HUJPU-ST:
SPATIAL AND TEMPORAL PATTERNS OF ANTHROPOGENIC FIRE IN YOSEMITE VALLEY

A thesis submitted to the faculty of
San Francisco State University
In partial fulfillment of
The requirements for
The degree

Master of Arts
In
Anthropology: Archaeology

by

Linn Gassaway

San Francisco, California

May, 2005

CERTIFICATION OF APPROVAL

I certify that I have read *HUJPU-ST: Spatial and Temporal Patterns of Anthropogenic Fire in Yosemite Valley* by Linn Gassaway, and that in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requirements for the degree: Master of Arts in Anthropology: Archaeology at San Francisco State University

Gary Pahl
Professor of Anthropology

Barbara Holzman
Professor of Geography

James Quesada
Associate Professor of Anthropology

HUJPU-ST: SPATIAL AND TEMPORAL PATTERNS OF ANTHROPOGENIC FIRE IN YOSEMITE VALLEY

Linn Gassaway
San Francisco State University
2005

This study explored whether the Native American inhabitants of Yosemite Valley used fire differently over the landscape based on divergent land uses and subsistence needs. Through a combined exploration of dendrochronological fire history and archaeological data differences observed between modern lightning igniting patterns and the prehistoric fire history record confirmed ethnographic data that indicated Native Americans intensive used fire to manipulate vegetation. For this location, the Native Americans appear to have used a system of small, low intensity ground fires in all areas within the catchment area of a village, regardless of differences in identified land-uses or village size. Two significant changes in fire return intervals suggest that following cultural change in the Late Prehistoric; cultural burning practices remained relatively stable from the Protohistoric until 1890. The findings suggest that coordinating fire history sampling and archaeological data enabling a greater understanding of Native American spatial and temporal land-use patterns.

I certify that the Abstract is a correct representation of the content of this thesis.

Gary W Pahl ______________________ March 19, 2005

Chair, Thesis Committee — Date

ACKNOWLEDGMENTS

Most of all I want to acknowledge all the people who lived in Yosemite Valley prior to 1852. It is a great loss that the majority of people who work, study, and visit Yosemite do not realize that your lives shaped our vision of Yosemite Valley, and that your occupation of Yosemite Valley has had more influence in creating the vegetation patterns than many know.

As with all Master's thesis projects there were struggles, excitement, and disappointments both personally and professionally. During this process, many people have taken their role in making this thesis what it is and making me a different thinker than when I first started. As Woody Guthrie said, "the amount that we owe is all that we have".

To my ancestors who gave me the brain I have and my way of thinking and acting. For good or bad without the genetic spelling errors in natural selection, I would not be me. Thanks to the teachers among my ancestors, Jimmy, Evelyn, and Peggy, who without knowing it are directing my life in new directions.

Gary Pahl: who knew when to push and when to listen. Most of all for supporting me when I felt I was caught in a firestorm, and pushed me to think of theories besides fire history.

Nelson Siefkin: Without his constant support of this project, it would not have gone as far as it did.

Kara Paintner for constantly reminding me when I was getting out of line or to emotionally attached. Most of all for telling me to get it finished and get on with my life.

Jan W. Van Wagtendonk: Who is a great man, was too good to me, introduced me to both Tom Swetnam and Henry Lewis, supported my project and ideas while being the fire science god.

To the five people who taught me that nothing is as important as having a life outside of thesis and work: Mom - Mary Gassaway, Dad – Gary Gassaway (1942-2003), Roger Lehman (1911-2003), Anna Bruckman (1910-2003) and Mike Beasley for the raft trip.

To all the fieldworkers who helped gather data: Dayna Tinsley, Mark Giambastiani, Nikolai Shebalin, Stacey Zolnoski, Lori Slicton, George Buckingham, Susan Kerr, Amy McCarthy, Phil Reid, Mathew Moore, Sonny Montague, and Laura Kirn. Anthropology 492: Archaeological Methods, SFSU (March 17-21, 2003): Barbara Jones, Billie Seet, Chiling Yeh, Dan Thompson, Danny Liu, Douglas Worley, Erin Evarts, Jessica Maxwell, Jose Camarena, Naoko Kodama, Peter Otte, Rebecca Kleinberg, Sarah Muno, Sarah Skinner, Stefanie Hemming, Suzanne Wells, Tim Preston, and Virginia Chao. Students from Modesto Junior College (April 5, 2003): Andrew Hayes, Angelo Martinez, Carlos Valenzuela, Chelsea Feeney, Danette Wumkes, Daniel Gonzalez, Heather Pack, Kristie Cheeseman, Margaret Pack, Philip Baird, Rosa Gonzalez, and Tawny Holt. Thanks to

Kirstie Haertel for help with lithic analysis and cataloging.

For those who helped in the Fire History collection: First, Brian Mattos (Park Forester Yosemite National Park) for working with me to collect as many samples as possible while keeping the public safe. Yosemite Fire sawyers who did the real work of cutting the samples: Kelly Singer, Jeff Pirog, Brandon Dethlefs, Taro Pusina, Jeff Hinson, Logan Sanders, Jeff Crandal, Parker Bevington, and Tony Thaler.

Without the additional help of three Universities, their staff and facilities this study would not have been completed: The Laboratory of Tree Ring Research, University of Arizona: Thomas Swetnam, Chris Baisan, Rex Adams, Ron Towner, and Jeffery Dean for all their support by allowing me to study at the lab for a semester and listening to my opinions. Pennsylvania State University: John Sakulich for doing the fire history analysis of some of my samples; Andy Scholl for helping me learn sampling methods and collecting highly visible samples in the height of tourist season; Alan Taylor for giving my samples a home. University of Washington: David L. Peterson and James Agee for letting me use their lab. San Francisco State University for giving me the education and room to roam.

To Resource Management Division of Yosemite National Park – "The conflict of forces and the struggle of opposing wills are the essence of our universe and alone hold it together" (Havelock Ellis).

Unidentified individual; Yosemite; C. Hart Merriam Collection, Reel 5 P17, Vol. 24.

TABLE OF CONTENTS

List of Tables

List of Figures

Chapter 1: Background

Problem Statement

Ethnographic data from throughout the world, North American and Australia, in particular, shows that native groups used fire differently over the landscape based on the culturally intended results (Barrett 1981; Bonnicksen, et al. 2000; Jones 1969; Lewis 1973, 1985; Pyne 1983, 1993, 1997; Stewart 1956, 2002; Williams 2000, 2003). Despite this evidence, anthropologists, geographers, fire scientists, and ecologists question how extensively hunter-gathering peoples modified their environments through the periodic burning of vegetation. In the past this discussion has often been limited to whether Native Americans burned or not; why they would burn; how Native American and Euro-American views and uses of fire differed; and how prehistoric fire return intervals (i.e. how often fire occurs in a selected location over a period of time) differed from frequencies of fires derived from lightning ignitions alone. Since 1993, the discussion has narrowed, looking at Native American's use of fire in specific areas and regions in attempt to determine how much native people used fire and whether Native Americans changed vegetation to a "condition outside of the natural realm of historical variability" (Bendix 2002:237; Blackburn and Anderson 1993; Boyd 1999; Stewart 2002; Vale 2002). The researchers are often polarized with all or nothing stances, and these discussions seldom touch on how native groups may have used fire differently in different locations to achieve specific results.

Within California and the Sierra Nevada, anthropological studies have shown that Native Californians used fire to manipulate vegetation for various reasons (Anderson 1988; Anderson and Moratto 1996; Gruell 1985; Lewis 1973; Pyne 1983; Reynolds 1959; Wickstrom 1987; Williams 1998). Some specific information on purpose and seasonality of burning, vegetation types, and frequency of burning (fire return interval) can be found in historic accounts and early ethnographies (Gruell 1985; Lewis 1973). To date, the inability to differentiate between anthropogenic fire and lightning fire hinders the ability to discern anthropogenic fire in environmental datasets. The large spatial scale of ecological analysis lacks the precision that would enable anthropologists to gain an understanding of how Native Americans interacted and used fire within their culture and landscape.

Dendrochronology, in combination, with archaeology provides insight into Native American land use for almost a century, but a limited number of fire history studies address the use of anthropogenic fire used to manipulate the landscape. The few fire history studies that have attributed short fire return intervals (FRI) to anthropogenic fire (Barrett 1981; Kilgore and Taylor 1979; Loope and Anderton 1998; Reynolds 1959; Seklecki, et al. 1996) have been limited by the following factors:

- Inability to distinguish between anthropogenic fire and lightning fire in tree rings.
- Failure to take into account the wide variety of uses Native Americans had for fire.
- Comparing fire histories to broad regional history rather than local, site-specific history

- Failure to accurately take into account the ethnographic and archaeological data in the study areas

This study overcomes many of the limitations found in previous studies because of Yosemite Valley's unique geography, ethnographic database, and archaeological information. No lightning ignited fires occurred in Yosemite Valley between 1930 and 2003, suggesting that lightning was not responsible for fire return intervals needed to maintain the vegetation patterns seen by the first non-native visitors (Ernst 1943a, 1943b, 1949, 1961; National Park Service 2004). Because of this lack of lightning fires, much of the fire history in Yosemite Valley can be attributed to anthropogenic sources. Numerous ethnographic studies through out the world indicate that hunter-gatherers used landscape fire for multiple reasons including hunting, crop management, insect collection, pest management, fireproofing, incendiarism, and ritual uses. The ethnographic data of M. Kat Anderson (1988; 1990; 1993a; 1993b; 1996; 1999) gives insights on how fire might have been used to increase the yield of specific plants, and within Yosemite Valley, the work of Brian Bibby (1994) gives specific locations at which these plants occur. The numerous archaeological studies in Yosemite Valley (Bennyhoff 1953, 1956; Hull 1999; Hull and Hale 1998; Hull and Kelly 1995; Hull, et al. 1999; Mundy and Hull 1988; Napton, et al. 1974) and ethnographic work of Powers (1976 [1877]), C. Hart Merriam (1917) give the temporal and spatial backdrops of human occupation and potential vegetation disturbances, which would limit fire spread.

The lack of 'natural' fire, along with ethnographic and archaeological data, gives a spatial and temporal backdrop not available to previous studies of anthropogenic fires. Because of this Yosemite Valley gives a unique opportunity to test the hypothesis that Native Americans did not use fire uniformly over the landscape.

Hypothesis

This study hypothesized that because of Yosemite Valley's unique geography, ethnographic database, and available archaeological data, a fire history study that takes into account archaeological and ethno-ecological data can expand our knowledge of hunter-gatherer subsistence patterns. The extensive existing archaeological and ethnographic data provides a means to test this hypothesis and gain insight on how the Southern Sierra Miwok used fire differently in relationship to village sites and traditional gathering plots.

The Southern Sierra Miwok probably used fire in a patchwork manner throughout Yosemite Valley due to the divergent uses and needs required to continually subsist in the same area. The Southern Sierra Miwok could confine fires to specific areas within Yosemite Valley through their knowledge of fire and the manipulation of fuels. Fires ignited to enhance traditionally gathered plants would be confined to those areas and fires set to clear travel areas could be controlled enough so that they did not endanger villages. Native Americans probably did not delineate boundaries or 'control' anthropogenic fire as strictly as fire managers do today. The spatial extent of individual fires would vary but fires would be limited enough in scale to create a mosaic of different fire return intervals. Fires of small spatial extent, rather than large-scale landscape wide fires, would have been the norm. Ground fire would not carry into villages due to trampling and compaction in the core areas resulting in no fires or few fires over a long period (i.e. a long fire return interval). In areas where plants were managed to increase yields or desired characteristics (i.e. locations of traditionally gathered plants) fire was used on a set rotation and would have the shortest fire return interval, potentially as low as every one to two years. Areas where the Miwok used fire for fireproofing, clearing areas for travel and pest management would show an intermediate fire return interval. See Figure 1 for schematic view of this hypothesis.

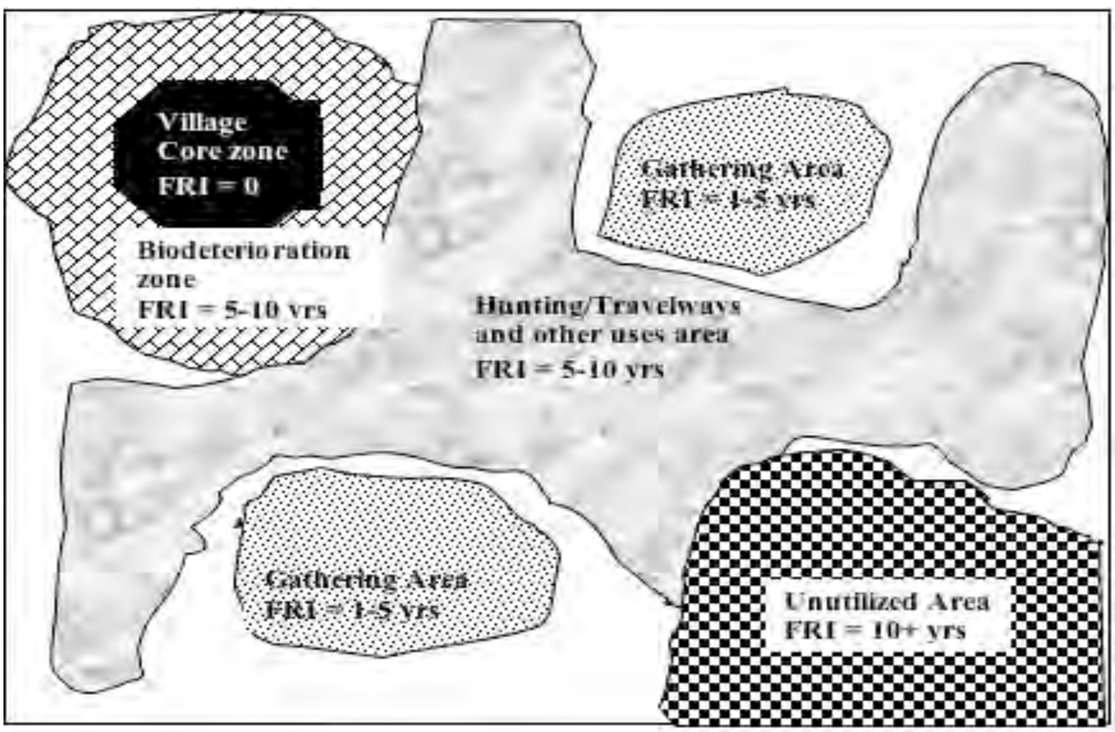

Figure 1: Schematic View of Hypothesized Fire Return Intervals (FRI)

Environmental Setting

> Local cultures know their plant, animal, and physical resources intimately and are expert at juggling their options for meeting day-to-day requirements and making the most of ephemeral opportunities (Nazarea 1999:4).

The context of how native peoples used fire on the landscape is directly related to the vegetation that is being burned. The environmental setting consisting of weather, elevation, topography, and geology determines the locations in which a culture lives and the range of vegetation and animals that people depend on for subsistence. This setting also determines the amount of manipulation and energy expended to change the vegetation to meet the needs of local populations. The setting also determines the ability to detect ignition source, i.e. human vs. lightning, and how these variables interact in producing a fire regime.

Yosemite Valley is located on the western slope of the central Sierra Nevada of California, and is approximately 250 kilometers (155 miles) east of San Francisco (see Figure 2). Yosemite Valley is a glacially carved valley measuring approximately one-mile wide by seven-miles long. Characterized by a U-shaped cross-section, the valley has broad expanses of glacially scoured granite cliffs topped by exposed bedrock domes. The valley floor is at approximately 1,200 meters (4,000 feet) elevation. The Merced River bisects the valley and is generally slow moving due to only a slight topographic gradient within the valley.

The western slope of the Sierra Nevada has a montane climate, with cool, moist

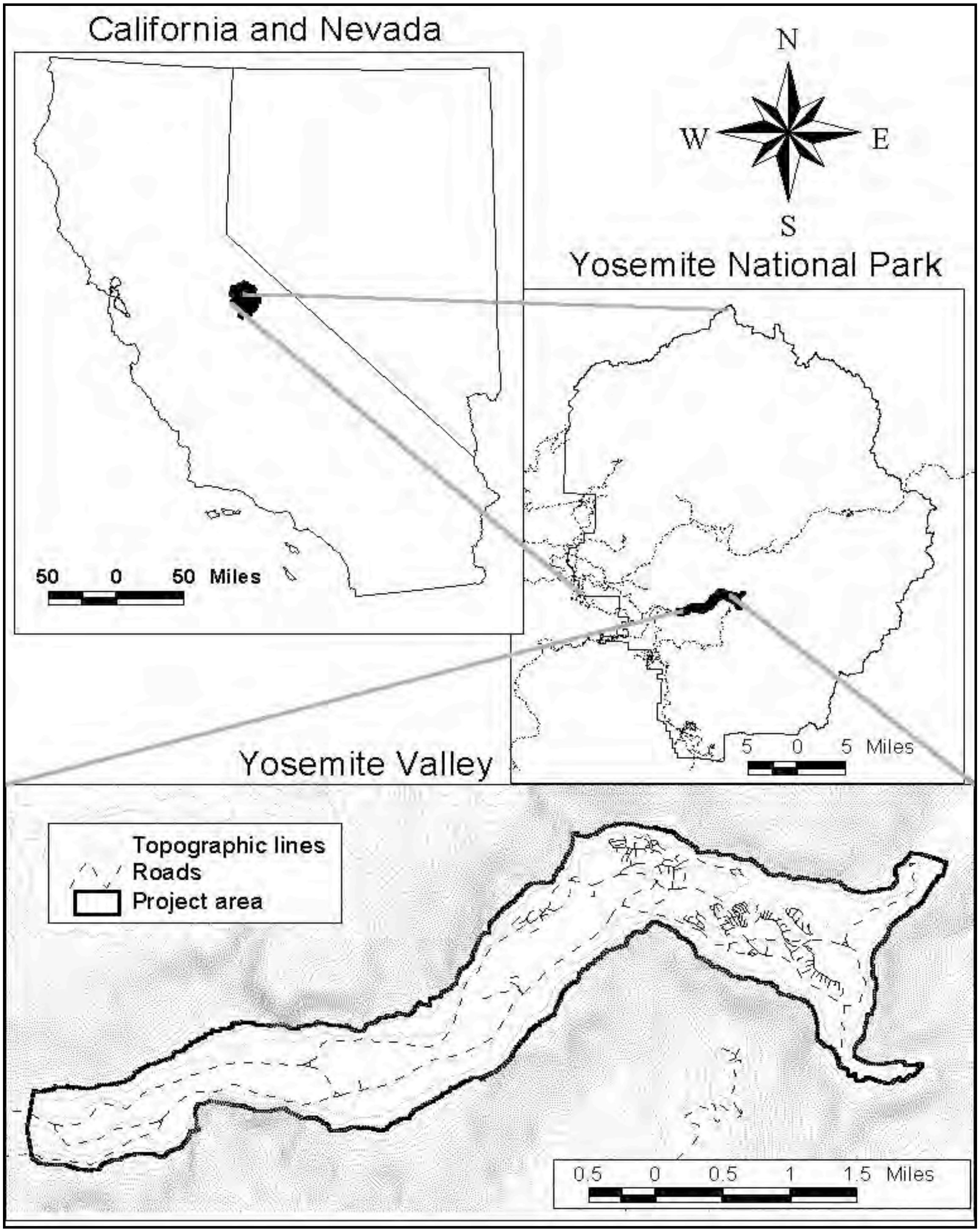

Figure 2: Project Location

winters and warm, dry summers. The high elevation of the Sierra Nevada presents a barrier to the pattern of prevailing storms that move east from the Pacific Ocean. Winter snows occur in areas above approximately 1,065 meters (3,500 feet); Yosemite Valley is often snow-free, allowing year round occupation (Hull and Kelly 1995:5). Yosemite Valley is located within the Sierran Montane Forest Mixed-Conifer vegetation type. See Table 1 for the dominant species found in this vegetation type.

Ethnographic sources indicate that the Southern Sierra Miwok, who occupied Yosemite Valley, exploited many of the plants and animals within the Sierran Montane Forest for food and building materials, and maintained and enhanced many of these plants using anthropogenic fire (Table 1).

Archaeological and Ethnographic Background

In order to determine how and why Native Americans used fire spatially there needs to be an understanding of the cultural context surrounding the use of anthropogenic fire. Our understanding of the inhabitants of Yosemite Valley comes from archaeological and ethnographic studies within the Sierra Nevada, Yosemite National Park, and Yosemite Valley itself. An understanding of past cultural manifestations and changes in culture through time is needed to interpret the uses of fire. Through the understanding of anthropogenic fire use archaeologists can gain a better understanding of subsistence patterns of California's hunting and gathering populations.

The first amateur archaeological investigations in the Yosemite area began in 1908

COMMON NAME	SCIENTIFIC NAME	MIWOK NAME (Northern Miwok name underlined)
Overstory Species		
Ponderosa pine	*Pinus ponderosa* Laws	*Wassa*
Incense Cedar	*Calocedrus decurrens* (Torr.) Florin	*Moonoku*
Black Oak	*Quercus kelloggii* Newb.	*Teleeli*
Cottonwood	*Populus sp.*	<u>*Tah-tah'-kal'-la*</u>
Alder	*Alnus sp.*	<u>*Yaw'-le-le-pah*</u>
Willow	*Salix sp.*	<u>*Wel'-le-neh*</u>
Understory Species		
Big leaf Maple	*Acer macrophyllum* Pursh	*Haayi'*
Sierra Currant	*Ribes nevadense*	
Sierra Gooseberry	*Ribes roezlii* Regel	*Kiili*
Manzanita	*Arctostaphylos viscida, A. mariposa, A. patula, A. nevadensis, A. mewukka*	*Eeye, mookosu, palapala, mookoolkine*
Thimbleberry	*Rubus parviflorus* Nutt.	
Deer Brush	*Ceanothus integerrimus*	*Tinpa*
Mountain Misery	*Chamaebatia foliosa* Benth.	
Mammals		
Mule Deer	*Odocoileus hemionus*	*Hikah, Uwuya*
Black Bear	*Ursus americanus*	<u>*Oo'-ye-moo*</u>
Grizzly Bear	*Ursus arctos horribillis*	*Uhumati*
Mountain Lion	*Felis concolor*	<u>*Pah'-woo-koo*</u>
Mountain Coyote	*Canis latrans*	*Aheli*
Bobcat	*Lynx californicus*	<u>*To-lomah*</u>
Porcupine	*Erethizon dorsatum*	<u>*Mu'-hoo-nah*</u>
Gray Fox	*Urocyon cinereoargenteus*	<u>*Choo-moo-yah*</u>
Spotted Skunk	*Mephitis mephitis*	<u>*His'-sik-kah*</u>
California Ground Squirrel	*Citellus beecheyi*	
California Gray Squirrel	*Sciurus griseus*	<u>*Oo-pook'-soo*</u>
Long-eared Chipmunk	*Eutamias quadrimaculatus*	<u>*Pis'-soo*</u>

Table 1: Major Plants and Animals of Sierran Montane Forest (Barrett and Kroeber 1908; Broadbent 1960; Jepson, et al. 1993; Merriam and Heizer 1979; Munz and Keck 1959; Storer and Usinger 1963; Whitney 1992)

with E.W. Harnden's description of pictographs in Pate Valley, north of Yosemite Valley. In 1930, Rangers C.C. Presnall and C.A. Harwell conducted the first formal archaeological survey in the Foresta area, approximately 10 miles northwest of Yosemite

Valley. Naturalist R. McIntyre conducted informal archaeological surveys in the central portion of the Yosemite National Park during the 1940s and 1950s. Robert F. Heizer visited the area and recorded several sites in 1949. The first formal large scale archaeological investigations in Yosemite began in 1951 when the University of California, Berkeley, conducted surveys at Lake Eleanor. Bennyhoff and Grosscup conducted the first formal surveys of Yosemite Valley in 1952 (Greene 1987:1069-1070).

Bennyhoff and Grosscup (1953-1956)

In the 1950s, the National Park Service contracted the University of California Archaeological Survey (UCAS) to conduct archaeological investigations in Yosemite National Park (Bennyhoff 1953, 1956; Grosscup 1954). UCAS' work consisted of site recording of village locations that were noted in ethnographic literature and observed by park employees and visitors. These initial surveys were "intuitive" instead of systematic, and certain site types, such as historic sites, were not included in the study. The UCAS crews did an incredible amount of work in 61 field days. The crews recorded 401 sites including 47 sites within Yosemite Valley and excavated four sites. Twenty-eight of the Yosemite Valley sites represented ethnographic\historic villages. The recording process provided scant detail, site descriptions consisting of a sentence or two. A site consisted of a "minimum of five scattered obsidian flakes, an artifact, a mortar rock, or pictograph" (Bennyhoff 1956:12). Bennyhoff noted that within Yosemite Valley,

> Little remains on the surface of most sites which would allow the delimitation of midden areas; even obsidian flakes are rarely found except at the largest sites. Mortar rocks are the primary indicators of aboriginal occupation, but as these are often isolated it is sometimes difficult to determine whether individual sites are represented or whether groups of mortar rocks should be classed as single sites (Bennyhoff 1956:14-15).

Napton, Albee and Greathouse (1974)

Crews from California State College (now University), Stanislaus (CSCS) under the direction of L. Kyle Napton and funded by the National Park Service undertook extensive surface surveys in the early 1970s (Napton, et al. 1974; Napton 1978). These surveys were more substantial and systematic than the UCAS surveys, albeit they sometimes employed judgmental survey techniques and they did not consider historic sites. Crews used two survey types: Intensive Survey Pattern and Terrain/Ecology Response Mode. Intensive Survey Pattern consisted of 33 meter (110 feet) transects, while the Terrain/Ecology Response Mode used teams of two-persons with each team using 61 meter (200 feet) transects and individuals responded to the physiographic and ecological features thus "permits each survey archeologist to direct maximum coverage to potential site areas and to minimize coverage in areas that appear to be unfavorable for occupation/utilization" (Napton, et al. 1974:17-18). Site definitions were similar to those outlined by Bennyhoff (1956) with a minimum of five artifacts and/or the presence of a feature such as a bedrock mortar, pictograph, or rockshelter representing a site while site boundaries were identified on the basis of presumed site area (Napton 1978:205). Site recordation was more substantial than Bennyhoff including more detail on site environmental context and site maps. The crews examined approximately 3,840 acres within Yosemite Valley with all previously recorded sites rerecorded and an additional 42 sites discovered and documented (Napton, et al. 1974).

Hull and Kelly (1995)

The National Park Service conducted three archaeological surveys during the 1980s, including an intensive survey of the Northside Drive corridor from Sunnyside Campground to Valley View in 1985-1986. A second survey, in 1986, entailed complete reconnaissance of the campgrounds at the eastern end of the Valley, and revisited and rerecorded sites in the general vicinity of the campgrounds. In 1987, an archaeological survey focused on the eastern portion of Yosemite Valley at Housekeeping and much of the current Yosemite Village area and rerecorded the remaining known sites in Yosemite Valley. All surveys used a systematic reconnaissance with 25-meter transect intervals. Site definitions were refined to five objects within a 500 square meter area, a cultural feature with more than one associated artifact, and/or a stationary milling feature with more than one mortar cup or milling slick. Discrete sites were defined if cultural materials were separated by more than 30 meters. Historic sites were recorded for the first time if artifacts were recognized to be more than 50 years old. The projects recorded thirty-seven sites and merged several sites bringing the total number of known sites in Yosemite Valley to 107.

Others Surveys

Besides the three major surveys reported in Bennyhoff (1956), Napton et al. (1974), and Hull and Kelly (1995), twenty-one small-scale surveys have taken place in Yosemite

Valley since the mid 1970s. These surveys brought the total number of known sites in Yosemite Valley to 126 consisting of 76 prehistoric, 28 multi-component, and 22 historic sites.

Excavations

In the late 1960s and the 1970s, the first subsurface archaeological investigations took place in Yosemite Valley (e.g. Danzinger 1979; Mayberry 1979; Rasson 1966). The majority of subsurface testing has been limited to the northeastern portion of Yosemite Valley in compliance with the National Historic Preservation Act (NHPA). Testing was required as part of the development of Yosemite Village, Yosemite Lodge and Yosemite Falls parking and trails areas, and utility line construction, and most testing was confined to small excavations (Hull and Kelly 1995). The two exceptions are *The 1984 and 1985 Yosemite Valley Archeological Testing Projects* (Mundy and Hull 1988), which tested 10 sites north of the Merced River in support of the design and construction of subsurface water and electric lines; and six sites sampled by Kathleen L. Hull in 1998 as part of her dissertation work (Hull 2002). As of 1998, subsurface investigations had been conducted in 19 Yosemite Valley archaeological sites, all but one of which lie north of the Merced River. Furthermore, only 14 of these sites, representing from nine to 12 ethnographically documented villages, were conducted at sites that the investigators recognized as being village identified by Powers (1976 [1877]) and\or Merriam (1917).

Native American Occupation of Yosemite Valley

While this study focuses on the latter part of the Late Prehistoric 3, Protohistoric, and

Historic Period 1 (as defined in Hull, et al. 1999), brief descriptions of the Prehistoric Periods are included as an overview of the status of Yosemite archaeology. This inclusion elucidates differences expected in the archaeological record when deciphering the period of occupation for village sites. Kent Lightfoot cautions that, "without this prehistoric perspective, one cannot undertake comparative analysis of cultural transformations that took place before, during, and after European contact and colonialism" (Lightfoot 1995:200). While Hull (2002) expanded our knowledge of the Protohistoric and Historic Periods from two sites in Yosemite Valley, these periods have not been systematically studied or defined archaeologically for the Yosemite Region. A short summary of expected archaeological materials based on studies from Yosemite Valley and surrounding areas is presented below.

The UCAS research was the first regional study of the central Sierra Nevada and documented use of the area for at least the past 3,000 years. Based on the UCAS work, Bennyhoff (1956) proposed a three-part chronology for the region, the Crane Flat complex (? – A.D. 500), the Tamarack complex (A.D. 500-1200), and the Mariposa complex (A.D. 1200-1850). Moratto (1999) refined and expanded Bennyhoff's original chronology proposing four Early Prehistoric and two Intermediate Prehistoric periods before the Crane Flat complex, and a protohistoric and four historic periods after the Mariposa complex (Table 6).

The first three Early Prehistoric (1-3) periods, >9500-7500 B.C., encompass pre-archaic cultural adaptations and are currently not represented in the Yosemite Region although they are recognized elsewhere in the West by fluted and/or stemmed points. The first period potentially represented in Yosemite National Park is the Early Prehistoric 4 (7500-6000 B.C.). This period may be represented in El Portal, 15 miles west of Yosemite Valley, with two sites yielding "large, broad-stemmed points, a possible crescent, and other stone tools comparable to Pre-Archaic specimens from Clark's Flat, Upper Meadow, Skyrocket, and other Sierran sites of early Holocene age" (Moratto 1999:181). Moratto suggests "that artifacts from El Portal with obsidian-hydration rims measuring between 8.0 and 9.8 microns (Casa Diablo) relate to this period, but application of Hull's (1996) temperature-dependent hydration rate formula indicates significantly younger age (e.g. 5000 B.P.) for such items" (Hull, et al. 1998:9). The affiliation of the El Portal complex with the Early Prehistoric 4 Period remains tenuous at best.

The Intermediate Prehistoric 1 (6000-3500 B.C.) is currently the first period observed within Yosemite Valley. Radiocarbon dating at CA-MRP-56/61/196/298/299/300/301/H shows potential habitation as early as 5200 B.P. (Moratto 1999:137, Table 136). Three other sites have been assigned to this Intermediate Prehistoric 1 by Moratto (1999) through obsidian hydration and projectile point types: CA-MRP-240/303, -292/293, and -748/765. The Merced and Wawona Complexes represent the Intermediate Prehistoric 2 Period (3500-1200 B.C.). The Merced Complex consists of "Pinto series projectile points; diverse cores, choppers, scraper planes (plano-convex scrapers), scraper-choppers, and flake tools; large bifacial 'knives'; preference for non-obsidian toolstone; inferred use of the atlatl and dart; and abundant grinding slabs and handstones" (Moratto 1999:185). Kathleen Hull suggests that the Merced Complex "seems to rely on data from surrounding areas rather than reflecting evidence from Yosemite" (Hull, et al. 1998:9). The only site within Yosemite Valley dated to the Merced Complex through radiocarbon 14 analyses is CA-MRP-67 (cal. 2013-1522 B.C.), see table 7. Artifacts assigned to the Wawona Complex are Humboldt, Large Side-notched, Sierra Side-notched, and medium square stemmed points. This period is represented at CA-MRP-0056/61/196/298/299/ 300/301/H.

The Late Prehistoric 1 Period (1200 B.C.-A.D. 650) represented by the Crane Flat Complex, is differentiated by Sierra Concave Base, Eared Concave Base, Sierra Contracting Stem, Triangular Contracting Stem, and Elko series projectile points; large "blacex and bifacial knives; 'nibbin' drills; numerous small modified flake tools; choppers; bowl awls and beads; Olivella Spire-lopped, Large Saucer, and Small Saucer beads; Haliotis ornaments and disk beads; and probable use of handstones and grinding slabs" (Moratto 1999:186). Two sites in Yosemite Valley have components dating to the Crane Flat complex. CA-MRP-163 based on two radiocarbon dates from an ash feature (cal average A.D. 579 and cal A.D. 614), a Sierra Triangular point, and a Haliotis bead (Moratto 1999:305). Two radiocarbon dates from CA-MRP-305 (cal. A. D. 256-556, A. D. 437-767) place it in the Crane Flat Complex, but Moratto gives no interpretation for the site and does not affiliate the site with the complex, possibly because the radiocarbon dates were obtained from unassociated soil samples.

The Late Prehistoric 2 Period, (Tamarack Flat Complex, A.D. 650-1350) is typified by Rose Spring projectile points. Within Yosemite Valley, CA-MRP-158/309 is assigned to this period based on two radiocarbon dates of cal A.D. 1021 and cal A.D. 1041 from charcoal found in stratified anthrosols and a Rose Spring Corner-notched point (Moratto 1999:161-162; Mundy and Hull 1988:146-148)

The Late Prehistoric 3 Period (Mariposa complex, A.D. 1350-1800) is represented by Desert Side-notched and Cottonwood Triangular projectile points, bedrock mortars and cobble pestles, various flake tools, steatite vessels, and disk beads. Large population is inferred based on many residential sites on permanent streams. Moratto speculates that acorn utilization intensified and, "this complex is thought to represent the late prehistoric Sierra Miwok, albeit with evident contributions by such neighboring peoples as the Paiute and Western Mono" (Moratto 1999:193). Indirect contact with occupants of the Spanish Mission system in western California began during this period. There is evidence that some Southern Sierra Miwok lived within the mission system. For example, Jean-Nicolas Perlot befriended Juan, a son of "the chief of the tribe of the Yo-se'-miti" who had stayed at a mission (Perlot 1985:182). The latter half of this period has been termed the Exploration or Early Mission period in other portions of California.

The Protohistoric Period (Yosemite Complex, A.D. 1800-1847) was a time of cultural adaptation and change. In 1833, Joseph Walker led the first Euro-American expedition into the area between the Tuolumne and Merced Rivers. During this period, impacts to the Southern Sierra Miwok culture included the introduction of diseases, interruptions in the trade networks and migrations of ex-mission Indians. Large-scale epidemics including smallpox, scarlet fever, measles, influenza, cholera, tuberculosis and malaria swept through California during the 1830s and 1840s (Bates and Lee 1990:25).

This period brought nontraditional articles including glass trade beads, steel knives, mission crucifixes, and horse regalia (Bates and Lee 1990:26; Bunnell 1990 [1880]). In the Yosemite Region, the integration of Euro-American goods reflected by the co-occurrence of nontraditional artifacts (e.g. glass tread bead, steel knives, etc.) and traditional artifacts (e.g. flaked- and ground- stone tools), rather than the transformation of nontraditional material into traditional forms, such as glass or ceramic projectile points (Hull 1995:25).

Van Bueren points out the changes that occurred in the Protohistoric Period had far ranging effects beyond material culture changes:

> The immigration of non-Miwok Indians must have created significant changes in settlement patterns, social and political structure, and subsistence practices. Such changes must have functioned in a complex synergistic interaction with each other, where transformations in one aspect of the Miwok culture had repercussions for all other cultural subsystems (Van Bueren 1983:7-8).

The Historic I Period (Tenaya Complex, A.D. 1848-1863) brought great changes to the Miwok culture following the discovery of gold in 1848 and large-scale migration of Euro-American, Hispanic, and Chinese miners into the Sierra Nevada. In 1849, James Savage established a trading post 13 miles west of Yosemite Valley at the confluence of the south and main forks of the Merced River. That same year William Penn Abrams

DATES	PERIODS	PHASES	DIAGNOSTIC ARTIFACTS
A.D. 1945-	Historic 4		
A.D. 1891-1944	Historic 3		1892 - First tobacco can 1894 – modern sanitary can 1904-present Bottles Automatic bottle machine
A.D. 1864-1890	Historic 2	Rancheria	Increased adaptation of nontraditional artifacts. Cut nails, Bottles Turn Molds
A.D. 1848-1863	Historic 1	Tenaya	Adaptation of nontraditional artifacts that functioned as analogues of traditional artifacts (i.e. metal spoons replace shell and wooden spoons); adoption of Euro-American clothes and food
A.D. 1800-1847	Protohistoric	Yosemite	Glass trade beads, steel knives, mission crucifixes and horse regalia
A.D. 1350-1800	Late Prehistoric 3	Mariposa	Desert Side-notched and Cottonwood Triangular points, Bedrock Mortars, steatite beads, and steatite vessels.
A.D. 650-1350	Late Prehistoric 2	Tamarack	Rosespring points, Bedrock Mortars; poorly defined
1200 B.C. - A.D. 650	Late Prehistoric 1	Crane Flat	Sierra Concave Base, Eared Concave Base, Sierra Contracting Stem, Triangular Contracting Stem and Elko series points; Bone, Olivella and Haliotis beads
3500-1200 B.C.	Intermediate Prehistoric 2	Merced Wawona	Pinto points (ca 5,000-1,000 B.C.), grinding slabs and handstones Humboldt (3,920-1,100 B.C.), Large Side-notched, and Sierra Side-notched points
6000-3500 B.C.	Intermediate Prehistoric 1	?	Diversity of projectile points: Pinto, Humboldt, Martis, Large Side-notched, Sierra Side-notched, foliate, pentagonal, (First occupation of Yosemite Valley?)
7500-6000 B.C.	Early Prehistoric 4	El Portal	Large lanceolate concave base points, large broad stemmed points

Table 2: Proposed Cultural Chronology for Yosemite Valley after Moratto (1999)

may have been the first Euro-American to visit Yosemite Valley (Heald 1947). However, most credit the discovery of Yosemite Valley to a militia group known as the Mariposa Battalion while searching for Native Americans accused of depredations against Euro-Americans, including James Savage, in March 1851. Upon entering the

Valley, members of the Battalion burned stored foods found in at least seven villages (Bunnell 1990 [1880]). Following the Mariposa Battalion, two other military expeditions were sent into Yosemite Valley "to punish the raiders and to bring them back to reservation life. Each time the Awanichi escaped, or attempted to escape, eastward to the Mono Lake area…. the second expedition captured a village of 35 inhabitants on the snow-covered shores of Lake Tenaya" (Bennyhoff 1956:5). The first tourist party lead by Robert C. Lamon visited the valley in 1854 (Taylor 1936). The first permanent hotel structure was built in 1856-57 (Bates and Lee 1990:29-30). In 1859, James Chenowith Lamon took possession of 160 acres in Yosemite Valley that he had purchased the possessory rights from Mr. Chas. Norris, Milton Mann, and others (*Petition of the People of Mariposa to the Legislature of California* 1867). During 1859 and 1860 he only stayed in Yosemite Valley during the summers, after spending the winter of 1861-62 when he became first non-Native to live year round in Yosemite Valley (Taylor 1936). From 1855 to 1864, 653 registered visitors entered the valley (Hutchings 1886). Publisher and Yosemite Valley resident Hutchings (1886) estimated that the number of unregistered visitors would have increased that total to over 700 individuals in nine years.

A study of Central Sierra Miwok acculturation by Van Bueren stated that two archaeological trends occur with integration of non-traditional materials into traditional culture:

> The first trend suggests that most of the nontraditional articles acquired by Indians had low value (as defined by Euro-Americans). This is in keeping with the restricted access Indians had to the white economic system. Second, almost every nontraditional artifact that was adopted by the Miwok had a functional analogue of some kind, suggesting that traditional lifeways may have had a significant influence upon the direction of Miwok culture change during the historic period (Van Bueren 1983:9).

By the late 1850's Native Americans of the Yosemite Region had taken up wearing Euro-American clothes and "metal implements became commonplace and newly introduced food such as bread and tortillas fast became staples" (Bates and Lee 1990:30)

During the Historic 2 Period (Rancheria Complex, A.D. 1864-1890) visitation to Yosemite Valley increased from 147 in 1864 to over 4000 in 1886 (Bates and Lee 1990:30-31; Hutchings 1886). On June 30, 1864, President Lincoln signed the Act protecting and granting "Yo-Semite Valley and the Mariposa Big Tree Grove" to the State of California. During this period, visitors noted an increase in the Mono Lake Paiute visiting and living in Yosemite Valley. While many traditional Indian practices continued, native lifeways increasingly integrated aspects of Euro-American culture. In 1886, James Hutchings wrote of the Yosemite Indians, "old habits are steadily, yet noticeably, passing away" (Bates and Lee 1990:37). Yosemite Indians were able to maintain separate residences from whites in semi traditional villages while the O'-chum (traditional dwelling) of poles and cedar bark was being replaced by structures of milled wood.

The Historic 3 Period (A.D. 1890-1944) begins with the creation of Yosemite National Park surrounding the Yo-Semite Grant in 1890. This same year the tribes of Yo-Semite petitioned congress for tribal rights to Yosemite Valley, but Congress never took any action on this petition. During this period, Yosemite Indians continued to integrate Euro-American goods into traditional practices, and non-traditional lifeways dominated (Bates and Lee 1990:36-37).

Southern Sierra Miwok Ethnography

While Yosemite Valley was occupied since at least ca. 5200 BP, Moratto suggests that the Miwok arrived in Yosemite Valley approximately 700-450 BP (Moratto 1999:173-174).

Since the late 19th century, five major ethnographic studies have extensively documented the native inhabitants of Yosemite Valley: Powers (1871-76), Barrett and Gifford (1906-1920s), Merriam (1900-1920s), Bibby (1994), and Anderson (1980s-1990s). These studies have shown that Yosemite Valley is within the traditional territory of the Southern Sierra Miwok, although several other groups traveled to the valley for purposes of trade and possibly for limited periods of residence (Bennyhoff 1956:2-4; Hull and Kelly 1995:6). Steward (1933) stated that the Washo possibly traveled as far south as Yosemite Valley and there was noted use of Little Yosemite Valley and upland areas by Mono-Paiute (Bates and Lee 1990).

The social organization of the Sierra Miwok was a totemic exogamous moiety system with paternal descent, while politically they were divided into tribelets. Each tribelet controlled the natural resources within a defined territory, and inhabited several permanent settlements and a larger number of seasonal campsites. A tribelet consisted of approximately 100 to 300 people (Broadbent 1960; Gifford 1916).

The Miwok are a linguistic subgroup of the Penutian language family. Within California the Miwok are divided into three large territorially discrete groups: Coast, Lake, and Interior-Sierra Miwok (Barrett and Kroeber 1908; Dixon and Kroeber 1913; Kroeber 1908; 1976 [1925]:443; Levy 1978:398). Linguistic divisions break the Sierra Miwok still further into northern, central, and southern groups. The Southern Sierra Miwok occupied the foothills and mountains of the Sierra Nevada in the drainages of the Merced and Chowchilla rivers. The western boundary of the Southern Sierra Miwok with the Yokuts was probably located at the juncture of the Central Valley and lowest foothills while the eastern boundary varied based on season but extended to the Sierra Nevada crest (Kroeber 1976 [1925]:443).

Although the groups were linguistically and culturally similar, the Miwok "were not in a sense a single people, but rather a number of separate and politically independent nations that happened to share a common language and a common cultural background" (Levy 1978:398). Both culturally and linguistically, the Sierra Miwok groups had more in common with one another than with the Lake Miwok and Coast Miwok. Dialectical differences between the groups of the Merced River drainage distinguished them from other Southern Sierra Miwok (Bennyhoff 1956:2; Levy 1978:398). "Yosemite speech may have had an additional spirant phoneme, /s/, which is lacking in the others … Speakers from Mariposa say that they could hardly understand those from Yosemite, only forty miles away" (Broadbent 1960:4).

Merriam identified the inhabitants of Yosemite Valley as "the *Ahwaneech* or *Ahwah'-nee Mew'-wah*, a subtribe closely akin to the neighboring *Chow-shil'-la Mew'-wah* of Chowchilla Canon" (Merriam 1917:202). According to Merriam (1917:202), occupation in Yosemite Valley consisted of both permanent villages occupied throughout the year, and summer camps used from May through October, and the Valley was "somewhat depleted in the winter" when the residents moved down to the Merced River Canyon. The first Yosemite Grant Guardian Galen Clark noted two groups occupied Yosemite Valley the *Ahwah'-nee* and "the *Po-ho-nee'-chees*, who lived near the headwaters of the *Po-ho'-no* or Bridal Viel Creek in summer, and on the South Fork of the Merced River in winter, about twelve miles below Wawo'na" (Clark 1904:5). Bunnell stated, "the Pohonichi occupied the region of Pohono Meadows in summer, and claimed land as far south as the right bank of the South Fork of the Merced" (Bennyhoff 1956:3). Bennyhoff further stated that "the frequent references to actual informants by Bunnell and the appearance of the group in the treaties leaves no doubt but that an actual group named Pohonichi did exist, living between the Awanichi and the Nutchu" with the Nutchu's northern boundary probably being "the left bank of the South Fork, so it is doubtful if any of their villages are included within Park boundaries" (Bennyhoff 1956:2).

Within Yosemite Valley the *Ahwah'-nee* totemic moiety system divided the villages by whether they were north or south of the Merced River, *Oo-hoo'-ma-tat ko'to'wahk* or *Oo-hoo'-ma-te ha-wa-ah* (grizzly bear) or *Ah-ha-leet ko-to'-wahk* or *Ah-ha-le ha-wa-ah* (coyote), and *Too-noo'-kah* (land) or *Kik-koo'-ah* (water). The upper end is the east end of the valley and the lower end *Til-til'-ken-ny* is the western end (Merriam 1917). The role of totemic moiety system on the spatial patterns of Miwok occupation (e.g. village locations, gathering areas, and hunting grounds) is not currently understood but it could have potentially affected the patterns and extent of fire.

Ethnographic Studies in Yosemite Valley

Since the late 19th century, anthropologists have extensively studied Southern Sierra Miwok inhabitants of Yosemite Valley, including five major ethnographic studies: Powers (1871-76), Barrett and Gifford (1906-1920s), Merriam (1900-1920s), Bibby (1994), and Anderson (1980s-1990s).

<u>Powers (1871-1876)</u>

Stephen Powers visited and studied in Yosemite Valley between 1871-1872, and again in 1875-1876. Through an informant named *Choko*, he identified nine village sites. Powers estimated that "these nine villages must have contained four hundred and fifty inhabitants" (Powers 1976 [1877]:365-366).

<u>Barrett and Gifford (1906-1930s)</u>

S.A. Barrett and E. W. Gifford conducted fieldwork in the Yosemite Region between 1906 and 1933 on behalf of the University of California. Their work culminated in the publication of *Miwok Material Culture: Indian Life of the Yosemite Region* (1976 [1933]). They outlined the potential environmental and cultural influences on elements of Miwok life, and describe in detail the production of food, medicine, clothes, shelter, arts, and "industry". The study provides a good basis for interpretation of protohistoric and ethnographic artifacts and plant uses, but it does not identify specific locations of activities.

Merriam (1900-1920s)

Based on his visits to Yosemite Valley in the late 1800s and early 1900s, C. Hart Merriam (1917) recorded the most extensive information on spatial patterns of Native American occupation in Yosemite Valley. He recorded the names and locations of 36 villages and summer camps in the valley itself. He reported that at least six villages were occupied as late as 1898, another 1907, another 1910 and still another until 1917.

Bibby (1994)

Brian Bibby inventoried ethnographic resources in *An Ethnographic Evaluation of Yosemite Valley: The Native American Cultural Landscape* (1994). This study identified traditionally used ethnobotanical resources, their use, and location of occurrence, and traditional cultural and historical places, including ethnographic village locations. Bibby (1994) included historic information for 10 villages inhabited in the historic period: *Hookehahtchke*, *Yowatchke*, *Koomine*, *Wahhoga*, *Soosemmoolah*, *Hakkiah*, *Loiyah*, *Hollow*, *Wiskahiah*, and *Ahwahne*.

Anderson (1980s-1990s)

Kat Anderson has done extensive ethnographic work on plant use and protoagricultural techniques of the Southern Sierra Miwok, including *Southern Sierra Miwok Plant Resource Uses and Management of the Yosemite Region: A Study of the Biological and Cultural Bases for Plant Gathering, Field Horticulture, and Anthropogenic Impacts on Sierra Vegetation* (1988) and *Indian Fire-Based Management in the Sequoia-Mixed Conifer Forests of the Central and Southern Sierra Nevada*

(1993a). These studies do not identify locations of activities, but give a basis for determining the differences in anthropogenic fire use across the landscape of Yosemite Valley. Anderson's studies are used throughout this thesis and will not be discussed in this section.

Archaeological Evidence of Occupation during the Protohistoric and Early Historic Periods

In order to interpret the relationship between fire regimes and culture there is a need for understanding of the specific spatial manifestations of Southern Sierra Miwok occupation during the periods observed in the fire history record.

Villages in Yosemite Valley

Since the 1950s archaeologists have attempted to identify which archaeological sites represent villages identified by Merriam (1917), Powers (1976 [1877]), Wheeler (1883) and Bunnell (1990 [1880]). Before the 1980s, studies essentially ignored most historical archaeological material, or noted them as disturbances to the prehistoric deposits, not as potential markers for ethnographic occupation, the only exception being trade beads. Casual collection of artifacts and limited surface visibility has hindered archaeological identification and temporal assignment of sites and artifacts dating to the protohistoric and early historic periods. Bennyhoff noted,

> In this region of intensive surface collecting for over half a century, combined with the frequent surface cover of leaves and needles, it is felt that five obsidian flakes are not too small a requirement for the definition of a site. Were it not for the mortar rocks, most of Merriam's ethnographic villages would have to go unrecorded because it was seldom possible to obtain this number of flakes from the surface of Yosemite Valley (Bennyhoff 1956:12).

All three major archaeological surveys in Yosemite Valley (Bennyhoff 1956; Hull and Kelly 1995; Napton, et al. 1974) as well as Bibby's (1994) study have attempted to correspond archaeological sites with the 36 village sites identified by C. Hart Merriam (1917). Bennyhoff (1956) identified 38 archaeological sites as representing 28 of Merriam's villages. Napton et al. (1974) identified 52 archaeological sites for 26 of Merriam's villages. Hull and Kelly (1995) identified between 32 and 45 archaeological sites corresponding to 32 of Merriam's villages. Between the four major studies, there is agreement on locations for only 18 of Merriam's villages. Of these, only five villages sites were all assigned the same and only one archaeological site: *Hep-hep'-oo'-ma* (CA-MRP-64); *Ti-e-te'-mah* (CA-MRP-187); *Poot-poo-toon* (CA-MRP-189); *Sap-pah'sam-mah* (CA-MRP-71); and *Kis'-se* (CA-MRP-76). In 13 instances where multiple archaeological sites were identified as a village site, all four studies identified the same primary archaeological site but differed on secondary or tertiary site designations (See Appendix A and B).

Land-Use Patterns

There are multiple reasons for why more than one archaeological site could constitute the physical remains of a village. These reasons include preservation limitations of the archaeological record and management decisions on the definition of an archaeological site. This is relevant not only in how archaeologists interpret village sites, but in how archaeologists seek to interpret non-material cultural practices. In Yosemite National Park archaeological site boundaries are defined solely on the extent of material culture remains. Material culture is differentiated into discrete archaeological sites based on a separation of artifacts and/or features by 30 meters or more. While this definition is appropriate for management purposes derived from legal mandates such as the National Historic Preservation Act, the archaeological definition is limiting and not necessarily appropriate to use when trying to study the full spectrum of cultural impacts to an ecosystem.

Separating cultural land-use into use zones based on their function and amount of resource exploitation can illuminate how cultural practices are not limited to archaeological manifestations, as currently defined, and how land use practices which extended beyond archaeological sites might have impacted anthropogenic ignition patterns, fuel loads and fire spread. Based on refuging and central place theories, land use within and surrounding villages falls into four zones: core, biodeterioration, trampling, and resource acquisition zones (see Figure 3). The boundaries of these zones, "fall along a continuum ranging from very distinct to very subtle" (Siefkin 2001:3).

The core zone is the central location of the population; it contains houses, stores, and tool processing areas. The core zone may be best described as a home base consisting of a "focus in space such that individuals can move independently over the surrounding terrain and yet join up again" (Isaac 1978:92). In his unpublished notes, C. Hart Merriam identifies 15 components comprising a typical Miwok village (see Table 3); those components clustered in the central high use area of a village would constitute the core zone. Margaret W. Conkey points out that "as we frame our expectations for prehistoric locales, we must keep in mind that social and ritual processes may well have been concomitant – if not central – activities at such locales" (Conkey 1980:610).

PART OR STRUCTURE	MIWOK NAME
Village place or ground ("plaza")	
The village as a whole (Rancheria)	*Oo-choo'-e-ah*
Bark house	*Oo-moo'-chah*
Ceremonial round-house	*Hang'-e*
Sweathouse	*Chap-poo'*
Menstrual hut	
Scaffold for drying acorns	
Scaffold for drying meal	
Arbor or canopy for shade	
Fireplace	
Place for cooking acorns	
Acorn caches	*Cak:a*
Mortar rocks	
Obsidian workshops	
Place for burning the dead	*Yu'-lah*

Table 3: Parts and Structures of a Miwok Village (Merriam N.d.)

Extending out from the core zone is the biodeterioration zone. Following initial occupation, foraging for foods, fiber, medicines, wood and bark for utensils, weapons, houses, and firewood would extend out from the main village areas (Day 1953:329). When intense occupation pressure takes place, this area becomes over utilized and devoid of resources. "Heavy utilization of vegetation in the immediate vicinity of C [core zone] may cause long-term changes in the environment, making it less suitable for the species being exploited" (Hamilton and Watt 1970:265). See Figure 3 for a hypothetical example of land-use zones for a historic village in Yosemite Valley.

Surrounding the biodeterioration zone is the resource acquisition zone. The zone is where most resources are acquired and would constitute the site catchment area (Vita-Finzi and Higgs 1970a). Based on the assumption that "a human group will in the long run make use of those resources with in its territory that are economic for it to exploit and that are within reach of the available technology" (Vita-Finzi and Higgs 1970a:2).

The travel ways are pathways or trails extending out from the core. The travel ways are an unproductive resource zone results from trampling that crushed vegetation and compacts soils.

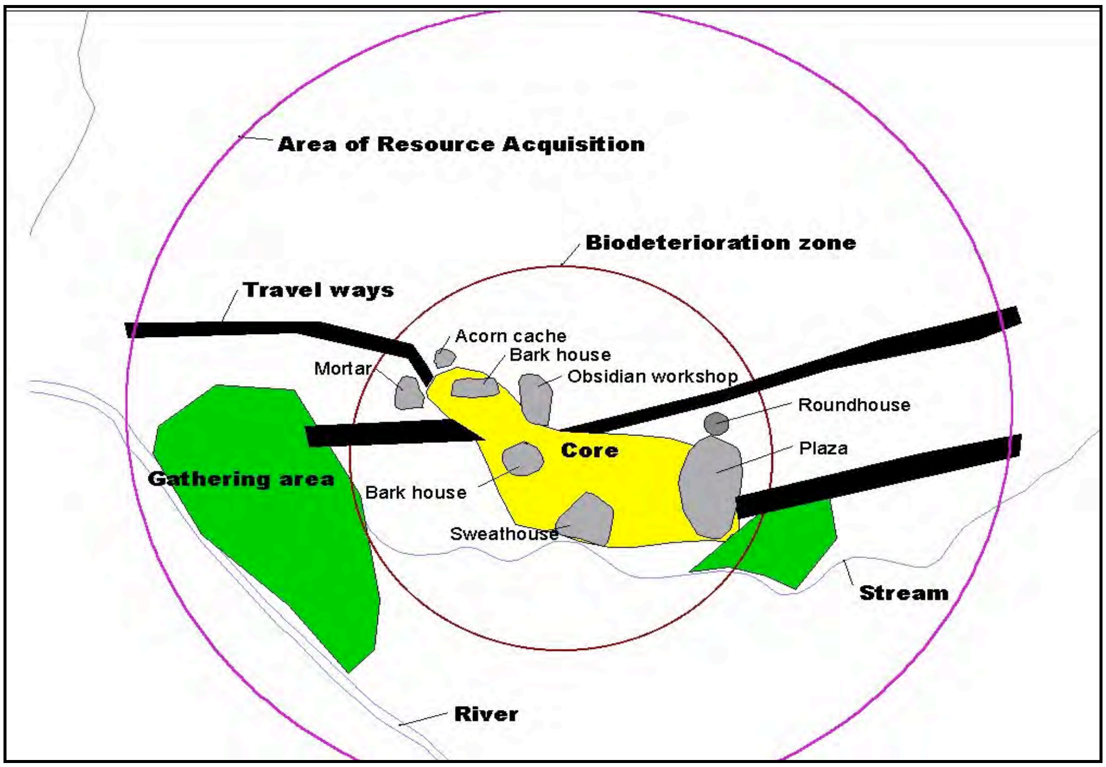

Figure 3: Hypothetical Land-Use Zones of Village Based on Central Place System (Hamilton and Watt 1970)

Re-Examining Villages Locations

When examining how Bennyhoff (1956), Napton et al. and Hull and Kelly (1995) determined the archaeological manifestation of villages documented by Powers (1976 [1877]) and Merriam (1917; c.1915) it can be seen that they understood that the core zone of a village might have encompassed multiple archaeological sites. Bennyhoff (1956) identified an average of 1.28 archaeological sites per village; Napton et al. (1974) identified 2.28 sites per village; while Hull and Kelly (1995) identified 1.47 sites per village. None of the studies described their methods for determining the extent of a village.

Due to discrepancies and variations in locations for villages described in previous archaeological studies, locations of village sites mentioned in ethnographic studies were re-examined as part of this study. The advent of Geographic Information Systems (GIS) also allows for potentially greater accuracy in location and extent determination than methods used in previous studies. GIS allows the maps of different projections, sizes and scales to be re-projected and overlaid at a similar size and scale and analyzed with modern datasets, of topography and waterways, to gain greater insight into geographic information.

The author reevaluated locations Merriam identified as village sites using ArcView 3.2a and Arc/Info 8.02 (ESRI). Copies of Merriam's (c.1915) field map, Bunnell's map (1892) (The Bunnell 1892: map used is from Bunnell's third edition which is slightly revised from the 1880 first edition), and Wheeler's 1878-1879 expedition map were scanned and georeferenced in order to analyze the spatial relationships to known archaeological sites. Merriam's field map provided point locations for 26 villages, and an additional ten villages were described with enough detail in his 1917 publication "Indian Village and Camp Sites in Yosemite Valley" that a point could be assigned to specific locations (Gassaway 2004).

Merriam's field map (c.1915) does not provide the spatial extent of village sites; he only provides an "X" and the village name. Because of this, it is difficult to interpret the potential archaeological manifestations of these villages.

In an attempt to estimate the spatial extent of Merriam's village sites, the written description provided in his 1917 publication were used to delineated buffered areas surrounding the point locations identified on his field map (Gassaway 2004). Merriam (1917:202) described three categories of villages or camps: permanent villages occupied the year round; summer villages, occupied from May to October; and seasonal camps for hunting and fishing. In this report of individual villages he uses ten site type descriptions: largest village, large village, large summer village, village, summer village, small summer village, small village, village or camp, camp, and winter shelter, although he did not provide definitions or spatial implications for categorization into one of these designations. The ambiguity of Merriam's descriptions may relate to the wide variation in human habitation based on social, geographic, and environmental confinements.

In order to delineate Merriam's ten categories of village types, information was sought from the local archaeological record. The largest archaeological site in Yosemite Valley (CA-MRP-56/61/196/298/299/900/301/H) is 246,241 m^2. The next largest site is 47,000 m^2. In Yosemite Valley, 85 percent of archaeological sites are less than 10,000 m^2, the average site size in Yosemite National Park is 7,014 $m^{2,}$ and the average site size for Yosemite Valley is 6,679 m^2. Hull (2002:204-206) examined trends in archaeological site size for Yosemite Valley and noted three clusters: 9000 to 5,000 m^2, 4,500 to 1,500 m^2, and less than 1,250 m^2. Using the archaeological site size categories it was determined what size circle (i.e. buffer radius) would encompass each size category. In order to clearly differentiate between the size categories and encompass a portion of the biodeterioration zone surrounding the core zone the buffer radius was rounded up and expanded to create the buffer used for this analysis (Table 4).

These size classes were used to create circular buffers around point locations. Where geographic barriers such as the Merced River or cliff walls would have impeded village occupation buffers were cropped and additional area added on all unimpeded sides. Buffers were expanded to maintain the originally projected size within +/- 1.5 acres (Figure 4 and Appendix B).

Effects of Land-Use Patterns on Fuel Loads

Different land-use zones will cause different impacts fuels that change the chance of ignition and suitability of carrying fire. As Hamilton and Watt (1970:264) noted "large groups of terrestrial animals dwelling at a central place may modify the environment by developing dwellings and roosts so extensive that they have a significant effect upon the distribution of energy within A [arena where resource acquisition takes place]" Impacts to fuels begin during the initial establishment of a village with clearing the immediate area in order to build structures. The core is generally over-utilized and generally devoid of resources, because "the heaviest exploitation of resources and the most intensive resource-searching efforts would be expected in the immediate vicinity of C [core zone]"

(Hamilton and Watt 1970:264).

Consequences of collecting dead and down fuels and trampling in the core and biodeterioration zones should have affected the spread of fire within these zones. Dead and down fuels were collected for firewood and wood was used for tools, and housing Potentially the longer the occupation or as a population increases there would be an related increase in the deterioration of the core and biodeterioration zones exponential reduction to fuel loads (e.g. ground fuels and dead materials) in the land-use zones and decreasing the potential for fire spread.

MERRIAM'S DESCRIPTION	SITE SIZE (M^2)	BUFFER RADIUS	BUFFER USED FOR THIS ANALYSIS	JUSTIFICATION FOR SITE SIZE (SOURCE)
Largest village	246,241	280m	300m	Largest archaeological site in Yosemite Valley
Large village	47,000	122m	250m	2nd largest archaeological site in Yosemite Valley
Large summer village	~30,000	97m	200m	Size in between large village and village
Village	10,000	56m	110m	85% of archaeological sites are <10,000 sq m.
Summer village	7,000	47m	80m	7,014 m sq average site size in Yosemite National Park
Small village	6,600	46m	75m	6,679 m sq average site in Yosemite Valley
Small summer village	5,000	40m	50m	5000-9000 m sq (0.5 -0.9 hectares) (Hull 2002:205-206)
Village or camp	4,500	38m	40m	1500-4500 m sq (0.15-0.45 hectares) (Hull 2002:205-206)
Camp	1,500	22m	30m	1500-4500 m sq (0.15-0.45 hectares) (Hull 2002:205-206)
Winter shelter	<1,250	20m	20m	<1250 m sq (<0.125 hectares) (Hull 2002:205-206)

Table 4: Spatial Extent of Merriam's Villages based on Archaeological Data (Gassaway 2004)

VILLAGE NAME (*UNDERLINE POWERS*)	SITE IDENTIFIED BY THIS ANALYSIS	MERRIAM (1917)	MERRIAM FIELD MAP	VILLAGE TYPE	POWERS (1976 [1877])	LATTA (C. 1930)	HALL (1929)	TIME OF OCCUPATION
Ah-wah'-mah *Ah-wah-ma*	None identified	X	X	Village		X		
Ah-wah'-ne *(A-wa'ni)*	None identified -56/61/196/… - 45 m north	X	X	Village	X	X		
Ap'-poo-meh	None identified	X		Camp		X		
Aw'-o-koi-e	-310	X	X	Small summer village		X	X	
Cha'-cha'-kal-lah *Cha'-cha-ka-la*	-322	X	X	Large village	X	X		
Ha-eng'-ah	None identified	X	X	Small summer village		X	X	
Hah-ki-ah *(Hakkiah)*	-67; -69; -817	X		Large village		X		Until approx 1897
Ham'-moo-ah	None identified	X	X	Village				
Haw-kaw-koo'-e-tah, *Ho-kok'kwe-lah,* *Haw-kaw'-koi* *(Hok-ok'-wi-dok)* *Haw-kaw-koo'-e-toh*	-78; -79/H; -750H; -1529H	X		Large village	X	X		
He-le'-jah	None identified -62 – 140m east	X	X	Small summer village		X	X	
Hep-hep'-oo'-ma	None identified -64 – 50 m NNE	X	X	Summer village		X	X	
Ho-ko'-nah	None identified -819H – 25m north	X	X	Small village		X		
Hol-low or *Lah'-koo'hah*	-57	X		Winter shelter		X		Possibly used in 1880s and 1890s
Ho-low	-78	X				X		Identified as Old

Table 5: Correspondence of Ethnographically Identified Villages and Archaeological Site

VILLAGE NAME (*UNDERLINE POWERS*)	SITE IDENTIFIED BY THIS ANALYSIS	MERRIAM (1917)	MERRIAM FIELD MAP	VILLAGE TYPE	POWERS (1976 [1877])	LATTA (C. 1930)	HALL (1929)	TIME OF OCCUPATION
								Indian Village on Bunnell map
Hoo-ke'-hahtch'-ke	None identified -46/47/74 – 300 m SE -45/326 – 105 m SW	X		Summer village		X		Identified as Old Indian Village on Bunnell map, Until approx 1897
Hoo'-koo-me'-ko-tah *Hoo-koo'-me*	-325/H	X	X	Village		X		Until approx. 1910
Hop'-to'-ne	None identified	X	X	Village or Camp				
Kis'-se or *Kis'-se-uh*	-76	X	X	Large village		X		
Kom'-pom-pa'-sah or *Pom'-pom-pa'sah*	-67; -307	X	X	Small village		X		
Koom-i-ne or *Kom-i-ne* *(Ku-mai'-ni)*	-59/H; -240/303; -749; P-22-001950	X	X	Largest village	X	X	X	Occupied until 1907
Lem-me'-hitch'-ke	None identified -319 – 40 m SSW	X		Village or Camp		X	X	
Loi-ah	-83/H; -92/H; -323/H; -324/H	X	X	Large village		X	X	Abandoned in fall of 1910
Poot-poo-toon or *Put-put-toon*	-189; -824; -314	X	X	Village		X		
Sap-pah'sam-mah	-71; P-22-0296	X		Village		X	X	
Soo-sem'-moo-lah	-66/H; -306	X	X	Village		X		Identified on Wheeler 1878 map. Until approx 1897

Table 5: Correspondence of Ethnographically Identified Villages and Archaeological Site (continued)

VILLAGE NAME (*UNDERLINE POWERS*)	SITE IDENTIFIED BY THIS ANALYSIS	MERRIAM (1917)	MERRIAM FIELD MAP	VILLAGE TYPE	POWERS (1976 [1877])	LATTA (C. 1930)	HALL (1929)	TIME OF OCCUPATION
Ti-e-te'-mah	-187; -822H; -1446; YOSE 1997V-2; -1447H	X	X	Village		X		
Too-lah'-kah'-mah	None identified -825 - 30 m North -84 - 60 m SW	X		Village or Camp		X		
Too-yu'-yu'-yu	-84; -827/H	X	X	Large village		X		
Um'-ma-taw	-186	X	X	Large village		X		
Wah-ho'-gah (Wah-ha'-ka)	None identified -325/H – 225 m WSW	X	X	Small village	X	X		Until approx 1897, re-inhabited 1932-1969
Wah'-tahk'-itch-ke	-519	X		Village		X		
We'-sum-meh'	None identified	X	X	Village or Camp		X	X	
We'-tum-taw	None identified - 820 – 75 m WNW	X	X	Village		X		
Wis'-kah-lah (Wis-kul'-la)	-52/H; -291/751; -292/293/H	X	X	Large summer village	X	X		
Yo'-watch-ke Mah-cha'-to (Mah-che'-to)	-56/61/196/298/299/300/301; -295; -296; -297	X		Large village	X	X	X	Occupied until 1936
Yu-a-chah	-65	X	X	Summer village		X	X	Identified as Old Indian Village on Bunnell map
Hoo-moo-ah	None identified					X		
No-to-mid'-u-la	None identified				X			
Le-sam'-ai-ti	None identified				X			

Table 5: Correspondence of Ethnographically Identified Villages and Archaeological Sites

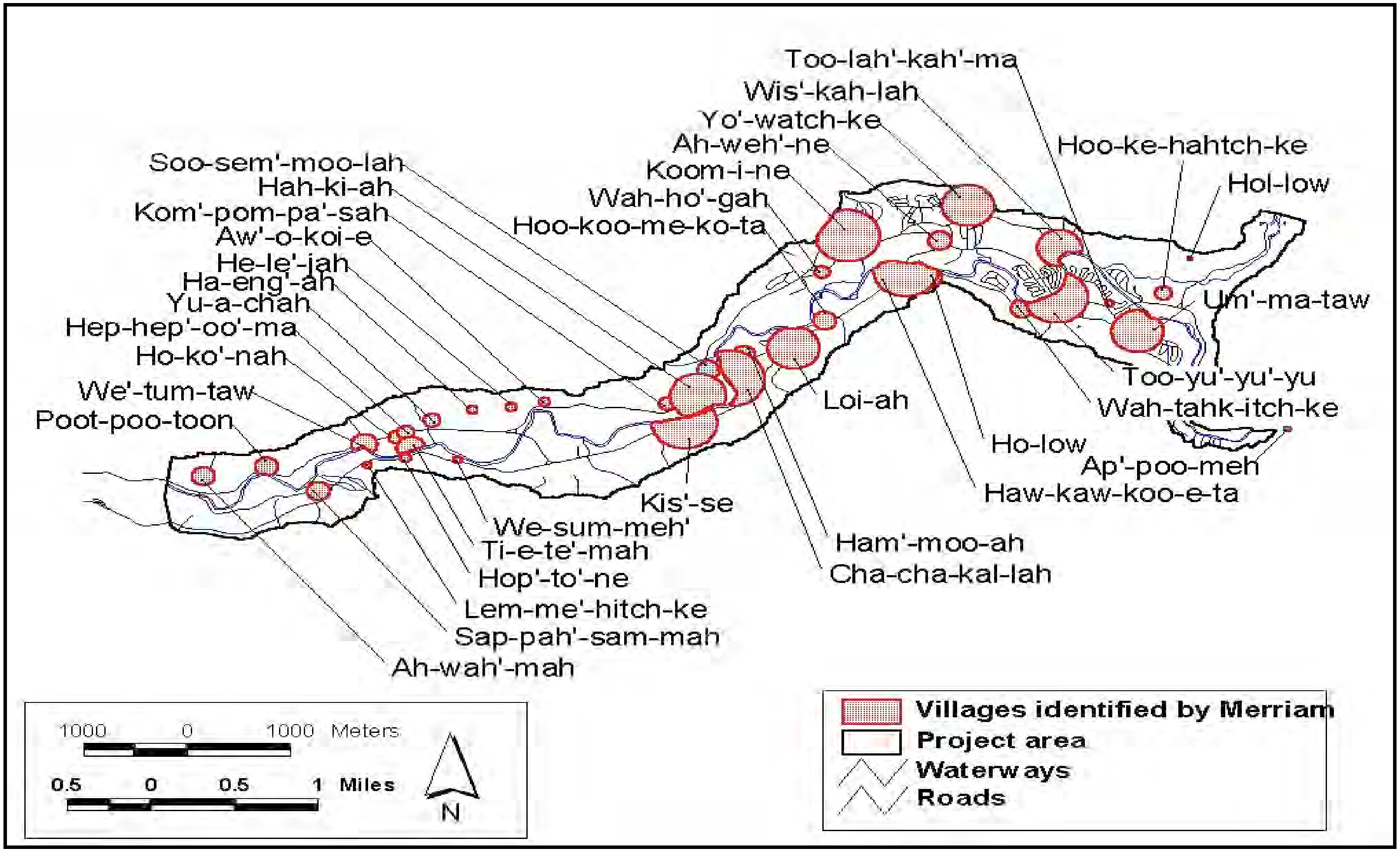

Figure 4: Spatial Extent of Village Identified by Merriam in Yosemite Valley (Gassaway 2004)

The trampling zone and travel ways become biologically unproductive due to effects of trampling and compaction. In areas where no fixed pathways exist and, "utilization of occupied space is uniform…traffic per unit space will decrease with distance from the core. Due to heavy activity in the vicinity of the core, trampling effects are often exaggerated" (Siefkin 1999:3; based on Vita-Finzi and Higgs 1970b) and the "size of this trampled or pathway zone relative to the total space within A [arena] is small compared to the total exploited space" (Hamilton and Watt 1970:265). Compaction of small fuels, such as duff, decreases the ability to supply oxygen to the fuel thus inhibiting ignition and creating a slower burning fire when ignited (Agee 1993:47; National Interagency Fire Center 1994:167). Even the least impacted trampling zones in and around villages, duff

Figure 5: Lack of Fuels in Village Sites. (Callipene and Lena Rube (Brown) at Loiyah, June 11, 1901). Photo by D.H. Wulzen. YM-26,968.

and litter (e.g. grasses, leaves and needles) would be compacted, decreasing the ability to carry fire or reduce the intensity and speed of fire spread to the point that it could be controlled or suppressed. The most heavily impacted areas become denuded, thus inhibiting and confining the spread of fire. Human manipulations in areas of resource acquisition to increase yields and/or increase access to the resource of interest, through repeated burning regardless of the intended result (i.e. crop management, clearing for travel or hunting, etc.), further reduces the intensity and potential for fire burning into village sites.

Not all of these zones are represented in the archaeological record. The core zone can be determined based on archaeological artifacts and features, but much of the biodeterioration; trampling and resource acquisition zones must be inferred through other types of data such as ethnographic analogies and settlement models, photographs, fire histories, and vegetation and succession patterns surrounding archaeological sites.

Chapter 2: Anthropogenic Fire and Fire History

Reasons for Using Fire

> Kroeber concluded that the Indians burned ‘considerably’ in both open country and forest for various reasons, but he expressed the opinion that ‘this burning was not indiscriminate, but tended to be limited to certain tracts in which they were interested’ (Stewart 2002:258)

Ethnographic studies indicate that Native Californians extensively used fire, and the Cultural Element Distribution surveys for the Sierra Nevada list all of the major tribal groups as having used fire (Aginsky 1943; Driver 1937; Gifford 1939; Lewis 1973:79, 104; Voegelin 1942). Reynolds (1959:139) showed that within California at least 35 tribes used fire to increase the yield of desired seeds, by 33 tribes to drive game, and “22 groups used it to stimulate the growth of wild tobacco; while other reasons included making vegetable food available, facilitating the collection of seeds, improving visibility, protection from snakes, and ‘other reasons’” (Lewis 1973:104). Based on data from throughout North America, motives for fire use can be grouped into eleven broad cross-cultural categories: hunting, crop management to increase growth and yields; fire proofing areas, insect collection, pest management, warfare or economic extortion, clearing areas for travel, felling trees, clearing riparian areas, “careless campfires”, and ritual use (Anderson 1988; Barrett 1981; Bonnicksen, et al. 2000; Lewis 1973; Stewart 1956; Williams 1994).

Hunting

Native groups used fire to divert game (such as deer, or rabbit) into openings, impoundments, or narrow chutes, where the animals were easily hunted. Barrett and Gifford reported that the Southern Sierra Miwok would hunt with fire by setting small fires in the hills around a meadow. The hunters concealed themselves and as the deer approached the fires from curiosity, they would shoot them with bow and arrows (Barrett and Gifford 1976 [1933]:179; Russell 1993).

> When the larger game is hunted, a large district is surrounded by every available Indian, and experts with the bow and arrow are stationed at a given point; when, by fire and noise, the affrighted animals are driven towards that spot, where they are killed. These general hunts take place in the fall of the year, when everything being dry is easily ignited, and when a winter supply of meat is needed. It is to this system of procuring game that so many forest trees have been burned in past years. (Hutchings 1886)

Crop Management to Improve Growth and Yields and Food Preparation

Fire was used to clear areas for planting, harvesting crops, and preparing seeds for food. People used fire in harvesting by clearing ground of grass and brush to facilitate the gathering of seeds, such as acorns. The Southern Sierra Miwok would use fire in preparation of sugar pine cones by collecting the cones, "as much as half a ton" after standing the cones upside down, "dry pine needles were then spread over them and ignited, to burn off the pitch, a process called *hiñatci mulu*" (Barrett and Gifford 1976 [1933]:150). Once the pitch was burned, the nuts could be easily harvested from the cones. Fire improved growth of various plants, such as buckeye (*Aesculus californica*), gooseberry (*Ribes* sp.), and deer grass (*Muhlenbergia rigens*) (Anderson 1988). See the

"Use of Fire in Sierra Nevada as Protoagricultural Tool" section for an in-depth discussion of fire used for improving vegetation growth.

Fire was used not only to increase yields of from post-fire plant growth. Lewis (2003) observed that some groups would burn the edge of meadow to kill stands of trees for future harvest as firewood.

Insect Collection

Figure 6: Grasshopper Collection (Hutchings 1854)

Insect collection consisted of using a "fire surround" to collect and roast crickets and grasshoppers. See an example from the Yosemite area.

> A hole is first dug deep enough to prevent their jumping out after which a circle is formed of Indians, both old and young, who with a bush beat the insects towards the hole, into which they fall and are taken prisoners. Sometimes the grass and weeds are set on fire, by which they are disabled, and afterwards picked up (Clark 1904:47-48).

Pest Management

Fires were set to reduce insect populations (black flies and mosquitoes) and rodents, as well as to kill mistletoe that invaded oak trees (Williams 1994).

Incendiarism

Fire was used to deprive the enemy of hiding places or for a "scorched-earth" policy to deprive enemies' access to game or crops. At this time, there is little archaeological evidence that warfare was common in the Sierra Nevada during the Protohistoric periods. A few instances show that incendiarism occurred in the historic period, such as when the Mariposa Battalion burned the villages it encountered in Yosemite Valley in 1851 (Bunnell 1990 [1880]).

Felling Trees

Fire was used to fell "trees by boring two intersecting holes with hot charcoal dropped in one hole, smoke exiting from the other" or by surrounding the base of a tree with fire (Williams 1994:3).

Forest Protection or Fireproof Areas

Anthropogenic fire helped protect the forest from large wildfires. Native peoples and present day prescribed fires use low intensity fires to burn accumulations of brush, grass, and small trees to reduce the threat of large scale fires and reduce the potential of fire spreading into the canopy and creating a crown fire. This technique is often cited as being used as way of protecting settlements by burning out from the edge of villages creating a buffer zone of recently burned areas surrounding the village.

Clearing Areas for Travel

Fires were used to clear trails for travel through areas that were overgrown with grass or brush. Fire helped provide better visibility through forests and brush lands.

Clearing Riparian Areas

Fire cleared brush from riparian areas and marshes for new grasses and tree sprouts. This in turn benefited beaver, muskrats, and waterfowl and increased visibility for hunting. Barrett and Gifford (1976 [1933]:182) documented that the Southern Sierra Miwok burned off tule around beaver ponds to expose the entrances to the beaver house.

"Careless" Campfires

Ernst noted that

> It is doubted very much that the Indians paid any attention to the fires after they had served their purpose of hunting and they must have often run uncontrolled throughout the forests. These uncontrolled fires would therefore serve one of the other purposes for which fire was used, and that was to reduce the amount of debris and brush patches that could harbor enemies. (Ernst 1943b:12)

Numerous studies of historic records state that "journals indicate Indians also cause careless, destructive fires" (Barrett 1981:26). Most of these "careless" fires were from campfires left unattended. Omer Stewart stated in *Fire as the First Great Force of Man* (1956):

> Europeans, as well as Indians from Alaska, California, Kansas, and Virginia, have been reported leaving campfires unextinguished. In a very extensive search of the literature I discovered almost no reference that natives anywhere carefully extinguished fires…. deduction about the beginning of fire as a factor of significance in modifying the surface of the earth. Everywhere that man traveled, he made campfires and left them to ignite any and all the vegetation in the vicinity…. native peoples have rarely been careful to extinguish their campfires when made in the open country and that primitive hunting and gathering peoples from the time they acquired fire have allowed their fires to ignite the landscape, because it did not occur to them to protect the vegetation from fire. (Stewart 1956:118)

A demonstration of unattended campfires comes from the boreal forests of western Canada. "In some cases, where grasses had not sufficiently dried, Indians would set and leave campfires with one or more smoldering logs extending into the grasses; these delayed fuses would later ignite the area, sometimes days after their departure" (Lewis and Ferguson 1988:69-70).

Ritual

In Northwestern California the Hupa, Karuk, and Yurok tribes are documented to have bi-annually burned Offield Mountain, Panamenik and Kepel as an act of prophylactic magic which symbolized the singeing of a widow's hair (Busam 2003:8; Kroeber and Gifford 1949:21,108).

Anthropogenic Fire in the Yosemite Region

Differences in Fire Return Intervals

It is often stated that anthropogenic fire may create different fire return intervals than areas where lightning fires prevails (Barrett 1981; Kilgore and Taylor 1979; Loope and Anderton 1998; Reynolds 1959; Seklecki, et al. 1996). Little has been noted in the literature about the differences in fire return intervals due to differences in the intended result of anthropogenic ignitions, but "unlike natural fires, human fires are ignited in selected areas, at particular times, while being excluded or temporarily withheld from other areas for shorter or longer periods" (Bonnicksen, et al. 2000:12).

The few ethnographic studies of fire use to manipulate crops state fire return intervals were closely spaced at one to four years (Anderson 1988). In areas where fire was used for other purposes (i.e. fireproofing, clearing areas for travel, clearing riparian areas, etc.), the fire return intervals would have been longer and more variable depending on the vegetation types and their respective growth rates.

Lightning Fires in Sierra Nevada

The nature of fires occurring over a given landscape over an extended period of time is described as a fire regime (Brown 1995; Morgan, et al. 2001). Fire regimes are described by frequency, size, magnitude (severity and intensity), spatial patterns, and seasonality and are categorized using time, space, and magnitude descriptors. Fire frequency, expressed as fire return interval, is the number of fire events at a point or within a specific area and time period (Agee 1993; Morgan, et al. 2001).

> The role fires play in an ecosystem is dependent on the interplay of several factors. First there must be an ignition source that has the potential for starting fires. Once lightning strikes [or other ignition source], there must be sufficient fuel available for ignition to occur. Finally, the weather conditions must be conducive to continued combustion and fire spread. Lightning and weather are primarily the result of regional climate but are also influenced by topography. Fuel is a direct result of the vegetation although its rate of decomposition is affected by climate (van Wagtendonk 1993:229).

The climate of the Sierra Nevada consists of a "summer drought, [which] is characterized by mild to warm temperatures, is of such duration and intensity that fire, given a source of ignition, is axiomatic as an important element of the landscape" (Reynolds 1959:1).

The Yosemite region has two pronounced periods of thundershower activity, one in late June and early July, and the second during September. Due to the seasonal differences in fuel moisture, fires produced during these two periods tend to differ.

> In the spring the melting snow pack maintains high fuel moisture, especially in the heavy fuels. Only light fires are possible during this period because only the lighter fractions of all the forest fuels are dry enough to burn. During the late summer and early fall, however, generally the heaviest fuels are dry enough to burn. Therefore, hotter and usually larger scale fires are produced. (Reynolds 1959:4)

Yosemite National Park contains approximately 635,000 vegetated-burnable acres and averages 41.5 lightning fires per year from an average of approximately 1,200 lightning strikes (van Wagtendonk 1993:226). Conservative estimates show that an average of 16,000 acres burned from wildfires per year under pre fire suppression conditions within Yosemite National Park (National Park Service 1990:1). Estimates for maintaining current maximum and minimum fire return intervals, based on vegetation types, indicate that between 14,000 and 162,800 acres burned annually (median of 37,000 acres annually) before fire suppression became routine (Paintner 2002). These estimates were derived from dividing total acres of each vegetation type by the minimum and maximum fire return interval for that vegetation type. Based on historic trends Paintner (2002) speculates that even attaining 37,000 acres burned annually might not be possible without anthropogenic fires supplementing lightning ignited fires. (See Table 6 and chapter 3 of NPS (2002) *Draft Fire Management Plan Environmental Impact Statement National Park Service, Yosemite National Park, California* for return intervals used to obtain these estimates.)

The current vegetation patterns within Yosemite Valley also indicate a closely spaced fire return interval that may not be sustainable without anthropogenic ignition sources. Table 6 outlines the fire return intervals projected to maintain the dominant vegetation types found in Yosemite Valley, as defined in the Draft Yosemite Fire Management Plan Environmental Impact Statement (National Park Service 2002).

VEGETATION TYPE	FIRE RETURN INTERVALS MIN	MEDIAN	MAX	SOURCE
Low elev. Meadow	1	2	5	Anderson (1993a); NPS (2002:3-17)
Mixed Ponderosa Pine	3	9	14	Kilgore and Taylor (1979); NPS (2002:3-13, -14)
Ponderosa Pine	2	4	6	Caprio and Swetnam (1995b); NPS (2002:3-14, -15)
Canyon Live Oak	7	13	39	Skinner and Chang (1996); NPS (2002:3-16)
Black Oak	2	8	18	Skinner and Chang (1996); NPS (2002:3-15, -16)

Table 6: Fire Return Intervals for Dominant Vegetation Types in Yosemite Valley.

Lack of Lightning Fires in Yosemite Valley

While Yosemite Valley is located within the elevational range, of 910 to 1,830 meters (3,000-6,000 feet), with a high density of lightning strike fires, modern fire history data indicates that the valley floor does not receive the same amount of lightning caused fires as other areas of similar elevation. Between 1930 and 2002, 2,877 lightning fires have burned 172,379 acres within Yosemite National Park, but there are no recorded lightning caused fires in Yosemite Valley during this period (National Park Service 2002).

While no formal studies have reported the lack of lightning ignited fires within Yosemite Valley, its absence is probably due to the topography of the Valley and its surrounding cliffs. Lightning strikes are a function of slope; it gravitates towards high points with ridge tops and midslope prominences being the most likely struck, features that are decidedly lacking on a valley floor (Komarek 1967). In a study from the Yosemite region, Reynolds (1959:63) found that of 319 lightning fires, 83% occurred in either the top or middle portion of a slope. The high granite walls that surround Yosemite Valley probably receive the vast majority of lightning strikes in the valley area, resulting in more fire occurring on the valley rim, above the valley floor and outside the project area.

Another “natural” ignition source for Yosemite Valley could be fire embers, firebrands, and rolling burning materials from the valley rim and fire burning up or down canyon from outside the project area. The amount to which these sources influenced the fire regime within Yosemite Valley cannot be determined from the historic fire record due to the policy of fire suppression around Yosemite Valley. To date no lightning fires have escaped suppression actions to ignite a fire within the project area of this study (National Park Service 2002). The changes in fuel loads since 1900 inhibit our ability to speculate as to what extent external fires could have burned into the valley. The potential for light undergrowth burns started from firebrands and burning rolling materials to have a large spatial impact may have been reduced if Native Americans actively suppressed these fires and/or fuels were reduced on the valley floor due to anthropogenic vegetation manipulations.

Ecological Effects of Anthropogenic Fire

> Plant cover is obviously almost always likely to stand in relation to culture. It largely expresses climate; it tends heavily to determine the fauna; and it enters directly into subsistence, besides at times affecting travel and transport. It is rather surprising in fact, that culture is not therefore a function of natural vegetation to a greater degree than actually obtains. That it is not suggests the preponderant strength of purely cultural forces (Kroeber 1947:206).

Native Americans manipulated at least some areas by shaping the distribution, structure, composition, and extent of certain plant and animal communities in order to meet their requirements for firewood, fish and game, vegetal foods, craft supplies, and building materials (Anderson 1988; Anderson and Moratto 1996; Bibby 1994; Blackburn and Anderson 1993; Lewis 1973; MacCleery N.d.; Wickstrom 1987; Williams 1998). While the native Californians did not modify their environment in the visible way of mound builders in the southeast or agricultural cultures of the southwest and northeast, they did manipulate the environment through the use of protoagricultural techniques such as burning, pruning, sowing, weeding, tilling, and selective harvesting. While many techniques would have limited spatial effect that is linked to population density, fire could have a widespread effect regardless of population. Omer Stewart (1956) stated the following about the large-scale affect of anthropogenic fire.

> The unrestricted burning of vegetation appears to be a universal culture trait among historic primitive peoples and therefore was probably employed by our remote ancestors. Archeology indicates that extensive areas of the Old and New World were being burned over ten thousand years ago. It is logical to assume that some of the reasons which motivated historic and Neolithic men would also have motivated our remote ancestors to set vegetation on fire. One may conclude that man has used fire to

> influence his geographic environment during his entire career as a human. Furthermore, it is impossible to understand clearly the distribution and history of vegetation of the earth's land surfaces without careful consideration of fire as a universal factor influencing the plant geography of the world (Stewart 1956:129).

Mounting evidence shows that humans have been in North America longer than 12,000 years. This places humans into the ecosystem during the last major climate changes and in many ways: "North America's forests and people developed together. They formed an inseparable whole. Neither the forests nor indigenous people could exist as they were found if they developed independently" (Bonnicksen, et al. 2000:4). Archaeological evidence shows that humans controlled and used fire for at least 60,000 years (Aschmann 1959; Bonnicksen, et al. 2000; Russell 1997; Sauer 1952; Stewart 1951, 1956). As Emily Russell stated

> No forests [shrublands or grasslands] are unaffected; humans have been a part of the ecosystem over the past ten centuries of major climatic change, so that all forests have developed under some kind of human influence, although its intensity has varied greatly over time and space. The influence must be accounted for as an important part of any study of forest structure and dynamics (Russell 1997:129).

In Lewis' classic study *Patterns of Indian Burning in California: Ecology and Ethnohistory*, he stated "throughout the mixed conifer forest there is visible evidence of the fact that fire has been a significant force in natural selection" (Lewis 1973:75). The ethnographic and fire history evidence of fire in the Sierra Nevada and specifically in the Yosemite Region shows that anthropogenic fire has shaped vegetation distributions in at least some localized areas (Anderson 1992, 1993a, 1999; Kilgore and Taylor 1979; Lewis 1973; Reynolds 1959). Pollen, ecological and vegetation studies have shown that all fires have an effect on vegetation and long-term use of fire has ecological repercussions. The pollen record from Woski Pond, Yosemite Valley shows that "the effect of climatic cooling with increased effective precipitation should have an effect directly opposite the observed change, favoring an increase in conifers, especially fir" (Anderson and Carpenter 1991:8). "Major change in pollen assemblages begins ca. 700 yr BP, with a decline in conifers and an increase in oak. Peaks in both charcoal, pollen and sediment influx occur contemporaneously, indicating a period of erosion. These factors taken together suggest a major vegetation disturbance at that time" (Anderson and Carpenter 1991:7). Anderson and Carpenter further speculate that the change in forest types is the result of the Miwok migration into Yosemite Valley.

> If the rapid shift in vegetation composition was instigated by fire, as suggested by the large charcoal peak, it cannot be determined whether this was accomplished by aboriginal populations or lightning ignition. However, the correlation between the increase in charcoal, the change in dominant pollen from pine to oak, and the transition in cultural systems from the Tamarack to the Mariposa complex (Moratto 1984) all occur at ca. 650-750 yr BP. The Mariposa cultural sequence included an increase in population and development of specialized economic and resource-procurement systems, including the development of and reliance on various horticultural techniques (M. K. Anderson per. comm. 1990). Manipulation of the natural environment by clearance of conifers within the valley would have favored expansion of oaks, the acorns of which were a major food resource for these people. (Anderson and Carpenter 1991:9)

The Little Ice Age, approximately A.D. 1350 to 1850, brought a mesic climate to North America and glaciers in the Sierra Nevada reaching their maximum extent in A.D. 1850 (Mayewski and Bender 1995; Reynolds 1959:9). Since c.1850, climate change in the region appears to be xerophytic and possibly xerothermic (warmer-drier). Forest types in a xeric climate tend to favor oak over pine and pine over the fir and if the climate trend is mesic, fir will be favored over pine and pine over oak (Reynolds 1959:9). "For pine and pine-fir forest types as a whole…repeated burning is necessary to hold succession in sugar pine to the pre-Anglo-American level of xerophytism" (Reynolds 1959:109).

Native American fire use not only holds succession and mimics xerothermic climatic conditions but it creates the following trends in forest structure (based on Anderson and Moratto 1996):

- Woodlands and forests often exhibited widely spaced trees, providing better light to the forest floor and leading to increased species diversity.
- Gaps or grassy openings were created, maintained, or enlarged within diverse plant communities, resulting in many "patches" of plants in varying successional states
- Native Americans managed fires to prevent fuel loading that would carry a large, devastating wildfire.
- Especially in areas sustaining desirable shrubs, fire regimes were frequent enough to maintain these shrubs in a "young" growth stage.
- Mixed conifer and oak woodland forests were often managed for maximum structural complexity, encouraging a variety of understory plant species.

Carl O. Sauer stated that the following ecological changes would occur with human habitation:

> (1) Thinning of litter and leaf mold occurred, accompanied by somewhat increased runoff and decreased penetration of rainfall, and hence by some reduction in leaching, and possibly increase in pH value. A certain degree of shift from acidic to neutral soils is inferred. (2) An advantage was furnished to aggressive, weedy plants, characterized by free seeding, broad tolerance in germination and robust early growth. (3) A shift took place form long-generation to short generation species, in particular increase in numbers of annuals, biennials, and plurennials…. (4) the frequency of disturbance of tuber-bearing plants is likely to encourage their reproduction …(5) Whenever protection was afforded to plants (trees) of one species, man was intervening to establish the dominance of that species in a given spot (formation of groves) (6) The refuse heaps furnished a specialized habitat for plants grossly feeding on nitrogenous matter and the nutrient salts dissolved from ash, bone, and shell.
>
> Thus, also, the processes of evolution were aided by man. Disturbances that he set up and kept up shifted survival chances in favor of an occasional variant plant. With more variants able to reproduce themselves, further diversity resulted in their offspring. (1) Gene mutations, affecting life cycle (for example, annual habit) or germination, which previously did not establish themselves under natural competition, might acquire reproductive advantage. (2) Polyploidy, especially if resulting in increase of size of seed or plant, quicker or more robust growth, might favor survival. (3) Introgressive hybridization was aided by accidental scattering of seed brought in from other localities. Unconscious human selection of plants was operative if any protection was given to any stand or clump because of the palatability of its fruits, seeds, or roots. (Sauer 1947:24-25)

The broad result of Indian-based management was continuous introduction of small disturbance regimes in various plant community types, creating openings or clearings. These clearings represented early forest successional stages, which allowed greater diversity of plant species and more productivity in terms of culturally desirable resources and oaks favored over pine (Anderson and Moratto 1996; Anderson and Nabhan 1991; Reynolds 1959). These patches also attract game (Bird, et al. 2003:3).

The widely spaced forest with grassy openings and a large variety of understory plants species is the vegetation pattern seen in Yosemite Valley at Euro-American contact in 1852 and in historic photographs from the late 19th century. While it has been suggested that meadow encroachment is the result of a lowering of the water table, Ernst (1943a; 1943b; 1949; 1961), Reynolds (1959), Gibbens and Heady (1964), and Heady and Zinke (1979) all suggest fire played a part because meadow encroachment began prior to the dropping of the water table if not prior to Euro-American contact.

Use of Fire in Sierra Nevada as Protoagricultural Tool

It has been suggested that anthropogenic fire "was not an 'energy extraction process' in the sense of exploiting something that already existed, but truly a food production technique more efficient than agriculture in this [California's] ecological setting" (Timbrook, et al. 1980:148). Fire was one tool used as part of intensive individual plant, or patch, level management practices that were required to produce the highest quantity of materials required for subsistence, basketry, cordage, and building materials. In addition to the use of fire, intensive individual plant level practices of pruning, sowing, weeding, tilling and selective harvesting, irrigating (Lawton, et al. 1993), pruning (Barrett and Gifford 1976 [1933]; Murphy 1959), sowing (Cornett 1978:17; Driver and Massey 1957), tilling (Anderson and Rowney 1998; Peri and Paterson 1976), weeding (Anderson 1993c) were required to produce the highest quantity of plant materials required for basketry, cordage, and building materials (Anderson 1990, 1993a; Anderson and Moratto 1996). All these techniques sought to "manipulate the plant architecture and keep the plants insects and pathogen-free", while enhancing the desired characteristics of flexibility, straightness, no lateral branching, color (i.e. no bark blemishes), clarity, diameter, and length (Anderson 1988:xvi, 1999:83).

The use of protoagricultural techniques greatly reduces the number of plants or patches needed to produce specific amounts of materials. This in turn decreases the energy and time expended in gathering. As seen in Table 7, the difference in productivity between managed, regardless of technique used, and unmanaged shrubs can be substantial, between a 1500% and 6500% increase in yield per patch.

Traditionally Gathered Plants within Yosemite Valley

Ethnographic studies of the Southern Sierra Miwok have shown the use of fire for crop management for at least 250 different plants (Anderson 1988, 1993a; Barrett and Gifford 1976 [1933]; Bibby 1994). Ethnographic work conducted within Yosemite Valley identified 23 plants obtained from 35 traditional gathering locations (Bibby 1994). Although, specific information regarding fire return intervals and seasonality of burning for different plant species is scant, some information derived from ethnographic studies regarding harvesting and desired characteristics for the 23 plants noted in Yosemite Valley is consolidated in Table 8.

BASKET TYPE	PLANT SPECIES USED	SHOOTS PER BASKET	SHOOTS PER SHRUB- PATCH UNMANAGED	SHOOTS PER SHRUB-PATCH MANAGED	% YIELD INCREASE
Burden	Rhus trilobata	1,200 (1.2 m each)	3	100	3333%
	Cercis occidentalis	25 (1.8 m each)	0.5	25	5000%
	Ceanothus cuneatus	2	0.2	1	500%
Coiled Cooking	Cercis occidentalis	25 (1.8 m each)	0.5	25	5000%
Full-sized cradleboard	Rhus trilobata	675	6.62	112.5	1700%
	Cercis occidentalis	75 (1.8 m each)	0.5	12.5	2500%
	Ceanothus cuneatus	13	0.2	13	6500%
Twined seed beater	Ceanothus cuneatus	2 (for rim)	0.2	1	500%
	Ceanothus cuneatus	188 (for warp and weft)	0.5	12.53	2507%
Seed gathering	Ceanothus cuneatus	2 (for rim)	0.2	1	500%
	Ceanothus cuneatus	376 (for warp and weft)	0.5	12.13	2426%
	Cercis occidentalis	50	0.5	12.5	2500%
Twined sifter	Rhus trilobata	1,000 (1.1 m each)	3	100	3330%
	Cercis occidentalis	25 (1.8 m each)	0.5	12.5	2500%

Table 7: Comparison of Numbers of Useful Shoots from Unmanaged Versus Managed Shrubs Used for Western Mono Basketry (adapted from Anderson 1993a; Anderson 1999:101; Anderson and Moratto 1996; Bibby 1994:14-55).

COMMON NAME	SCIENTIFIC NAME	S. SIERRA MIWOK NAME	USE	BURNING SEASON	GROWTH BEFORE HARVESTING	DESIRED CHARACTERISTICS
Big leaf maple	*Acer macrophyllum*	*Haayi'*	Split shoots used for baskets Larger branches were split and used to make staves for a gambling game		1 year basket elements (weft) 2-4 years looped stirring stick	Long un-branched shoots for basket materials Long un-branched trunks for ceremonial flag materials
Black oaks	*Quercus Kelloggii*	*Teleeli*	Acorns were a staple food source	Late fall, early spring	1 year for basket materials (weft, warp and rim stick) 2-4 years for digging stick	Straight shoots about six feet in length for hooped spoons
Bracken fern	*Pteridium aquilinim*	*Luhnna*	Fiddleheads were used as a food source Filaments in the root are used in basket making	Late fall, early spring to clear off litter accumulations.		Long rhizomes for basket material
Creek dogwood	*Cornus californica*		Whole shoots - red color in baskets Unpeeled shoots - foundation material in seed beater or burden basket Pigeon decoy cage		1 year for basket materials (warp) and pigeon decoy cage	Long un-branched shoots
Deer grass	*Muhlenbergia rigens*	*Huulum*	Flower stalks, and stems foundation material for baskets	Late fall, early spring		Long flower stalks
Deerbrush	*Ceanothus integerrimus*	*Tinpa*	Young shoots - foundation rods in baskets Peeled, and split - sewing strands in some baskets	Late fall/early spring	1 year for warping 2-3 years for rim stick	Long un-branched shoots
Elderberry	*Sambucus mexicana*	*Angtay*	Berries are used for food; shoots are split to make clapper sticks and staves for a gambling game or used whole for flutes and fire drills.	Late fall, early spring	1-2 years for flute; 2-4 years for clapper stick	Long inter-nodal stems for flutes and clapper sticks, long straight pieces for stave pieces.

Table 8: Traditional Plant Use in Yosemite Valley (Bibby 1994; Driver 1936; Latta 1977; Turner 1995)

COMMON NAME	SCIENTIFIC NAME	S. SIERRA MIWOK NAME	USE	BURNING SEASON	GROWTH BEFORE HARVESTING	DESIRED CHARACTERISTICS
Indian hemp	*Apocynum cannabinum*		Fiber from stalks -cordage	Late fall, early spring		Long un-branched, larger diameter stems
Milkweed	*Asclepias sp.*	*Huken*	Fiber from stalks - cordage	Early spring		Long straight larger diameter stems
Mint	*Mentha arvensis, sp.*		Tea	Late fall, early spring		
Mushroom, tree /fungi	*Trametes hispida*		Food	Late fall		
Mushrooms, White	*Lentinus lepideus*	*Helli*	Food	Late fall		
Sedge	*Carex vesicaria*	*Paywa*	Split roots - basketry Leaves - worm carriers for fishing	Late fall		Long un-branched rhizomes
Snakeroot	*Goodyera oblongifolia*	*Kawibe*	Snake bite antidote	Late fall, early spring		
Soaproot	*Chloragalum sp.*	*Palaawi*	Glue, soap, fish poison Coating for baskets Roots - baked and eaten Fibers - brushes and stuff footballs	Late fall early spring before leaf set.		Large bulbs
Sour dot [sic "dock"]	*Rumex acetosella*	*Uy'uyumma*	Greens Medicine	Late fall, early spring		
Spicebush	*Calycanthus occidentalis*		Food, cold remedy, basketry, piths used for arrows	Late fall, early spring	2-3 years arrow	Long un-branched stems for arrows

Table 8: Traditional Plant Use in Yosemite Valley (Bibby 1994; Driver 1936; Latta 1977; Turner 1995) (continued)

COMMON NAME	SCIENTIFIC NAME	S. SIERRA MIWOK NAME	USE	BURNING SEASON	GROWTH BEFORE HARVESTING	DESIRED CHARACTERISTICS
Strawberries	*Fragaria californica, F. Vesca (current), F. virginiana*	*Chiini*	Food			Quantity
Yerba Santa	*Eridictyon californicum*	*Passaluh*	Medicinal	Late fall, early spring		

Table 8: Traditional Plant Use in Yosemite Valley (Bibby 1994; Driver 1936; Latta 1977; Turner 1995)

Historic Observations and Supporting Statements of Native Burning in Yosemite Valley and Sierra Nevada

Historic records must be subjected to standard historical criticism which considers the objectivity of the witness, his knowledge of the subject matter, and the chronological and geographical consistency of his description (Russell 1983:79). The following historic references have been separated into direct observations and supporting statements. Gruell (1983:69) observed that within the interior west few historical eyewitness reports describe lightning ignitions and that observer biases may have blamed Indians for some fires. Historic records of California and the Sierra Nevada and the discussions of historic fire management policy (see Agee 1993: and; Carle 2002) indicate that many did distinguish between lightning and human ignitions sources. This is exemplified by an article in The Atlantic Monthly (1897:146), "even the fires of the Indians and the fierce shattering lightning seemed to work together only for good in clearing spots here and there for smooth garden prairies, and openings for sunflowers seeking the light".

While indirect observations of anthropogenic ignition are still subject to speculation as to why specific fire starts were attributed to humans and not lightning, some examples are provided here to illustrate how Euro-American observers viewed the interaction of native peoples with the landscape. Many of the written descriptions on Miwok landscape burning come from the reports of *Commissioners to Manage the Yosemite Valley and the Mariposa Big Tree Grove*, 1866-1888, due to the style of the reports it is difficult to determine if the authors were making first hand observations of Native burning or were repeating a standard belief. Nonetheless, they are presented here to show the commonly held belief that the Southern Sierra Miwok did burn and manipulate the vegetation patterns in Yosemite Valley.

Areas Surrounding Yosemite Valley

The majority of statements regarding Native's use of fire in areas surrounding Yosemite Valley come from observations of fire scars in the Giant Sequoia groves. No direct observations of Native ignitions for areas surrounding Yosemite Valley were found.

An early tourist to Yosemite Valley, James Henry Lawrence describe the following conversation with Huston Mann that occurred during their trip in 1855: "Don't you remember we saw just before sunset some little columns of faint blue smoke rising up in the hills east of us? We agreed that those were Indian fires. About this time of year straggling bands of Monos come over here to gather pine nuts and seeds." (Lawrence 1884)

Reverend Todd stated in 1870 "many now standing have been sadly injured by the fires which the Indians, in former years, built against them. It makes one feel almost indignant at a stupidity which could see nothing in these trees but a good back log for their fires. Nothing in the future is so much to be dreaded, in regard to them, as forest fires" (Todd 1870:87).

In 1875 while visiting the Mariposa Grove Mary Cone noted, "the fire has scathed them [Sequoia trees] and more or less injured their appearance. This was done before the groves were known to white men. The Indians were accustomed to kindle fires in order to burn the underbrush, and so facilitate their hunting operations" (Cone 1876:202).

John Muir (1894) in *The Mountains of California* discusses how Native American and Euro-American uses of fire differed,

> These mill ravages, however, are small as compared with the comprehensive destruction caused by "sheepmen." Incredible numbers of sheep are driven to the mountain pastures every summer, and their course is ever marked by desolation. Every wild garden is trodden down, the shrubs are stripped of leaves as if devoured by locusts, and the woods are burned. Running fires are set everywhere, with a view to clearing the ground of prostrate trunks, to facilitate the movements of the flocks and improve the pastures. The entire forest belt is thus swept and devastated from one extremity of the range to the other, and, with the exception of the resinous *Pinus contorta*, Sequoia suffers most of all. *Indians burn off the underbrush in certain localities to facilitate deer-hunting*, mountaineers and lumbermen carelessly allow their campfires to run; but the fires of the sheepmen, or *muttoneers*, form more than ninety per cent. of all destructive fires that range the Sierra forests. (Muir 1894:199 emphasis added)

Captain G.H. Gale in his report to the Secretary of the Interior in 1894 stated that "it was a well known fact that the Indians burned the forests annually" (Ernst 1943b:10-11).

In his 1898 report to the Secretary of the Interior, Special Inspector and Acting Superintendent, J.W. Zevely reported, "prior to the inauguration of the present policy, fires occurred almost every year in all parts of the forest – in fact, they were frequently set by the Indians, but there was so little accumulation on the ground that they were in a great measure harmless, and did not in any sense retard the growth of the forest" (Ernst 1943b:10-11).

Yosemite Valley

Three first hand observations of anthropogenic fire in Yosemite Valley were found in the historic literature. The first occurred on March 21, 1851 when the Mariposa Battalion entered Yosemite Valley, "soon after we crossed the ford, smoke was seen to issue from a cluster of Manzanita shrubs that commanded a view of the trail. On examination, the smoke brands indicated that it had been a picket fire, and we now felt assured that our presence was known and our movements watched by the vigilant Indians we were hoping to find" (Bunnell 1990 [1880]:73). Hutchings relates the same incident: "smoke from a slumbering picket fire near El Capitan* [* all local objects of interest were without known names at this time.] unmistakably revealed the presence of Indians, and that they knew of the advent of the whites, and were evidently watching their movements" (Hutchings 1886).

H. Willis Baxley, in the fall of 1861, observed:

> A fire-glow in the distance, and then the wavy line of burning grass, gave notice that the Indians were in the Valley clearing the ground, the more readily to obtain their winter supply of acorns and wild sweet potatoe root (huckhau). This unwelcome discovery was soon after confirmed by the barking of dogs, that came echoing from the walk of this grand corridor in startling reverberations. (Baxley 1865:476)

Frederick Law Olmsted stated in his *Yosemite and the Mariposa Grove: A Preliminary Report, 1865*:

> Indians and others have set fire to the forests and herbage and numbers of trees have been killed by these fires; the giant tree before referred to as probably the noblest tree now standing on the earth has been burned completely through the bark near the ground for a distance of more shall one hundred feet of its circumference; not only have trees been cut, hacked,

> barked and fired in prominent positions, but rocks in the midst of the most picture picturesque natural scenery have been broken, painted and discolored, by fires built against them. (Olmsted 1993)

In 1887, Joaquin Miller noted:

> In the Spring after the leaves and grasses had served their time and the season in holding back the floods and warming and nourishing the earth, then would the old squaws begin to look above for the little dry spots of headland or sunny valley. And as fast as dry spots appeared, they would be burned.
>
> In this way the fire was always under control. In this way the fire was always the servant, never the master. And by the time the floods came again there was another coat of grass and leaves, stronger and better than the one before, because of the careful and temperate fire of the careful and wise old woman. By this means the Indians always kept their forests open, pure and fruitful, and conflagrations were unknown. (Miller 1887:25)

All other reports of anthropogenic fire for Yosemite Valley are within the context of reports on vegetation encroachment and increased undergrowth.

William H. Hall submitted a report to the Commissioners, May 20, 1882, which stated:

> The area of meadow is decreasing, while young thickets of forest or shrub growth are springing up instead. Members of your Board have observed this change; it is very marked, and it may be regarded as in a degree alarming, sufficiently so, at least, to prompt measures calculated to check it.
>
> The cause is alleged to be the abolition of the old practice of burning off the thickets, which practice formerly made new clearings almost every year for grass growth. (Ernst 1943b:14).

M.C. Briggs, Secretary of the Commission stated in the December 18, 1882 Report of the Commission to the Governor, “While the Indians held possession, the annual fires kept the whole floor of the valley free from underbrush, leaving only the majestic oaks and pines to adorn the most beautiful of parks. In this one respect protection has worked destruction" (Ernst 1943b:14).

In 1883, Gordon-Cumming wrote that,

> Indeed, there is a corner of danger, lest in the praiseworthy determination to preserve the valley from all ruthless 'improvers' and leave it wholly to nature, it may become an unmanageable wilderness. So long as the Indians had it to themselves, their frequent fires kept down the under-wood, which is now growing up everywhere in such dense thickets, that soon all the finest views will be altogether hidden, and a regiment of wood-cutters will be required to clear them...Of course, as each year's growth increases the density of the thickets and the height of the trees, this evil will become more serious. (Gordon Cumming 1883:415)

C. F. Cummings in 1884 noted "that so long as the Indians had it to themselves, their frequent fires kept down the underwood" (Ernst 1943b:10).

Dr L.H. Bunnell wrote in the Commissioner's Report to the Governor for the years 1889-1890, "There was a great variety of evergreen and deciduous trees, planted by Nature's landscape gardeners and, as the undergrowth was kept down by annual fires while the ground was yet moist, to facilitate the search for game, the valley at the time of discovery presented the appearance of a well kept park" (Ernst 1943b:12)

The 1891-1892 Commissioner's Report to the Governor stated, "As this Commission has already demonstrated, the valley originally was a forest park, dotted with open meadows. It's Indian owners kept the floor clear of underbrush. It is know that besides the careful use of fire for this purpose they annually pulled up unnecessary shrubs and trees as soon as they sprouted" (Ernst 1943b:15).

Galen Clark in a letter to the Board of Commissioners of the Yosemite Valley and

Mariposa Big Trees Grove, August 30, 1894 said,

> The Valley had then been exclusively under the care and management of the Indians, probably for many centuries. Their policy of management for their own protection and self-interests, as told by some of the survivors who were boys when the Valley was first visited by whites in 1851, was to annually start fires in the dry season of the year and let them spread over the whole Valley to kill young trees just sprouted and keep the forest groves open and clear of all underbrush, so as to have no obscure thickets for a hiding place, or an ambush for any invading hostile foes, and to have clear grounds for hunting and gathering acorns. When the forest did not thoroughly burn over the moist meadows, all the young willows and cottonwoods were pulled up by hand (Ernst 1943b:11).

H.J. Ostrander in 1897 stated: "No under-brush, cottonwood not second growth pines and fire to obstruct the view of the marvelous walls of the valley. It may be asked why was this. Because the Indians burned the floor of the valley over each year, so that they could better hunt the game. The practice was also followed through the whole range of the Sierras for the same purpose" (Ernst 1943b:10-11).

Native American Fire Suppression

Native groups' environmental knowledge and experience with landscape burning enabled them to use the same factors as present day fire managers to determine the appropriate risk factors for ignition. These include seasonality, time of day, relative humidity of certain fuel types, knowledge of winds, slope, aspect, size of burn, and frequency of burning (Turner 1991:68).

An example of Native Americans controlling fire comes from the work of Henry T. Lewis with tribes in the Canadian boreal forests. He stated the following ways that indigenous peoples were able to control fire:

> A combination of natural and man-made firebreaks was regularly employed. Streams, lakes, and bogs provided natural barriers, as did the higher humidity levels of brush and trees. Artificial firebreaks included adjacent burned areas, whose relatively drier fuels had been fired several days earlier. Also stands of brush and trees within a previously burned meadow could be intensively fired. … Finally, people could help contain fires. Watersoaked spruce boughs were used by women and children to beat out flames at the edges of meadows and around settlements (Lewis 1980:78).

Regarding suppression of fire by indigenous peoples within California, Gayton (1948:176) recorded the following comment from the Foothill Yokuts and Western Mono of the southern Sierras:

> J.R. claims that when he was a boy the Indians throughout this region set fire to the brush after the seeds had been gathered (about July). The men started the fire and the women watched to see that it did not approach the houses. When it did, it was beaten out. 'It burned the hills, all over, clean through to the next one.' The trees, which were green, did not ignite easily: however, 'dead trees and logs were all cleaned up that way.' The tree covering of this country, J.R. says, was about the same quantity. (Lewis 1973:84)

Fuel loads and climate are the primary limiting factors of fire. The interaction of climate and fuel loads determines the potential for ignition and spread. Burn severity, seasonality, and number of previous fires influence of fuel loads. Thus the very act of repeated burns can control and reduce the spread and severity of fires (Lewis 1973:110-111).

Chapter 3: Methods

This study used a multistage adaptive sample strategy with each stage determining the extent of sampling needed in the subsequent stage. Due to the dependence on two very different data sets, archaeological and fire history, a large amount of field time, background research, and geographic analysis was needed to determine the appropriate sampling locations. Initial investigations focused on determining the extent of human occupation during the 1800-1900; the methods and findings of this investigation were presented in Chapter 2.

Fire History Methods

Fire Scar Survey

Since this was the first fire history work in Yosemite Valley, the National Park Service expressed concerns over cutting live trees and potential for creating hazard trees, a survey was conducted to determined the most appropriate locations for fire history sampling in relationship to gathering areas and potential villages. Approximately 45% of Yosemite Valley was surveyed for trees exhibiting well-preserved fire scars. Survey focused on areas in and around village sites identified in Table 5 and traditional gathering areas identified in Bibby (1994). All fire scars on cedar and pine trees, stumps, and logs were recorded; scars on oaks and other species were selectively recorded based on the number of scarred trees in the area and the ability to determine if the scar was produced by fire. A description of species, diameter at breast height, maximum height of catface, and number of externally visible scars was recorded for each fire scarred tree. In select areas, the project used flagging and aluminum tags in order to eliminate potential multiple counts of the same tree and for ease in relocation during collection of samples. When possible locations were recorded by a Global Positioning Unit, if satellites were unavailable due to military operations (Gulf War II), geological barriers (granite valley walls) or thick canopy, locations were plotted on a 7.5 USGS topographic map, or distance from last satellite position acquired. Locations were then transferred into ArcView 3.2 (ESRI) using the DNRgarmin extension (Department of Natural Resources), Pathfinder office, longitude and latitude placed in a excel table and converted into a shapefile, or transferred to GIS by heads up plotting.

Point locations for fire-scarred trees were converted into a density grid using ArcView 3.2 Spatial Analyst 2.0a (ESRI), see Figure 7 for point data used to create density grid. The density grid was created using a 10-meter cell size (based on the Yosemite 10m Digital Elevational Model), with a kernel 110-meter search area, and one-hectare output. This created a density of fire scarred trees per hectare. Oaks, aspen, willow, and "unknown" species types were excluded from this analysis since they were not sampled. The grid was overlaid with ethnographic village sites, gathering areas, and fire history data (1970-2002). Modern fire data were used to eliminate areas where fire scars were potentially destroyed by prescribed fires.

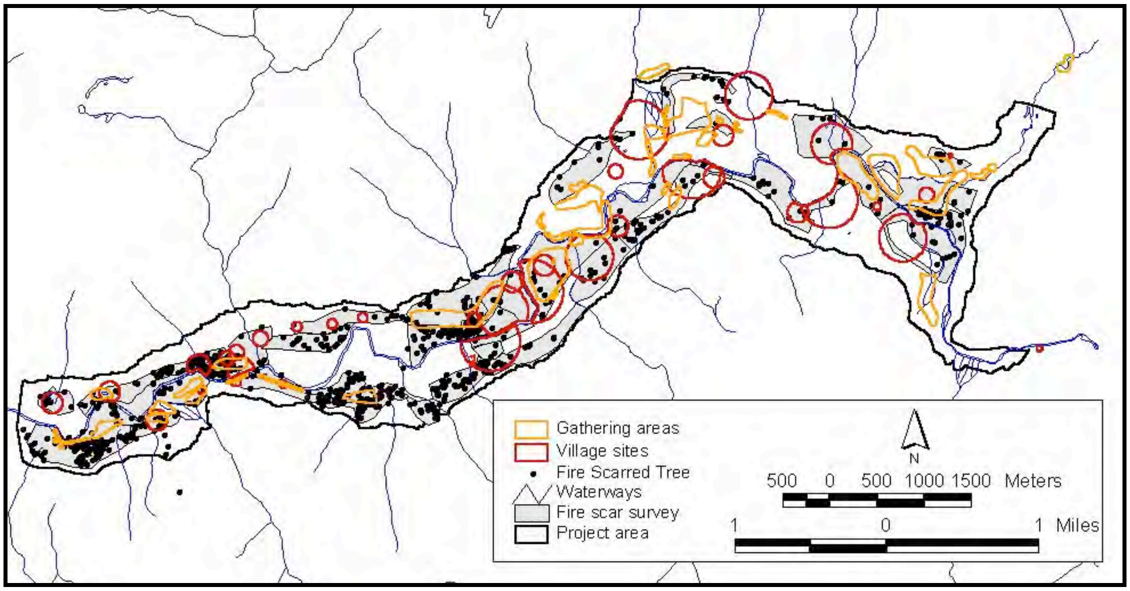

Figure 7: Overlay of Fire Scarred Trees, Villages, and Gathering Areas

Determining Fire Scars to be Sampled

Study sites were eliminated if they were not appropriate for the fire history reconstruction, such as differential preservation, destruction from prescribed fires, and lack of spatial correspondence with archaeological and gathering areas. Cook and Kairikiukstis (1990) emphasize the following about nonrandom site selection in dendroecological studies:

> This is a principle that at first glance seems to run contrary to statistical considerations requiring random sampling. However, tree and site selection is an extension of the principle of limiting factors, the concept of ecological amplitude and replication. Differences in site lead to differences in the most important limiting factors. Thus, it is important to choose the specific site and to replicate within this site, so that all the sampled trees will have the same or similar signals. (Cook and Kairikiukstis 1990:24)

The distribution of fire-scarred trees is not only a manifestation of the fires that created the scars but also human and natural disturbances including differential preservation, natural processes creating fire scars, historic and modern landscaping, vegetation manipulation, and prescribed fire; thus, the lack of fire scars does not necessarily indicate a lack of fire. Consequently, sampling locations were determined by whether the locations were appropriate based on archaeological, ethnographic, and fire history criteria, as described below.

<u>Archaeological Site</u>

(1) Location corresponds to a village site identified by Merriam (1917; c.1915).

(2) Archaeological data place occupation of the site partially or entirely within the latter portion of the Late Prehistoric 3, Protohistoric, or Historic Periods 1-3.

(3) Availability of fire scarred trees in or surrounding the archaeological site.

(4) Areas not isolated from continuous fire fuels (e.g. forested islands within a landslide, stream, or river).

<u>Traditional Gathering Areas</u>

(1) Area identified in Bibby (1994).

(2) Availability of fire scarred trees within or surrounding the gathering area.

(3) Areas not isolated from continuous fire fuels.

<u>Fire History "Control" Areas</u>

(1) Availability of fire scarred trees.

(2) Area lacks evidence of archaeological occupation.

(3) Area lacks evidence of use as a traditional gathering area.

(4) Areas not isolated from continuous fire fuels.

Throughout the study controls will be used hypothetically, i.e. "control". The “control” locations were used based on their lack of archaeological and ethnographic data establishing human use but due to their proximity to both villages and gathering they are within the site-catchment zone of the their respective village. Both “controls” at a minimum would have been used as a travel route between the village and the gathering site.

Sampling Methods

Given that this study anticipated encountering high fire frequencies, multiple samples from each area were collected. The high number of samples were needed because a complete record of all fire events are rarely contained in a single tree; samples from numerous trees are needed to approach a complete fire history record (Brown 2002). ‘Cookies’ and wedges from live *Calocedrus decurrens* (Torr.) Florin (incense cedar) and dead *Pinus ponderosa* (ponderosa pine) were collected from 11 locations. These consisted of 10-30 samples collected from each location, which ranged in size from one to ten hectares. Sampling methods followed standard fire history methods, as shown in Figure 8 and Figure 9, and outlined by Arno and Sneck:

> A … chain saw … is used to make parallel horizontal cuts 1-1/2 to 2 inches (4 to 5 cm) apart. These extend from the pith to the cambium across the clearest portion of the car sequence, on only one side of the catface. The cut is made just deep enough to insure that it goes behind the deepest penetration of each scar so the count can be made in unscarred tissue … Then the tip of the saw is pushed in vertically along the back of the parallel cuts, from cambium to pith (Arno and Sneck 1977:12).

Laboratory Methods

Analysis of fire scar samples was conducted by the author and the vegetation

Figure 8: Fire History Sampling

Figure 9: Left- Fire Scarred Tree after Sampling; Right - Fire Scar Sample

dynamics lab at Penn State University using slightly different methods. All samples were air-dried and sanded until ring structure detail was visible. Specimens were cross-dated by matching common patterns of wide and narrow rings in comparison to local master chronologies (King 1991; Stephens and Collins 2004). The author used methods based on Stokes and Smiley (1996) with annual growth rings being assigned a calendar year based on visual inspection and skeleton plots created for each sample. Pennsylvania State University used methods based on Yamaguchi (1991) where annual growth rings were assigned calendar years based on visual pattern matching with local tree-ring chronologies without the creation of a skeleton plot. In both cases fire scars were identified on the basis of three criteria: (1) the presence of a gap or break within a ring or along a ring boundary, (2) charred wood within the gap or break, and (3) subsequent overlapping curvilinear growth over the gap (Dieterich and Swetnam 1984:239-240; Savage and Swetnam 1990:2375; Stokes 1980). A calendar year was assigned to each fire scar.

The season a fire occurred was based on the position of each scar within the annual growth ring. Scar positions were assigned to one of six categories: (1) early earlywood (first one-third of earlywood); (2) middle earlywood (second one-third of earlywood); (3) late earlywood (last one-third of earlywood); (4) latewood (in latewood); (5) dormant (at ring boundary); or (6) Undetermined (Baisan 1990; Kaye and Swetnam 1999). See Figure 10 for diagram of positions in annual ring.

Radial Growth

Not only can it be determined when the during the growth season a fire occurred but based on modern silvacultural studies it can be determined the approximate month in which the fire took place. On average at 1520 m (5,000 ft) elevation ponderosa pine start radial growth on March 23 and height growth on April 26. Radial growth lasts 177 days

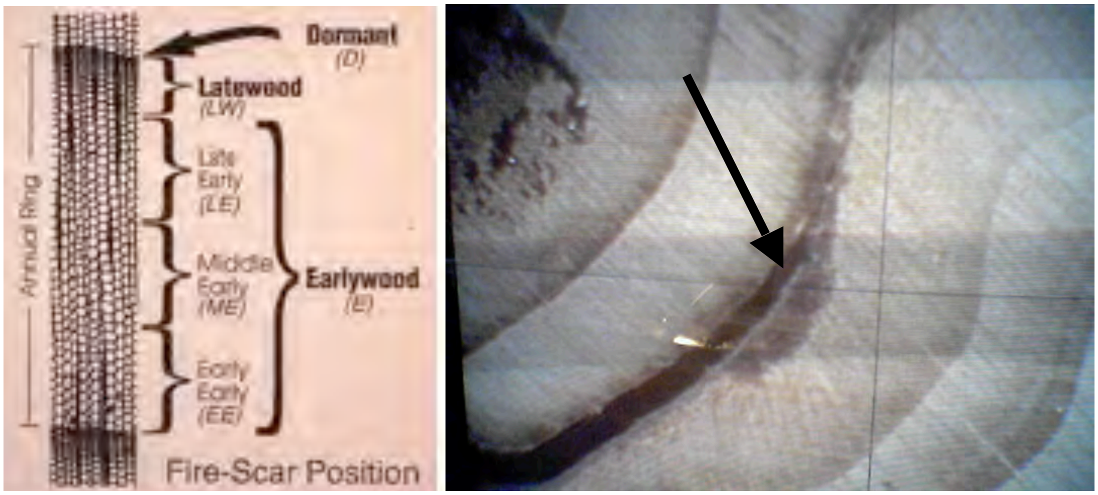

Figure 10: Left - Scar Positions within a Trees Annual Ring (Caprio and Swetnam 1995a); Right - Example Dormant Season Fire Scar

(Curtis and Lynch 1965; Oliver and Ryker 1990). For Incense-Cedars radial growth begins about April 15 and lasts between 136 and 146 days (Powers and Oliver 1990; Powers 1981; Schubert 1965). Based on the average number of days growth of each species the positions within an annual ring can be assigned to calendar days (see Table 9).

POSITION IN SCAR	PONDEROSA PINE GROWTH 177 DAYS (44.25 DAYS PER POSITION)	INCENSE-CEDAR GROWTH 136 – 146 DAYS (34-36.5 DAYS PER POSITION)
EARLY EARLYWOOD	March 23 - May 6	April 15 - May 20
MIDDLE EARLYWOOD	May 7 - June 20	May 21 - June 25
LATE EARLYWOOD	June 21 - August 4	June 26 - July 30
LATEWOOD	August 5 - Sept 18	July 31 - Sept 4
DORMANT	Sept 19 - March 23	Sept 5 - April 15

Table 9: Correspondence of Calendar Days to Annual Ring Position of Fire-Scars

Statistical Analysis

Student's t-test, F-test and two-sample Kolmogorov-Smirnov test produced through the use of FHX2 software (Grissino-Mayer 2001) were used to determine statistical differences between the sampling areas, villages, and time periods.

Archaeological Methods

Following the fire history survey to determine the appropriate locations for fire history sampling and spatial analysis determined the village appropriate for this study, surveys, and shovel testing was conducted at two villages in order to confirm occupation.

Field Investigations

Surveys consisted of two meter wide transects over the recorded extent of the sites and extending at least 50 meters beyond the recorded boundaries. If cultural materials continued beyond 50 meters, survey continued 30-50 meters beyond the last cultural materials observed, unless a topographic feature (e.g., river or cliff) limited survey. All diagnostic artifacts observed were numbered and described.

In both cases dense surface vegetation and duff, inhibited visibility and subsurface investigations were employed to better define the period(s) of occupation. Surface scrapes and shovel tests were placed on a north-south and east-west grid that bisected at five or ten meter intervals. Surface scrapes consisted of 1 by 1 meter units. Shovel tests were 50 by 50 centimeter and limited to maximum depth of 50-centimeter. All materials were screened using 1/16-inch screen. A plan view map was completed for all archaeological sites at which new data was collected. Written and photographic documentation were maintained throughout the project. Documentation consists of daily notes, photo logs, field specimen logs, site sketch maps, and feature records.

Laboratory Methods

All artifacts were cleaned and sorted as appropriate by material class. Materials were stabilized as necessary to protect them from deterioration. All artifacts were examined visually and measurements taken when appropriate. All artifacts collected were fully analyzed and categorized by the author based on Wilson et al. (2002), except lithic materials which were analyzed and categorized based on Byram (1996).

Curation

Following the completion of this project, all archaeological artifacts were returned to Yosemite National Park for curation and management. At the completion of this thesis, accession and catalog numbers had not yet been assigned by the National Park Service. Fire scar and dendrochronological samples were curated at Penn State University, State College Pennsylvania, Department of Geography, Vegetation Dynamics Lab.

Chapter 4: Sampling Locations

Spatial analysis of fire-scarred trees, Merriam's village sites, archaeological excavations, and traditional gathering areas identified two locations appropriate for this study. The locations consisted of two areas in the southwestern portion of Yosemite Valley. Both locations contained a gradient of human use from a village site with archaeological remains to no known use to a traditional gathering area. Fire history samples were collected from a third location but due to the failure of archaeological excavations to yield material remains associated with the village of Hoo-ke'-hahtch'-ke, the fire history samples were not analyzed for this study.

Location 1: *Sap-pah'sam-mah*

Location 1 is associated with the village of *Sap-pah'sam-mah* and is located at the far southwestern portion of Yosemite Valley, south of the Merced River, between Pohono Bridge and the Wawona Road.

Sap-pah'sam-mah was identified as "the lowermost (most westerly) village or camp on south side of the valley, about half a mile east of Pohono Meadows" (Merriam 1917:205). Hall described the location as being, "somewhere in this vicinity [the bronze plaque in honor of Bunnell] once stood the Indian settlement of *Sap-pah'sam-mah*" (Hall 1929:58-59). Latta (c.1930), and Bibby (1994) also identified the village in the same general location as described by Merriam.

Archaeological evidence for *Sap-pah'sam-mah* consists of one archaeological site, CA-MRP-71. Previous surface observations of CA-MRP-71 noted a stationary milling feature and pictograph. Presence of a stationary milling features and pictograph suggest late Prehistoric 2 and 3 phases (A.D. 500 to A.D. 1850) occupation. Excavations at CA-MRP-71 consisted of sixteen 50 by 50 centimeter units. Recovered artifacts were consistent with two periods of occupation. A late prehistoric period consisting of small obsidian retouch flakes and debitage, one transverse side scraper, and one blue glass trade bead, all consistent with Merriam's description of a seasonal camp with possibly seasonally low intensity use, with a low diversity of use. A second period of use consisted of artifacts dating from c. 1870 to 1960s, which is consistent with Euro-American occupation and tourism associated with the Wawona Road, which opened in 1875.

The majority of prehistoric artifacts recovered are obsidian flake fragments (51%, n=35), complete flakes (19%, n=13), and broken flakes (16%, n=11), see Figure 11. Flake density was low with one to fourteen obsidian artifacts per 0.5 m^3 and was made up of very small flakes (Figure 12). The presence of the bedrock mortar and one heat-treated, transverse scraper recovered during the excavation hint at the sites use as a center for resource extraction.

The best temporally diagnostic artifact for Native American occupation of CA-MRP-71 is the monochrome translucent blue cylindrical wire wound translucent glass trade bead. It likely postdates A.D. 1770. Glass trade beads were probably widespread through the central California interior by A.D. 1800 and groups in the Sierra probably acquired them through trade with native groups of the San Joaquin Valley rather than through direct contact with non-native people (Arkush 1993, 1995).

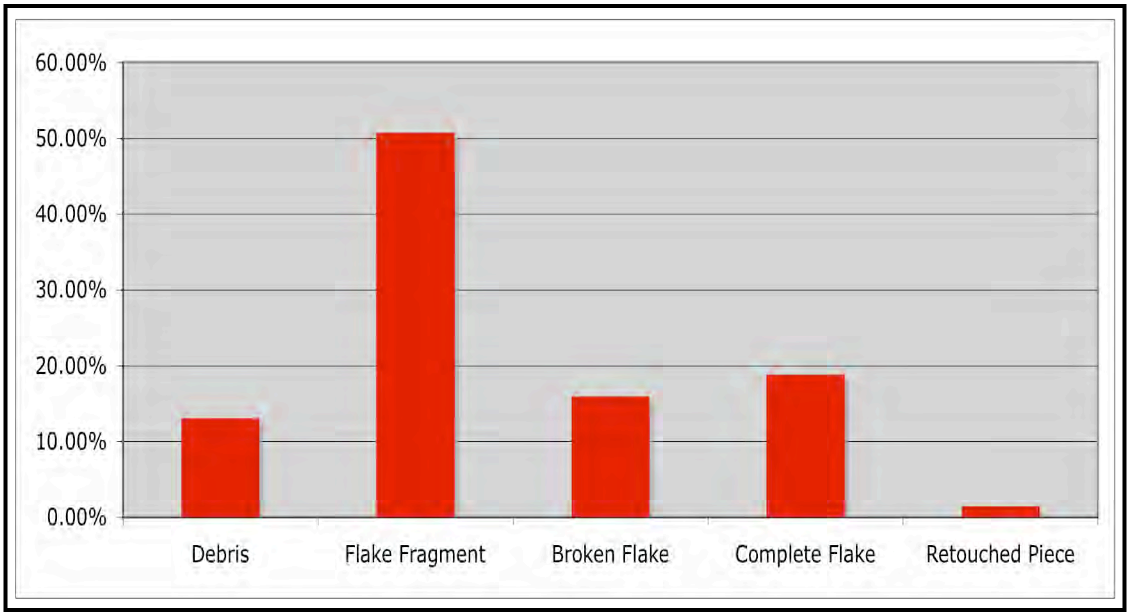

Figure 11: Flakes by Type, CA-MRP-71

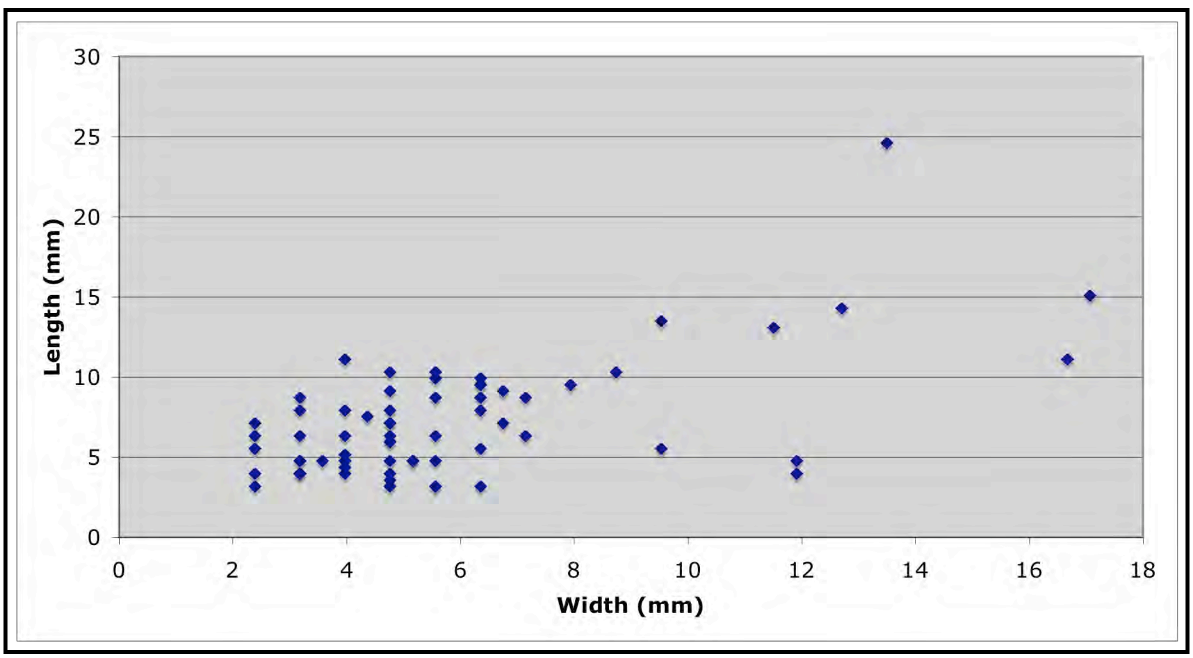

Figure 12: Flake Sizes, CA-MRP-71

The distribution of artifacts both vertically and horizontally confirmed two distinct periods of occupation. Obsidian flakes are confined to northern and western units close to the bedrock mortar and the majority came from subsurface deposits. Historic artifacts were located on all four sides of the bedrock mortar, with the majority occurring in the southern portion of the site and most located within ten centimeter of the surface, see Figure 13 and Figure 14. The majority of historic artifacts consisted of wire nails (47%, n=36), glass fragments (20%, n=15), and lamp glass (13%, n=10). The historic artifacts are consistent with use of the Old Wawona Road (P-22-0296) which operated from 1875 to 1933 (Greene 1987), see Figure 15.

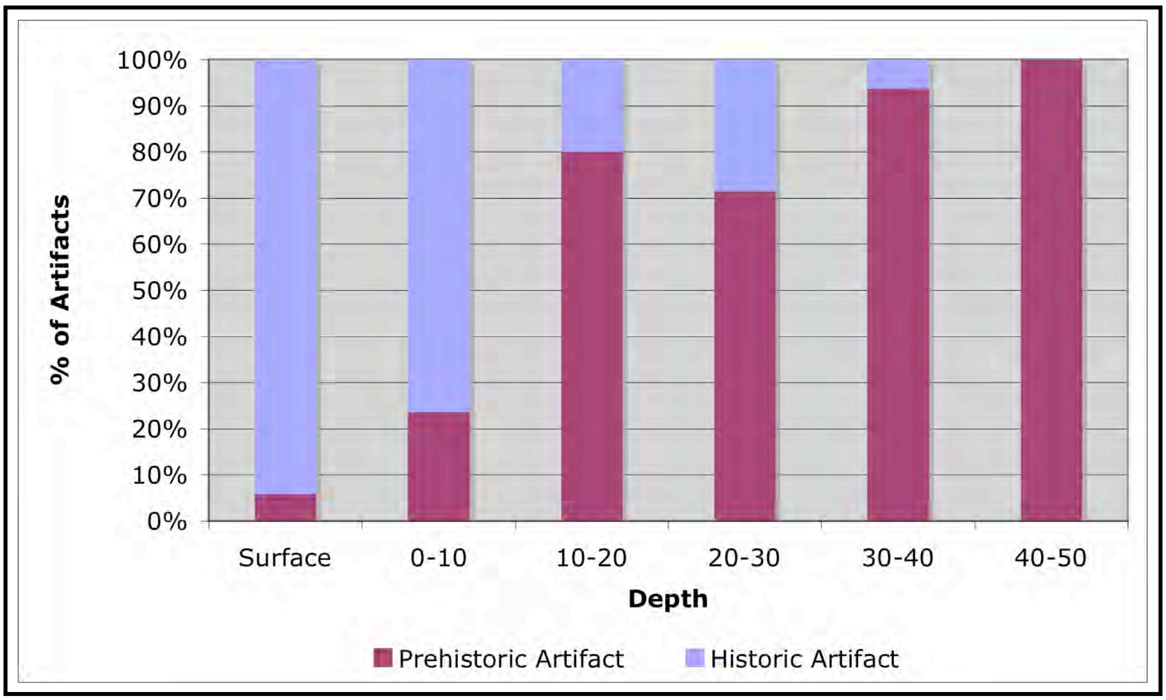

Figure 13: Artifacts by Depth, CA-MRP-71

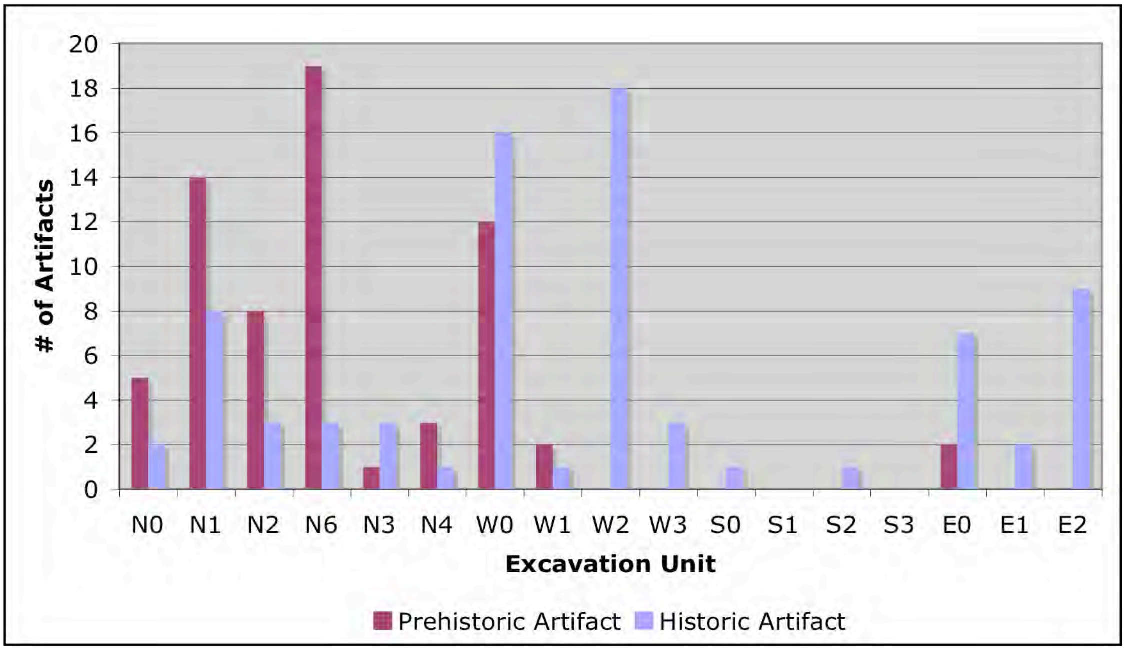

Figure 14: Artifacts by Unit Location, CA-MRP-71

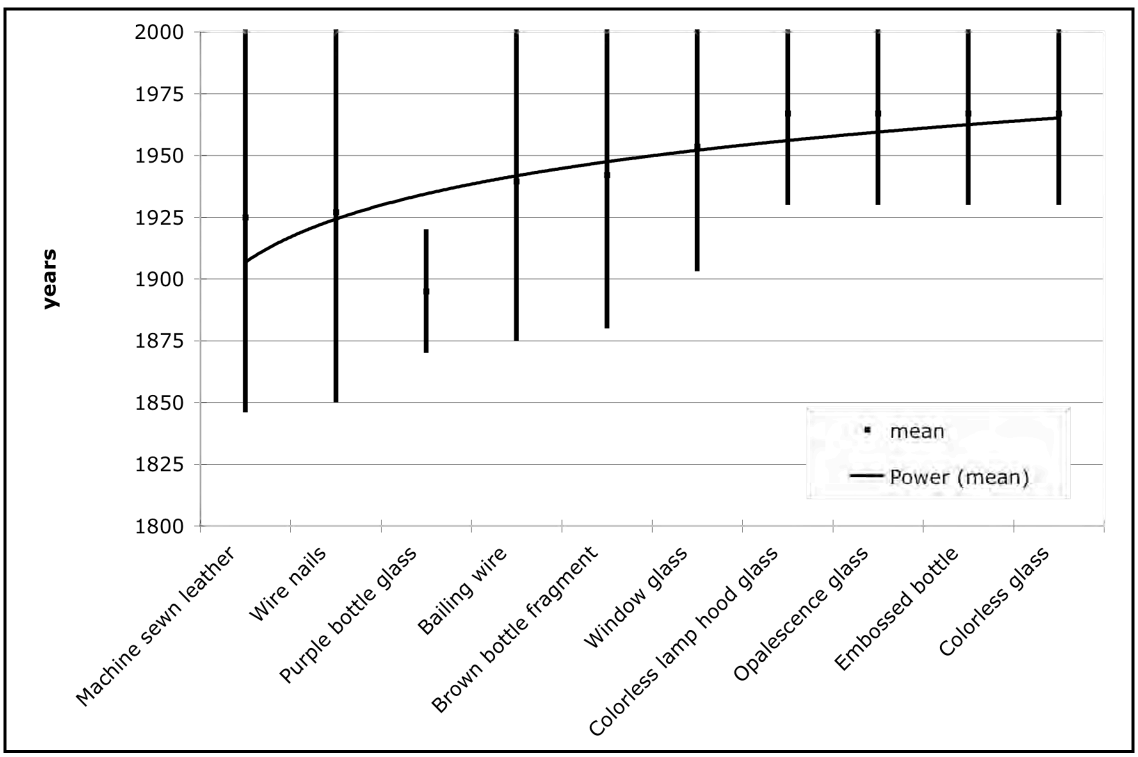

Figure 15: Temporal Placement of Historic Artifacts from CA-MRP-71Excavations

Located west of *Sap-pah'sam-mah* is a traditional gathering area (Bibby #5) for two plants, big leaf maple, *Acer macrophyllum Pursh,* and bracken fern, *Pteridium aquilinum (L.) Kuhn*.

The Southern Sierra Miwok used the shoots of big leaf maple for baskets (see Table 8). Larger branches were split and used to make staves for a gambling game. Long trunks with very few branches were used for ceremonial flag materials. The most desired characteristics were long un-branched shoots for basket materials. Branches and trunks were traditionally gathering in the spring.

The fiddle-heads of the bracken fern were used as a food source, while the rhizomes are used in basket making. While bracken fern is found throughout Yosemite Valley generally sandy stream terraces were favorite gathering areas where longer, straighter root could be dug with ease. The sprouts were gathered for food while the root rhizomes were gathered in the spring and summer. Anderson (1993a) stated that the Miwok would burn bracken fern in late fall or early spring to clear off litter accumulations.

To the east and south of *Sap-pah'sam-mah* is an Indian hemp, *Apocynum cannabinum L.*, gathering area (Bibby #6 and 10). The fiber of the stalks was used to make cordage. The stems are cut, split open and the long, silky fibers removed, the fibers are then twisted into string that provides cordage. Long un-branched, larger diameter stems were most desired for maximum fiber production.

Stems were collected in the fall after the leaves have begun to senesce or dry up and the stalks turn a deep reddish brown color. In late summer, from August to September the seedpods were collected. Hemp was burned in the late fall, or early spring

> Vast quantities of fiber plants are required for nets, regalia, and cordage. … that it takes approximately five stalks of milkweed or Indian hemp to manufacture one foot of cordage. A Sierra Miwok feather skirt or cape contain about 100 feet of cordage made from approximately 500 plant stalks, while a deer net 40 feet in length (Barrett and Gifford 1933:178) contained some 7,000 feet of cordage, which would have required the harvesting of a staggering 35,000 plant stalks. Therefore, propagation and conservation of this species for fiber is very important for production of traditionally manufactured cordage, which is still used today. Both milkweed and dogbane are burned in the fall to eliminate dead stalks and stimulate new growth. Burning causes new growth to have taller, straighter stems (with longer fibers). It also stimulates flower and seed production. (NRCS 2002)

Survey for fire scarred trees around *Sap-pah'sam-mah*, the gathering areas Bibby #5, 6 and 10 revealed an abundance of fire scars. The fire scars covered a continuum of human land-use, from east to west scars covered a hemp gathering area, a seasonal camp of *Sap-pah'sam-mah,* Bridalveil Medial Moraine, a area of unknown use with rock falls, and traditional gathering areas for big leaf maple, and bracken fern.

Fifty-nine samples were collected and, of these, 29 cedar samples were crossdated, fire scars dated, and season of fire was determined. The samples were collected from three locations, YV-01, YV-02, and YV-03, consisting of a village, "control" and gathering area (Figure 16).

Sampling at the village of *Sap-pah'sam-mah* (YV-03) consisted of ten trees dating from A.D. 1666 to 2004 exhibiting 48 fire scars and injuries contributing to a 4.69 years mean fire return interval (MFI) (Weibull Median Interval 3.33), Figure 19. The "control" (YV-02) consisted of 14 samples spanning A.D. 1598 to 2004 and showing evidence of

47 fires and injuries creating a MFI of 4.7 (3.48), Figure 18. Only three samples could be crossdated from the big leaf maple and bracken fern gathering area (YV-01) showing four fires spanning A.D. 1558 to 2004 creating a MFI of 17.83 (16.5), Figure 17. See Table 10 for statistics for all three sampling locations.

	YV-01 Gathering	YV-02 "Control"	YV-03 Village
Samples	5	14	10
Years	A.D. 1558-2004	A.D. 1598 - 2004	A.D. 1666-2004
Mean Fire Interval	17.83	4.7	4.69
Median Fire Interval	17	3	3
Weibull Modal Interval	13.19	0.44	0.16
Weibull Median Interval	16.5	3.48	3.33
Fire Frequency	0.06	0.29	0.3
Standard Deviation	11	6.28	5.58
Minimum Fire Interval	5	1	1
Maximum Fire Interval	31	43	25
% with season	71.4%	78.40%	75.00%
% of Dormant season	60.00%	44.80%	35.60%
% of Early Earlywood	0.00%	12.10%	11.00%
% of Middle Earlywood	0.00%	6.90%	2.20%
% of Late Earlywood	20.00%	12.10%	4.40%
% of Latewood	20.00%	24.10%	46.70%

Table 10: Location 1 Fire History Data

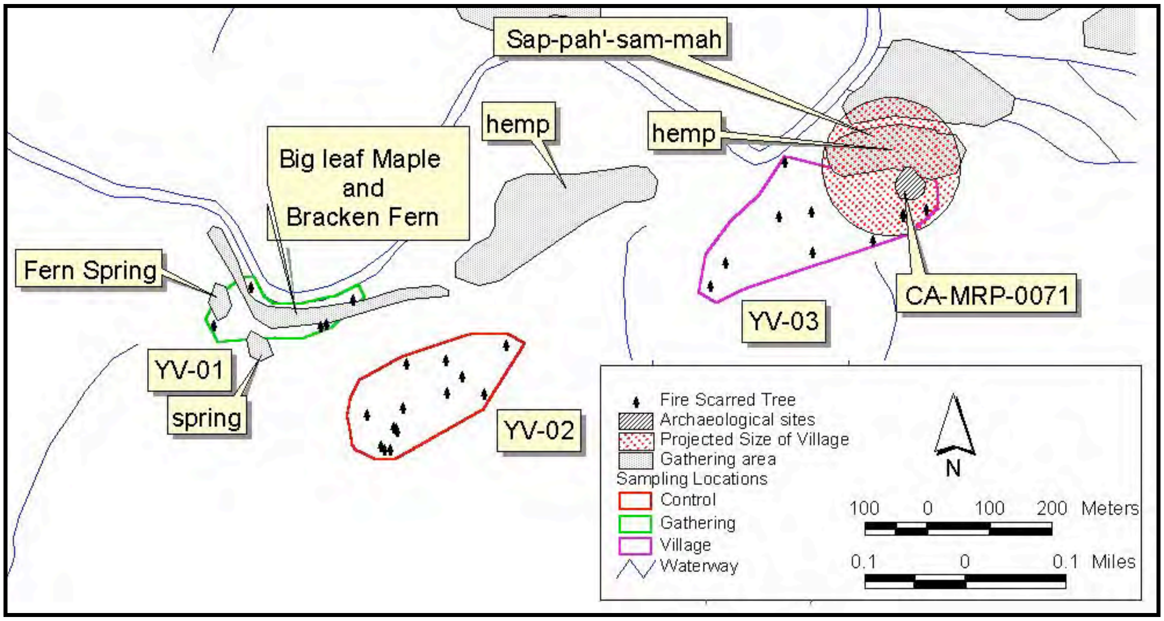

Figure 16: Location 1: *Sap-pah'sam-mah* Map

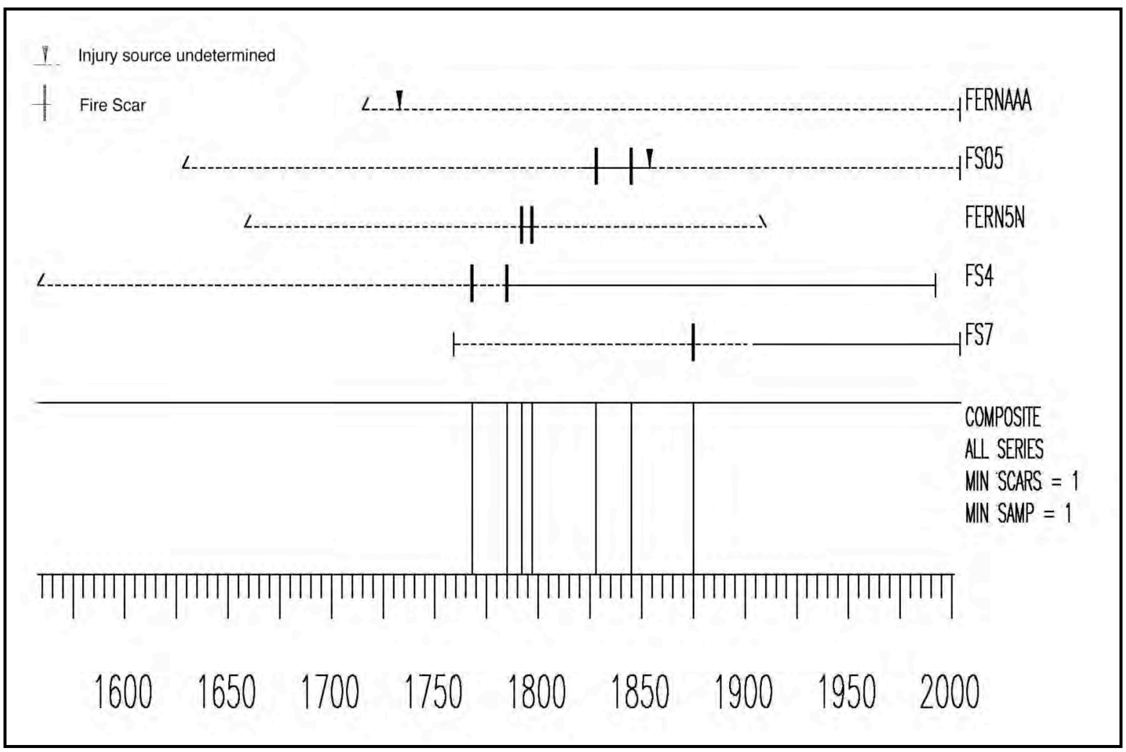

Figure 17: Fire History for YV-01 - Location 1 Gathering Area

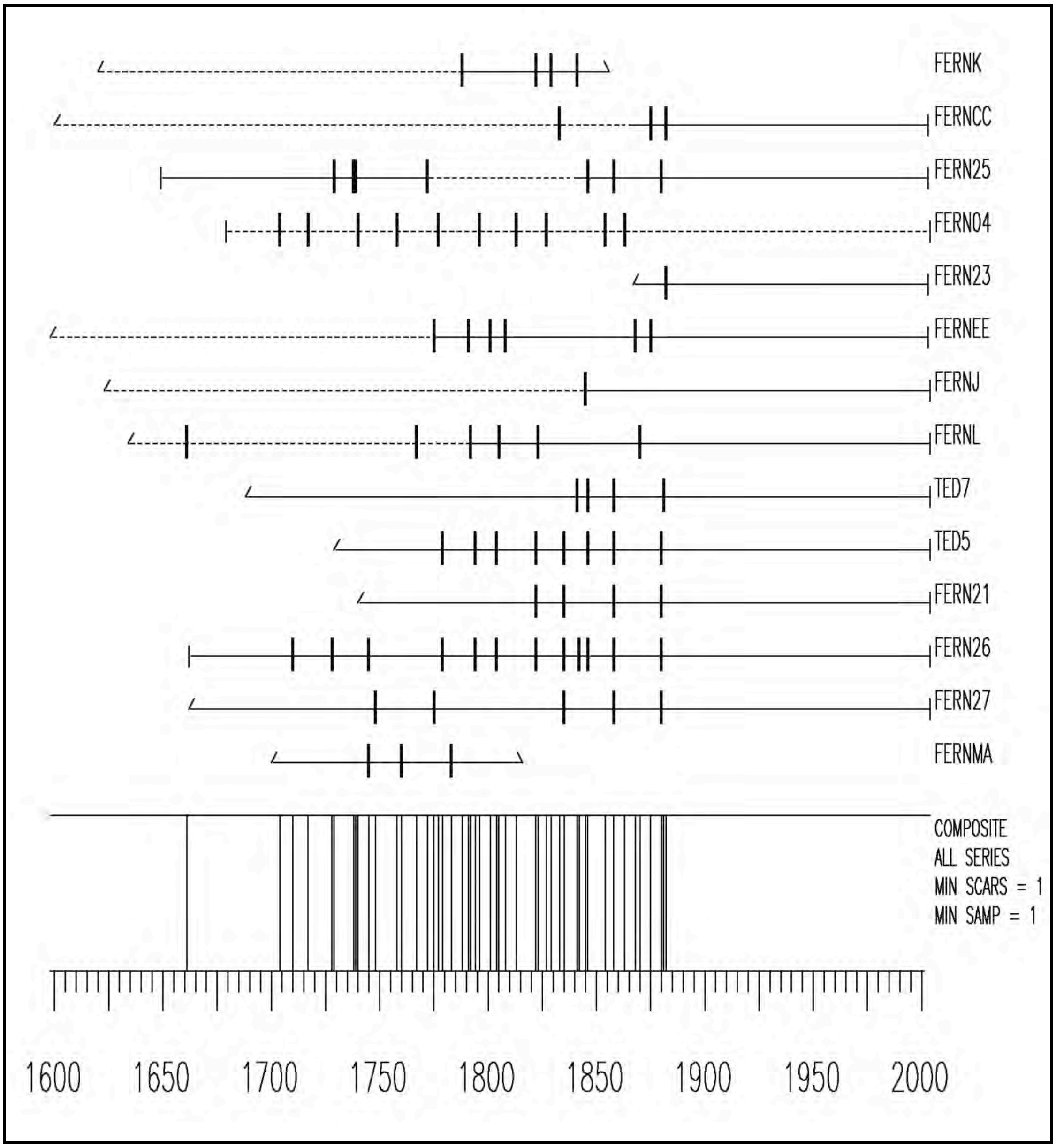

Figure 18: Fire History for YV-02 - Location 1 "Control" Area

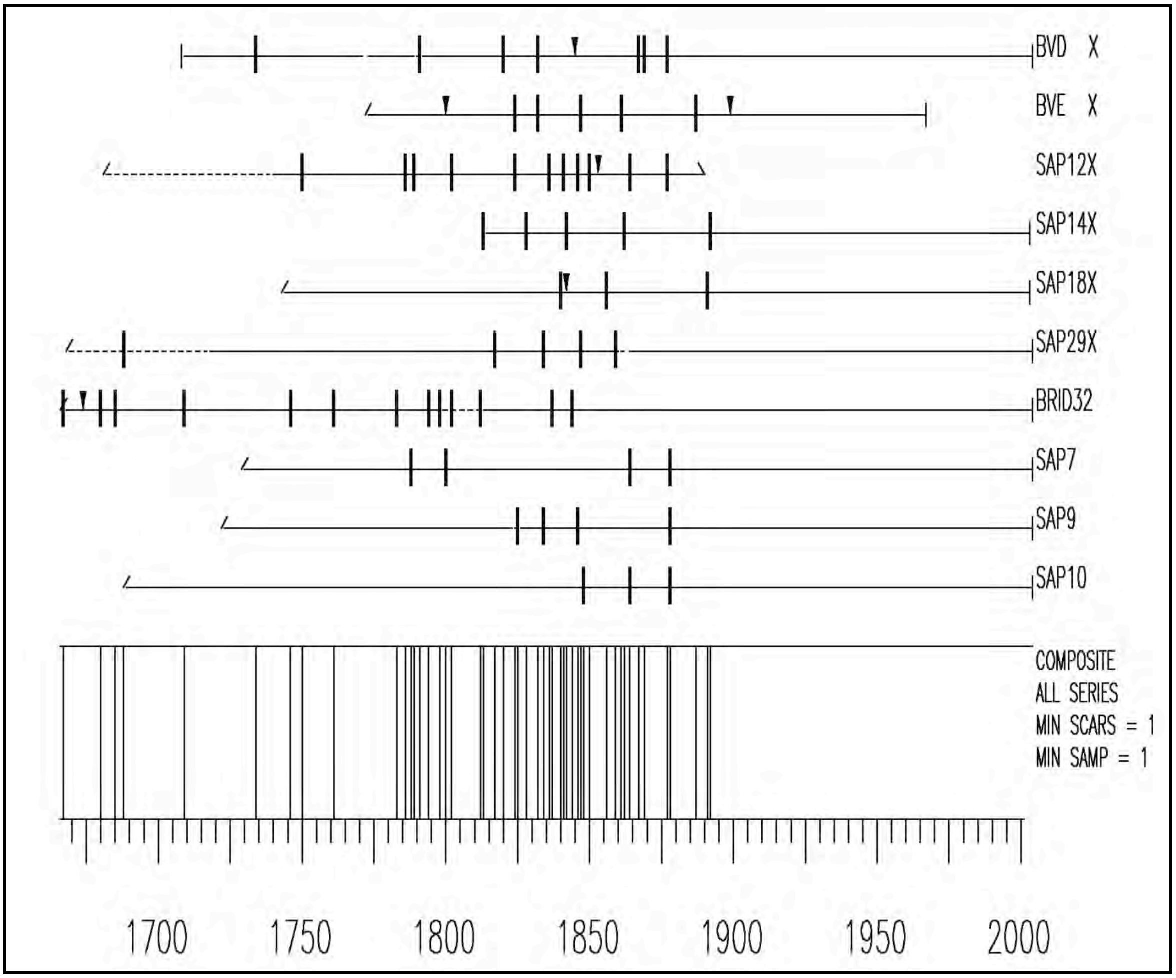

Figure 19: Fire History for YV-03 - Location 1 Village of *Sap-pah'sam-mah*

Location 2: *Kis'-se*

Location 2 is associated with the village of *Kis'-se* is located mid-valley, south of the Merced River, between Four Mile Trail and El Capitan Crossover.

The first documented use of this area by Native Americans occurred in 1879 on the Wheeler Survey map (Hutchings 1886; Wheeler 1883). The map indicates that the area northwest of *Kis'-se* and its adjacent gathering area was "Indian Pasture" (Figure 20). The first written description of *Kis'-se* was by C. Hart Merriam in 1917. He described

Kis'-se or *Kis's-se-uh* it as a "large village near the river… Kis'-se was the westernmost of the large villages on the south side" (Merriam 1917:207).

Figure 20: Section of Wheeler Survey 1879 Map Depicting Area Surrounding Location 2.

The village of *Kis'-se* consists of the archaeological site CA-MRP-76. The constituents of CA-MRP-76 are midden soils, two stationary milling outcrops with 50 mortar cups and an obsidian debitage scatter (Hull and Kelly 1995).

Due to delays in the permitting process which limited field work, and concerns from the Park Service on the extent of excavations, subsurface testing did not take place at CA-MRP-76. Based on the unambiguous location identified by C. Hart Merriam as *Kis'-se*, it was determined that CA-MRP-76 could be confidently inferred to have evidence of Protohistoric and Historic 1 occupation without excavation.

West of *Kis'-se* Bibby (1994) identified a traditional gathering area of snakeroot *Goodyera oblongifolia Ref* (Bibby #26), Snakeroot is used as antidote to snake bites and was gathered opportunistically. Anderson (1993a) indicates that the Southern Sierra Miwok burned snakeroot in the late fall, or early spring.

Survey for fire scarred trees around *Kis'-se*, and the gathering area Bibby #26 revealed an abundance of fire scars and that those fire scars covered a continuum of human land-use. Moving east to west, scars were documented in a large village, areas of unknown use, and the snakeroot gathering area. The locations were bisected by two seasonal streams that could have limited fire spread between the different land-use areas within the analyzed locations.

Of the seventy-three samples collected 30 cedar samples were crossdated, the fire scars dated and season of fire was determined. The samples were collected from three locations, YV-09, YV-08, and YV-04, consisting of a village, "control" and gathering area (Figure 21).

Sampling at the village of *Kis'-se* (YV-09) consisted of eight trees dating from A.D. 1609 to 2004 consisting of 43 fires and injuries contributing to a 5.42 MFI (3.93) see Figure 24. The "control" (YV-08) consisted of ten samples spanning A.D. 1533 to 2004 and showing evidence of 35 fires and injuries creating a MFI of 7.17 (4.86), see Figure 23. Twelve samples spanning A.D. 1520 to 2004 were taken from the snakeroot gathering area (YV-04). These samples exhibited 46 fire scars and injuries creating a MFI of 5.22 (3.7), Figure 22. See Table 11 for statistics for all three sampling locations.

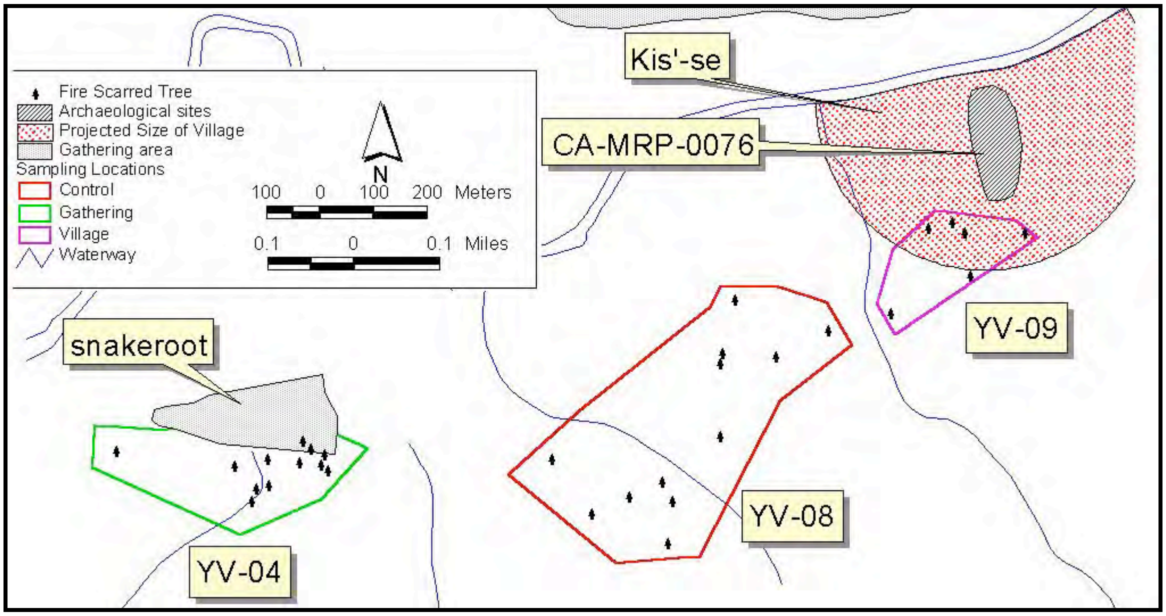

Figure 21: Location 2 Map: Fire-scar Samples from Areas Associated with the Village of *Kis'-se*

	YV-04 Gathering	YV-08 "Control"	YV-09 Village
Samples	12	10	8
Years	A.D. 1520-2004	A.D. 1533-2004	A.D. 1609-2004
Mean Fire Interval	5.22	7.17	5.42
Median Fire Interval	3.5	4	3
Weibull Modal Interval	0.15	0	0.35
Weibull Median Interval	3.7	4.86	3.93
Fire Frequency	0.27	0.21	0.25
Standard Deviation	6.49	8.46	6
Minimum Fire Interval	1	1	1
Maximum Fire Interval	31	40	27
% with season	82.70%	84.20%	70.40%
% of Dormant season	44.20%	67.40%	52.60%
% of Early Earlywood	7.0%	4.70%	0%
% of Middle Earlywood	0%	4.70%	13.20%
% of Late Earlywood	4.70%	2.30%	10.50%
% of Latewood	44.20%	20.90%	23.70%

Table 11: Location 2, *Kis'-se* Fire History Data

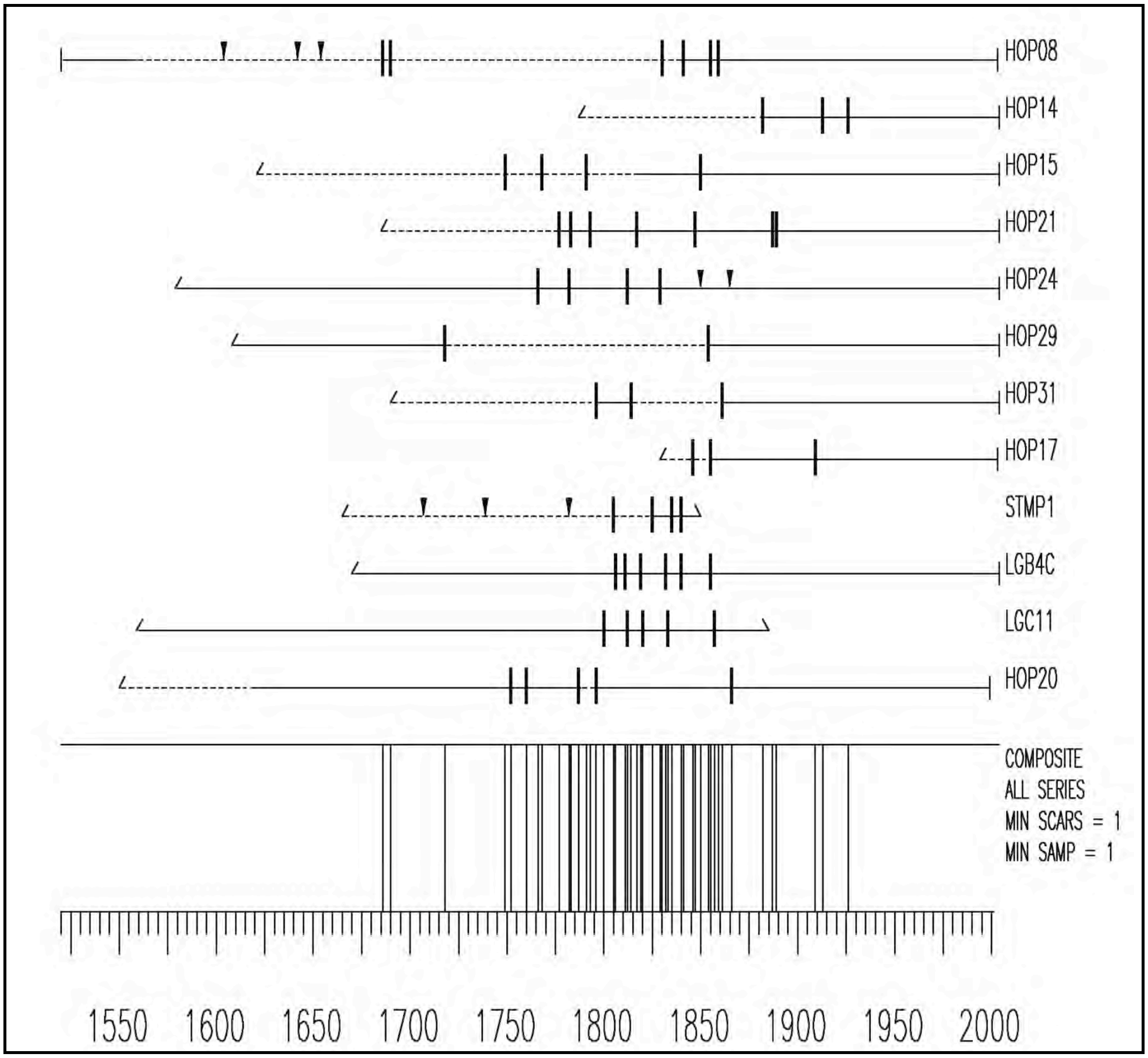

Figure 22: Fire History for YV-04 - Location 2 Gathering Area

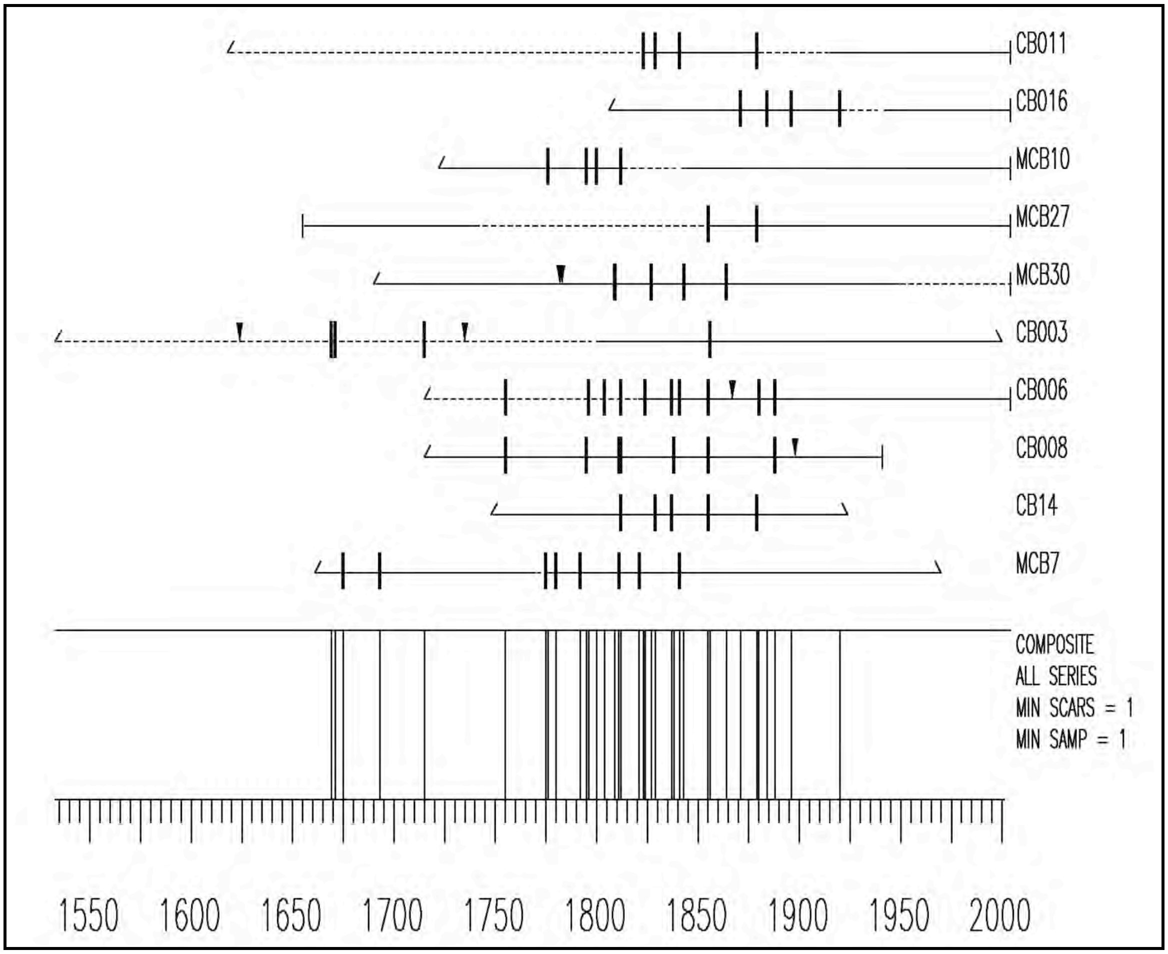

Figure 23: Fire History for YV-08 - Location 2 "Control" Area

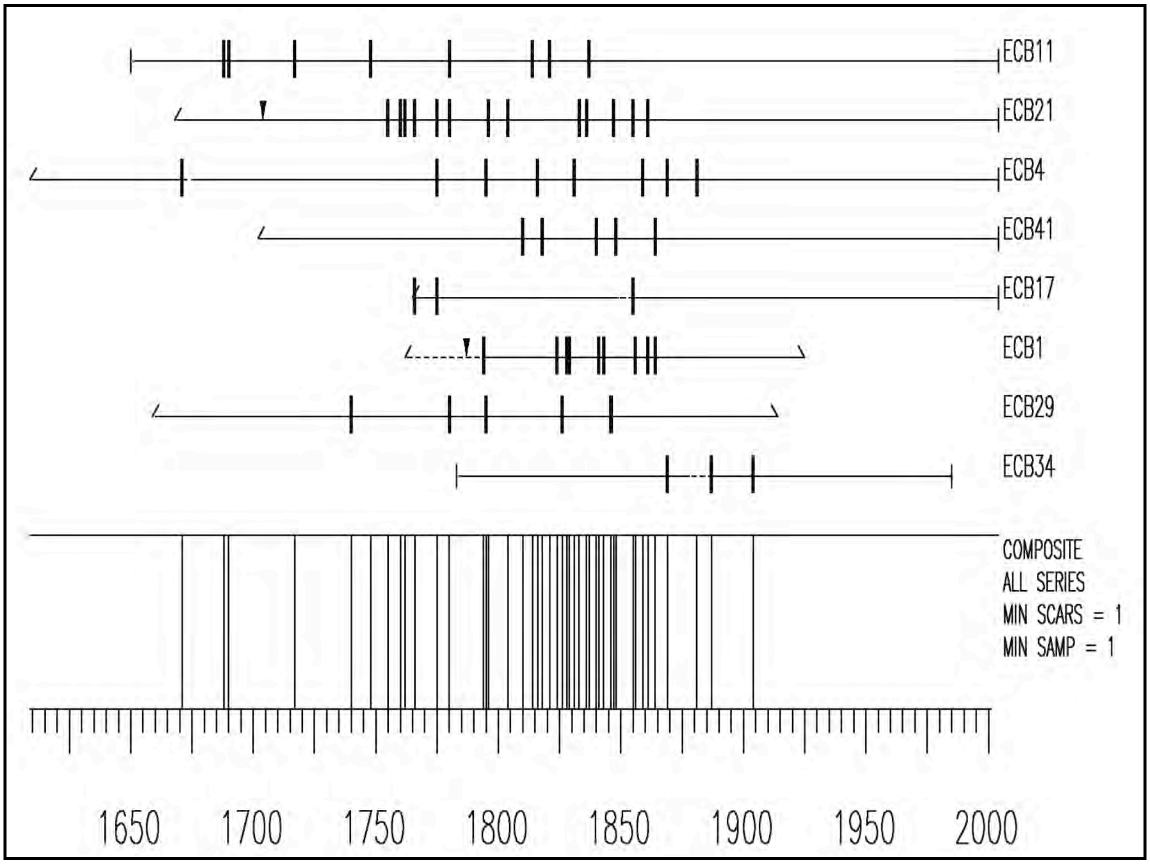

Figure 24: Fire History for YV-09 - Location 2 Village

Chapter 5: Fire History Analysis

Prior to exploring the implications of the Native American use of fire in Yosemite Valley, it must be established that the fire regime observed in the dendrochronological fire history could not have been produced through lightning ignitions and that the regime can be attributed to a human ignition sources. The fire return intervals observed in the dendrochronological fire history, A.D. 1552 to 2004, revealed of a mean fire return interval of 1.92 to 17.83 years with a range of one to 56 years, (see Table 12). Modern fire records kept since 1930 by the NPS show that there has been no lightning ignited fires on the floor of Yosemite Valley, thus creating a "natural" fire return interval of 70-plus years. In the absence of a dramatic change in climate and lightning ignition patterns between A.D. 1890 and 1930, which have not been documented, it can be stated that the modern "natural" lightning ignited fires cannot account for the fire return intervals observed in the prehistoric and early historic dendrochronological fire record; consequently the fire regime within Yosemite Valley was the product the human occupants of the valley. With the abundance of archaeological data showing human occupation throughout Yosemite Valley, anthropogenic fires would have had an impact on fuels that, in turn, would have reduced the chance of ignition, spread and intensity of any lightning strikes. As such, the fire regimes in Yosemite Valley are uniquely human.

The general patterns of fire showed short fire return intervals, with median fire return intervals of one to 18 years and ranging from one to 56 years. The large number of fire-scarred trees with multiple scars indicates low intensity ground fires rather than large-scale crown fires.

	Study area	Sample Area	Sample
Size (hectares)	30	1.5-11	Tree
Samples	57	5-14	
MFI (Weibull Median)	1.92 (1.61)	4.69 - 17.83 (3.33 - 16.5)	17.7
Interval Range	1-11	1-43	2-56

Table 12: Fire interval Analysis by Sample Size

Changes Over Time

In order to determine when culture change or Euro-American influence may have effected burning patterns, time periods developed by Moratto (1999) were used to compare changes of mean fire intervals over time. Using FHX2 software, each time period was compared to the period subsequent to it. Statistically significant differences were observed between the late Prehistoric 3 and Protohistoric periods and the Historic 2 and Historic 3 periods (See Table 13 and Figure 25). This suggests that, at least for the southwestern portion of Yosemite Valley, something impacted the Native American burning patterns during the late Prehistoric period. Following A.D. 1800, and until 1890, the temporal pattern of burning remained relatively constant. Eighteen eighty-eight is the last year in which two trees were scarred by fire, while A.D. 1891-1892 were the last years in which fires scarred trees in back-to-back years.

It is interesting that despite the changes brought about by the direct contact between the *Ahwah'-nee* and Euro-Americans and the initial occupation of Yosemite Valley by Hutchings in 1855, it was not until 1890 that burning patterns were significantly altered in the southwestern section of the valley.

Time Period	Statistical Difference	P
Prehistoric vs. Protohistoric (A.D. 1520-1800) (1800-1847)	**Significant**	**0.0000**
Protohistoric vs. Historic 1 (A.D. 1800-1847) (1848-1863)	Not Significant	0.1929
Historic 1 vs. Historic 2 (A.D. 1848-1863) (1864-1890)	Not Significant	0.9610
Historic 2 vs. Historic 3 (A.D. 1864-1890) (1891-1944)	**Significant**	**0.0001**

Table 13: Two-Tailed T-Test Comparison of Fire Intervals by Time Period.

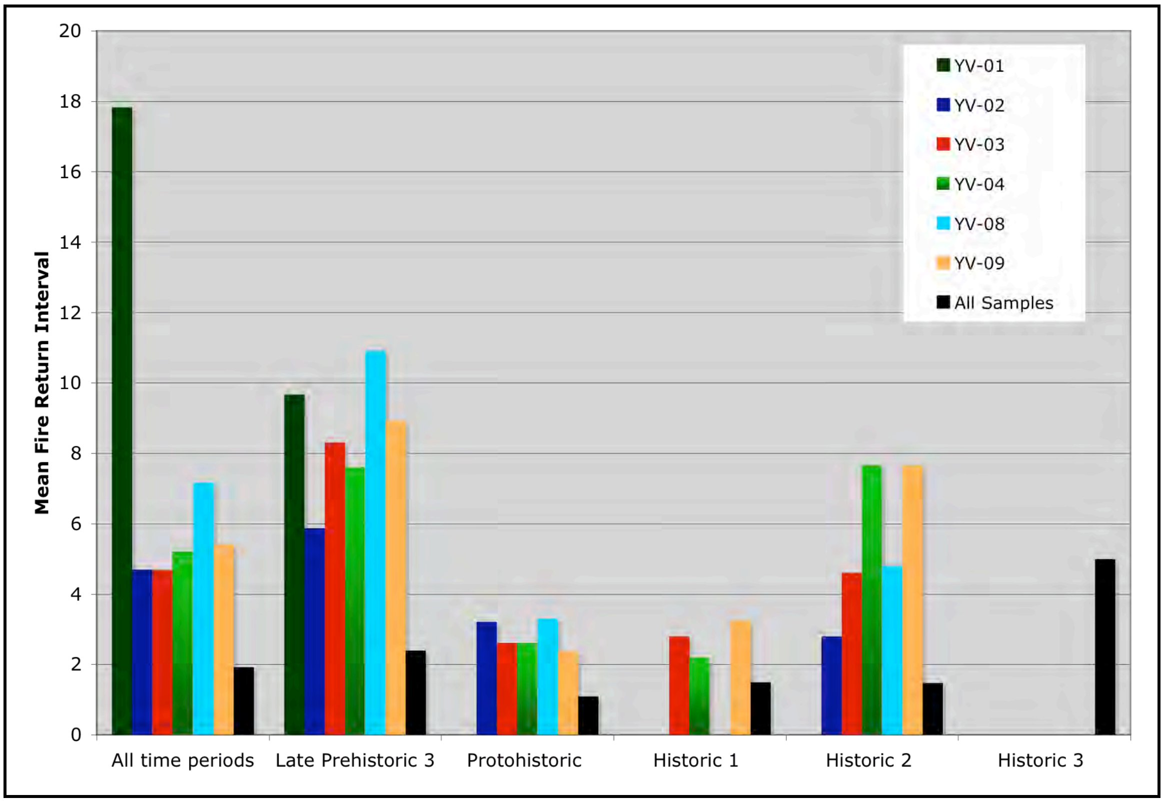

Figure 25: Comparison of Median Fire Return Interval by Location Over Time.

Intra-Village Comparisons by Land-Use Types

The focus of this study was to determine if patterns of fire use differed based on the inferred land-use patterns observed in existing archaeological and ethnographic data. To this end, sampling locations were compared based on the known anthropological land-use type: village-camp, gathering area and "control". Due to the changes over time observed during the previous analysis, each sampling location was analyzed in the different time periods, with the exception of Historic 3 period, which was dropped from the rest of the analysis.

Sap-pah'sam-mah

Samples associated with *Sap-pah'sam-mah* (CA-MRP-71) included three locations: YV-01, big leaf maple and bracken fern gathering area; YV-02, "control"; and YV-03, adjacent to the camp of *Sap-pah'sam-mah*. These areas were then tested to determine if there were intra-site differences based on land-use types.

The only statistically significant difference between land-use areas occurred when analyzed over the entire sample history (Table 14). The big leaf maple and bracken fern gathering area showed a significant difference from both the "control" and the camp locations, although no statistically significant differences were recognized within the analyzed time periods. The difference between YV-01 and the other two locations may have less to do with shifts in Native American fire use than a problem of sample size and proximity to the Merced River. Due to the limited sample size of YV-01 (n=5) statistical analysis could not be completed for the Protohistoric, Historic 1 or Historic 2 periods. The limited sample size may also the reason for the variations seen over the whole sample period. The close proximity of YV-01 to the Merced River and to Fern Spring showed in samples, the close proximity to stable water sources created highly complacent tree rings and limited the ability to cross date samples. The close proximity of YV-01 to the Merced River and Fern Springs may also have caused a lag in fuels drying (due to wetter conditions), which would have limited fire spread and intensity, and thus produce fewer scars.

Time Period	Gathering (YV-01) vs. "Control" (YV-02)	Gathering (YV-01) vs. Village (YV-03)	"Control" (YV-02) vs. Village (YV-03)
A.D. 1520-2004	**Significant (0.0045)**	**Significant (0.0001)**	Not Significant (0.7140)
Late Prehistoric 3 A.D. 1700-1800	Not Significant (0.1522)	Not Significant (0.4706)	Not Significant (0.2204)
Protohistoric A.D. 1800-1847	N/A	N/A	Not Significant (0.4213)
Historic 1 A.D. 1848-1863	N/A	N/A	Not Significant (0.3637)
Historic 2 A.D. 1864-1890	N/A	N/A	Not Significant (0.4304)

Table 14: Two-Tailed T-Test Comparison of Intra-Site Land-Use Types at Sap-pah'sam-mah

Kis'-se

Samples associated with *Kis'-se* (CA-MRP-76) were divided into three locations: YV-04, snakeroot gathering area; YV-08, "control"; and YV-09, adjacent to the village of *Kis'-se*. Comparison of the three different land-use types associated with *Kis'-se* showed no statistical differences between any of the use areas or any temporal periods (see Table 15).

Comparison of Land-Use between Sampling Locations 1 and 2.

In order to determine if there was a significant difference between the land-use areas at the two sampling locations, each gathering area (YV-01 and YV-04), control (YV-02 and YV-08), and village (YV-03 and YV-09) were compared using a two-tailed t-test.

The statistical comparisons showed no statistically significant differences between land-use types at the two locations, except of YV-01, as illustrated in Table 16. The significant difference between YV-01 and YV-04 is probably an effect of sampling size, as discussed previously in this chapter.

Time Period	Gathering (YV-04) vs. "Control" (YV-08)	Gathering (YV-04) vs. Village (YV-09)	"Control" (YV-08) vs. Village (YV-09)
A.D. 1520-2004	Not Significant (0.2753)	Not Significant (0.8268)	Not Significant (0.3892)
Late Prehistoric 3 A.D. 1700-1800	Not Significant (0.6268)	Not Significant (0.6764)	Not Significant (0.9190)
Protohistoric A.D. 1800-1847	Not Significant (0.4383)	Not Significant (0.9691)	Not Significant (0.3707)
Historic 1 A.D. 1848-1863	N/A	Not Significant (0.5718)	N/A
Historic 2 A.D. 1864-1890	Not Significant (0.6216)	Not Significant (0.9238)	Not Significant (0.2757)

Table 15: Two-Tailed T-Test Comparison of Intra-Site Land-Use Types at *Kis'-se*

Time Period	Bracken Fern (YV-01) vs. Snakeroot (YV-04)	"Control" (YV-02) vs. "Control" (YV-08)	*Sap-pah'sam-mah* (YV-03) vs. *Kis'-se* (YV-09)
A.D. 1520-2004	**Significant (0.0003)**	Not Significant (0.1605)	Not Significant (0.4339)
Late Prehistoric 3 A.D. 1700-1800	Not Significant (0.3643)	Not Significant (0.1594)	Not Significant (0.8666)
Protohistoric A.D. 1800-1847	N/A	Not Significant (0.9735)	Not Significant (0.9952)
Historic 1 A.D. 1848-1863	N/A	N/A	Not Significant (0.8576)
Historic 2 A.D. 1864-1890	N/A	Not Significant (0.2225)	Not Significant (0.3030)

Table 16: Two-Tailed T-Test Comparison between Land-Use Types at Locations 1 and 2

Comparison of General Land-Use Types

Due to the lack of statistical differences between the two sampling areas land-use types, similar land-use areas were combined and compared to each other. The two-tailed t-test showed no statistical differences between the land-use types (see Table 17 and Figure 26).

Time Period	"Control" vs. Village	Gathering vs. "Control"	Gathering vs. Village
A.D. 1520-2004	Not Significant (0.6355)	Not Significant (0.2011)	Not Significant (0.0570)
Late Prehistoric 3 A.D. 1700-1800	Not Significant (0.6598)	Not Significant (0.4971)	Not Significant (0.7384)
Protohistoric A.D. 1800-1847	Not Significant (0.3410)	Not Significant (0.4471)	Not Significant (0.0840)
Historic 1 A.D. 1848-1863	Not Significant (0.8365)	Not Significant (0.6772)	Not Significant (0.5902)
Historic 2 A.D. 1864-1890	Not Significant (0.2323)	Not Significant (0.0348)	Not Significant (0.6094)

Table 17: Two-Tailed T-Test Comparison by Land-Use Type.

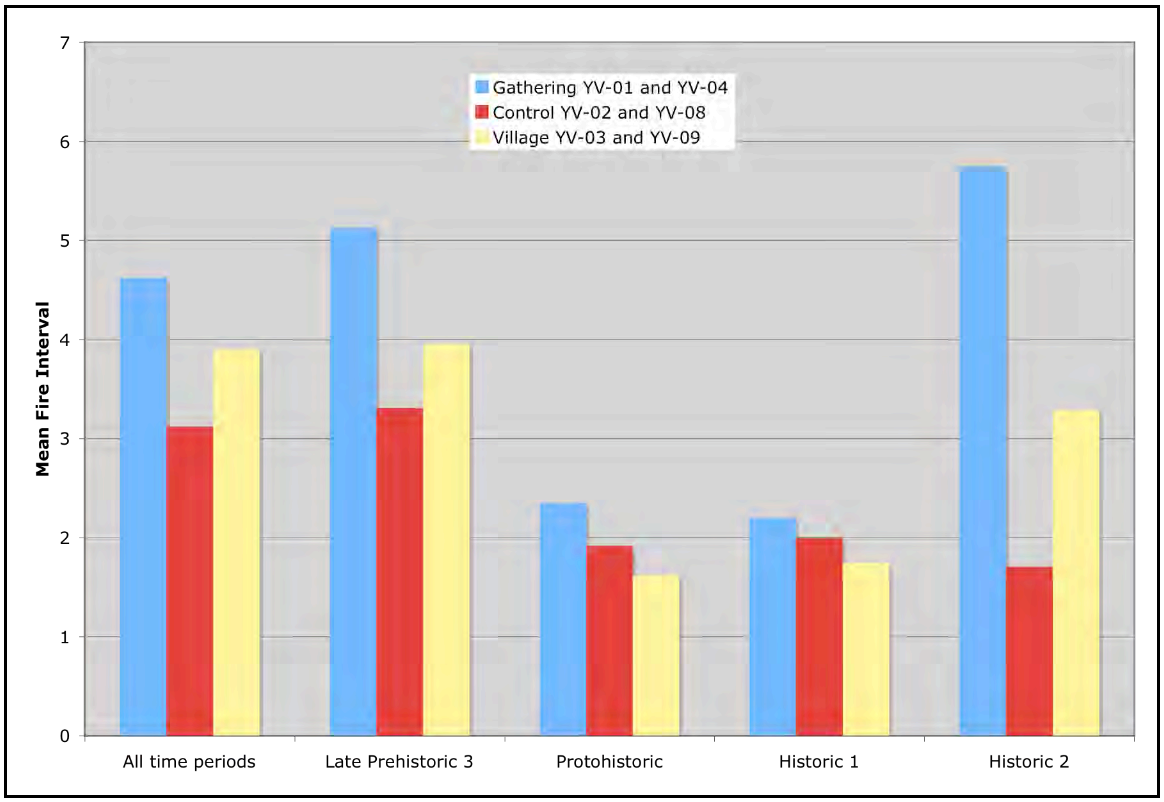

Figure 26: Mean Fire Return Interval by Land-Use Types over Time

Differences by Village Size

As stated in Chapter 1, C. Hart Merriam (1917) identified different types of villages. He identified *Kis'-se* as a large village while *Sap-pah'sam-mah* was a village or camp (Table 5). The archaeological remains confirm that there was at least a difference in the extent between the two villages. *Kis'-se* (CA-MRP-76) encompasses 1.6 hectares while *Sap-pah'sam-mah* (CA-MRP-71) extends only 0.2 hectares. To determine if the size of the village potentially had an effect on fire return intervals all samples associated with *Sap-pah'sam-mah* (YV-01, -02, and 03) and *Kis'-se* (YV-04, -08 and -09) were combined and statistically compared using a two-tailed t-test and a chi-squared test.

The two-tailed t-test showed no statistically significant differences in the time periods analyzed; see Table 18 and Figure 27. The two locations were then compared for synchronicity in fire dates to see if fires observed at the two villages could have been produced by the same fire events. In no year were ≥25 percent of the samples scarred when compared using ≥10 percent of the samples, and only five years (1775, 1783, 1800, 1841, 1864) showed potential for being produced by the same fire.

The high frequency of fires and lack of synchronicity between villages suggests that the fires were small scale, low intensity ground fires and not crown fires. The two locations are separated by Bridalveil Creek and its wetlands, features that could potentially inhibit ground fire spread. Bridalveil is a one of the few perennial creeks in Yosemite Valley because it is feed by Ostrander Lake rather than seasonal precipitation, which would limit low intensity ground fires in all but the most extreme drought conditions.

The low frequency of synchronicity within each village suggests that the fires observed in this study were low intensity with small spatial spread. These small fires were probably set in rotational pattern created a highly dynamic patchwork of different vegetation communities and communities in various successional stages.

	Sap-pah'sam-mah vs. *Kis'-se*	
Time Period	MFI Difference (p – two tail t-test)	Years with synchronicity of ≥10% samples scarred
A.D. 1520-2004	Not Significant (0.8146)	
Late Prehistoric 3 A.D. 1700-1800	Not Significant (0. 8576)	1775, 1783, 1800
Protohistoric A.D. 1800-1847	Not Significant (0.3171)	1841
Historic 1 A.D. 1848-1863	Not Significant (0.9102)	
Historic 2 A.D. 1864-1890	Not Significant (0.8402)	1864

Table 18: Statistical Comparison of Village Type by Time Period

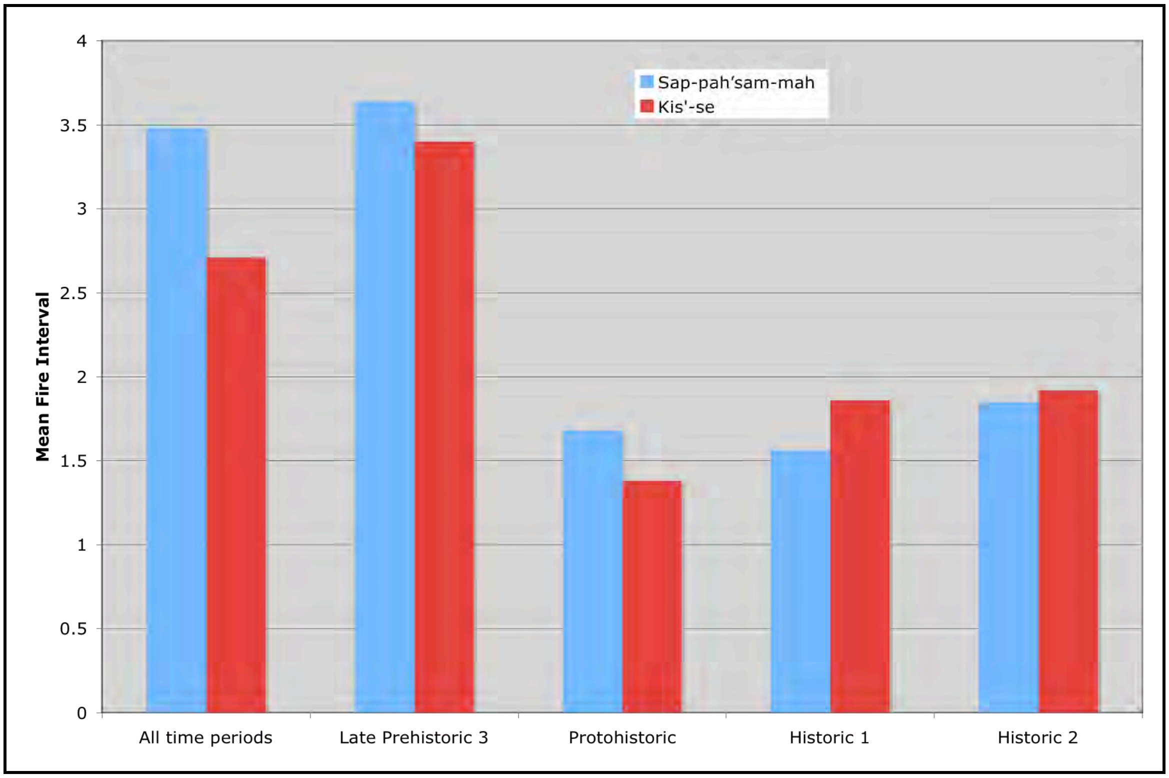

Figure 27: Mean Fire Return Interval by Village Type

Chapter 6: Implications and Conclusions

As stated in Chapter 5, the Native American inhabitants of Yosemite Valley produced the fire patterns observed in this study. As such, the differences observed, either spatial or temporal, can be attributed to different cultural phenomena. While Chapters 4 and 5 explored the specific findings from this study, this chapter will explore implications of these findings and highlight how these findings can be expanded upon to gain greater understanding of Native American interactions with fire.

Lack of Intra-Site Differences

The original hypothesis speculated that differences in land-use such as occupation and gathering areas would create a patchwork of different fire regimes, and this would manifest itself with village areas showing little or no fire; gathering areas having intense MFI of less than 5 years; and "controls" having a moderate MFI of above 5 years. As reported in Chapter 5, the observed fire regimes showed no statistical differences between different land-use areas, see Table 17 and cause the original hypothesis to be rejected.

Two major obstacles hindered this study: (1) the inability to determine if lack of fire scarred trees was a product of prehistoric fire exclusion or historic and modern disturbance factors impacting preservation; and (2) limited knowledge of traditional gathering areas and resource acquisition zones or site catchment areas.

Lack of Fire

Since this study sought to compare human disturbance influences with potential for closely spaced fire return intervals, it was determined that large sample sizes were required and locations with few or no fire-scarred trees were eliminated from the study. This choice may have created a bias against core areas where occupation may have created large-scale impacts to fuels and the Native Americans excluded fire. Due to differential preservation and modern influences, including natural mortality and modern development, the lack of fire scarred trees does not necessarily mean that fire did not occur in a particular location, but to determine the exact cause which produced a lack of fire scars would have required both historical research and vegetation studies that were far beyond the ability and scope of this study.

Anecdotally, survey revealed locations that had a distinct lack of fire-scarred trees; this included an area east of Kis'-se. Due to the absence of fire-scarred trees, this area was excluded from this study, however; it is unknown if this was a product of prehistoric occupation, historic vegetation manipulations or differential preservation.

Site Catchment Areas

As previously stated in Chapter 1, our understanding of prehistoric human cultures, settlement patterns, and resource acquisition through archaeology is limited by preservation, management decisions, and limitations of a science based on material culture. Sierran archaeology is also limited in its ability to discern resource acquisition beyond lithic materials as the highly acidic soils limit the preservation of faunal and flora remains. Due to the limited ability of Sierran archaeology to gain insight on site catchment areas, one must turn to ethnographic and ethnohistoric studies to expand our knowledge in this arena. This is where vegetation studies and dendrochronological studies can expand upon ethnographic and archaeological data to expand our understanding of prehistoric land use.

This study showed there was no statistically significant difference between land-use patterns either within villages and between general land-use types. The main reason for this lack of difference probably steams from our very limited understanding of subsistence patterns and needs in the Sierra Nevada.

While Yosemite Valley is one of the few areas within the Sierra Nevada with documented traditional gathering areas, the extent of this knowledge is still limited. The current documentation of 22 plants (Table 8) is a small percentage of the 250 different plants known to have been used by the Southern Sierra Miwok. Additionally, the documented plants and their locations are based on modern ethnographic interviews and not historic documentation of the vegetation and its cultural utilization. As such, the documentation is based on modern land and plant use, which may not mimic prehistoric and early historic land-use or vegetation patterns.

It is speculated that the main reason for lack of statistical differences between MFI at the different land-use areas used in this study was that all the sampling areas were located within areas close proximity to locations known to have had continuous habitation during the period of interest. Yosemite Valley is small enough that a person could easily hike from one end to another and back within less than a day making the resources from through out the valley accessible to any village. As stated in Chapter 3, even prior to sampling it was acknowledged that, at a minimum, the control areas would have been used as a travel route between the village and the gathering site. The lack of statistical difference between all locations indicates that all areas were at least equally influenced, if not equally manipulated and utilized by the *Ahwah'-nee*.

As stated earlier, the spatial analysis of fires showed that there was a pattern of rotational burning. Small fires were set in the different locations in different years. This probably created a highly dynamic patchwork of different vegetation communities and communities in various successional stages. This mosaic of successional stages had direct impact on the energy expended in subsistence. Less energy is expended in acquisition if multiple patches of different foodstuff or material collection areas were maintained near habitation sites. The close proximity of these patches to villages reduces the energy and dangers accompanying travel and foraging further away from villages.

The number of archaeological sites in Yosemite Valley indicates that settlement patterns shifted through time. These shifts may have been relatively small with village core zones shifting from a few meters to a kilometer but this movement probably meant that the core, biodeterioration zone, etc. for an abandoned village lay within the arena of resource acquisition of an adjacent, occupied settlement; therefore, the fire history may reflects not only occupation within the studied village, but also those that surround it.

Anthropogenic Fire and Culture Change in Yosemite Valley

The statistically significant differences observed during the different cultural periods (Table 13 and Figure 25) can give some insight on cultural changes among the Native

American inhabitants between the 17th and the 20th centuries. As indicated in Chapter 5 and Table 13, the MFI showed a significant change between the Late Prehistoric 3 period and the Protohistoric Period. The MFI then remained statistically stable throughout the Protohistoric, Historic 1 and Historic 2 periods and significantly changed following 1890

Settlement Pattern Changes in Late Prehistoric and Protohistoric Periods

The differences in MFI indicate that fire intervals decreased following 1800 indicating that more fire activity was taking place in the Protohistoric period than in the Late Prehistoric 3 period. This is at odds with commonly held beliefs that the *Ahwah'-nee* culture was severely impacted during the Protohistoric period. It is often cited that Yosemite Valley was abandoned at c. A.D. 1800 and a group under leadership of Chief Tenaya return in the 1830s or 1840s (Bunnell 1990 [1880]; Hull 2002; Reynolds 1959). Hull even stated that:

> The 16 percent random sample of the residential sites or portions thereof indicates temporary abandonment of the area around AD. 1800 as native people left Yosemite Valley for the eastern side of the Sierra. Relatively few sites (or, more correctly, sub-site areas) were evidently occupied, if indeed any were occupied for about 20 years thereafter. (Hull 2002:516-517)

Despite Hull's (2002) suggestion that the sample indicated a depopulation of the entire valley, excavations within Yosemite Valley are distinctly skewed towards sites located in the northeastern portion of the valley. In 2002, of the 104 sites with a prehistoric component in the valley, only 5% (n=19) of the sites had been excavated and of these excavations, only one lies on the south side of the Merced River and none occur in the western third of the valley. The small sample size and the disparity in representative samples from both north and south of the Merced River, and the upper and lower sections of the valley restrict our ability to unequivocally detect changes in settlement patterns within the valley.

Changes in fire return intervals suggest that subsistence and/or settlement patterns changed substantially in the Late Prehistoric 3 period and stabilized in the Protohistoric and early Historic Periods. The decrease in fire return intervals show that more fire was being applied to the southwestern portion of Yosemite Valley post A.D. 1800. The cause of this change is unknown but three different changes in settlement patterns could account for this: (1) population within Yosemite Valley shifted between villages or from previously occupied villages to new locations (i.e. shifting from the north side to the south side or east to west), thus, shifting gathering locations; (2) increased seasonal use of the western portion of the valley; (3) new populations of Native Americans began utilizing the western portion of the valley.

As noted in Chapter 1, Bunnell (1990 [1880]), Clark (1904) and Bennyhoff (1956) all indicate that the *Pohonichi* occupied Pohono Meadows (now Bridalveil Meadows) in summer. Influences from Spanish settlement caused changes in population and tribal relationships which could have caused shifts in settlement patterns for both the *Ahwah'-nee* and the *Pohonichi*. Ethnographic data suggests there was some land conflicts in the western portion of Yosemite Valley, "there were formerly others extending as far down as Bridal-Veil Fall, which were destroyed in wars that occurred before the whites came" (Powers 1976 [1877]:365). The increased fire use could have been caused by shifts in

Ahwah'-nee and/or *Pohonichi's* territories with increased dependence on plant products from the southwestern portion of Yosemite Valley.

Fire Use during the Early Historic Period

Following the cultural changes that occurred prior to A.D. 1800, the use of fire remained statistically stable throughout the early historic periods. This stability remained despite large-scale, historically documented, changes that occurred in both the region and Yosemite Valley, in particular (e.g. 1849 California gold rush, Mariposa Battalion, Euro-American occupation in Yosemite Valley, etc.). The relative stability of fire use throughout this period speaks to the relative continuity of subsistence patterns and non-material culture aspects of culture (e.g. management of basketry materials, fire-proofing settlements) despite changes in material culture and the influx of Euro-American goods. This maybe directly related to the Miwok's restricted access to the white economic system. As Van Bueren stated for this period "Almost every nontraditional artifact that was adopted by the Miwok had a functional analogue of some kind, suggesting that traditional lifeways may have had a significant influence upon the direction of Miwok culture change during the historic period" (Van Bueren 1983:9). Especially during the Protohistoric and Historic 1 periods, Yosemite Valley was distant enough from Euro-American influences that the inhabitants of Yosemite Valley had to retain on traditional lifeways for subsistence. The continuation of traditional subsistence patterns into the Historic 2 period despite the ever increasing Euro-American infrastructure and occupation probably is a product of both the a restricted access white economic systems and inability of Yosemite Valley to produce enough food for Euro-American occupants and visitors. This limited access to nontraditional foods would have required Native American's to produce their own traditional foodstuffs. Sources of basketry material would also have been highly sought after, because Native American women made baskets for sale to tourists (Bates and Lee 1990).

In light of more intensive Euro-American occupation, it seems unlikely that traditional subsistence patterns were retained beyond the southwestern portion of the valley. Lamon's occupation of the east end of the valley and the early development of the old Yosemite Village in the south central portion of the valley may have caused the southwestern portion of the valley to become a refugia for traditional subsistence patterns.

Traditional Fire Use during the Historic 1 and 2 Periods

While it was expected that subsistence patterns remained stable in the Historic 1 Period, it is surprising that there is not a substantial change following the signing of the Yosemite Grant Act in 1864. During the early historic period while the *Ahwah'-nee* were chased or removed from Yosemite Valley three times, between 1851 and 1853, although these departures were temporary, ranging from a few days to a few months. Beginning in 1854 tourists began entering the valley but numbers remained low, averaging 70-80 visitors a year between 1855 and 1864 (Hutchings 1886; Taylor 1936). It was not until 1861 that the first Euro-American, James Lamon stayed the winter in the valley and continuous occupation by non-native peoples began (Taylor 1936).

It was expected that following the California State Legislature Act, of 1866, which passed the Yosemite Grant to the State of California there would be a significant change in broadcast burning. Formal legislation even made it illegal for a person to set fires.

> It shall be unlawful for any person willfully to … cut down or carry off any wood, underwood, tree, or timber, or girdle, or otherwise injure any tree or timber, or deface or injure any natural object, or set fire to any wood or grass upon said premises…Any person committing either or any of said acts … shall be guilty of a misdemeanor, and on conviction thereof, shall be punished by fine, not exceeding five hundred dollars, or by imprisonment in the County Jail… (Commissioners to Manage the Yosemite Valley and the Mariposa Big Tree Grove 1867:24)

Despite the legislation and increasing tourism (Figure 28), fire continued to be used on the landscape in the southwest portion of the valley. Between 1854 and 1890, there was almost a fire a year in this portion of the valley; in fact, in only nine years did fires not occur (Table 18). The reasons for this lack of significant difference in fire use maybe two-fold: (1) the southwest portion of Yosemite Valley was refugia for traditional gathering and fire use; (2) sympathetic or at least indifferent oversight by the Yosemite Grant Guardians prior to the Yosemite Valley coming under the jurisdiction of the U.S. Army.

The southwestern portion of the valley may have been one of the few locations available for Native Americans to use fire and exploit traditionally gathered plants. By the end of the 19th century the majority of the eastern portion of the valley was grazed or under cultivation (Jones 1965; Figure 27).

This also highlights native peoples, ability to adapt and maintain practices despite the oversight of the Yosemite Guardians. This may be related to the relationship the early guardians of the Yosemite Grant had with native peoples. Galen Clark (1866-1880, and 1889-1897) and James Hutchings (1880-1884) had both lived among the Miwok and may have been disinclined to interfere with traditional subsistence patterns. Following Hutchings removal as a guardian, fires began to decrease with the last substantial burning occurring in 1888, but fires did not cease until 1892 at *Sap-pah'sam-mah* and 1926 at *Kis'-se*.

Decreased fire use coincides with the Yosemite Act of 1890 in which Congress set aside areas surrounding Yosemite Valley and created Yosemite National Park. Guardianship of these lands fell to the U.S. Cavalry. Yosemite Valley was still administered by California until 1906 and soldiers were discouraged to enter Yosemite Valley. When crossing the valley, the Cavalry was not permitted to camp east of Bridalveil Meadow (Johnston 1995). Beginning in 1891 the presence of the Cavalry camping in Bridalveil Meadow may have impacted burning at *Sap-pah'sam-mah*, but the area may have been equally impacted by new rules and regulations adopted by the commissioners of the Yosemite Grant on June, 1890, which included giving law enforcement authority to the guardian (Johnston 1995).

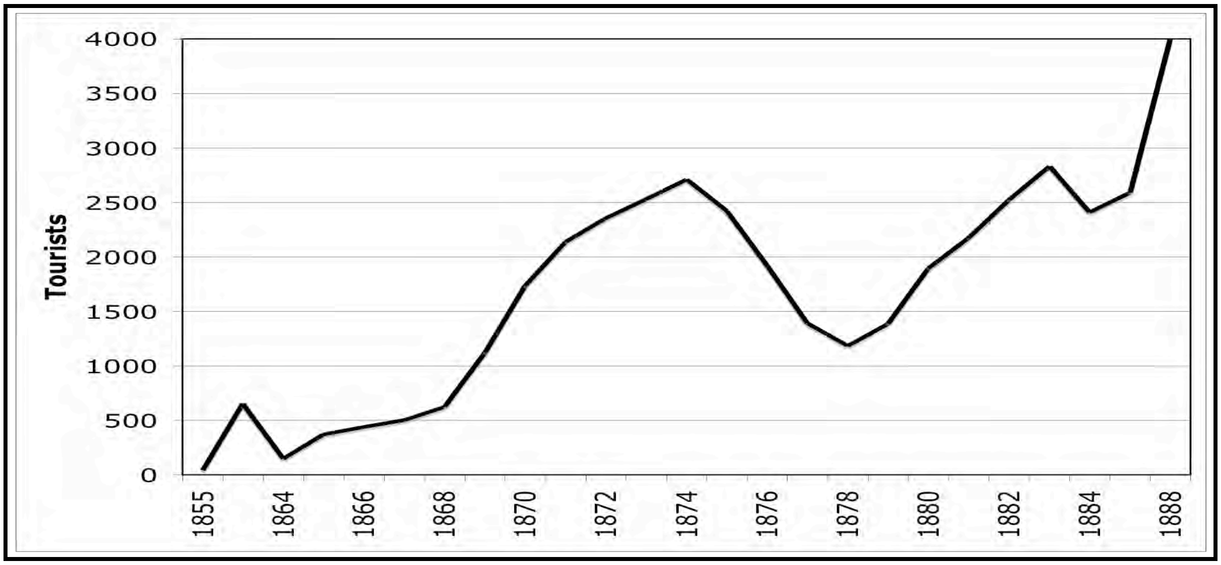

Figure 28: Tourist Counts in Yosemite Valley 1854-1890 (Hutchings 1886; Johnston 1995)

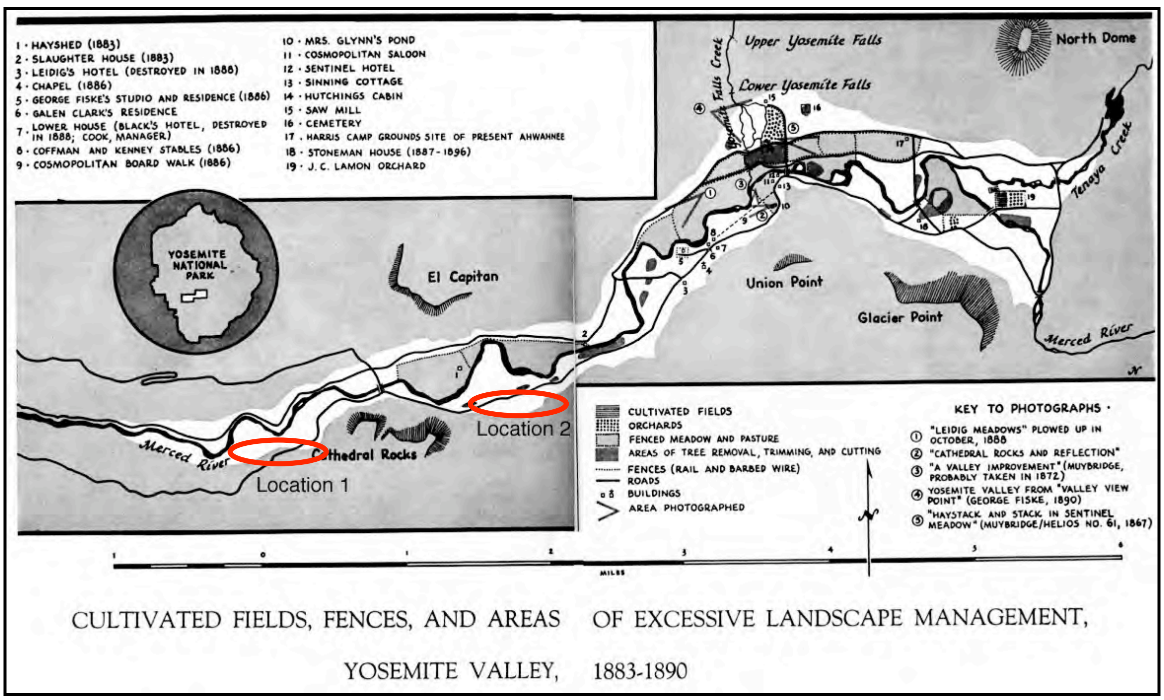

Figure 29: Euro-American Cultivated Fields, And Excessive Landscape Management, Yosemite Valley, 1883-1890 (Jones 1965)

Anthropogenic Fire in a Larger Context

Implications and the Problems in Understanding Native American Fire Use

The use of location specific environmental data in conjunction with archaeological studies can help anthropologists gain a greater understanding of subsistence and settlement patterns, especially in the Sierra Nevada where preservation of archaeological floral materials is minimal and the use of fire history and vegetation pattern studies can lead to insight on catchment areas and plant uses. For the most part California archaeologists have ignored these data sets. While some anthropologists and geographers, most notably Henry T. Lewis, Omer Stewart, Carl Sauer, and M. Kat Anderson, have championed Native American fire use, most of our knowledge comes from ethnographic data and generalized culture patterns. This scope does not lend itself to site-specific archaeological and environmental studies, and has left Native California's use of fire as a generalized side note within large studies. This study shows that when location specific fire history and archaeological data are used together we can gain a better understanding of culture change than through archaeology alone.

Common Cultural Background

Some have argued that Native Americans could not and did not move "the vegetation mosaic of the Sierra Nevada to a condition outside of the natural realm of historical variability" and that "lightning incidences *appears* to be sufficient in the Sierra Nevada to account for pre-European fire frequencies" (Parker 2002:237 emphasis added). This study has shown that modern lightning incidences within Yosemite Valley were not sufficient to account for pre-European fire frequencies. While the exact reasons for burning in relationship to cultural differences in land-use patterns remains unclear, it can be said that the Southern Sierra Miwok did use fire to manipulate vegetation patterns outside the "natural realm". In addition, from an anthropological standpoint the Southern Sierra Miwok culture is not anomalous. Archaeological data show no major difference between the material culture of the *Ahwah'-nee* and other Sierra Miwok tribelets, or other groups in the Sierra Nevada or Great Basin. In fact "there is no reason to believe other Miwoks used fire less than those in Yosemite, nor is there any basis for assuming that the fire outside of Yosemite Valley had less pronounced influence on the plant cover than did those in Yosemite" (Anderson 1993c:174).

Despite the lack of anthropological data denoting distinctive differences in cultural use of fire, why then do the majority of fire history studies fail to suggest humans as an ignition source while they do not test to determine if local lightning patterns are sufficient to account for fire frequencies? Omer Stewart suggested "our difference of opinion stems mostly from a different weighting of the evidence" (Stewart 2002:290). In addition, the lack of insight maybe a problem of differences in the questions being asked, basic assumptions within different studies, sampling methods, and the lack of cross disciplinary understanding between anthropologists and fire historians.

Williams (2000) noted that most studies asserting to document Indian manipulation of ecosystems through fire use suffer from basic methodological shortcomings:

- *Sweeping generalizations*: (e.g., "Indians burned the prairies"), whereas others are very specific (e.g., "The women of the Kalapuya Indians burned the prairies and foothills of the middle Willamette Valley every fall").
- *Underreporting:* Some studies focus on instances of fire use by Indian people that did not result in ecosystem changes.
- *Overreporting:* Some studies attribute ecosystem changes to Indian fire use when those changes have natural explanations.
- *Misinterpretation:* Some studies misinterpret the unfamiliar language and perspectives— far removed from those of today—in source materials that can be up to four centuries old.
- *Reliance on secondary sources:* Some studies cite other studies to support their conclusions instead of examining the primary sources of evidence.
- *Reliance on hearsay:* Some studies rely on reports of Indian fire use, especially by early settlers, that amount to hearsay or third-party accounts.
- *Overgeneralization:* Some studies fail to account for regional and tribal variations in the use of fire.
- *Imprecision:* Some studies fail to name the tribe or band that used fire in the ecosystem, the exact location or even the general area of fire use, or the purposes of burning (such as hunting or improving pasture for game). (Williams 2000:9)

While Williams focused his remarks towards proliferation of generalized statements based on ethnographic data expounded upon in the literature, it must be pointed out that all studies should strive to avoid the shortcomings he outlines. As such, some of the basic assumptions observed during the course of this study are explored below. This is not exhaustive, but it highlights the need for integration of multiple data sets and the need for testing basic assumptions.

Hunter Gatherer Intensification: Archaeology and Fire

> Hunter-gatherers are necessarily responsive to local environmental fluctuations and perturbations, whether natural or man-made. Like men everywhere, hunter-gatherers cannot long ignore disruptions which adversely effect their day-to-day subsistence. However, because their subsistence strategies are more directly and immediately linked to environmental imperatives, they must soon make accommodations or else

become one more evolutionary failure. (Lewis 1993:56)

Our understanding of how hunter gatherers modified and maintained local environments and their subsistence interactions was largely ignored until the recently, the few exceptions being, Jones (1969), Lewis (1972; 1973; 1989), and Stewart (2002). Even today the vast majority of recent publications only state that Native Americans used fire and then outlines the reasons fire was used (i.e. hunting, plant intensification, etc.). While ethnobotonists and anthropologists have delved more intensely into specific reasons and how much Native American's used fire, the basis for this has been management-based for specific applications (i.e., ethnographic questions of why and when a Native Americans would burn, in order to develop prescribed burn prescriptions and/or impacts to specific plant types). There has been little synthesis of data into anthropological theory of how fire integrated in to large-scale cultural dynamics. Lewis (1972) and Bean and Lawton (1993) have both suggested that intensification of subsistence resources through the use of fire may have acted as a barrier to agricultural expansion, most specifically in California. However, this question has been largely ignored, leaving plant intensification through fire as another tool to be mentioned. However, it is usually relegated to having less impact on culture change than the introduction of the bow and arrow or ground stone use. Yet, as mentioned previously, fire has the potential for much larger impacts on spatial, temporal, and number of species impacted through its use or misuse. The application of fire is such a powerful tool that it can cause ecological effects, which shift vegetation types, thus impacting the fauna outside the ‘natural’ patterns that would be seen if fire was not applied. The ability to cause or not cause these shifts in vegetation at specific locations may have had an enormous impact on the culture patterns in California if not all of North America. That stated, it must be noted that while fire can cause wholesale shifts in vegetation patterns. Its ability to shift vegetation is dependant on the original vegetation to which fire was applied and the geological, elevational, and weather variations that occur through out the world (e.g. application of fire will not allow a Giant Sequoia grown in the desert Southwest but it will allow the expansion or contraction of Giant Sequoia range within the Sierra Nevada).

Fire History and Native American Influences

For researchers seeking to explore human influences on fire regimes the appropriate use of fire history studies must be explored. Most fire history studies are not designed to test for Native American influences on the fire regime. The inability to distinguish between human and lightning ignitions in tree rings and sampling strategies of many fire history studies do not lend themselves to comparisons to archaeological data. Many of the published fire history studies, designed to determine baseline fire regime for a location, often focus on large fire years to determine the interaction of climate and fire and how modern Euro-American cultures influenced fire regimes. These studies may lend themselves to studying the interaction of local populations to large-scale fire events and disruption in native cultural practices, but the published data from many of these studies does not address Native American influences on fire regimes. Many studies do not indicate what tribal group lived in the region and usually there is no indication as to proximity from known concentrations of archaeological sites the study took place. Of the studies that do indicate the tribal group in the area, they often use broad regional histories that fail to take into account the ethnographic and archaeological data for the study area and the wide variety of uses Native Americans had for fire.

This leads to two major problems: (1) a basic assumption that all pre Euro-American settlement fire regimes are "natural" unless findings are aberrant, i.e. outside the range of "natural" lightning fire regimes, and (2) A lack of studies which explicitly and quantitatively determine ignition sources.

"If Native American groups altered past fire regimes, then distinct patterns of fire occurrence indicating such use may be apparent in certain fire chronologies" (Seklecki, et al. 1996:239). This assumes that humans cannot, do not, or choose not to mimic "nature". This neglects the possibility that in the face of climate change humans may have created fire regimes, which mimicked previous "natural" regimes as a way to maintain specific plants or vegetation patterns vital to subsistence. They could also have transplanted a "natural" fire regime from one location to another location in which lightning is not active, i.e. mimicking a MFI from a valley rim in the valley bottom. While it was initially hypothesized that this study could detect different anthropogenic fire signatures, the lack of sampling outside of site catchment areas limited the observable differences that might occur. As such, the assumption that anthropogenic fires are always aberrant from natural still remains to be tested.

From a purely climate based view the determination of ignition source may not be needed or appropriate because factors influencing large scale fire events are climatic and fuels based regardless of ignition source and climate can limit fire regardless of fuels or ignition source, i.e. drought creates higher fire danger, while high fuel moistures inhibit fire spread. From an anthropological view, the determination of ignition source can increase our understanding of subsistence and culture change. For land managers, there are implications as to how much natural process vs. management actions are needed to restore and maintain a desired landscape.

In order for fire history studies to aid archaeologists in answering questions of subsistence, land-use patterns, and culture change, sampling strategies must be examined critically. It is known that sample size can have an impact on MFI, and sample location such as slope and aspect can influence fire regimes (Agee 1993; Caprio N.d.). It is common for fire history studies to report large-scale watershed landscapes, without analysis of intra watershed differences. As fire history analysis has gained greater sophistication and awareness of these potential influences, including slope and aspect, sampling strategies have changed, but the potential differences and influence of anthropogenic ignition sources are generally not integrated into sampling methods and are not analyzed. If fire history studies are going to test for potential human influence on fire regimes, they must recognize a site-specific human occupation. Native American occupation is not continuous throughout all geographical locations, and the interactions occur at different scales, temporal and spatial, than most fire history studies are designed.

As noted in Chapter 2, within the Yosemite region 85% of archaeological sites are <10,000 sq meters. Assuming that humans do have a continuum of impact radiating out from these central locations, a sampling method of one or two well scarred trees per hectare over a large watershed may create very small samples per land-use area and limit the ability of the sample to observe small scale variability and human disturbance factors.

The comparison of site-specific fire history data to large-scale archaeological overviews rather than site-specific archaeological data may also lead to different conclusions. Based on early archaeological overviews, many have expanded views that human occupation was greater at lower elevation and reduced at higher elevation in the Sierra Nevada and these differences in occupational tendencies could be equated to human disturbance being greater at low elevation. However, when recent archaeological data are analyzed, the differences between low and high elevation occupation and its relationship to ecological impacts may not be clear-cut as presented in the archaeological overviews. As shown in Table 19, the land base occupied, based on archaeological manifestations, does not follow a linear continuum from low elevation to high elevation. Higher elevation has a larger percentage of land occupied than lower elevations. While this basic analysis does not take into account differences in seasonal and year round occupation that may have had different impacts to vegetation and fire history it highlights the potential for misinterpretation of human influence when the most recent location specific data is not used.

Landscape	Elevation	Acres	Survey acres	% survey	Sites	Site area (Acres)	% of land occupied*
Upper Yosemite Valley	4000	3514	1533	44%	66	136	9%
Lower Yosemite Valley	3880	4585	1343	29%	53	67	5%
Tamarack Flat	6400	4618	609	13%	18	34	6%
Tuolumne Meadows	8560	4588	1059	23%	89	148	14%
Dana Meadow	9700	10836	575	5%	74	82	14%

Table 19: Utilized Land Base Use based On Current Archaeological Manifestations (* % of land occupied = acres covered by archaeological manifestations vs. acres surveyed)

Conclusions

This study supports previous studies (Ernst 1943a, 1943b, 1949, 1961; Reynolds 1959) in supporting the hypothesis that *Ahwah'-nee* manipulated vegetation patterns within Yosemite Valley. While most studies have focused on meadow systems, this study showed that areas surrounding villages and traditional gathering areas outside meadow systems were also greatly influenced by human fire regimes. By developing a fire history study based on archaeological and ethnographic data, fire regimes can be used to gain a greater understanding of prehistoric cultures. While the study did not support the hypothesis that different land-use patterns would exhibit different fire regimes, this is likely a problem of modern definitions of land-use patterns does not correctly identifying prehistoric cultural land-use, data resolution, sampling locations, and/or sampling size.

While Yosemite Valley is relatively unique in its geographic and geological setting and lack of lightning ignitions, it is not unique in the cultural manifestations of the Native American occupants, the intensity of prehistoric human occupation, population density, or cultural manifestations of that culture. The Native American occupation of Yosemite

Valley is very similar to numerous mid-elevation valleys in the Sierra Nevada. As such this study shows that fire history studies integrated into an archaeological study can help gain a greater understanding of culture change and subsistence patterns, especially in the potential use as a way of defining resource acquisition areas. It also raises questions as to how the lack of integration of archaeology and fire history studies limits a studies ability to identify ignition source and may thus directly relate to identification of a natural or an anthropogenic fire regime.

The full range of impacts from fire, both ecologically and culturally, remains to be explored. Integrating fire history studies into native culture studies could offer amazing insight into our understanding of subsistence patterns, culture change and gender foraging studies, but in order to produce meaningful, unbiased insights, many of the basic assumptions need to be tested in a variety of ecological and cultural settings. Basic questions of proximity between culture and fire ignition needs to be explored in order to test many of assumptions, which permeate both archaeology and fire history studies.

LITERATURE CITED

Agee, James K.

1993 Fire Ecology of Pacific Northwest Forests. Washington, D.C.: Island Press.

Aginsky, B. W.

1943 Culture Element Distributions: Xxiv, Central Sierra. Anthropological Records 8(4):393-468.

Anderson, M. Kat

1988 Southern Sierra Miwok Plant Resource Use and Management of the Yosemite Region: A Study of the Biological and Cultural Bases for Plant Gathering, Field Horticulture, and Anthropogenic Impacts on Sierra Vegetation. Unpublished Master's thesis, University of California, Berkeley.

1990 Yosemite's Native Plants and the Southern Sierra Miwok. Yosemite Association (Summer):12-15.

1992 From Burns to Baskets. California Indians and the Environment, News from Native California Special Reports #1:6.

1993a Indian Fire-Based Management in the Sequoia-Mixed Conifer Forests of the Central and Southern Sierra Nevada: Submitted to Yosemite Research Center, Yosemite National Park.

1993b The Mountains Smell Like Fire. Fremontia 21(4):15-20.

1993c Native Californians as Ancient and Contemporary Cultivators. In Before the Wilderness: Environmental Management by Native Californians. T.C. Blackburn and M.K. Anderson, eds. Pp. 151-174. Menlo Park, CA: Ballena Press.

1996 Tending the Wilderness. Restoration and Management Notes 14(2):154-166.

1999 The Fire, Pruning, and Coppice Management of Temperate Ecosystems for Basketry Material by California Indian Tribes. Human Ecology 27:79-90.

Anderson, M. Kat, and Michael J. Moratto

1996 Native American Land-Use Practices and Ecological Impacts. In Status of the Sierra Nevada: Sierra Nevada Ecosystems Project Final Report to Congress. M. Barbour, ed. Pp. 09-01 - 09-20, Vol. II Assessments and Scientific Basis for Management Options. Davis, CA: University of California Centers for Water and Wildland Resources, Davis.

Anderson, M. Kat, and Gary Paul Nabhan

1991 Gardeners in Eden. Wilderness Fall:27-30.

Anderson, M. Kat, and David L. Rowney

1998 California Geophytes: Their Ecology, Ethnobotany, and Conservation. Fremontia 26(1):12-18.

Anderson, R. Scott, and Scott Carpenter

1991 Vegetation Change in Yosemite Valley, Yosemite National Park, California, During the Protohistoric Period. Madrono 38(1):1-13.

Arkush, Brooke

1993 Yokuts Trade Networks and Native Culture Change in Central and Eastern California. Ethnohistory 40(4):619-640.

1995 The Archaeology of Ca-Mno-2122: A Study of Pre-Contact and Post-Contact Lifeways among the Mono Basin Paiute. Volume 31: University of California Press, Berkeley.

Arno, Stephen F., and Kathy M. Sneck

1977 A Method for Determining Fire History in Coniferous Forests of the Mountain West. Ogden, Utah: Intermountain Forest and Range Experiment Station Forest Service U.S. Dept. of Agriculture.

Aschmann, Homer

1959 The Evolution of a Wild Landscape and Its Persistence in Southern California. Annals of the Association of American Geographers 49(3 Part 2 (Sept)):34-56.

Baisan, Christopher H.

1990 Fire History of the Rincon Mountain Wilderness, Saguaro National Monument. San Francisco: Western Region National Park Service Dept. of the Interior.

Barrett, S. A., and Edward Winslow Gifford

1976 [1933] Miwok Material Culture: Indian Life of the Yosemite Region. Yosemite National Park, Calif.: Yosemite Natural History Association.

Barrett, S. A., and Alfred Louis Kroeber

1908 The Geography and Dialects of the Miwok Indians. Volume 6 no. 2 and 3. Berkeley: The University Press.

Barrett, Stephen W.

1981 Relationship of Indian-Caused Fires to the Ecology of the Western Montana Forests. Master's thesis, University of Montana.

Bates, Craig D., and Martha J. Lee

1990 Tradition and Innovation: A Basket History of the Indians of the Yosemite-Mono Lake Area. Yosemite National Park, Calif.: Yosemite Association.

Baxley, H. W.

1865 What I Saw on the West Coast of South and North America and at the Hawaiian Islands. New York: D. Appleton and Co.

Bean, Lowell John, and Harry W. Lawton

1993 Some Explanations for the Rise of Cultural Complexity in Native California with Comments on Proto-Agriculture and Agriculture. In Before the Wilderness. T.C. Blackburn and M.K. Anderson, eds. Pp. 27-54. Ramona, CA: Ballena Press.

Bendix, Jacob

2002 Pre-European Fire in California Chaparral. In Fire, Native Peoples, and the Natural Landscape. T.R. Vale, ed. Pp. 269-293. Washington: Island Press.

Bennyhoff, James A.

1953 Preliminary Report on Archaeological Excavations in Yosemite National Park. In University of California Archaeological Survey.

1956 An Appraisal of the Archaeological Resources of Yosemite National Park. Volume 34. University of California Berkeley.

Bibby, Brian

1994 An Ethnographic Evaluation of Yosemite Valley: The Native American Cultural Landscape: M.S. on File Yosemite National Park.

Bird, Douglas W., Rebecca Bliege Bird, Christopher H. Parker, and Bonnie Bass

2003 Aboriginal Burning Regimes and Hunting Strategies in Australia's Western Desert.

Blackburn, Thomas C., and M. Kat Anderson, eds.

1993 Before the Wilderness: Environmental Management by Native Californians. Menlo Park, CA: Ballena Press.

Bonnicksen, T. M., M. Kat Anderson, Henry T. Lewis, and r. Knudson

2000 American Indian Influences on the Development of Forest Ecosystems. In Ecological Stewardship: A Common Reference for Ecosystem Management. N.C. Johnson, A.J. Malk, W.T. Sexton, and R. Szaro, eds. Oxford: Elsevier Science Ltd.

Boyd, Robert T., ed.

1999 Indians, Fire and the Land in the Pacific Northwest. Corvallis, Oregon: Oregon State University Press.

Broadbent, Sylvia Marguerite

1960 A Grammar of Southern Sierra Miwok. Unpublished Ph.D. Dissertation, University of California.

Brown, J. K.

1995 Fire Regimes and Their Relevance to Ecosystem Management. Proceedings of the Society of American Foresters Annual Meeting, Bethesda, MD, 1995, pp. 171–178. Society of American Foresters: Washington, D.C.).

Brown, Peter Mark

2002 Personal Communication. L. Gassaway, ed.

Bunnell, Lafayette Houghton

1892 Discovery of the Yosemite, and the Indian War of 1851 Which Lead to That Event. New York, Chicago: F. H. Revell company.

1990 [1880] Discovery of the Yosemite and the Indian War of 1851 Which Lead to That Event. Yosemite National Park, California: Yosemite Association.

Busam, Heather M.

2003 Thesis Prospectus: Bucks, Baskets, and Pyrotechnics: Anthropogenic Fire in Northwestern California.

Byram, Scott

1996 On-Site Lithic Analysis Manual: Prepared for the Malheur National Forest: U.S.D.A.

Caprio, Anthony C.

N.d. Landscape Patterns of Pre–20th Century Fire in the Kaweah Watershed, Sequoia and Kings Canyon National Parks.

Caprio, Anthony C., and Thomas W. Swetnam

1995a Fire History and Fire Climatology in the Southern and Central Sierra Nevada, Progress Report 1993/94.

1995b Historic Fire Regimes Along an Elevational Gradient on the West Slope of the Sierra Nevada, California. In Proceedings: Symposium on Fire in Wilderness and Park Management: Past Lessons and Future Opportunities. J.K. Brown, R.W. Mutch, C.W. Spoon, and R.H. Wakimoto, eds. General Technical Report Int-Gtr-320. Missoula, MT.: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT.

Carle, David

2002 Burning Questions: America's Fight with Nature's Fire. Westport, Conn.; London: Praeger.

Clark, Galen

1904 Indians of the Yosemite Valley and Vicinity, Their History, Customs and Traditions. Yosemite Valley, Cal.: G. Clark.

Commissioners to Manage the Yosemite Valley and the Mariposa Big Tree Grove

1867 Report of the Commissioners to Manage the Yosemite Valley and the Mariposa Big Tree Grove: D.W. Gelwicks State Printer.

Cone, Mary

1876 Two Years in California. Chicago: S.C. Griggs and company.

Conkey, Margaret W.

1980 The Identification of Prehistoric Hunter-Gatherer Aggregation Sites: The Case of Altamira. Current Anthropology 21(5):609-630.

Cook, E. R., and Leonardas A. Kairikiukstis

1990 Methods of Dendrochronology: Applications in the Environmental Science. Dordrecht, Netherlands; Boston: Kluwer Academic Publishers.

Cornett, James W.

1978 Indians and the Desert Fan Palm. Masterkey.

Curtis, James D., and Donald W. Lynch

1965 Ponderosa Pine (Pinus Ponderosa Laws.). In Silvics of Forest Trees of the United States. H.A. Fowells, ed. Pp. 417-431. Agriculture Handbook 271. Washington, DC.: U.S. Department of Agriculture.

Danzinger, S.

1979 Auger Test of 4-Mrp-56, Yosemite Village Mall, Yosemite National Park, California.

Day, Gordon M.

1953 The Indian as an Ecological Factor in the Northeastern Forests. Ecology 34(2 (Apr)):329-346.

Department of Natural Resources

Dnrgarmin.

Dieterich, John H., and Thomas W. Swetnam

1984 Dendrochronology of a Fire-Scarred Ponderosa Pine. Forest Science 30(1):238-247.

Dixon, Roland Burrage, and Alfred Louis Kroeber

1913 New Linguistic Families in California. American Anthropologist 15(4):647-655.

Driver, H.E., and W.C. Massey

1957 Comparative Studies of North American Indians. Transactions of the American Philosophical Society 47(2):165-449.

Driver, Harold Edson

1936 Wappo Ethnography. American Archaeolgy and Ethnology 36(3):179-220.

1937 Culture Element Distributions: Vi Southern Sierra Nevada. Anthropological Records 1(2):53-154.

Ernst, Emil F.

1943a Preliminary Report on the Study of the Meadows of Yosemite Valley. Pp. 68: United States Department of the Interior National Park Service, Yosemite National Park, California.

1943b Supplement to the Preliminary Report on the Study of the Meadows of Yosemite Valley: United States Department of the Interior National Park Service, Yosemite National Park, California.

1949 Vanishing Meadows in Yosemite Valley. Yosemite Nature Notes 28(5):34-41.

1961 Forest Encroachment on the Meadows of Yosemite Valley. Sierra Club Bulletin October:21-33.

ESRI

Arcview 3.2.

Gassaway, Linn

2004 Reexamination of Village Sites Identified by Merriam and Powers in Yosemite Valley. In Proceedings of the Society of California Archaeology, 37th Annual, Sacramento, California, March, 2003, Vol. 17. Chico, CA: Society of California Archaeology.

Gayton, Anna H.

1948 Yokuts and Western Mono Ethnography: Ii Northern Foothill Yokuts and Western Mono. Anthropological Records 10(2).

Gibbens, Robert P., and Harold F. Heady

1964 The Influence of Modern Man on the Vegetation of Yosemite Valley. [Berkeley]: University of California Division of Agricultural Sciences.

Gifford, Edward Winslow

1916 Miwok Moieties. Volume 12, no. 4 June 24. Berkeley: University of California Press.

1939 Karok Field Notes. In Part 1. Ethnological Document No. 174 in Department and Museum of Anthropology. Berkeley, CA: University of California, Bancroft Library.

Gordon Cumming, C. F.

1883 Wild Tribes of the Sierras. National Review 2(8):412-421.

Greene, Linda Wedel

1987 Historic Resource Study, Yosemite: The Park and Its Resources, a History of the Discovery, Management, and Physical Development of Yosemite National Park, California. 3 vols: U.S. Department of the Interior, National Park Service.

Grissino-Mayer, Henri D.

2001 Research Report: Fhx2- Software for Analyzing Temporal and Spatial Patterns in Fire Regimes from Tree Rings. Tree-Ring Research 57(1):115-124.

Grosscup, G.L.

1954 An Archaeological Survey of Yosemite National Park, 1954. Berkeley: University of California Archaeological Survey.

Gruell, George E.

1983 Fire and Vegetative Trends in the Northern Rockies: Interpretations from 1871-1982 Photographs. Ogden, UT.: U.S. Dept. of Agriculture Forest Service Intermountain Forest and Range Experiment Station.

1985 Indian Fires in the Interior West: A Widespread Influence. In Proceedings - Symposium and Workshop on Wilderness Fire. J.E. Lotan, B.M. Kilgore, W.C. Fischer, and R.W. Mutch, eds. Pp. 69-74. General Technical Report Int-182. Missoula, Montana: USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Hall, Ansel Franklin

1929 Yosemite Valley: An Intimate Guide. Berkeley, CA: National Parks Publishing House.

Hamilton, William J., and Kenneth E. F. Watt

1970 Refuging. Annual Review of Ecology and Systematics 1:263-286.

Heady, Harold F., and Paul J. Zinke

1979 Vegetational Changes in Yosemite Valley. Washington: U.S. Dept. of the Interior: for sale by the Supt. of Docs. U.S. Govt. Print. Off.

Heald, Weldon Fairbanks

1947 The Abrams Diary," [William Penn Abrams Diary, October 18, 1849]. Sierra Club Bulletin 32(5):126-127.

Hull, Kathleen L.

1995 Toward an Historical Anthropology of Native American Occupation in the Yosemite Region.

1999 Report of Archeological Sampling of Six Sites in Yosemite Valley for Demographic Reconstruction. San Francisco, California: Submitted to: National Park Service, Pacific West Region.

2002 Cultural Contact in Context: A Multiscalar View of Catastrophic Depopulation and Culture Change in Yosemite Valley, California. Unpublished Ph.D. Dissertation, University of California.

Hull, Kathleen L., Mark Hale, Russell W. Bevill, and W. Geoffrey Spaulding

1998 Archeological Subsurface Survey and Test Excavations at Yosemite Lodge, Yosemite Valley, Yosemite National Park, California: U.S. Dept of the Interior, National Park Service, Yosemite National Park, Yosemite Research Center.

Hull, Kathleen L., and Mark R. Hale

1998 Draft - Research Design for Archaeological Subsurface Survey and Test Excavations at Yosemite Lodge, Yosemite Valley, Yosemite National Park, California. In Yosemite Archaeology Office.

Hull, Kathleen L., and Michael S. Kelly

1995 An Archeological Inventory of Yosemite Valley, Yosemite National Park, California: U.S. Dept of the Interior, National Park Service, Yosemite National Park, Yosemite Research Center.

Hull, Kathleen L., Michael J. Moratto, Helen McCarthy, C. Kristina Roper, W. Geoffrey Spaulding, Mark R. Hale, and Elena Nilsson

1999 Archeological Synthesis and Research Design, Yosemite National Park, California. Yosemite, Calif.: U.S. Dept of the Interior, National Park Service, Yosemite National Park, Yosemite Research Center.

Hutchings, J. M.

1854 Hutching's California Scenes. San Francisco.

Hutchings, James Mason

1886 In the Heart of the Sierras: The Yo Semite Valley, Both Historical and Descriptive: And Scenes by the Way. Big Tree Groves. The High Sierra, with Its Magnificent Scenery, Ancient and Modern Glaciers, and Other Objects of Interest; with Tables of Distances and Altitudes, Maps, Etc. Profusely Illustrated. Yo Semite Valley; Oakland, Calif.: Published at the Old Cabin; Pacific Press Publishing House.

Isaac, G.L.

1978 The Food-Sharing Behavior of Protohuman Hominids. Scientific American 238(4):90-108.

Jepson, Willis Linn, James C. Hickman, and Willis Linn Jepson

1993 The Jepson Manual: Higher Plants of California. Berkeley: University of California Press.

Johnston, Hank

1995 The Yosemite Grant, 1864-1906: A Pictorial History. Yosemite National Park, Calif.: Yosemite Association.

Jones, Holway R.

1965 John Muir and the Sierra Club: The Battle for Yosemite. San Francisco: Sierra Club.

Jones, Rhys

1969 Fire-Stick Farming. Australian Natural History 16:224-228.

Kaye, Margot W., and Thomas W. Swetnam

1999 An Assessment of Fire Climate and Apache History in the Sacramento Mountains, New Mexico. Physical Geography 20(4):305-330.

Kilgore, Bruce M., and Dan Taylor

1979 Fire History of a Sequoia-Mixed Conifer Forest. Ecology 60(1 (Feb)):129-142.

King, John C.

1991 Douglas-Fir Chronology, Yosemite Valley, Yosemite N.P. Boulder, Colorado, USA: International Tree-Ring Data Bank, IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program.

Komarek, Edwin V., Sr.

1967 The Nature of Lightning Fires. Tall Timbers Fire Ecology Conference Proceedings, Tallahassee, 1967. Vol. 7, pp. 5-41.

Kroeber, A. L., and E.W. Gifford

1949 World Renewal, a Cult System of Native Northwest California. University of California Archaeology Records 13:1-156.

Kroeber, Alfred Louis

1908 On Evidences of the Occupation of Certain Regions by the Miwok Indians. Volume 6, No. 3.

1947 Cultural and Natural Areas of Native North America. Berkeley: University of California Press.

1976 [1925] Handbook of the Indians of California. New York: Dover Publications.

Latta, Frank F.

1977 Handbook of the Yokut Indians: Kern County Museum.

c.1930 Fieldnotes: Yosemite Villages, Archaeology, Frank Latta Papers, Yosemite National Park Archives.

Lawrence, James Henry

1884 Discovery of the Nevada Fall. Overland Monthly 4 (2nd series)(22):360-371.

Lawton, Harry W., Philip J. Wilke, Mary DeDecker, and William M. Mason

1993 Agriculture among the Paiute of Owens Valley. In Before the Wilderness: Environmental Management by Native Californians. T.C. Blackburn and M.K. Anderson, eds. Pp. 329-278. Menlo Park, CA: Ballena Press.

Levy, Richard

1978 Eastern Miwok. In California. R.F. Heizer, ed. Pp. 398-413. Handbook of North American Indians, Vol. 8. Washington, D.C.: Smithsonian Institution.

Lewis, Henry T.

1972 The Role of Fire in the Domestication of Plants and Animals in Southwest Asia: A Hypothesis. Man, New Series 7(2 June):195-222.

1973 Patterns of Indian Burning in California: Ecology and Ethnohistory. Ramona, CA: Ballena Press.

1980 Indian Fires in Spring: Hunters and Gatherers of the Canadian Forest Shaped Their Habitat with Fire. Natural History 89(1 Jan.):76-78, 82-83.

1985 Why Indians Burned: Specific Versus General Reasons. In Proceedings - Symposium and Workshop on Wilderness Fire. J.E. Lotan, B.M. Kilgore, W.C. Fischer, and R.W. Mutch, eds. Pp. 75-80. General Technical Report Int-182: USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

1989 Non-Agricultural Management of Plants and Animals: Alternative Burning Strategies in Northern Australia. In Wildlife Production Systems: Economic Utilization of Wild Ungulates. R.J. Hudson, K.R. Drew, and L.M. Baskin, eds: Cambridge University Press.

1993 In Retrospect. In Before the Wilderness: Environmental Management by Native Californians. T.C. Blackburn and M.K. Anderson, eds. Pp. 389-400. Menlo Park, CA: Ballena Press.

2003 Personal Communication. L. Gassaway, ed. Orlando, Florida.

Lewis, Henry T., and Theresa A. Ferguson

1988 Yards, Corridors, and Mosaics: How to Burn a Boreal Forest. Human Ecology 16(1 March):57-77.

Lightfoot, K. G.

1995 Culture Contact Studies: Redefining the Relationship between Prehistoric and Historical Archaeology. American Antiquity 60:199-217.

Loope, Walter L., and John B. Anderton

1998 Human Vs. Lightning Ignition of Presettlement Surface Fires in Coastal Pine Forests of the Upper Great Lakes. American Midland Naturalist 140(2 (Oct.)):206-218.

MacCleery, Douglas W.

N.d. The Role of American Indians in Shaping the North American Landscape, Vol. 2000.

Mayberry, J.D.

1979 Test Excavations at Site 4-Mrp-56, Yosemite National Park: On file, USDI National Park Service, Western Archeological and Conservation Center, Tucson, AZ.

Mayewski, Paul A., and Michael Bender

1995 The Gisp2 Ice Core Record - Paleoclimate Highlights. U.S. National Report to Iugg, 1991-1994. Rev. Geophys 33 Suppliment.

Merriam, C. Hart

1917 Indian Village and Camp Sites in Yosemite Valley. Sierra Club Bulletin 10(2):202-209.

c.1915 Map of Yosemite Valley, Mariposa County, California / U.S. Geological Survey; State of California. Annotated to Show Indian Tribes in the Region.: Bancroft Library, University of California, Berkeley.

N.d. Container E. Ethnography Reel 21 Notes on Yosemite Me'-Wuk (Southern Me'-Wuk). In C. Hart Merriam Papers, Volume 1: Papers Relating to Work with California Indians, 1850-1974 (bulk 1898-1938). Bancroft Library, University of California, Berkeley.

Merriam, C. Hart, and Robert Fleming Heizer

1979 Indian Names for Plants and Animals among Californian and Other Western North American Tribes. Socorro, N.M.: Ballena Press.

Miller, Joaquin

1887 Paper. Report of the American Forestry Congress:25-26.

Moratto, Michael J.

1984 California Archaeology. Orlando: Academic Press.

1999 Cultural Chronology 2: The Yosemite Data. In Archeological Synthesis and Research Design, Yosemite National Park, California. Publications in Anthropology No. 21. Yosemite, Calif.: U.S. Dept of the Interior, National Park Service, Yosemite National Park, Yosemite Research Center.

Morgan, Penelope, Colin C. Hardy, Thomas W. Swetnam, Matthew G. Rollins, and Donald G. Long

2001 Mapping Fire Regimes across Time and Space: Understanding Coarse and Fine-Scale Fire Patterns. International Journal of Wildland Fire 10:329-342.

Muir, John

1894 The Mountains of California. New York, NY: The Century Co.

Mundy, W. J., and Kathleen L. Hull

1988 The 1984 and 1985 Yosemite Valley Archeological Testing Projects: U.S. Dept of the Interior, National Park Service, Yosemite National Park, Yosemite Research Center.

Munz, Phillip, A., and David D. Keck

1959 A California Flora. Berkeley: University of California Press.

Murphy, Edith Van Allen

1959 Indian Uses of Native Plants. Fort Bragg, CA.: Mendocino County Historical Society.

Napton, L. K., A. D. Albee, and E. A. Greathouse

1974 Archeological Survey in Yosemite National Park, California: Yosemite Valley (Parts 1–2). Submitted to USDI National Park Service, Western Archeological and Conservation Center, Tucson.

Napton, L. Kyle

1978 Archeological Overview of Yosemite National Park, California: Institute for Archeological Research California State College, Stanislaus, Turlock, California.

National Interagency Fire Center

1994 Intermediate Wildland Fire Behavior. Volume NFES #2378. Boise, Idaho.

National Park Service

1990 Fire Management Plan Yosemite National Park: National Park Service, Yosemite California.

2002 Draft Yosemite Fire Management Plan: Environmental Impact Statement. Yosemite, Calif.: Yosemite National Park.

2004 Final Yosemite Fire Management Plan: Environmental Impact Statement. Yosemite, Calif.: Yosemite National Park.

Nazarea, Virginia D.

1999 A View from a Point: Ethnoecology as Situated Knowledge. In Ethnoecology: Situated Knowledge/Located Lives. V.D. Nazarea, ed. Pp. 3-20. Tucson, AZ: University of Arizona Press.

NRCS

2002 The Plants Database, Version 3.5, (Http://Plants.Usda.Gov) National Plant Data Center: Baton Rouge, LA 70874-4490 USA.

Oliver, William W., and Russell A. Ryker

1990 *Pinus Ponderosa* Dougl. Ex Laws. Ponderosa Pine. In Silvics of North America. R.M. Burns and B.H.H.t. coords.), eds. Agriculture Handbook 654, Vol. 1: Conifers. Washington, DC.: United States Department of Agriculture, Forest Service.

Olmsted, Frederick Law

1993 Yosemite and the Mariposa Grove: A Preliminary Report, 1865. Yosemite National Park, Calif.: Yosemite Association.

Paintner, Kara

2002 Personal Communication. L. Gassaway, ed.

Parker, Albert J.

2002 Fire in Sierra Nevada Forests: Evaluating the Ecological Impact of Burning by Native Americans. In Fire, Native Peoples, and the Natural Landscape. T.R. Vale, ed. Pp. 233-268. Washington: Island Press.

Peri, David W., and Scott M. Paterson

1976 The Basket Is in the Roots, That's Were It Begins. journal of California Anthropology 3:2.

Perlot, J–N.

1985 Gold Seeker: Adventures of a Belgian Argonaut During the Gold Rush Years. New Haven: Yale University Press.

Petition of the People of Mariposa to the Legislature of California

1867 Memorial of J. M. Hutchings and J. C. Lamon, Settlers in Yosemite Valley, Mariposa County, California. To the Senate and House of Representatives of the United States, in Congress Assembled.

Powers, Rober F., and William W. Oliver

1990 *Libocedrus Decurrens* Torr. Incense-Cedar. In Silvics of North America. R.M. Burns and B.H.H.t. coords.), eds. Agriculture Handbook 654, Vol. 1: Conifers. Washington, DC.: United States Department of Agriculture, Forest Service.

Powers, Robert F.

1981 Nutritional Ecology of Ponderosa Pine (Pinus Ponderosa Laws.) and Associated Species. PH.D Dissertation, University of California, Berkeley.

Powers, Stephen

1976 [1877] Tribes of California. New York: AMS Press.

Pyne, Stephen J.

1983 Indian Fires: The Fire Practices of North American Indians Transformed Large Areas from Forest to Grassland. Natural History 92(2 (Feb)):6, 8, 10-11.

1993 Keeper of the Flame: A Survey of Anthropogenic Fire. In Fire in the Environment: The Ecological, Atmospheric, and Climatic Importance of Vegetation Fires: Report of the Dahlem Workshop, Berlin, 15-20 March 1992, Environmental Sciences Research Report Es 13. P.J. Crutzen and J.G. Goldammer, eds. Pp. 245-266. New York, NY: John Wiley & Sons Ltd.

1997 Fire in America: A Cultural History of Wildland and Rural Fire. Seattle: University of Washington Press.

Rasson, J.

1966 Excavations at Ahwahnee, Yosemite National Park, California. In Archaeological Survey Annual Reports 8. Pp. 165–184. Los Angeles: University of California, Los Angeles.

Reynolds, Richard Dwan

1959 Effect of Natural Fires and Aboriginal Burning Upon the Forests of the Central Sierra Nevada. unpublished Thesis M A, University of California, Berkeley.

Russell, Carl Parcher

1993 Last of Yosemite Indians Vists Valley after a 75-Year Absence. Berkeley, CA: California Indian Library Collections distributor.

Russell, Emily W. B.

1983 Indian-Set Fires in the Forests of the Northeastern United States. Ecology 64(1 February):78-88.

1997 People and the Land through Time: Linking Ecology and History. New Haven, [Conn.]; London: Yale University Press.

Sauer, Carl Ortwin

1947 Early Relations of Man to Plants. Geographic Review XXXVII:1-25.

1952 Agricultural Origins and Dispersals. New York: American Geographical Society.

Savage, Melissa, and Thomas W. Swetnam

1990 Early 19th-Centuray Fire Decline Following Sheep Pasturing in a Navajo Ponderosa Pine Forest. Ecology 71(6):2374-2378.

Schubert, G. H.

1965 Incense-Cedar (*Libocedrus Decurrens* Torr.). In Silvics of Forest Trees of the United States. H.A. Fowells, ed. Pp. 243-247. Agriculture Handbook 271. Washington, DC.: U.S. Department of Agriculture.

Seklecki, Mariette, Henri D. Grissino-Mayer, and Thomas W. Swetnam

1996 Fire History and the Possible Role of Apache-Set Fires in the Chiricahua Mountains of Southeastern Arizona. In Effects of Fire on Madrean Province Ecosystems, a Symposium Proceedings. P.F. Ffolliott and e. al., eds. Pp. 253-264. General Technical Report Rm-Gtr-289. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Siefkin, Nelson

1999 Cultural Resource Management and Prescribed Fire at Lassen Volcanic National Park, Lava Beds National Monument, and Whiskeytown National Recreation Area.

2001 Fire as a Natural and Cultural Process in Northern California. In Cultural Resource Management and Prescribed Fire at Lassen Volcanic National Park, Lava Beds National Monument, and Whiskeytown National Recreation Area. Pp. Chapter 2, Vol. Volume 1.

Skinner, Carl N., and Chi-ru Chang

1996 Fire Regimes, Past and Present. In Status of the Sierra Nevada: Sierra Nevada Ecosystems Project Final Report to Congress. M. Barbour, ed. Pp. 1041-1069 (Chapter 1038), Vol. II Assessments and Scientific Basis for Management Options. University of California Centers for Water and Wildland Resources, Davis.

Stephens, Scott L., and Brandon M. Collins

2004 Fire Regimes of Mixed Conifer Forests in the North-Central Sierra Nevada at Multiple Spatial Scales. Northwest Science 78(1).

Steward, Julian H.

1933 Ethnography of the Owens Valley Paiute. University of California Publications in American Archaeology and Ethnology 33:223-350.

Stewart, Omer Call

1951 Burning and Natural Vegetation in the United States. Geographical Review 41(2 (Apr)):317-320.

1956 Fire as the First Great Force Employed by Man. In Man's Role in Changing the Face of the Earth. W.L. Thomas, ed. Pp. 115-133. Chicago: Published for the Wenner-Gren Foundation for Anthropological Research and the National Science Foundation by the University of Chicago Press.

2002 Forgotten Fires: Native Americans and the Transient Wilderness. Norman: University of Oklahoma Press.

Stokes, M. A.

1980 The Dendrochronology of Fire History. In Proceedings of the Fire History Workshop. Pp. 1-3. Usda Forest Service General Technical Report Rm-81. Fort Collins, Colorado: Rocky Mountain Forest and Range Experimental Station.

Stokes, Marvin A., and Terah L. Smiley

1996 An Introduction to Tree-Ring Dating. Tucson: University of Arizona Press.

Storer, Tracy Irwin, and Robert L. Usinger

1963 Sierra Nevada Natural History. Berkeley: University of California Press.

Taylor, H. J.

1936 Yosemite Indians and Other Sketches. San Francisco: Johnck & Seeger.

The Atlantic Monthly

1897 The American Forests. 80(478).

Timbrook, Jan, John R. Johnson, and David D. Earle

1980 Vegetation Burning by the Chumash. Journal of California and Great Basin Anthropology 4(2 Winter):163-186.

Todd, Rev. John, D.D

1870 The Sunset Land; or, the Great Pacific Slope. Boston: Lee and Shepard.

Turner, Nancy J

1995 Ethnobotany Today in Northwestern North America. In Ethnobotany: Evolution of a Discipline. R.E. Schultes and S. von Reis, eds. Portland: Dioscordies Press.

Turner, Nancy J.

1991 Burning Mountain Sides for Better Crops: Aboriginal Landscape Burning in British Columbia. Archaeology in Montana 32(2):54-74.

Vale, Thomas R.

2002 Fire, Native Peoples, and the Natural Landscape. Washington, D.C.: Island Press.

Van Bueren, T.M.

1983 Archaeological Perspectives on Central Sierra Miwok Culture Change During the Historic Period, Department of Anthropology, San Francisco State University.

van Wagtendonk, Jan W.

1993 Spatial Patterns of Lightning Strikes and Fires in Yosemite National Park. Proceeding 12th Conference Fire and Forest Meteorology, Jekyll Island, GA, 1993. Vol. 12, pp. 223-231.

Vita-Finzi, C., and E.S. Higgs

1970a Prehistoric Economy in the Mount Carmel Area of Palestine: Site Catchment Analysis. Proceedings of the Prehistoric Society 36:1-37.

1970b Prehistoric Economy in the Mount Carmel Area of Palestine: Site Catchment Analysis. Proceedings of the Prehistoric Society 36(1-37).

Voegelin, Erminie Wheeler

1942 Culture Element Distributions: Xx, Northeastern California. Anthropological Records 7(2):47-251.

Wheeler, G. M.

1883 Topographical Map of Yosemite Valley and Vicinity.

Whitney, Stephen

1992 Audubon Society Nature Guides Western Forests. New York: Alfred A. Knopf Publishers.

Wickstrom, C. Kristina Roper

1987 Issues Concerning Native American Use of Fire: A Literature Review. Volume no. 6: USDI Park Service.

Williams, Gerald W.

1994 References on the American Indian Use of Fire in Ecosystems.

1998 References on the American Indian Use of Fire in Ecosystems.

2000 Introduction to Aboriginal Fire Use in North America. Fire Management Today 60(3):8-12.

2003 References on the American Indian Use of Fire in Ecosystems.

Wilson, Douglas, Robert Cromwell, Theresa Langford, Debra Semrau, and Gretchen Kaehler

2002 Archaeology Lab Manual. F.V.N.H.S. USDI, Vancouver National Historic Reserve, ed.

Yamaguchi, D.K.

1991 A Simple Method for Cross-Dating Increment Cores from Living Trees. Canadian Journal of Forest Research 21:414-416.

APPENDIX A:

Ethnographically Identified of Villages in Yosemite Valley

Village Name (Bold Powers)	Powers	Merriam	Merriam field map	Merriam Village type	Hall	Latta	Kroeber	Levy
Ah-wah'-mah		X	X	Village		X		
Ah-wah'-ne (**A-wa'ni**)	X	X	X	Village		X	X	X
Ap'-poo-meh		X		Camp		X		
Aw'-o-koi-e		X	X	Small summer village	X	X		
Paiute village CA-MRP-54								
Cha'-cha'-kal-lah	X	X	X	Large village		X		
Ha-eng'-ah		X	X	Small summer village	X	X		
Hah-ki-ah (Hakkiah or Sah-li'-a)		X		Large village		X		
Ham'-moo-ah		X	X	Village				
Haw-kaw-koo'-e-tah, Ho-kok'kwe-lah Haw-kaw'-koi (**Hok-ok'-wi-dok**) Hokokwito (Levy)	X	X		Large village		X		X
He-le'-jah		X	X	Small summer village	X	X		
Hep-hep'-oo'-ma		X	X	Summer village	X	X		
Ho-ko'-nah		X	X	Small village		X		
Hol-low or Lah'-koo'hah		X		Winter shelter		X		
Ho-low		X				X		
Hoo-ke'-hahtch'-ke		X		Summer village		X		
Hoo'-koo-me'-ko-tah or Koo-Koo-mik		X	X	Village		X		

Village Name (Bold Powers)	Powers	Merriam	Merriam field map	Merriam Village type	Hall	Latta	Kroeber	Levy
Hop'-to'-ne		X	X	Village or Camp				
Kis'-se or Kis'-se-uh		X	X	Large village		X		
Kom'-pom-pa'-sah or Pom'-pom-pa'sah		X	X	Small village		X		
Koom-i-ne or Kom-i-ne (**Ku-mai'-ni**)	X	X	X	Largest village	X	X		X
Lem-me'-hitch'-ke		X		Village or Camp	X	X		
Le-sam'-ai-ti	X							X
Loi-ah		X	X	Large village	X	X		
No-to-mid'-u-la	X							X
Poot-poo-toon or Put-put-toon		X	X	Village		X		
Sak'-ka-ya Sakaya (Levy)								X
Sap-pah'sam-mah		X		Village	X	X		
Soo-sem'-moo-lah		X	X	Village		X		
Ti-e-te'-mah		X	X	Village		X		
Too-lah'-kah'-mah		X		Village or Camp		X		
Too-yu'-yu'-yu		X	X	Large village		X		
Um'-ma-taw		X	X	Large village		X		
Wah-ho'-gah Wahogah (**Wah-ha'-ka**)	X	X	X	Small village		X		

Village Name (Bold Powers)	Powers	Merriam	Merriam field map	Merriam Village type	Hall	Latta	Kroeber	Levy
Wah'-tahk'-itch-ke		X		Village		X		
We'-sum-meh'		X	X	Village or Camp	X	X		
We'-tum-taw Wetumtah		X	X	Village		X		
Wis'-kah-lah (**Wis-kul'-la**)	X	X	X	Large summer village		X		
Yo'-watch-ke Mah-cha'-to (**Mah-che'-to**)	X	X		Large village	X	X		X
Yu-a-chah		X	X	Summer village	X	X		
Hoo-moo-ah						X		

NEL – No Exact Location; NL – Not Located; NSKL - No site known at this location or No site known; NI - None identified
Table based on Merriam (1917, N.d.), Powers (1976 [1877]:365), Kroeber (1976 [1925]:445), Levy (1978:400), Bibby (1994), Hull and Kelly (1995:90-91), Mundy and Hull (1988:32), Napton et al (1974:22-23), Bennyhoff (1956: Table 1), Hull (1995:45-46), Hall (1929), Latta (c. 1930), Gassaway (2003)
For the purposes of this study Cha'-cha'-kal-lah and Sak'-ka-ya are not the same village because Merriam identifies both villages on his field map. While Sak'-ka-ya is not mentioned in his 1917 publication, his notes do not indicate that they are different names for the same site.

APPENDIX B:

Correspondence of Ethnographically Identified Villages and Archaeological Sites from the Major Archaeological Studies in Yosemite Valley

Village Name (Bold Powers)	Bennyhoff	Napton et al	Hull and Kelly	Mundy and Hull	Bibby	Hull	GIS Analysis
Ah-wah'-mah	NL	NL	821		NEL	821	None identified
Ah-wah'-ne (**A-wa'ni**)	56	56 196 298 299 300	56/61/196/ 298/299/ 900/301 60?	56/298/299 196/300	56	56/61/196/298/ 299/900/301 60?	None identified 56/61/196/… - 45 m north
Ap'-poo-meh	85	Out of survey area			85		None identified
Aw'-o-koi-e	Near 158	158 309	158/309	158/309	158	158/309	310
Paiute village CA-MRP-54	54	"Shelter Cluster"					
Cha'-cha'-kal-lah	NL	322	322?		NEL	322?	322
Ha-eng'-ah	65	NL	NSKL		65	NSKL	None identified
Hah-ki-ah (Hakkiah or Sah-li'-a)	67 69	67 307	69 817	67 307	67 69 307	69 817	67 69 817
Ham'-moo-ah	NL	NL	NSKL		NEL	NSKL	None identified
Haw-kaw-koo'-e-tah, Ho-kok'kwe-lah Haw-kaw'-koi (**Hok-ok'-wi-dok**) Hokokwito (Levy)	78 79	77 79	79/H		78 79	79/H	78 79/H 750H 1529H

Village Name (Bold Powers)	Bennyhoff	Napton et al	Hull and Kelly	Mundy and Hull	Bibby	Hull	GIS Analysis
He-le'-jah	62	62 311	62	62 311 818 823	62	62	None identified 62 – 140m east
Hep-hep'-oo'-ma	64	64	64		64	64	None identified 64 – 50 m NNE
Ho-ko'-nah	NL	NL	820?		NEL	820?	None identified 819H – 25m north
Hol-low or Lah'-koo'hah	57	57	57		57	57	57
Ho-low	82	78	82/H		82	82/H	78
Hoo-ke'-hahtch'-ke	45?	45? 46? 47? 74? 326?	45/326? or 46/47/74?		45	45/326? or 46/47/74?	None identified 46/47/74 – 300 m SE 45/326 – 105 m SW
Hoo'-koo-me'-ko-tah or Koo-Koo-mik	161 162	161 162 324 325	161/H 162/H 324/H 325/H?		161 162	161/H 162/H 324/H 325/H?	325/H
Hop'-to'-ne	NL	NL	NSKL		NEL	NSKL	None identified
Kis'-se or Kis'-se-uh	76	76	76		76	76	76
Kom'-pom-pa'-sah or Pom'-pom-pa'sah	159 160	160	67 160?	159 160 308	159 160	67 160?	67 307
Koom-i-ne or	58	59	59	59	58	59	59/H

Village Name (Bold Powers)	Bennyhoff	Napton et al	Hull and Kelly	Mundy and Hull	Bibby	Hull	GIS Analysis
Kom-i-ne (**Ku-mai'-ni**)	59 240	63 240 303 304 305	 240/303/H	63 240/303 304 305 748 765	59 240 303	 240/303	 240/303 749 P-22-001950
Lem-me'-hitch'-ke	73	73 318 319	73? or 318? or 319?		73	73? or 318? or 319?	None identified 319 – 40 m SSW
Le-sam'-ai-ti	NL	291 292					
Loi-ah	83 92	83 92 323	83/H 323/H		83 92	83/H 323/H	83/H 92/H 323/H 324/H
No-to-mid'-u-la	188	 293 294	188?			188?	
Poot-poo-toon or Put-put-toon	189	189 314	189	189 314 824	189	189	189 314 824
Sak'-ka-ya Sakaya (Levy)							
Sap-pah'sam-mah	Near 71	71	71		71	71	71 P-22-0296
Soo-sem'-moo-lah	66	66 68	66/H 68/H		66 68	66/H 68/H	66/H

Village Name (Bold Powers)	Bennyhoff	Napton et al	Hull and Kelly	Mundy and Hull	Bibby	Hull	GIS Analysis
		69 306					306
Ti-e-te'-mah	187	187	187		187	187	187 822H 1446 YOSE 1997V-2 1447H
Too-lah'-kah'-mah	84	84	825/H?		84	825?H?	None identified 84 - 60 m SW 825 - 30 m North
Too-yu'-yu'-yu	NL	NL	NSKL		NEL	NSKL	84 827/H
Um'-ma-taw	80 186	15 80 81 186	186		80 186	186	186
Wah-ho'-gah Wahogah (**Wah-ha'-ka**)	63	163	748/H	163	63 304 305	748/H	None identified 325/H – 225 m WSW
Wah'-tahk'-itch-ke	NL	82	519?		NEL	519?	519
We'-sum-meh'	75?	70 75 320	75? 320?		75	75? 320?	None identified
We'-tum-taw Wetumtah	NL	312 313	312? 313? 314?	312 313	NEL	312? 313? 314?	None identified 820 – 75 m WNW

Village Name (Bold Powers)	Bennyhoff	Napton et al	Hull and Kelly	Mundy and Hull	Bibby	Hull	GIS Analysis
Wis'-kah-lah (**Wis-kul'-la**)	51 52	50 51 52 53 191 290	291/751 292/293		51 52	291/751 292/293/H	52/H 291/751 292/293/H
Yo'-watch-ke Mah-cha'-to (**Mah-che'-to**)	61 Paiute village	61 188 295	60? 61	61 188 295	61 188 295	60? 61	56/61/196/… 295 296 297
Yu-a-chah	NL	65	65		NEL	65	65
Hoo-moo-ah							

NEL – No Exact Location NL – Not Located NSKL - No site known at this location or No site known NI - None identified

Table based on Merriam (1917, N.d.), Powers (1976 [1877]:365), Kroeber (1976 [1925]:445), Levy (1978:400), Bibby (1994), Hull and Kelly (1995:90-91), Mundy and Hull (1988:32), Napton et al (1974:22-23), Bennyhoff (1956: Table 1), Hull (1995:45-46), Hall (1929), Latta (c. 1930), Gassaway (2003)

For the purposes of this study Cha'-cha'-kal-lah and Sak'-ka-ya are not the same village because Merriam identifies both villages on his field map. While Sak'-ka-ya is not mentioned in his 1917 publication, his notes do not indicate that they are different names for the same site

APPENDIX C:

Fire History Sample Data

YV-01

Series	FERNAAA	FS05	FERN5N	FS4	FS7
Inner Ring	1715	1628	1658	1558	1759
Bark Date	2004	2004	1910	1992	2004
Length of sample	290	377	253	435	246
Sample mean fire interval		17	5	2	
Fires	1733 u	1828 L	1792 A	1768 D	1875 D
		1845 U	1797 U	1785 D	
		1854 u			

a-injury A-fire scar
Season of scar:
E=early earlywood
M=middle early
L=late early
A=latewood
D=dormant
U=unknown

YV-02

Series	FERNK	FERN26	FERN25	FERN04	FERNL	TED5	FERNEE
Inner Ring	1620	1662	1649	1679	1634	1729	1598
Bark Date	1856	2004	2003	2004	2004	2004	2003
Length of sample	237	343	355	326	371	276	406
Sample MFI	17.7	15.5	13.8		26	14.4	20
Fires	1788 D	1710 L	1729 A	1704 E	1661 L	1779 U	1775 L
	1822 D	1728 D	1738 A	1717 E	1767 E	1794 M	1791 E
	1829 A	1745 A	1739 M	1740 L	1792 E	1804 D	1801 A
	1841 D	1779 U	1772 A	1758 E	1805 L	1822 D	1808 U
		1794 M	1846 A	1777 D	1823 D	1835 D	1868 U
		1804 D	1858 D	1796 L	1870 U	1846 A	1875 U
		1822 U	1880 D	1813 A		1858 D	
		1835 D		1827 U		1880 D	
		1842 D		1854 M			
		1846 A		1863 U			
		1858 D					
		1880 D					

a-injury A-fire scar
Season of scar:
E=early earlywood
M=middle early
L=late early
A=latewood
D=dormant
U=unknown

Series	FERNJ	FERN23	TED7	FERNCC	FERN21	FERNMA	FERN27
Inner Ring	1623	1867	1688	1600	1740	1700	1662
Bark Date	2004	2003	2004	2003	2004	1816	2004
Length of sample	382	137	317	404	265	117	343
Sample MFI			13.3	8.5	19.3	19	33
Fires	1845 A	1882 U	1841 D	1833 L	1822 D	1745 U	1748 D
			1846 A	1875 A	1835 D	1760 A	1775 U
			1858 D	1882 E	1858 U	1783 D	1835 D
			1881 U		1880 U		1858 D
							1880 U

YV-03

Series	BVDX	BVEX	SAP12X	SAP14X	SAP29X	BRID32
Inner Ring	1708	1772	1681	1813	1668	1666
Outer Ring	2004	1967	1890	2003	2004	2004
Length of sample	297	196	210	191	337	339
Sample MFI	23.2	15.8	12.7	19.8	35.3	16.3
Fires	1734 A	1800 u	1750 E	1813 U	1688 D	1667 A
	1791 D	1824 A	1786 A	1828 D	1817 U	1674 a
	1820 D	1832 U	1789 A	1842 E	1834 U	1680 A
	1832 D	1847 A	1802 E	1862 E	1847 A	1685 A
	1845 d	1861 A	1824 A	1892 U	1859 D	1709 M
	1867 L	1887 D	1836 A			1746 U
	1869 U	1899 d	1841 A			1761 E
	1877 D		1846 L			1783 A
			1850 U			1794 A
			1853 u			1798 U
			1864 A			1802 U
			1877 A			1812 U
						1837 U
						1844 U

a-injury A-fire scar

Season of scar:

E=early earlywood

M=middle early

L=late early

A=latewood

D=dormant

U=unknown

Series	SAP18X	SAP7	SAP9	SAP10
Inner Ring	1743	1729	1722	1688
Outer Ring	2003	2004	2004	2004
Length of sample	261	276	283	317
Sample MFI	25.5	30	17.7	15
Fires	1840 D	1788 A	1825 A	1848 U
	1842 u	1800 D	1834 D	1864 D
	1856 A	1864 D	1846 D	1878 D
	1891 A	1878 D	1878 U	

YV-04

Series	HOP08	HOP14	HOP15	HOP21	HOP24	HOP29
Pith Date	1520	1787	1621	1685	1579	1608
Bark Date	2003	2004	2004	2004	2004	2004
Length of sample	484	218	384	320	426	397
Sample MFI	6.3	22	33	18.7	21	
Fires	1604 a	1882 A	1749 D	1777 A	1766 D	1718 D
a-injury A-fire scar	1642 u	1913 U	1768 D	1783 A	1782 D	1854 U
<u>Season of scar:</u>	1654 a	1926 U	1791 D	1793 A	1812 A	
E=early earlywood	1686 L		1850 E	1817 A	1829 A	
M=middle early	1690 U			1847 E	1850 u	
L=late early	1830 E			1887 L	1865 u	
A=latewood	1841 D			1889 A		
D=dormant	1855 D					
U=unknown	1859 D					

Series	HOP31	HOP17	STMP1	LGB4C	LGC11	HOP20
Inner Ring	1690	1829	1665	1670	1559	1550
Outer Ring	2004	2003	1850	2004	1885	1999
Length of sample	315	175	186	335	327	450
Sample MFI	18	54	7.5	9.8	14.2	26.7
Fires	1796 A	1846 A	1707 d	1806 A	1800 A	1752 D
	1814 A	1855 D	1739 m	1811 D	1812 U	1760 D
	1861 A	1909 U	1782 d	1819 D	1820 D	1787 A
			1805 A	1832 D	1833 D	1796 A
			1825 U	1840 U	1857 A	1866 D
			1835 D	1855 U		
			1840 A			

YV-08

Series	CB011	MCB10	MCB27	MCB30	CB003
Inner Ring	1618	1722	1655	1690	1533
Outer Ring	2004	2004	2004	1949	2000
Length of sample	387	283	350	260	468
Sample MFI	18.7	12	24	18.3	56
Fires	1823 A	1776 D	1855 E	1782 e	1624 a
	1829 A	1795 A	1879 D	1783 m	1669 E
	1841 D	1800 A		1809 D	1671 D
	1879 D	1812 D		1827 U	1715 M
				1843 D	1735 e
				1864 D	1856 D

Series	CB006	CB008	CB14	MCB7
Inner Ring	1715	1715	1748	1661
Outer Ring	2004	1941	1924	1970
Length of sample	290	227	177	310
Sample MFI	11.2	22.2	16.7	23
Fires	1755 U	1755 M	1812 A	1675 D
	1796 U	1795 U	1829 A	1693 D
	1804 D	1811 D	1837 D	1775 D
	1812 D	1812 D	1855 D	1780 D
	1824 L	1838 D	1879 D	1792 U
	1837 A	1855 D		1811 D
	1841 D	1888 D		1821 A
	1855 D	1898 u		1841 U
	1867 u			
	1880 U			
	1888 A			

a-injury A-fire scar
<u>Season of scar:</u>
E=early earlywood
M=middle early
L=late early
A=latewood
D=dormant
U=unknown

YV-09

Series	ECB11	ECB41	ECB4	ECB29	ECB21	ECB1
Inner Ring	1650	1702	1609	1659	1668	1762
Outer Ring	2004	2004	2004	1914	2004	1925
Length of sample	355	303	396	256	337	164
Sample MFI	21.3	13.5	29.4	26.5	8.8	8.8
Fires	1688 D	1810 U	1671 U	1740 D	1704 e	1787 u
	1690 D	1818 D	1775 U	1780 U	1755 M	1794 D
	1717 A	1840 D	1795 U	1795 A	1760 U	1824 A
	1748 A	1848 D	1816 U	1826 U	1762 A	1828 U
	1780 U	1864 U	1831 D	1846 A	1766 M	1829 U
	1814 D		1859 D		1775 U	1841 D
	1821 A		1869 M		1780 U	1843 D
	1837 M		1881 U		1796 D	1856 D
					1804 D	1861 L
					1833 L	1864 M
					1836 A	
					1847 D	
					1855 D	
					1861 L	

a-injury A-fire scar

Season of scar:

E=early earlywood

M=middle early

L=late early

A=latewood

D=dormant

U=unknown

Series	ECB17	ECB34
Inner Ring	1765	1783
Outer Ring	2004	1985
Length of sample	240	203
Sample MFI	41.5	13
Fires	1766 U	1869 L
	1775 D	1887 D
	1855 A	1904 D

APPENDIX D:

Historic Artifacts Excavated from Site CA-MRP-71

CA-MRP-71: Historic Artifacts

FIELD #	OBJECT	UNIT	LEVEL	N	DESCRIPTION
4	Lamp Glass	N0	0-10	1	Opaque White, body fragment, no seam
6	Bone - Unworked	N1	0-10	1	
8	Lamp Glass	N1	0-10	3	Opaque White, body fragment, no seam
10	glass	N1	0-10	2	colorless, body, no seam
15	Window glass	N2	0-10	1	
16	Nail, wire	N2	0-10	2	common wire nail, complete, bent head on one, 6d (2")
21	Metal pipe fitting	N3	surface	2	Embossed "MALL 1 IN 10 PAT"
23	Bottle, Medicine	N3	10-20	1	colorless, machine made, patent lip, rounded shoulder, embossed, seam
24	Window glass	N4	surface	1	
26	Bead,	N6	0-10	1	Monochrome, blue, cylindrical, translucent
27	Nail, wire	N6	0-10	2	common wire nail, complete, 6d (2") and 8d (2.5")
35	Bottle, soda	S0	surface	1	Brown, body fragment, machine made?, no seam
36	bottle glass	SO	0-20	1	Brown, body fragment, machine made?, no seam
37	Leather, boot	S2	0-10	1	Boot upper frag
39	Ceramic, Tile	W0	surface	1	Red possible tile fragment, small grooves
40	Tile	W0	surface	1	
41	bottle glass	W0	surface	1	Purple, body fragment, machine made, no seam
42	Nail, wire	W0	Surface	5	Complete common wire nail, 8d (2.5") and 9d (2.75")
44	Nail, wire	W0	0-10	6	Complete common wire nail, 4 - 8d (2.5"), roofing nail 2 - 9/10", Complete common wire nail 9d (2.75")
45	Nail, wire	W0	10-20	1	Complete common wire nail,

FIELD #	OBJECT	UNIT	LEVEL	N	DESCRIPTION
					8d (2.5")
48	Nail, wire	W0	20-30	1	Complete common wire nail, 9d (2.75")
50	Nail, wire	W1	0-10	1	Complete common wire nail, 6d (2")
52	Nail, wire	W2	Surface	8	Complete common wire nails 5 - 8d (2.5") and 6d 2"
53	Lamp Glass	W2	0-10	1	colorless, body fragment, no seam
54	Nail, wire	W2	0-10	9	Complete common wire nails, 2d (1"), 2 - 3d (1.25"), 1 - 5d (1 3/4"), 3 - 6d (2"), 2 - 8d (2.5")
55	Nail, wire	W3	Surface	1	Complete common wire nail, 8d (2.5")
56	Nail	W3	20-30	1	Complete brass tack (0.5")
57	Nail	W3	30-40	1	Complete brass tack (0.5")
59	bottle glass	E0	0-10	1	colorless, body fragment, machine made?, no seam
60	Lamp Glass	E0	10-20	1	Opaque White, body fragment, no seam
61	Bailing Wire	E0	10-20	1	Roll of Bailing wire
63	glass	E0	20-30	1	colorless, body fragment, no seam
64	Lamp Glass	E0	20-30	3	Opaque White, body fragment, no seam
65	glass	E1	surface	1	colorless w/ opalescence, body fragment, machine made?, no seam
66	Bailing Wire	E1	surface	1	short twist of wire
67	glass	E2	surface	9	colorless, body fragment

APPENDIX E:

Prehistoric Artifacts Excavated from Site CA-MRP-71

Field #	Unit	Depth	Raw Material	Color	Translucency	Debitage Category	Description
1	N0	0-10	obsidian	black	opaque	Flake Fragment	
2	N0	0-10	obsidian	black	opaque	Flake Fragment	
3	N0	0-10	Glass	colorless	Translucent	Complete Flake	
5a	N0	10-20	obsidian	black	opaque	Flake Fragment	
5b	N0	10-20	obsidian	black	opaque	Flake Fragment	
5c	N0	10-20	obsidian	black	opaque	Flake Fragment	
7a	N1	0-10	obsidian	black	opaque	Flake Fragment	
7b	N1	0-10	obsidian	gray-black	semi translucent	Flake Fragment	
7c	N1	0-10	obsidian	grayish-black	Translucent	Flake Fragment	
9	N1	0-10	Glass	colorless	Translucent	Complete Flake	
11a	N1	10-20	obsidian	black	opaque	Broken Flake	
11b	N1	10-20	obsidian	black	opaque	Flake Fragment	
11c	N1	10-20	obsidian	grayish	Translucent	Flake Fragment	
12a	N1	20-30	obsidian	black	opaque	Broken Flake	
12b	N1	20-30	obsidian	gray	Translucent	Complete Flake	bifacial thinning flake
13a	N1	20-30	obsidian	black	opaque	Flake Fragment	
13b	N1	20-30	obsidian	gray	semi translucent	Flake Fragment	
13c	N1	20-30	obsidian	gray	semi translucent	Flake Fragment	
14a	N1	40-50	obsidian	gray	semi translucent	Flake Fragment	
14b	N1	40-50	obsidian	gray	Translucent	Flake Fragment	
17a	N2	20-30	obsidian	gray	semi translucent	Complete Flake	
17b	N2	20-30	obsidian	dark gray	opaque	Flake Fragment	
18a	N2	20-30	obsidian	black	opaque	Broken Flake	
18b	N2	20-30	obsidian	black	opaque	Flake Fragment	
19a	N2	30-40	obsidian	gray	opaque	Flake Fragment	
19b	N2	30-40	obsidian	black	opaque	Flake Fragment	
20a	N2	40-50	obsidian	black	opaque	Complete Flake	
20b	N2	40-50	obsidian	gray	translucent	Flake Fragment	bifacial thinning flake

174

Field #	Unit	Depth	Raw Material	Color	Translucency	Debitage Category	Description
				banded			
22	N3	surface	obsidian	black with gray banding	semi translucent	Complete Flake	
25a	N4	20-30	obsidian	gray	semi translucent	Flake Fragment	bifacial thinning flake
25b	N4	20-30	obsidian	gray	semi translucent	Broken Flake	
25c	N4	20-30	obsidian	gray	semi translucent	Complete Flake	
28a	N6	0-10	obsidian	gray	semi translucent	Flake Fragment	
28b	N6	0-10	obsidian	gray	Translucent	Complete Flake	
29	N6	0-10	obsidian	black	opaque	Retouched Piece	Transverse scraper, heat treated, retouched flake, platform faceted, right edge has obverse, concavo-convex, short, scaled flake scars creating low cutting edge; mesial left edge has short sub-parallel flakes creating a straight abrupt "backed" edge.
30a	N6	10-20	obsidian	light gray	Translucent	Flake Fragment	
30b	N6	10-20	obsidian	black	opaque	Flake Fragment	
30c	N6	10-20	obsidian	gray-black	semi translucent	Complete Flake	
30d	N6	10-20	obsidian	gray	semi translucent	Debris	
31a	N6	20-30	obsidian	black	semi translucent	Complete Flake	
31b	N6	20-30	obsidian	gray	semi translucent	Complete Flake	
31c	N6	20-30	obsidian	clear-gray	Translucent	Debris	
32a	N6	30-40	obsidian	gray	Translucent	Complete Flake	
32b	N6	30-40	obsidian	gray	Translucent	Debris	
32c	N6	30-40	obsidian	black	semi translucent		
32d	N6	30-40	obsidian	clear-gray	Translucent	Debris	
32e	N6	30-40	obsidian	clear-gray	Translucent	Debris	
32f	N6	30-40	obsidian	grayish-black	semi translucent	Broken Flake	

Field #	Unit	Depth	Raw Material	Color	Translucency	Debitage Category	Description
32g	N6	30-40	obsidian	black	semi translucent	Debris	
32h	N6	30-40	obsidian	black with gray banding	semi translucent	Flake Fragment	
33	N6	40-50	obsidian	black	opaque	Broken Flake	
34a	N6	wall 0-50	obsidian	black	opaque	Flake Fragment	
34b	N6	wall 0-50	obsidian	gray	Translucent	Flake Fragment	
38	W0	surface	obsidian	black	semi translucent	Flake Fragment	
43	W0	0-10	obsidian	black	opaque	Broken Flake	
46a	W0	10-20	obsidian	clear-gray	Translucent	Broken Flake	
46b	W0	10-20	obsidian	black	semi translucent	Flake Fragment	
46c	W0	10-20	obsidian	black	opaque	Debris	
46d	W0	10-20	obsidian	black	opaque	Broken Flake	
46e	W0	10-20	obsidian	gray	Translucent	Broken Flake	
46f	W0	10-20	obsidian	clear-gray	Translucent	Debris	
47	W0	20-30	obsidian	black	semi translucent	Broken Flake	
49a	W0	30-40	obsidian	gray with black bands	semi translucent	Flake Fragment	
49b	W0	30-40	obsidian	clear-gray	Translucent	Flake Fragment	
49c	W0	30-40	obsidian	gray	Translucent	Flake Fragment	
51a	W1	10-20	obsidian	black gray	semi translucent	Flake Fragment	
51b	W1	10-20	obsidian	black gray	semi translucent	Flake Fragment	
58	E0	0-10	obsidian	black	semi translucent	Flake Fragment	
62	E0	20-30	obsidian	clear-gray	Translucent	Complete Flake	