THE POWER OF THE ACORN: LATE HOLOCENE SETTLEMENT AND RESOURCE DISTRIBUTION IN THE CENTRAL SIERRA

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The settlement and subsistence patterns of the late Holocene Sierra Nevada are not well understood. Tens of thousands of acres have been inventoried by archaeological surveys over the last thirty years and thousand of sites have been recorded. Few comprehensive examinations of the results of these surveys have been undertaken. This study examines the relationships between settlement patterns and target resources in this largely mountainous area. The project used a Geographic Information System to compare the records from 1367 prehistoric archaeological sites with the distribution of black oaks, sugar pines and deer aggregation areas in a study area of roughly 325,000 hectares. The results indicate that good stands of black oak below the permanent winter snowline exhibit a powerful influence on the distribution of sites and features.

Archaeological sites created by hunter-gatherer activities are a fragile and diminishing resource in California and throughout the world. Our discipline faces a future in which we must supplement our traditional data gathering techniques with alternative, non-destructive methods to extract information from these sites. Paradoxically, even as their absolute numbers decrease, more and more hunter-gatherer sites are being discovered. In the Sierra Nevada over the last thirty years, tens of thousands of acres have been inventoried and thousand of sites have been recorded. However, few comprehensive regional examinations have analyzed the results of these surveys. With a few notable exceptions, the relationships between site and resource locations have rarely been looked at. One reason for this is that these large amounts of spatial data are unwieldy to organize and study. Modern technology can now facilitate this kind of analysis.

This paper examines the relationships among various sites types and features, and, the locations of oak stands, sugar pine concentrations, and deer aggregation areas on a large tract of land in the central Sierra Nevada. Bedrock mortars, or BRMs, are important elements of this study. The research used a Geographic Information System (GIS) because GIS is especially good at looking at the numbers and types of sites found in circumscribed geographic areas. Because GIS is ideal for spatial analysis, it has sometimes become the focus of research, rather than just a valuable tool. One of my objectives here is to use GIS as any other device—so that it is in the background, not the focus of the work, and no more visible in the final product than a trowel, stadia rod, or a spreadsheet.

In the past both Bennyhoff (1956) and Elsasser (1960) performed this kind of analysis on a large scale in the Sierra. They made a number of conclusions about the relationships between different site types and oaks:

Bennyhoff, who focused on the Yosemite area:

1. Used BRMs an important element in his site typology;
2. Found that BRMs coincided with oak locations;
3. Saw that most BRMs are below 2000 m elevation
4. Found no BRMs above 2300 m, and;
5. Saw the largest number of sites above 2000 m.
6. Thought that the upper elevations were used mostly for hunting.

Elsasser, using data pulled from throughout the Sierra Nevada:

1. Also used BRMs to type sites;
2. Saw a peak in number of sites between 1200 m and 1500 m;
3. And, found that this peak correlated with oak distribution.

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THE STUDY AREA

The study area for this project is Eldorado National Forest, approximately 325,000 hectares (ca. 800,000 acres) of public land, located in the central Sierra Nevada, just north of Yosemite (Figure 1). It ranges in elevation from about 250 m in the west to just over 3000 m along the Sierra crest; and, is drained by: the South and Middle Forks of the American River; the Cosumnes River; and, the North Fork of the Mokelumne River.

This project used the records from 1367 prehistoric sites (Figure 2). The spatial location of each site was attached to a database that described many of the attributes of the sites. The first thing that was needed was a way to classify the sites. Like Bennyhoff (1956) and Elsasser (1960), this project also uses bedrock mortars in defining site types, borrowing from a model developed in the southern Sierra by Jackson (1984:190). He found evidence of a sophisticated logistical strategy and generated the concept of the key-site (or k-site), which is defined as an archaeological site with at least 14 bedrock milling surfaces, associated with a lithic scatter or midden deposit. A key-site conforms to a residential base or task site in Binford's (1980) collector strategy.

A number of related site types and features were also derived from the site database (Table 1). The categories used in this analysis are total number of sites, k-sites, sites associated with k-sites, sites with BRMs only, sites with lithic scatters only, sites with both components, total number of BRMs and total number of bedrock grinding slicks. Earlier work in this geographic area (Hunt 1999:68-69) suggests that there were different subsistence strategies used above and below snowline. So, this study followed Jackson's (1984) division of his southern Sierra study area into above and below the more or less permanent winter snowline. For this study 1400 m in elevation was used for this line (Figure 3).

Speakers of three different languages (Kroeber 1925), Northern Sierra Miwok, Nisenan (Southern Maidu) and Washoe, used the resources of the study area before the intrusion of Euro-Americans. The Miwok used the southern part of the area, including the Mokelumne River drainage and the Nisenan used the northern sections, as far south as the American River drainage (Levy 1978, Littlejohn 1928). Most of the study area lies within what has been called the Washoe "peripheral area" (Downs 1966; Price 1962), an area in which the Washoe exercised hunting and gathering rights, but in which they had no winter villages. How far east the Nisenan and Miwok traveled in the summer is not clear. It may be that all three groups were using the western part of the project area in summer.

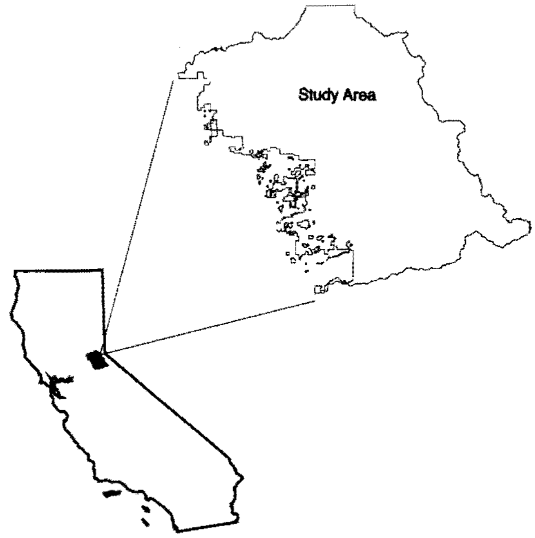


Figure 1: Project location.

RESOURCES

The acorn was the most important dietary staple in much of protohistoric and historic California, including the Sierra Nevada, and it has been frequently acknowledged that acorn eating (or balanophagy) was probably the most characteristic feature of the domestic economy of the California Indians (see Baumhoff 1963, 1981; Gifford 1936; Kroeber 1925). These balanophagous subsistence economies appear to have emerged late in the prehistoric period, but at different times in different places (Basgall 1987:29-39). Acorns seem to have become the primary subsistence resource in the Sierra over the last 1000 years.

Barrett and Gifford (1933:141) report that the Central Sierra Miwok preferred black oak acorns, but also used a number of other, less favored acorns. The use of a number of species probably buffered against the failure of any one type. Black oak is scattered throughout the study area and is frequently found in concentrations.

Baumhoff (1963, 1981) has noted the high correlation between oak productivity and population density in ethnographic California. McCarthy (1993:6)

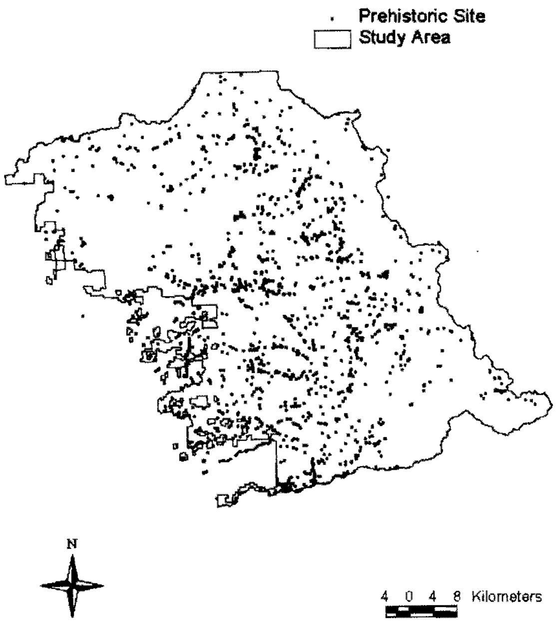


Figure 2: Recorded prehistoric sites.

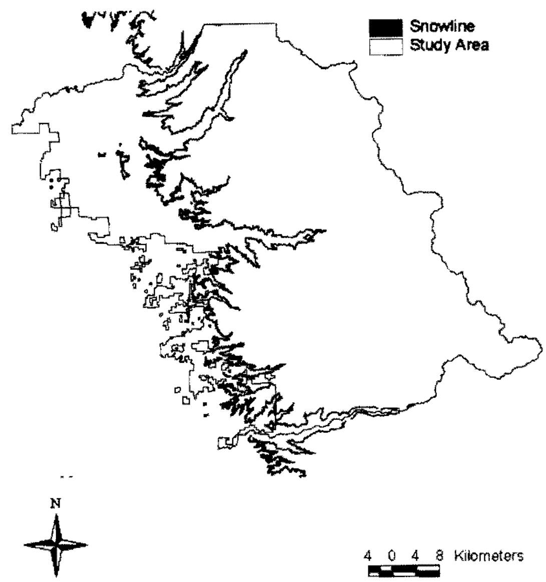


Figure 3: Winter snowline.

has further recognized that the acorn was far more that just a dietary staple:

> It must be assumed that the high degree of sedentism and population concentration as well as the nonegalitarian sociopolitical organization and religious elaboration exhibited by precontact California Indian peoples are founded on the capacity of the subsistence system to produce not only the necessary dietary requirements both caloric and nutritional to support large, localized population on a daily and annual basis, but also to supply the surplus that fueled the demands of the socioceremonial system.

The vegetation of the project area has been classified in many different ways. This study used the CALVEG system (Parker and Matyas 1979), which has some drawbacks for archaeological use, because it represents contemporary vegetation. The locations of existing black oak stands were extracted from the CALVEG GIS layer (Figure 4).

The seeds of the sugar pine were also an important subsistence resource (Barrett and Gifford 1933; Farris 1982). Sugar pine, the largest of the pines, is a common tree in Sierran forests from about 760 m to 2700 m (Munz and Keck 1968:52). Although the species grows over a wide range of environmental conditions, it does not form pure stands (Oliver 1992:28). Though currently widespread, sugar pine was historically a much larger proportion of the Sierra Nevada mixed conifer forests, and its range extended further west. Several turn-of-the-century reports describe stands dominated by sugar pine. The two principal factors in the decline in abundance are sugar pine's high commercial value, which caused it to be logged heavily, and the fact that the species does not readily re-invade its former range or increase its proportion in existing stands.

Sugar pine has carried to an extreme some of the characteristics of trees associated with late seral stages: a long life span, large size, late reproduction, and large seeds. They commonly live between 300 and 500 years and rank in size only behind giant sequoia, redwood and Douglas fir. Young trees are poor cone producers and cone production increases with increasing tree size up through 178 cm in diameter (Oliver 1992:30). This peculiarity may have made older, larger trees the target of prehistoric gatherers.

Few activities had the large-scale communal involvement found in pine nut exploitation, except perhaps antelope and rabbit drives. Descriptions of the sugar pine collecting system sound very much like a collector subsistence strategy. Reports (e.g., Barrett and Gifford 1933:151; Farris 1982:19-20; Goddard 1903:29-30) indicate that the gathering of pine nuts, especially sugar pine nuts, was a major operation in which families, sometimes whole villages, would go to the higher elevations where sugar pines are found and set up camp for as much as two months. Because sugar

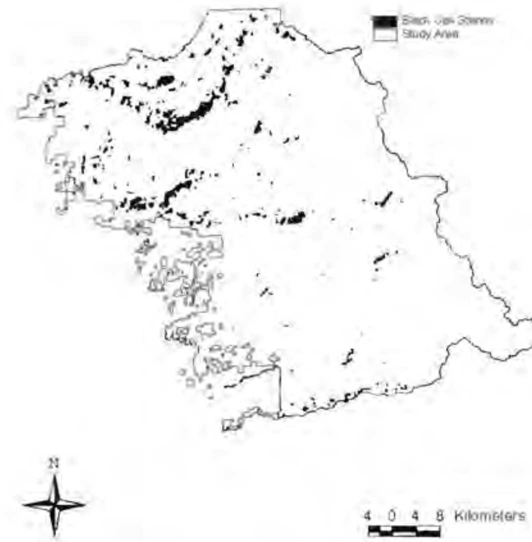


Figure 4: Black oak distribution.

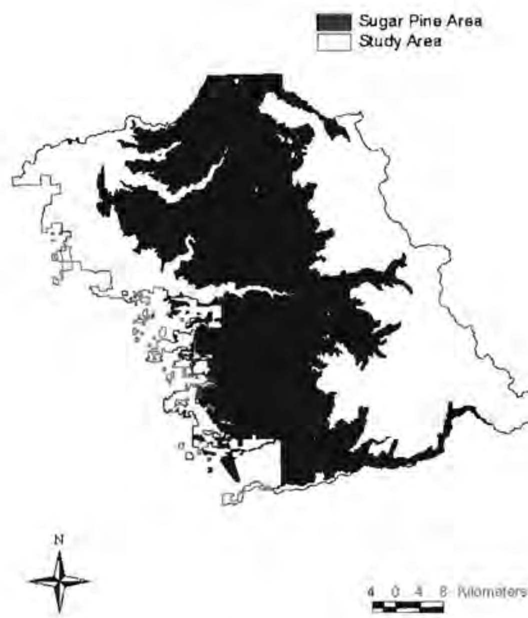


Figure 5: Sugar pine distribution.

pines do not form pure stands, the location where sugar pine was available was approximated using their favored elevation (Figure 5).

Deer were also an important resource (Baumhoff 1963, 1981; Kroeber 1925) and four deer herds presently inhabit the study area (Bailey *et al.* 1981, Fowler *et al.* 1982, Hinz *et al.* 1982, Hinz *et al.* 1984). Deer activity areas for their summer and intermediate ranges, unfortunately all above winter snowline, are available in digital form. The areas where deer aggregate, such as migration corridors and fawning and holding areas, were extracted from those maps (Figure 6).

SITES AND RESOURCES

After the resource areas were mapped the numbers of each of the site types and features were counted in each of the areas. These numbers were then tested using a Chi-square statistic. First, the null hypothesis of a random distribution was developed based on the amount of survey done within each of the resources areas (Table 2). For example, this table shows that, of the archaeological survey done in the entire study area, about 26 percent of it was executed in the oak area. So, a random distribution will find about 26 percent of each of the sites and features in this area.

RESULTS

There are many ways to display the results of this investigation. The most instructive seems to be a graph of the chi-square values. In the graphs in Figures 7 through 10 the x-axes show the various site types and features, while the y-axes show the chi-square values. The white bars indicate the results above snowline; dark bars, below the snowline. Any of the bars between the two dotted lines approximate a random distribution; bars that extend beyond the dotted lines indicate a significant variance from the null hypothesis.

Figure 7 is a representation of the Chi-square values from the sugar pine area. Though this chart shows both positive and negative values, of course, we

Table 1: Sites, features and survey for the entire study area.

Total Sites	K-sites	Associates	BRMs Only	Lithics Only	Both	Total BRM	Slicks	Acres Surveyed
1,367	109	1,258	492	309	552	7,568	285	273,110

Figure 6: Deer aggregation area.

Table 2: Completed survey in each resource area.

Zone	Acres Surveyed	% of Total Survey
Entire Oak Area	70,413	25.8
Oaks Above Snowline:	40,766	14.9
Oaks Below Snowline	29,647	10.9
Deer Area (all above snowline)	71,282	26.1
Sugar Pine Area:	167,690	61.4
Sugar Pine Above Snowline:	143,110	52.4
Sugar Pine Below Snowline:	24,580	9.0
All Three Resources	18,025	6.6

all know that by definition, there can be no negative Chi-square values. The negative numbers you see here simply indicate that the site or feature occurred *less* frequently than expected. Positive numbers indicate that the site or feature occurred *more* frequently than expected. For example, the sugar pine area has only one site type occurring more frequently than expected: bedrock mortar sites below snowline. At the same time the absolute numbers of BRMs is actually lower than expected. This fits with a model of pine nut production where nuts are collected in many locations and processed at numerous small mortar stations. Note that none of the site types above snowline are concentrated by sugar pines; and, two elements, lithic scatters and total BRMs are found in much fewer numbers than expected.

Figure 8 represents the sites and features found in the areas where deer aggregate. It only represents areas above snowline because low elevation deer data was not available. Most of the feature types in the deer aggregation areas show a random distribution, except that BRM sites and the absolute number of BRMs are low—just what is expected in a hunting area. The most interesting result is the high value for grinding slicks in this area. Since it is unlikely that this phenomenon is related to hunting, it is tempting to think that the high number of grinding slicks may be related to ethnicity. Great Basin people used this area in the snow-free months, and also used the metate or bedrock slick to process many products, including acorns. The results for the sugar pine and deer areas are interesting, but do not indicate that these resources were particularly important in influencing the organization of settlement patterns.

The most remarkable result is the concentration of all sites and features around productive black oak groves below snowline. Once again, the only features concentrated above snowline, this time by oaks, are grinding slicks. However, below snowline it is a completely different story: Every kind of site and feature is concentrated in this area. The oak results are displayed in two different forms in the graphs in Figures 9 and 10 because the large Chi-square value for total number of bedrock mortars overwhelms the other values. Figure 9 shows all of the features *except* total bedrock mortars, and you can see that they are all significantly higher than a random distribution. But, the value for the total number of BRMs is almost off the chart. Figure 10 shows the same data when total bedrock mortars are added. The value for total bedrock mortars dwarfs the other features, even though those other values are highly significant. The Chi-square value for total number of BRMs in the below snowline oak area is 1200, or an impressive 300

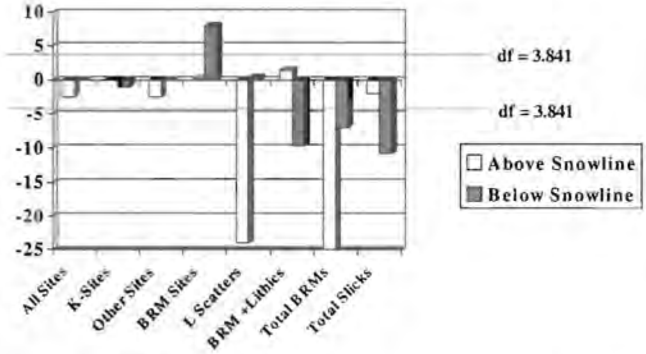


Figure 7: Chi-square values for features in the sugar pine area.

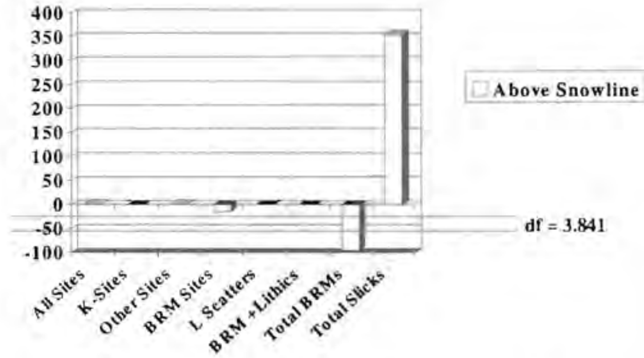


Figure 7: Chi-square values for features in the deer aggregation areas.

Figure 9: Chi-square values for features near oak groves, without becrock mortars.

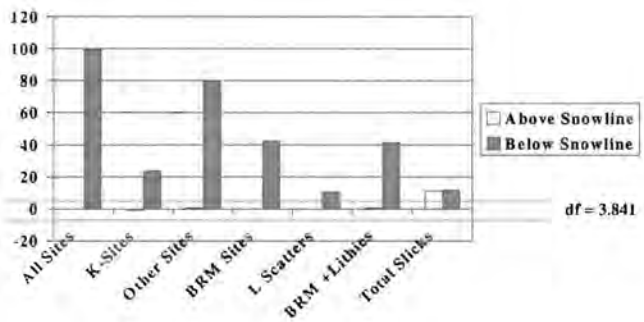
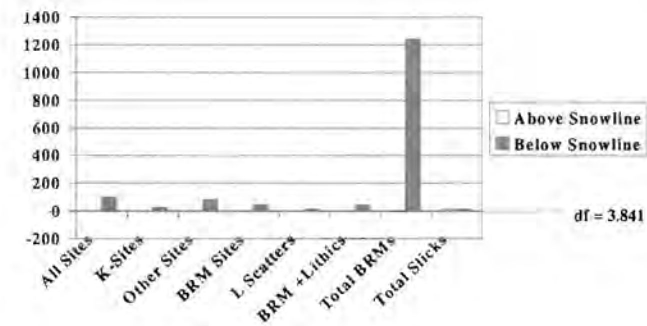


Figure 7: Chi-square values for features near oak groves, with bedrock mortars.



times the level of significance. This not only verifies the close relationship between acorns and bedrock mortars, it also indicates that oaks below snowline are the most powerful factor for the location of every kind of site and feature in the surface archaeological record of this part of the Sierra Nevada.

Discussion

Bennyhoff (1956) and Elsasser (1960) certainly had it right when they suggested the distribution of sites and bedrock mortars is related to the distribution of oaks. However, the concentration of sites is much more pronounced below snowline, or below 1400 m. And, the distribution of bedrock mortars is certainly not limited to the distribution oaks. Figure 11 shows that they are found throughout the study area, even at elevations above 2700 m. Bedrock mortar concentrations at lower elevations and their presence in remote areas argues for the intensive use of oaks below snowline and for the intensive use of *all environments* above snowline. The ubiquitous presence of bedrock mortars also indicates that they were used not only for acorns, but also for processing a full range of plant and animal products.

This study used a new technology, GIS, to make a more fine-grained examination of settlement and subsistence in the central Sierra. It has shown the potential of this approach to contribute to an understanding of the archaeology of California. In the end, it has quantified what we have always known intuitively: That productive low elevation oak stands are a powerful magnet for late period archaeological sites.

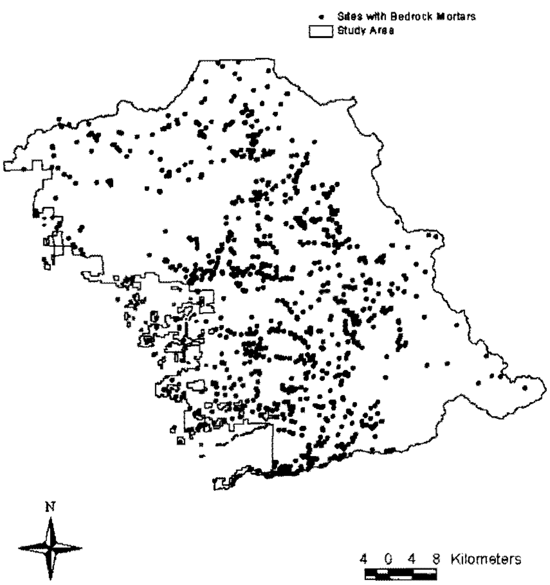


Figure 11: Bedrock mortar sites.

REFERENCES CITED

Bailey, B., D.E. Beauchamp and W. H. Griffith
1981 The Salt Springs Deer Herd Management Plan. California Department of Fish and Game and U.S.D.A. Forest Service. Eldorado National Forest, Placerville, CA.

Barrett, S. A., and E. W. Gifford
1933 Miwok Material Culture. Bulletin of Milwaukee Public Museum 2(4). Reprinted by the Yosemite Natural History Association, Inc., Yosemite National Park.

Basgall, M. E.
1987 Resource Intensification Among HunterGatherers: Acorn Economies in Prehistoric California. Research in Economic Anthropology 9:2152. JAI Press, Greenwich, Connecticut.

Baumhoff, M.A.
1963 Ecological Determinants of Aboriginal California Populations. University of California Publications in American Archaeology and Ethnology 49 (2):155-236. Berkeley.

1981 The Carrying Capacity of Hunter-Gatherers. *In* Affluent Foragers: Pacific Coasts East and West, S. Koyama and D.H. Thomas, eds. National Museum of Ethnology, Senri Ethnological Series 9:77-87. Osaka.

Beals, R.L.
1933 Ethnology of the Nisenan. University of California Publications in American Archaeology and Ethnology 31(6):335-414. Berkeley.

Bennyhoff, James A.
1956 An Appraisal of the Archaeological Resources of Yosemite National Park. University of California Archaeological Survey Reports 34:197. Berkeley.

Binford, Lewis R.
1980 Willow Smoke and Dogs' Tails: HunterGatherer Settlement Systems and Archaeological Site Formation. American Antiquity 45(1):4 20.

Downs, James F.
1966 The Two Worlds of the Washo, An Indian Tribe of California and Nevada. Holt, Rinehart, and Winston, New York, New York.

Elsasser, A.B.
1960 The Archaeology of the Sierra Nevada in California and Nevada. University of California Archaeological Survey Reports 51:193. Berkeley.

Farris, G.
1982 Aboriginal Use of Pine Nuts in California: An Ethnological, Nutritional, and Archaeological Investigation into the Uses of the Seeds of *Pinus lambertiana* Dougl. and *Pinus sabiniana* Dougl. by the Indians of Northern California. Unpublished Ph.D. Dissertation. University of California, Davis.

Fowler, G. S., R.B.Wagner and J. Bower
1982 The Blue Canyon Deer Herd Management Plan. California Department of Fish and Game and U.S.D.A. Forest Service. Eldorado National Forest, Placerville, CA.

Gifford, E.W.
1936 Californian Balanophagy. *In* Essays Presented to A.L. Kroeber, pp. 87-98. University of California Press. Berkeley.

Goddard, P.E.
1903 Life and Culture of the Hupa. University of California Publications in American Archaeology and Ethnology 1:3-87. Berkeley.

Hinz, D., D.E. Beauchamp and W. H. Griffith
1982 The Pacific Deer Herd Management Plan. California Department of Fish and Game and U.S.D.A. Forest Service. Eldorado National Forest, Placerville, CA.

Hinz, D., D.E. Beauchamp and P. Perkins
1984 The Grizzly Flat Deer Herd Management Plan. California Department of Fish and Game and U.S.D.A. Forest Service. Eldorado National Forest, Placerville, CA.

Hunt, D.C.
1999 Bedrock Mortars as Indicators of Late Holocene Settlement and Subsistence: A GIS Approach. Unpublished Masters Thesis, Department of Anthropology, California State University, Sacramento.

Jackson, Thomas L.
1984 Predictive Model of Prehistoric Settlement Patterning in the Southern Sierra Nevada. *In* Cultural Resources Overview of the Southern Sierra Nevada, pp. 179-203. Theodoratus Cultural Research, Inc., and Archaeological Consulting and Research Services, Inc. Submitted to USDA Forest Service, South Central Contracting Office, Bishop, CA.

Kroeber, Alfred L.
1925 Handbook of the Indians of California. Bureau of American Ethnology Bulletin 78, Washington, D.C. Reprinted 1976 by Dover Publications, Inc, New York.

Levy, R.
1978 Eastern Miwok. In California, edited by R.F. Heizer, pp. 398413. Handbook of North American Indians, vol. 8, W. C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

McCarthy, H.
1993 A Political Economy of Western Mono Acorn Production. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

Munz, P.A. and D.D. Keck
1973 A California Flora and Supplement. University of California Press. Berkeley.

Oliver, W.W.
1992 Silvics of Sugar Pine: Clues to Distribution and Management. *In* Sugar Pine: Status, Values, and Roles in Ecosystems, edited by Kinloch, B.B., M. Marosy and M. Huddleston. Division of Agriculture and Natural Resources Publication 3362. University of California, Davis.

Parker, I. And W. Matyas
1979 CALVEG: A Classification of Californian Vegetation. United States Forest Service. San Francisco.

Price, John A.
1962 Washo Economy. Nevada State Museum Anthropological Papers 6.