). If this is indeed the case, it might be that the inception of pinyon collecting, which roughly coincides with this event, reflects a measure to accommodate a population increase resulting from the immigration of some of these groups to Owens Valley at this time.[2]

In sum, at least two explanations may account for the inception of pinyon collecting at or around A.D. 1000. One is that it reflects a deterioration in climate leading to a decrease in the environmental production of lowland plant resources. The other is that the subsistence change was due to population pressure on these same resources, which necessitated a more intensive use of alternative food sources, in this case, pinyon nuts. These explanations are not necessarily mutually exclusive; it might also be the case that a regional decrease in available moisture at this time was reflected more acutely in other areas, specifically southern California, necessitating migration away from these areas into other parts of the Great Basin. The movement of new populations into Owens Valley might have placed additional pressure on lowland plant resources already strained by a warm and dry spell and led the inhabitants to diversify their subsistence base by seeking new sources of food. It should be pointed out that this explanation assumes the following: (1) that the bulk of Owens Valley population remained in place during this period of proposed environmental stress; (2) sufficient numbers of immigrants established themselves in Owens Valley at least long enough to upset the balance between the existing subsistence base and local population. While I cannot conclusively demonstrate either assumption, both are reasonable given that Owens Valley supports plant and animal resources far in excess of those available in surrounding localities (e.g., Death Valley). Thus, it is likely that most Owens Valley groups would continue to occupy the region during periods of environmental stress and that, under the same conditions, some additional populations would be attracted to Owens Valley from areas where resources were substantially less abundant and the effects of climatic stress were concomitantly more severe.

SUMMARY

Recent archaeological research in Owens Valley, eastern California, has revealed four archaeological phases spanning the period between 3500 B.C. and the historic period. Reconstruction of the prehistoric settlement-subsistence patterns during this interval showed that nuts of the pinyon pine, an important component of the historic diet in the region, were relatively ignored as a subsistence resource until sometime between A.D. 600 and A.D. 1000, when a distinctive procurement system developed around their exploitation (Table 4). Several factors which might account for this shift were explored.[3] At present, there are two viable explanations, both of which view the inception of pinyon exploitation as an attempt to maintain a balance between population and resources. One is that there was a reduction in the pre-existing subsistence base; the other is that there was an increase in local population through natural growth or immigration. Climatic evidence appears to support the former view, while linguistic evidence supports the notion of population increases through immigration. It is also possible that these two factors are functionally related and that the increase in local population was due to immigration from localities more severely affected by an area-wide warm-dry interval. These data fail to support Jennings' (1957, 1964, 1968) contention that Great Basin subsistence patterns incorporated all available resources and that this adaptation showed no fundamental changes through time, but tend to support the view that

Table 4

SUBSISTENCE, CLIMATIC, AND LINGUISTIC CHARACTERISTICS OF ARCHAEOLOGICAL PHASES IN OWENS VALLEY

Calendar Year	Archaeological Phase	Subsistence Focus	Climate	Linguistic Affiliation
1860				
1300	Klondike	Lowland Plants and Pinenuts	Cool and Wet	↑
				Numic
	Baker	(Pinyon exploitation begins) Lowland Plants	Warm and Dry	(Numic Expansion)
A.D. 600 B.C.				Pre-Numic ↓
	Cowhorn	Lowland Plants	Cool and Wet	
1500				?
	Clyde	Lowland Plants	Warm and Dry	
3500				

the human ecology of the region was quite variable through time and space.

One final point should be made. Although this discussion has been confined to subsistence patterns, there are certain constraints in the procurement of pinyon which have important implications for Great Basin social organization. As research by Steward (1938, 1955) and Thomas (1974) shows, sharp fluctuations in the location and abundance of nut crops effectively prevent large, multi-family groups from maintaining continuous social contact in those societies which use it and in this way favor the development of a family-band organization.[4] This suggests that in localities where pinyon is unavailable or unused, large social groupings above the nuclear-family level are likely to be more stable and well-organized than in localities where pinyon is important to the diet, even though population densities in such areas might be lower than those where pinyon is used. Although the full effect of this factor would not be fully reflected in Owens Valley, because pinyon is not *the* primary resource there, I suspect that prior to A.D. 600—when pinyon exploitation was initiated—social organization above the family level was more formally structured than after that date, even though late period population densities were apparently greater than those in earlier periods. Similarly, the constraints of pinyon procurement would seem to explain why the Reese River Shoshoni of central Nevada enjoyed a particularly abundant subsistence base, as shown by the highest population densities in the Great Basin, but developed a family-band level of social organization (Steward 1938; Thomas 1974), while the Owens Valley Paiute, exhibiting lower population densities and less reliance on pinenuts, developed relatively cohesive organizations at the village level (Steward 1933, 1970). Archaeological research and a review of the extant ethnographic literature should disclose evidence of a similar nature.

New York University
New York

NOTES

1. The apparent discrepancy reflects my pooling of several desert scrub plant species rather than any fundamental reassessment of Steward's data, however.

2. Goss (1975) has recently rejected Lamb's hypothesis, suggesting that Numic groups have occupied the Great Basin for at least 8000 years. The proposal, however, is obviously tentative, being based on distributional and lexical data which are either unpublished or equivocal. Several other lines of evidence clearly favor Lamb's interpretation (cf. Miller 1972). It should be pointed out, however, that Goss' hypothesis is consistent with the notion of population increase through natural growth rates, as opposed to the immigration suggested by Lamb's hypothesis.

3. At least one other explanation deserves mention here. Grant, Baird, and Pringle (1968) have argued that the Numic diffusion was at least in part precipitated by the introduction of the bow and arrow to eastern California. This innovation, the argument goes, resulted in the rapid depletion of local mountain sheep herds, and forced the aboriginal groups in the area to move north and east into the Great Basin in search of this game animal. The hypothesis can be criticized on a number of grounds, the most important of which are: (1) It overemphasizes the importance of meat in a predominantly plant-based diet. (2) It fails to consider the conservation measures built into aboriginal procurement systems (Flannery 1968). (3) The extinction or near extinction of an ungulate species may be beyond the capability of an aboriginal group armed with only the bow and arrow (Flannery 1968:73). In sum, while this hypothesis may prove correct, it lacks the strength of the other potential explanations which are offered here.

4. As Steward (1938) notes, many other resources fluctuate, but it would appear within a much narrower range of variation.

REFERENCES

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, eds. pp. 275-302. New Haven: Yale University Press.

Ambro, R. D.
1967 Dietary-Technological-Ecological Aspects of Lovelock Cave Coprolites. University of California Archaeological Survey Reports 70:37-47.

Baumhoff, M. A., and R. F. Heizer
1965 Postglacial Climate and Archaeology in the Desert West. *In* The Quaternary of the United States, H. E. Wright and D. E. Frey, eds. pp. 697-707. Princeton: Princeton University Press.

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

Bettinger, Robert L., and R. E. Taylor
1974 Suggested Revisions in Archaeological Sequences of the Great Basin in Interior Southern California. Nevada Archaeological Survey Research Papers 5:1-26.

Birdsell, Joseph B.
1968 Some Predictions for the Pleistocene Based on Equilibrium Systems among Recent Hunters. *In* Man the Hunter, Richard B. Lee and Irven Devore, eds. pp. 229-240. Chicago: Aldine Publishing Co.

Chalfant, William A.
1933 The Story of Inyo. Los Angeles: Citizens Print Shop.

Cowan, Richard A.
1967 Lake Margin Exploitation in the Great Basin as Demonstrated by an Analysis of Coprolites from Lovelock Cave, Nevada. University of California Archaeological Survey Reports 70:21-35.

Curry, R. R.
1971 Holocene Climatic and Glacial History of the Central Sierra Nevada, California. Geological Society of America Special Paper 123.

Davis, Emma Lou
1963 The Desert Culture of the Western Great Basin: A Lifeway of Seasonal Transhumance. American Antiquity 29:202-212.
1964 An Archaeological Survey of the Mono Lake Basin and Excavation of Two Rock Shelters, Mono County, California. Los Angeles: University of California Archaeological Survey Annual Report 1963-64:255-353.
1970 Archaeology of the North Basin of Panamint Valley, Inyo County, California. Nevada State Museum Papers 15:Part 3.

Davis, Wilbur A.
1966 Theoretical Problems in Western Prehistory. *In* The Current Status of Anthropological Research in the Great Basin, Warren d'Azevedo *et al.*, eds. Reno: University of Nevada, Desert Research Institute Social Sciences and Humanities Publication 1:147-165.

Flannery, Kent V.
1968 Archaeological Systems Theory and Early Mesoamerica. *In* Anthropological Archaeology in the Americas, B. J. Meggars, ed. pp. 67-87. Washington, D.C.: Anthropological Society of Washington.

Goss, James
1975 Linguistic Tools for the Great Basin Prehistorian. Paper presented at the 1975 Annual Meeting of the Society for American Archaeology, Dallas.

Grant, Campbell, James W. Baird, and J. Kenneth Pringle
1968 Rock Drawings of the Koso Range, Inyo County, California. China Lake, California: Maturango Museum Publication 4.

Heizer, R. F.
1956 Recent Cave Explorations in the Lower Humboldt Valley, Nevada. University of California Archaeological Survey Reports 33:50-57.

Jennings, Jesse D.
1957 Danger Cave. Memoirs of the Society for American Archaeology 14.
1964 The Desert West. *In* Prehistoric Man in the New World, J. D. Jennings and E. Norbeck, eds. pp. 149-174. Chicago: University of Chicago Press.
1968 Prehistory of North America. New York: McGraw-Hill.

LaMarche, Valmore C.
1974 Paleoclimatic Inferences from Long Tree-Ring Records. Science 183:1043-1048.

Lamb, Sidney
1958 Linguistic Prehistory in the Great Basin. International Journal of American Linguistics 24:95-100.

Lanning, Edward P.
1963 Archaeology of the Rose Spring Site, Iny-372. University of California Publications in American Archaeology and Ethnology 49(3).

Lee, Richard B.
1969 !Kung Bushmen Subsistence. *In* Environment and Cultural Behavior, Andrew P. Vayda, ed. pp. 47-79. Garden City: Natural History Press.

Meighan, Clement W.
1955 Notes on the Archaeology of Mono County, California. University of California Archaeological Survey Reports 28:6-28.

Miller, Wick
1966 Anthropological Linguistics in the Great Basin. *In* Current Status of Anthropological Research in the Great Basin, Warren d'Azevedo *et al.*, eds. Reno: University of Nevada, Desert Research Institute Social Sciences and Humanities Publication 1:75-112.

Napton, Lewis K.
1969 The Lacustrine Subsistence Pattern in the Desert West. Kroeber Anthropological Society Special Publication 2:29-98.

O'Connell, James F.
1971 The Archaeology and Cultural Ecology of Surprise Valley, Northeast California. Ph.D. dissertation, University of California, Berkeley.

O'Connell, James F., and Paul S. Hayward
1972 Altithermal and Medithermal Human

Adaptations in Surprise Valley, Northeast California. *In* Great Basin Cultural Ecology: A Symposium, Don D. Fowler, ed. Desert Research Institute Publications in the Social Sciences 8:25-42.

Parcher, F. M.
1930 The Indians of Inyo County. Los Angeles: Southwest Museum Masterkey 4: 146-153.

Rogers, Malcolm J.
1939 Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas. San Diego Museum Paper 3.

Siegel, Sydney
1956 Non-Parametric Statistics for the Behavioral Sciences. New York: McGraw-Hill.

Service, Elman R.
1964 Primitive Social Organization: An Evolutionary Perspective. New York: Random House.

Steward, Julian H.
1933 Ethnography of the Owens Valley Paiute. University of California Publications in American Archaeology and Ethnology 33(3).

1934 Two Paiute Autobiographies. University of California Publications in American Archaeology and Ethnology 33(5).

1938 Basin-Plateau Aboriginal Socio-Political Groups. Washington: Bureau of American Ethnology Bulletin 120.

1955 Theory of Culture Change. Urbana: University of Illinois Press.

1970 Foundations of Basin-Plateau Shoshonean Society. *In* Languages and Cultures of Western North America: Essays in Honor of Sven Liljeblad, Earl H. Swanson, Jr., ed. pp. 113-151. Pocatello: Idaho State University Press.

Streuver, Stuart
1968 Woodland Subsistence-Settlement Systems in the Lower Illinois Valley. *In* New Perspectives in Archeology, Sally R. Binford and Lewis R. Binford, eds. pp. 285-312. Chicago: Aldine Publishing Co.

Thomas, David H.
1972 Western Shoshone Ecology. *In* Great Basin Cultural Ecology: A Symposium, Don D. Fowler, ed. Desert Research Institute Publications in the Social Sciences 8:135-153.

1973 An Empirical Test for Steward's Model of Great Basin Settlement Patterns. American Antiquity 38:155-176.

1974 An Archaeological Perspective on Shoshonean Bands. American Anthropologist 76:11-23.

Vita-Finzi, C., and E. S. Higgs
1970 Prehistoric Economy in the Mount Carmel Area of Palestine: Site Catchment Analysis. Proceedings of the Prehistoric Society 37:1-37.

Wallace, William J.
1962 Prehistoric Cultural Development in the Southern California Deserts. American Antiquity 28:172-180.