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Contributions to San Francisco Bay Prehistory:
Archaeological Investigations at CA-MRN-44/H, Angel Island State Park, Marin County, California

By Alex DeGeorgey, M.A., Sentinel Archaeological Research, LLC
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Spanish establishment of St. Francisco in New California, 1806, Georg Heinrich Von Langsdorff. View from the ship "Juno." Four Indians in reed canoe, with Presidio buildings in the background, possibly the oldest known view of San Francisco. Banc PIC 1963 002:1021-FR, The Bancroft Library, University of California, Berkeley.

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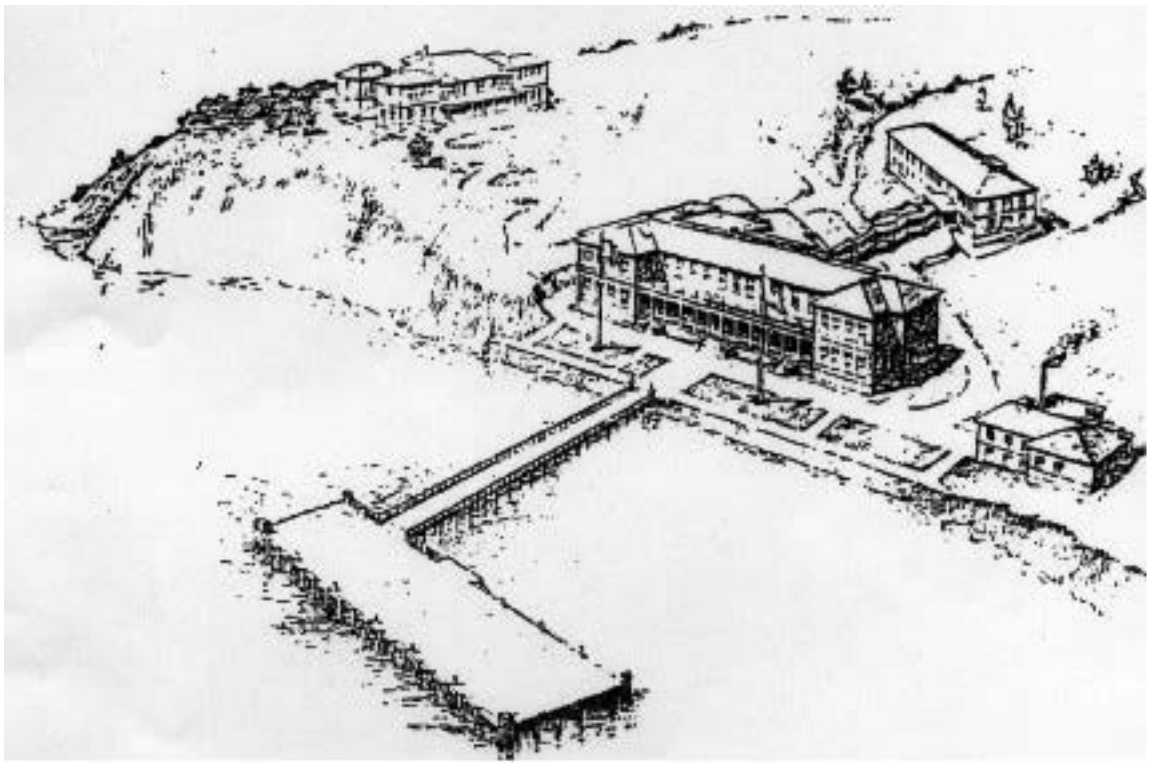

Sketch of Proposed Immigration Station (CDPR Archives).

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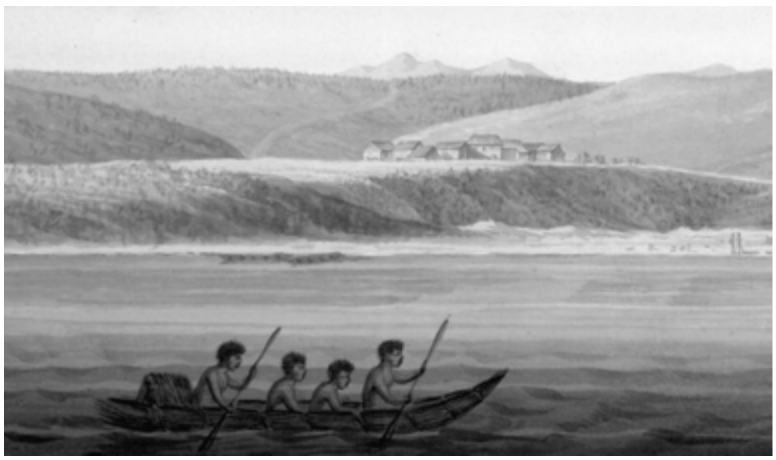

PREFACE

Global warming ended the last ice age more than 15,000 years ago and created San Francisco Bay. The area's ancient low-lying valleys were inundated and high ground was left stranded, effectively becoming islands. As a result, San Francisco Bay today has some 20 islands, with more in adjacent Suisun Bay and the Sacramento Delta. Some (Rat Rock) are no more than protruding rocks, others (Angel Island) are large and well-vegetated—many (Belvidere Island) are nestled within marshes almost abutting the mainland, while others (Alcatraz Island) lie in deep cold, water.

Twentieth-century American perceptions of these ecologically diverse bay islands were distinctly pragmatic and functional. Islands tended to be transformed either into specialized localities—a prison, an immigration holding station, or a military base—capitalizing on the ease with which one could isolate them from the surrounding communities; or made more physically connected with the adjacent mainland residential areas (especially by landfilling) to extend housing tracks. Thus, these urban, historical land uses of San Francisco Bay islands tell us much about modern sensitivities toward connectedness and isolation, and our willingness to transform nature.

In contrast, the original Native American inhabitants clearly viewed these Bay Area islands in a very different light. Local Ohlone and Miwok groups excelled in hunting, gathering, and fishing, and lived off a bounty provided by both the land and the sea. From their perspectives, these islands were an integral part of a broader Bay Area landscape well-suited for foraging and maintaining successful village life.

When the Spanish first arrived almost 250 years ago, they were struck by how easily local indigenous groups traversed the Bay in their tule boats (creating a seamless connectedness between various mainland settings and the islands), and how they modified the landscape through, for example, prescribed burning to enhance native plant and animals and the use of fishing weirs. From archaeological and ethnohistoric studies, we know that Bay Area groups had very high population densities and well-defined group territories. Local groups—living both along the mainland shore and on many of the islands—were also able to overcome occasional local shortfalls in resources through strong patterns of regional interaction (via trade and exchange) while still maintaining a residential footprint.

It was diarist Juan Crespi, of the Pedro Fages Spanish party of 1772 exploring the east shore of San Francisco Bay, that first noted indigenous watercraft ("rafts") on San Francisco Bay, which he observed along the Carquinez Strait (Crespi [1772] 1927). Soon thereafter native watercraft was observed by Captain Juan Manual de Ayala, commander of the San Carlos, the first ship to enter San Francisco Bay in 1775. Anchored just off shore of Angel Island in what is now called Ayala Cove, he witnessed "two floats… carrying 15 Indians…" (Ayala [1775] in Galvin 1971). The voyage's priest Father Vicente Santa María also mentions these craft on the same occasion, correctly calling them "reed boats" (Santa María [1775] 1971). These and other early observations, along with the presence of several well-formed shellmounds on Angel Island and the smaller Brooks and Yerba Buena Islands, attest to the capabilities of the native peoples to cross San Francisco Bay—a body of water known for its blustery winds and strong currents.

These "island" mounds are not nearly as large as some mainland shellmounds such as Emeryville (CA-ALA-309), West Berkeley (CA-ALA-307), or Ellis Landing (CA-CCO-295). Yet they are substantial enough to raise questions about their role within the larger regional settlement pattern of San Francisco Bay, and whether this changed over time in concert with broader trends during the last 2,500 years (the time span when the majority of mounds were constructed). For example, the use of the islands may have been magnified at times when population densities increased and pressure was placed on critical resources such as shellfish and acorns. In this sense, the archaeological assemblages at sites such as CA-MRN-44/H can provide a unique window into broader trends in the trajectory of Bay Area prehistory. The range and nature of the exploited resources (including shellfish, plant, and vertebrate fauna) at these island sites provide insight into the nature of the occupation events (for example, were they permanently, seasonally, or only occasionally occupied), are key barometers in unraveling cultural and environmental changes of San Francisco Bay. Other pertinent archaeological issues that can be addressed from San Francisco Bay "island" archaeology are their roles in economic specialization, ideological/religious practices, as cultural boundaries, and as refugia.

It is with these topics in mind that we are proud to present as Volume 33 of our Publications in Cultural Heritage, *Contributions to San Francisco Bay Prehistory: Archaeological Investigations at CA-MRN-44/H, Angel Island State Park, Marin County California*. This report represents the findings of archaeological data recovery of the "Angel Island State Park Immigration Station Area Restoration Project." This Immigration/ Detention station (the west coast point of entry to the United States for predominately Asia immigrants) was built between 1905 and 1910 directly on top of this shellmound. This destroyed much of the site, as noted by Nels Nelson in 1907 during his celebrated survey of Bay Area shellmounds. Fortunately, intact portions of the mound survived and were re-discovered in 2005 during construction of a septic tank and utility trench for a renovation project. The report that follows presents the archaeological data recovery program that mitigated impacts of the immigration station renewal project, and this study represents an important contribution to the "island" prehistoric archaeological record of San Francisco Bay.

Richard Fitzgerald
Editorial Advisor and Guest

Brian Byrd
Far Western Anthropological Research Group, Inc.

ACKNOWLEDGEMENTS

The Department of Parks and Recreation (DPR) funded archaeological investigations on Angel Island and the research results are presented in this volume. Alex DeGeorgey, Principal Investigator, supervised all aspects of the study and directed archaeological investigations at CA-MRN-44/H. This study would not have been possible without the support and hard work of many individuals. We would like to acknowledge those DPR personnel who were instrumental in the overall success of the investigation. Jeff Brooke acted as the principal DPR archaeologist at the site and was responsible for coordinating with the Native American community. He deserves special recognition in his role as advocate for the cultural resource. Don Bybee and Mark Manning are appreciated for their patience and professionalism in their position of Project Manager. Special thanks are due to Rick Fitzgerald who visited the site on several occasions, participated in the excavation effort, and generously offered his expertise about Bay Area prehistory. Dan Osanna is appreciated for his assistance and interest in the study. Warren Wulzen was present to monitor construction activities on several occasions. State Parks archaeologists Kelly Long and Jessica Einhorn graciously provided their assistance in wet screening of shell midden materials. Wintress Huetter expertly completed technical edits of the draft report.

Many individuals played a crucial part in the field investigation. Jay Rehor and Risa Huetter were courageous and reliable in their roles as Crew Chief. Dr. Sandra Hollimon and James Mangold completed analysis of human skeletal remains at the site and contributed sections to this report. The highly energetic field crew included Allison Scott, Melinda Button, Joe Fayer, Thomas Martin, Phil Kaijankoski, Ben Elliot, Karin Goetter, William Cull, Martin Spannaus, Toni Douglas, Laura MacDonald, Joann Mellon. Their willingness to excavate and wet-screen under "less than ideal" conditions was immensely appreciated. Field efforts were aided by the support of a small crew from the California Conservation Corps (CCC), which included Kathy Barr (supervisor), April Harris, Monique Carter, Tyler Pool, and Eder Martinez.

The following professional archaeologists made a special effort to visit the project area during field investigations: Mark Hylkema and Breck Parkman of DPR, Jack Meyer and Jeff Rosenthal of Far Western Anthropological Research Group, Inc. (Far Western), Mike Newland of Anthropological Studies Center at Sonoma State University, Dan Murley of the Healdsburg Museum, Tom Origer of Origer and Associates, and James Nelson of Furlong and Associates.

Several hundred hours of post-field processing of archaeological materials were gladly completed by a host of laboratory technicians including: Allison Scott, Elizabeth Bedolla, Emily Wik, Sandra Ledebuhr, and Rafael Graham. Special thanks are extended to all the persons who contributed special studies and analyses for the report. Karin Goetter expertly conducted marine shell identifications on a large volume of shell recovered from the site. Faunal analysis and identifications were completed by Tim Carpenter of ArchaeoMeterics and he was also a junior author of the chapter on vertebrate remains from the site included in this report. Dwight Simons provided a detailed summary of the present state of knowledge regarding Bay Area prehistoric subsistence patterns, described some of the on-going regional research questions, and situated the CA-MRN-44/H faunal collection within this larger framework. We are greatly indebted to Eric Wohlgemuth (Far Western) who undertook flotation studies including identification of macrobotanical remains from the site. Tom Rigger completed obsidian hydration analysis of specimens recovered from the site. Craig Skinner conducted X-Ray Fluorescence testing of obsidian materials. Beta Analytic completed Radiometric dating of organic materials. Thanks to Darden Hood of Beta Analytic who graciously explained calibration systems and openly discussed the reliability of results. We extend our appreciation to the graphic expertise of Phil Schmidt who completed true-to-life illustrations of important artifacts from the site.

We also thank Gene Byvelot and Nick Tipon, Native American representatives from the Federated Band of Coast Miwok, who visited the site and offered their cultural input. Finally, we are indebted to Frank Ross, who deserves recognition for his diligence as the on-site representative and Most Likely Descendant. His passionate input made a considerable contribution to the positive outcome of this project. This report is dedicated to you Frank.

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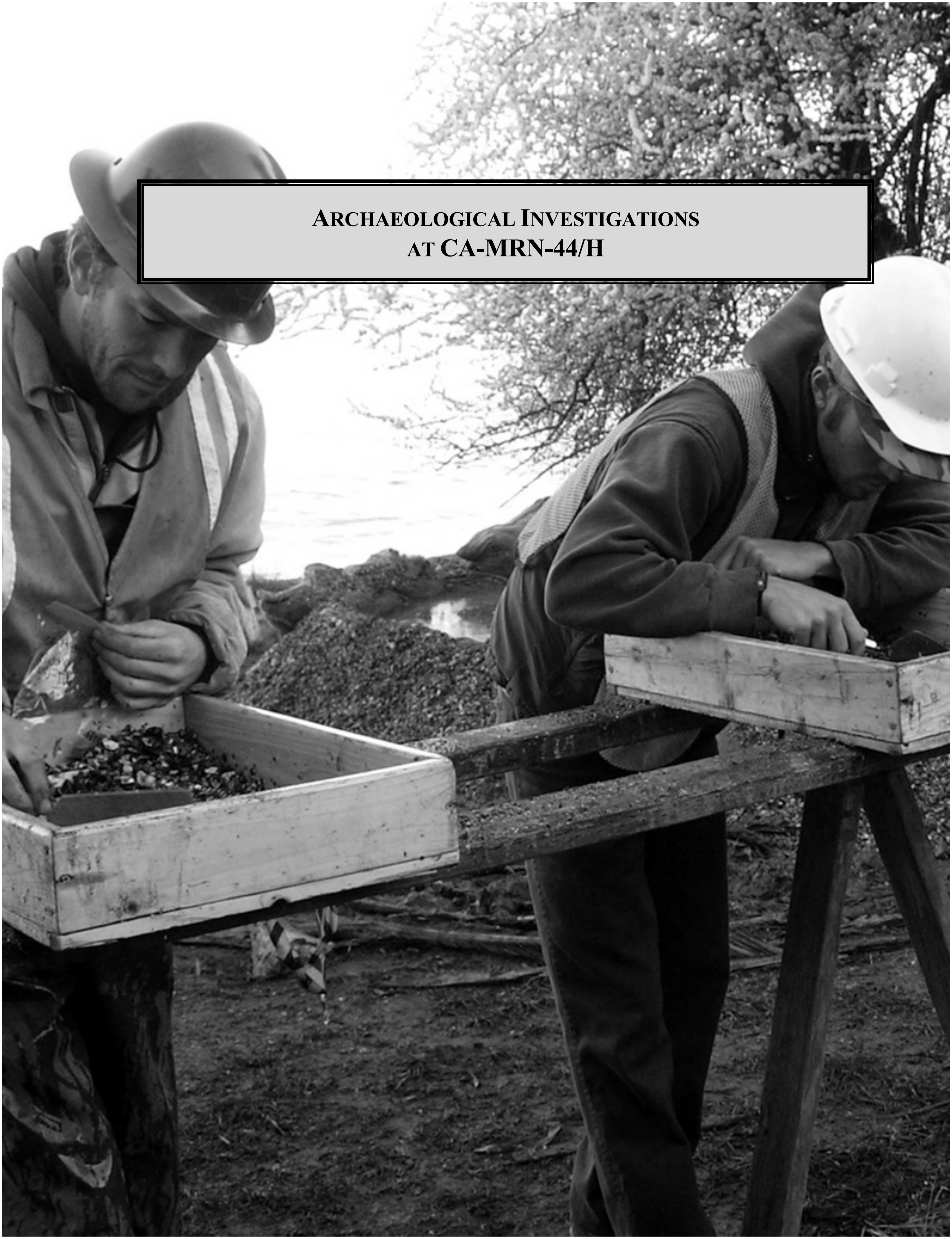
ABSTRACT

This report represents the findings of archaeological investigations at CA-MRN-44/H, a prehistoric and historic site located on Angel Island in the San Francisco Bay, Marin County, California. Sentinel Archaeological Research conducted controlled hand-excavation of 7.8 cubic meters of shell midden. Salvage screening of approximately 9.0 cubic meters of sediments was completed on materials mechanically excavated from a deeply buried component. In addition, an intensive program of exploratory backhoe trenching was conducted. The archaeological sampling strategy focused on understanding the nature and extent of cultural deposits, identification of intact subsurface contexts, and recognition of elements related to site structure. This information was used to formulate strategies for avoidance and mitigation of adverse impacts to the cultural resource.

Archaeological investigations yielded a large assemblage of prehistoric materials including about 96,589 items and/or lots arranged among 771 catalogue numbers. These items include 667 pieces of baked clay, 353 flaked stone artifacts (including 40 projectile points and point fragments), 49 ground stone tools (including stone beads, pendants, and charmstones), 84 bone artifacts, 58 shell artifacts (including three fishhooks, five *Olivella* beads, and 11 *Haliotis* ornaments), 110 soil samples, approximately 95,062 unmodified bone fragments, 145 samples of unmodified shell, and numerous charcoal, macrobotanical, and radiocarbon samples.

Archaeological excavations revealed an intact stratified shell midden deposit and numerous cultural features including occupation surfaces, hearths, rock lined ovens, baking pits, concentrations of fire-affected rock, a shellfish cache, and a Native American grave. Prehistoric Native American use of the site dates between about AD 500-1500. The most intensive and continuous occupation occurred during the Terminal and Late Phases of the Middle period (circa AD 500-1000). During this time the site served as a residential village with an economic emphasis on shellfish gathering and fishing. There is evidence for a significant transformation in subsistence orientation, settlement strategy, and site use during the Middle/Late Transition Period (circa AD 1200). During the Middle/Late Transition Period, the shell mound area of the site seems to have been completely abandoned. Occupation does not appear to be as continuous or intense as during the preceding period. The site probably functioned as a short-term camp centered on salmon fishing and deer hunting. The most striking trait of this component is the paucity of marine shellfish dietary debris in the assemblage. The abandonment of the large residential village during the Middle/Late Transition Period may be a cultural response to environmental degradation connected with the Medieval Climatic Anomaly, which created drought-like conditions throughout the Western United States between AD 800 to 1350.

ARCHAEOLOGICAL INVESTIGATIONS AT CA-MRN-44/H



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Wet Screening at Locus A.

Chapter 1: Introduction

PURPOSE

This report provides a summary of the archaeological studies related to data recovery excavations, laboratory analysis, and curation of prehistoric archaeological materials from CA-MRN-44/H, located within Angel Island State Park in Marin County, California (Figure 1). Sentinel Archaeological Research, LLC (Sentinel) completed this document under California Department of Parks and Recreation (DPR) Standard Agreement C2013007.

Site CA-MRN-44/H is located within the confines of the historic Angel Island Immigration Station, which is located on the north side of Angel Island adjacent to China Cove and within the boundaries of Angel Island State Park. The project is located on USGS 7.5-minute Quadrangle map San Francisco North, T1S, R5W. This area has not been surveyed into sections. The project vicinity is shown in Figure 1. The project location is shown in Figure 2.

MANAGEMENT CONTEXT

This section briefly discusses the nature and extent of State and local regulations that apply to CA-MRN-44/H and describes some of the actions that were undertaken to streamline the compliance process. As part of the compliance process the DPR addressed the California Environmental Quality Act (CEQA) of 1970, as amended, and its implementing regulations found in the CEQA Guidelines, codified in Title 14 of the California Code of Regulations (Public Resource Code Sections 5097, and its implementing guidelines 21082 and 21083.2).

CEQA applies to certain projects undertaken that require approval by State and/or local agencies. Property owners, planners, developers, as well as State and local agencies are responsible for complying with CEQA's requirements regarding the identification and treatment of historic and prehistoric cultural resources. Under CEQA, cultural resources must be evaluated to determine their eligibility for listing in the California Register of Historic Resources (CRHR). If an archaeological resource is determined *ineligible* for listing on the CRHR the resource is released from management responsibilities and a project can proceed without further cultural resource considerations.

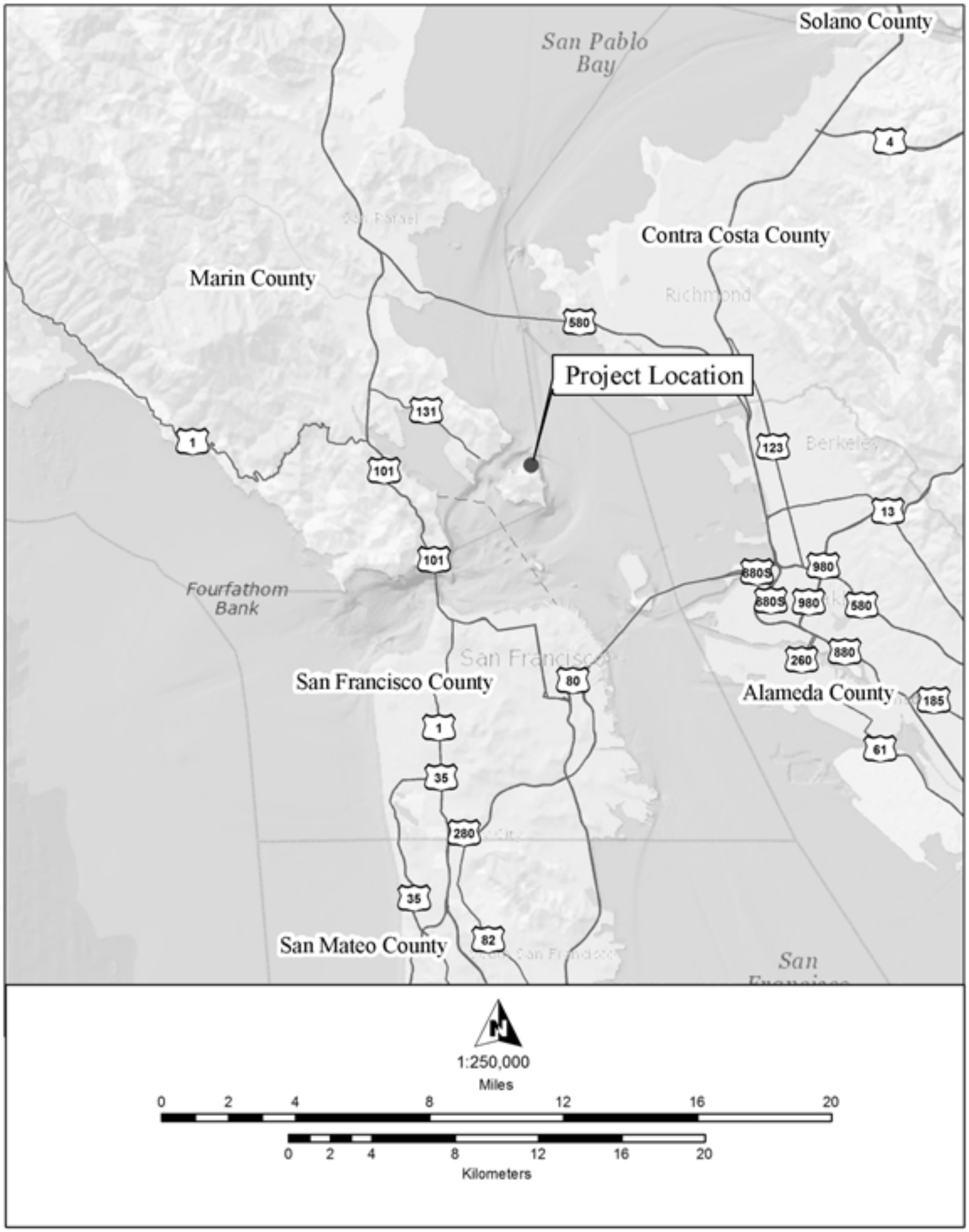


Figure 1. Project Vicinity Map.

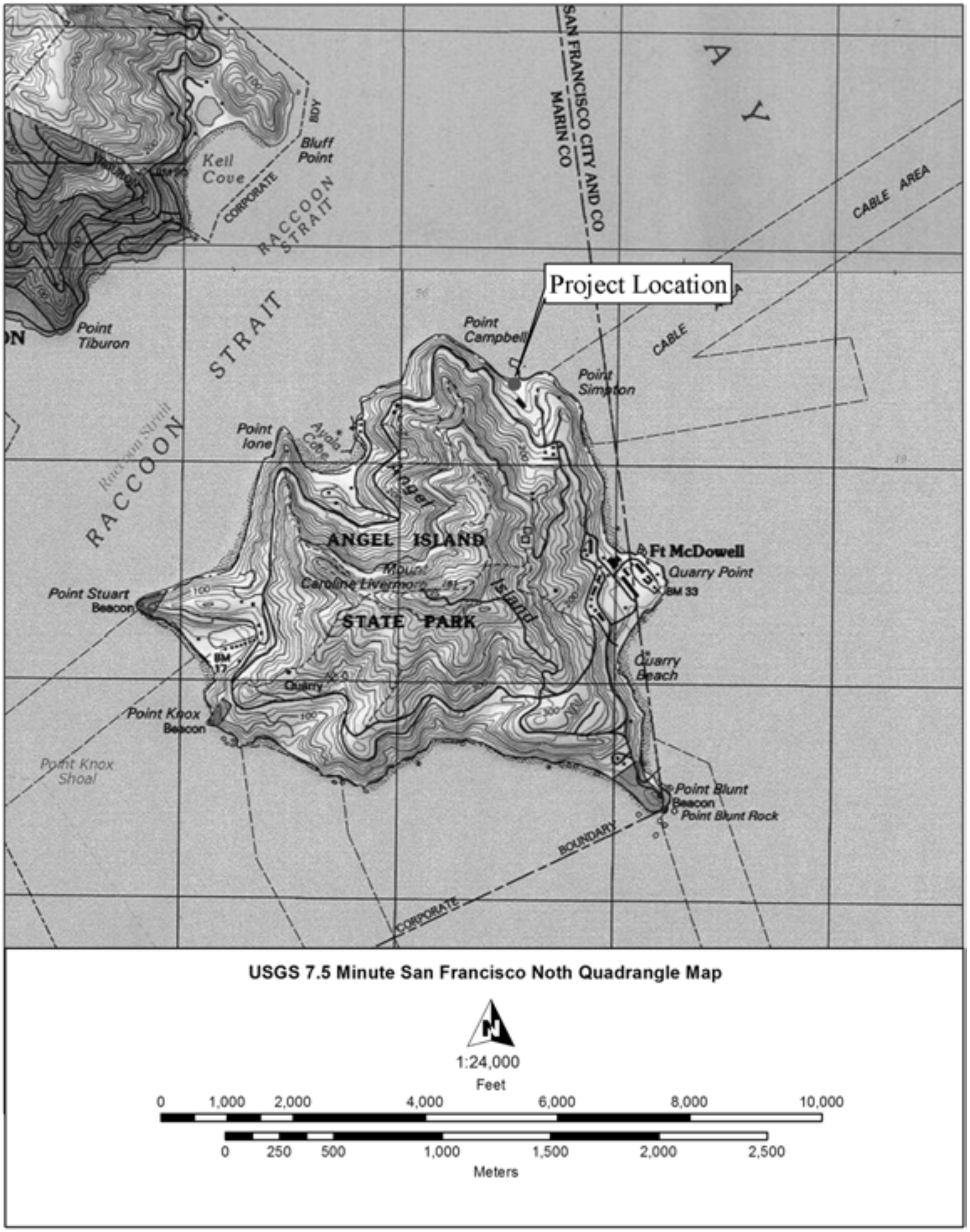


Figure 2. Project Location Map.

As set forth in Section 5024.1(c) of the Public Resources Code, a cultural resource may be deemed "important" under CEQA (and thus eligible for listing on the CRHR), if it meets at least one of the following criteria:

(1) is associated with events that have made a significant contribution to the broad patterns of California history and cultural heritage; or

(2) is associated with the lives of persons important to our past; or

(3) embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or posses high artistic value; or

(4) has yielded, or is likely to yield, information important to prehistory or history.

Angel Island is listed as California Historical Landmark No. 529. The entire island is listed on the National Register of Historic Places as a historical district. In addition, the Immigration Station was designated a National Historic Landmark in 1997. The site was nominated for two different periods of significance: the primary Immigration Station period (1910-1940) and a secondary period (1942-1946), when the Immigration Station was used as a World War II Prisoner of War camp and processing center for troops heading to and returning from the Pacific theatre.

The prehistoric shell midden at CA-MRN-44/H is an eligible property under Criterion 4 for its potential to yield information important to prehistory. This resource has the capacity to address pertinent local and regional research themes. For this reason, a research design is presented to mitigate potential adverse effects to the resource by recovering important information from the site through data recovery excavations. Mitigation of eligible prehistoric properties involves four major steps: (1) development of an archaeological research design (2) field excavations, (3) laboratory analysis, and (4) report preparation.

SITE DESCRIPTION

Site CA-MRN-44/H is a multi-component archaeological site. The prehistoric component consists of a shell midden deposit. The historic component consists of the Angel Island Immigration Station and the Fort McDowell North Garrison, which were constructed on top of the shell midden in 1909 and 1941, respectively. The shell midden is located at the north end of Angel Island Immigration Station facing the San Francisco Bay. The midden is characterized by highly fragmented shell material consisting primarily of mussel with some clam also present. In maximum dimensions, the midden measures roughly 105 meters (east-west) by 30 meters (north-south). The midden was disturbed in the early 1900s by construction of the Immigration Station Administration Building and associated buildings and walkways, as well as by later military era buildings. The site also has numerous underground facilities that criss-cross the area. The present depth of the midden is unclear although several studies have helped better define the horizontal extent of the deposit (Fernandez 2003; Hines 1983; Price and Self 2002; Treganza 1966). The midden is visible due to erosion of the shoreline escarpment on the north side of the site. Trenching of the northern section of the site (Hines 1983) revealed midden laying under 30 to 60 centimeters of overburden in the northeast section of the cove. The midden was also noted in auger holes at the west side of the cove, 70 to 137 centimeters below the current ground surface (Price and Self 2002). Pockets of disturbed midden were observed in two trenches, encountered 70 to 80 centimeters below the current ground surface (Fernandez 2003:49-52).

History of Investigations at CA-MRN-44/H

The earliest account of the prehistoric site is in the military records of Bentley (1869:12) who noted the presence of an Indian shell mound in the cove that later became the North Garrison. In 1907, Nels C. Nelson conducted an informal survey of Angel Island. At that time the shell midden at CA-MRN-44/H was being leveled for construction of the Immigration Station. The island was a restricted government area and "it is evident from Nelson's brief notes"…that "his observations were limited and perhaps in violation of military restrictions" (Treganza 1966:13). Nelson described the site as an Indian village and noted the presence of artifacts and human remains. The site appears on Nelson's map of the San Francisco Bay Region showing the distribution of shell heaps (Nelson 1910).

In 1965, Adan E. Treganza of San Francisco State University conducted archaeological investigations at several prehistoric sites on Angel Island. He described the site as a village (shell midden) covering and area measuring 200 by 300 feet (61 by 91.5 meters), with a depth of 6 feet (1.8 meters). Treganza generated a site record for CA-MRN-44/H based on Nelson's original notes and adapted them to the standard site forms. The site record reports "at least a dozen burials in contracted posture" and notes the presence of mortars, pestles, and charmstones recovered from the area of the Boiler Room (Nelson 1907). Treganza provides the following description:

> This site had been virtually destroyed by the time of Nelson's visit, by construction of a Government wharf and associated buildings. What remained was eroding down onto a beach. His information regarding burials and artifacts were based on reports by members of the construction crew. He examined one skull, which he said was female with pronounced superciliary ridges, similar to those he had observed in the top of Ellis Landing mound. [Treganza 1966]

Treganza conducted auger and shovel tests at CA-MRN-44/H to determine the site's scientific value and potential for future research. The following is a report of his findings:

> Since Nelson reports burials for this site, he must have been present during a period of construction, or noted human remains on the eroded beach front. We made auger and shovel tests of this site, and all attempts at subsurface examination were frustrated with the mass of underground construction, which characterizes the entire cove. What originally used to constitute the main portion of the Indian village was removed when the boiler room was constructed and then further terracing up the canyon demanded what remnant midden was left. No recommendations are made for any further work on this site other than if more extensive landscaping is planned it should be noted that occasional Indian remains still might be present in small undisturbed patches. [Treganza 1966]

Treganza thought that CA-MRN-44/H was "probably originally the best site" (1966:7) on the island, but that its midden had been almost completely removed as a result of the massive demolition and construction undertaken for the Immigration Station and the Army mess hall and kitchen. He said that the main portion of the village area was removed when the boiler room was constructed. The entire site had been covered by buildings, roads, and landscaping. Erosion continued along the sea front and approximately 95% of the site had been destroyed (Treganza 1965). The likelihood of finding undisturbed areas of the site was so minimal that further archaeological excavation was not justified (Treganza 1966:22).

In 1982, DPR archaeologist Phil Hines conducted monitoring during excavation of a 180-foot-long (54.8-meter-long) by 3-foot-deep (0.9-meter-deep) trench dug for a water main near the shore of the bay. Trenching indicated that the midden had been extremely disturbed, with what remains of the site found in the eastern 80 feet (24 meters) of the trench (Hines 1983:18). A single pocket of intact midden was noted, with the majority of the deposit covered by 30 to 60 centimeters of overburden. Ten screen loads of midden were sifted through 1/4-inch screen and Native American artifacts were collected from back dirt and trench soils. Five Native American artifacts were recovered from the site including a basalt pestle, two grooved stone (net sinkers), an obsidian biface fragment, and an obsidian flake. In addition, numerous vertebrate and invertebrate faunal remains were recovered but just one mammal bone was identified as belonging to a sea otter (*Enhydra lutris*) and one bird bone from a Common Murre (*Uria aalge*). A total of 21 fish bones was identified to the level of class. Shellfish included mussel (*Mytilus* sp.) and clam (*Macoma* sp.). No temporally diagnostic artifacts were recovered (Hines 1983).

In 2003, an Initial Study (IS) and Mitigated Negative Declaration (MND) was prepared by the DPR to evaluate the potential effects of the proposed Angel Island State Park Immigration Station Area Restoration Project at Angel Island State Park, Marin County, California. This document was prepared in accordance with the CEQA, Public Resources Code (PRC) §21000 *et seq*., the State CEQA Guidelines, California Code of Regulations (CCR) §1500 *et seq*., and conformed to the content requirements defined under the CEQA Guidelines §15701.

The DPR proposes to make improvements to the Immigration Station Area at Angel Island State Park. The DPR is the lead agency with primary authority over the proposed project.

The Angel Island Immigration Station project Area of Potential Effect encompasses approximately 14.3 acres of the historic Immigration Station, as well as most of the 18.55-acre World War II (WWII) era North Garrison. This site is bound on the north by the San Francisco Bay, on the east by a hill slope, on the southwest by a perimeter road, and on the west by a steep bluff. The Angel Island Immigration Station has been listed on the National Register of Historic Places under three main categories: Cultural Landscape (Criterion A) relating to the Immigration Station (1903-1941) and the North Garrison (1940-1947); Individual Buildings and Poetry (criteria A and C), and Archaeological Sites (Criterion D). The cultural landscape and historical features have been previously addressed (Osanna 2002).

In 2003, a geophysical survey and backhoe test excavations were undertaken in an effort to discover the Immigration Station Administration building foundation and the tar-lined foot path (Fernandez 2003). Pockets of disturbed midden were observed in two trenches (Trench A and B), encountered 70 to 80 centimeters below the current ground surface (Fernandez 2003:49-52). These trenches were situated about 18 meters east of the Boiler Room. The following description of the prehistoric component of the site is summarized from the most recent site record (Jewett et al. 2003).

In December 2005, DPR archaeologists Jeff Brook and Warren Wulzen, with Native American Representative Frank Ross from the Graton Rancheria, monitored backhoe operations at the Immigration Station. High frequencies of shell fragments and artifacts representing an intact midden were discovered within the area of a proposed septic holding tank and utility trench on the north side of the consolidated mess hall. The midden deposit was found buried at an average depth of 150 centimeters below the existing grade. Jeff Brook completed a schematic profile sketch showing the locations of historic features, backhoe trenches, intact midden deposits, and proposed depth of excavations for underground utilities and the septic holding tank. The DPR halted construction in the area until an appropriate course of action for proper management of the archeological resource was determined.

In January 2006, the DPR contracted with Sentinel Archaeological Research, LLC (Sentinel) to develop a research design, data recovery program, and work plan to mitigate anticipated impacts upon the prehistoric archaeological resources present at CA-MRN-44/H. The *Research Design for Archaeological Investigations at CA-MRN-44/H on Angel Island Marin County, California* (DeGeorgey 2006) was intended to addresses the cultural resource management requirements of CEQA and to describe a comprehensive archaeological mitigation program for the prehistoric component of the site.

REPORT ORGANIZATION

This technical report is organized into 11 chapters and presents the results of fieldwork, artifact analysis, and special studies completed at CA-MRN-44/H. *Chapter 1: Introduction* describes the purpose of the study, the management context, provides a site description, and a history of investigations at the site. *Chapter 2: Background* describes the relevant environmental, ethnographic, archaeological, and historical contextual information appropriate to the project area. This includes a review of existing cultural chronologies, archaeological investigations in the vicinity, and current state of knowledge concerning prehistoric adaptations in the region. *Chapter 3: Research Design* describes the theoretical assumptions, hypotheses, test implications, and data requirements for site investigations. *Chapter 4: Methods* describes the types of data collected, sampling techniques, and artifact recovery practices sufficient to document all field and lab methods undertaken in the study. *Chapter 5: Soil Strata and Site Features* presents a summary of controlled excavations at the site, describes the physical context of the archaeological deposit(s) and soils, and describes the cultural features recorded at the site. *Chapter 6: Site Report* presents a description of the archaeological site, describes the artifact assemblage, artifacts, and materials (ecofacts). The final section of this chapter is a description of the discovery, examination, and disposition of human remains encountered during implementation of the study. *Chapter 7: Chronometrics* summarizes the temporal data collected from the site with an emphasis on radiocarbon dating, obsidian hydration studies, and stylistically diagnostic artifact types. *Chapter 8: Vertebrate Remains* presents the findings for zooarchaeological analysis of the vertebrate collection. This chapter includes a summary of the number and quantity of faunal materials present at CA-MRN-44/H, describes the subsistence orientation of site inhabitants, and relates these findings to others sites in the region. *Chapter 9: Plant Use* is a discussion of prehistoric plant use at the site. This chapter describes the relevant research issues, methods, and results with regard to assemblage composition, intra-sample variability, and seasonal indicators of site occupation. *Chapter 10: Shellfish Remains* presents the findings from taxonomic identification of shellfish species at the site. *Chapter*

11: Discussion and Conclusions integrates the findings from CA-MRN-44/H into the existing regional and local archaeological frameworks, identifies shifts in settlement and subsistence strategies, discusses the seasonality of occupation, relates these findings to other sites in the region, and provides suggestions for future research and management. *References Cited* provides a list of all references used in the final document.

In addition, appendices are connected to the body of the report that present the complete artifact catalogue, obsidian hydration results, XRF obsidian source determination studies, findings from macrobotanical analysis, lithic analysis, and faunal studies summary.

Chapter 2: Background

In this section, background information is presented to situate CA-MRN-44/H within its relevant environmental, historical, ethnographic, and archaeological context. This will include a detailed review of existing cultural chronologies, archaeological investigations in the vicinity, and the current state of knowledge concerning prehistoric adaptations in the region. This chapter provides the necessary information for the development of regional research topics to be fully discussed in Chapter 3.

ENVIRONMENTAL CONTEXT

Project Location

CA-MRN-44/H is located at the Immigration Station (North Garrison) near China Cove, on the north side of Angel Island State Park. The site is situated on the beach along the island's north shore, between Campbell Point to the east and Simpson Point to the west (see Figure 2).

Angel Island is approximately 740 acres in size and is situated in the central part of San Francisco Bay, physically isolated by the bay waters. The closest mainland is located at the city of Tiburon, approximately one mile west of the island across the Raccoon Strait. The island is characterized by generally steep terrain consisting of several ridges and seasonal drainages. Beaches along the edges of the island are typically narrow. Areas of extensive flat terrain are found at Ayala Cove, West Garrison, Point Blunt, and Winslow Cove. The highest point on Angel Island is Mount Livermore (formerly Mount Ida), which rises 781 feet (243 meters) above mean sea level.

Natural Setting

Climate

A maritime climate predominates at Angel Island. The winters are cool and wet, and the summers are warm and dry. The ocean waters along the California coast are generally cold due to southern-trending water currents from Alaska. The cold temperature causes condensation of water vapor in the air near the ocean surface, resulting in frequent fog along the coast, which is held in place by the mountains of the Coast Range. Fog may be present within the area about 30% of the days, although the high portions of coastal ridges are generally sunny and clear while the nearby coastal prairie and beaches are inundated. In the northern Coast Ranges, the constant condensation from fog supports a Coast Redwoods habitat.

Geology

Angel Island is situated within the Coast Range geologic provenience. The Coast Range land mass originated between 65 and 150 million years ago (Bailey et al. 1964). Formation of these ranges has been attributed to subduction of the Pacific plate beneath the western border of the North America continental plate. As the ocean floor of the Pacific plate slid beneath the Continental margin, island arc volcanics and materials deposited in a deep submarine trench became accreted to the western edge of California. Eastward directed pressure from the Pacific plate folded and cracked the edge of the continent to form the parallel series of ridges and valleys that characterize the Coast Range we know today.

Angel Island itself is a large block of Franciscan sandstone. This area is mapped as part of the Cretaceous Franciscan Complex, a formation that consists of sandstone, shale, chert, limestone, and conglomerate (Jennings 1977). Igneous and metamorphic rocks dominate the western half of the island. CA-MRN-44/H is situated within the Tocaloma-McMullin complex of soils (Kashiwagi 1985). These soils are typically deep, well-drained, brown loams formed in sediments derived from sandstone parent material. The dominant geomorphic processes acting on the site are colluvial deposition from the adjacent steep slopes, wave action reworking beach sediments along the shoreline, and sea-level fluctuation due to tidal change. In combination, these processes have led to vertical and horizontal development of the beach area over time.

Site Formation History

A photographic overview of China Cove taken in 1902 (CDPR Archives) shows CA-MRN-44/H and the Detention Camp in the upper right corner (Figure 3). The detention camp was used for soldiers returning from Hong Kong with possible infectious diseases (Davidson and Meier 2002a:17). This photo provides a glimpse of the natural conditions that existed prior to major disturbances associated with historic construction and landscaping. In 1902, the small drainage that forms China Cove was an active alluvial fan. A fan-shaped wedge of sediments emanated from the narrow upslope portion of the drainage and extended down onto the lowlands adjacent the bay shore. As a result, a cone of debris accumulated in these lowland areas. At the margin of the cone nearest the hill slope, a small terrace rises slightly above the rest of the debris cone. A gentle low swale near the center of the cone constitutes the primary drainage of the watershed. The location where intact shell midden deposits were observed by DPR archeologists in November 2005 is indicated in Figure 3.

A number of plausible expectations can be developed based on the historic site conditions. Given the low elevation of the landform relative to the bay, construction of the Immigration Station facilities would have required deposition of fill material into the low spots of the landform in order to create a level surface grade. Given potential issues with the water table and the proximity to the bay waters, importation of fill material would have been a preferable strategy rather than cutting the high ground down to grade. If historic construction activities deposited fill into the low areas of the landform, we can expect that: (1) the low swale in the center of the drainage is covered with a thick layer of historic fill and archaeological materials present in this zone are deeply buried; and (2) elevated areas of the landform are capped with a thin layer of fill and archaeological materials present on the elevated portions of the original landform will occur in near-surface contexts.

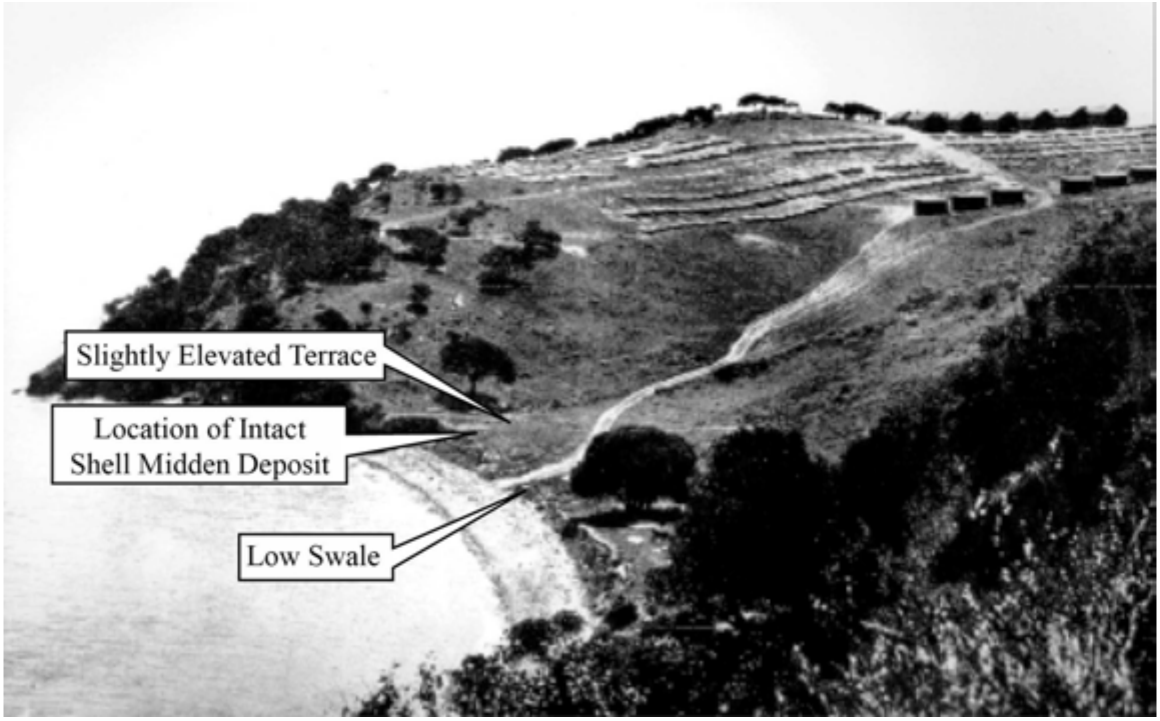


Figure 3. Overview southeast China Cove, CA-MRN-44,
and Detention Camp in background, circa 1902 (CDPR Archives).

Paleoenvironment

Prior to human occupation, the vegetation on Angel Island probably resembled that of the adjacent mainland, which is dominated by oak woodland on north and eastern facing slopes and brush and scrub communities on the south and west-facing slopes. Native species include oak, bay, madrone, sagebrush, chemise, manzanita, toyon, elderberry, and coyote brush. However, the natural vegetation of Angel Island has changed significantly within the last 100 years as a result of human introduction of non-native species and landscape modification. Angel Island was a fueling stop used by sailing vessels to replenish wood supplies (Dana 1895:267-268) and it was likely during this time that the oak-woodland plant community was decimated. Eucalyptus, introduced after 1900, is the predominant tree on the island. Other introduced tree species include Monterey pine, Douglas fir, Monterey cypress, black locust, Australian tea tree, and Portuguese cork oaks. Invasive species of plants include shrubs and grasses, Scotch broom, Spanish broom, and bull thistle (Davison and Meier 2002b).

The structural trough occupied by San Francisco bay was probably established in its present form during the late Pliocene or early Pleistocene (Trask and Rolson 1951). Sea levels rose world-wide during the Holocene, dramatically restructuring the natural and physical environment of the San Francisco Bay. Prior to about 15,000 years ago, the sea level was lower and the shoreline was located west of the Farallon Islands. Sea levels began to rise as glaciers melted. The sea entered the Golden Gate about 10,000-11,000 years ago to form the San Francisco Bay. There was a relatively rapid rise of the sea level from about 12,000 to 6,000 radiocarbon years before present. Sea levels rose much more slowly between 6,150 and 4,658 years ago. Radiocarbon dated peat in San Francisco Bay indicates that sea levels reached their present position about 5,000-6,000 years ago (Helley et al. 1979). The apparent rise of sea level was probably accelerated between 4,860 and 2,420 years ago (Story et al. 1965:49). In totality, sea levels have risen approximately 130 meters since 15,000 BP (Bickel 1978).

By about 4500 BP the tidal marshes were well established in the north and east bay (Bickel 1978). "Marshes developed in the tidal area at the same time that mud was being deposited in the deeper zones, and oyster beds began to flourish where favorable conditions existed" (Story et al. 1965:49). It is about this time that many Bay Area shell mounds begin to appear along the bay shore (Lightfoot 1997; Lightfoot and Luby 2002).

Radiocarbon dating of oyster shell and peat found within bay mud near the San Mateo bridge indicate that oyster beds (*Ostrea lurida*) experienced a population explosion about 2,500 years ago (Story et al. 1965:48). The greatest population of oysters existed for a 200 year span between 2,300 and 2,500 years ago. "Beginning about 2,300 years ago, and continuing to the present, the oyster population in the southern part of the bay became much more restricted in areal distribution" (Story et al. 1965:48).

Paleoenvironmental studies in the region indicate that the San Francisco Bay has undergone considerable environmental change during the mid to late Holocene (Malamud-Roam and Ingram 2004). Originally the bay was characterized as a rocky intertidal zone. During the mid Holocene rising sea levels changed the local environment to one more typically characterized by mud and sandy bays. Previous researchers noted (Gifford 1916; Nelson 1909) that oyster was the dominant mollusk found in the basal components of many mounds, with the upper portions dominated by boring clams. Moratto (1984) attributed this pattern to changing conditions of the bottom of the San Francisco Bay (gravel to mud), which ultimately favored clams over mussels and oysters. Oysters are a reliable index of ecological change and their relative abundance should be greater earlier in time (Greengo 1975). Later, as sedimentation of the bay increased the frequency of oyster beds was reduced.

HISTORICAL CONTEXT

The following historical context is summarized from Fernandez (2003), Treganza (1966), Moore (2002), Milliken (1995), and Davison and Meier (2002a, 2002b).

On August 6, 1775, the Spanish naval vessel *San Carlos*, carrying a thirty-man crew under the direction of Lieutenant Juan Manuel de Ayala, entered the San Francisco Bay with orders to chart the extensive estuary of San Francisco Bay (Milliken 1995:40-41). The *San Carlos* stayed in the vicinity for over a month while the longboat sounded the estuary northward to San Pablo Bay and eastward to Suisun Bay (Milliken 1995:42). The San Carlos anchored and stayed at Ayala Cove (a.k.a. Hospital Cove) at Angel Island from August 13 until September 7, 1775. Both Nelson (1907) and Treganza (1966) document the presence of a prehistoric site (CA-MRN-45) at this location. During this time Lieutenant Ayala visited a *Huimen* village on the Marin Peninsula. Father Vicente de Santa Maria, first sailing master Jose Canizares, and Lieutenant Ayala took extensive notes and kept daily journals of this historic visit (Galvin 1971). They document a series of cordial and formal cultural interactions between the Spaniards and members of various local tribes (Galvin 1971; see also Milliken 1995:40-51). Between 1769 and 1776, most of the people around the San Francisco Bay clearly desired glass beads from the foreign visitors (Milliken

1995:57). Throughout the visit the Spanish frequently passed out strings of glass beads, earrings, and other items (Milliken 1995:43, 44, 48, 50).

During the *San Carlos* visit to the San Francisco Bay, Father Vicente Santa Maria discovered and described a shrine on Angel Island consisting of feathered objects in a cleft in a rock.

> These were slim round shafts about a yard and a half high, ornamented at the top with bunches of white feathers, and ending, to finish them off, in an arrangement of black and red-dyed feathers imitating the appearance of the sun. They even had, as their drollest adornment, pieces of the little nets with which we had seen the Indians cover their hair.
>
> At the foot of this niche were many arrows with their tips stuck in the ground as if symbolizing abasement. This last exhibit gave me the unhappy suspicion that those bunches of feathers representing the image of the sun (which in their language they call *gismen*) must be objects of the Indians' heathenish veneration; and if this was true-as was a not unreasonable conjecture-these objects suffered a merited penalty in being thrown on the fire. [Santa Maria [1775] 1971:49]

The establishment of Mission San Francisco de Asis (also known as Mission San Francisco Dolores) and the San Francisco Presidio in 1776 brought the most drastic and permanent change to the local Coast Miwok way of life. Many people from the village of *Huimen* were brought to the Mission San Francisco beginning in 1783 (Milliken 1995:244). In February 1809, Aleuts brought down from Alaska by a Russian expedition were reported to be hunting sea otters in San Francisco Bay and had contact with the Indians on Angel Island (Arrillaga [1809] 1995). Although no positive Aluet contact materials have been reported on Angel Island, Treganza recovered a wild boar tusk, originally from a South-pacific Island, at CA-MRN-45 (1966:6, 41). The origin of this item may have been from early Russian-Aluet contact with local Miwok tribes (Treganza 1966:6).

In 1839, A. M. Osio, a Mexican customs official and politician, obtained Angel Island for a ranch. By 1846, 500 head of cattle and caretakers were on the island. From this point forward, the island was subjected to Caucasian interference. In the early 1840s, Angel Island was used by mariners for replenishing supplies of water and wood and is noted on early nautical maps, which show the watering place and anchorage to have been located immediately north of Quarry Point.

Between 1863 and 1946, the US Army almost continuously occupied Angel Island. Civil War fortifications were placed on the island and today represent one of the largest groups of surviving Civil War buildings in the county. Camp Reynolds was established in 1863 where the present-day West Garrison is located. A medical hospital was built in 1864 in the area now called Hospital Cove (Ayala Cove).

"At the turn of the twentieth century, the port of San Francisco provided minimal facilities to support immigration" (Davison and Meier 2002a:29) and Bureau of Immigration officials publicly criticized the small, crowded, and unsanitary conditions. As a result, Congress introduced Senate Bill 1278 under the Sundry Civil Appropriation Act to provide for the erection of buildings for a new Immigration Station. Angel Island was chosen as a logical location and work began to transfer land from the Army to the Bureau of Immigration. Work on the Immigration Station was delayed as a result of the 1906 earthquake and ground breaking did not begin until early 1907. The Immigration Station on Angel Island was officially opened on January 21, 1910 (Figure 4 and Figure 5). Facilities included a large two-story administration building, wharf, hospital, central heating plant, and detention barracks for about 400 Asians and Germans.

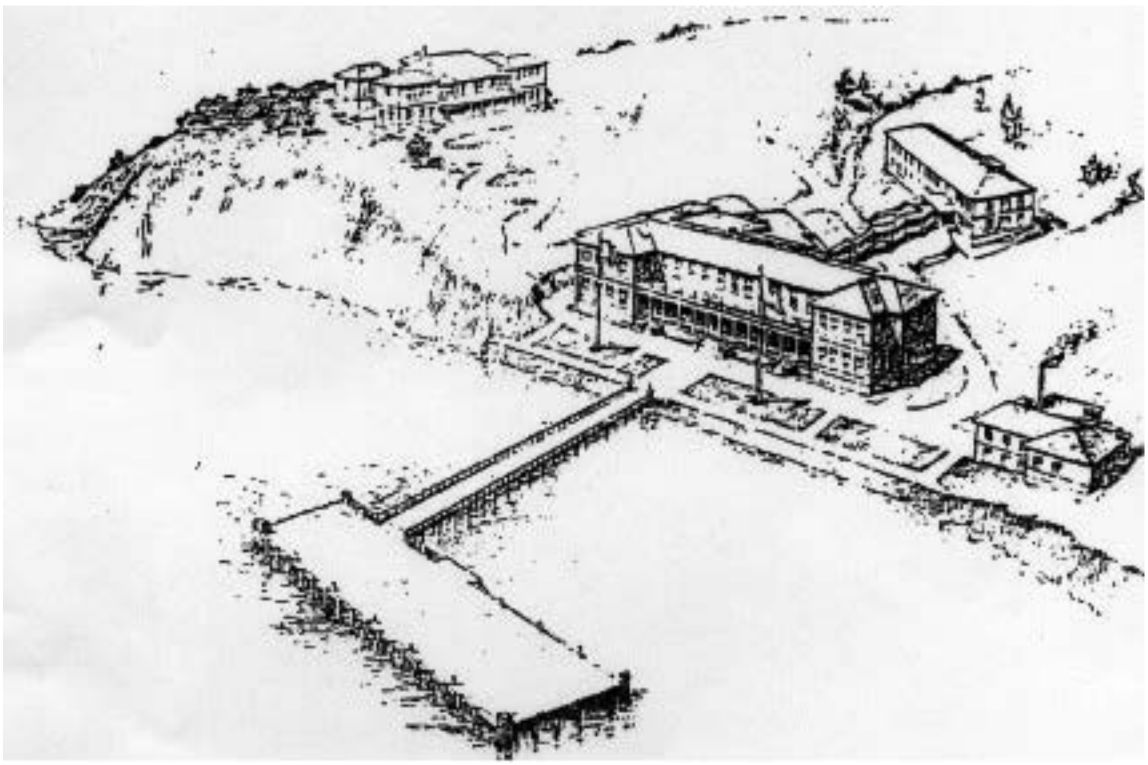


Figure 4. Sketch of Proposed Immigration Station (CDPR Archives).

The island was the main port of entry for Asians arriving on the west coast of the United States from 1910 to 1940. One of the purposes of the immigration detention facilities was to enforce the Chinese Exclusion Act of 1882 and other discriminatory policies against Chinese immigrants. Angel Island became a symbol of exclusion rather than freedom for many Asian immigrants and was described by historian Him Mark Lai as "a prominent symbol of racist immigration policy."

On August 12, 1940, the Administration Building on Angel Island caught fire and the Immigration Station did not have enough water to fight the flames (Figure 6). The Building was destroyed but no lives were lost. The Bureau of Immigration moved the operations off the island and by October 1940 the final group of Chinese detainees were moved to various locations on the mainland, including the county jail (Davison and Meier 2002a:94). The Immigration Station was officially closed on November 5, 1940.

Fort McDowell, the military installation, experienced an accelerated amount of building activity in the late 1930s and early 1940s in response to WWII. During WWII, all enemy aliens were removed from German and Japanese ships in United Stated ports and taken to Angel Island where they were held until they were sent to North Carolina (and elsewhere) for the duration of the war. A large-prisoner-of-war camp was established at the North Garrison, housing both German and Japanese prisoners. With the close of WWII, the

Army no longer needed the post and on August 28, 1946, Angel Island was declared surplus and was turned over to the US District of Engineers. In the 1950s the island was home to a Nike nuclear weapons missile base. Angel Island became a California State Park in 1961. Today, there are two small parcels on the island owned by the Coast Guard but managed by State Parks.

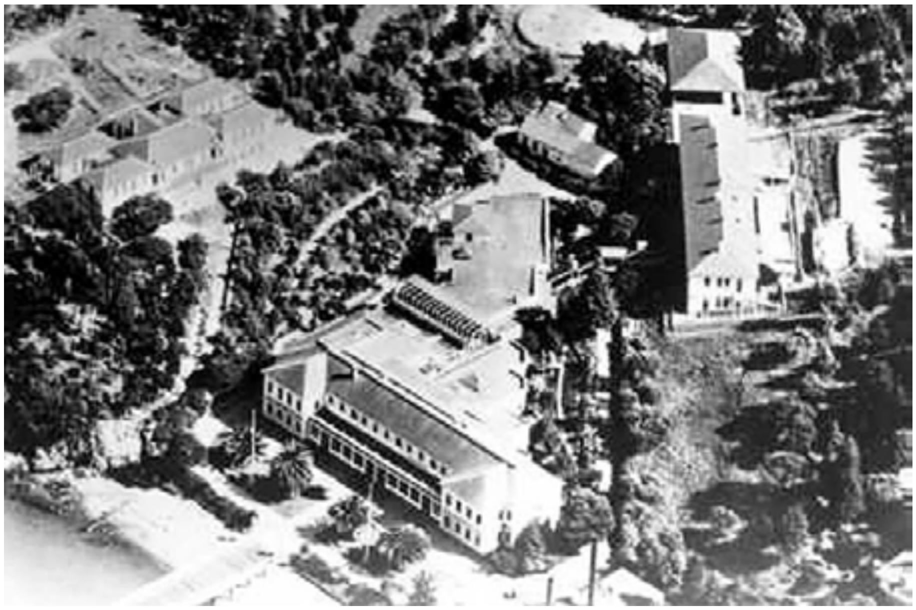


Figure 5. Aerial View of Immigration Station Complex circa 1910 (CDPR Archives).

Figure 6. Fire in the Administration Building 1940 (CDPR Archives).

ETHNOGRAPHIC CONTEXT

This section describes the ethnographic setting of Angel Island. Although there was intense ethnographic work conducted in California around the turn of the twentieth century, little is specifically known about Angel Island. Archaeological evidence of prehistoric occupation on Angel Island dates to the Late Horizon (AD 500-1880), which includes the ethnographic period (Treganza 1966:41). It is likely that Angel Island was the ethnographic territory of the Coast Miwok (Kelly 1978; Kroeber 1925; Milliken 1995; Treganza 1966). The Coast Miwok are one of several Penutian language groups found in the North Coast Range, the Central Valley, and the Sierra Nevada. The Coast Miwok may have arrived in the area around 3000-4000 BP (years before present), displacing Hokan speakers already inhabiting the region (Moratto 1984:277).

Ethnographic accounts by Kroeber (1925:272) note that the Coast Miwok were comprised of three tribes: the *Olamentko* of Bodega, the *Lekahtewut* between Petaluma and Freestone, and the *Hookooeko* of Marin County. The closest known ethnographic village is *Liwanelowa* (Kelly 1978:415) located at present-day Sausalito. *Liwanelow* is also known as *Liuaneglua* or *Livanegula* (Milliken 1995:50, 244). Milliken (1995:Map 4) indicates that this village would have been within the *Huimen* tribal area whose center is located on what is now Richardson Bay on the Marin Peninsula.

The basis of Coast Miwok social life was the family and village community. Village communities included numerous family dwellings. It was customary for several related families to live together in a round or oval shaped home of thatch secured to a pole frame. The main village served as the center of communal activities, was the residence to the chief, contained the community dance house, and was generally occupied throughout the year. The *Huimans* had three key villages, *Anamas*, *Linangeula*, and *Naique*, all on or near present-day Richardson Bay (Milliken 1995:21). Smaller satellite villages typically associated with the main village consisted of fewer houses, fewer people, and were generally seasonally occupied. For each village community there was a chief who acted as spokesperson and leader. This position was not exclusively hereditary and a retiring chief had some input in the choice of a successor. It was the responsibility of the chief to make arrangements for important communal activities such as acorn gathering parties, fishing and hunting expeditions, and ceremonial activities. The chief had little real authority but instead served to guide the community through consultation.

Coast Miwok subsistence strategies were well adapted to their environment. Like most Native Californians, they extracted and used local resources on a seasonal basis. A number of subsistence pursuits were undertaken, including fishing in bays and estuaries, fowling in the marshes, hunting large and small mammals along the coastal prairie and in the uplands, and gathering a diverse range of plant and marine species from various eco-zones. No doubt fishing for pelagic and seasonally available fish and shellfish were important subsistence pursuits at Angel Island. A variety of marine resources were exploited including numerous shellfish, aquatic fish, and seaweed. Sea mammals were hunted including harbor seal and sea otter. Villages were typically situated adjacent a shore, lagoon, or slough. Prolonged and intensive use of the bayshore villages resulted in the development of large shell refuse heaps or "shell mounds." Shell mounds typically contain large quantities of shell, large mammal bones, fire-affected rock, artifacts, and other discarded items. Human burials are typical constituents of Bay Area shell mounds.

ARCHAEOLOGICAL CONTEXT

Taxonomy

Through the efforts of a number of researchers, a three-part sequence was developed for understanding Central California's prehistory (e.g., Beardsley 1948, 1954; Heizer 1941, 1949; Heizer and Fenega 1939; Lillard et al. 1939; Lillard and Purves 1936; Schenck and Dawson 1929). Early, Middle and Late Horizons were identified on the basis of temporally diagnostic artifact types and mortuary customs (e.g., Beardsley 1948, 1954; Lillard et al. 1939). This three-part sequence was patterned after the Midwestern Taxonomic System (McKern 1939) and became commonly referred to as the Central California Taxonomic System (CCTS; Beardsley 1948, 1954; Gerow 1954). Following the advent of radiocarbon dating in the early 1950s attempts were made to correlate this relative sequence with absolute chronometric dates (Fredrickson 1973, 1974; Heizer 1958; Ragir 1972).

Considerable archaeological variability is apparent in the prehistory of northern California and attempts have been made to deal with the cultural-historical relationship of prehistoric assemblages (Bennyhoff and Fredrickson 1994). Many researchers were frustrated by the CCTS's use of the term *horizon* because it obscured cultural variability, causing local manifestations to be overlooked (Moratto 1984). Additionally, it specified no minimum of characteristic traits for definition of horizons and the dimensions of time and culture are confused (Bickel 1978:2). Bickel (1978) concluded that the Bay Area picture is one of such complexity that it cannot be portrayed in simple unilineal models. Fredrickson also identified shortcomings in this three-horizon chronological framework (Beardsley 1948, 1954; Lillard et al. 1939).

The distinction between cultural chronology and culture history serves to resolve taxonomic inconsistencies by dealing with the existence of contemporaneous but separate prehistoric cultures occupying the same region. In a critique of previous taxonomic frameworks developed for the North Coast Range, White et al. (2002:46) states the "periods have no spatial dimension, spatial units have no temporal dimension, and neither has specific cultural meaning." In order to deal with these issues, a taxonomic model was developed which allows for the co-occurrence of two or more aspects at one time in a single district (i.e., a small geographic region), the shift of one aspect from another district, or the expansion of one aspect from one to several districts over time" (Fredrickson 1994a).

Seminal work on the prehistory of Central California by Bennyhoff and Fredrickson (1994) established a taxonomy that opened new doors to understanding regional prehistory. Bennyhoff and Fredrickson (1969) described the cultural units of *pattern*, *aspect*, and *phase*. On the level of pattern the taxonomic model seeks to identify prehistoric cultures with similar social, economic, and technological systems. On the level of aspect, it attempts to group discrete historically related assemblages distinguished by recognizable stylistic traditions. The integrative taxonomic units of pattern, aspect, and phase use comparative research to effect cultural historical organization.

A *pattern* is defined as a specific economic/cultural adaptation bound geographically but not temporally. The pattern is the largest cultural historical unit employed in the taxonomy. A pattern is "a configuration of basic traits (representing) a basic adaptation generally shared by a number of separate cultures over an appreciable period of time within an appreciable geographic space" (Bennyhoff and Fredrickson 1994:21).

An *aspect* is a set of historically related technological and stylistic cultural assemblages within a pattern. The aspect is separated out of the larger, more generalized unit of the pattern. The identification of an aspect is largely dependent on artifact time/space distribution studies.

Each aspect can be divided into discrete temporal *phases* based on similarities and differences in historically related artifacts types, styles, and materials. Phases are the smallest recognizable cultural unit in time and space (Bennyhoff and Fredrickson 1994:34).

Archaeological Patterns

Through its long history, the region defined by the San Francisco Bay Area, North Coast Range, and Sacramento Delta Region has witnessed many population movements, pulses of cultural complexity and recession, and a complex interplay of cultural and environmental influences. Currently, four archaeological patterns have been clearly identified in the Bay Area region: the Borax Lake Pattern, Windmiller Pattern, Berkeley Pattern, and Augustine Pattern.

Borax Lake Pattern

The Borax Lake Pattern (6000 to 8000 BP) is the regional expression of the Lower Archaic Period (Fredrickson 1973:189). The Borax Lake adaptation demonstrates a reliance on seed processing as evidenced by higher frequencies of milling slabs and hand stones in assemblages (Fredrickson 1973:214-217; Fredrickson and White 1988; Meighan and Hayes 1970). This subsistence shift has been suggested to be a response to the Altithermal, a major change in the general climatic regime toward warmer and drier conditions when ancient lakes dried up (Fredrickson 1974:46). Milling stone assemblages are found in abundance during this Period suggesting emphasis of vegetable resources at the expense of hunting. Most artifacts are manufactured from local materials and exchange presumably occurred in an ad hoc fashion. Wealth does not appear an emphasis and the social unit probably consisted of the extended family (White et al. 2002:43).

Knowledge of human occupation at this time depth is based largely on studies completed in the Northern Coast Range (Fredrickson 1974, 1984). Owing to the general paucity of early sites in the Bay Area region, very little is known of the Lower Archaic Period (before ca. 5000 BP) of the Bay Area. Recent research in Contra Costa County (Meyer and Rosenthal 1997) has documented the some of the earliest archaeological evidence of human occupation in the greater Bay Area region and has contributed to our understanding of regional prehistory.

Between August 1994 and May 1996, the Anthropological Studies Center at Sonoma State University undertook emergency archaeological excavations at several prehistoric sites located within the proposed Los Vaqueros Reservoir area of Contra Costa County. An extensive deposit of archaeological materials was found deeply buried in a backhoe trench associated with a buried paleosol. The artifact assemblage included a wide stem obsidian projectile point, milling slabs, flaked-stone core tools, and some floral and faunal remains. Two radiocarbon assays of more than 9000 BP were obtained from the deposit indicating that it is the oldest archaeological deposit yet dated in the greater Bay Area region. In addition, a human burial was radiocarbon dated to 7400 BP and is cited as the oldest human burial in the region (Meyer and Rosenthal 1997:iv). Archaeological evidence at Los Vaqueros bears similarities to Lower Archaic assemblages in the North Coast Range.

Windmilller Pattern

The Windmiller Pattern (5000-2000 BP) begins during the Middle Archaic Period. Windmiller was previously assigned to the Early Horizon (Heizer 1949:39). It has been suggested that the Windmiller culture in Central California represents the arrival and initial diversification of Utian languages from the Columbia Plateau or Western Great Basin (Moratto 1984:207, 279-283). Windmiller assemblages are present in the Delta region dating some time before 2500 BC. By circa 1800 BC, a strong Windmiller influence had spread west to the San Francisco Bay shoreline (Elsasser 1978).

Windmiller Pattern assemblages emphasize hunting, as evidenced by the relative proportion of tools representing hunting, fishing, and other activities (Moratto 1984:202-207). Large stemmed projectile points, dominated by chert and slate, suggest spear technologies. Relatively rare milling slabs and handstones indicate the processing of plant foods did not constitute the mainstay of the diet, although mortar fragments are present in some Windmiller sites indicating the grinding of acorns and/or other seeds may have been somewhat important (Ragir 1972:98). Baked clay net weights, bone angling hooks, bone spear tips, and the remains of sturgeon, salmon, and smaller fishes provide evidence for fishing (Bennyhoff 1950; Heizer 1949; Moratto 1984:201; Ragir 1972). Close-twined basketry is indicated from baked clay impressions (Moratto 1984:203). Trade appears to have focused primarily upon the acquisition of finished ritual and ornamental objects. These are found in burial contexts, in both scattered village plots and off-village (non-midden) cemeteries. Grave offerings are commonly abundant, including shell beads, quartz crystals, and charmstones. Notable are the ground and polished charmstones of alabaster, marble, diorite, and other rocks. Burials are frequently oriented to the west in a ventrally extended position, although western dorsal extensions also occur. Flexed burials, non-westerly orientation, and cremation occur infrequently (Fredrickson 1973; Ragir 1972).

Berkeley Pattern

The Berkeley Pattern dates to the Middle and Upper Archaic Period (1500-6000 BP). The Berkeley Pattern appears to have developed in the San Francisco Bay region as early as the Lower Archaic period and later spread to surrounding coastal and interior areas of central California (Moratto 1984:209). The majority of sites representative of this pattern date to the Middle Archaic. Berkeley Pattern assemblages may be associated with expansion of Miwok groups from the Bay Region eastward into the Valley and beyond.

Berkeley Pattern sites have been identified at numerous archaeological sites in the Central Valley, Bay Area, and North Coast Range regions. Several Berkeley Pattern assemblages have been identified in the North Coast Range. Berkeley pattern assemblages have been documented in the lowland areas of the Russian and Napa River valleys (Bennyhoff 1994b; Heizer 1953). To the north and west of the Clear Lake Basin, Berkeley Pattern assemblages appear to date post 2500 BP and have been reported in the southern Geysers, Lake Sonoma, and Mendocino County Coast (Basgall 1982, 1993; Basgall and Bouey 1991; Baumhoff 1980; Bouey 1986; Fredrickson 1985; Layton 1990).

The Berkeley Pattern shows subsistence activities that focused upon acorns as a dietary supplement. The Berkeley Pattern is distinguished from the Windmiller Pattern by a higher occurrence of mortars and pestles, a well-developed bone tool industry, distinctive diagonal flaking of large concave-based points, and certain forms of *Olivella* and *Haliotis* beads and ornaments (Moratto 1984:210).

The Berkeley Pattern is characterized by a maritime emphasis centered on saltwater shellfish gathering as evidenced by large accumulations of shell refuse. Oyster, clam, and mussels predominate Bay Area shell refuse deposits while freshwater mussel occurs in the Central Valley and North Coast Range archaeological assemblages. Bone fishing spears, harpoons, various types of hooks, and stone net sinkers denote the importance of fishing activities (Beardsley 1954; Bennyhoff and Elsasser 1978). Several types of baked clay artifacts are known, including spool and loaf shaped items, as well as baked clay pieces showing basketry impressions (Beardsley 1954:75; Lillard et al. 1939:44).

The importance of status distinctions based on wealth first appears in Berkeley Pattern assemblages (Fredrickson 1974:48). Greater complexity of exchange systems is evidenced by regular, sustained exchanges between groups. Territorial systems do not appear fully established during this period. Group oriented religious organizations may indicate the emergence of the Kuksu religious system during the end of the Archaic Period (White et al. 2002:43).

The Berkeley Pattern is characterized by a highly developed bone tool industry. Bone needles, awls, whistles, serrated scapula "saws," tubes, and miscellaneous split, ground, polished or incised bone artifacts are common burial-associated artifacts. Burial practices are generally characterized by tightly flexed internments with no obvious patterning in orientation. Berkeley Pattern burials tend to have few associated funerary objects compared to the earlier Windmiller Pattern and later Augustine Pattern. A small proportion of cremations with funerary artifacts may identify high-status individuals (Moratto 1984:21). *Olivella* saucer and saddle beads as well as *Haliotis* ornaments were frequent grave associations, but also have been documented as unassociated midden finds. Several types of dart-sized contracting stem and non-stemmed lanceolate (e.g., Excelsior) projectile points are commonly associated with the Berkeley Pattern. Diagonally flaked obsidian, concave-based, and non-stemmed projectile points are unique to Berkeley Pattern assemblages (Moratto 1984:210). The mortar and pestle continue to be important while milling slabs and hand stones occur infrequently.

Augustine Pattern

The Augustine Pattern within the Emergent Period (AD 500-1800) is the final prehistoric pattern identified within the North Coast Range, Bay Area, and Sacramento Delta regions (Fredrickson 1973). This Pattern was previously assigned to the "Late Horizon" (Ragir 1972).

The Augustine Pattern is distinguished by the emergence of distinctive "cultural climax" areas, generally characterized by large, dense populations, social stratification, complex exchange systems, and elaborate ceremonialism (Fredrickson 1973). Characteristic artifacts include small corner-notched and triangular arrowhead projectile points, clam shell disk beads, small-diameter stone drills, magnesite cylinders, "banjo" type *Haliotis* ornaments, bedrock mortars, evidence of intensive fishing, hunting, and gathering of acorns, and house pits (White et al. 2002).

The exploitation of acorns as a primary food source marks this pattern. The bow and arrow appears to have quickly replaced the atlatl and dart as the favored hunting implement. Augustine Pattern mortuary practices include pre-interment grave pit burning of artifacts, flexed burials, and cremation. Fish harpoons (with barbs unilaterally or bilaterally placed in opposed or staggered positions) first appear in Phase I. Early Phase II abandons their use, in sharp contrast with the continuity (often with elaboration and expansion) of most other Phase I cultural elements (Bennyhoff 1950). Trade networks become highly developed. Clamshell disk beads, which first appear in Phase II, are hypothesized to have served as standards of values (i.e., money). A greater reliance on ceremonialism and the development of secret societies associated with the Kuksu Religious Cult (documenting the beginning of the ethnographic period) may have had their origins in the beginnings of this period, as reflected in assemblages, which emphasize shell beads and ornaments (Fredrickson 1974). Social differentiation is proposed based on the unequal distributions of wealth and associated burial modes. Cremation, initially reserved for individuals of high status during Phase I of the Emergent Period became a wide-spread practice in Phase II of the Emergent Period (Fredrickson 1974:127; Moratto 1984:211). Grave goods such as shell beads and ornaments commonly occur with utilitarian items including mortars and pestles. Mortars and pestles were customarily damaged, or "killed," before burial.

The Augustine Pattern is thought to represent a population replacement by Wintuan groups originating from the Columbia River Plateau region (Bennyhoff 1994b). This transition in Central California is marked by a change in tools and traits. Six new traits were introduced: simple harpoon tip, collared pipe and bird bone mouth pieces, grave pit burning, self bow and arrow, spindle whorls for manufacturing cordage for fish nets, and brachycephaly or "round-headedness." Whistler (1977) proposed population movements of Penutian speaking groups based on names of plants and animals that differed from or were absent in newly occupied areas. These names for plants appeared to come from locations outside California or were borrowed from groups already present in the area. Whistler (1977) proposed Southwestern Oregon was the origin of Proto-Wintuan groups.

Regional History of Archaeological Research

This section situates CA-MRN-44/H within the regional archaeological context of Marin County, providing a brief review of select archaeological studies that have been previously conducted within the vicinity of Angel Island.

A substantial amount of archaeological work has been completed in Marin County. Beginning in the early 1900s, anthropologists at the University of California undertook efforts to locate and identify the shell mounds of the San Francisco Bay Area (Nelson 1910). The first survey of Marin was undertaken as part of Nelson's 1906-1909 Bay Area-wide search. In 1909 and 1910, Nelson excavated at San Rafael (CA-MRN-315), Sausalito (CA-MRN-3), and Greenbrae (CA-MRN-76; Nelson 1910). Nelson reported the presence of two prehistoric complexes in Marin County similar to those along the eastern bay shore. The older phase, (later subsumed under the Ellis Landing Facies) was represented by cobble mortars, large projectile points, *Olivella* saucer beads, mica ornaments, and elk bone whistles. The younger phase (subsequently placed within the Emeryville Facies) was characterized by shaped, flat-bottom mortars, *Olivella* rectangular beads, incised *Haliotis* ornaments, and imperforate charmstones (Nelson 1910). Nelson concluded that southeastern Marin County was part of the San Francisco Bay cultural region.

In the 1940s, Richard K. Beardsley undertook substantial excavations at four sites on the Point Reyes Peninsula, including the Mendoza Site (CA-MRN-275), the Cauley Site (CA-MRN-242), the Estero Site (CA-MRN-232) and the McClure Site (CA-MRN-266). Beardsley noted that the use of the Horizon terminology (Lillard et al. 1939) did not adequately represent spatial differences in cultural assemblage variability. In order to overcome the awkwardness of the existing chronological framework, Beardsley presented the concept of Facies to describe the geographic province of Marin Coast (1954:57). The prehistory of the Marin Coast was organized into three-part sequence of various facies. The temporal sequence proposed for Marin County coast begins with the McClure Facies of the Middle Horizon and continues through the Mendoza Facies of the Late Horizon to the Estero Facies of the Late Horizon (Beardsley 1954:57). Each facies had "clear-cut differences" in the total cultural assemblage (Beardsley 1954:58) and are summarized by Moratto (1984:Table 6.1). Figure 7 presents Moratto's summary of Beardsley's (1954) Marin Coast chronology. Beardsley's (1954) Marin Coastal chronology was slightly modified by Bennyhoff (1994a) and is presented in Figure 8.

More recently, excavations in Marin County have explored topics related to socio-cultural dynamics (King 1970; Slaymaker 1977), ethnographic affiliation (Goerke and Cowan 1983), and cultural chronology and assemblage composition (Bieling 1998; Moratto et al. 1974).

Socio-Cultural Dynamics

Research conducted by Thomas F. King offered testable models of sociopolitical nature. In his 1970 study, *The Dead at Tiburon: Mortuary Customs and Social Organization on Northern San Francisco Bay,* King documented a distinct burial area. Excavations at a shell midden (CA-MRN-27) revealed a total of 49 individuals was interred in a discrete cemetery area approximately 24 meters square. A radiocarbon assay was completed on a cremation (Burial 3) with a resulting date of 1980 ± 95 BP (30 BC) (King 1970:6). King argued that the dedicated cemetery reflects elements of social structure, suggested ways of determining a ranked society, and used the site to argue a model of sociocultural evolution (1970). He suggested that circa 2000 BP, status within society was organized based on the closeness to a direct line of descent from a real or mythical ancestor and that this form of social organization was characteristic of the Coast Miwok from about 2000 BP until the time of contact (King 1970:23-26).

Ethnographic Affiliation

In 1983, excavations were undertaken at the Pacheco Site (CA-MRN-152) with the primary goal of determining if the archaeological deposit represents the ethnographic village of *Pu yu' ku* (Barrett 1908:309). Chronological information from cross-dating and time-sensitive artifacts such as beads, and radiocarbon determinations indicated that CA-MRN-152 was occupied primarily during the broad time-span of the Middle Horizon. Three absolute dates on human bone were generated resulting in 3050 ± 130 BP, 3270 ± 70 BP, and about 3480 BP (Goerke and Cowan 1983:52). At the time, these were earliest known radiocarbon-dated evidence of human occupation in Marin County (Clewlow and Wells 1981:143; Goerke and Cowan 1983:53).

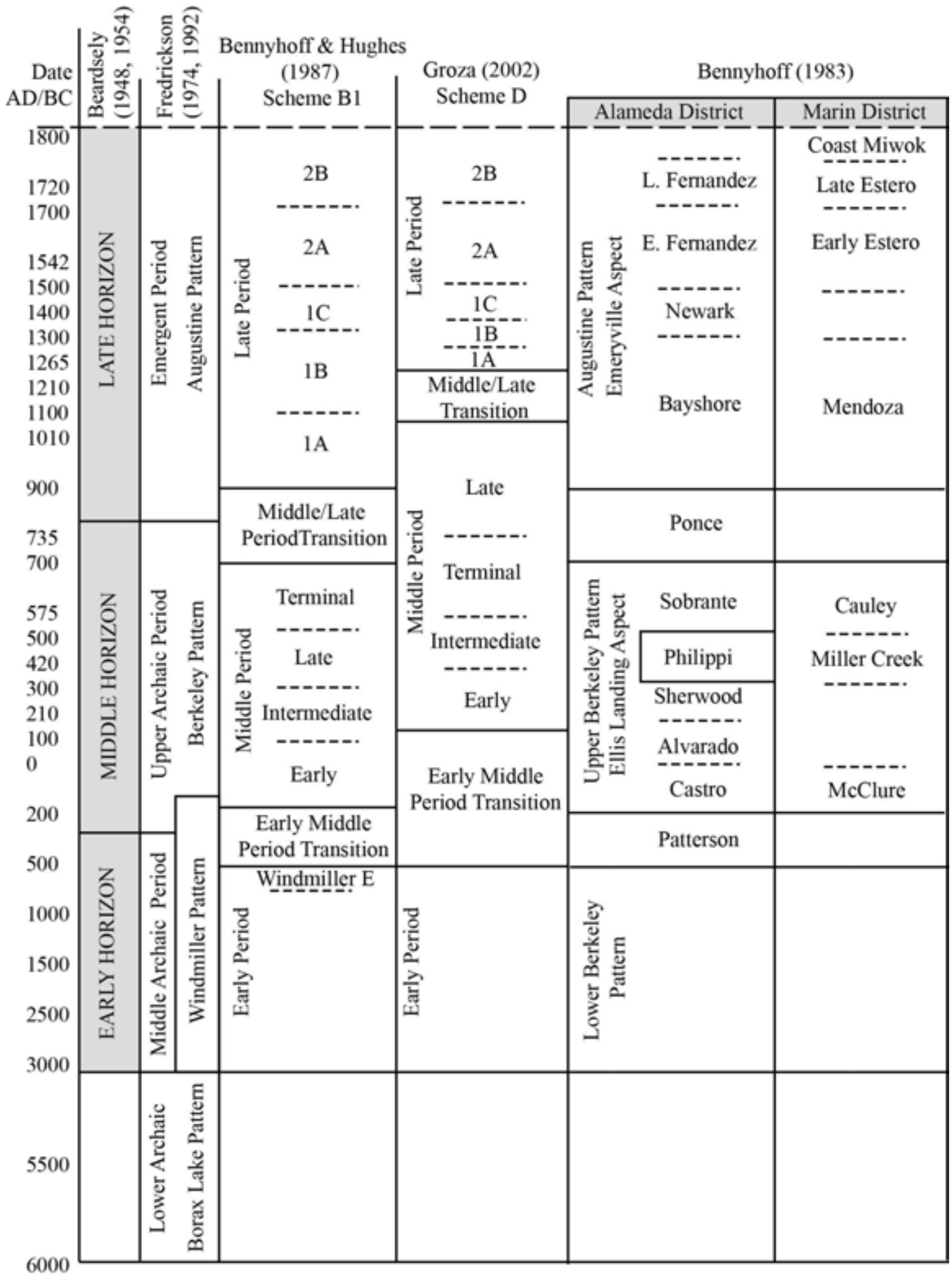


Figure 7. Concordance of Select Bay Area, North Coast, and Marin County Chronologies.

	McClure Facies	*Mendoza Facies*	*Estero Facies*
Central California concordance	Middle Horizon	Late Horizon: Phase I	Late Horizon: Phase II
Disposal pattern	Primary interment; high frequency of funerary offerings; beds of red ochre	Primary inhumation and cremation; numerous "killed" show mortars	Mostly cremations; associations are frequent
Artifacts	1. Infrequent round-bottom mortars	Flat-based show mortars	Flat-based show mortars
	2. Shaped pestles	Shaped pestles	Rare flanged pestles
	3. Numerous crude stone sinkers		
	4. Net mesh gauges		
	5. Long, heavy projectile points; use of atlatl?	Small projectile points of obsidian; triangular body	Small obsidian projectile points often with square serrations
	6. Some points with slight shoulder		Points often triangular with corner notches
	7. Finely chipped stone drills		
	8. Quartz crystals with pitch		
	9. Abundant bone artifacts: tubes head scratchers, needles, awls, chisels, daggers, etc.	Relatively few bone artifacts; hairpins, awls, needles	Tubular bird bone artifacts are common: pyro-incised tubes, bird-bone whistles, bone beads
	10. *Olivella* A1, F3a, G1, G2a	*Olivella* A1, G2a, E1	*Olivella* E2
	11. —	—	*Tivela* tubular beads; great numbers of clam disk beads; steatite and magnesite beads.
	12. Rectangular *Haliotis* ornaments		Banjo shaped and triangular *Haliotis* pendants.
	13. Baked-earth steaming ovens		Historic spikes, porcelain, trade beads, glass.

Figure 8. Diagnostic Traits of Coastal Marin County Facies
(after Beardsley 1954: adapted from Moratto 1984:Table 6.1).

Cultural Chronology

Research on cultural chronology is a fundamental research issue. Many studies have been directed at identifying the sequence of human occupation in Marin County. In general, Early Horizon sites generally lack obsidian toolstone (Elsasser 1978:37). Artifacts characteristic of the Early Horizon include *Olivella* bead types, small, spire-lopped, Types 1a, small diagonal ground Type 1c, thick rectangular shelved, Type 2b, *Mytilus* rectangular and square beads, rectangular or square Type 1a with double perforation and incisions, *Haliotis* beads and ornaments, and steatite and mammal-bone pendants (Elsasser 1978:37-38). Burials tend to be flexed with no set orientation (Elsasser 1978:38).

Research conducted by Moratto, Riley, and Wilson (1974) at the Shelter Hill Site (CA-MRN-14) in Mill Valley documented a diverse artifact assemblage typical of the Middle Horizon. At the Sand Hill Site, diagnostic artifacts of the Middle Horizon include: shaped pestles, numerous crude stone sinkers, net mesh gauges, long heavy projectile points (e.g., atlatl spear points), and abundance of bone artifacts (such as tubes, polished bone head scratchers used for removing lice, needles, awls, chisels, and daggers, *Olivella* bead types include small spire-lopped, 1a, 1b, modified saddle, 3b2, saucer, 3c, *Haliotis* ornaments, and baked earth steaming ovens (Moratto et al. 1974:34). Burials tend to be loosely flexed and randomly encountered throughout the site. (Moratto et al. 1974).

In Marin County, the Late Horizon is marked by a dramatic increase in the number of occupational sites. Many Late Horizon sites overlay earlier Middle Horizon occupations (cf. CA-MRN-14, -17, -152, -158, -192, -357, and others). While Middle Horizon sites tend to be situated along the bayshore, Late Horizon sites are found in a variety of ecological niches (King 1970:20).

The Late Horizon is generally divided into Phase I (AD 300-1600) and Phase II (AD 1600-1850). Diagnostic artifacts of Phase I of the Late Period found at CA-MRN-14 include: flat-based "show" mortars (large well-crafted mortars likely used during feasting events or communal ceremonies) and shaped pestles, small obsidian arrowheads, and relatively few bone artifacts, as well as *Olivella* bead types 1a, 1b, 3d, and 3e (Moratto et al. 1974:34). Burials tend to be flexed and lack grave goods (Elsasser 1978:43). Diagnostic artifacts of Phase 2 found at CA-MRN-14 and include: small obsidian projectile points (often with square serrations), frequent tubular bone artifacts (i.e., whistles and beads), *Olivella* bead type 3, clamshell disc beads, *Haliotis* pendants, and glass trade beads (Moratto et al. 1974:34). Cremation is more common than inhumation during the Late Period (Moratto et al. 1974:34).

The earliest absolute dated component in the San Francisco Bay region is reported by Gary Pahl (2003) from a shellmound site situated on De Silva Island (CA-MRN-17; Table 1). De Silva Island is located about three miles west of Angel Island at the head of Richardson Bay near Mill Valley. Excavations reached a depth of more than 600 centimeters. The radiocarbon assays on archaeological materials recovered between 520 and 600 centimeters are some of the oldest absolute dated materials reported on cultural materials at a San Francisco bayshore site. Uncalibrated dates range in age from 5415 ± 260 to 5575 ± 220 BP (Pahl 2003).

Table 1. Select Absolute Dates from the DeSilva Island Site (CA-MRN-17).

DEPTH (CM)	UNCALIBRATED DATE	CONTEXT	MATERIAL
520-540	5415 ± 260 BP	Burial No. 3	Charcoal from Feature 45/48
560-580	5480 ± 145 BP	Burial No. 3	Charcoal from Feature 45/48
580-600	5575 ± 220 BP	-	Faunal

Chapter 3: Research Design

A program of archaeological research, analysis and curation was proposed to mitigate significant adverse impacts to cultural resources by the Angel Island Immigration Station Restoration Project. This research design, as provided herein, describes the theoretical assumptions, hypotheses, test implications, and data requirements for site-specific investigations. While much of the surface integrity of CA-MRN-44/H has been compromised by historic activities, intact subsurface deposits still exist as well as important datasets from disturbed contexts. Controlled subsurface excavation and mechanical excavation were used to better establish the time span of site use, identify single component areas, and to document the nature, extent, and function(s) of the archaeological site. The results of archaeological investigation focused on three regional research issues pertinent to the archaeological site. The three areas of investigation include: cultural chronology, subsistence strategy, and settlement systems.

RESEARCH ISSUE 1: CULTURAL CHRONOLOGY

Background

The cultural chronology of CA-MRN-44/H and environs is part of the overall cultural chronology of the Bay Area and North Coast Range. A number of cultural chronology schemes have been described for this region and provide a comprehensive background on contemporary views (Beardsley 1954; Bennyhoff 1994a; Bennyhoff and Hughes 1987; Fredrickson 1974, 1984, 1994b; Groza 2002). In the previous chapter, Figure 7 presents a concordance of select chronological sequences for the North Coast Range, Bay Area, and Marin Coastal Area, while Figure 8 presents a description of the cultural constituents and traits associated with each of the three Facies of the Marin District.

The chronological scheme adopted for this research design places an emphasis on local temporal trends noted within the coastal zone of Marin County (Beardsley 1954; Bennyhoff 1994a). It is not our purpose to construct any new specific localized chronology, nor ignore the importance of examining time-sensitive information within small regional contexts. This research proposes to examine CA-MRN-44/H with regard to temporal trends and relevant research issues based on local (Beardsley 1954; Bennyhoff 1994b) and regional chronologies (Beardsley 1954; Bennyhoff and Hughes 1987; Fredrickson 1974, 1994b; Groza 2002), as well as within broader taxonomic frameworks (Beardsley 1954; Lillard et al. 1939).

Research Objective

Establishing the time span of site use is fundamental information that must be completed prior to attempting to understand any other aspect of prehistoric behavior. The following research issues will be specifically addressed in this study:

1. Over how long a period was the site used?
2. When was the site most intensively occupied?
3. Are single component areas present at the archaeological site that could be useful in defining cultural assemblages?
4. Can cultural components be arranged into chronological sequence based on obsidian hydration results, time-sensitive artifacts, archaeological stratigraphy, and/or radiocarbon determinations?
5. Are cultural assemblages present that could aid in the construction of source-specific obsidian hydration rates?
6. Where does the archaeological site fit within existing chronologies for Marin County (Beardsley 1954; Bennyhoff 1994a) and the greater Bay Area (Beardsley 1954; Bennyhoff and Hughes 1987; Fredrickson 1974, 1994b; Groza 2002; Lillard et al. 1939)?

Data Needs

Investigation of cultural chronology at CA-MRN-44/H will require collection of the following data:

- Identification of archaeological contexts retaining integrity of cultural or natural stratigraphy.
- Organic material from reliable archaeological contexts for radiocarbon dating.
- Culturally modified obsidian, including flakes and tools, to be used in obsidian hydration studies.
- Pairing of radiocarbon dates with obsidian artifacts from clearly associated archaeological contexts for source specific obsidian hydration rate calibration.
- Chronological indicators such as stylistically diagnostic artifacts, e.g., projectile points, shell beads, or other temporally discrete items.

RESEARCH ISSUE 2: SUBSISTENCE STRATEGY

Background

Research on subsistence examines ways in which plant and animal resources were exploited for food and raw materials for the fabrication of items of material culture. This topic emphasizes the study of sources of food, diet, and technological assemblages associated with food acquisition, processing, or consumption. Traditionally, particular attention has been directed at the influence of past environmental conditions on subsistence strategy (Baumhoff 1963). Contemporary research on the topic of subsistence has focused on the effects of over exploitation of natural resources and its effect on human cultural processes (Basgall 1987; Broughton 1987, 1994; Cohen 1981). Several large-scale studies have been completed, many of which involved development and testing of regional subsistence and settlement models (Baumhoff 1963; Broughton 1994, 2002a, 2002b;

Hildebrandt and Levulett 1997; Jones 1997; Schultz 1981; Simons 1992; Wohlgemuth 1996b, 2004; White et al. 2002).

In general, subsistence research interests and goals have traditionally focused on: (1) describing the dietary focus and/or breadth; (2) subsistence change through time; (3) correlation of subsistence choice, and technology with environmental variables; and (4) examining the profitability of subsistence choice (e.g., intensification, prey choice models, and catchment area studies).

Research Objective

Subsistence is best addressed by examining the direct evidence of prehistoric diets such as floral and faunal remains. Indirect sources for the study of subsistence include artifacts, features, site function, bioarchaeology, or environmental information. Specific objectives to be pursued in the analysis of subsistence at CA-MRN-44/H include:

1. What is the dietary composition, diversity, and emphasis noted in the archaeological assemblage?
2. What is the degree of specialization or generalization of subsistence pursuits?
3. Are dietary changes indicated in the archaeological record through time?
4. Are there indications of technological evolution associated with food production through time?
5. How does the dietary debris compare to other sites in the area?

Data Needs

Investigation of subsistence research problems at CA-MRN-44/H will require collection of the following data:

- Samples of lithic artifacts, including flaked and ground stone tools and debitage that will allow characterization of site assemblages in terms of subsistence focus.
- Identification of discrete site components through which potential changes in subsistence patterns may be tracked.
- Archaeological deposits containing a substantial sample of faunal, floral, and/or shellfish remains.

RESEARCH ISSUE 3: SETTLEMENT SYSTEM

Background

Understanding site settlement patterns is a major research theme of the Bay Area and Central California. Present evidence suggests that Angel Island was settled around AD 1000 by the Coast Miwok (Treganza 1966). Temporary camps or villages were established on the island, which afforded good access to the waters of San Francisco Bay and a plentiful supply of edible mollusks (Hines 1983).

Research into prehistoric settlement systems is greatly concerned with examining how past peoples were differentially distributed across space. Investigations of settlement systems is part of the larger issue related to prehistoric economies and the relationship between settlement pattern and mode of resource acquisition. Researchers in Central California prehistory have noted a fundamental shift in settlement strategy that occurred around 1000 BP when many large-scale residential sites in the region were abandoned (Jones et al. 1999; Lightfoot and Luby 2002; Rosenthal and Meyer 2004). Studies of settlement strategy have sought to address the nature of regional land use with respect to physical geography (Basgall 1982; Hildebrandt and Hayes 1983, 1984), understanding the nature of land-use changes though time (Basgall and Bouey 1991; Hildebrandt and Hayes 1983, 1984, 1993; White 1984), and examining how the organization of technology may account for land-use patterns (Jackson 1976, 1989; Jones 1993; White 1988).

Models of prehistoric settlement patterns are often built upon middle range hypothesis testing or evolutionary ecology. The forager/collector model first posited by Binford (1978, 1979, 1980) and later adapted by numerous researchers in California (Bettinger 1991; Bettinger and Baumhoff 1982; Hildebrandt 1984; White 1984) has served to better understand whether settlement patterns involve use of short-term camps from which locally, seasonally available resources were obtained, or if certain sites, from which resource acquisition trips and forays were staged, were occupied for longer time periods.

Research at CA-MRN-44/H is designed to investigate the relationship of tool technologies in archaeological contexts to past economic behaviors, site function, and use. This analysis will focus on issues of tool diversity, use, maintenance, and discard activities. Tool life and use strategies are assumed to represent patterns in the archaeological record to the extent that the organization of technology and settlement are also patterned. Patterns formed by the transportation of tool materials will be especially evident in reduction trajectories, economics of production, and discard of individual tool types. Clearly the pattern of tool production, use and discard would shift most radically in relation to settlement patterns (Binford 1980; Schiffer 1976; White 1984).

Research Objectives

1. What is the range or emphasis of behavioral activities represented at CA-MRN-44/H?
2. How did this site function within a broader settlement system?
3. Is there evidence for a change in site function though time?
4. How does the organization of technology account for land-use patterns and/or what is the nature of land-use pattern with respect to environmental conditions in the area?

Data Needs

Investigation of settlement strategy at CA-MRN-44/H will require collection of the following data:

- Flake stone samples representative of the extent and variability of tool stone production, use, and discard at the site.
- Recognition of discrete activity areas, which demonstrate the range or emphasis of site function(s).
- Definition of single component assemblages, strata, or loci that can be used to understand diachronic shifts in site function.

Chapter 4: Methods

This chapter details the field methods, laboratory practices, and analytical efforts undertaken in the study. This section also describes the types of data collected, sampling techniques, and artifact recovery practices sufficient to document all field and lab methods.

Field Methods

The archaeological sampling strategy at CA-MRN-44/H focused on understanding the nature and extent of cultural deposits, identification of intact subsurface contexts, and recognition of elements related to site structure. Field strategies were flexible and adapted to address various cultural resources issues and contingencies, which developed as the result of construction activities in the area of the site. In order to reach these basic objectives an excavation strategy was implemented that maximized the return of data required for analysis.

Field methods implemented at CA-MRN-44/H include controlled excavation, exploratory backhoe trenching, construction monitoring, and data recovery. These tasks are incorporated into the following sections.

The scope of work included controlled excavation of 6.8 cubic meters of sediments from four excavation units (EU) in Locus A, and 1.0 cubic meter in Locus B. In addition, salvage screening of approximately 9.0 cubic meters of sediments from Locus C was completed. A total of 16.8 cubic meters of sediment was screened for cultural materials. Field methods are described for each of the three loci at the site.

Locus A

Field investigations in Locus A took place between Monday February 6 through Friday February 17, 2006. Work in this area began by removing water, mud, and other sediments that had been deposited by winter rains in the area of the intact shell midden (Figure 9). Sump pumps and a backhoe were used to expose the shell midden. Once the majority of water and mud was removed, crews cleaned up the floor and profile of the excavation area with hand tools to fully expose the shell midden.

A sampling grid was established consisting of a main north-south line that provided a transect across the entire length of the site. The sampling grid was established along a true north bearing with grid datum (N0/W0) designated as the southeast corner of a concrete flagpole foundation located at the east end of the cove.

A series of five hand augers were excavated within the area where mechanical excavations for a proposed septic tank had exposed intact shell midden soil (Figure 10). The purpose of the augering programs was to determine the depth and extent of the intact shell midden deposits and to provide information for the placement of controlled excavation units (Figure 11). Hand augers were 3.5 inches (8.89 centimeters) in diameter, situated on grid at

Figure 9. Controlled Excavations and Soil Profiling, Locus A.

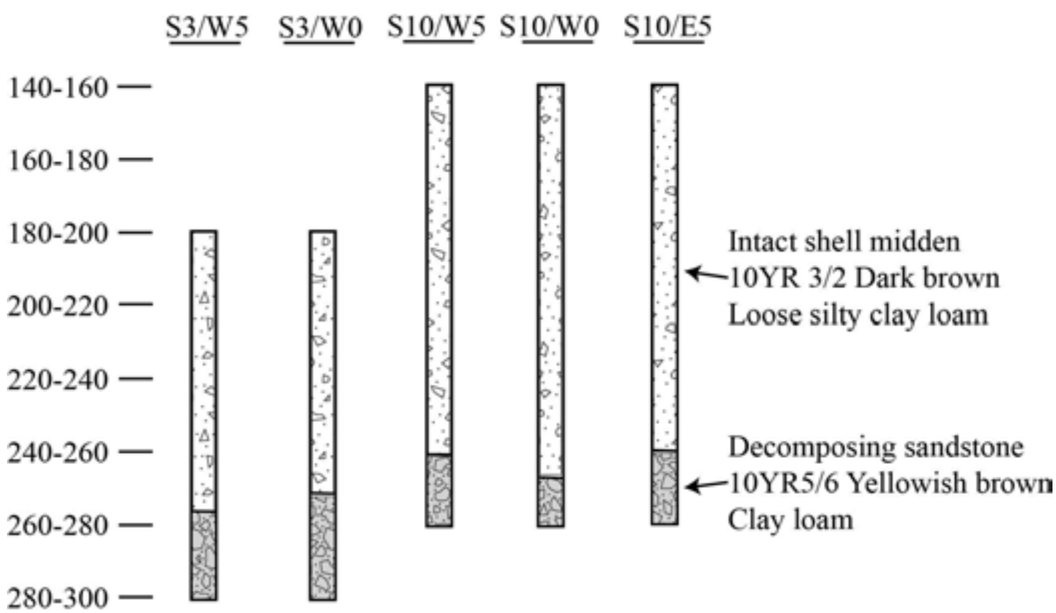


Figure 10. Summary of Hand Augers in Locus A.

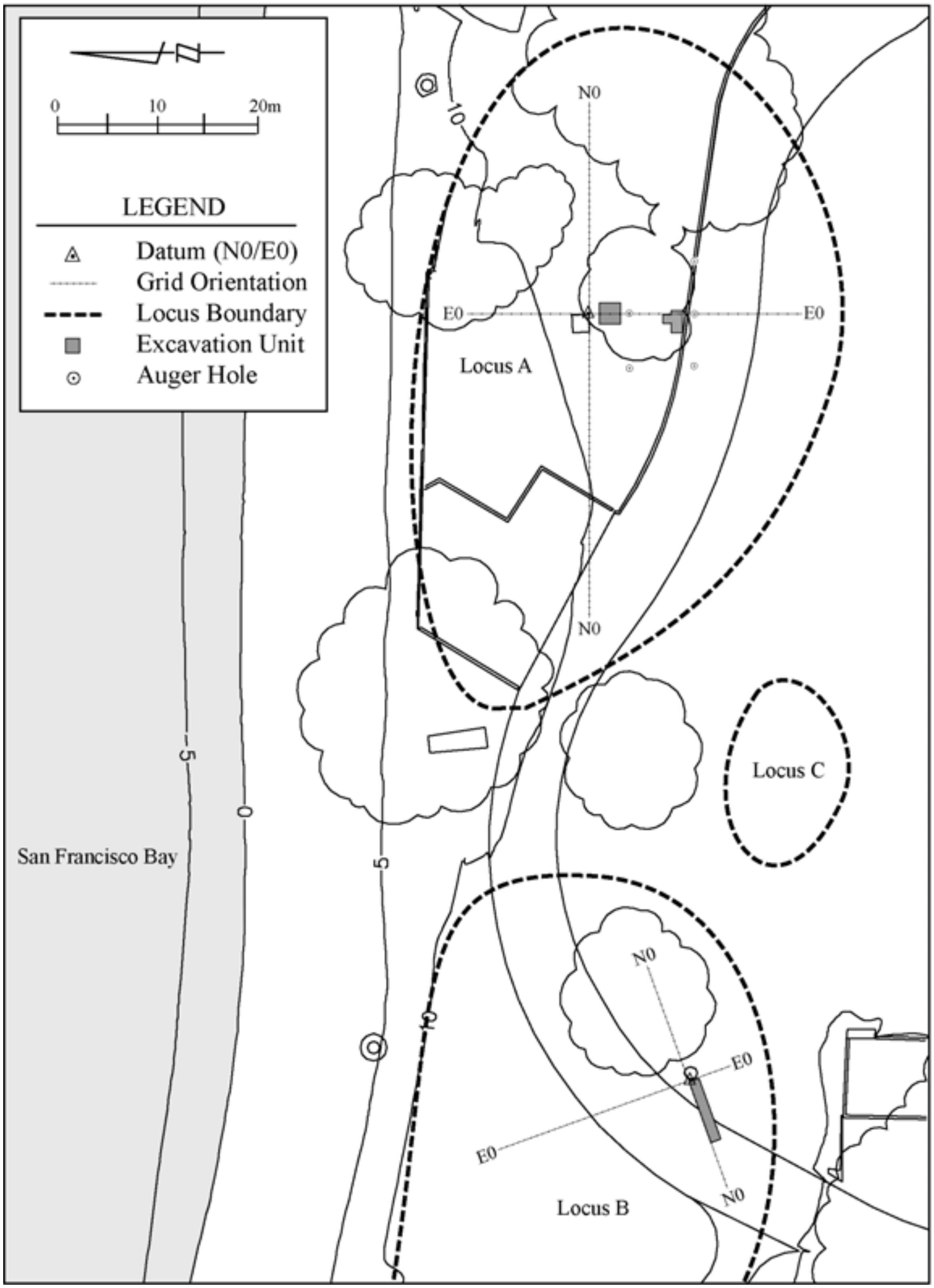


Figure 11. Controlled Excavations and Auger Locations.

5-meter intervals, excavated in 20-centimeter levels, with depth measurements taken in centimeters below datum (cmbd). All soils recovered from the auger were wet-screened through 1/8-inch mesh hardware cloth (Figure 12). The upper portions of the shell midden had been removed during mechanical excavation for the proposed septic tanks, and augers began at a depth of 140 cmbd. Hand augering revealed an intact and dense shell midden extending to a maximum depth of 270 cmbd (see Figure 1). All cultural materials recovered from hand augers were replaced into the hole and reburied at the same location.

Figure 12. Wet Screening, Locus A.

An area of high artifact density was identified in the exposed soil profile of the septic tank exposure and directed placement of controlled excavation units. This artifact-rich area was expected to provide a larger sample of cultural materials from the area of the site shown to exhibit the greatest potential for subsurface archaeological remains. Although models of site formation suggest that such concentrations may, in fact, reflect multiple episodes of use and therefore have the greatest potential for component mixing, these zones often provide the greatest abundance and diversity of cultural materials (Jackson 1976; White 1984). Recoveries of such samples are often crucial to sufficiently characterize the nature and extent of the deposit.

Once the sampling grid and hand augering was completed, a series of four conjoining EUs were laid out to form a single block exposure. Precise placement of the exposure was determined in the field, in consultation with DPR staff, upon completion of the initial overburden removal (Figure 13). All EUs were 1 x 1 meter and laid out based on grid coordinates. EUs were excavated using hand tools in 10-centimeter levels measured below the northwest corner of the unit. When discrete cultural features or stratigraphy was observed during fieldwork, the excavation strategy switched to stratigraphic excavation. Hydraulic shoring was installed to support the walls of the excavation unit. The water table was encountered at 180 centimeters below surface (160-centimeter level). Standing water infiltrated the excavation units, which greatly hindered systematic excavation. A sump pump was installed in the northeast corner of the exposure to dewater the hole and allow for controlled excavation to continue. Controlled excavation reached a maximum depth of 200 centimeters below surface (180-centimeter level) and included a total of 6.8 cubic meters of sediments. Excavation of the exposure was terminated due to cultural concerns of the Native American monitor and methodological issues associated with excavating through the water table. The Native American representative was concerned by the recovery of several isolated human skeletal remains, the discovery of a possible grave associated artifact that consisted of a carved steatite pendant (see ahead to Figure 44, d), and the identification of a cache of 321 sea snails (*Nucella lamellosa*) shells (Feature 15), which was interpreted as a burial offering by the Native American monitor.

Figure 13. Control Units S1/W0, S1/W1, S2/W0, and S2/W1, Locus A.

All controlled excavated soils were transferred to buckets in the unit and passed to screener(s). All excavated soils were wet-screened in the field using 1/8-inch hardware cloth (Figure 14). All cultural materials or items of interest were collected and placed in a bag by the excavation team. Field observations were recorded on EU forms for each unit, noting the types and quantity of materials retrieved from each level and the soil characteristics. Soil columns for flotation analysis were extracted from selected unit walls or features. Select profile walls were delineated stratigraphically, photographed, and illustrated upon completion of all excavation units.

Figure 14. Storm Drain Trench in Front of Central Heating Plant, Locus B, Trench 15.

To maximize recovery, reduce date redundancy, and make the most effective use of available time and funding, ordinary shell or bone debris were not recovered from the screens in the field. From each unit a $20cm^3$ column sample was recovered. The column samples were bagged in the field and transported to the laboratory, where they were wet-screened through nested 1/4-inch, 1/8-inch, and 1/16-inch mesh. All bone and shell in the 1/8-inch fraction was sorted, identified to the lowest taxonomic level, and analyzed accordingly. The 1/16-inch fraction was sorted for fish bone or other small remains amenable to analysis. An additional a $10cm^3$ column from each EU was excavated and retained for flotation, archaeobotanical analysis, or other studies.

Figure 15 illustrates the sampling strategy and locations of special studies in units S1/W0, S1/W1, S2/W0, and S2/W1, Locus A. Two complete soil columns for analysis of marine shellfish, not shown in Figure 15, were analyzed and identified to the lowest taxonomic level.

A fragmentary portion of an adult right femur was found among intact shell midden soils in Locus A, at S8/W1, approximately 90 cmbd. Identification of this skeletal element prompted test excavations in the area of the find to determine the presence or absence of an intact human burial. Excavation units were based on grid coordinates, excavated in 10-centimeter levels, and all sediments were dry-screened through 1/4-inch mesh. Approximately 0.4 cubic meters of sediments were treated in this manner. Testing did not reveal any additional skeletal elements or evidence of an intact inhumation. All cultural materials recovered from this phase of testing were reburied at S9/E0, 135 cmbd.

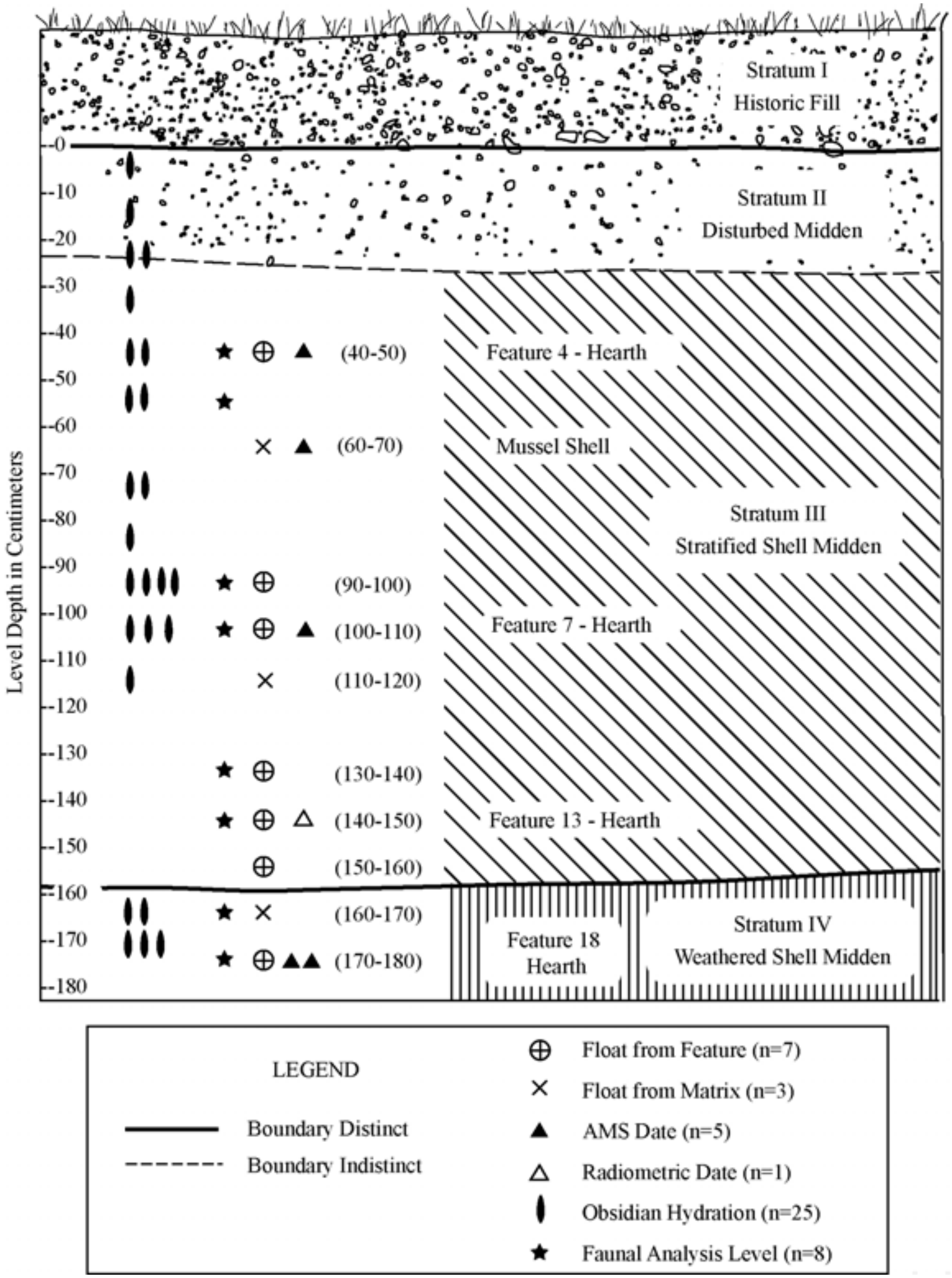


Figure 15. Sampling Strategy for Special Studies in Locus A.

Locus B

In June 2006, DPR archaeologist Jeff Brooke and Native American representative Frank Ross were monitoring backhoe excavations for a proposed storm drain (Trench 16). Intact shell midden deposits and other archaeological materials were identified in the trench at approximately 130 centimeters below the surface. Construction in the area of the find was halted until an appropriate course of action could be determined.

Sentinel archaeologists initiated data recovery excavations in Locus B on Wednesday June 22 and continued through Sunday June 26, 2006. A sampling grid was established that followed the alignment of the excavated storm drain trench. The sampling grid was set with north aligned to 342° and the grid datum (N0/W0) was designated as the southwest corner of a concrete storm drain box. A series of six 1-x-1-meter EUs were laid out along the north zero line to form a 6-meter-long excavation trench. The trench was dug using hand tools in 10-centimeter levels measured below the northwest corner of the unit (Figure 16 and Figure 17). Methods and techniques for controlled excavation were the same as Locus A (Figure 18). Soils were transferred to buckets in the unit, passed to screener(s), and wet-screened using 1/8-inch hardware cloth. From two units, S0/W2, 170-180 centimeters and S0/W4, 170-180 centimeters, a $50cm^3$ soil sample was recovered. These soil samples were bagged in the field, transported to the laboratory, and submitted to analysis. Materials recovered in the heavy fraction were screened through nested 1/4-inch, 1/8-inch, and 1/16-inch mesh. All bone and shell in the 1/8-inch fraction was sorted, identified to the lowest taxonomic level, and analyzed accordingly. The 1/16-inch fraction was sorted for fish bone or other small remains amenable to analysis. Controlled excavation reached a maximum depth of 180 cmbd (the 180-centimeter level) and included a total of 1.3 cubic meters of sediment. Excavation focused on recovering materials within the Area of Potential Effect for the proposed storm drain.

Figure 16. Mechanical Trenching Areas of Proposed Impacts.

Figure 17. Septic Tank Exposure, Locus B.

Figure 18. Controlled Excavation, Locus B.

A 3.5-inch hand auger was placed at the bottom of two EUs (S0/W0 & S0/W3) and excavated to the bottom of the shell midden. The shell midden continued to a maximum depth of 286 cmbd, more than 100 centimeters below the last level of the EUs. A thick layer of crude oil was identified in the augers. This oil was characterized by a strong chemical odor, silky texture, and dark iridescent color. Oil-covered sediments were present between 235 and 315 centimeters below surface (cmbs). Much of the intact shell midden at this depth was covered in oil. It is highly likely that the oil is associated with Immigration Station Central Heating plant, which used crude oil as fuel.

Locus C

On April 27, 2006, Frank Ross and Alex DeGeorgey were monitoring backhoe excavation of Trench 13 (Figure 19). This trench was aligned east-west and measured approximately 12.2 meters long, 1.2 meters wide, and 6.7 meters deep. The top 3.65 meters of sediments were mixed containing pockets of shell midden, historic structural debris, and oil stains. Intact soils, consisting of a homogenous layer of mottled gray colored silt, were identified below the 3.65-meter depth. Archaeological materials were encountered within a thick stratum of black mud at approximately 5.0-5.5 meters below surface. The assemblage consisted of several hundred animal bone fragments, a portion of a bowl mortar, a pestle, two obsidian projectile points, a chert drill, a hammer stone, a carved wooden stake, an acorn hull, an abalone shell ornament, and human skeletal remains. The most striking element of the assemblage was the complete lack of marine shell dietary debris, which was abundant in all other areas of the site. Approximately 76.6 kilograms of sediment was bagged in the field and transported to the laboratory. A 30-liter sample of soil was submitted for flotation analysis. Materials recovered in the heavy fraction were screened through

Figure 19. Stockpiled Soils from Buried Component, Locus C, Trench 13.

nested 1/4-inch, 1/8-inch, and 1/16-inch mesh. Faunal materials recovered in this same sample were sorted and identified to the lowest taxonomic level.

The north wall of the trench collapsed shortly after construction was halted. Approximately 15 cubic meters of sediment fell from the top three meters of the northern sidewall into the bottom of the trench. The decision was made to immediately backfill the trench with sterile soils due to the unstable condition of the trench and the potential safety hazard it created. Stockpiled soils from the buried archaeological component were delineated with exclusionary flagging, covered with a plastic tarp, and stored on site until a course of action could be determined. Approximately 11.9 cubic meters of artifact bearing soils were stockpiled.

Recognizing the potential importance of the discovery, efforts were made to have a geoarchaeologist reopen Trench 13, examine the intact soil profile, study the site formation processes, determine the age of the cultural deposits, and document the integrity of the archaeological stratum. Time constraints associated with the project construction schedule did not allow for this critical study to be completed. As a result, fundamental information regarding the age and integrity of Locus C are presently unresolved.

Sentinel conducted salvage operations of stockpile soils from the buried component beginning on Monday July 17 and continuing to Friday July 21, 2006. The focus of salvage work was to recover a larger sample of the artifact assemblage. Stockpiled soils were transferred to buckets, passed to screener(s), and wet-screened using 1/4-inch hardware cloth. Approximately 9.0 cubic meters of sediments were sorted and screened for cultural materials (Figure 20).

Figure 20. Salvage Screening of Soils from Buried Component, Locus C.

Construction Monitoring

Archaeological monitoring was conducted to ensure that no significant cultural resources were impacted by construction activities. Jeff Brooke, Warren Wulzen, Alex DeGeorgey, and Frank Ross conducted archaeological site monitoring at CA-MRN-44/H between November 2005 and July 2006. Construction monitoring revealed significant cultural resources are present within the Area of Potential Effect. The following section documents the adequacy of identification efforts and highlights some of the findings from field monitoring.

Intact cultural resources were first discovered at the east end of the cove in December 2005 by DPR archaeologists Jeff Brook and Warren Wulzen, and Native American Representative Frank Ross. High frequencies of shell fragments and artifacts representing an intact midden were discovered within the area of a proposed septic holding tank and utility trench in Locus A at the east end of the cove. The midden deposit was found buried at an average depth of 150 centimeters below the existing grade. DPR archaeologists halted construction in the area until an appropriate course of action for proper management of the archeological resource was determined. In January 2006, the DPR contracted with Sentinel to develop a research design, data recovery program, and work plan to mitigate anticipated impacts upon the prehistoric archaeological resources. Controlled archaeological excavations in Locus A documented a large, intact, and significant cultural deposit. As a result of these findings, it was determined that the proposed septic tank would be moved to another location outside of Locus A to an area with no cultural deposits.

On April 25 and 26, 2006, Alex DeGeorgey, Jeff Brooke, and Frank Ross were present to monitor excavation of a large exposure at the new location of two proposed septic tanks. The second location for the proposed septic tanks was located in the west end of the cove near the Central Heating plant. The excavation exposure, measuring 12.2 meters (east-west) by 4.9 meters (north-south) was dug to a depth of 4.2 meters (see Figure 17). Heavy equipment was used to install trench plate shoring to support the walls of the exposure and allow excavation to continue to the proposed depth of 6.1 meters (Figure 21). The top 2.2 meters of soil was composed of a combination of historic fill and disturbed shell midden. A large volume of disturbed shell midden was present approximately 1.5-2.2 meters below surface. Human skeletal elements were identified in this context. All soils from the disturbed shell midden stratum were stockpiled separately and subsequently examined for human skeletal remains and associated grave goods. Intact shell midden deposits were identified at 220 centimeters below surface in the western one-half of the excavation exposure. A thick layer of crude oil and the water table were also encountered at this depth. Construction was halted in order to address the newly identified resource and determine an appropriate course of action. A 3.5-inch (8.89-centimeter) hand auger was placed within the intact shell midden near the northwest corner of the excavated area. The hand augering of the deposit revealed that the shell midden was about 60 centimeters thick and continued to a maximum depth of 280 centimeters. The entire column of shell midden was contaminated with crude oil. Oil stained earth continued to 310 centimeters and was imbedded in a stratum of black clay. Project proponents decided to abandon construction of the septic tanks at this location due to the presence of a significant prehistoric resource and hazardous materials. All excavated shell midden was redeposited into the bottom of the exposure and a layer of geocloth was laid down over the entire length of the hole. Historic fill excavated from the top 2.4 meters of the unit were used to refill the exposure.

Figure 21. Septic Tank Exposure with Trench Plate Shoring, Locus B.

Exploratory Trenching

A program of exploratory trenching was implemented at CA-MRN-44/H. The purpose of backhoe trenching was to identify and determine the extent of any intact cultural resources present within the area of proposed construction.

A total of 17 mechanical trenches and one large exposure was excavated within the recorded limits of CA-MRN-44/H (Figure 22). Intact cultural resources were identified in 9 trenches. Trenching was successful in defining the approximate horizontal limits and vertical extend of site loci. Trenching identified three horizontally and vertically discrete loci. Table 2 provides a summary of exploratory trenching.

The cubic volume of intact shell midden was estimated by using the formula to calculate the volume of a cone [v=1/3 (3.141592654 r^2) h] where v = volume, r = mean radius of the locus, and h = height of cone.

Locus A appears to be a low mound of intact shell midden. The midden measures approximately 40 meters north-south, 65 meters east-west, and has a height of 2.3 meters. Intact cultural deposits were present close to the ground surface (20 cmbs) near the grid datum and were documented to a maximum depth of 250 centimeters. The estimated total volume of intact shell midden in Locus A is 1,659.6 cubic meters.

In Locus B, intact shell midden was documented between 160 and 286 centimeters below surface. The top portion of the shell midden was destroyed during construction of the Central Heating Plant and Administration building for the Immigration Station. The midden measures approximately 35 meters north-south, 40 meters east-west, has a height of 1.5 meters, and an estimated total volume of 574.32 cubic meters.

Insufficient data was recovered from exploratory trenching to estimate the volume of Locus C.

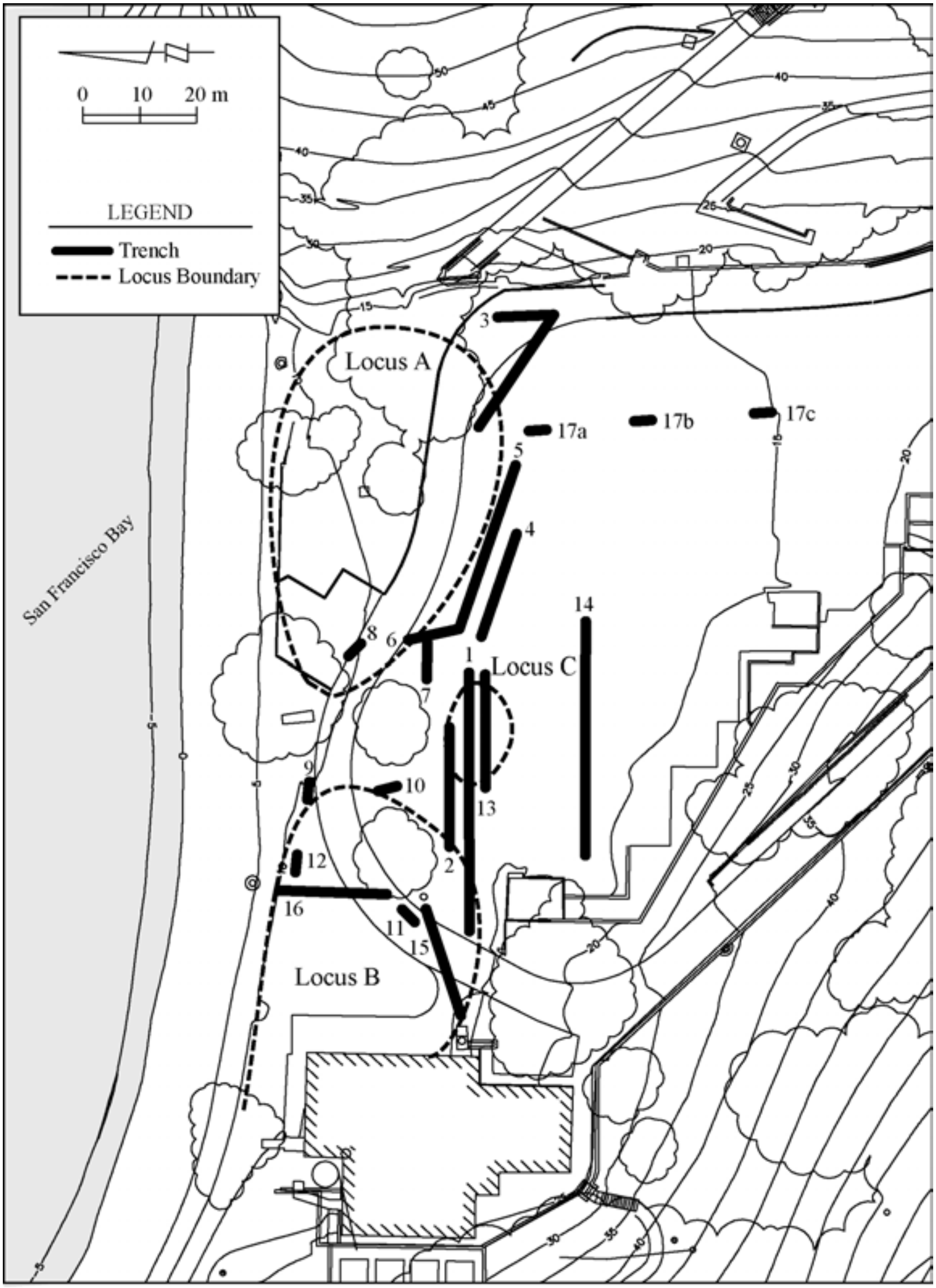


Figure 22. Exploratory Backhoe Trenches.

Table 2. Summary of Exploratory Trenching.

Locus	Trench	L (m)	W (m)	D (cm)	Intact Resource	Resource Depth (cm)	Comments
B	1	35	1	220	N	na	Orange clay encountered at 180 cm at west end trench
B	2	20	0.5	200	Y	200	Small area of intact shell midden located 14 m from the west end of trench
A	3	20	1	90	Y	70	Intact shell midden encountered at 70-75 cm below surface
A	4	7	1.5	170	Y	170	Intact shell midden located at bottom of trench
A	5	8	1.5	80	Y	80	Intact shell midden at north end of trench
A	6	6	2	120	Y	60	Intact shell midden throughout trench in east wall below, not present in west wall
A	7	3	1	150	Y	120	Intact shell midden located near intersection of Trench 6 and 7 and 195 cm at west end
A	8	1.5	1	250	Y	250	Intact shell midden found at 250 cm below surface
B	9	1.5	1	220	N	na	Disturbed soils throughout profile
B	10	2	1	230	N	na	Orange clay encountered at 160 cm
B	11	1.5	1	270	Y	250	Oil has covered midden materials
B	12	1.5	1	150	N	na	Large deposit of crude oil at 150 cm
C	13	12	1.5	550	Y	450	Buried component in black clay matrix
C	14	20	1.5	600	N	na	Orange clay encountered at 160 cm
B	15	9	1.5	180	Y	150	Disturbed shell midden present in profile above 150 cm, intact midden below
B	16	8	1.5	160	N	na	Disturbed shell midden present in profile
B	17a	1.5	1.5	120	N	na	Mixed midden materials
B	17b	1.5	1.5	160	N	na	Disturbed fill
B	17c	1.5	1.5	230	N	na	Disturbed fill

Notes: L – Length; W – Width; D – Depth.

Laboratory Methods

Upon completion of field investigations, cultural materials recovered from the CA-MRN-44/H were transported to the Sentinel laboratory to be washed, sorted, catalogued, analyzed, and prepared for curation. The artifact assemblage was catalogued using database software (MS Excel). The artifact collection was subjected to standard analyses (e.g., flaked stone, ground stone, and faunal analysis) and special studies (radiocarbon dating, obsidian hydration dating, geochemical source determination) as appropriate. These standard analyses and special studies are described in the following sections.

One of the primary objectives of the laboratory processing was to prepare artifacts for permanent curation. Curation of archaeological specimens recovered from CA-MRN-

44/H followed the *Guidelines for Curation of Archaeological Collections* (1993) as described by the State Historic Resources Commission, DPR.

As curation of archaeological materials is costly and time consuming, serious consideration was given as to what materials were subject to retention and what were discarded. Items of low research value (e.g., fire-affected stone, gravels, or large volumes of soil) were weighed, measured, counted, described, and recorded. Each specimen retained as part of the permanent collection was separately packaged and labeled. All materials from the field investigation were washed, sorted, weighed, measured, described, labeled, and catalogued. Catalogue numbers were applied directly to the surface of complete, fragmentary, and diagnostic specimens when possible. Archival quality bags, packaging material, and legal boxes were used to package the collection for permanent curation. All curated items meet Title 36 Code of Federal Regulations, Chapter 1, Part 79 standards for curation of archaeological collections.

Catalogue data was computerized into a Microsoft Excel spreadsheet following the standards defined by Title 36 Code of Federal Regulations, Chapter 1, Part 79. Artifacts were identified in the catalogue by provenience, material, functional category, type, subtype, quantity, color, weight, and other diagnostic traits, with the aim of identifying their function, origin, date of manufacture, and minimum number of complete items. A complete catalogue of materials is provided in Appendix A.

SPECIAL STUDIES

Macrobotanical Analysis

Macrobotanical research examines ways in which plant resources were exploited for food and raw materials used for the fabrication of items of material culture. This topic emphasizes the study of sources of food, diet, and technological assemblages associated with food acquisition, processing, or consumption. Traditionally, particular attention has been directed at the influence of past environmental conditions on subsistence strategy (Baumhoff 1963). Contemporary research on the topic of subsistence has focused on the effects of over exploitation of natural resources and its effect on human cultural processes (Basgall 1987; Broughton 1987, 1994; Cohen 1981). Several large-scale studies have been completed, many of which involved development and testing of regional subsistence and settlement models (Baumhoff 1963; Broughton 1997; Jones 1997; Hildebrandt 1997; Schultz 1981; Wohlgemuth 1996a, 2004).

In general, subsistence research interests and goals have traditionally focused on describing the dietary focus and/or breadth, subsistence change through time, correlation of subsistence choice and technology with environmental variables, and examining the profitability of subsistence choice (e.g., intensification, prey choice models, and catchment area studies).

Subsistence is best addressed by examining the direct evidence of prehistoric diets such as floral and faunal remains. Indirect sources for the study of subsistence include artifacts, features, site function, bioarchaeology, or environmental information. Specific objectives to be pursued in the subsistence analysis at CA-MRN-44/H include: (1) understanding the dietary composition, diversity, and emphasis noted in the archaeological assemblage; (2) recognizing the degree of specialization or generalization of subsistence pursuits; (3) documenting dietary changes indicated in the archaeological record through time; and (4) noting indications of technological evolution associated with food production through time.

A total of 13 soil samples (14.7 liters) from three separate loci was submitted for flotation and macrobotanical analysis. Macrobotanical samples were examined for evidence of paleobotanical remains. Dr. Eric Wohlgemuth of Far Western Anthropological Research Group, Inc., conducted this analysis. The results of this analysis are presented in Chapter 9.

Faunal and Shell Analysis

A substantial amount of shell and faunal remains were recovered from excavations at CA-MRN-44/H. Analysis of faunal remains can contribute to the understanding of prehistoric diet, butchery techniques, seasonality, or hunting strategies (Klein and Cruz-Uribe 1984). Analysis of faunal remains was directed at gaining information based on direct evidence of subsistence practices. The approach first determined the lowest possible taxonomic unit for each individual specimen. An effort was then be made to identify the relative abundance of each taxa represented by determining the Minimum Number of Individuals (MNI), and Number of Identified Specimens Present (NISP; White 1953). For specimens not identifiable beyond the taxonomic level of Class, the general size range of the faunal material (e.g., large and small mammal) are represented.

Identification of unit or locus was compared in an attempt to identify patterns of faunal exploitation and interpret these patterns in the context of site structure and site formation processes. Particular attention was directed at faunal remains associated with recognizable features or single component areas. This strategy revealed temporal patterns in subsistence orientation over time and differences in seasonality of site use.

Faunal identifications were completed by Tim Carpenter of ArcheoMetrics Inc. using comparative collections housed at the Zooarchaeology Laboratory of the Department of Anthropology located on the campus of the University of California at Davis. A total of 16,856 pieces of bones was analyzed (Appendix D). Dwight Simons conducted an inter-site analysis of the faunal assemblage and authored a report included in Chapter 8.

Karin Goetter conducted identification of marine shell material recovered from column samples. A total of 0.4 cubic meters of sediment yielded 25.4 kilograms shell material. Identification followed Smith and Carlton (1975) *Light's Manual: Intertidal Invertebrate of the Central California Coast*. Any cultural modifications (i.e., burning, chipping, grindings) and non-cultural modifications (i.e., weathering) were recorded. Marine shellfish from CA-MRN-44/H is discussed in Chapter 10. Appendix E provides the data sheets for shellfish identifications.

Radiocarbon Dating

Radiocarbon analysis is often the most reliable means for assigning temporal age to archaeological deposits. Radiocarbon age determinations are useful for accurate dating of features, strata, or sites and the absolute dates have been used to develop and refine obsidian hydration rates. Discrete charcoal deposits derived from a hearth or other well-documented archaeological features were generally considered a more reliable substance for radiocarbon assay.

At CA-MRN-44/H, radiocarbon analysis focused on materials from primary contexts, particularly where temporally diagnostic or functionally discrete artifacts co-occur for cross-dating. Beta Analytic, Inc. performed a total of 14 radiocarbon assays. Radiocarbon dating consisted of 13 Accelerated Mass Spectrometer (AMS) assays and one radiometric assay. The results of radiometric dating are discussed in Chapter 7. Appendix F provides the radiometric analysis reports.

Obsidian Hydration Dating

Hydration analysis of obsidian materials recovered from archaeological contexts can contribute to a variety of research topics. Obsidian hydration data often provides fundamental information useful for examination of site structure, evaluation of integrity, understanding site-specific chronologies, understanding shifts in economic use of tool stone, and/or identification of single component areas within a site. This technique can be especially useful when temporally diagnostic artifacts or suitable materials for radiocarbon age determination are lacking in archaeological deposits.

A large percentage of flaked stone materials were derived from obsidian material at CA-MRN-44/H. Obsidian hydration was used to determine the relative age of obsidian artifacts by measuring the thickness of the specimen's hydration rim (layer of water penetration). A total of 62 specimens, including formal artifacts and obsidian debitage, was be selected for hydration analyses and resulted in a total of 68 thin sections. Mr. Tom Origer of Origer's Obsidian Laboratory performed these analyses. The results of obsidian hydration rim analysis are discussed in Chapter 7. Appendix G provides the data sheets and reports of obsidian hydration analysis.

Obsidian Source Determination

Obsidian sourcing was accomplished through X-Ray Fluorescence spectrometry to identify and quantify trace elements. This information was used to determine the geologic source of obsidian specimens recovered from the site. Variability through time in the use of source specific obsidian material may indicate shifts in territoriality, mobility pattern, and/or the nature of trade relations. Angel Island is situated within the proximity of a number of obsidian sources, including Borax Lake and Mount Konocti in the Clear Lake Basin, and the Napa and Annadel sources in Napa and Sonoma Counties. A total of 64 specimens was selected for obsidian source determination analysis. Mr. Craig Skinner of Northwest Research Obsidian Studies Laboratory performed these analyses. The results of geo-chemical source determination are discussed in Chapter 7. Appendix C provides the reports and data sheets for X-Ray Fluorescence spectrometry.

Technological Analysis

The basic goal of flaked stone analysis at CA-MRN-44/H was the identification of reduction stages and recognition of technologies used in the manufacture of chipped stone artifacts and debitage. In particular, attention was directed to the types and source of raw material used, general patterns in lithic reduction, and differences in reduction technology relative to material type. These analyses also described any formed flake tools or diagnostic projectile points and assign placement within appropriate cultural traditions.

The goals of stone tool analysis are: (1) identification of the range or emphasis of behavioral activities represented at the site; (2) understanding how the site functioned within a broader settlement system; (3) examination for a change in site function through time; and (4) investigation of the relationship between the organization of technology and land-use patterns.

The methodology used to describe the flaked stone assemblage followed Callahan (1979), Flenniken (1987), and Crabtree (1972). Functional and morphological attributes were identified, and each formed artifact was separated by material and artifact type including: debitage, simple flake tools, formed flake tools, cores, bifaces, and projectile points.

Debitage

Debitage includes all stone byproducts (flakes) produced through the production of chipped stone tools by percussion or pressure techniques.

Simple Flake Tools

Simple flake tools are characterized as having no retouching or intentional shaping of the cutting edge. These items generally display micro-chipping or edge modification. Simple flake tools tend to be causal or expedient use items when a cutting or scraping edge is necessary but the item is not part of a curated tool kit. The objective of simple flake tool analysis was to determine the source and character of use-wear.

Formed Flake Tools

Formed flake tools are distinguished from simple flake tools based on the degree that intentional flaking for retouching or shaping has altered the original form of the flake. Attributes recorded on these implements include flake type, number of modified edges, edge-shape (e.g., convex, concave, straight), and type of edge modification (e.g., micro chipped, battered, ground). Recognition of simple versus formed flake tools was used to show the degree to which specific tools were fashioned for particular tasks, and thereby imply tool use-life.

Cores

Cores are flaked stone items that have been reduced from an original cobble, nodule, or chunk and are intended as material for the production of flakes, formed flake tools, bifaces or projectile points. Cores are an early stage of reduction representing the source of material for manufacture of stone tools. Cores are generally classified as chipped stone materials having three or more flake removal scars. Attributes relevant to the analysis of cores include material type, amount of remnant cortex present, length of detachment scars, number of detachment scars, platform preparation, direction of flake scars (e.g., bi-directional, bipolar, or bifacial), core form (e.g., tabular, cobble, or assay cobble), and platform type (conical, interior, or prepared). Analysis of core tool technology is useful for describing tool stone economics and defining divergent material reduction trajectories.

Bifaces

Bifaces are artifacts that exhibit flake scars on two opposing surfaces that form at least one continuous margin. A number of researchers have developed models of bifacial reduction in order to correlate stone tool reduction trajectories with stone tool economics. Callahan (1979) recognizes five stages of bifacial reduction. Stage-1 bifaces display rough bifacial edges, thick margins, and are characterized by having less than 60% of the perimeter edge shaped. Stage-2 bifaces are percussion shaped items with a rough outline defined. Stage-3 bifaces are percussion thinned, well-formed specimens. Stage-4 bifaces differ from the previous stage as evidenced by intermittent pressure flaking on opposing surfaces having regularly spaced flake removal scars. Stage-5 bifaces constitute a near finished product, a non-diagnostic projectile point "blank," or a formalized bifacial knife/blade. As outlined above, the biface reduction trajectory is marked by a progressive continuum of flake removal completed in sequential order resulting in a final bifacial tool. Recognition of biface reduction trajectories is useful for understanding settlement and mobility patterns and the economics of tool stone production.

Projectile Points

Projectile points are bifacially modified implements with diagnostic hafting elements (or other typological attributes such as stems, shoulders, or barbs) that were used as hunting implements or weapons. This category does not include fragments of bifacially modified pieces that may have functioned as projectile points but do not have sufficient intact portions to classify them as such. Projectile points are typed on the basis of both morphological and typological attributes. Standard projectile point attributes include maximum length, axial length, stem length, maximum width, neck width, maximum thickness, weight, distal shoulder angle, proximal shoulder angle, and notch opening index.

Temporally diagnostic projectile points are often used to develop regional chronologies and to examine issues of mobility, settlement, subsistence, and land-use patterns over time and space. The project subjected all projectile points manufactured from obsidian material to both XRF and obsidian hydration analysis. These data were used in conjunction with those obtained from debitage analysis to understand obsidian procurement patterns and the organization of stone tool production.

Ground Stone Analysis

Ground stone artifacts are typically associated with food procurement and processing activities. Objectives of ground stone analysis include identification of varying functional, temporal, or typological types and the co-association of these items with other artifact types. The analysis of these artifacts contributes to our understanding of prehistoric subsistence practices, cultural chronology, and the study of settlement strategies.

Analysis of ground stone materials was comprised largely of descriptive traits with the intention of identifying the types of materials being processed. Ground stone artifacts were separated into several categories including hand stones, milling slabs, pestles, mortars, and others. These generalized categories were further subdivided according to overall shape, milling surface characteristics, or potential functional or temporal divisions. Specific attributes recorded for each specimen include material type, presence of striations, polish, beveling, pecking or battering, shape of grinding surface, size of object, number of milling surfaces, dimensions of polish, condition, thickness and other modifications.

Chapter 5: Soil Strata and Site Features

SOIL STRATA DESCRIPTIONS

Locus A, Units S1/W0, S1/W1, S2/W0, S2/W1

The soils in Locus A were composed of a series of intact cultural stratigraphy, shell refuse lenses, and cultural features. Eight stratigraphic units were observed, numbered Stratum 1 through Stratum 8. These units were numbered as they were encountered in the profile from top to bottom and are ordered from youngest to oldest based on their relative position within the vertical profile. The units and their estimated radiometric age are presented in the following sections. Figure 23 is an expanded view of all four sides of the excavated exposure.

Stratum 1

10YR3/3 dark brown, clay loam, ~25% angular gravels, massive structure. This stratum is made up of historic fill material with very limited amounts of shell midden material. The stratum begins at the ground surface and continues to a maximum depth of about 24 cmbs. This stratum has a distinct wavy boundary between it and the underlying stratum.

Stratum 2

10YR2/1, black, moist silty sandy loam, with a high amount of shell, charcoal, and ash. The soil is friable, massive, and has about 10% subangular gravels. Soils in Stratum 2 were disturbed from a 1.5-inch PVC pipe water line, which was installed in 1983 and monitored by DPR archaeologists (Hines 1983). Trenching for the waterline truncated several small lenses of friable shell. This disturbance reached a maximum depth of 65 cmbs.

Stratum 3

10YR2/1 black, silty sandy loam with a high amount of shell, charcoal, and ash. This stratum is composed of intact shell midden material, has a massive structure, is moist, friable, and has about 10% angular gravels comprised of fire-affected rock. The stratum begins at 18 cmbs at the north end of the profile and reaches a maximum depth of about 60 cmbs. It has a distinct level boundary with the underlying stratum. Three features

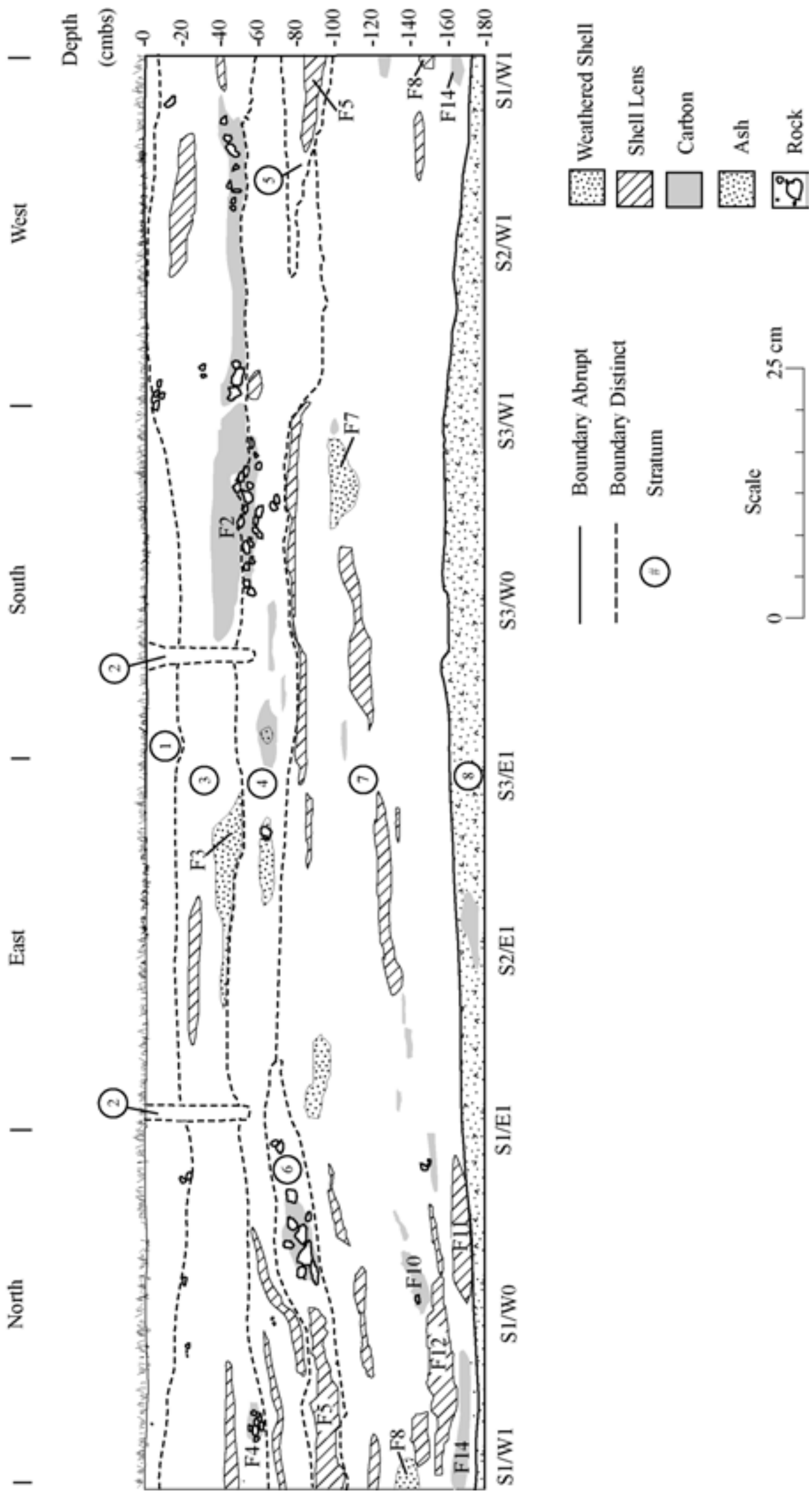


Figure 23. Soil Profile 2-x-2-meter Excavation Unit Expanded View Profile Locus A.

are present in this stratum. Feature 2 is a small irregular shaped hearth, which is cut in cross-section by the excavation unit profile of S1/W1 and S2/W1 in the 20-40-centimeter levels. Feature 3 is a large baking pit or oven consisting of burnt marine shells and a fine ash. This feature is located in the eastern portions of units S1/W0 and S2/W0 in the 20-40-centimeter levels. Feature 4 is a rock-lined hearth present along the north wall of unit S1/W0 in the 40-50-centimeter level. Radiometric dating of a *Macoma nasuta* (Bent-nose clam) shell recovered from Feature 4 resulted in an AMS date of 1360-1180 cal BP.

Stratum 4

10YR2/1 black, silty sandy loam with a high amount of shell, charcoal, and ash. This soil is an intact shell midden similar to Stratum 3 but shows a significant increase in the amount of ash. Stratum 4 appears as a diffuse layer of ashy soil. The stratum begins at about 55 cmbs and reaches a maximum depth of about 85 cmbs. It has a distinct boundary with the underlying stratum.

Stratum 5

10YR4/4 dark yellowish brown, silty sandy loam with a high frequency of shell, charcoal, and ash. This intact shell midden soil has a massive structure, is moist, friable, and has about 15% angular gravels of fire-affected rock (FAR). This stratum appears as a thin lens of soil. Stratum 5 begins at 70 cmbs and continues to 80 cmbs. It has a distinct level boundary with the underlying stratum.

Stratum 6

10YR2/2 very dark brown, silty sandy loam, with a high frequency of shell, charcoal, and ash. This stratum is composed of intact shell midden material, has a massive structure, is moist, friable, and has about 10% angular gravels (FAR). Stratum 6 begins at 75 cmbs and continues to 115 cmbs. It has a distinct boundary with the underlying stratum. One feature is present within Stratum 5. Feature 5 consists of a concentration of highly burnt shell. This lens measures approximately 130 centimeters in diameter and 20 centimeters thick and is located in the profile of S1/W1 and S2/W1, 80-90 centimeters.

Stratum 7

10YR4/4 very dark yellowish brown, silty sandy loam, with a high frequency of shell, stained with pockets of dark charcoal and light ash. This intact shell midden is similar to Stratums 3, 4, 5, and 6. Stratum 7 begins at about 100 cmbs and continues to 170 cmbs. It has a very distinct level boundary with the underlying stratum.

Stratum 8

10YR4/4 very dark yellowish brown, silty sandy loam, with a high frequency of shell, charcoal, and ash. This stratum is distinguished by the increased amount of weathering and highly fragmentary nature of shell debris. The water table is present at approximately 165 cmbs. Soil structure is massive, wet, friable, and contains about 15% angular gravels (FAR). Stratum 8 begins at 170 cmbs and continues to bottom of the excavation profile (180 cmbs). Hand augering one meter south of this area documented the shell midden reaching a maximum depth of 250 cmbs. A cluster of four features was encountered situated on top of this stratum. Features include a cache of 321 Frilled dogwinkle shells (Feature 15), a large baking pit (Feature 17), and two rock lined hearths (Features 16 and 18). Radiometric dating of two shells derived from Feature 18 resulted in age estimates of 1250-1420 cal BP and 1160-1370 cal BP.

Locus A, Profile Sketch Septic Tank Exposure

The soils presented complex stratigraphy, a series of intact shell midden lenses, and nine cultural features. A total of 11 stratigraphic units was observed, numbered Stratum 1 through Stratum 11. These units were numbered as they were encountered in the profile from top to bottom. A description of the soil units and cultural features are presented in the following section. Figure 24 is a profile sketch of the north wall of the mechanically excavated septic tank exposure. Figure 13 (see page 27) is a photographic overview of the profile while it was being recorded.

Stratum 1

10/YR4/3 brown, loam, A Horizon characterized by a granular structure, clear smooth lower boundary, few fine active roots, no clay films, and >10% subangular to subrounded gravels. No artifacts were observed in this stratum. The stratum begins at the surface and continues to about 25 cmbs.

Stratum 2

Varied 10/YR4/3 brown and 10/YR 2.5/2 very dark brown, clay loam, C Horizon, consisting of historic fill material that is highly disturbed. The color of the stratum is variable with yellowish brown clay, brown loam, charcoal, and brick. The soil has a massive structure, about 25% medium large gravels, and a clear smooth lower boundary. The stratum occurs between about 12-75 cmbs.

Stratum 3

10YR 2.5/2 very dark brown, loam and clay. This stratum represents a trench dug through stratum 4 and 5 and subsequently filled with a mix of materials. The hole was dug through intact midden deposits, presumably during the historic period. Soils within this stratum resemble Stratum II although they are slightly darker. Stratum 3 occurs between 40 and 80 cmbs.

Stratum 4

10YR3/1 very dark gray-black, silty loam, massive structure, friable consistency, with 25% subangular to subrounded large fire-affected rock, and less palm roots than the preceeding stratum. The primary constituent of this stratum is shell. This stratum is an intact shell midden. Feature A is a dense lens of shell and charcoal probably representing a hearth. This oval shaped feature measures 25 centimeters wide by 10 centimeters thick. The stratum occurs between 50 and 100 cmbs.

Stratum 5

10YR3/1 very dark gray, silty clay loam, massive structure, with <10% subangular to subrounded small and medium gravels. This stratum is a dense intact shell midden, characterized by very greasy soil and high concentrations of shell, some bone, and numerous

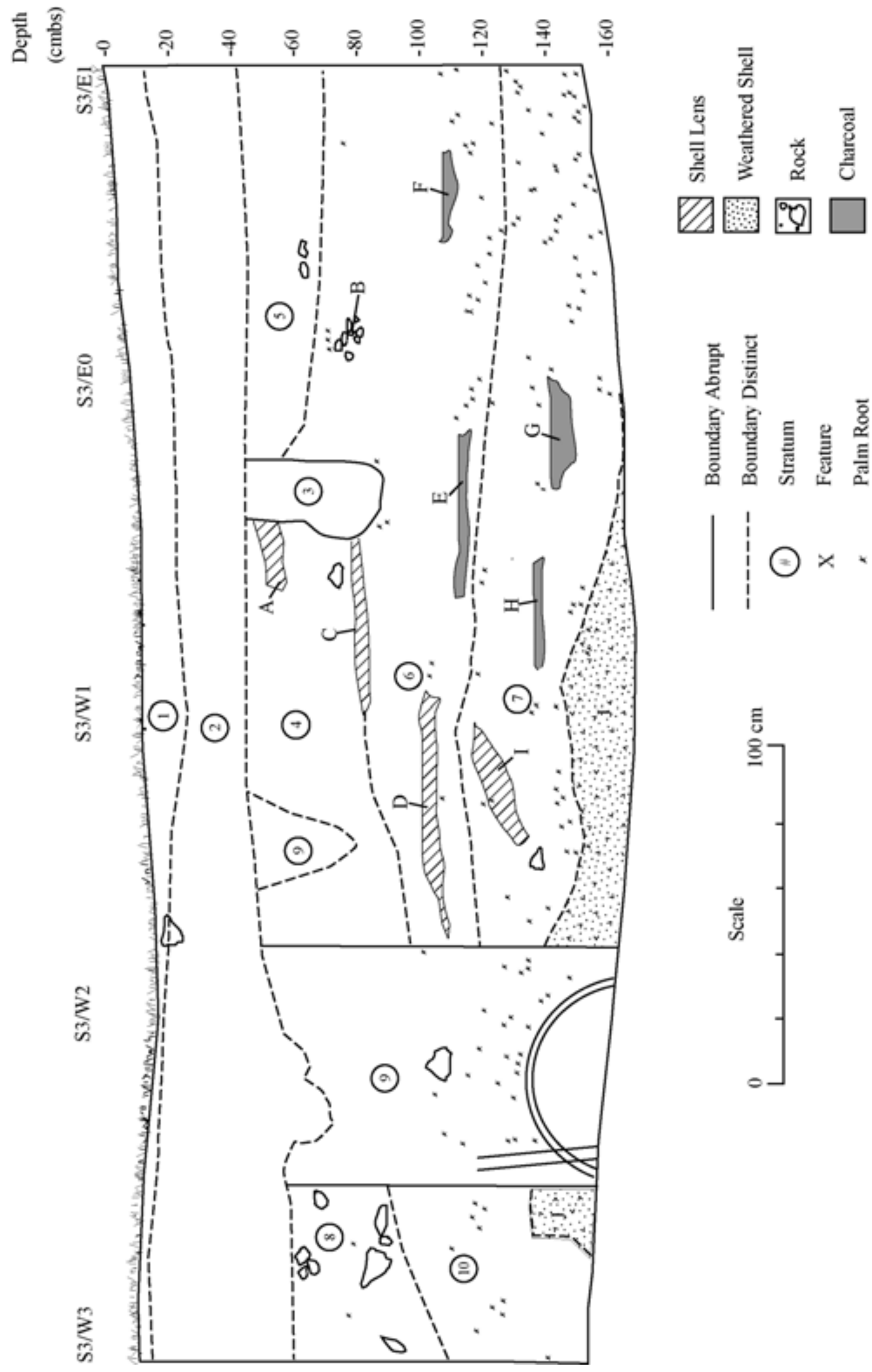


Figure 24. Soil Profile Septic Tank Exposure, North Wall Locus A.

charcoal stains and approximately seven lenses of shell (similar to stratum 4 described below). No features were observed within this stratum. The stratum occurs between 40 and 70 cmbs.

Stratum 6

10YR2.5/2 very dark brown, silty clay loam, massive structure, friable consistency, with <10% angular to subrounded small and medium gravels. This stratum is a thick layer interbedded with lenses of shell similar to Stratum 6. Charcoal, large angular rocks, and a lot of roots are present within the stratum. Five features were observed in this stratum. Feature B is a concentration of several pieces of large fire-affected rocks encompassing an area about 15 centimeters in diameter. Feature C is a small lens of highly concentrated burnt shell with small amounts of clay, sand, and charcoal. The shell lens measures about 5 centimeters thick and 50 centimeters wide. Feature D is a dense concentration of burnt shell and charcoal probably representing a baking pit or oven. The feature measures about 60 centimeters long by 10 centimeters thick. Feature E is a discrete lens of black stained soil and charcoal representing a hearth. The hearth is situated at the bottom of Stratum 6 and on top of Stratum 7. The hearth feature measures about 40 centimeters long and 10 centimeters thick. Feature F is a dense lens of unburnt shell measuring 25 centimeters long and 5 centimeters thick. Stratum 6 occurs between 70 and 125 cmbs.

Stratum 7

10YR3/2 very dark grayish brown, loam, massive structure, friable consistency, with <10% subrounded small to medium gravels. This stratum is the same as Stratum 7 but with considerably fewer lenses of shell, slightly lighter color, and fewer large cobbles. Lots of roots are present particularly on the east side of the stratum. Three cultural features were documented in this stratum. Feature G is a baking pit or oven that appears as a bowl shaped lens of shell, charcoal, and ash. This feature measures 30 centimeters long by 10 centimeters thick. Feature H is a hearth that appears as a thin discrete lens of charcoal measuring 30 centimeters long and about 5 centimeters thick. Feature I is a concentrated lens of burnt shell that measures 25 centimeters long by 10 centimeters thick. The shell lens was observed to dip slightly on the west side. Stratum 7 occurs between 125 and 160 cmbs.

Stratum 8

10YR3/2 very dark grayish brown, clay loam, massive structure, friable consistency, with 40% angular medium to large gravels. This stratum contains a high amount of large (5-10 centimeters) pieces of oxidized sandstone. This strata extends to the west where it expands to encompass the majority of the profile. The sandstone pieces appear to be remnants of the building foundation possibly discolored by the 1940 fire in the administration building. Shell midden and historic debris are mixed in this stratum. Unlike intact shell midden observed in other stratums, this stratum does not contain lenses of shell and charcoal. The stratum occurs between about 50 to 110 cmbs.

Stratum 9

10YR 2.5/2 very dark brown, loam and clay. This stratum represents a trench dug through Stratum 4 and 5 and subsequently filled with a mix of materials. The trench was dug through intact midden deposits during the historic period to install a 50-centimeter diameter clay storm drainpipe. Stratum 9 occurs between 40 and 160 cmbs.

Stratum 10

10YR2.5/2 very dark brown, clay loam, massive structure, friable consistency, with >10% angular medium gravels. This stratum is overlaid by Stratum 8 and is generally similar, with fewer sandstone pieces. This stratum appears to be disturbed as indicated by the lack of charcoal and shell lenses and the presence of historic fill materials. Stratum 10 occurs between 90 and 160 cmbs.

Stratum 11

10YR3/2 very dark grayish brown, loam, massive structure, friable consistency, with <10% subrounded small to medium gravels. This stratum is composed of an intact shell midden characterized by a highly compact, dense, concentrated thick stratum of weathered and fragmentary shell. The stratum appears to continue horizontally over a large area. The water table is present within this stratum and may account for the broken and weathered nature of the shell midden. Alternatively, this stratum may have been exposed to surface weathering for a duration of time and was subsequently buried by later site inhabitants. Hand augering showed that Stratum 11 occurs between about 150 to 250 cmbs.

Locus B, Units S0/W1, S0/W2, S0/W3, S0/W4, and S0/W5

The soils in Locus B were composed of mixed historic fill, disturbed shell midden, and intact shell midden. Five stratigraphic units were observed, numbered Stratum 1 through Stratum 5. The units are described in the following sections. Figure 25 is a profile sketch of the north wall of the excavated Trench 15.

Stratum 1

10YR3/3 dark brown, silty clay, ~5% angular gravels, massive structure. This stratum is made up of mixed historic fill material and concentrated pockets of shell midden. The stratum begins at the ground surface and continues to a maximum depth of about 104 cmbs. This stratum has a distinct wavy boundary between it and the underlying stratum.

Stratum 2

10YR3/3 very dark brown, sandy clay with a limited amount of shell, charcoal, and ash. This stratum consists of disturbed historic fill marked by a decrease in shell midden and a significant increase in the amount of sand. The stratum begins at about 55 cmbs and reaches a maximum depth of about 130 cmbs. It has a distinct boundary with the underlying stratum.

Stratum 3

10YR3/3 very dark brown, silty clay with an increased amount of shell midden and carbon. This stratum consists of disturbed historic fill. The stratum begins at about 120 cmbs and reaches a maximum depth of about 160 cmbs. It has a very distinct boundary with the underlying stratum.

Stratum 4

10YR2/1 black, silty sandy clay is characterized by a high amount of shell midden. This stratum is composed almost entirely of redeposited shell midden material. It has a massive structure, is moist, friable, and contains about 10% angular gravels. The stratum

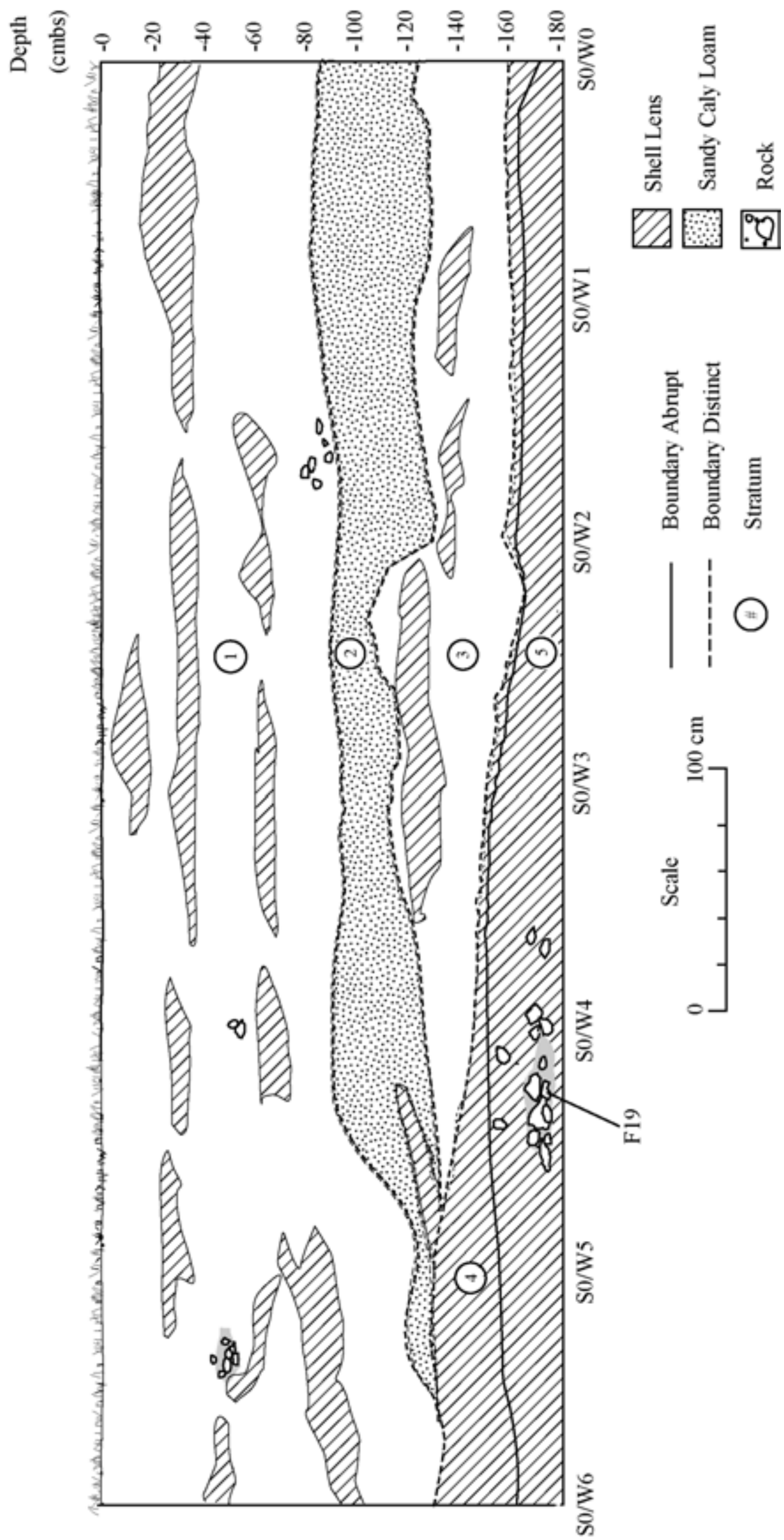


Figure 25. Locus B Trench 15 Soil Profile North Wall.

begins at 125 cmbs at the west end of the profile and reaches a maximum depth of about 165 cmbs. It has a distinct wavy boundary with the underlying stratum.

Stratum 5

10YR2/1 black, silty sandy clay is characterized by a high amount of shell midden. This stratum is composed of intact shell midden, which appears to have a high level of integrity. Soil in this stratum has a massive structure, is friable, and contains about 10% angular gravels. This stratum is separated from the overlaying stratum due to the integrity of the deposit. The stratum begins at 160 cmbs. Hand augering of the bottom of the profile documented that intact shell midden continued to a maximum depth of about 320 cmbs. The intact shell midden is more than 160 centimeters thick. Oil was present in the hand auger column.

Summary of Stratigraphy and Site Formation

A study of the project area and site soils was completed to characterize the sediments and stratigraphy of the shell mound (CA-MRN-4/H). This provided fundamental information regarding the nature and completeness of the archaeological record and facilitated a better understanding of the landscape setting during the time of prehistoric occupation. Figure 26 provides a schematic reconstruction of the shell mound stratigraphy and landform formation. The deepest excavation at the site occurred in Trench 13, which was situated near the center of Garrison Cove and reached a maximum depth of about 640 centimeters.

The natural environment of CA-MRN-44/H originally consisted of a small, sheltered cove on the north side of Angel Island with a small freshwater spring. The alluvial fan that formed at the base of the slope was incised by seasonal run off. Both sides of the alluvial fan were slightly elevated, and a small saltmarsh formed in the low lying areas present near the mouth of the cove. These elevated areas of the cove were attractive locations for human settlement. Native people occupied these landforms as evidenced by intact shell midden deposits on the east side (Locus A) and west side (Locus B) of Garrsion Cove.

The earliest evidence of human occupation at CA-MRN-44/H dates to approximately 1450 cal BP (500 AD) during the Terminal Later Phase of the Middle Period. The oldest deposits are found in Locus A at the lowest levels of the soil profile. The shell midden at this depth appears highly fragmentary and weathered. Occupation of the shell mound spanned approximately 500 years ending circa 950 cal BP.

The small freshwater marsh present at the mouth of the cove consists of a black marsh deposit of silt and clay (Ag), which overlays the gleyed clay (Cg) stratum. These two strata formed under similar conditions and were observed at a depth of approximately 500-550 centimeters. The upper portion of this deposit is rich with organic plant remains, likely tule. The lower part of this stratum is a grey-blue colored gleyed clay parent material (Cg). The deposit likely formed in a shallow water environment during the Mid-Late Holocene. The archaeological assemblage associated with Locus C was recovered primarily in the upper portions of this stratum at 500-520 centimeters. Radiocarbon dates on cultural materials recovered from this stratum suggest that the cultural deposit formed circa 750 cal BP (1200 AD) during the Middle-Late Transition Period.

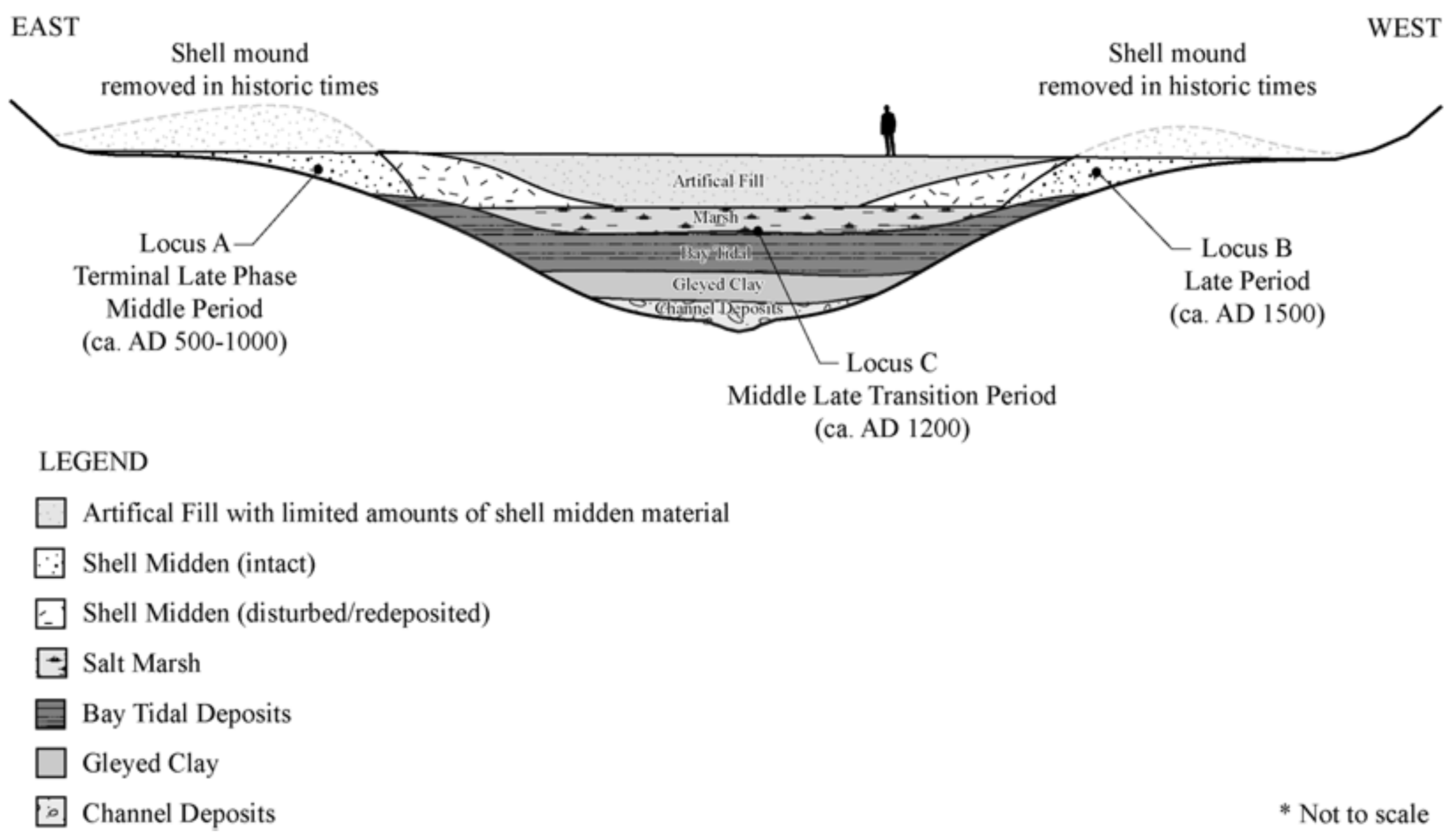


Figure 26. Schematic Profile of CA-MRN-44/H (View South).

The most recent occupation of CA-MRN-44/H occurred circa 450 cal BP (AD 1500) during the Late Period. Deposits within Locus B date to this time period.

A thick stratum of artificial fill was created as a result of early twentieth-century construction of the Immigration Station Facility. Artificial fill is present to a depth of approximately 365 centimeters. Limited amounts of shell midden material were found within this stratum along with historic-era materials.

At either side of Garrison Cove, the fill material covers dense concentrations of redeposited shell midden. On the west side of Garrsion Cove, the redeposited shell midden in Locus B is about 60 centimeters thick and continues to a maximum depth of 260 centimeters. The shell midden within this zone is contaminated with a thick coating of crude oil that has saturated much of the cultural deposit. The crude oil originated from the boiler house, which provided heat to the Immigration Station facility.

Oil stained sediments continued to a depth of about 310 centimeters and were observed in a stratum of black marsh deposits (described below). In Locus A, redeposited shell midden was about 50 centimeters thick and continued to a maximum depth of 160 centimeters. Historic activities associated with construction of the Immigration Station appear to have truncated the shell mound deposits associated with both loci A and B. As a result, the most recent occupation of the site was likely destroyed.

A layer of relatively thin, coarse-grained alluvium representing channel fill and sand deposits was observed at a depth of approximately 600-620 centimeters.

The lowest soil stratum consists of a truncated, oxidized terrestrial landform. The layer is characterized by a yellow-orange color of decomposing sandstone material. It was observed in hand augers in Locus A at a depth of 260-300 centimeters and near the center of Garrison Cove at a depth of about 620-640 centimeters.

Features

Shell mounds in the Bay Area typically represent large accumulations of residues from fixed multi-seasonal settlement. Common features include concentrations of dietary debris, heaps of fire-affected rock, shallow hearth and baking pits, house floors, and living surfaces, caches, and human graves.

Excavation strategies employed for this project recognized features as discrete events. Whenever possible, features were distinguished from deposits that developed through cultural accretion. Features were treated as unique contexts, excavated stratigraphically, and numbered consecutively for the entire site. A minimum of one liter in soil sample was collected from each feature. Archaeological investigations identified a total of 19 cultural features within controlled excavations: including: ten fire hearths, four baking pits, three concentrations of burnt marine shell, one pile of fire-affected rock, and one cache of unmodified Frilled dog-winkle (*Nucella lamellosa*). An additional nine features were identified and briefly described in the soil profile of the septic tank exposure (see Figure 24). The following sections present individual feature descriptions including type, location, constituents, integrity, associated artifacts, and probable functional interpretation. Feature maps and images are included as figures at the end of this section. Table 3 provides a summary of all features and associated relevant data.

Table 3. Summary of Features at CA-MRN-44/H.

Locus	Feature	Provenience	D (cm)	Description	Float #	Radiocarbon (C^{14} cal)	OH (n)	Mean
A	1	S9/E4	10-20	Rock heap	-	-	-	-
A	2	S1/W1, S2/W1	20-30	Hearth, ash	-	-	-	-
A	3	S2/W0, S1/W0	20-30	Baking pit/oven	-	-	5	2.2
A	4	S1/W1, S2/W1	40-50	Hearth	7	1280-1070 BP	3	2.7
A	5	S1/W1, S2/W1	80-90	Concentration burnt shell	3	-	1	3
A	6	S1/W0. S1/W1	100-110	Hearth	-	-	1	2.9
A	7	S2/W1	100-110	Baking pit/oven	8	1360-1180 BP	-	-
A	8	S1/W1, S2/W1	100-110	Baking pit/oven	-	-	-	-
A	9	S2/W1	110-120	Concentration burnt shell	-	-	1	2.8
A	10	S1/W1, S1/W0	120-130	Hearth, rock lined	10	-	-	-
A	11	S2/W1	140-150	Concentration burnt shell	-	-	-	-
A	12	S1/W1	140-150	Hearth, rock lined	-	-	-	-
A	13	S2/W1, S2/W0	140-150	Hearth, ash	1	1240-1040 BP & 1030-1000 BP	-	-
A	14	S2/W0, S1/W0	150-160	Hearth, ash	-	-	-	-
A	15	S1/W0. S1/W1	150-160	Cache rock snails	-	-	-	-
A	16	S1/W0	150-160	Hearth, rock lined	5	-	-	-
A	17	S2/W0	160-170	Baking pit/oven	-	-	-	-
A	18	S2/W0	160-170	Hearth, ashy	2	1420-1250 BP & 1370-1160 BP	2	2.8
B	19	S0/W4	170-180	Hearth, rock lined	-	-	-	-

Notes: D – Depth; Float – Flotation; OH – Obsidian hydration.

Feature 1

This feature is a small rock-lined hearth located in southeast corner of unit S9/E4, 10-20 centimeters (Figure 27). Approximately one-half of this feature is present within the excavated area. This well defined ash and rock deposit is surrounded by midden matrix. A total of 13 pounds of fire-affected rock was recovered from the feature, which measures about 50 centimeters in diameter and 5 centimeters thick.

Feature 2

Feature 2 is a small irregularly shaped hearth (Figure 28). The hearth is present along the west wall of units S1/W1 and S2/W1 in the 20-30-centimeter level and extends west for an unknown distance outside the area of excavation. Feature 2 appears as a discrete concentration of fine light colored ash, carbonized wood, burnt marine shell, and thermally altered sandstone cobbles. Ash, carbon, and burnt shell occur as thin horizontal lenses within the hearth feature. Approximately 30 pounds of fire-affected rock are associated with the hearth. A thin layer of burnt marine shell, measuring one to four centimeters thick, is present immediately beneath the hearth. This hearth measures about 75 centimeters (north-south), by 50 centimeters (east-west), and averages 6-10 centimeters thick.

Feature 3

Feature 3 is a large baking pit or oven (Figure 28). Feature 3 is located in the eastern portions of units S1/W0 and S2/W0 in the 20-40-centimeter levels. The feature consists of a very dense concentration of burnt marine shells, a fine light colored ashy matrix, and limited amounts of thermally affected and broken sandstone cobbles. Only six pounds of fire-affected stone is associated with this feature. Feature 3 is roughly lenticular is cross-section, thin at the western edge of the feature (3-5 centimeters), and thickest (15-18 centimeters) along the southeast corner of the excavation unit. The observed burnt shell lens measures 200 centimeters (north-south) by about 70 centimeters (east-west), and extends north, south and east an unknown distance outside the excavation units. Five obsidian artifacts from this feature were submitted for geochemical sourcing and obsidian hydration analysis. All five specimens are from the Napa geologic source and the average hydration rim measurement is 2.2 microns.

A modern white three-inch PVC pipe is present running roughly northeast-southwest through the western limits of Feature 3. The trench dug to install the PVC pipe is about 15 centimeters wide and was excavated to a depth of about 30 centimeters. Midden soil exposed in the process was used backfill the pipe trench. In addition, disturbance from burrowing animals was noted in a small portion of the southeast corner of the feature.

Feature 4

This feature is a rock-lined hearth. The hearth is present along the north wall of unit S1/W0 in the 40-50-centimeter level. The wall of the excavation unit splits Feature 4. This hearth is a discrete aggregation of thermally broken sandstone cobbles, compacted burnt marine shell, small concentrations of light colored ash, and black carbon stained soil. The layers of carbon, shell, and ash suggest multiple cooking events. These layers are concentrated in the roughly circular rock ring. A total of 17 pounds of fire-affected rock is associated with the hearth. This regular shaped circular hearth measures about 50 centimeters (north-south), by 85 centimeters (east-west), and averaged 6-10 centimeters thick (Figure 29). This feature appears in excellent condition with a very high degree of integrity.

A 10-cubic-meter sample of soil was taken from within this feature and submitted for radiocarbon dating and archaeobotabical analysis (see Chapter 9). Radiometric dating of a *Mytilus californianus* (California mussel) shell from this feature resulted in an AMS date of 1070-1280 cal BP. Three obsidian artifacts from this feature were submitted for geochemical sourcing and obsidian hydration analysis. All three specimens are from the Napa geologic source and the average hydration rim measurement is 2.7 microns.

Feature 5

This feature consists of a concentration of highly burnt shell (Figure 30). The feature is found in units S1/W1 and S2/W1, at a depth of 80-90 centimeters. This circular lens measures approximately 130 centimeters in diameter and 20 centimeters thick. Low quantities of unburnt sandstone pebbles, few carbon or charcoal flecks, and large amounts of highly fragmentary burnt marine shell characterize this feature. One obsidian artifact from this feature was submitted for geochemical sourcing and obsidian hydration analysis. The specimen is from the Napa geologic source and has a hydration rim measurement of 3.0 microns.

The shell debris is notable for its small size in comparison to other midden remains. Burning on shell indicates heat levels in excess of that necessary for cooking. The lack of carbon and presence of small-unburnt sandstone pebbles suggests that the shell refuse was burnt and subsequently redeposited as a discrete lens. Functionally, this shell lens may have served to create a soft homogenous textured living surface or floor.

Feature 6

This feature consists of a fire hearth found in units S1/W0 and S1/W1, 100-110 centimeters (Figure 31). Feature 6 is a discrete concentration of yellowish-brown colored sandy/ashy shell debris overlaid by a layer of fine gray colored ash and black carbon stained soil. Little fire-affected rock is present. The feature measures about 25 centimeters in diameter and about 10 centimeters thick. A cluster of cooking features were present in close proximity to Feature 6. These include two baking ovens (Features 7 and 8) and a large concentration of 55 pounds of fire-affected rock. One obsidian artifact from this feature was submitted for geochemical sourcing and obsidian hydration analysis. This specimen is from the Napa geologic source and the hydration rim measurement is 2.9 microns.

Feature 7

Feature 7 consists of a baking pit or oven present in the northwest corner of unit S2/W1, 100-110 centimeters (Figure 31). This feature represents a discrete concentration of compacted fine, light tan colored ashy soil. Shell debris contained within the ash lens is small, fragmentary, and highly burned. The baking feature is roughly oval in plan, measures about 100 centimeters in diameter, and averages about 15 centimeters thick. A 10-cubic-meter soil sample was taken from the center of this feature and submitted for archaeobotanical analysis (see Chapter 9). Radiometric dating of a *Macoma nasuta* (Bent-nose clam) shell retrieved from the feature resulted in an AMS date of 1180-1360 cal BP.

Feature 8

Feature 8 consists of a baking pit similar to Feature 6. This discrete concentration of compacted fine light tan colored ash has small, fragmentary, and highly burned shell debris underlain by a cluster of fire-affected rock (Figure 31). A total of 13 pounds of fist-sized fire-affected rocks was present at the base of this feature. Feature 8 is located in the northeast corner of unit S1/W1, 100-110 centimeters. The baking feature is round in plan, measures about 45 centimeters in diameter, and averages about 10 centimeters thick.

Feature 9

This feature consists of a large concentration of compacted fine, light tan colored ash with small, fragmentary, and highly burned shell debris (Figure 32). Feature 9 is located in the southeast corner of unit S2/W1, 120-130 centimeters. Approximately three-quarters of the feature are located outside of the excavation area. The baking feature is circular in plan, measures 70 centimeters in diameter and averages about 10 centimeters thick. Only four pounds of fire-affected rock were recovered from this feature. This feature is similar in constituents and form to Features 5 and 11. One obsidian artifact from this feature was submitted for geochemical sourcing and obsidian hydration analysis. This specimen is from the Napa geologic source and the hydration rim measurement is 2.9 microns.

Feature 10

Feature 10 is a large rock concentration located in units S1/W0 and S1/W1, 120-140 centimeters. This feature consists of an extensive and very discrete accumulation of fire-affected cobbles, dense deposits of crushed burnt marine shell, unburnt animal bones, and concentrated pockets of black carbonized wood and light colored compact ashy soil (Figure 32). The feature is surrounded by homogenous shell-filled non-midden matrix. A total of 125 pounds of fire-affected rock was recovered associated with this feature. The feature measures more than 200 centimeters (east-west), by 70 centimeters (north-south), and is 20-25 centimeters thick. A ground stone net weight (44-86) was recovered from this feature. Three 10-cubic-meter soil samples were taken from this feature. One sample was submitted for archaeobotanical analysis (see Chapter 9).

Feature 11

Feature 11 consists of a large concentrated layer of highly fragmentary small burnt marine shell (Figure 33). This feature is located in units S1/W0, S1/W1, S2/W0, and S2/W1, 140-150 centimeters and is characterized by low quantities of fire-affected rock and relatively little carbon. This feature bears similarities to Feature 5 and 9. The feature may represent the reuse of large quantities of shellfish dietary refuse to create a soft homogenous living surface.

Feature 12

This feature consists of a rock-lined hearth and associated animal remains (Figure 33). Fire-affected rock was present in a small concentration measuring about 60 centimeters in diameter. Two discrete areas of light colored yellowish-brown fine compact ash were also present. A total of 20 pounds of fire-affected rock was recovered from this feature. The remains of a harbor seal (*Phoca vitulina*) and the semi-articulated bones of a juvenile California sea lion (*Zalophus californianus*) were found on top of this feature. Two bone hairpins (44-266, -267, -268) and 25 pieces of baked clay (44-244 and -369) were recovered from this feature. Feature 12 is present in the unit S1/W1, 140-150 centimeters. Approximately one-half of the rock hearth is located outside of the excavated area.

Feature 13

Feature 13 is a fire hearth found in the northwest corner of unit S2/W1 and the southwest corner of S2/W0, 140-150 centimeters (Figure 33). Approximately one-half of this feature is located within the excavated area. The hearth appears as a concentrated yellowish-light brown colored compact ash, layered burnt shell, and large concentrated pockets of black carbonized wood. No fire-affected rock was present within this feature. The feature measures about 60 centimeters in diameter and is about 15 centimeters thick. A 10-cubic-meter soil sample was taken from the center of this feature and submitted for archaeobotanical analysis (see Chapter 9). Radiometric dating of a large piece of carbonized wood taken from the center of this feature resulted in two dates (1240-1040 cal BP and/or 1030-1000 cal BP).

Feature 14

This feature is a hearth located in unit S2/W1, 150-160 centimeters (Figure 34). Eighteen pounds of fire-affected rock were scattered among a layer of concentrated carbon and light colored ash. About one-half of this hearth is located outside of the excavated area. The hearth measures about 85 centimeters long and 15 centimeters thick. A finely polished unburnt bone hairpin (44-484) was recovered from this feature.

Feature 15

Feature 15 consists of a cache of shellfish (Figure 34). This concentration of 321 Frilled dogwinkle (*Nucella lamellosa*) shells is located in unit S1/W0, 150-160 centimeters. The circular shaped shell cache measures approximately 40 centimeters in diameter and 15 centimeters thick. Four pounds of fire-affected rock were found scattered in loose association with the shell cache. A finely manufactured (ground, incised, and perforated) steatite pendant was recovered at 230 cmbd associated with this feature. Unlike other Frilled dogwinkle shells recovered from the midden, all the shells in Feature 15 are unburnt and unmodified. This feature does not appear to be associated with subsistence pursuits. It is likely that this cache represents some ritual behavior or "offering." Following the request of the Native American monitor, no photographs were taken of the feature and all materials associated with the cache were reinterred into the excavation unit where they were encountered.

Feature 16

This feature is a small rock-lined fire hearth located in unit S1/W0, 150-160 centimeters (Figure 34). The entire feature was exposed within the excavated area. This hearth consists of concentrated black, greasy, carbon-rich soil situated among a concentration of 26 pounds of fist-sized thermally altered angular cobbles. The feature measures 40 centimeters in diameter and is about 10 centimeters thick. A 10-cubic-meter soil sample was taken from the center of this feature and submitted for archaeobotanical analysis (see Chapter 9).

Feature 17

Feature 17 is a large baking pit or oven (Figure 34). This discrete concentration of fine light yellow-tan colored compact ash is located completely within unit S2/W0, 160-170 centimeters. The baking feature is round in plan, measures 70 centimeters in diameter, and has a maximum thickness of 15 centimeters. This feature was encountered at the top of the water table. Standing water filled the excavation unit making careful stratigraphic excavation difficult. Following the request of the Native American monitor, all materials associated with the baking pit were reinterred in the excavation unit where they were encountered.

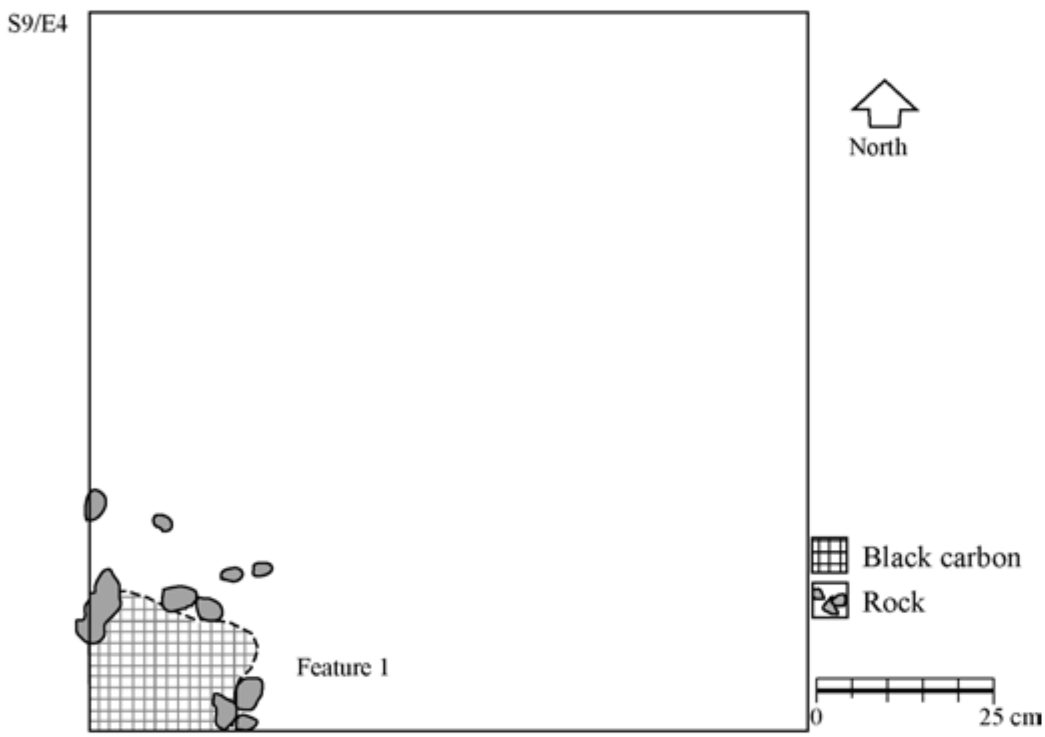
Feature 18

This feature is a small fire hearth located in the northeast corner of unit S2/W0 and the southeast corner of unit S1/W0, 160-170 centimeters (Figure 34). The entire feature was excavated. This feature consists of a concentrated area of black carbonized wood and fire-affected rocks. The feature measures about 35 centimeters in diameter and 10 centimeters thick. A 10-cubic-meter soil sample was taken from the center of this feature and submitted for archaeobotanical analysis (see Chapter 9). Two samples from this feature were submitted for Radiometric dating. A complete bent-nosed clam (*Macoma nasuta*) resulted in an AMS date of 1250-1420 cal BP. The second sample, a Frilled dogwinkle (*Nucella lamellosa*), returned an AMS date of 1160-1370 cal BP. Two obsidian artifacts from this feature was submitted for geochemical sourcing and obsidian hydration analysis. These specimens are from the Napa geologic source and the average hydration rim measurement is 2.8 microns, confirming the age of this feature.

Feature 19

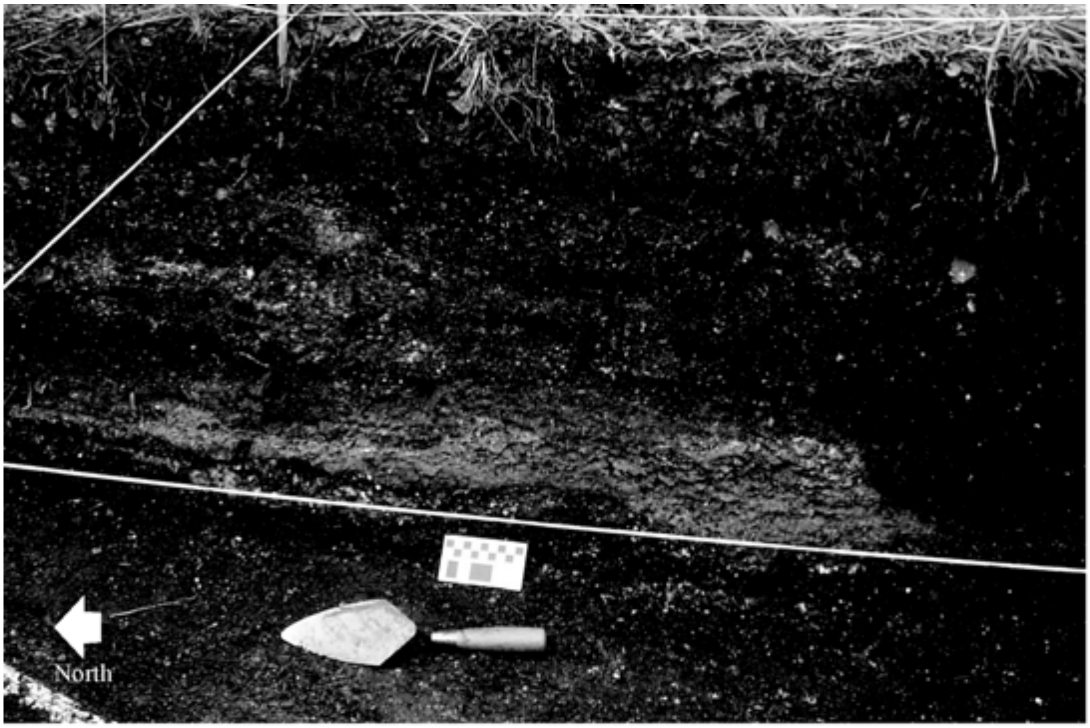
This feature is small rock hearth located along the north wall of unit S0/W4, 170-180 centimeters in Locus B. This cluster of six pounds of fire-affected rocks associated with carbonized black soil. The rock cluster measured roughly 45 centimeters in diameter. This feature appeared to extend outside of the excavated area. Controlled excavation was terminated at a depth of 180 centimeters. As a result this feature was not completely excavated.

Feature 1 - Unit S9/E4, 10-20 cm

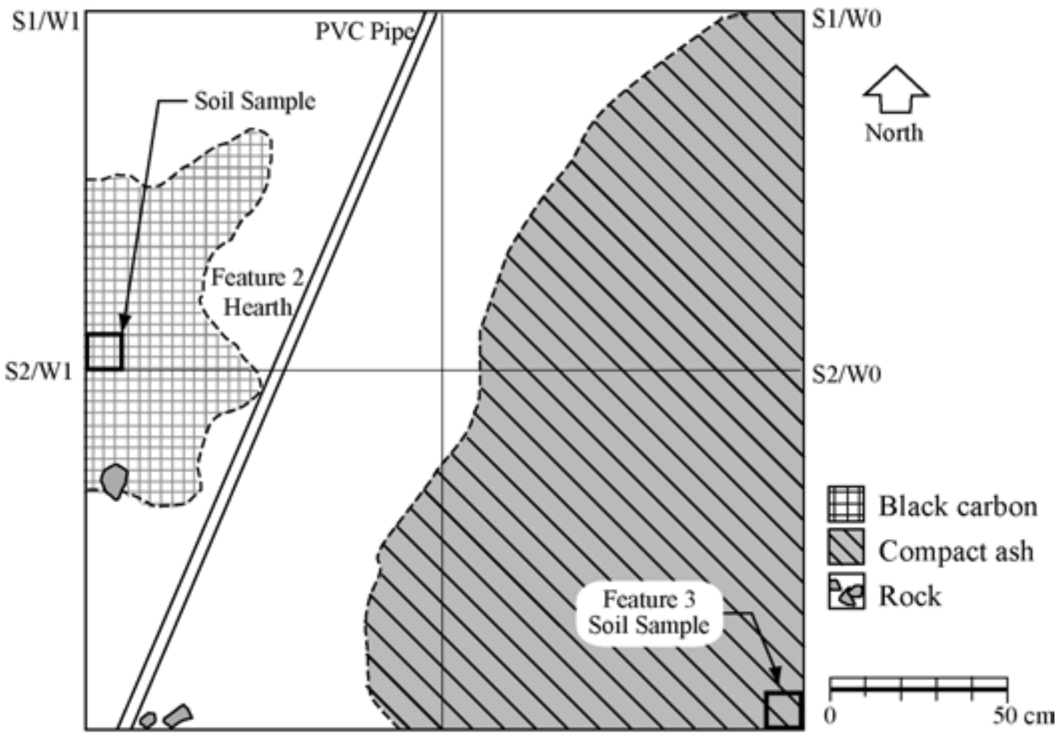


Feature 1 - Unit S9/E4, 10-20 cm

Figure 27. Feature 1.

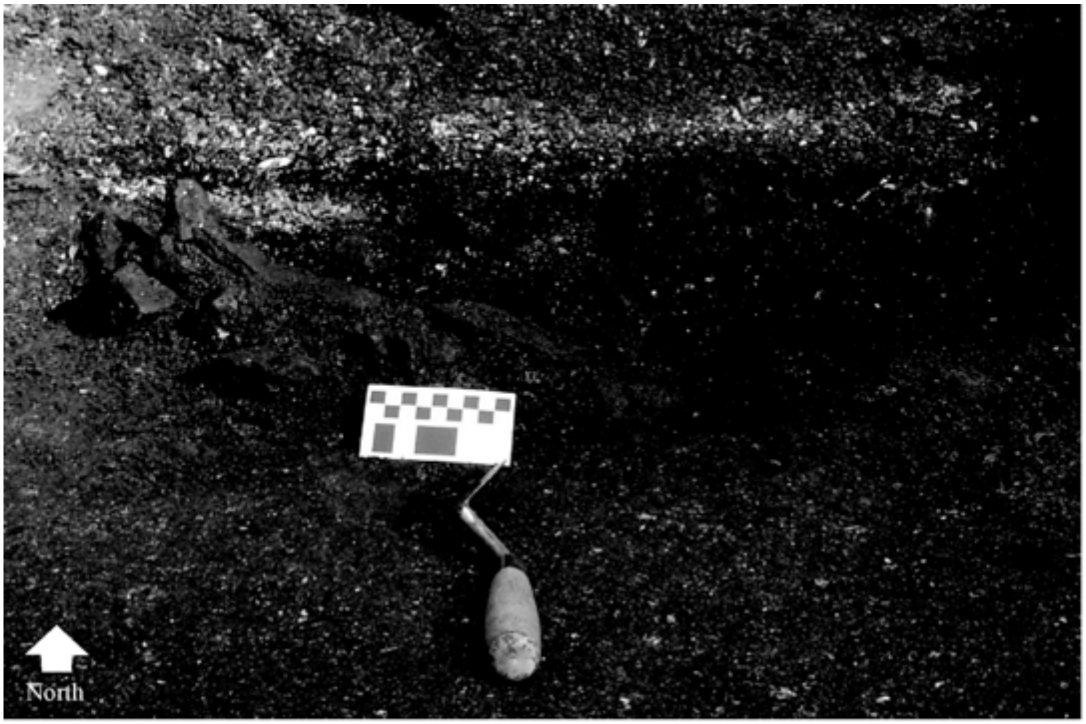


Feature 2, Cross-section in profile 30-40 cm

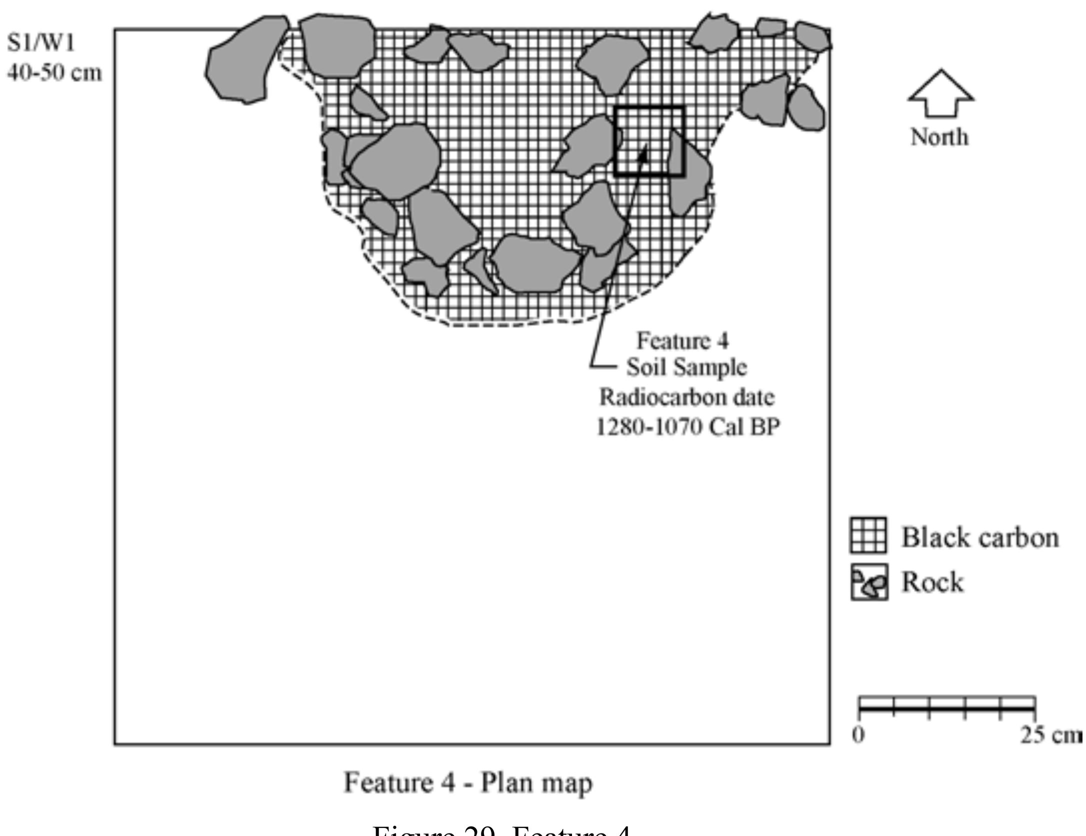


Feature 2 & 3 - 20-30 cm

Figure 28. Feature 2 and 3.



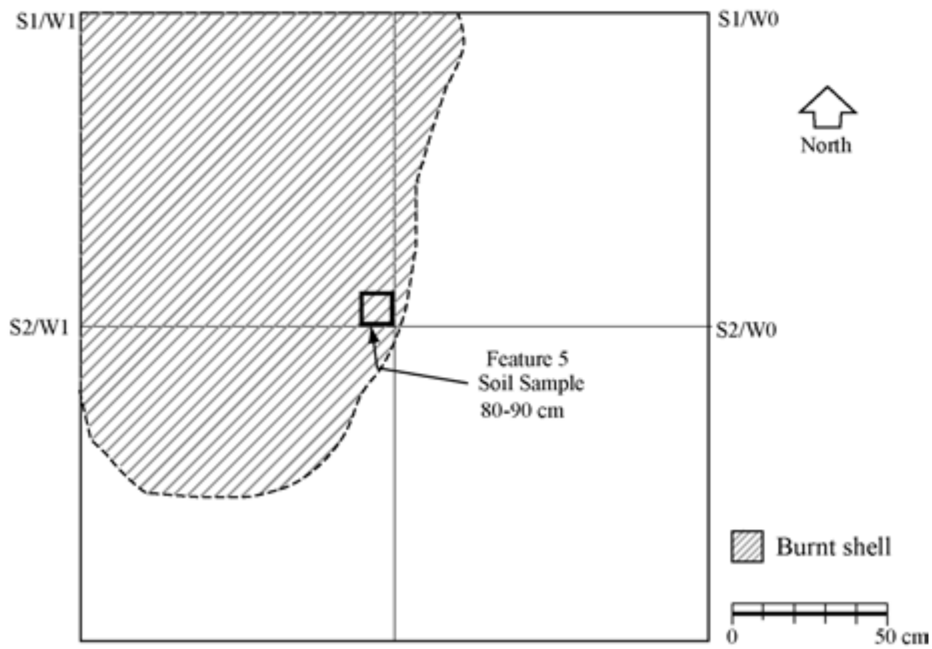
Feature 4 - Hearth, Unit S1/W1, 40-50 cm



Feature 4 - Plan map

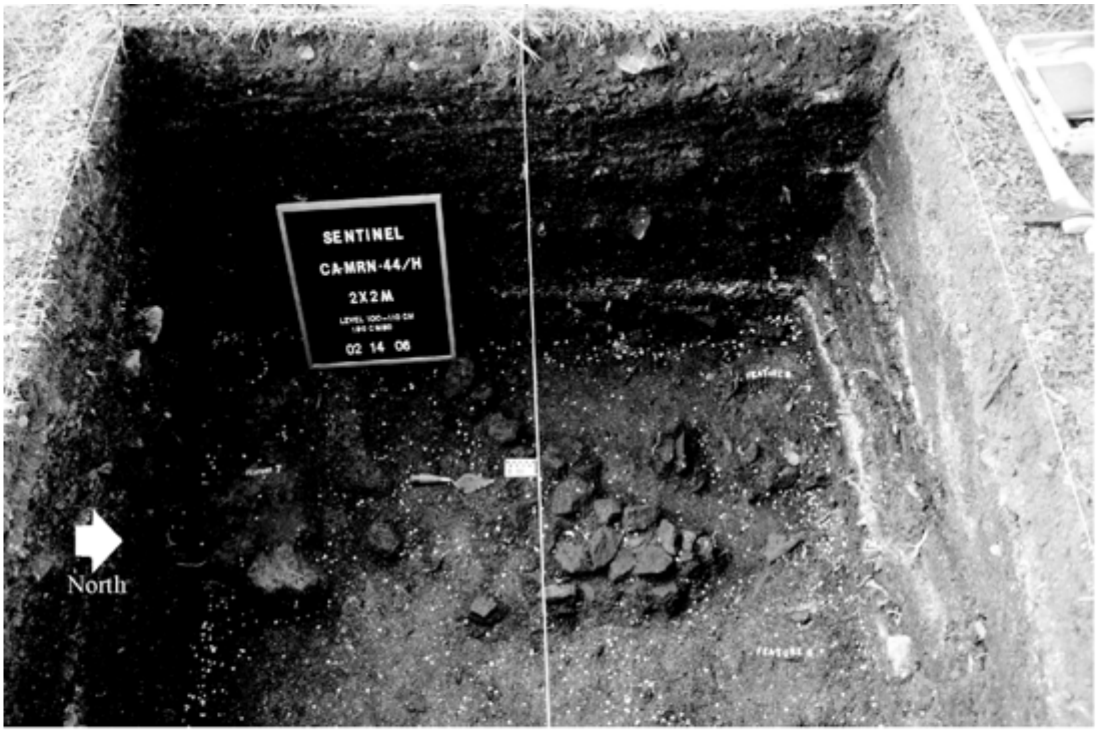
Figure 29. Feature 4.

Feature 5 - Concentration burnt shell

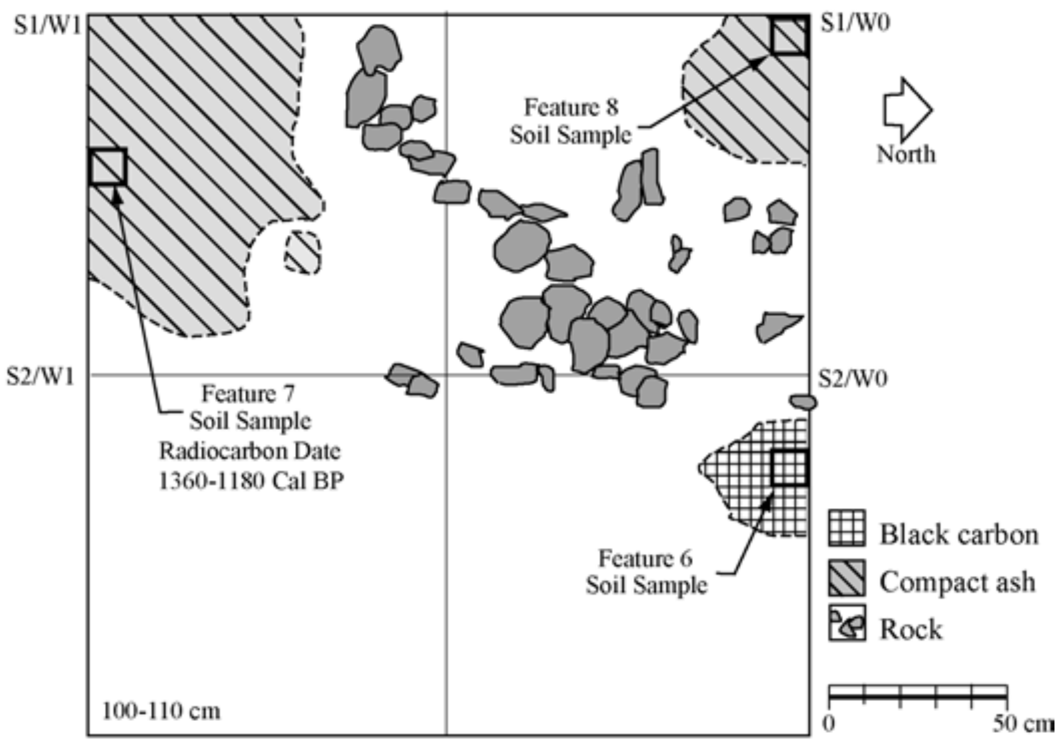


Feature 5 - 80-90 cm level

Figure 30. Feature 5.



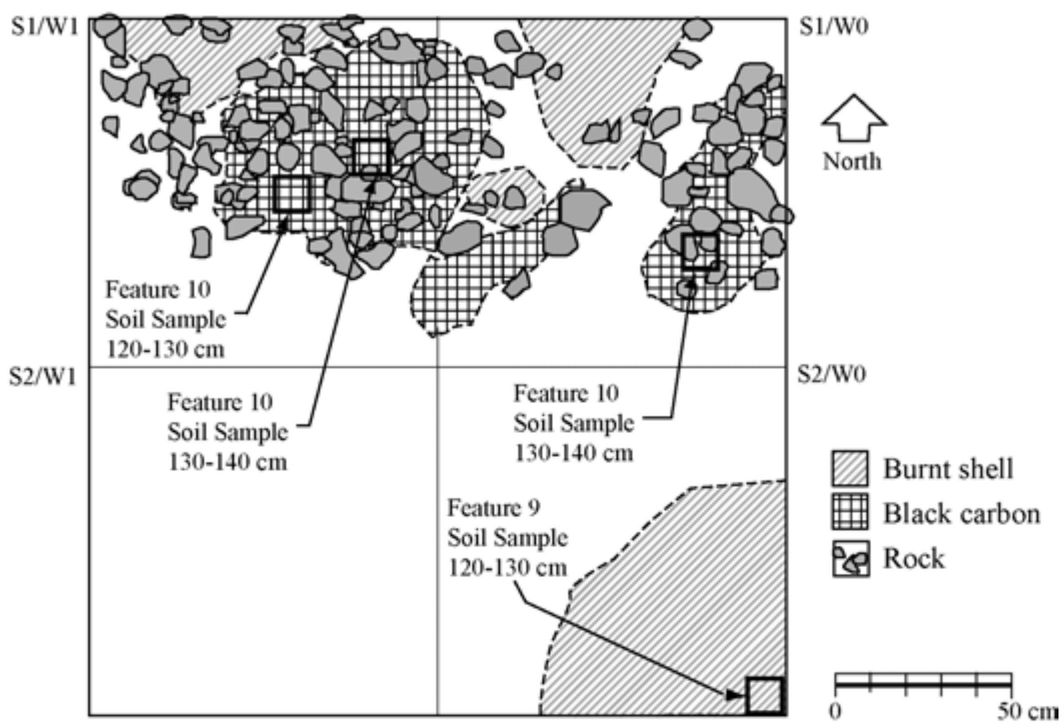
Features 6, 7, and 8 at 110 cm



Features 6, 7, and 8 at 110 cm

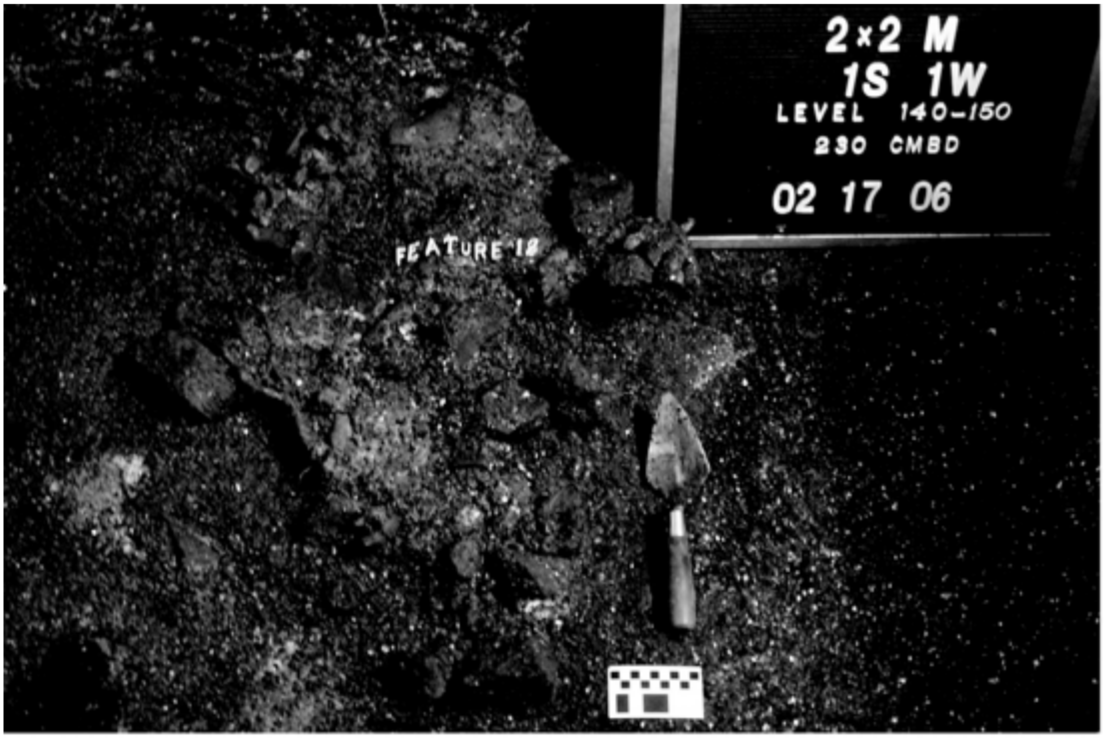
Figure 31. Feature 6, 7 and 8.

Feature 10 Units S1/W1 and S1/W0, 120-130 cm

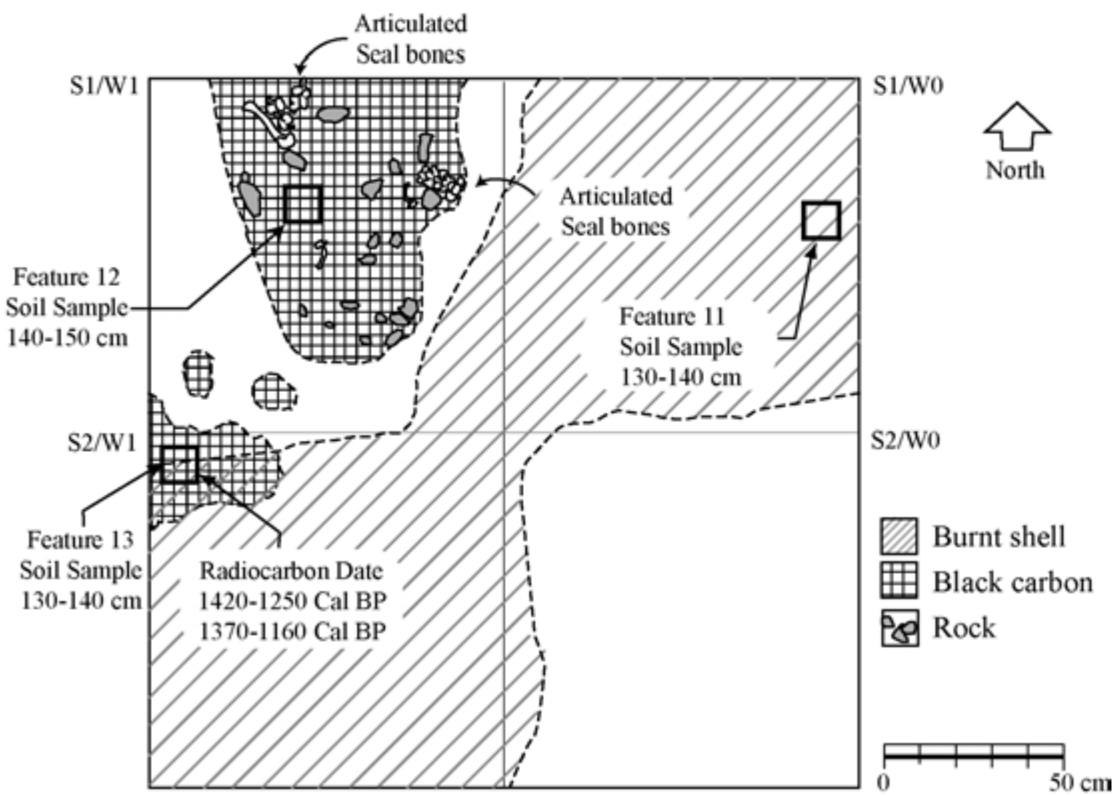


Feature 9 and 10, 120-130 cm

Figure 32. Feature 9 and 10.



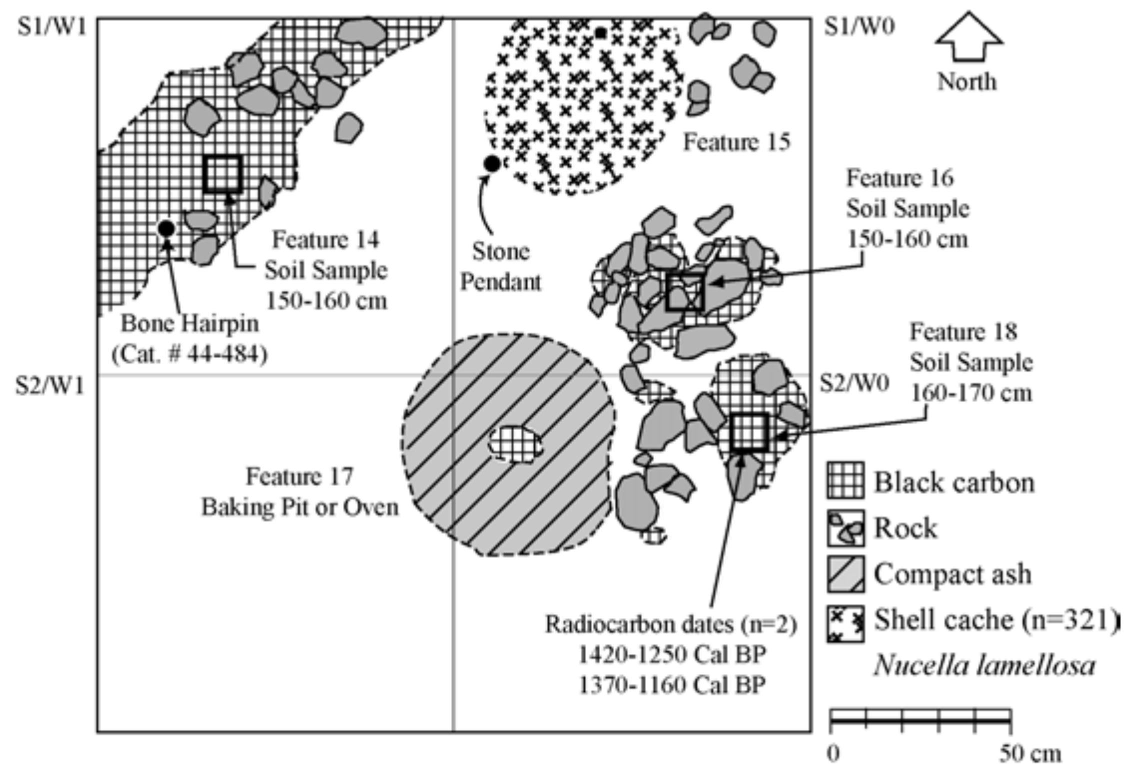
Feature 12, Unit S1/W1,140-150 cm



Feature 11, 12, and 13

Figure 33. Feature 11, 12, and 13.

Feature17 Baking pit unit S2/W0, 160-170 cm



Feature 14, 15, 16, 17 and 18

Figure 34. Feature 14, 15, 16, 17, and 18.

Chapter 6: Site Report

This chapter presents a site report for CA-MRN-44/H. It includes a summary of the physical character of the site, artifacts, and ecofacts recovered from CA-MRN-44/H and recounts the discovery, examination, and disposition of human skeletal remains. This information is presented in sufficient detail to fully document the nature, extent, and condition of the archaeological assemblage.

ARTIFACT ASSEMBLAGE

Archaeological investigations at CA-MRN-44/H yielded a large assemblage of prehistoric materials including about 96,589 items and lots arranged among 771 catalogue numbers (Appendix A). These items include 667 pieces of baked clay, 353 flaked stone artifacts, 49 ground stone tools, 84 modified bone items, 58 modified shell items, 110 soils samples, approximately 95,062 unmodified bone fragments, 145 unmodified shell samples, and other miscellaneous items. It will be necessary to assign additional catalogue numbers to artifacts if soils samples are analyzed. The following discussion of artifactual items is organized by material type (e.g., bone, shell, stone), method of modification (e.g., chipped stone, ground stone), and by typological and functional classes.

Bone Artifacts

A total of 84 items of modified or worked bone artifacts was recovered. Fragments of polished, ground, and/or shaped tools represent most modified bone items. Complete bone items were scarce and limited to a few cannon bone awls. Classification of modified bone tools follows the conventions established by Gifford (1940) with some regional modifications developed by Bennyhoff (1953) and White et al. (2002). The CA-MRN-44/H collection is divided into six types including: awls (n=14), flat pins (n=12), pointed items (n=6), worked bone tubes (n=3), bone wedge (n=1), and miscellaneous modifications (n=32).

Awls

A total of 14 awls was collected (Figure 35, a-f). Two specimens (44-169 and -263) were complete enough to determine that the element and species of the bone is consistent with artiodactyl cannon bones (metapodials), most likely representing black tailed deer (*Odocoileus*

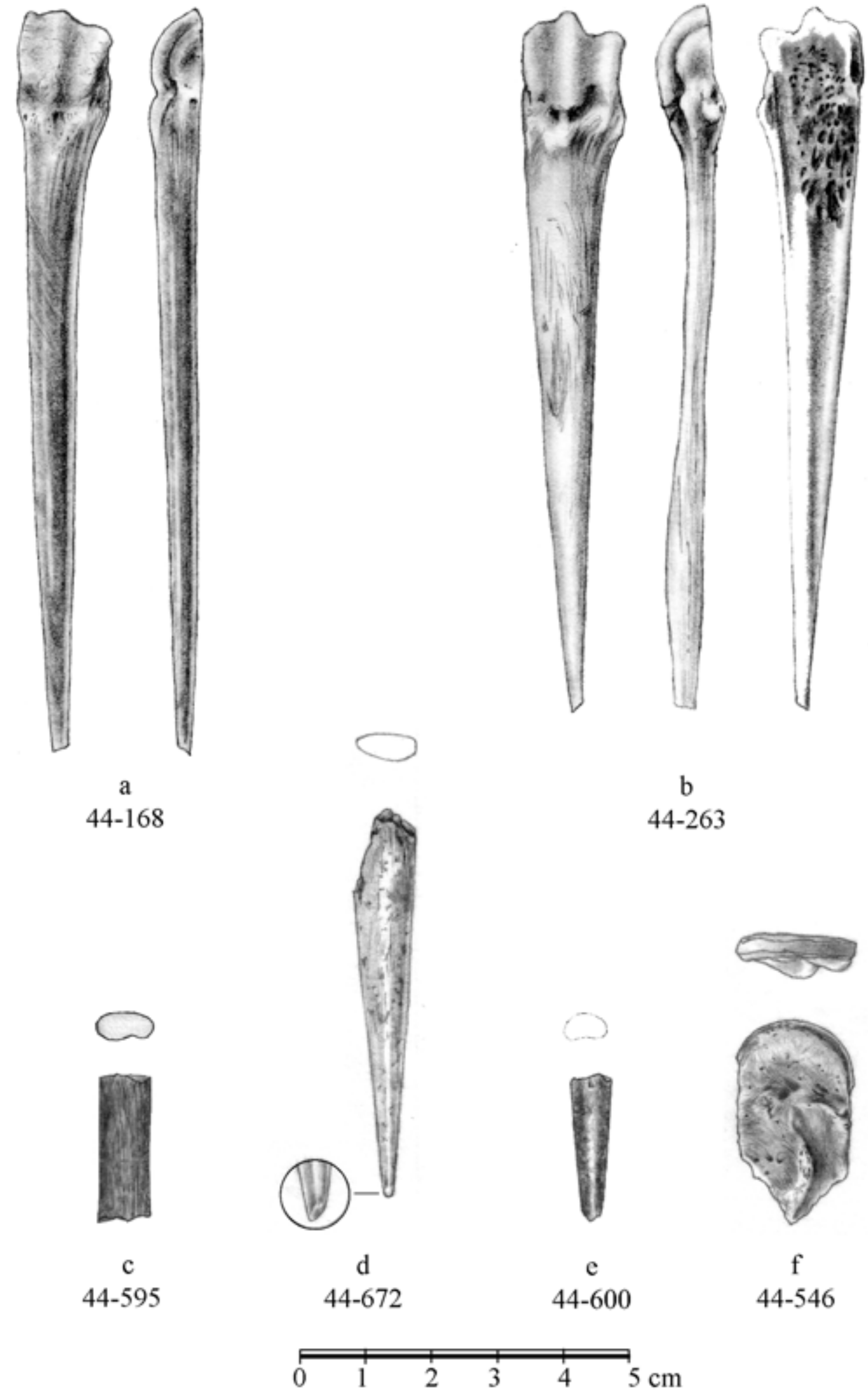


Figure 35. Bone Awls.

hemionus). The general size and shape of the cannon bone is also similar to pronghorn (*Antilocapra americana*). Seven specimens were represented by highly polished rounded mid-sections fragments of awl shaft (44-101, -347, -42, -431, -547, -595, -596) and four fragmentary specimens were represented by the pointed or distal end of the awl (44-47, -600, -626, -672). One fragment consists of a longitudinally split fragment of the round articular condyle representing the proximal end (44-546).

Awls are worked long bones that are carved, ground, split and polished along the shaft, have a blunt proximal end, and a sharp pointed distal end used for puncturing or piercing. They have a fine rounded tip, a tapered shaft with incised lines along its length, and are generally round to ovate in cross-section. Two-thirds of the awls present in the assemblage show signs of burning suggesting that heat alteration was part of the manufacturing process. The two types of awls, split metapodial and sulcus, indicate some variability in the method of manufacture.

Split Metapodial

These awls are manufactured by breaking the bone shaft along the axial plane into symmetrical medial and lateral halves along the intermedial groove (see Figure 35, a-b). Two complete or nearly complete specimens were split vertically and ground and shaped on all surfaces. The final form represents about one-quarter section of the original length of the shaft. Specimen 44-168 measured 112.2 millimeters long, 12.8 millimeters wide, and 6.2 millimeters thick at the handle. Specimen 44-263 measured 104.6 millimeters long, 15.0 millimeters wide, and 6.6 millimeters thick at the handle. Both items have extensive polish along two-thirds of the shaft from the tip.

Sulcus Awls

Two fragmentary sulcus awls were identified (44-595, -596). Sulcus awls are manufactured by splitting the metapodial along the medial plane to incorporate the intermedial groove or sulcus into the final artifact form (see Figure 35, c). These items are fully ground on all surfaces. Both specimens are midsections of the shaft, appear to be heat-treated or burnt, and have high degree of polish and wear.

Distribution

A potential pattern in the distribution of split metapodial and sulcus awls was present at CA-MRN-44/H. Split metapodial awls were recovered exclusively from Locus A (eastern shell midden), while sulcus awls were recovered from Locus B (western shell midden). In the north Central Valley sulcus awls have been found associated with Archaic deposits at CA-COL-247 and -158A (White et al. 2002:126). This is the predominate awl form in Upper Archaic deposits in the eastern Clear Lake basin (White et al. 2002:232-235).

Flat Pins

A total of 12 flat pins was collected (Figure 36, a-i). Pins are generally ground flat, polished, shaped items manufactured from large mammal long bone shafts. Insufficient evidence of the original bone is present to determine element or species. All specimens are fragmentary incomplete items. In contrast to bone awls, in which two-thirds of the specimens were burned, none of the flat pins show any sign of heat alteration. Figure 33 (see

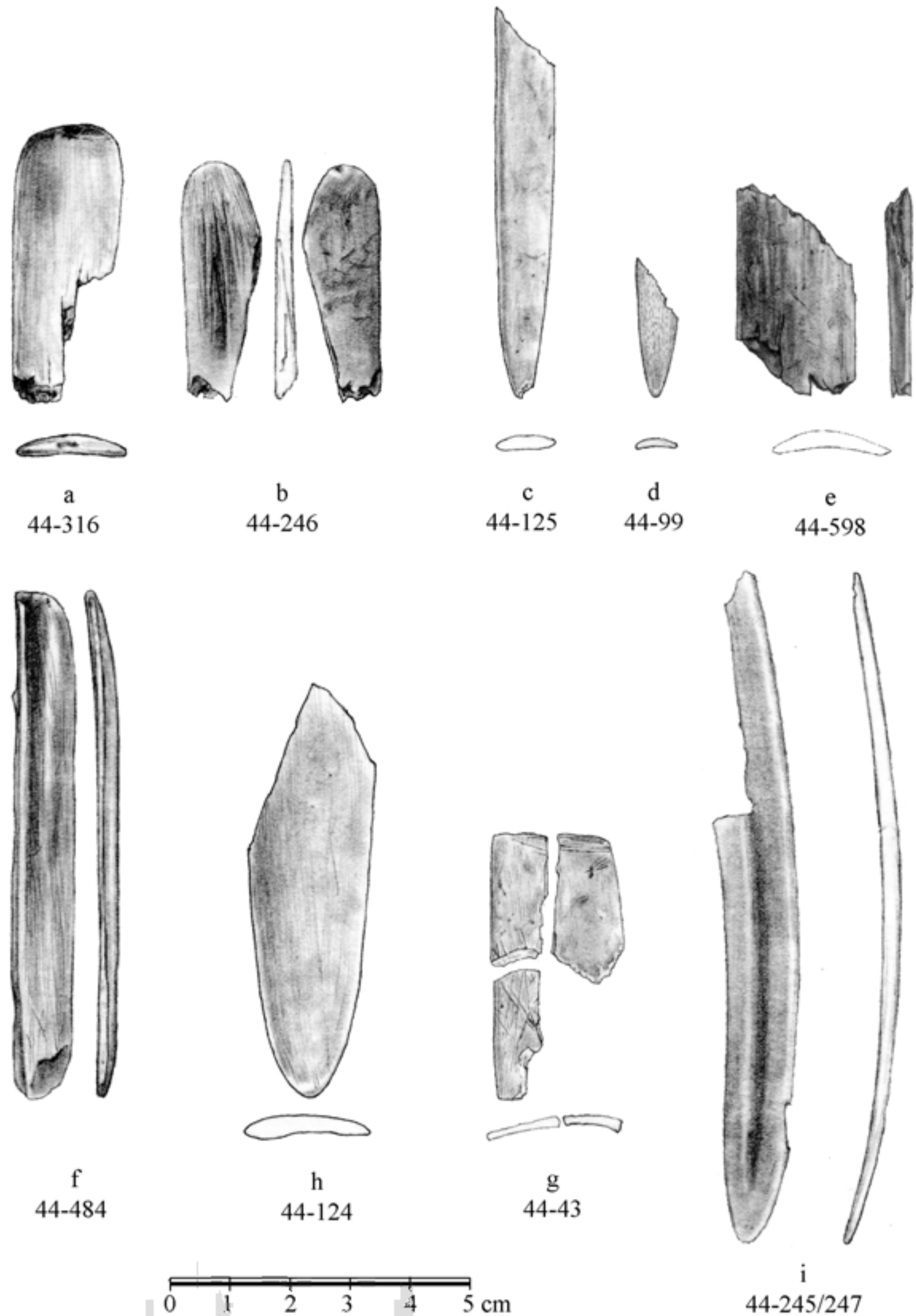


Figure 36. Bone Pins and Bone Spatula.

page 66) shows the size difference between flat pins in the CA-MRN-44/H assemblage. These may represent two morphological and/or function types large and small.

Small Flat Pins

A total of six small flat pins is present in the CA-MRN-44/H collection (44-99, -125, -246, -316, -484, -620) and probably represent hairpins. Small flat pins are generally flat, thin, delicate, ground, polished, and sometimes incised artifacts that have a tapering shaft and rounded tip. One side of the shaft is a convex surface and the opposite side is ground flat. Three specimens (44-246, -316, -484) are proximal end fragments. The proximal end is a rounded half ovate shape with a decorative laterally incised line near the end (see Figure 36, a-f). On average small pins are 1.9 millimeters thick and 13.2 millimeters wide. Small flat pins are similar to Gifford's (1940:174) P4 hairpin, which is described as a thin, elliptical transverse cross section with incised designs.

Large Flat Pins

Five items are described as large flat pins (44-43, -124, -317, -598, -646). In general, large flat pins are similar in form and manufacture to small pins. On average large pins are 3.4 millimeters in thickness and 18.5 millimeters wide (see Figure 36, g-h). These items are similar to what Gifford described as type E (1940:172) spatalate knife or scraper. Specimen 44-245/247 has a slight arching curve along the highly polished shaft and rounded thin tip. Specimen 44-646 is much larger in width than the rest of the collection and due to the fragmentary nature of this item it is unknown what function this item served.

Distribution

A total of eight flat bone pins was recovered between 70 and 180 centimeters in Locus A (44-43, -99, -124, -125, -245, -246, -316, -317, -484). Three flat bone pins were recovered from Locus B (44-598, -620, -646).

Pointed Items

A total of six pointed items was collected (Figure 37, a-b). These include three ray caudal spines, two bone needles, and one *Pinnipedia* whisker probably from a California sea lion (*Zalophus californianus*).

Caudal Spines

Three bat ray (*Myliobatis californica*) caudal spines (44-265, -390, -639) were recovered at CA-MRN-44/H. Caudal spines are a sharp barbed bone found at the base of the whip like tail. These spines are venomous and can cause serious injury. One specimen 44-390 has been fashioned into a polished needle with the spines removed from the shaft of the spine. This item is similar to Gifford's (1940:170) type A5a Stingray spine. The other two specimens 44-265 and 44-639 show no clear signs of modification. The only complete specimen (44-265) measures 68.0 millimeters long, 6.1 millimeters wide, and 3.6 millimeters thick. Gifford (1940:170) notes that unworked caudal spines are common in the bay region. Similar artifacts are documented at nearby sites including CA-MRN-254 (Bieling 1998:97) and at CA-MRN-17 (Pahl 2003).

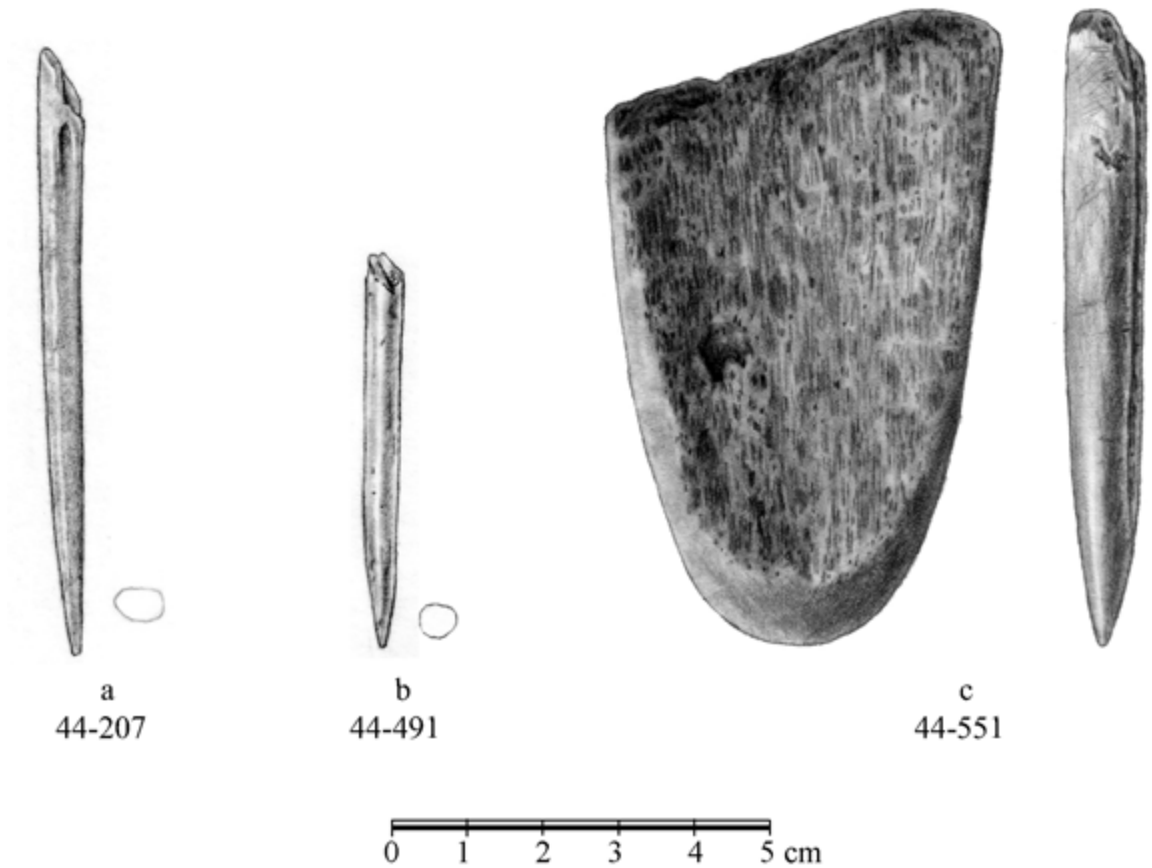


Figure 37. Bone Needles and Wedge.

Bone Needles

Two specimens (44-207, -419) are bone needles. These items appear roughly cylindrical in cross section with a tapering shaft that has a sharp pointed end used for puncturing or perforation (Figure 37, a-b). Both items represent the distal or working end of the needle. Both are manufactured from a split, ground and polished large mammal long bone shaft. The proximal end is missing on these specimens and it is unknown whether they had a perforated end for threading material. The needles are 4.1 millimeters and 4.7 millimeters thick at the mid-shaft and have a fine pointed tip less than 1 millimeter in diameter. Gifford (1940:174) described a similar object as a type P3a eyed needle less than 200 millimeters long, conical near the tip and relatively flat at the proximal end with small eye.

Whisker

One specimen 44-492 appears to represent a whisker from a California sea lion (*Zalophus californianus*). This item measures 78.7 millimeters long and 2.7 millimeters thick. It has a slight polish along the shaft. This item may have served as a needle or some other purpose.

Distribution

A total of five pointed bone items was recovered from Locus A (44-207, -265, -390, -491, -492). One specimen (44-639) was recovered from Locus B in S0/W5, 170-180 centimeters.

Worked Bone Tubes

Three bird bone tubes were classified as artifacts (Figure 38, e). Specimen 44-493 is manufactured from large sized bird ulna as indicated by papillae present on the shaft. This fragmentary specimen shows that the ulna was cut horizontal to the mid shaft and is edge ground. A series of fine decorative incised lines are present near the cut end. The exterior of the bone has a moderately well-developed polish and a series of scratched striations parallel to the shaft. Specimen 44-216 is from a small sized bird. This artifact appears similar to a tibiotarsus shaft as indicated by its roughly triangular cross section and presence of the cnemial crest. This fragmentary mid-shaft exhibits a slight polish and evidence of heat alteration. Specimen 44-494 is a small, unburnt fragment of a cut, ground, and incised bird bone tube. Two parallel-incised lines are present perpendicular to the shaft near the ground end. Bird bone tubes are a widespread morphological type in Central California that are commonly interpreted as whistles, beads, or ear ornaments (Bennyhoff 1953; Gifford 1940).

Distribution

All bird bone tube specimens were collected from Locus A. Two specimens (44-493, -494) were found in unit S1/W1 at the 160-170-centimeter level. One specimen was recovered in S1/W1 at the 120-130-centimeter level.

Bone Wedge

One bone wedge was recovered (see Figure 37, c). Specimen 44-551 consists of the distal end of a carved and polished bone artifact with a tapered small flat sharp beveled end and rounded sides. The proximal end of the item is missing. The artifact appears to be manufactured from a very large sea mammal long bone or rib bone possibly derived from a harbor seal (*Phoca vitulina*) or whale. The exterior polished portion of the artifact is hard cortical bone and the interior is spongy, porous, light-weight cancelleous bone. This artifact is similar to bone wedges described by Gifford as type D6 (Gifford 1940:171). Gifford notes that the differentiation of wedges from chisels or scrapers is difficult and that the general size range of these artifacts likely correlates with coarse and fine work (Gifford 1940:171).

Distribution

This specimen was recovered during salvage screening of soils exposed from Trench 13 in Locus C at a depth of 500-550 centimeters below surface.

Miscellaneous Modifications

A total of 32 items was classified as miscellaneous modified bones (Figure 38, a-d, f). This general category includes 14 fragmentary polished bones, 10 butchered bones, and eight fish vertebra with central perforations.

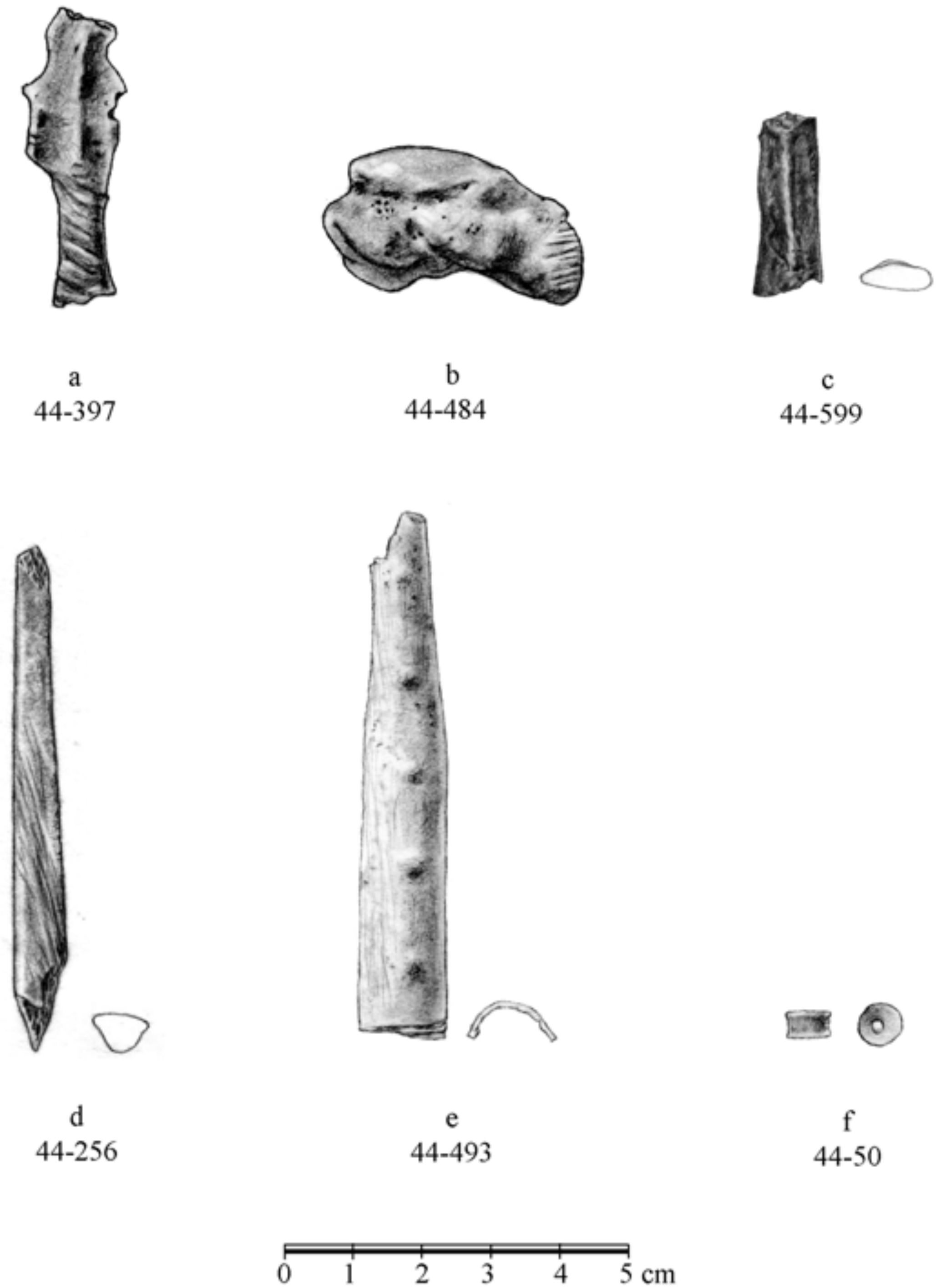


Figure 38. Butchered and Polished Bone, Bird Bone Tube, and Perforated Fish Vertebra.

Fragmentary Polished Bone

All 14 items are included in this category show some signs of polish or burnishing due to intentional shaping or use wear (Figure 38, c). Eleven specimens represent small fragmentary portions of formal bone tools (44-13, -45, -82, -163, -234, -318, -391, -482,

-548, -549, -599). Insufficient remains are present to identify these specimens to a more specific category. Specimens 44-548 and 44-549 are highly polished long bones with a cluster of fine striations parallel to the shaft. These items were not classified as awls or needles due to the unusual crescent shape of the shaft cross-section.

Butchered Bone

Twelve faunal specimens show evidence of butchering (44-12, -255, -256, -268, -397, -398, -481, -544, -555). Seven of these items show incised lines as part of the process of disarticulating the skeleton. Specimen 44-397 is the synsacral thoracic and sacral vertebra of a medium to large sized bird. This element has eight deeply cut parallel incisions at about a 45-degree angle to the axial plane cut into the anterior surface of the sacral vertebra. The incisions appear as back and forth sawing motion on the bone (see Figure 38, a). Specimen 44-481 is a complete medium to medium-large size terrestrial mammal talus bone with eight fine parallel cuts on the anterior head that articulates with the navicular. The remaining butchered bone consists of relatively incidental small cuts and marks on small fragmentary bone (see Figure 38, b).

Fish Vertebra with Perforation

Eight specimens were catalogued as possibly representing fish bone beads (see Figure 38, f). These items consist of six large salmon or steelhead (*Oncorhynchus* sp.) vertebrae that have a small perforation through the center (44-49, -51, -134, -254, -330, -455). Two small possible beads (44-50, -336) are from an unidentified species of small fish. It is unclear whether the center hole is a natural phenomena or was intentionally modified to facilitate stringing materials through the vertebra.

Distribution

Locus A had the majority of modified bone items recovered from the site. A total of 24 unidentified modified bone items was collected from Locus A (44-12, -23, -45, -49, -50, -51, -82, -134, -163, -234, -254, -255, -256, -268, -318, -330, -336, -391, -397, -398, -400, -455, -481, -482). Four specimens (44-599, -627, -630, -634) were recovered from Locus B and four specimens (44-544, -548, -549, -550) were recovered from Locus C.

Shell Artifacts

A total of 27 modified shell artifacts was collected from CA-MRN-44/H. Shell artifacts described in the following sections were recovered from controlled and non-controlled proveniences. These items have been divided into five categories including *Olivella* beads (n=5), *Haliotis* ornaments and pendants (n=11), *Mytilus* pendants (n=7), *Siliqua* ornament (n=1), and J-shaped fishhooks (n=3).

Olivella *Beads*

Classification, description, and typological assignment of *Olivella* beads were completed in reference to *Shell Bead and Ornament Exchange Networks Between California and the Western Great Basin* (Bennyhoff and Hughes 1987). Four basic types of *Olivella* beads were collected (Figure 39, h-l). All five *Olivella* beads were recovered from controlled contexts within the eastern shell midden of Locus A between 90 and 180 centimeters.

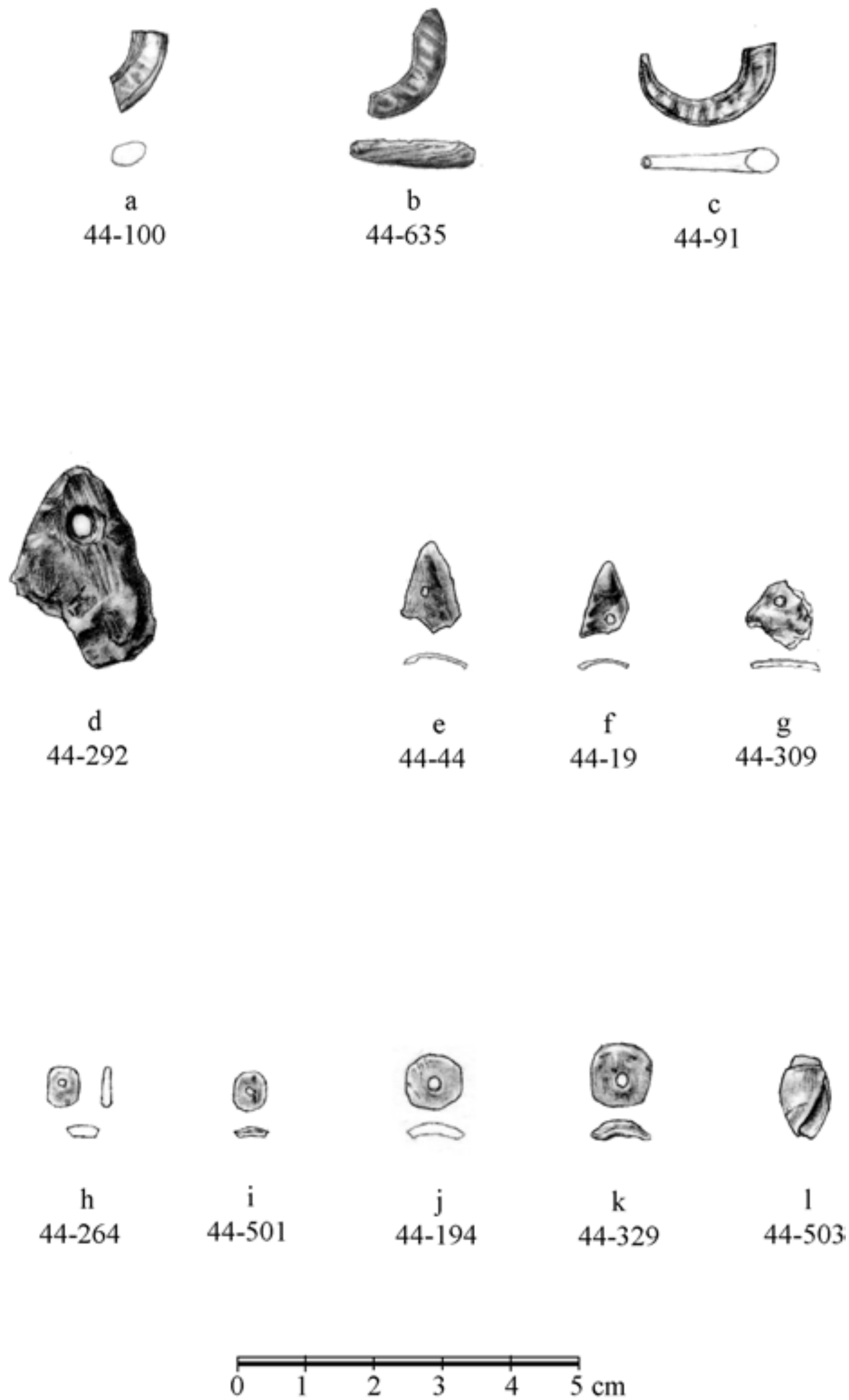


Figure 39. *Mytilus* Fishhooks, *Mytilus* Pendants, and *Olivella* Beads.

Specimen 44-503 is a complete type A1b *Olivella biplicata* simple spire-lopped (see Figure 39, l). Breaking or grinding removed the tip of the spire. This item has no additional modifications to the shape. The specimen measures 11.5 millimeters long, 8.8 millimeters wide, and 6.2 millimeters thick. Bennyhoff and Hughes (1987:119) note that medium sized spire-lopped A1b beads are poor temporal indicators and occur during any period.

Specimens 44-194 and 44-329 fit within the F3a series of Square Saddle beads (see Figure 39, h-i). These roughly square beads have a small central drilled conical perforation and rounded corners. Specimen 44-194 measures 7.9 millimeters long, 7.4 millimeters wide, and 1.7 millimeters thick with a 1.7-millimeter diameter hole. Specimen 44-329 is slightly larger and measures 8.4 millimeters long, 8.1 millimeters wide, 1.3 millimeters thick, with a 2.0-millimeter diameter hole. Bennyhoff and Hughes (1987:131) argued that F3a series Square Saddle beads are a marker of the terminal and late phases of the Middle period, that they continued to be used into the Middle/Late period Transition, and that the F3a series is thought to be ancestral to the type M1 Rectangles of the Late Period.

Specimens 44-264 and 44-501 are F3b series Small Saddle beads (see Figure 39, j-k). These are smaller versions of the F3a series and have a similar appearance. Specimen 44-264 measures 5.7 millimeters long, 4.4 millimeters wide, 1.6 millimeters thick, and has a hole 0.9 millimeters in diameter. Specimen 44-501 measures 5.4 millimeters long, 4.6 millimeters wide, 1.2 millimeters thick, and has a center hole 1.1 millimeters in diameter. The F3b series small saddle beads most commonly occur during the Late and Terminal phases of the Middle period (Bennyhoff and Hughes 1987:132). Recent reevaluation of *Olivella* beads by Groza (2002) included radiometric dating using the Accelerated Mass Spectrometer (AMS) method and resulted in the formation of an improved dating scheme for the Alameda District cultural assemblage sequence. Groza's Scheme D indicates that F3a and F3b series beads only co-occur during the Terminal Middle Period and Late Middle Periods between cal AD 575-1010 (Groza 2002:Figure 6). This time range is an excellent match with the six AMS dates between cal AD 530-1030 derived from cultural features in Locus A at CA-MRN-44/H.

All five *Olivella* beads were recovered from Locus A. Specimen 44-194 was collected from S1/W1 at 100-110 centimeters. Specimen 44-264 was found in S1/W1 at 160-170 centimeters. Specimen 44-329 was found at S2/W1 at 90-100 centimeters. Specimen 44-501 was found in S2/W0 at 170-180 centimeters. Specimen 503 was found associated with Feature 10 a large rock fire hearth. This item was recovered from S2/W0 at 120-130 centimeters.

Haliotis *Shell Ornaments and Pendants*

Classification and typological assignment of *Haliotis* ornaments were completed using *California Shell Artifacts* (Gifford 1947). Five basic types of *Haliotis* pendants were identified in the CA-MRN-44/H collection (Figure 40, a, c-f).

AF Teardrop-shaped Pendants

Three specimens are type AF Teardrop-Shaped *Haliotis* pendants and include one fragmentary and two nearly complete specimens (Figure 40, d-f). All type AF pendants (44-179, -191, -483) are manufactured from red abalone (*Haliotis rufescens*) and portions of the reddish exterior are still present. These pendants are long, flat, teardrop or pear shape in

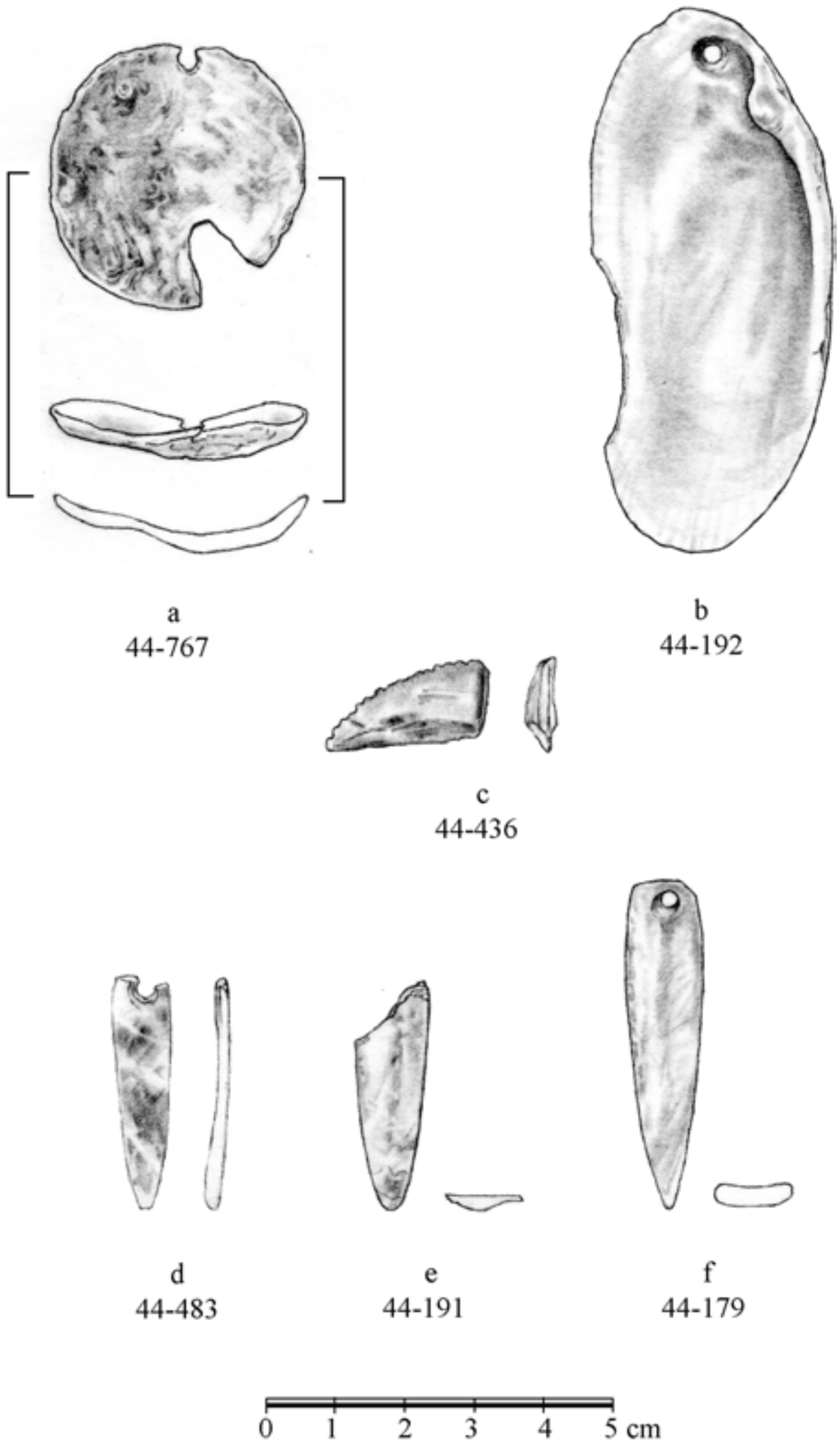


Figure 40. *Haliotis* Pendants and Ornaments and *Siliqua* Pendant.

outline, and have ground edges and a small bi-conically drilled perforation at the wide proximal end (Gifford 1947:40). Specimen 44-179 measures 45.7 millimeters long, 10.2 millimeters wide, 2.6 millimeters thick and has a perforation 1.9 millimeters in diameter. Specimen 44-483 measures 33.8 millimeters long, 8.3 millimeters wide, 2.0 millimeters thick, and has a perforation 3.3 millimeters in diameter. Complete specimens show considerable differentiation in size, with an average length of 33.7 millimeters, 9.2 millimeters wide, 2.3 millimeters thick and a perforation 2.6 millimeters.

All three AF type pendants were found in Locus A between 90 and 160 centimeters.

AP **Haliotis** *Crescents*

Two specimens (44-615, -633) are type AP *Haliotis* Crescents. These artifacts were most likely manufactured from red abalone (*Haliotis rufescens*) by curving the rim end of the shell adjacent the whorl (Gifford 1947:42). Specimen 44-615 consists of eight fragments of a single crescent that measure about 155 millimeters long by about 9.5 millimeters wide, by 3.5 millimeters thick. Specimen 44-633 is a small mid-section of a crescent in two pieces measuring about 26.0 millimeters long, 5.5 millimeters wide, and 3.1 millimeters thick.

Both specimens were recovered from controlled exactions in Locus B at a depth of 150-170 centimeters.

K Perforated **Haliotis** *Disk*

One specimen was categorized as a type K Perforated Disk (see Figure 40, a; Gifford 1947:15). This ornament (44-767) is nearly circular in outline has a shallow concave cross-section, is ground along the edges, and has two “U” shaped perforations along the edge. The item was manufactured from red abalone (*Haliotis rufescens*) as is indicated by the reddish exterior of the shell present on one side.

This specimen was recovered from Locus C from spoils excavated in exploratory backhoe Trench 13, at a depth of 4.8 to 5.5 meters below surface. Radiometric dating of the specimen using the AMS method returned a Conventional Age of 1350 ± 40 (cal AD 1190 to 1330) and an intercept of cal BP 670 (Appendix F, Beta-218548).

K8b **Haliotis** *Incised Edge*

One specimen (44-436) is a type K8b *Haliotis* Incised Edge (see Figure 40, c; Gifford 1947:18). This fragmentary specimen represents about one-eight of the complete original ornament and was manufactured from red abalone (*Haliotis rufescens*) as is indicated by the reddish exterior of the shell. The outline of this ornament is circular in shape, flat in cross-section, and characterized by a series of 28 fine incisions along the rim, which create a fine serrated edge. The complete item would have probably measured about 200 millimeters in diameter.

This specimen was recovered during controlled excavations of Locus A in S2/W0 at 80-90 centimeters.

L Oval **Haliotis** *Ornament*

One specimen (44-495) is a type L Oval *Haliotis* Ornament (Gifford 1947:19). This complete specimen was manufactured from black abalone (*Haliotis cracherodii*) as is indicated by the dark blackish exterior of the shell (see Figure 40, a). The outline of this item is an irregular pear shape that is flat, smooth in cross-section, and measures 21.5 millimeters long, 12.8 millimeters wide, by 2.0 millimeters thick.

This specimen was recovered during controlled excavations of Locus A in S2/W0 at 160-170 centimeters.

Unidentified **Haliotis**

Three specimens are fragmentary unidentifiable pieces of *Haliotis* spp. shell that probably represent pieces of ornaments or pendants. One specimen (44-632) is a large thick piece of the whorl body weighting more than 8.6 grams.

Specimen 44-632 was recovered during controlled excavations in Locus B in S0/W4 at 160-170 centimeters. Two pieces (44-604, -605) were found in soils excavated during exploratory backhoe trenching of Locus C, Trench 13 about 500-550 centimeters below surface.

Mytilus *Pendants*

A total of seven perforated *Mytilus* shells was collected (see Figure 39, d-g). These include four bay mussels (*Mytilus trossulus*) and three Pacific mussels (*Mytilus californianus*). Bay mussels are characterized by a long thin shell and inhabit the inter-tidal areas around rocks. Four fragmentary specimens were recovered (44-19, -44, -309, -454) that appear to have been modified (see Figure 39, e-g). These are burnt a dark gray color and have a small perforation drilled in the body of the shell near the hinge presumably to hang the object. Specimens 44-53, -193, and -292 are Pacific mussels that have been drilled through the shell. Pacific mussels are characterized by their thick shell and large size, and are found in active inter-tidal areas on rocks. Specimen 44-292 is a fragment representing about one-third the original size. It has a biconical perforation near the hinge, extensive grinding on the exterior surface, and has been turned a dark gray by heat (see Figure 39, d). The perforation measures 4.0 millimeters in diameter. Two specimens (44-53, --193) are large pieces of Pacific mussel with small fine uniconical perforations in the body of the shell. It is unclear whether these items are the result of natural or cultural processes and have been included in this category due to the scarcity of these items in the assemblage.

Siliqua *Ornament*

One specimen (44-192) is a near complete Pacific razor clam (*Siliqua patula*) with an uniconically drilled hole near the hinge (see Figure 40, b). This shell is a large, elongated, oblong shape, with a relatively thin shell and light pink iridescent appearance. The item measures 77.1 millimeters long, 43.1 millimeters wide, about 2.4 millimeters thick and has a hole 2.4 millimeters in diameter. Specimen 44-192 was recovered from Locus A, S1/W1, at 100-110 centimeters.

J-Shaped Fishhooks

Three specimens (44-91, -100, -635) are J-shaped fishhooks (see Figure 39, a-c). Similar items are described by Gifford (1940:44) as type AT2aI *Mytilus californianus* fishhooks. All three of the CA-MRN-44/H fishhooks are manufactured from the body of *Mytilus californianus* shell, ground into a flat cross-section and beveled along the edges. The shank of the hook is present on one specimen (44-91) and appears as a sharp tapering tip forming a nearly complete crescent. This item measures 22.2 millimeters wide and 3.7

millimeters thick. Specimens 44-100 and 44-635 are midsections of the shaft. The average thickness of the body of all fishhooks is 2.8 millimeters. The proximal end that would connect to the line is missing on all three specimens.

Two fishhooks (44-91, -100) were recovered from Locus A, S1/W0, 130-140 centimeters and 140-150 centimeters. Specimen 44-635 was recovered from Locus B, S0/W4, 170-180 centimeters.

Chipped Stone

Flake stone artifacts comprise a significant category of materials recovered from CA-MRN-44. Excavations and surface collections yielded a total of 351 flaked stone artifacts. Flaking debris or debitage composed over 84% of the total flaked stone assemblage. The flaked stone is divided into five general classes including debitage, projectile points, bifaces, simple flake tools, and cores. The assemblage includes 295 individual pieces of debitage, including 40 projectile points and fragments, 12 bifaces, 1 simple flake tool, and 3 cores. The analysis presented below includes artifacts collected during the monitoring and excavation stages of fieldwork.

Projectile Points

Chipped stone items with diagnostic haft elements such as stems, notches, or shoulders are classifiable as points. A total of 28 stylistically diagnostic projectile points and 12 fragmentary projectile points was recovered. Fragmentary points are discussed in the biface analysis section. All diagnostic points recovered from the site were manufactured from obsidian (Napa Valley n=21; Annadel n=3; unidentified n=4). As all the points present in the assemblage represent just two typological series, special attention was directed at segregating specimens into variants or subtypes. The classification of projectile points used here followed White et al. (2002:221-222, 228-234). Classification of all non-stemmed, non-concave-based point forms were based on a simple thickness/width (T/W) ratio. Specimens with T/W ratios >0.43 (thickness less than 43% of width) was classified as "Thick Leaf Series" (Fredrickson and White 1988) and specimens with T/W ratios <0.43 was representative of "Excelsior Foliate Series."

Thick Leaf Series

This typological series is a provisional morphological classification based on evidence of temporal and geographic differences with Excelsior Foliate Series points found elsewhere in northern California (White 1984, 1988). Leaf Shaped Series points are non-stemmed, non-concave-based forms that have a maximum thickness >43.5% of the maximum width (White et al. 2002:228). This series has been subdivided into two variants: "Copsey Bipoint" (Fredrickson 1961: Type 5 and 5A) and "large thick-leaf" (White et al. 2002:228). The distinguishing characteristics of large thick-leaf points include T/W >0.43 ratio and maximum width blade (WBLD) <19.5 millimeters.

A total of five Thick Leaf Series points was collected from CA-MRN-44/H (44-323, -565, -566, -567, -569). Although just 17.8% of all projectile points collected at the site showed signs of weathering, a relatively high proportion (n=3, 60%) of Thick Leaf Series specimens had extensive weathering on the surface of the artifact. The presence of a weathered patina on Thick Leaf Series points suggests more significant antiquity of these items. All points in this class were manufactured from obsidian (Napa n=3, Annadel n=1, unidentified n=1). The average obsidian hydration for Thick Leaf Series points is 2.3 microns (n=4) on Napa obsidian.

Thick Leaf subtype. A total of three specimens (44-566, -567, -569) had a T/W ratio <0.43 and WBLD ¬19.5 millimeters, distinguishing them as falling within the Thick Leaf subtype (Figure 41). Thick Leaf subtype points present in the collection have a mean T/W ratio of 0.50 and an average WBLD of 17.1 millimeters. These points are roughly symmetrical in outline, have an uniform profile, and exhibit a regular flaking pattern. One complete specimen (44-569) measured 49.0 millimeters long.

Copsey Bipoint subtype. Two specimens (44-323 and 44-565) had a T/W ratio >0.43 and WBLD >19.5 millimeters identifying them as Copsey Bipoints (White et al. 2002:229; Figure 41). Copsey Bipoints in the collection have a mean T/W ratio of 0.32 and an average WBLD of 20.7 millimeters. These points are relatively symmetrical in outline, have a uniform profile, and exhibit an irregular flaking pattern. One complete specimen (44-323) measured 58.3 millimeters long.

Distribution. The vast majority of Thick Leaf Series points (80%, n=4) were recovered from Locus C, Trench 13, at a depth of 4.9-5.4 meters below surface (44-565, -566, -567, -569). One specimen (44-323) was recovered from Locus A, S2/W1, 80-90 centimeters.

Excelsior Foliate Series

Excelsior points are defined as non-stemmed points with a T/W <0.43, are shouldered or non-shouldered, possess a flat, concave, or convex blade, have fine dentate or rough lobed serrations on the blade, and have a round, square, or pointed base. The Excelsior typological series was first proposed by Fredrickson (1973).

> The defining characteristics of the Excelsior point are a triangular, straight-edged body and convex base, which is frequently ogive in outline; that is, it resembles a pointed arch. A frequent but not necessary attribute of the Excelsior series point is the presence of a definite shoulder at the junction of the body and base. This shoulder may be further marked by an abrupt broadening of the specimen as the body terminates and the base begins. Point types falling within the Excelsior series are distinguished on the basis of other attributes, such as serrated or denticulate edge, and relative breath and length. [Fredrickson 1973:199]

Other researchers have noted that Excelsior series points are the predominant point type in the north coast region and possess the greatest time depth in the region of the Clear Lake basin, and south through Napa, southern Sonoma, and Marin Counties (e.g., Heizer 1953; Jackson 1978; Origer 1982). Until relatively recently, Excelsior points were a poor temporal indicator due to their prolonged duration of use and seemingly homogeneous morphology. More recent studies on Excelsior points offer evidence for morphological change, chronology, and distribution. Researchers have pointed out that average length of shouldered Excelsior series points tended to decrease over time (Basgall 1993:183-187; Baumhoff 1985:177; White and Fredrickson 1992). At Anderson Flat in Clear Lake, Excelsior Shouldered Bipoints (Type A) and Shouldered Leaf-shaped (Type B) are the predominant from 3200 to 2600 BP. These subtypes are replaced by Non-shouldered

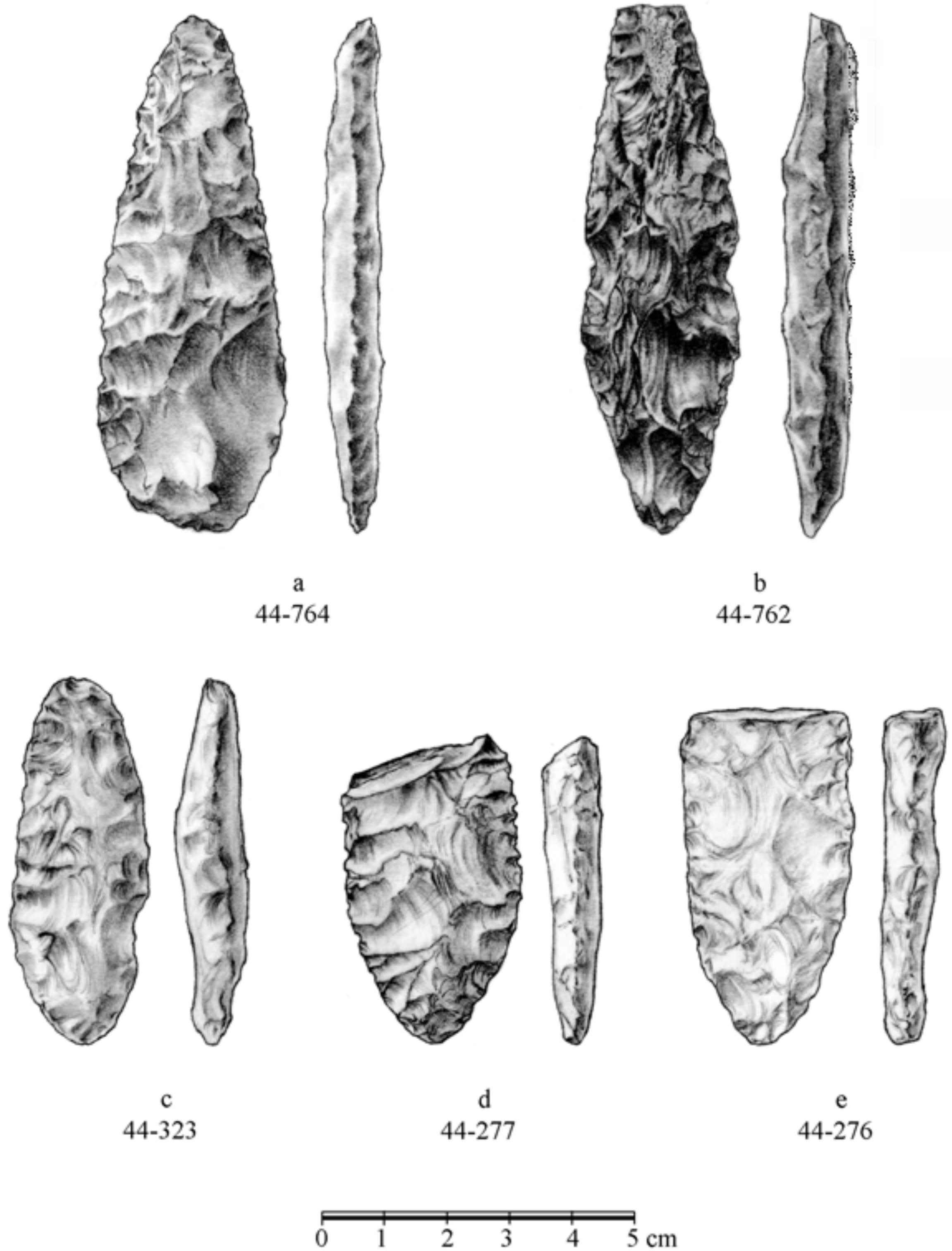


Figure 41. Excelsior Series and Leaf Shape Series Projectile Points.

Bipoint (Type C) and Leaf-shaped (Type D) between 1900 and 1200 BP (White et al. 2002:453). At Warm Springs/Lake Sonoma, Excelsior points came into use after approximately 2500 BP and were in general use through the late prehistoric (Basgall 1993). Similar findings have been reported in the Santa Rosa area (Origer 1982). On the Mendocino coast, Excelsior points appear to date to more recent than 2200 BP (Layton 1990). At the Dominican College site (CA-MRN-254) Excelsior points were present beginning 1800 BP (Bieling 1998:99). Excelsior points are also reported at the Pacheco site (CA-MRN-152) in Middle and Late Period components (Goerke and Cowan 1983).

A total of 22 Excelsior Foliate Series points was collected at CA-MRN-44/H (Figure 42). Excelsior Foliate Series points were segregated into any of four morphological subtypes based on size class, morphological variants, and type of serration on the blade edge (White et al. 2002:222, 230-234, 236). Three specimens were categorized as (Type B) Shouldered Leaf-shaped (44-41, -277, and -518). Eight points were classified as (Type C) Non-shouldered Bipoints (44-276, -444, -556, -559, -561, -564, -559, -568, and -628). Six points were categorized as (Type D) Leaf-shaped (44-303, -381, -670, -762, -764, and -765). Five points were bipointed but the shoulder was missing to completely classify the type (44-3, -42, -274, -445, and -641). One specimen (44-617) held insufficient characteristics to classify its type.

The majority of Excelsior Foliate Series points (41.6%, n=10) were recovered from Locus A (44-3, -41, -42, -274, -276, -277, -303, -381, -444 and -445). Four specimens were recovered from Locus B (44-518, -617, -628, and -641) and nine specimens were recovered from Locus C (44-556, -559, -561, -564, -568, -762, -764, and -765).

Table 4 presents a summary of the obsidian hydration rim values per size class of Excelsior points. The intention of this table was to determine if the width of the blade (WBLD) of Excelsior points correlates with an increase or decrease in obsidian hydration rim values. No morphological change in size relative to obsidian hydration rim values is indicated in the table. At CA-MRN-44/H Excelsior points of various sizes appear to have been in use during roughly the same time period and size class does not appear to be a good indicator for segregating Excelsior points into chronological order.

Table 5 presents a summary of the obsidian hydration rim values per variant type of Excelsior point. This table was generated to determine if the morphological shape of Excelsior points correlates with an increase or decrease of obsidian hydration rim values. No Shouldered Bipoint (Type A) Excelsior Variants were recovered. The table indicates that non-shouldered Bipoints (Type B) have a small obsidian hydration rim value (1.8 microns) relative to other types in the sample. Superficially, this pattern may indicate that the Non-shouldered Bipoint variant (Type C) post-dates both Shouldered Leaf-shaped (Type B) and Leaf-shaped (Type D). The present data set is small and future research with a large regional data set is necessary to properly test this pattern.

Bifaces

A total of 24 biface fragments was recovered. Half of these bifaces appear to be projectile point fragments. Projectile point fragments are included in the biface category due to the lack of stylistically diagnostic elements, such as the hafting elements or base. Appendix B provides metrical, source, provenience, and hydration data for all bifaces in the collection.

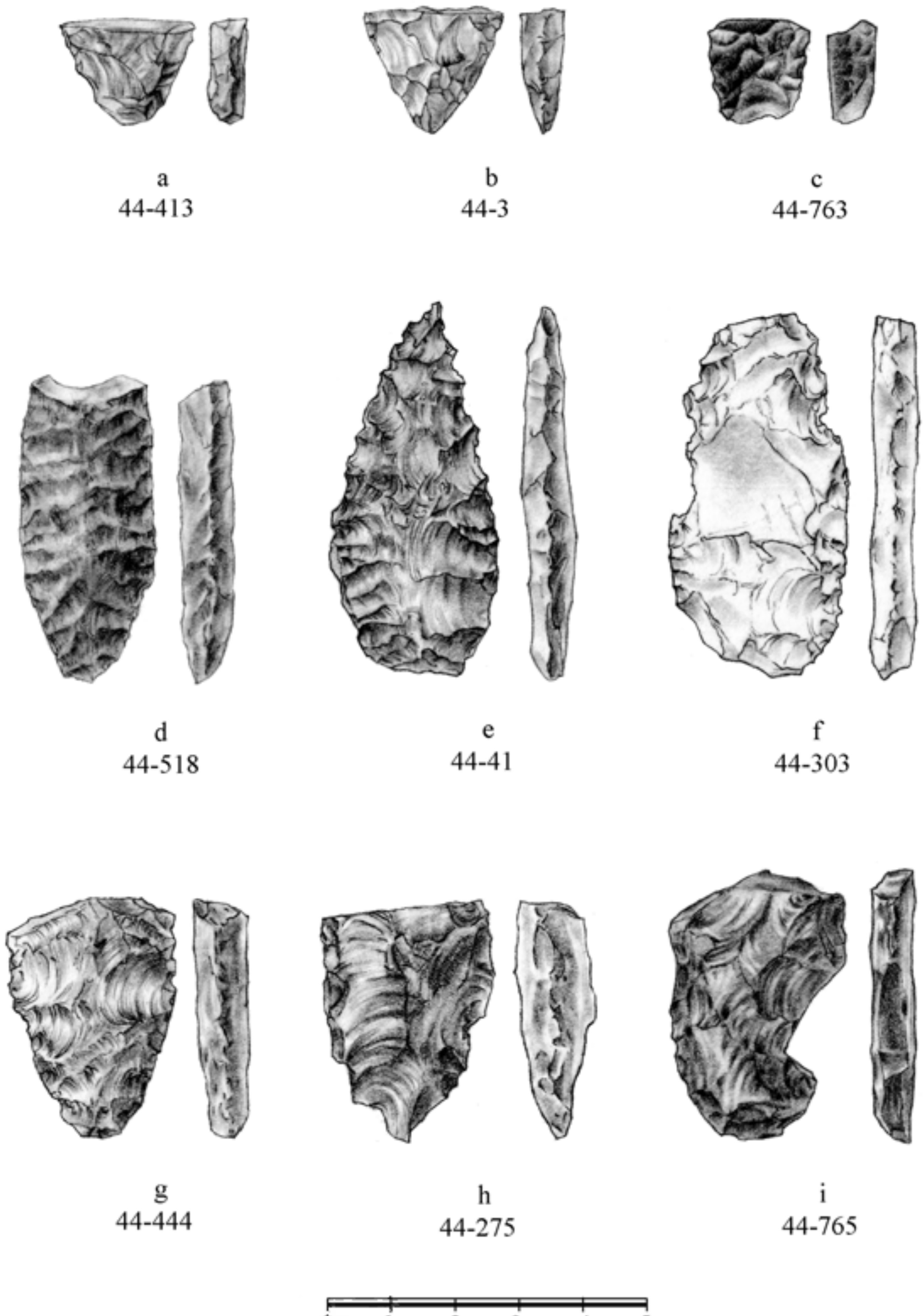


Figure 42. Excelsior Series and Shoulder-notched Projectile Points.

Table 4. Excelsior Size Class and Obsidian Hydration Summary.

SIZE CLASS	MEAN HYDRATION	RANGE	SD	N
Class 1 (<20 mm WBLD)	2.0	1.7-2.3	0.8	3
Class 2 (>20->26 mm WBLD)	2.1	1.1-3.5	0.7	8
Class 3 (>26-<28 mm WBLD)	2.3	1.4-2.8	0.8	4
Class 4 (>28 mm WBLD)	2.1	2.1	0	1

Notes: WBLD – Width of Blade; Hydration and Range in microns; SD – Standard deviation; N – Number.

Table 5. Excelsior Variants and Obsidian Hydration Summary.

VARIANT	MEAN HYDRATION	RANGE	SD	N
Shouldered Bipoint (Type A)	NA	NA	NA	NA
Shouldered Leaf-shaped (Type B)	2.9	2.4-3.5	1.0	3
Non-shouldered Bipoint (Type C)	1.8	1.1-2.8	1.1	5
Leaf-shaped (Type D)	2.5	1.4-2.9	1	6
Bipoint (Missing shoulder)	2.5	1.6-3.8	1.1	6

Notes: Hydration and Range in microns; SD – Standard deviation; N – Number.

Projectile Point Fragments

Twelve specimens are identified as possible projectile point fragments based on the degree of chipping (e.g., greater than three flake scars per centimeter) and greater symmetry of form (Figure 43). All of the 12 specimens are obsidian. These include three tips (44-273, -437, -555), six midsections (44-413, -525, -558, -563, -592, and -763), and three margins (44-14, -414, -601). Four specimens exhibit impact scars perpendicular to the margin (44-14, -273, -592, -601). One specimen is broken bipolar (44-414). Cortex was not present on any of the specimens. All of these specimens are Stage Four bifaces having symmetrical forms, parallel or controlled pressure flaking along the entire margin, and a highly regularized outline. Projectile point fragments recovered from CA-MRN-44/H have an average thickness of 6.3 millimeters, ranging from 4.2 to 11.6 millimeters (SD 0.92). This average was significantly lower than the bifacial tools. Geological source determination performed on 12 of these specimens identified the following sources: Napa (n=11) and Annadel (n=1). Obsidian hydration measurements (n=13) taken on projectile point fragments ranged from 1.5 to 4.8 microns, with a mean of 2.9 microns. Multiple hydration bands were indicated on three specimens (44-14, -414, -558) possibly indicating scavenging of obsidian from earlier site components.

A total of five projectile point fragments was found in association with the shell midden area of Locus A (44-14, -273, -413, -414, -437). All of these specimens were recovered from the first 90 centimeters below surface. This number constitutes nearly half of

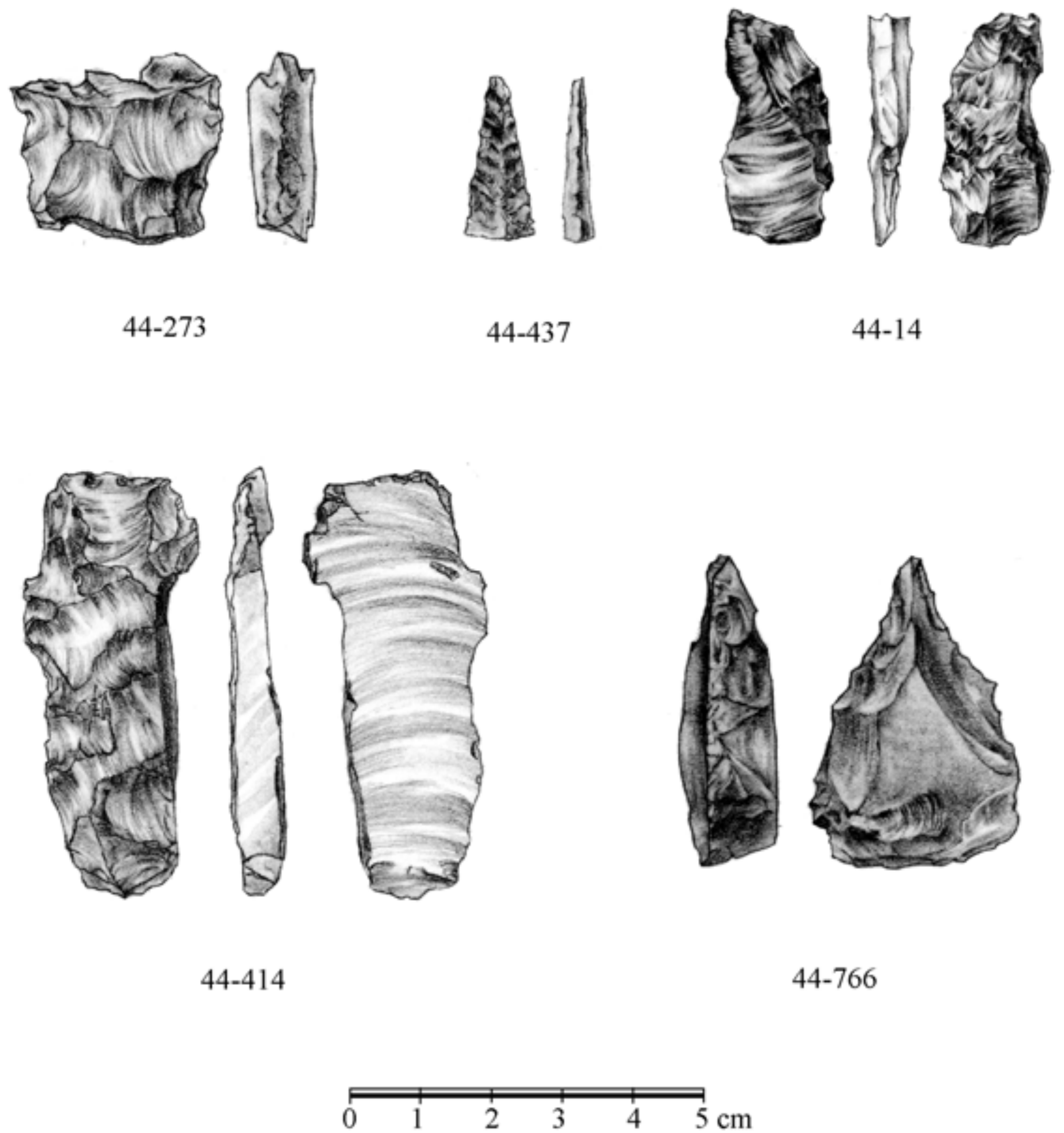


Figure 43. Bifaces, Bipolar Pieces, and Stone Drill.

all unidentifiable projectile point fragments recovered at the site. Two projectile point fragments were recovered within the shell midden of Locus B (44-592, -601), from S0/W0 and S/0W1, 170-180 centimeters respectively. A total of five specimens was recovered during mechanical trenching in Locus C (44-525, -555, -558, -563, -793). These items were recovered at a depth of 500-550 centimeters below ground surface.

Bifacial Tools

Twelve fragmentary items were identified as bifacial tools (Figure 43). The specimens include: four ends (44-65, -337, -557, -607), three margins (44-380, -560, -562, -608, 611, and 616), and two mid-sections (44-275, and 44-606). Cortex was present on just one of specimens (44-608). There are two Stage 3 Refined Bifaces (44-

606, -608), and 10 Finished Bifaces (44-65, -275, -337, -380, -557, -560, -562, -607, -611, -616). Bifacial tools had an average thickness of 6.0 millimeters, ranging from 4.9 to 9.2 millimeters. Specimen 44-606 may represent a portion of a knife as indicated by the micro stepping along the margins of the item. The average thickness of bifacial tools was similar to the average thickness of projectile point fragments recovered from the site. This similarity might be attributed to down-the-line trade networks that imported finished bifacial items. All 12 specimens were manufactured from obsidian and were submitted for geochemical source determination. They were traced to Napa Valley (n=11) and Annadel (n=1). Obsidian hydration measurements (n=10) ranged from 1.2 to 3.4 microns with a mean of 2.5 microns.

Four of the bifacial tools were recovered during excavation of the midden area of Locus A (44-65, -275, -337, -380). Five specimens were recovered in Locus B (44-606, -607, -608, -611, -616) at a depth of 150-170 centimeters below surface. The remaining two specimens (44-557, -560) were recovered during monitoring of mechanical trenching in Locus C, Trench 13, 500-550 centimeters below surface.

Simple Flake Tools

One simple flake tool was recovered (44-642). This specimen was classified by the degree of edge modification consisting of unifacial micro stepping. A discrete area of edge wear measured about 55 millimeters, with an edge angle of 35-45°, numerous micro stepping fractures, and some intentional flaking. Intentional flaking was completed presumably to resharpen the tool. Experimental studies have equated edge angle with the hardness or softness of material being processed (Crabtree 1972). An acute angle of a flake or blade is an excellent cutting edge for processing raw materials. Relatively steep or acute edge angles (45-60°) were noted on two items (345-111 and 247). These steep edge angles suggest use of the items for cutting soft materials. This specimen may have served as a scraper or plane. The simple flake tool is complete, measures 75.4 millimeters long, 34.5 millimeters wide, is 21.6 millimeters thick and weighs 45.6 grams. It is manufactured from a gray colored Monterey chert.

This artifact was recovered from disturbed shell midden soil in Locus B during backhoe excavation of Trench 15.

Cores

Cores are angular chunks or cobbles, which have been worked for the purpose of producing flakes but bear no evidence of transitory or additional functions. A total of three cores was recovered from CA-MRN-44/H. Two cores were manufactured from chert and one from basalt tool stone. One core (44-338) is bifacial in form having multiple platform or striking surfaces and negative flakes detached toward opposing surfaces. One core is multi-directional (44-656) and is characterized by numerous flake detachment scars in multiple directions around the body of the specimen. One core (44-517) had no recognizable form (345-250). Table 6 summarizes the metrical information for all cores.

Two cores were recovered during controlled excavation in the midden area of Locus A between 90 and 110 centimeters below surface (44-338, -517). One core (44-656) was recovered in the Locus C, at 500-550 centimeters below surface.

Table 6. Cores Metrical Information.

Acc. No.	Material	Cnd.	Crtx.	L (mm)	W (mm)	T (mm)	W (g)	Shape
44-338	Basalt	C	No	71.1	43.3	29.1	102.6	Bifacial
44-517	Chert	F	No	121.1	84.8	75.8	822.4	Unidentified
44-656	Chert	C	Yes	54.1	38.2	29.7	62.9	Multidirectional

Notes: Cnd. – Condition; Crtx. – Cortex; L – Length; W – Width; T – Thickness; W – Weight.

Debitage

Excavations at CA-MRN-44/H yielded a total of 295 unmodified flakes, including 128 obsidian (43.4%) and 169 chert (57.2%). Comparison of the data presented in Table 7 reveals a spatial patterning of flake stone material use at the site. Locus A has a high relative percentage of obsidian tool stone. Locus B showed nearly even percentages of chert and obsidian chipping debris. In contrast, Franciscan chert is the most prevalent tool stone present in Locus C constituting over 70% of the chipped stone waste.

Table 7. Summary of Lithic Technology by Material Type.

	Locus A			Locus B			Locus C		
	No.	% by Material Type	% of all Flakes in Locus A	No.	% by Material Type	% of all Flakes in Locus B	No.	% by Material Type	% of all Flakes in Locus C
Obsidian									
EC	0	0	0	0	0	0	0	0	0
LC	1	1.8	1.4	2	15.4	6.9	1	1.7	0.5
EB	3	5.4	4.2	1	7.7	3.4	15	26.3	7.7
LB	23	41.1	31.9	7	53.8	24.1	9	1.8	4.7
PR	26	46.3	36.1	3	23.1	10.3	32	56.1	16.5
SH	3	5.4	4.2	0	0	0	0	0	0
Subtotal	56	100	77.8	13	100	44.9	57	100	29.4
Chert									
EC	0	0	0	1	6.2	3.4	17	12.4	8.8
LC	8	50	11.1	9	56.2	31	93	67.8	47.9
EB	7	43.7	9.7	6	37.5	20.7	22	16.1	11.4
LB	1	6.2	1.4	0	0	0	2	1.4	1
PR	0	0	0	0	0	0	0	0	0
SH	0	0	0	0	0	0	3	2.2	1.5
Subtotal	16	100	22.2	16	100	55.1	137	100	70.6
Total	72	-	100	29	-	100	194	-	100

Notes: EC – Early Core; LC –Late Core; EB – Early Biface; LB – Late Biface; PR – Pressure; SH – Shatter.

Technological analysis was directed at recognizing patterns in the reduction of flake stone material at CA-MRN-44/H. Toward this end, the three loci were used as analytical units of comparison. Table 7 presents a summary of reduction stage for each material class including the number of specimens, the percentage of specimens by material type, and the percentage of specimens within each locus. The percentage of all flake types within each locus is a useful category of comparative analysis and is used here as the primary means for measuring the relative abundance of each reduction stage by material type.

Locus A

Obsidian is the most common material in Locus A (77.8%, n=56). Late biface thinning and pressure flakes constitute 87.4% (n=49) of all obsidian flakes recovered from this locus. Just 7.4% (n=4) of obsidian is categorized as early stages of reduction (i.e., late core and early biface thinning). In addition, obsidian flaking debris is quite small with 92.9% (n=52) of the specimens less than two centimeters in diameter. Visual sourcing indicates that nearly all obsidian is derived from the Napa Valley source (>99%) with the Annadel present in small quantities. Chert represents just 22% (n=16) of the chipped stone waste. Late core and early biface reduction constitute over 93% (n=15) of the flake stone debris. Sources of Franciscan chert are available on Angel Island.

Locus B

Obsidian and chert occur in almost equal quantities in Locus B (44.9%, n=13 and 55.1%, n=13 respectively). In general, obsidian flakes were small; less than two centimeters. Late biface thinning and pressure flakes constitute 74.8% (n=10) of the obsidian. Nearly all the obsidian was identified to the Napa Glass Mountain source. Chert is dominated by late core and early biface reduction (93.7%, n=15). No late biface thinning or pressure flakes were identified.

Locus C

The most common toolstone material in Locus C is chert (n=137, 70.6%). Flaking debris represents the production of expedient chert tools. Late core and early biface thinning constitute 83.9% (n=115) of the chert flakes. Just 1.4% (n=2) of chert is categorized as late biface thinning. Chert flakes tend to be larger than obsidian flakes, with 51.9% (n=71) of the specimens measuring more than three centimeters in diameter. One chert drill (44-766) was recovered from Locus C.

Distribution

Discrete spatial patterning of material types and reduction stages are indicated at CA-MRN-44/H. The most likely explanations for this patterning are discrete activity areas of production and maintenance within the site and shifts in stone tool preference over time.

Locus A and B are characterized by a relatively high frequencies of small Napa Valley obsidian dominated by late biface and pressure flakes. Obsidian arrived on site as finished bifacial tools and projectile points. The relatively high proportion of obsidian projectile points, point fragments, and bifacial tools (n=52) further supports this conclusion. The high proportion of late stage reduction debris indicates that maintenance and resharpening of formal obsidian tools was a common site activity. Tool use and maintenance behaviors are commonly associated with residential activities (Binford 1980; White 1984).

In contrast, Locus C demonstrates a higher proportion of chert flakes relative to other areas of the site. Local Franciscan chert was put to practical use in the production of informal, expedient, and/or expendable tools. Only one formal chert tool (44-766) was recovered. Locus C is exceptional for its lack of marine shell dietary debris, which is present in large quantities in all other areas of the site. It is highly likely that increased use of chert is associated with differences in subsistence pursuits.

Ground and Pecked Stone Artifacts

A total of 50 ground stone items was recovered from CA-MRN-44/H. The ground stone assemblage was arranged among nine function categories including: stone beads and pendants (n=4), charmstones (n=3), mortars (n=5), pestles (n=11), handstones (n=7), hammerstones (n=5), milling slabs (n=3), net and fishing weights (n=6), and unidentified ground stone items (n=6).

Stone Beads and Pendants

Four specimens were stone beads or pendants (Figure 44, a-d). Specimen 44-133 is a complete green colored steatite bead. The artifact was biconically drilled with one side drilled about four-fifths and the other drilled one-fifth to create an hour-glass shaped hole. The overall shape of the bead is round, is completely shaped, polished and ground. Interior striations show the direction of drilling and some scrapes are present on the exterior surface. The bead measures 14.4 millimeters wide, 9.9 millimeters thick, and weighs 3.0 grams. Specimen 44-310 is a complete green-gray colored steatite pendant. This needle shaped artifact was biconically drilled. The item is completely shaped, polished, and ground. Linear striations are present on the exterior surface running the length of the item. The pendant measures 36.4 millimeters wide, 7.8 millimeters thick, and weighs 2.8 grams.

One specimen (Figure 44, d) is a nearly complete light green colored steatite pendant with a biconical perforation and polished grooves. This oval shaped artifact has a biconically drilled perforation offset from the center of the item. The artifact was completely shaped, polished, and ground. Linear striations are present on the exterior surface of the item. Pecked and ground grooves run from the perforation to the exterior surface. The pendant measures 72.1 millimeters long, 46.9 millimeters wide, 12.2 millimeters thick, and has a hole 13.7 millimeters at the widest point of the perforation, and 7.4-millimeter hole. This item was recovered from Locus A, Feature 16, unit S1/W0, 150-160-centimeter level. Due to cultural concerns of Frank Ross, Native American representative for the Graton Rancheria of Coast Miwok, no photographs were taken of the object. A quick field sketch and measurements were completed, and the pendant was reinterred in the excavation unit, so the artifact is not present in the materials curated in the assemblage.

Specimen 44-382 is a light gray to white colored drilled mica ornament. This nearly complete item is very fragile and has a tendency to exfoliate in thin layers. The item measures 37.9 millimeters long, 14.6 millimeters, 0.4 millimeters thick, and weighs 0.5 grams. A circular shaped perforation located near the end of the item measures 5.5 millimeters wide. Mica ornaments are commonly found at prehistoric sites in the Bay Area (Banks and Orlins 1985; Beardsley 1954; Bennyhoff 1994b) as well as in Marin County (Beardsley 1954; Bieling 1998; King 1974; Meighan 1953; Pahl 2003). An assemblage of more than 500 mica ornaments was recovered from the San Pablo Reservoir in Orinda (CA-CCO-407). The ornaments were associated with an adult male burial and the cremated remains of an infant (Pahl et al. 1982). At the McClure Site (CA-MRN-266) an adult female burial (Burial 13) included 160 mica ornaments that were found clustered near the pelvic region (Contreras 1957:29). This burial represents the largest collection of mica ornaments recovered in Marin County.

Specimen 44-133 was recovered from Locus A, S1/W1, 20-30 centimeters. Specimen 44-310 was recovered from Locus A, unit S2/W1, 60-70 centimeters. Specimen 44-382 was recovered from Locus A, S1/W1, 160-170 centimeters.

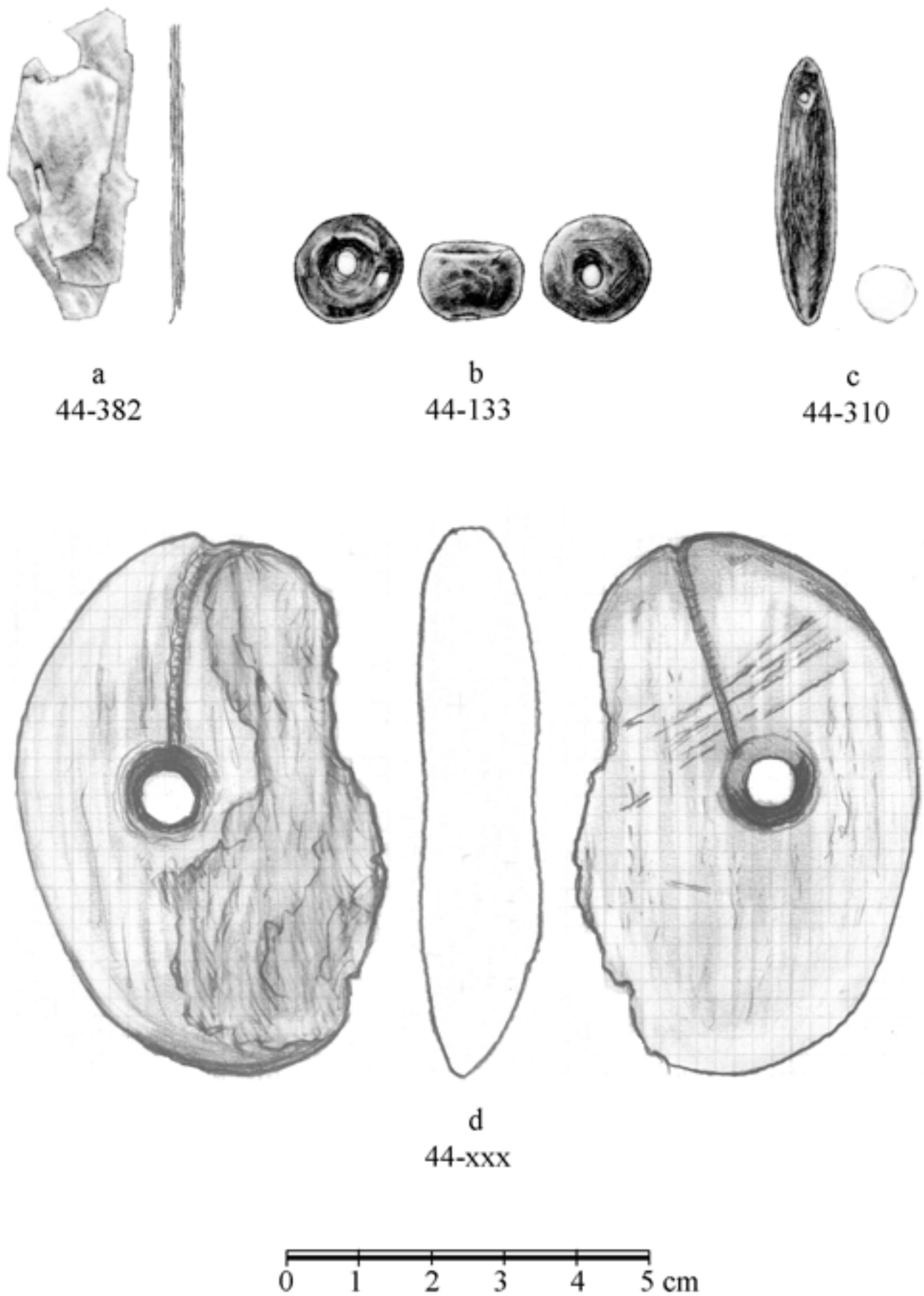


Figure 44. Mica Ornament, Drilled Stone Bead, Stone Pendant, and Steatite Ornament.

Charmstones

Charmstones recovered from prehistoric sites in California have been the focus of academic inquiry beginning at the end of the nineteenth century (Yates 1889). In general, the major factors used to identify the potential function of a charmstones are the type of stone used, how finely worked and shaped it is, whether it is battered or abraded, and relevant ethnographic references (Hector et al. 2005:7). Often materials selected for manufacture of "ritual" charmstones are better quality: The items have a higher degree of craftsmanship and labor investment in their construction. A great variety of utilitarian and ceremonial functions have been proposed for charmstones. Ceremonial interpretations include ear ornaments, simple pendant, amulet, charmstone, luck stone, phallic representation, games stone, drum rattle, medicine, or fishing stones (Hector et al. 2005:7). In several instances charmstones have been found associated with human burials such as the lower Paterson Mound (CA-ALA-328; Bickel 1976:399), Santa Rita Village (CA-ALA-413), and University Village (CA-SMA-77). In addition, ethnographic references suggest the use of charmstones in shaman's bundles.

Functional interpretations of charmstones include use as a plummet in construction, net weight and fishing line sinkers, sling stones, use as pestles, war clubs, spinning weights in textile construction, rubbing stones, and other functions. There is a considerable body of evidence that charmstones served no ritual significance. Hundreds of charmstones have been recovered in old lakebeds of Sonoma County (Elsasser 1955; Meredith 1900:280; Peabody 1901:139). The context and condition of these items has led researchers to conclude that the artifacts served as net weights or sling stones. The preponderance of charmstones recovered in California's Central Valley and Bay Area are not associated with burials, or in any other obvious ceremonial context, but instead occur in midden debris (Treganza and Cook 1948:295; Wallace and Lathrap 1975:26). Specimens recovered from Hultman Aspect components in eastern Lake County were also found in the midden (White et al. 2002:360-361). In Marin County (CA-MRN-254 and -357), charmstones have also been recovered from the midden matrix (Bieling 1998:103; King et al. 1966:66, 68). At Ellis Landing and West Berkeley (CA-ALA-307) charmstones appear to replace edge-notched and grooved stone net sinkers in Middle and Late Period assemblages (Gerow 1968:80).

Three charmstones were recovered from CA-MRN-44/H (Figure 45, a-c). Specimen 44-511 is about one-half a complete charmstone manufactured from fine-grained sandstone, with a lateral snap break near the middle of the artifact. The item appears to represent a charmstone blank. It is roughly cylindrical with a tapering end, has extensive pecking along the edges, and a fair degree of polish on two opposing flat surfaces. The item measures 78.1 millimeters long, 42.7 millimeters wide, 27.6 millimeters thick, and weighs 146.4 grams. Specimen 44-515 is charmstone manufactured from fine-grained sandstone and has breaks near the ends of the artifact. The item is roughly ovate with two tapering ends, has pecking and grinding along the edges, and exhibits a high degree of polish on two opposing relatively flat surfaces. The item measures 84.2 millimeters long, 38.8 millimeters wide, 27.3 millimeters thick, and weighs 119.3 grams. Specimen 44-644 is a charmstone manufactured from fine-grained basalt and broken in half near the middle of the artifact. The item is roughly ovate with a tapered end, and has pecking and grinding along the edges, a high degree of polish on two opposing relatively flat surfaces, and a rounded lipped end. This charmstone is much larger than the other two specimens in the assemblage. The item

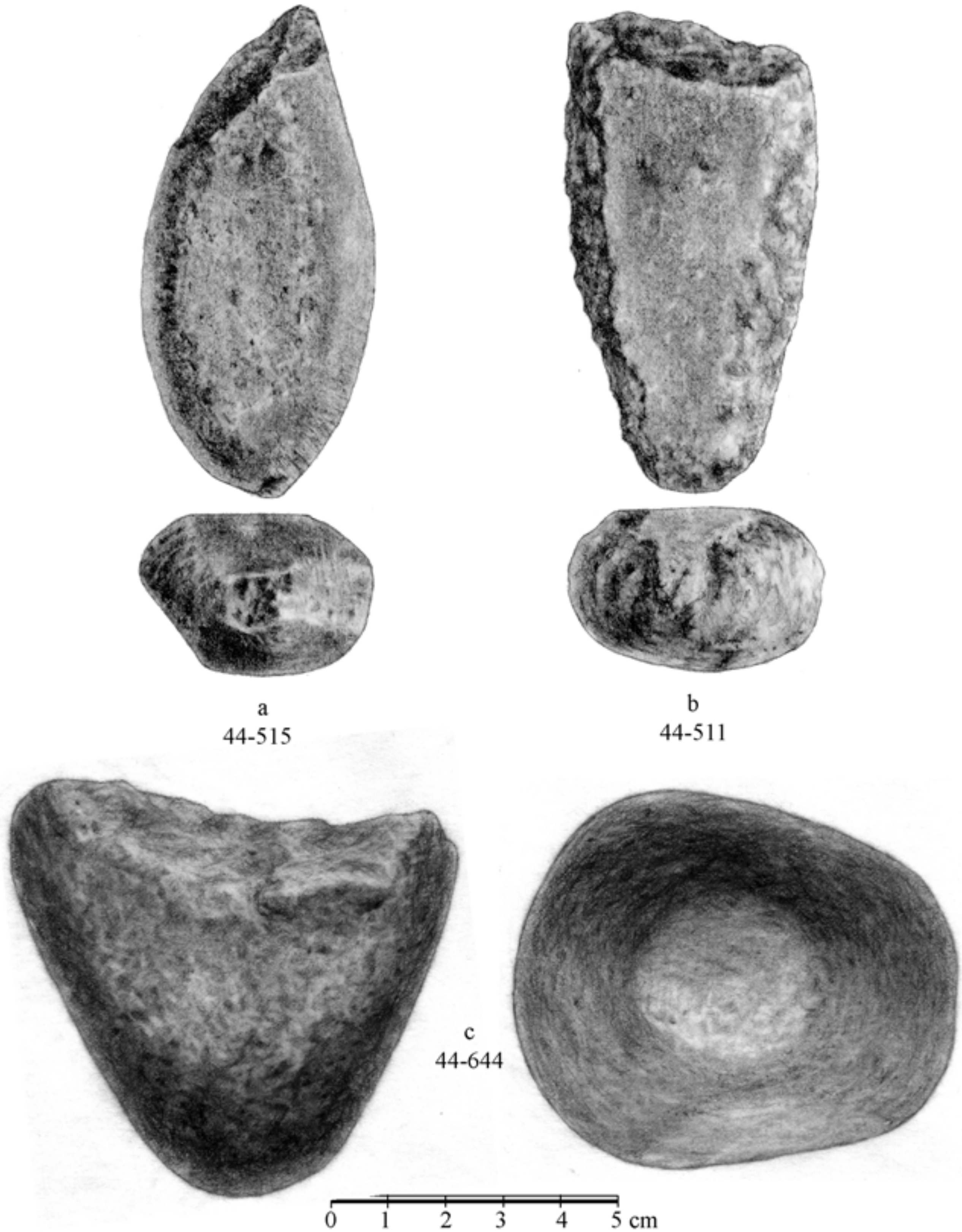


Figure 45. Charmstones.

measures 73.6 millimeters long, 60.1 millimeters wide, 76.2 millimeters thick, and weighs 370.5 grams.

Specimen 44-511 was recovered in disturbed midden soil in Trench 6 in Locus A. Specimen 44-515 was recovered from intact shell midden soil in Locus A at about S8/E2, 190 centimeters. Specimen 44-644 was recovered from disturbed shell midden soil in Trench 15 in Locus B.

Mortars

A total of five artifacts was classified as mortar fragments (Figure 46, a). Specimen 44-217 is a rim fragment, manufactured from a meta-sedimentary material. It is highly shaped and shows polish on all original exterior surfaces. Fewer than 10% of the original artifact is present making size descriptions limited. Specimen 44-539 is a rim fragment, manufactured from basalt, is shaped, and exhibits some polish on the interior surface. Fewer than 10% of the original artifact is present. Specimen 44-542 is a rim and body fragment, manufactured from granite, and has a fair degree of polish on the interior surface. This specimen represents about 20% of the original artifact. Specimen 44-623 is a rim fragment manufactured from fine-grained basalt and exhibits a high degree of polish on the interior surface. Fewer than 10% of the original artifact is present. Specimen 44-669 is a rim fragment manufactured from relatively soft sandstone and exhibits some polish on the interior and exterior surfaces. About 10% of the original artifact is present.

Specimen 44-217 was recovered in Locus A, S1/W1, 160-170 centimeters. Specimen 44-539 and -542 was recovered in Locus C at 4.9 to 5.4 meters below surface. Specimen 44-623 was recovered in Locus B, S/W3, 160-170 centimeters. Specimen 44-669 was collected in November/December 2006 by Jeff Brook and Frank Ross from a trench within alignment A upslope and east of the detention barracks above the East Reservior.

Pestles

A total of 11 artifacts was classified as pestles or pestle fragments (see Figure 44, a-b; see Figure 45, a-b; Figure 46, a). Four of the specimens represent complete, fully shaped forms. Specimen 44-663 is a proximal fragment (representing about two-thirds of the whole) of a very large meta-sedimentary pestle (Figure 47, b). The fragment measures about 250 millimeters long by 99.3 millimeters wide, and 54.2 millimeters thick. This specimen has extensive pecking and shaping along the edges and a smooth, well-developed polish on two opposing, relatively flat surfaces. This item may have also served as a large handstone on a milling slab. Specimen 44-516 is a nearly complete shaped pestle manufactured from sandstone material (Figure 47, a). This item has extensive pecking throughout the entire surface, a large bulbous distal end, and a flared lip (74.0 millimeters wide) where it inserted into the mortar. The artifact measures 185 millimeters long, 77.7 millimeters wide, by 67.7 millimeters thick. Specimen 44-514 is a complete pestle, manufactured from a green colored meta-sedimentary material with extensive pecking and grindings on all surfaces. The artifact measures 200.5 millimeters long, by 56.7 millimeters wide, by 41.6 millimeters thick. Three fragments of the distal end of a pestle were recovered (44-110, -537, -538). Specimen 44-110 is an end-spall, manufactured from dark gray basalt, and has some slight evidence of battering. Specimens 44-537 and -538 are manufactured from a soft sandstone material and have battering at their ends. Both items were recovered in Locus C at a depth of 4.9 to 5.4

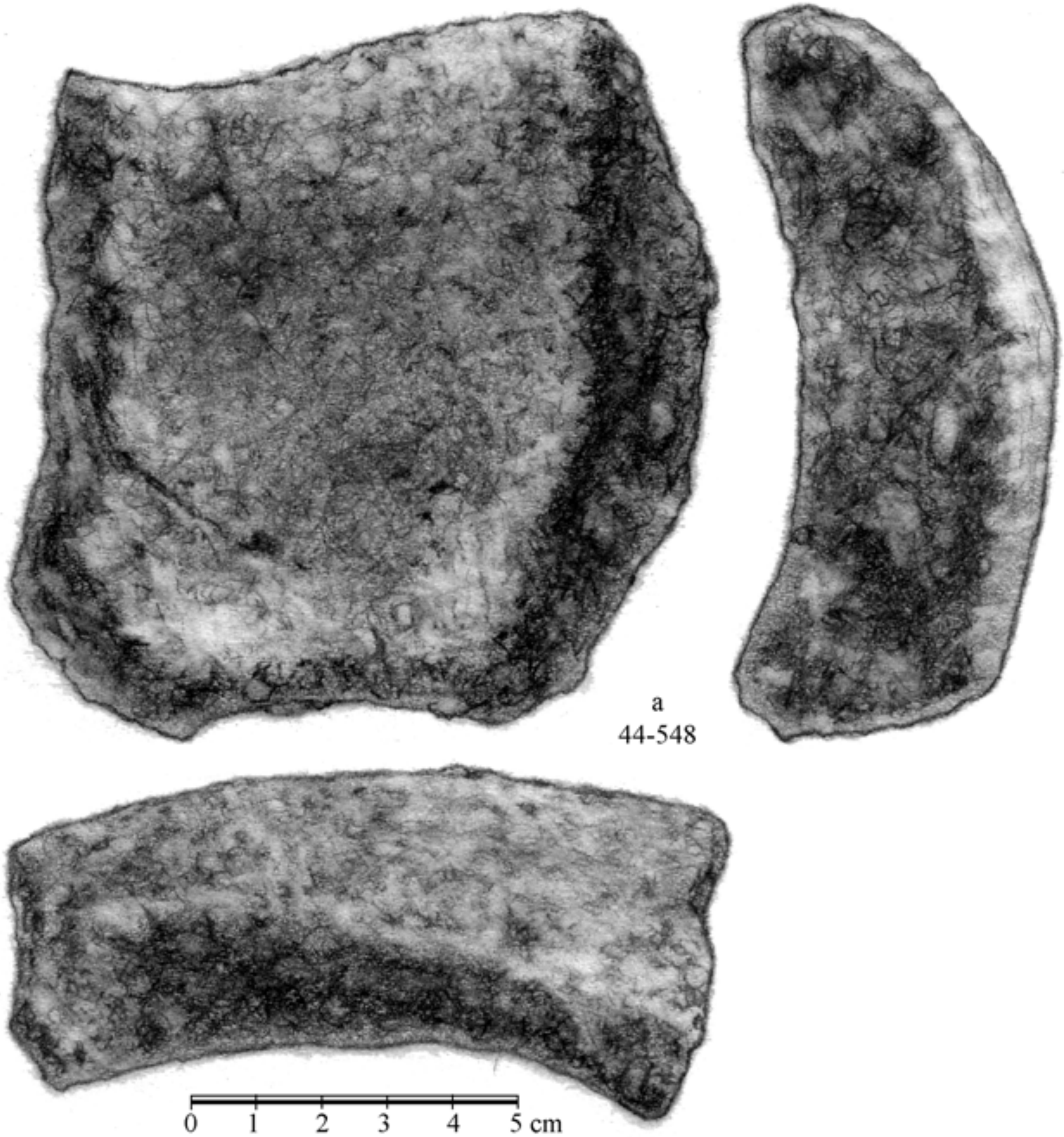


Figure 46. Bowl Mortar.

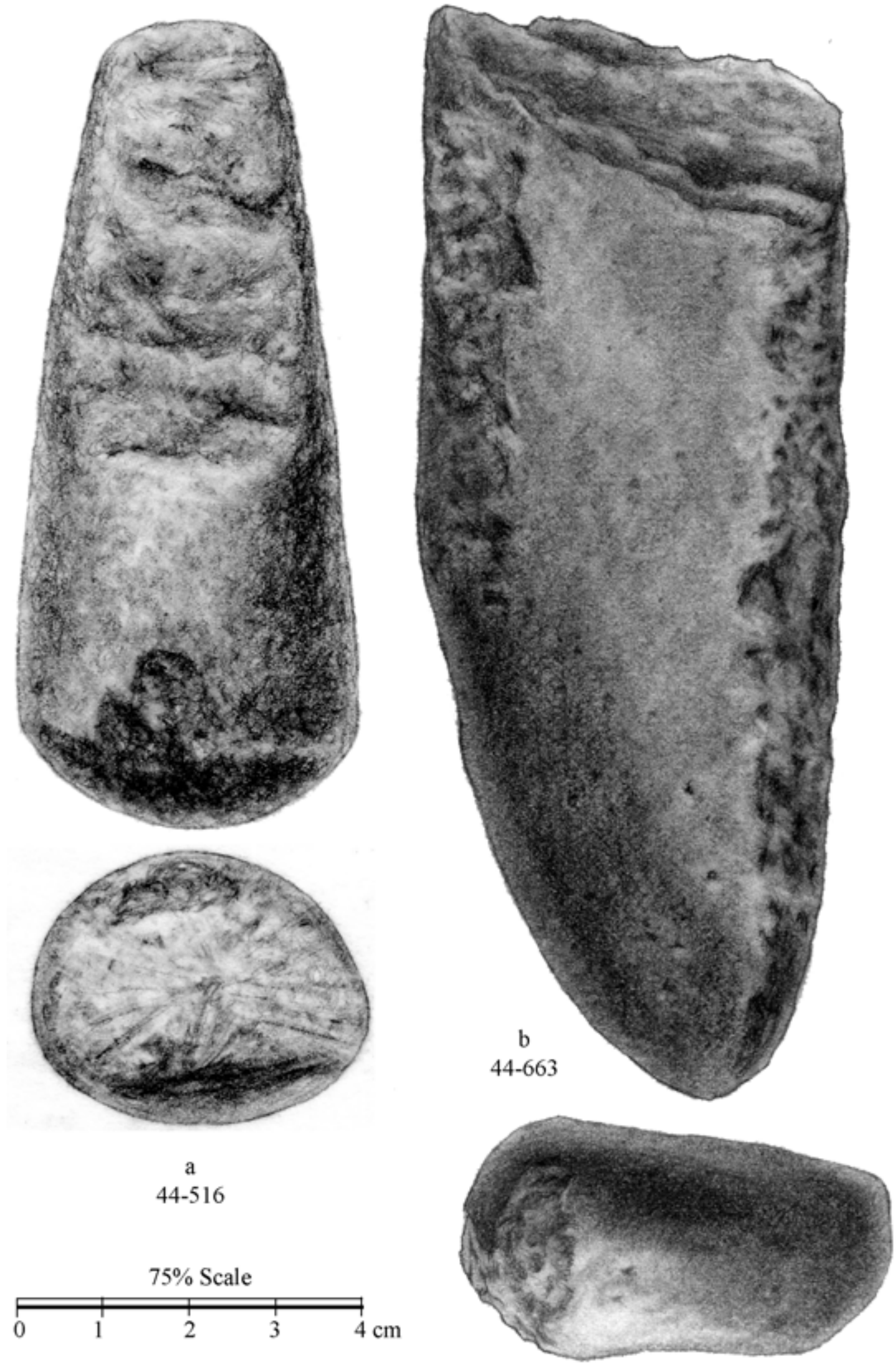


Figure 47. Stone Pestles.

meters below surface. Three pestles (44-261, -541, -665) are represented by small fragmentary pieces of sandstone, are water worn, and have a slight polish. Specimen 44-645 is a fragment of distal end of a highly shaped and finely manufactured basalt pestle (Figure 48, b). This artifact is a nearly perfect cylinder, circular in cross-section, with a battered, slightly concave end. The item measures 57-60 millimeters wide. Specimen 44-769 is a complete pestle manufactured from fine-grained sandstone (Figure 48, a). This finely manufactured phallic shaped object has a smooth tapering end, is cylindrical in cross-section. It has a pecked collar around the body, a slightly concave end, and extensive pecking along all the exterior surfaces. It shows two small areas of flat polish on opposing sides. The item measures 93.8 millimeters long, 43.5 millimeters wide, by 41.3 millimeters thick at the pecked collar. No evidence of use is present on the item.

One specimen (44-516) was recovered from disturbed midden soil in Locus A, S5/W5, 190 centimeters. Specimen 44-514 was recovered from disturbed shell midden in Locus A at about S5/W2, 170 centimeters. Specimen 44-110 recovered in Locus A, S1/W0, 150-160 centimeters. Specimen 44-261 was recovered from Locus A, S1/W1, 150-160 centimeters. Three specimens (44-663, -649, -665) were recovered from a disturbed shell midden soil in Locus B at 1.5 to 2.4 meters. Three pestles (44-537, -538, -541) were recovered from Locus C, Trench 13, about 500-550 centimeters below surface.

Handstones

A total of seven handstones (six fragmentary and one complete) was recovered and demonstrate a high degree of morphological variability. Three of the handstones show only minor polish or pecking on the surface (44-109, -287, -509, -668). Specimen 44-109 is complete, manufactured from sandstone, and has a small battered area on one pointed end. It measures 108.2 millimeters long, 83.7 millimeters wide, by 42.6 millimeters thick. Specimens 44-287 and 44-509 are fragmentary pieces of water worn cobbles with a slight polish on one surface. Specimen 44-507 is a complete well-rounded pitted handstone with extensive battering and shaping (Figure 49, b). This item is manufactured from green-gray sandstone and measures 99.6 millimeters by 77.8 millimeters by 61.2 millimeters. A pitted surface on one side measures about 47 millimeters in diameter and 4 millimeters deep. The exterior surface has a slight polish on its convex surfaces. Specimen 44-668 is manufactured from sandstone, is a rounded oval shape, has good polish on two opposing surfaces, and is chipped on the edge and end of the item. Approximately one-half of the original form is present. Specimen 44-512 is a large, well-rounded, complete handstone manufactured from a green meta-sedimentary material. The item has a fair degree of polish on two opposing convex surfaces and extensive battering/pecking along the edges and sides. Calcium carbonate is present on some portions of the artifact. This large handstone measures 128.7 millimeters by 121.4 millimeters by 68.6 millimeters. Specimen 44-535 is a fragmentary piece of a polished handstone manufactured from basalt. This item has a high degree of polish on one convex surface and pecking on the polish.

Specimen 44-512 was recovered from the backhoe exposure in Locus A at about S11/E2, 150 centimeters. Specimen 44-109 was recovered in Locus A, S1/W0, 150-160 centimeters. Specimen 44-287 was recovered from Locus A, S2/W1, 20-30 centimeters, two specimens (44-507, -509) were recovered from disturbed shell midden in Locus A. Specimen 44-668 was recovered from Locus B in a disturbed shell midden soil about 0.9

meters below surface. Specimen 44-535 was recovered in Locus C, Trench 13, at 4.9 to 5.4 meters below surface.

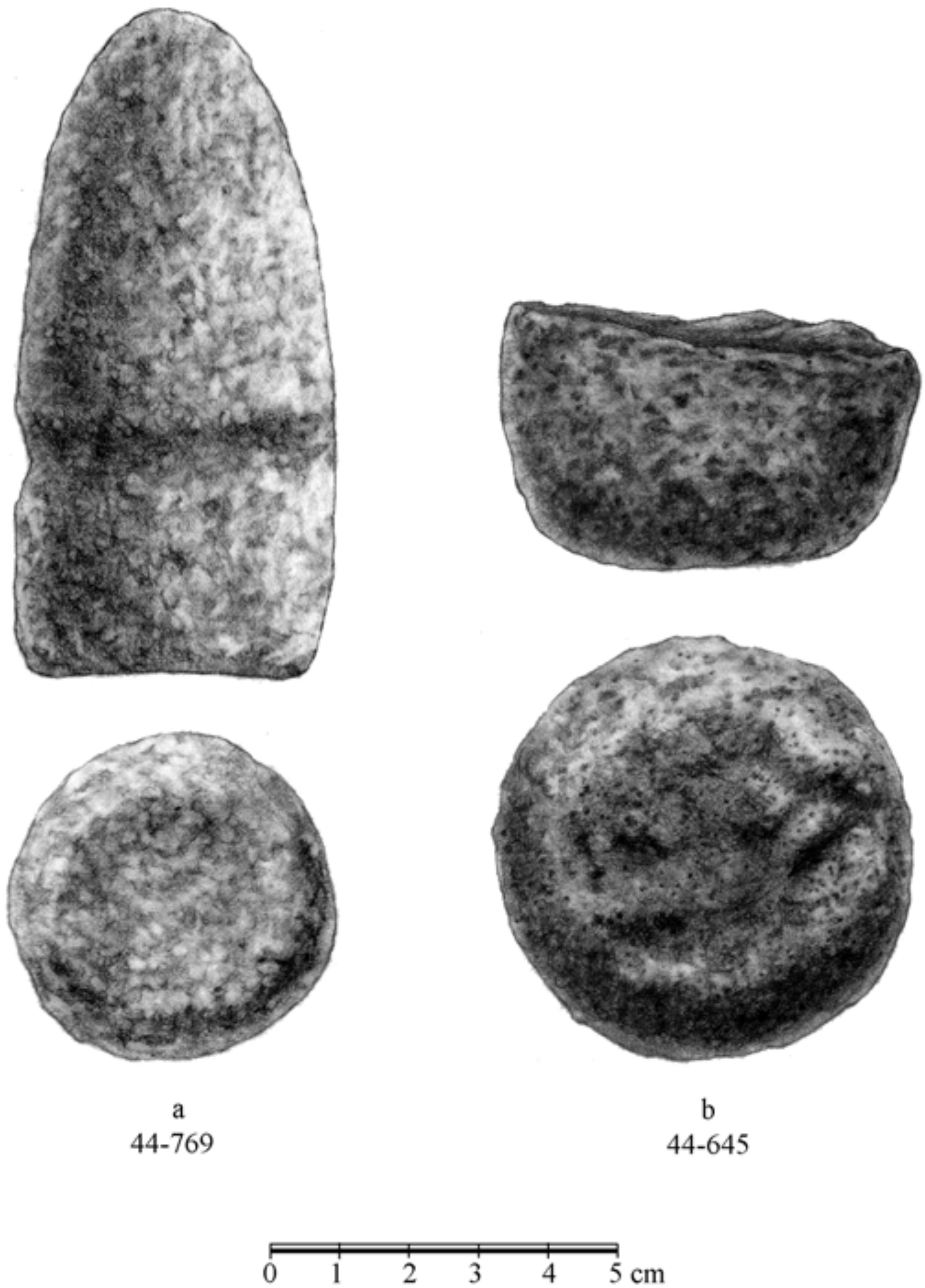
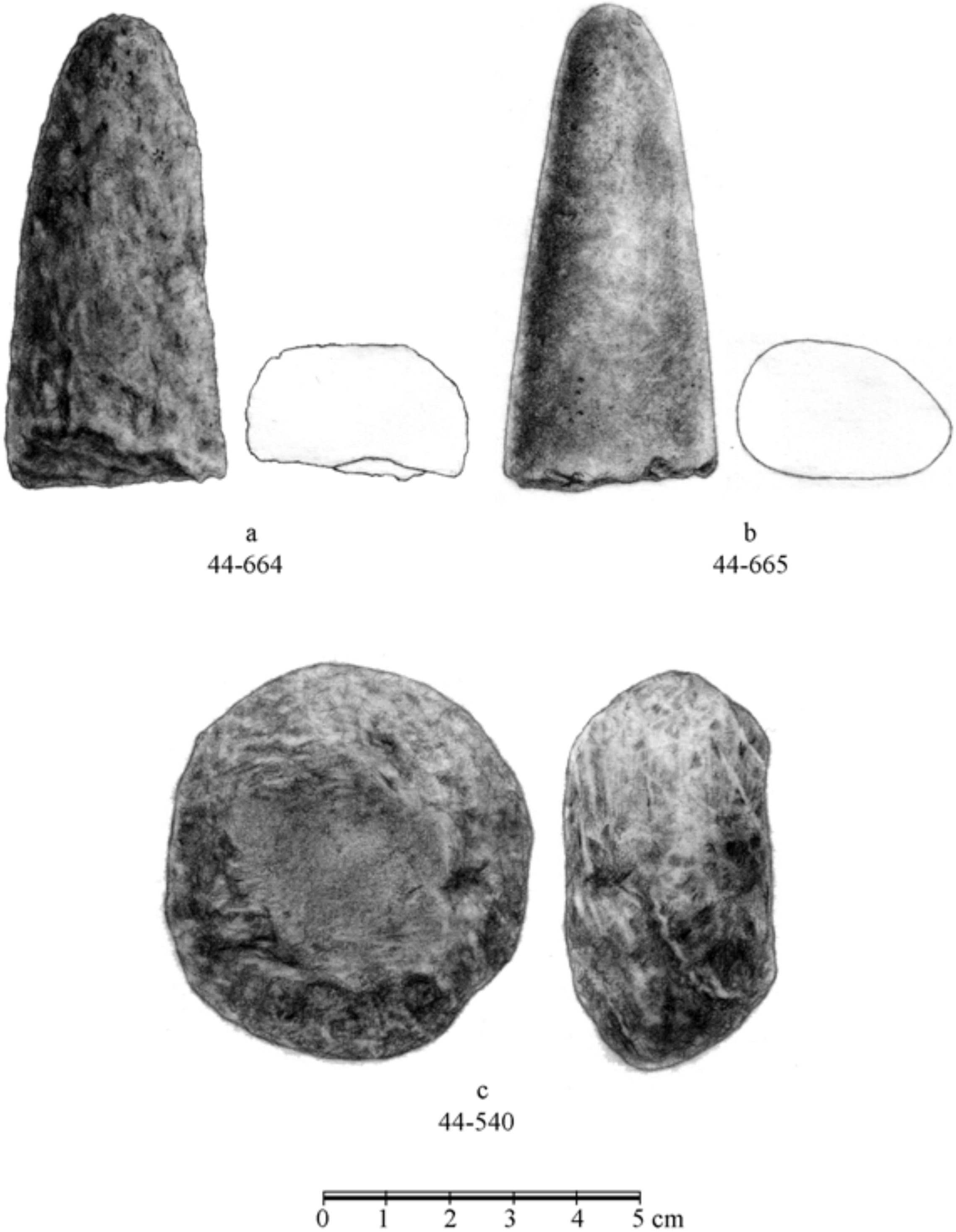


Figure 48. Stone Pestles.



a
44-664

b
44-665

c
44-540

0 1 2 3 4 5 cm

Figure 49. Hammerstone and Pitted Handstone.

Hammerstones

A total of four hammerstones was recovered (Figure 50, b; see Figure 49, c). Two hammerstones recovered from Locus C are morphologically (size, shape, and weight) and technologically (location of battering and grinding) similar, possibly representative of a stylistically sensitive tool type. Specimen 44-536 is a complete ovoid shaped sandstone hammer with extensive battering along the edges of and slight polish on the two opposing convex surfaces. This item measures 69.2 millimeters long by 49.2 millimeters wide by 35.5 millimeters thick, and weighs 174.5 grams. Specimen 44-540 is a complete roughly oval shaped sandstone hammer with extensive battering along the edges of and slight polish on one convex surface. This item measures 58.8 millimeters long by 58.3 millimeters wide by 34.1 millimeters thick, and weighs 175.6 grams. Specimen 44-667 is a complete hammerstone, manufactured from a dark gray sandstone material, with slight polish on two opposing flat surfaces, and battering on both ends. This item measures 139.7 millimeters long, 60.6 millimeters wide, 18.4 millimeters thick, and weighs 293.9 grams. The polish on two opposing surfaces indicates that this item may have also served as a handstone. Specimen 44-242 is a small fragment of a hammerstone. This item is manufactured from a dark green/gray micro-siliceous material, has a rounded, water worn exterior, and a small area of intense battering on the edge.

Specimen 44-242 was recovered from Locus A, S1/W1, 140-150 centimeters.

Specimen 44-667 was recovered in the shell midden of Locus B in a disturbed shell midden, about 0 to 0.9 meters below surface. Two specimens (44-536, -540) were recovered from Locus C, Trench 13, at 4.9 to 5.4 meters in depth.

Net and Fishing Weights

A total of six weights was recovered representing three types: small collared, large collared, and end notched (Figure 51, a-c; Figure 52, a-c). Three specimens (44-178, -513, -770) were categorized as "small collared weights" due to their relatively small size compared to other net weights in the assemblage and the presence of a pecked ring around the middle of the stone, presumably to fasten the item to cordage. It is highly likely that these small collared weights were used with a hand line for fishing and were not used as net weights (Figure 51, a-c). Specimen 44-178 is a one-half fragment of a sandstone net weight. This item exhibits extensive pecking in the form of a ring around the center of item to form an indented collar. The item measures 39.9 millimeters long (original form ca. 75 millimeters), 39.9 millimeters wide, 30.0 millimeters thick, and weighs 62.8 grams (original form ca. 120 grams). Specimen 44-513 is a complete sandstone net weight. This item exhibits extensive pecking in the form of a three-quarter ring around the center of the item to form an indented collar. The item measures 48.2 millimeters long, 43.2 millimeters wide, 42.8 millimeters thick, and weighs 128.4 grams. Specimen 44-770 is a complete sandstone net weight with pecking on the ends forming an indented collar. The item measures 47.5 millimeters long, 40.9 millimeters wide, 38.4 millimeters thick, and weighs 100.9 grams.

Two specimens (44-86, -671) were categorized as "end notched" due to the presence of small indent or notch located at the end of the artifact (Figure 52, a, c). These end notched weights are larger in size than other weights, were expediently made (showing minimal amounts of modification) and manufactured from locally available materials. It is highly

Figure 50. Stone Pestle and Hammerstone.

Figure 51. Stone Fishing Sinkers.

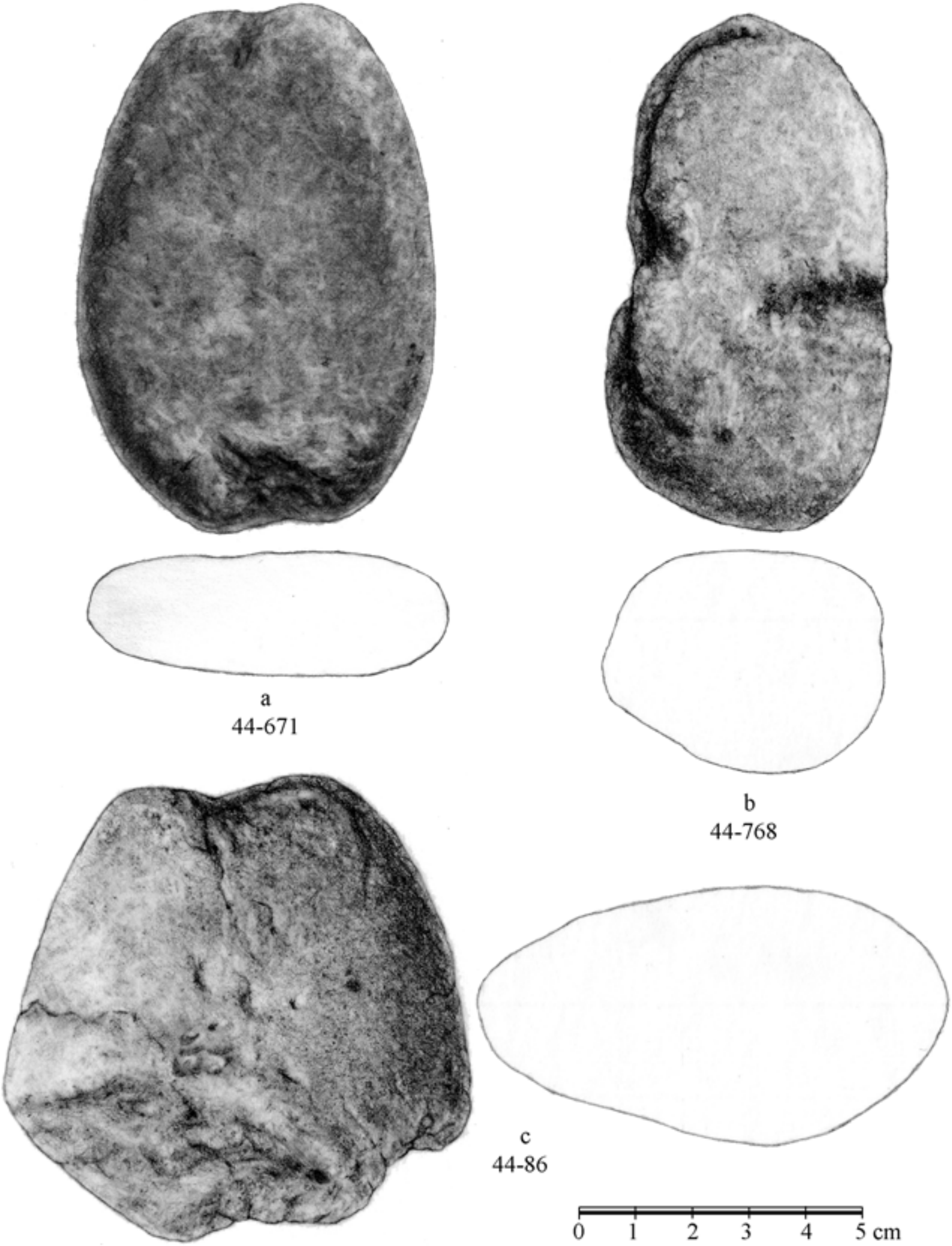


Figure 52. Stone Net Weight Sinkers.

likely that these end notched -stones were fastened to cordage and used to submerge large nets for fishing. Specimen 44-86 is a complete water worn sandstone cobble with pecking and/or biconical flaking at the ends. The item measures 89.4 millimeters long, 61.7 millimeters wide, 24.5 millimeters wide, and weighs 204.7 grams. Specimen 44-86 is considerably larger than the other end notched weight. This fragmentary item is 83.4 millimeters long, 81.3 millimeters wide, 44.7 millimeters thick, and weighs 339.7 grams. It has pecking at the end to create a small indent.

One specimen (44-768) was categorized as a “large collared” weight (see Figure 52, b). This weight is relatively larger in size, is expediently made, and manufactured from locally available material. This complete artifact is manufactured from a water smoothed sandstone material and was probably used as a net weight for fishing. Pecking is present in two areas located near the center of the item, creating a small circular groove. The artifact measures 91.0 millimeters long, 47.0 millimeters wide, 38.5 millimeters thick, and weighs 242.9 grams.

Three net weights were found in Locus A. Specimen 44-86 was recovered from a fire hearth (see Figure 52), in S1/W0, 120-130 centimeters. Specimen 44-178 was recovered from S1/W1, 90-100 centimeters. Specimen 44-513 was recovered from S2/W0, 160-10 centimeters. Specimen 44-671 was recovered from Locus B, Trench 16, at about 25 centimeters. Specimen 44-768 was recovered from Locus B, in the mechanical exposure for the septic tank, within disturbed shell midden soil, at 1.5 to 2.4 meters below surface. Specimen 44-770 was recovered from Locus C, Trench 13, at 500-550 centimeters.

Milling Slabs

Three milling slabs were recovered. Specimen 44-182 is a complete water worn sandstone slab that is relatively flat in cross section and has rounded edges. The item has a good degree of polish on two opposing flat surfaces. A small area of white stain from calcium carbonate is present in the middle of the polished surface. This item measures 164.5 millimeters long by 79.9 millimeters wide by 16.1 millimeters thick, and weighs 363.3 grams. Specimen 44-266 is a thermal spall from a sandstone-grinding slab. The item has a fair degree of polish on one relatively flat surface. A small area of battering is present along the edge. Specimen 44-643 is a fragment of a small sandstone slab. This item is relatively flat in cross section, oval in plan, and has water worn rounded edges. Polish is developed on two opposing flat surfaces. This item measures 32.7 millimeters long by 32.6 millimeters wide by 14.1 millimeters thick, and weighs 179.2 grams.

Specimen 44-182 was recovered from Locus A, S1/W1, 90-100 centimeters. Specimen 44-266 was recovered from Locus A, S1/W1, 160-170 centimeters. Specimen 44-643 was recovered from Locus B, Trench 15, from disturbed shell midden.

Unidentified Ground Stone Items

A total of six specimens was classified as unidentifiable ground stone. These items consist of highly fragmentary artifacts manufactured from sandstone, and exhibiting some degree of polish. Three specimens (44-59, -104, -666) have a slight to fair polish on one flat exterior surface. These items may have been part of handstones, although an insufficient amount of the artifact is present to identify its function. Specimens 44-582 and 44-650 are small fragments that retain a small area of polish on an exterior surface. Specimen 44-510 is a sandstone item with flat polish on three surfaces. This specimen is thermally altered and broken.

Specimen 44-59 was recovered from Locus A, S1/W0, 90-100 centimeters. Specimen 44-104 was recovered from Locus A, S1/W0, 140-150 centimeters. Specimens 44-510 and 582 were recovered from Locus B during mechanical trenching of the first 1.5 meters of disturbed shell midden soil. Specimen 44-582 was recovered from Locus B, S1/W4, 170-180 centimeters. Specimen 44-650 was recovered from Locus C, Trench 13, at about 500-550 centimeters.

Non-Artifactual Materials

Unmodified Shell

A substantial about of marine shell (52.9 kilograms) was recovered at CA-MRN-44/H from cultural features, discrete concentrations, and the general midden matrix. To maximize use of available time and funding, ordinary shell debris was not recovered from the screens in the field. The shell recovery strategy in Locus A included a 20cm^3 column sample from each unit level. Due to the limited amount of controlled excavation completed in Locus B, a larger sample of shell (50cm^3) was taken from unit levels for comparative purposes. Column samples were bagged in the field and transported to the laboratory, where they were wet-screened through nested 1/8-inch (3-millimeter) and 1/16-inch (1.5-millimeter) mesh hardware cloth. Shell was sorted from bone and other materials and bagged separately. Karin Goetter completed identifications of marine shell. The identified sample includes two complete columns from Locus A (S2W0, 0-180 centimeters and S1/W0, 0-180 centimeters) and two proveniences in Locus B (S0/W2, 170-180 centimeters and S0/W4, 170-180 centimeters). A total of 11,079.2 grams of marine shell was identified to the level of family or better. A taxonomic list of species is presented further ahead in Table 14. All species present in the assemblage were native to the region. Comparative analysis of marine shell is presented in Chapter 10.

Unmodified Bone

A substantial about of unmodified faunal material was recovered at CA-MRN-44/H. The faunal recovery strategy in Locus A included 20cm^3 column sample from each excavation unit level. Faunal materials encountered during controlled excavation were examined for signs of cultural modifications and discarded in the field after determining that they were unmodified. Due to the limited amount of controlled excavation completed in Locus B, a larger sample of shell (50cm^3) was taken from unit levels for comparative purposes. Column samples were bagged in the field and transported to the laboratory, where they were wet-screened through nested 1/8-inch (3-millimeter) and 1/16-inch (1.5-millimeter) mesh hardware cloth. Shell was sorted from bone and other materials and bagged separately. Tim Carpenter completed identifications of faunal materials and Dwight Simons completed the report. The identified sample includes two complete columns from Locus A (S2W0, 0-180 centimeters and S1/W0, 0-180 centimeters), two proveniences in Locus B (S0/W2, 170-180 centimeters and S0/W4, 170-180 centimeters), and a five-liter sample from Locus C (500-550 centimeters). Approximately 95,062 unmodified bone fragments were collected and catalogued from the site and 16,856 pieces of bone were analyzed. A total of 4,018 specimens could be identified to the level of family or better representing 37 individual taxa (see ahead to Table 14). Comparative analysis of faunal remains is presented in Chapter 8.

Fire-Affected Rock (FAR)

Thermally altered rock was recovered in substantial quantifies from several locations at the site. Locus A produced meaningful data regarding the volume and distribution of FAR. A total of 1,379 pounds of FAR was recovered from 6.8 cubic meters of controlled excavation. Fire-affected greywacke, miscellaneous volcanic rock, and sandstone were the most common material types with Franciscan chert occurring in lesser quantities.

> Quantitative data on recovery rates of FAR is often poorly reported in archaeological literature. Quantitative constituent analysis of prehistoric mounds in the Bay Area was a focus of scientific inquiry in the late 1940s through the 1960s. Researchers were interested in describing the type and density of materials present in archaeological sites in order to quantify accumulation rates and estimate the size of prehistoric populations. Some of the outcomes of this research were: (1) a renewed interest in shellfish remains, (2) more focused investigation of faunal materials, and (3) inquiry into toolstone use and inter-group exchange. [Fredrickson 1974]

At the Emeryville shell mound, data is available on the amount of burned rock present in the mound. Unfortunately, the methods used in the analysis were unsystematic and only the frequency of burnt rock was reported. Schenck noted that: "The collecting was uneven and the determination of the burned rock could not be exact" (1926:177). Cook and Treganza (1947, 1950) completed quantitative analysis of three prehistoric sites located in the greater Bay Area. The Petersen Mound I and Petersen Mound II are Late Period village sites located in the Sacramento Delta region east of Fairfield in Solano County. At Petersen Mound I, an average 836.6 pounds of rock and baked clay were recovered per cubic meter of sediment (Cook and Treganza 1947:138-140) and at Peterson Mound II, an average 1,464.5 pounds of rock and baked clay were recovered. At the Richmond Mound I, located on the edge of the San Francisco Bay near the City of Richmond, an average 264.8 pounds rock and baked clay were recovered per cubic meter (Cook and Treganza 1947:138-140). Because baked clay and unburnt rock were combined in the weight/volume calculations these data are problematic for comparing the recovery rate of FAR among sites.

Recent investigations of Bay Area sites provide some useful data for comparative purposes on the recovery rate of FAR. At the nearby Dominican College Site (CA-MRN-254), controlled excavations were completed on 20.65 cubic meters of sediment and resulted in the recovery of 886 pounds of FAR (Bieling 1998:55, 83). The average density of FAR recovered from CA-MRN-254 was 42.8 pounds per cubic meter of sediment.

At CA-MRN-44/H, an average of 203 pounds of FAR were recovered per cubic meter of sediment (Figure 53; Table 8). This figure is more than five times that recovered at CA-MRN-254. Multiple explanations are plausible for the unusually high volume of FAR present at CA-MRN-44/H as compared to other sites in the vicinity. Potential reasons include differences in site function among localities, variability in archaeological sampling strategies, and site structure. It is highly likely that the large volume of FAR present at CA-MRN-44/H is a byproduct of intensive shellfish processing and use of the site as a fishing village.

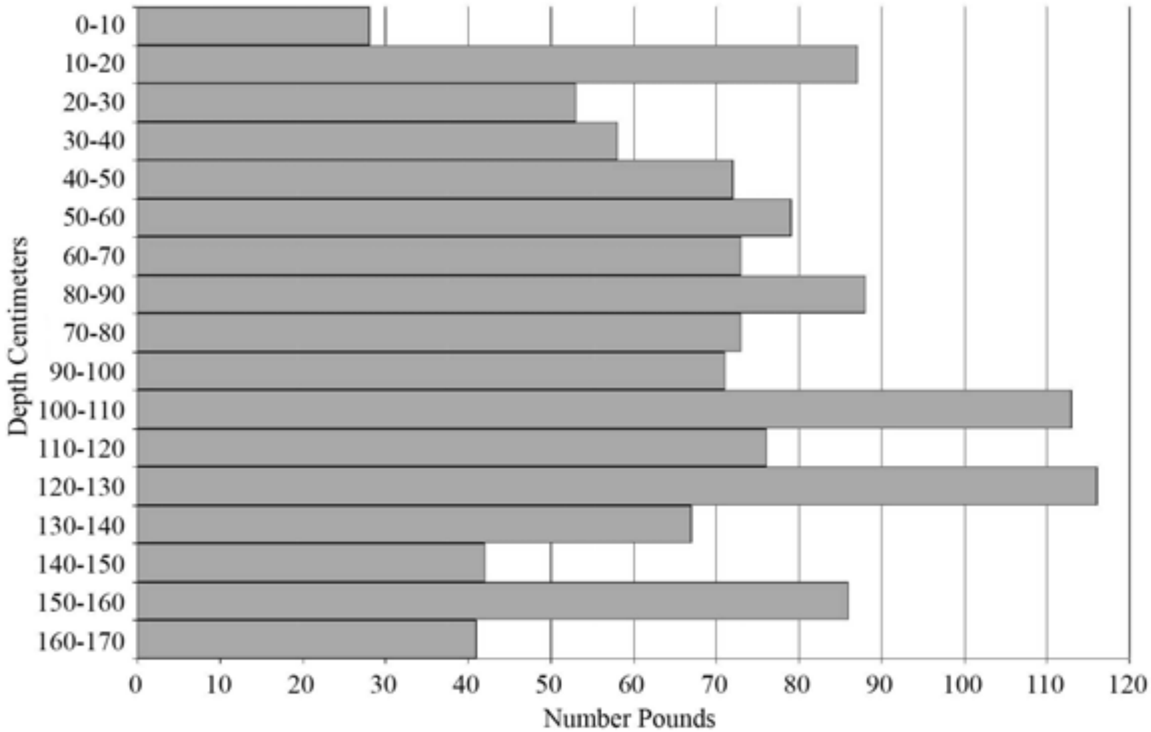


Figure 53. Distribution of Fire-Affected Rock by Depth in Locus A.

Table 8. Distribution of Fire-Affected Rock in Locus A.

Depth (cm)	S1/W0		S1/W1		S2/W0		S2/W1		Total
	Midden	Feature	Midden	Feature	Midden	Feature	Midden	Feature	
0-10	11	-	4	-	6	-	7	-	28
10-20	6	-	56	-	13	-	12	-	87
20-30	5	-	9	-	7	-	32	-	53
30-40	8	6	8	-	6	4	26	-	58
40-50	10	-	9	17	11	-	25	-	72
50-60	34	-	18	-	11	-	16	-	79
60-70	7	-	35	-	7	-	24	-	73
70-80	14	25	21	5	13	-	10	-	88
80-90	11	1	6	6	8	-	6	35	73
90-100	6	2	6	34	7	-	16	-	71
100-110	10	6	7	71	7	-	8	4	113
110-120	26	-	21	8	7	-	14	-	76
120-130	1	55	3	36	8	-	9	4	116
130-140	7	-	5	41	4	-	10	-	67
140-150	6	6	3	14	8	-	3	2	42
150-160	8	41	6	12	2	12	5	-	86
160-170	10	-	8	-	14	-	9	-	41
Subtotal	180	142	225	244	139	16	232	45	1,223
Total	322	-	469	-	155	-	277	-	1,223

Notes: All units in pounds.

Concentrations of cracked stone often occurred as clusters or mounds associated with concentrations of burnt shell, carbon and ash indicating sustained and or temporally discrete activity areas. The greatest concentration of thermally altered rock (22.2%, 305 pounds) was documented between 100 and 130 centimeters. This corresponds with a cluster of six cooking features that were identified at this depth (Features 5, 6, 7, 8, 9, and 10).

Baked Clay

A total of 833 (520.4 grams) baked clay items was recovered from CA-MRN-44/H. Most baked clay specimens consist of mussel shell endocasts. Endocasts are formed when dead or dying mussels are filled with fine-grained intertidal or bay sediments. These sediment filled shells were inadvertently gathered as food items by Native Americans and roasted in fires. The cooking process bakes the clay, which results in a hardened cast of the interior of the shell. The endocasts in the CA-MRN-44/H collection often exhibit smooth rounded convex surfaces of the interior of the shell and a narrow linear ridge created from the seam where the two shells meet.

A total of 819 items (505.4 grams) was recovered from Locus A and 24 specimens (15 grams) were recovered from Locus B. No baked clay was recovered from Locus C. By weight, 97% of the baked clay was recovered from Locus A. The high frequency of baked clay in Locus A is likely associated with exploitation of *Mytilus* sp. Table 9 provides a summary of the frequency and distribution of baked clay items recovered from Locus A. Figure 54 provides the frequency by weight of baked clay items for Locus A. Eighty-two percent (416.7 grams) of all baked clay was recovered below 110 centimeters depth. A cluster of several cooking features, high frequencies of FAR, higher percentages of baked clay, and increased artifact recovery rates at this depth indicate that the site was the focus of intensive shellfish processing and residential activities associated with a discrete living surface at this depth. Baked clay was probably the byproduct of *Mytilus* processing.

HUMAN SKELETAL REMAINS

Sandra Hollimon, Ph.D. and Alex DeGeorgey

Introduction

Archaeological testing of CA-MRN-44/H yielded one primary Native American inhumation (Burial 1) and 8 isolated human bone fragments (Table 10). The recovered skeletal remains represent a minimum of four individuals. Elements from one adult and one juvenile were found in Locus A. One adult male is represented in the skeletal remains recovered from Locus B. Burial 1 consists of the remains of an adult male. This burial was identified in Locus C. The overall condition of skeletal remains was relatively poor, consisting of small fragmentary elements that lacked primary context and were disassociated from well-dated components. These factors limit meaningful comparative analysis of the human remains at the site.

Human skeletal remains were first discovered on February 11, 2006, during mechanical trenching in Locus A on the east side of the Immigration Station Cove. Skeletal remains consisted of the proximal head of an adult right femur. Construction activities in the vicinity of the remains were halted immediately and a physical marker (i.e., exclusionary

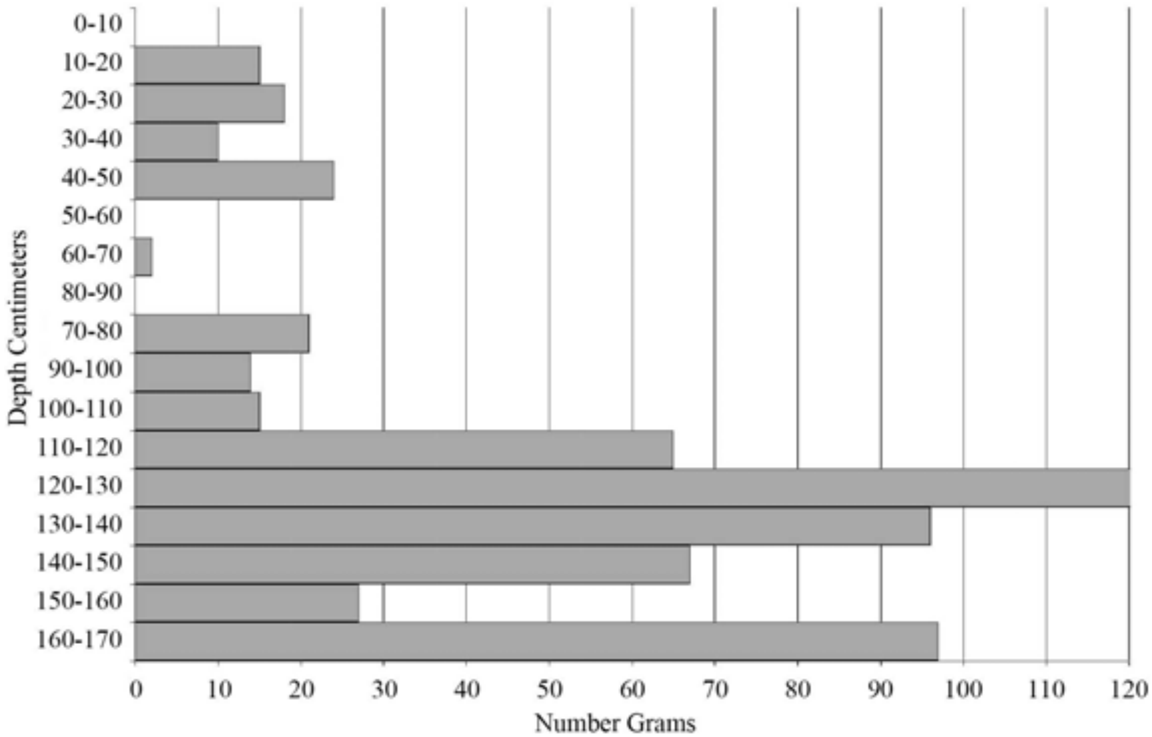


Figure 54. Distribution of Baked Clay Specimens by Depth in Locus A.

Table 9. Frequency and Weight of Baked Clay in Locus A.

Depth (cm)	S1/W0		S1/W1		S2/W0		S2/W1		Total	
	Wt.	N	Wt.	N	Wt.	N	Wt.	N	Wt.	N
0-10	0	0	0	0	0	0	0	0	0	0
10-20	11.9	9	4.6	4	1.5	1	1.1	1	19.1	15
20-30	0.6	11	0.1	1	0	0	1.6	6	2.3	18
30-40	6	8	0	0	0	0	1.1	2	7.1	10
40-50	5.9	24	0	0	0	0	0	0	5.9	24
50-60	0	0	0	0	0	0	0	0	0	0
60-70	0	0	0.2	1	0	0	0.8	1	1	2
70-80	0	0	0	0	0	0	0	0	0	0
80-90	1.8	12	8	5	5.1	2	1.8	2	16.7	21
90-100	0.2	1	0.8	2	11.9	11	0	0	12.9	14
100-110	0.7	1	2.7	2	2.9	1	11.9	11	18.2	15
110-120	16.4	9	8.4	10	11	16	18.1	30	53.9	65
120-130	25	10	17.7	26	43.8	56	32.5	252	119	344
130-140	9.6	9	9	7	42.6	45	21.5	35	82.7	96
140-150	2.8	4	35.8	42	7.9	11	8.6	10	55.1	67
150-160	2.7	2	7.8	10	13.7	11	2.5	4	26.7	27
160-170	2	19	7	9	43.2	40	27.3	29	79.5	97
170-180	1.2	2	0	0	4.1	2	0	0	5.3	4
Total	86.8	121	102.1	119	187.7	196	128.8	383	505.4	819

Notes: Wt. – Weight; N – Number.

Table 10. Inventory and Distribution of Human Skeletal Elements at CA-MRN-44/H.

Locus	Trench	Unit	Depth (cm)	Burial	Element	Description
A	-	S8/W1	90	-	Femur	Right, adult, fragment of head and neck
A	-	S1/W0	150-160	-	Metatarsal	4th metatarsal, adult, left, complete
A	-	S2/W0	160-170	-	Rib	Adult, three fragments
A	-	S2/W0	150-160	-	Molar	Lower right 1st molar, adult, complete, 3.2 grams
A	-	S0/W2	170-180	-	Molar	Lower right 2nd molar, adult, complete, 2.4 grams
B	-	-	180-240	-	Femur	Right, adult, fragment of head and neck, very large
B	16	-	20-30	-	Metatarsal	5th metatarsal, adult, right, complete
B	2	-	130-150	-	Talus	Left, adult, complete
C	13	-	500-550	1	Maxilla	Right, adult, fragment
C	13	-	500-550	1	Canine	Upper right canine, adult, complete
C	13	-	500-550	1	Premolar	Upper right 1st premolar, adult, complete
C	13	-	500-550	1	Mandible	Left, adult, fragment, 4 teeth
C	13	-	500-550	1	Canine	Lower left canine, adult, complete
C	13	-	500-550	1	Premolar	Lower left 1st premolar, adult, complete
C	13	-	500-550	1	Premolar	Lower left 2nd premolar, adult, complete
C	13	-	500-550	1	Cranial	Adult, fragments
C	13	-	500-550	1	Vomer	Adult, fragments
C	13	-	500-550	1	Sphenoid	Adult, fragments
C	13	-	500-550	1	Vertebra	2nd Cervical vertebra, 2 fragments, ventral arch
C	13	-	500-550	1	Vertebra	Lumbar vertebra, fragment, articular facet
C	13	-	500-550	1	Innominate	Right ishium and illium, 2 fragments, sciatic notch
C	13	-	500-550	1	Triquetral	Right, adult, complete
C	13	-	500-550	1	Metacarpal	3rd Metacarpal, right, adult, complete
C	13	-	500-550	1	Scaphoid	Left, adult, fragment

flagging) was erected to prohibit potentially damaging activities from occurring in this zone. In accordance with section 1064.5 of the California Environmental Quality Act (CEQA) and the California Health and Safety Code (section 7050.5), the Marin County Coroner was contacted immediately. The remains were determined to be Native American by their context within a known prehistoric archaeological site. The County Coroner notified the Native American Heritage Commission (NAHC) shortly after the discovery. Mr. Frank Ross, representative of the Graton Rancheria of Coast Miwok, was identified by the NAHC as the Most Likely Descendant (MLD). Mr. Ross worked closely with the DPR and the Principal Investigator to decide on an appropriate course of action for the proper treatment of the remains and grave associated artifacts.

At the direction of the MLD, none of the human remains, burial-related objects, or associated grave goods were photographed, subjected to destructive analysis, or removed from Angel Island. Non-destructive analysis such as descriptive morphological and metrical data was collected in the field. On April 21, 2006, Mr. Ross conducted a funeral ceremony and reburial. All human skeletal remains, presumed grave goods, and non-human bone were placed in a cardboard box and lowered into the bottom of excavation unit S1/W1, 170 centimeters. A modern carved wooden clapper stick and bundle of sage were added to the remains prior to reburial. A repatriation tube was set-up in case additional human remains were discovered at the site during project implementation. This repatriation tube consisted of a 6-inch diameter PVC pipe vertically aligned and situated in the northeast corner of unit S1/W0, at a depth of 170 centimeters. The top end of the pipe was exposed above the ground surface so additional items could be added at a later date. Skeletal remains recovered from Locus B and C were delivered to the Coast Miwok and reinterred at the designated burial site. Following the ceremony the repatriation tube was removed and the hole was backfilled with sterile soil.

Methods

Dr. Sandra Hollimon, James Mangold, and Alex DeGeorgey conducted field analysis of human skeletal remains. Studies followed the techniques presented by Bass (1987), Ubelaker (1978), and White (2000). Metric and morphological analysis focused on determining the age and sex, describing pathologies, and determining the Minimum Number of Individuals (MNI). A variety of nondestructive analytical procedures were used to study the skeletal remains. Descriptive data was collected on the skeletal morphology and a variety of quantitative measurements were taken. All analyses were completed in the field. Tools for osteological measurement included digital sliding and spreading calipers, cloth measuring tape, and in some instances a digital scale. Estimation of the biological age of individuals was completed based on changes in age-related skeletal developmental morphology. Determination of sex relied on pelvic anatomy and general robustness of skeletal elements. General observation of pathological conditions was completed for all elements. Upon completion of analyses all human remains were turned over to the MLD for final disposition at the site. Osteological data presented in the following analysis focuses on the nature, extent, condition, and location of human bone present at the site.

Burial 1

The remains of an articulated human burial were identified during monitoring of mechanical trenching in Locus C. The remains were discovered in Trench 13, at an estimated depth of 500-550 centimeters below surface, and were present within a very dark gray (10YR 2/1) clay-rich matrix. The orientation and position of the burial are unknown due to the happenstance associated with the discovery. A total of 20 elements was identified including portions of the maxilla, mandible, numerous teeth, cranial bones, ribs, the second cervical vertebra, portions of the innominate, triquetral, metacarpal, scaphoid, and cuneiform. These elements appear to be from an intact burial representing a single individual. No grave goods were clearly associated with the remains. This individual appears to be an adult male as suggested by the angle of the greater sciatic notch, morphology of the mental eminence, and general robustness of the mandible. Age at death was grossly estimated at 35 years based on fusion of cranial sutures and morphology of postcranial bones. Enamel wear on teeth also indicates an adult around this age and is consistent with other dental evidence, such as the lack of dental caries and periodontal disease, which are usually found in older individuals. There was no observable joint degeneration and there was no osteopenia, or loss of bone density, suggesting that this individual was no older than 45 years age. The following provides a description of the individual elements from Burial 1.

Fragments of the right maxilla included the alveolus of the second upper incisor, the canine, and third premolar. Although fragmentary, this bone appeared unweathered, and in relatively good condition. An isolated maxillary left canine and left third molar were recovered, which displayed similar enamel wear to the intact right canine.

The left half of a mandible was recovered that was broken near the mental eminence (protuberance). This element included the mandibular body, alveolus of all five teeth, the sublingual spines, and the mental fossa. The left canine, left first premolar, first premolar, and second molar were present in the mandible. Missing teeth were lost post-depositionally. The morphology of the mental eminence (chin) and robustness of the body suggests that this individual was male. Moderate wear on the tooth enamel indicates that the individual was around 35 years old at the time of death.

Fragments of cranial bones were recovered including portions of the temporal(s), maxilla, as well as very small pieces of interior cranial bones, such as the vomer or sphenoid. Specific identification of the interior cranial fragments was not possible due to the small size of the fragments.

An adult second cervical (axis) vertebra was recovered. This fragmentary specimen included the entire dens epistrophei and the left half of the vertebral arch. A small portion of the right vertebral arch was present, but could not be fitted to the left half due to post-depositional damage. Nevertheless, the two fragments most likely came from the same individual. The superior articular facet of a lumbar vertebra was also present, as were a number of fragments of ribs.

Two fragments of innominate were recovered consisting of the right ischium, right ilium, and sacroiliac joint articulation. These specimens were found articulated within the clay matrix making possible measurement of the greater sciatic notch. The opening of the greater sciatic notch measured about 70°, further indicating that this individual was male.

A right triquetral, a left third metacarpal, an left scaphoid, and a left first cuneiform were also recovered from this context. These elements all represent a mature adult, are probably derived from the same individual, and are associated with Burial 1.

Isolated Elements

Locus A

A fragmentary portion of an adult right femur was found among intact shell midden soils in Locus A, at S8/W1, 80-90 centimeters. Controlled excavations in the area of the find did not reveal additional skeletal elements. This fragmentary element consisted of the femur head, neck, and greater trochanter. The circumference of the femur head measured 12.1 centimeters and the neck circumference measured 8.0 centimeters.

A complete adult left fourth metatarsal was recovered from controlled excavations in S1/W0, 150-160 centimeters. This element was in good condition, measured 7.6 centimeters long, by 1.8 centimeters at the proximal end, and 1.2 centimeters at the narrowest point.

Three fragments of a single adult rib were recovered in S2/W0, 160-170 centimeters. Fragments were represented by the midshaft and no diagnostic elements were present.

Two complete teeth were recovered: a lower right first and a lower right second molar. Dental attrition was present on both teeth marked by extensive grinding and polish on the cusps. The first lower right molar weighed 3.2 grams and was recovered in S2/W0, 150-160 centimeters. The second lower right molar weighed 2.4 grams and was recovered in S0/W2, 170-180 centimeters. Dental attrition is common among prehistoric Native populations and is often attributed to coarse sand in the diet, usually introduced during acorn processing.

Locus B

An adult right proximal femur was found among disturbed shell midden soil during mechanical excavation for a proposed septic tank in Locus B, 1.8 to 2.4 meters below surface. This fragmentary element was broken near the proximal end of the shaft at the top of the intertrochanteric crest. The element was broken prior to being exposed by mechanical trenching. Major features present on the element include the femur head, neck, greater trochanter and lesser trochanter. The circumference of the femur head measured 14.2 centimeters and the neck circumference measured 10.0 centimeters. The relatively large size of the femur head suggests that the element belonged to an adult male.

A complete adult right fifth metacarpal was found among disturbed shell midden soils in Locus B, Trench 16, 20-30 centimeters. The element measured 5.6 centimeters long, and 1.2 centimeters wide at the narrowest part of the shaft. It identified by its small thin morphology and the presence of two basal facets on the proximal end.

A complete adult left talus was recovered during mechanical excavation of disturbed shell midden soil in Locus B, Trench 2, at 0.9 to 1.5 meters in depth. This specimen measured 5.1 centimeters long and 3.9 centimeters wide and was in good condition.

Chapter 7: Chronometrics

Establishing the time span of site use is fundamental to understanding any other aspect of prehistoric behavior. In this study, two independent lines of chronological evidence are explored: radiocarbon dating and obsidian hydration. The chronological sequence used here follows the Central California Taxonomic System (Bennyhoff and Hughes 1987) as revised in Dating Scheme D (Groza 2002). The results of radiocarbon studies are presented to establish temporal control of the site loci. Obsidian hydration data is used to compare with other chronometric data. This chapter concludes with a summary of the temporal components defined at the site based on a synthesis of dating methods.

RADIOCARBON DATING

A total of 14 samples was selected and submitted to Beta Analytic for radiocarbon dating (Appendix F). The Accelerated Mass Spectrometer (AMS) technique was used on 13 samples and the radiometric technique was used on one sample (Table 11). Radiocarbon dating focused on defining single component assemblages, identifying stratigraphic breaks, and recognizing discrete loci within the site deposit. When possible, samples were selected from well-defined cultural features with a high level of integrity that could be paired with obsidian hydration data and/or flotation analysis.

Five types of organic material were submitted for radiocarbon dating: marine shell (n=8), marine mammal bone (n=3), terrestrial mammal bone (n=1), charred wood (n=1), and an acorn hull (n=1). The majority of radiocarbon determinations were made on marine shell, which were calibrated using a local reservoir correction of 225 ± 35 (Stuiver and Reimer 1993). Figure 55 presents a summary of the radiocarbon age determinations and obsidian hydration values per individual locus at CA-MRN-44/H. Radiocarbon dates are presented as calibrated date ranges.

Locus A

A total of six samples was submitted for radiometric dating from Locus A. Samples were derived from controlled hand excavations and set at intervals along the profile in order to demonstrate the age of vertical strata from top to bottom. Five samples were derived from features and one sample (Beta-216413) was taken from a discrete lens of shell debris. One sample

(Beta-216346) used the radiometric technique to date charred wood remains from a fire hearth feature. The resulting date is out of sequence in the vertical profile and is more than 500 years younger than any of the other dates. For these reasons Beta-216346 is considered an unreliable radiocarbon date and was filtered from the following discussion.

Radiometric dating of Locus A successfully identified a single component assemblage, with a high level of integrity that is useful as an analytical context. Locus A has a coherent set of radiocarbon dates and is neatly paired with obsidian hydration values. Locus A demonstrates an age range of about 300 years beginning 1320 ± 40 BP and ending 1050 ± 50 BP. This situates Locus A within the Terminal and Late Phases of the Middle Period (Groza 2002).

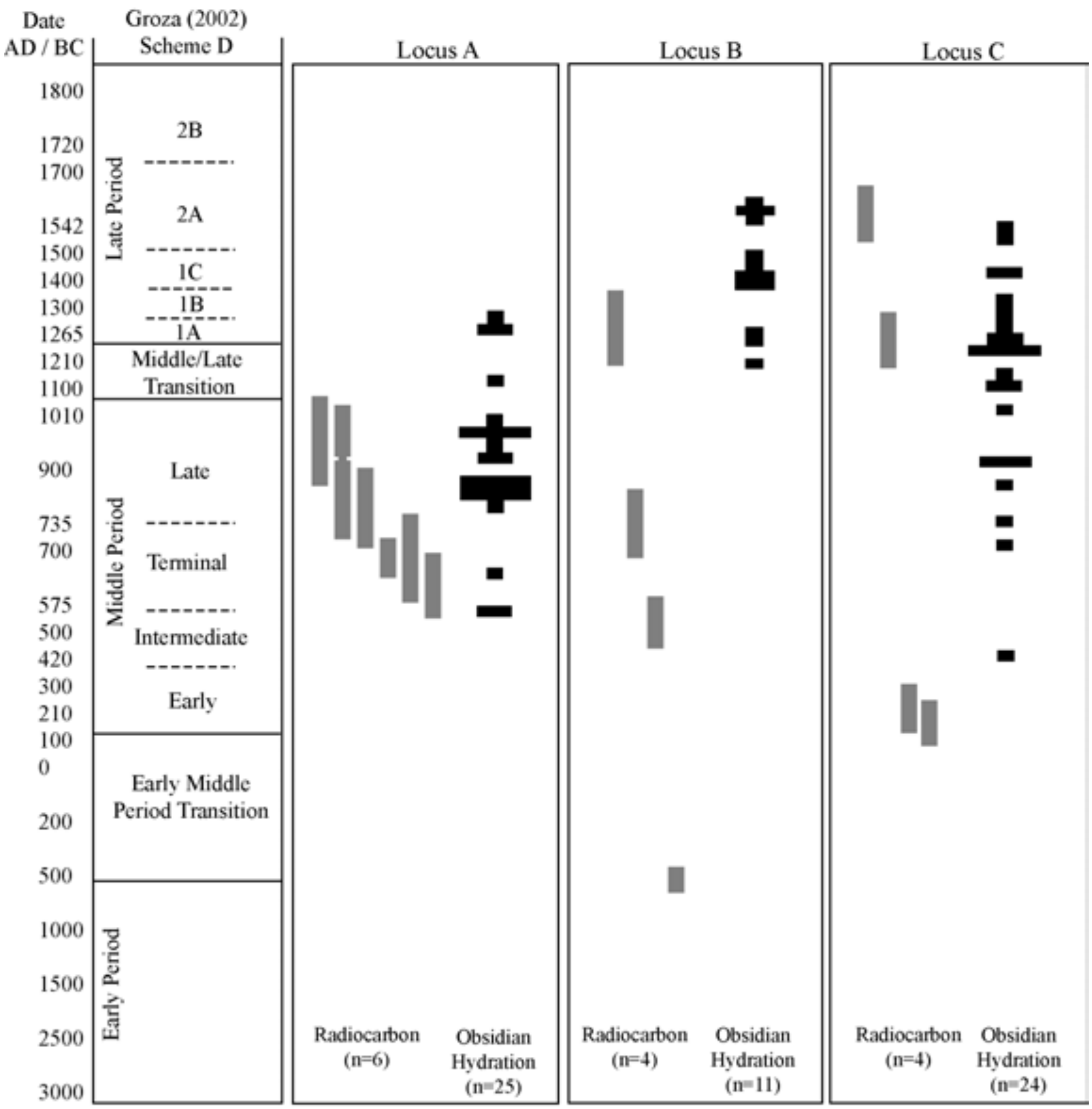


Figure 55. Summary Radiometric and Obsidian Hydration Results CA-MRN-44/H.

Table 11. Summary of Radiometric Dates from CA-MRN-44/H.

Lab # (Beta-)	Measured Age	Conventional Age	2 Sigma Calibration	Technique	Locus	Unit	Level	Feature	Material
216413	1320 ± 40 BP	1720 ± 50 BP	Cal AD 770 to 1030 (cal BP 1180 to 920)	AMS	A	S2/W1	60-70 cm	-	*Mytillus* sp.
216344	1450 ± 40 BP	1850 ± 40 BP	Cal AD 670 to 880 (cal BP 1280 to 1070)	AMS	A	S1/W1	40-50 cm	4	*Mytillus* sp.
216345	1550 ± 40 BP	1950 ± 40 BP	Cal AD 590 to 760 (cal BP 1360 to 1180)	AMS	A	S2/W1	100-110 cm	7	*Mytillus* sp.
216346	1220 ± 40 BP	1200 ± 40 BP	Cal AD 710 to 910 (cal BP 1240 to 1040) Cal AD 920 to 960 (cal BP 1030 to 1000)	Radiometric	A	S2/W1	140-150 cm	13	Charred wood
216347	1520 ± 50 BP	1940 ± 50 BP	Cal AD 580 to 780 (cal BP 1370 to 1160)	AMS	A	S2/W0	170-180 cm	18	*Nucella lamellosa*
216348	1600 ± 40 BP	2010 ± 40 BP	Cal AD 530 to 700 (cal BP 1420 to 1250)	AMS	A	S2/W0	170-180 cm	18	*Nucella lamellosa*
220056	2760 ± 40 BP	2950 ± 40 BP	Cal BC 820 to 740 (cal BP 2770 to 2690)	AMS	B	S0/W2	170-180 cm	-	Harbor seal tooth
220057	1460 ± 40 BP	1880 ± 40 BP	Cal BC 660 to 830 (cal BP 1290 to 1120)	AMS	B	S0/W2	170-180 cm	-	*Nucella lamellosa*
220058	1760 ± 40 BP	1980 ± 40 BP	Cal AD 330 to 510 (cal BP 1620 to 1440)	AMS	B	S0/W4	170-180 cm	-	Seal or seal lion
220059	980 ± 40 BP	1400 ± 40 BP	Cal AD 1130 to 1300 (cal BP 820 to 640)	AMS	B	S0/W4	170-180 cm	-	*Nucella lamellosa*
217284	320 ± 40 BP	280 ± 40 BP	Cal AD 1500 to 1670 (cal BP 450 to 280)	AMS	C	Trench 13	16-18 feet	-	Acorn hull
216692	1780 ± 40 BP	1850 ± 40 BP	Cal AD 70 to 250 (cal BP 1880 to 1700)	AMS	C	Trench 13	16-18 feet	-	*Odecolius heminous*
220060	2050 ± 40BP	2120 ± 40 BP	Cal AD 140 to 350 (cal BP 1810 to 1600)	AMS	C	Trench 13	16-18 feet	-	Large mammal tibia
218548	950 ± 40 BP	1350 ± 40 BP	Cal AD 1190 to 1330 (cal BP 760 to 620)	AMS	C	Trench 13	16-18 feet	-	*Halitiotis rufescens*

Locus B

A total of four samples was submitted from Locus B consisting of two Frilled dogwinkle shells (*Nucella lamellosa*) and two marine mammal bones. Samples were recovered during controlled hand excavations of a six-meter trench through shell midden matrix. Radiocarbon dates were paired with obsidian hydration, faunal analysis, flotation studies, and marine shell analyses. Two samples taken from the same location, unit S0/W2 170-180 centimeters, returned calibrated age estimates of 2730 ± 40 cal BP and 1230 ± 40 cal BP. Although the samples were taken from the same context, the dates are divergent by 1,500 years. Similarly, two samples taken from unit S0/W4 170-180 centimeters resulted in calibrated age estimates of 1530 ± 40 cal BP and 710 ± 40 cal BP. Overall, Locus B demonstrates an age range of more than 2,000 years. The high level of variability in radiocarbon dates suggests that: (1) this area was previously disturbed; (2) several temporal components have been commingled in the midden matrix; and/or (3) radiometric dating was influenced by site conditions. Crude oil was observed in the soil matrix distributed over a wide area in this locus. Cultural materials suitable for dating may have been contaminated with crude oil. It is highly likely that site conditions affected integrity of radiocarbon samples and greatly reduced the reliability of absolute dates from this locus.

Locus C

A total of four samples was submitted from Locus C: an acorn hull, a marine mammal bone, a deer bone (*Odocoileus hemionus*), and an abalone shell ornament (*Haliotis rufescens*; 44-767). Samples were recovered during exploratory backhoe trenching with a mechanical excavator. Artifacts and features were identified in the soils of Trench 13 at a depth of about 500-550 centimeters below surface. Samples were taken from a discrete dark gray colored clay soil that contained a high frequency of cultural items. Radiometric age estimates varied from 310 ± 40 BP to 1810 ± 40 BP, a range of 1,500 years. The lack of continuity in age estimates and the large range of dates are problematic for assigning Locus C to a particular time period, thus it is not considered to have a reliable set of radiocarbon dates useful for component definition. Soils above the artifact-bearing stratum were contaminated with crude oil, which may have affected the reliability of radiometric age estimates. Our understanding of the integrity of the deposit is further hindered by the lack of controlled excavation in this locus.

OBSIDIAN HYDRATION

Introduction

Obsidian has an affinity for water and maintains a molecular film of moisture on its surface. This moisture is chemically active and is absorbed inward from a freshly broken surface along a pronounced diffusion front, eventually producing a hydrated layer on the outer surface of the piece. This hydrated layer is chemically and physically distinct from the inner, non-hydrated obsidian. All else being equal, the thickness of the hydration layer is a function of elapsed time from the onset of hydration. In order to use the method to measure specific units of time, it is necessary to calibrate the rate of hydration rind formation to another, independent calendar measurement of time. To solve this problem, researchers have sought reliably dated archaeological contexts.

There has been considerable debate concerning the use of obsidian hydration analysis for absolute dating. Debates have centered on the differing mathematical models of the hydration process (Anovitz et al. 1999; Friedman and Trembour 1978; Freidmam et al. 1981; Michaels and Tsong 1980), the effects of obsidian geochemistry on the hydration process (Friedman et al. 1994; Mazer et al. 1991), and the influence of environmental factors (humidity, temperature, etc.). In addition, both laboratory-based induced hydration research and field-based empirical approaches to rate formula deviation have been employed with varying degrees of success (Hull 2001).

Several different obsidian hydration calibrations have been developed for the Napa Valley obsidian source including simple constant rate and regression formulas (Bouey 1995; Clark 1961; Ericson 1981; Michaels 1982; Origer 1982; Rosenthal 2006). Constant rate models appear to over-estimate the age of specimens with relatively small hydration rinds and under-estimate the age of specimens with relatively large hydrations rinds. Curvilinear models appear to overestimate the age of specimens with large hydration rinds. The Napa rate developed by Origer (1982) has seen the most widespread application in northern California. It was generated based on five radiocarbon-hydration pairings and a regression formula constrained by a theoretical diffusion model (Freidman and Smith 1960). Although this rate was considered “provisional” it has remained in use for more than 20 years.

Rosenthal (2006) developed a new formula to model the hydration rate of Napa Valley obsidian (Figure 56) utilizing over six times as many pairings as Origer’s (1982) formula. This study compiled 22 radiocarbon-hydration pairings generated from burial contexts, at 15 sites ranging in age between 3775 and 39 cal BP, located throughout the San Francisco Bay-Delta region of Central California. Rosenthal employed a theoretical diffusion model, [T=x2/k], where T=Years before present (BP), x=the rim value, and k=the hydration rate. The hydration rate formula is BP=148.7x2. Rosenthal concluded that: (1) the new rate only slightly diverges from Origer’s (1982) formula; (2) the model provided “age estimates within 200 years of the associated radiocarbon date” in 8 of 10 cases (2006:11); and (3) samples older than 3,000 years generate less accurate results.

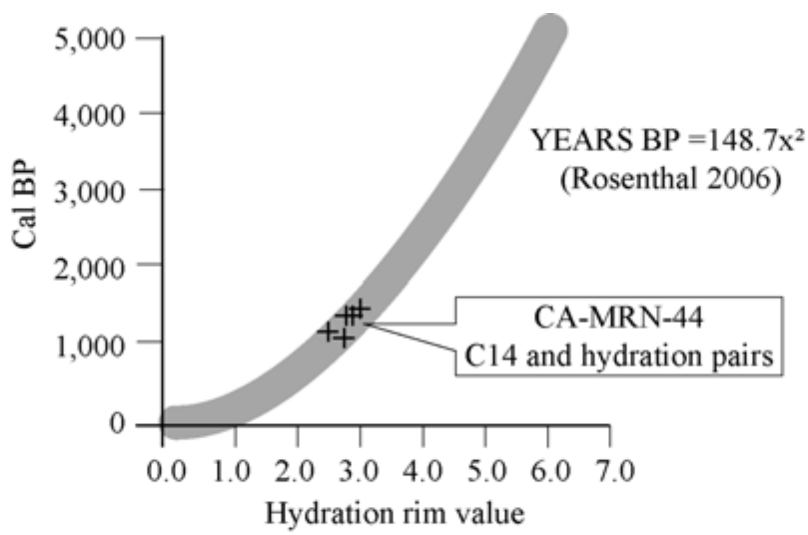


Figure 56. Napa Obsidian Hydration Rate Curve (Rosenthal 2006).

Methods

A sample of 65 specimens was submitted to Tom Origer of Origer's Obsidian Laboratory for obsidian hydration testing (Appendix G). Sixty-two items were selected for X-Ray Fluorescence (XRF) geochemical source determination and analyzed by Craig Skinner of Northwest Obsidian Studies Laboratory (Appendix C). Nearly all obsidian recovered at CA-MRN-44/H was derived from the Napa obsidian source. Previous researchers have noted that Napa obsidian is common in sites on the eastern side of the Marin Peninsula (Jackson 1974:70-71).

Independent analysis of Rosenthal's (2006) Napa Valley rate was completed based on radiocarbon data from CA-MRN-44/H. A total of five reliable radiocarbon-hydration pairs was generated from Locus A. These pairs were based on feature and stratigraphic coassociation, representing the intercept of the calibrated radiocarbon date and the average hydration rim value for each provenience determined to have stratigraphic integrity. The CA-MRN-44/H dataset includes five radiocarbon dates and 25 hydration rim readings from four contexts. All obsidian hydration rims were completed on Napa obsidian that was geochemically sourced using the XRF method. The AMS technique was used on all five radiocarbon samples. Radiocarbon assays on shell were calibrated using a local reservoir effect of 225 ± 35.

Results

Table 12 lists the five radiocarbon-hydration pairs from CA-MRN-44/H. The coefficient variation (CV) value is the standard deviation expressed as a percent of the mean and is an important measure of reliability. The CV value for each of the five pairs is quite low suggesting a reliability of these results. In Figure 56, Rosenthal's (2006) rate is represented as a gray regression line with hydration on the Y-axis and calibrated years BP on the X-axis. The five radiocarbon-hydration pairs are plotted at the intercept of the mean rim value and the calibrated radiocarbon date. Calibrated obsidian hydration dates tend to be slightly younger than associated AMS dates by 104-393 years. This is within the expected range of accuracy for the Napa Valley hydration model (Rosenthal 2006). There are multiple factors that can explain why the results differ slightly from the expectations

Table 12. Radiocarbon and Hydration Pairs from CA-MRN-44/H.

LAB # (BETA-)	CONVENTIONAL AGE	2 SIGMA CALIBRATION	INTERCEPT	FEAT.	MATERIAL	AVG. OH	NO.	RANGE	SD	CV
216344	1850 ± 40 BP	cal AD 670 to 880 (cal BP 1280 to 1070)	1180 BP	4	*Mytilus* sp.	2.3	8	1.5-3.8	0.8	0.3
216413	1720 ± 50 BP	cal AD 770 to 1030 (cal BP 1180 to 920)	1050 BP	-	*Mytilus* sp.	2.5	4	2.4-2.6	0.1	0
216345	1950 ± 40 BP	cal AD 590 to 760 (cal BP 1360 to 1180)	1280 BP	7	*Mytilus* sp.	2.7	6	2.4-3.0	0.2	0.1
216347	1940 ± 50 BP	cal AD 580 to 780 (cal BP 1370 to 1160)	1270 BP	18	*Nucella lamellosa*	2.8	2	2.8-2.9	0.1	0
216348	2010 ± 40 BP	cal AD 530 to 700 (cal BP 1420 to 1250)	1320 BP	18	*Nucella lamellosa*	2.8	2	2.8-2.9	0.1	0

developed in the Rosenthal model. The most likely explanation for the slightly smaller hydration rim values is influence of cool air temperatures present in the San Francisco Bay that slow down the rate of hydration.

Discussion

Many researchers have suggested that effective temperature and relative humidity are the most important variables effecting hydration rates. Lee (1969) posed the first Effective Hydration Temperature (EHT) formula for compensating for the thermal history of an obsidian item. Lee's equation made use of the mean annual temperature and the annual temperature range to solve for the environmental effective mean. Subsequent researchers have suggested that annual soil temperatures are a more important variable than the average annual air temperatures (Freidman and Long 1976; Mundy 1993). This seems to be a common concern particularly in buried contexts. Theoretically, the more deeply buried the obsidian specimen, the cooler the temperature and therefore the slower the hydration rate. If this were true, a piece of obsidian at 5 centimeters would hydrate faster than one at 150 centimeters below surface (Ambrose 1984; Freidman and Long 1976). Modeling EHT has lead researchers to suggest that obsidian exposed to the sun can be expected to hydrate five times faster than a sample at two meters below ground (Freidman 1976; Freidman and Obradovich 1981).

However, studies that compare hydration measurements of surface and buried artifacts do not appear to support these predictions. Observations made by Michaels (1965, 1969) showed no significant difference among hydration measurements from deeply buried and near-surface artifacts. Comparison of buried and surface projectile points from the Santa Rosa plain in Sonoma County (Origer and Wickstrom 1982:129) concluded that while hydration from surface contexts were slightly larger than buried specimens, there was no statistical difference between them. In accordance with these findings, Hall and Jackson (1989:44) observed minimal difference between surface and subsurface specimens in Inyo and Kern counties sites. In fact, they found that hydration means were consistently higher, with few exceptions, from subsurface contexts (Hall and Jackson 1989).

The precision of obsidian hydration dating seems to depend largely on knowledge of the thermal and humidity history of particular objects. Artifacts at different depths have undergone different temperature histories and possibly humidity histories. In addition, artifacts often undergo a number of disruptive processes after burial (Schiffer 1987) Compounding this issue is the fact that the "thermal history of an object after it entered the archaeological record…is virtually impossible to ascertain in most instances" (Hall and Jackson 1989:44). Therefore the basic assumption that objects found in relative stratigraphic positions have not changed through time often remains unexamined.

These observations suggest that fairly good results can be obtained from surface contexts and buried contexts should not vary considerably from buried contexts. Until all the factors affecting the hydration rate of an individual object are understood the method is best used as a relative-age technique when applied to surface specimens. Use of obsidian hydration to assign chronometric dates should therefore be considered tentative. Numerous factors may affect the obsidian hydration information. A brief summary of these variables is offered above. This summary illustrates the need for careful evaluation and checking against empirical data when using obsidian hydration results for dating.

Figure 57 provides obsidian hydration profiles for Napa obsidian from the three loci identified at CA-MRN-44/H. The profiles are arranged from smallest average rim value to largest. The gray line is plotted as the mean for all specimens per locus and illustrates the

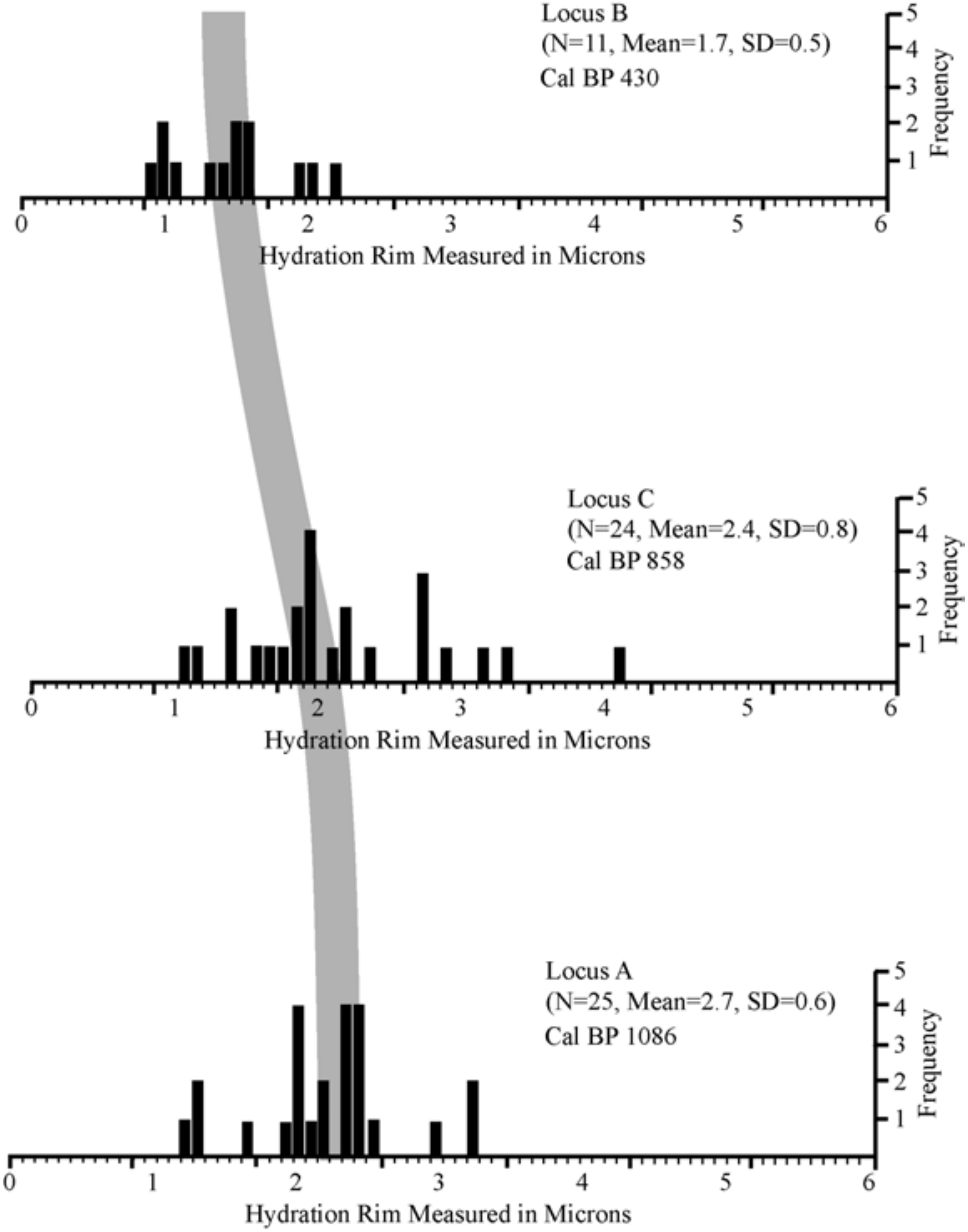


Figure 57. Obsidian Hydration Values per Locus at CA-MRN-44/H.

general trend of obsidian rim values. Locus B at the top has the lowest average hydration value. A total of 11 specimens was analyzed resulting in a range of 1.1 to 2.6 microns, a mean of 1.7 microns, and a low standard deviation of 0.5. Calibration of the mean hydration from Locus B resulted in an age estimate of 430 BP. This age estimate falls within Phase Two of the Late Period (Groza 2002).

At Locus C, a total of 24 obsidian samples was submitted, resulting in a range of 1.3 to 4.8 microns, a mean of 2.4 microns, and a standard deviation of 0.8. Conversion of the mean hydration resulted in an age estimate of 858 BP, which suggests that Locus C dates to the Middle/Late Transition Period (Groza 2002). Locus C has the highest standard deviation of the three loci at the site, possibly suggesting prolonged use of this component.

In Locus A, a total of 25 specimens was analyzed and resulted in obsidian hydration rim values that range from 1.5 to 3.8 microns, have an average 2.7 microns, and a low standard deviation of 0.6. Calibration of the mean obsidian hydration from this locus resulted in an age estimate of 1086 cal BP. Calibration of hydration rim values places Locus A within the Terminal Phase of the Middle Period (Groza 2002).

Chapter 8: Vertebrate Remains

Dwight D. Simons and Tim Carpenter

INTRODUCTION

Site CA-MRN-44/H has a large assemblage of vertebrate remains, especially those of fish, which allows detailed, quantitatively based analyses and interpretations directed at current zooarchaeological research issues pertinent to prehistoric central California. Among these are paleobiological themes/questions concerning zoogeography, extirpated species, and past environmental conditions. Paleoeconomic themes/questions include those regarding dietary composition and resource selectivity, seasonality of exploitation, vertebrate exploitative strategies, and procurement practices. All of these are discussed in the following both in terms of site-specific inferences and those focused upon regional patterning. Of particular concern is how these themes/questions are relevant to analyzing archaeofaunas occurring at island sites in San Francisco Bay and at sites located in southeastern Marin County, California.

MATERIALS AND TECHNIQUES

The archaeofaunal assemblage from CA-MRN-44/H includes fish, reptile, bird, and mammal remains derived from the site's surface, trenches, features, and excavation units placed in the midden. Upon receipt of the vertebrate remains, identifiable elements were segregated from unidentifiable specimens. The former were identified to order/family/genus/species level whenever possible. The fish, reptile, bird, and mammal bones were identified by Tim Carpenter, using comparative osteological collections maintained by the Department of Anthropology, University of California, Davis. Dr. Kenneth W. Gobalet, Department of Biology, California State University, Bakersfield provided consultation on the fish remains. Dwight D. Simons reviewed bird and small mammal identifications.

Faunal remains from three different loci (Locus A thru C) were examined. Faunal materials recovered during controlled excavation of the site were not examined. Sampling concerns are frequently noted with regard to small fish in and around coastal sites. These issues were addressed using one column sample (20 x 20 x 10 centimeters) in Locus A and smaller samples of material from Locus B and C. The entire column sample from Locus A was wet-screened through nested 1/4-inch, 1/8-inch, and 1/16-inch mesh. From Locus B a large sample was analyzed from two excavation levels (50 x 50 x 10 centimeters). Form the Locus B sample 100% of the 1/4 and 1/8-inch samples were analyzed, while only 50% from the 1/16-inch was examined. The Locus C sample consisted of a 5-liter grab sample from the soil stratum. A total of 100% of the 1/4-inch sample was examined, 50% of the 1/8-inch, and 25% from the 1/16-inch.

Following identification, various data were recorded for each identified specimen. These included: (1) taxonomic identity; (2) skeletal element; (3) side of the body or body segment represented; (4) configuration (that is, whole element, proximal portion, distal portion, and so forth); and (5) adult or juvenile status. No attempt was made to determine the sex of individuals. Additional observations included signs of cultural modification, including intentional breakage, presence of butchering marks, burning, polishing, striations, modification into an artifact, and so forth. If present, indications of non-cultural modifications, such as animal gnaw marks, weathering, and post-depositional breakage, also were noted for each specimen. After recordation, the data were tabulated and summarized. Skeletal element counts (NISP) were determined for each identified vertebrate taxon by tallying total numbers of identified skeletal elements assigned to each.

Fish that could not be identified to family, genus, and/or species level were assigned to the categories cartilaginous fishes and ray-finned (i.e., "Bony") fishes. Unidentified birds were placed into one of five possible size classes and unidentified mammal remains were placed into one of five size-classes (Table 13).

Table 13. Size Categories Used to Classify Unidentified Mammal and Bird Bone.

Animal Size Class	Types of Animals within size class	Weight
Very Small Mammal [a]	Mice, Voles	<50 g
Small Mammal [a]	Wood rats, Gophers	100–500 g
Small-Medium Mammal	Hares, Rabbits, Cottontails	700 g – 20 kg
Medium Mammal	Coyotes, Dogs, Sea otter	5–25 g
Medium-Large Mammal	Pronghorn, Deer	20–100 kg
Large Mammal	Elk, Sea lions, Harbor seal	>100 kg
Very Small and Small Birds [b]	Perching birds, Doves, Quail	>150 g
Small-Medium Bird	Teal, Grebes, Crow, Egret	>250 g
Medium Bird	Ducks, Gulls, Tern, Shoveler	>500 g
Medium-Large Bird	Ducks, Large raptors	>775 g
Large Bird	Geese, Sandhill Crane, Golden Eagle	<2,000 g

Notes: [a] Very small and small mammals are lumped in this analysis. [b] Very small and small avian fauna are lumped in this analysis.

Results

In all, 16,856 pieces of bone were analyzed. Nearly all of the specimens (greater than 90%) are fish. Moderate amounts of medium and medium to large sized mammal bone (mostly sea mammal) were also recovered. Specimens that could be identified to the level of Family or better were considered "Identifiable." A total of 4,018 identifiable fish, reptile, bird, and mammal elements was recovered, representing 37 taxa (Table 14). The 37 taxa include 25 (67.6%) fish species (leopard shark, bat ray, sturgeon, white sturgeon, herring, Pacific herring, Pacific sardine, northern anchovy, salmon, Chinook salmon, smelt, plainfin midshipman, Pacific tomcod, silversides, jacksmelt, rockfish, brown rockfish, ling cod, kelp greenling, cabezon, surf perch, rubberlip surf perch, shiner surf perch, striped surf perch, pile surf perch); two (5.4%) reptile (snake, western garter snake); one (2.7%) bird (cormorant); and nine (24.3%) mammal (i.e., rodent, meadow mouse, carnivore, sea otter, seal/sea lion, California sea lion, harbor seal, deer/elk, black-tailed deer) taxa. Among the 4018 identified bones, 3940 (98.1%) are fish, eight (0.2%) reptile, three (0.1%) bird, and 67 (1.7%) mammal. All the fish, reptile, bird, and mammal taxa are/were native to the vicinity of CA-MRN-44/H. Sea otters have been historically extirpated from the vicinity of the site. No historically introduced vertebrate taxa were observed.

Table 14. Fish, Reptile, Bird, and Mammal Taxa from CA-MRN-44/H.

Common Name	Vertebrate Taxa	Number of Specimens
Fish		
Leopard Shark	*Triakis semifasciata*	1
Bat Ray	*Myliobatis californica*	18
Sturgeon	*Acipenser* sp.	60
White Sturgeon	*Acipenser transmontanus*	24
Herring	Clupeidae	75
Pacific Herring	*Clupea pallasii*	37
Pacific Sardine	*Sardinops sagax*	74
Northern Anchovy	*Engraulis mordax*	665
Salmon	*Oncorhynchus* sp.	2,490
Chinook Salmon	*Oncorhynchus tshawytscha*	37
Smelt	Osmeridae	1
Plainfin Midshipman	*Porichthys notatus*	7
Pacific Tomcod	*Microgadus proximus*	4
Silversides	Atherinopsidae	20
Jacksmelt	*Atherinopsis californiensis*	45
Rockfish	*Sebastes* spp.	19
Brown Rockfish	*Sebastes auriculatus*	8
Ling Cod	*Ophiodon elongatus*	2
Kelp Greenling	*Hexagrammos decagrammus*	3
Cabezon	*Scorpaenichthys marmoratus*	6
Surf Perch	Embiotocidae	301
Rubberlip Surfperch	*Rhacochilus toxotes*	1

Table 14. Fish, Reptile, Bird, and Mammal Taxa from CA-MRN-44/H *continued*.

COMMON NAME	VERTEBRATE TAXA	NUMBER OF SPECIMENS
FISH CONTINUED		
Shiner Surfperch	*Cymatogaster aggregata*	4
Striped Surfperch	*Embiotoca lateralis*	28
Pile Surfperch	*Damalichthys vacca*	10
Fish Subtotal		3,940
REPTILE		
Snake	Serpentes	5
Western Garter Snake	*Thamnophis elegans*	3
Reptiles Subtotal		8
BIRD		
Cormorant	*Phalacrocorax* sp.	3
Bird Subtotal		3
MAMMAL		
Rodent	Rodentia	30
California Meadow Mouse	*Microtus californicus*	10
Carnivore	Carnivora	2
Sea Otter	*Enhydra lutris*	6
Seals/Sea Lions	Pinnipedia	1
California Sea Lion	*Zalophus californicanus*	3
Harbor Seal	*Phoca vitulina*	7
Deer/Elk	Cervidae	1
Black-Tailed Deer	*Odocoileus hemionus*	7
Mammal Subtotal		67
TOTAL IDENTIFIED BONES		4,018

The 37 vertebrate taxa include 33 (89.2%) that were economically significant to the prehistoric inhabitants of CA-MRN-44/H. The remaining four (10.8%) taxa are animals living and dying naturally on-site (snake, western garter snake, rodent, meadow mouse). The total bones representing economically significant vertebrate taxa (n=3970; 98.8%) overwhelmingly outnumber those of non-economically significant animals (n=48; 1.2%).

All the identified fish and bird bones (100% each) are from economically significant taxa. The reptile bones are totally (100%) of non-economically significant taxa. As for mammals, seven (77.8%) taxa, represented by 27 (40.3%) elements, are economically significant. They include carnivores, marine mammals, and artiodactyl herbivores. The remainder of the mammal remains (n=40; 59.7%) are non-economically significant rodents and meadow mice.

Undifferentiated and size-classed fish, bird, and mammal remains from CA-MRN-44/H total 12,015 elements (Table 15). As with vertebrate remains identified to taxa, those of fish dominate (n=11,268; 93.8%) over mammals (n=643; 5.3%), and birds (n=104; 0.9%). Among the fish, bony fish (n=11,238; 99.7%) overwhelmingly outnumber

Table 15. Undifferentiated and Size-Classed Fish, Bird, and Mammal Bones from CA-MRN-44/H.

GROUPING	FREQUENCY
FISH	
Undifferentiated Cartilaginous Fish	30
Undifferentiated Bony Fish	11,238
Fish Subtotal	11,268
BIRDS	
Small Bird	1
Small to Medium Bird	1
Medium Bird	2
Medium+ Bird	57
Medium to Large Bird	12
Large Bird	25
Large+ Bird	1
Bird Indeterminate Size	5
Bird Subtotal	104
MAMMALS	
Small Mammal	2
Small to Medium Mammal	4
Medium Mammal	37
Medium+ Mammal	157
Medium-Large Mammal	146
Medium-Large+ Mammal	5
Large Mammal	10
Mammal Indeterminate Size	282
Mammal Subtotal	643
TOTAL BONES	12, 015

cartilaginous fish (n=30; 0.3%). Within birds, Medium+ birds (n=57; 54.8%) are the most numerous size-classed category, followed by large birds (n=25; 24.0%), and medium-large birds (n=12; 11.5%). Small numbers of indeterminate-sized, medium, small, and small-medium birds occur (total n=10; 9.6%). Indeterminate-sized mammal bones (n=282; 43.9%) are most abundant. Medium+ mammal (n=157; 24.4%), and medium-large mammal (n=146; 22.7%) remains are common. Those of large mammals (n=10; 1.6%), medium-large+ mammals (n=5; 0.8%), small-medium mammals (n=4; 0.6%), and small mammals (n=2; 0.3%) are rare.

DISCUSSION – PALEOBIOLOGY

Extirpated Taxa

Today, sea otters (*Enhydra lutris*) occur in the North Pacific in the Commander Islands, Aleutian Islands, and along the southern coast of the Alaskan mainland. They currently are found along the central California coast between Half Moon Bay, San Mateo County, and Government Point near Santa Barbara (Estes et al. 2003:199; Leatherwood et al. 1978; Riedman and Estes 1988:10-11, 1990:77-81). The current total population size is approximately 2,000 animals, down from a mid-1990s high of about 2300 (Estes 1980:2; Estes et al. 2003:199-200[Figure 1]; Geibel and Miller 1984; Riedman and Estes 1988:11, 1990:76-77).

The original range of the sea otter was circum-North Pacific. In the west, it began at the island of Hokkaido Japan, extended north through the Kuril Islands and along the coast of Kamchatka, continuing east through the Commander Islands, Pribilof Islands, and Aleutian Islands to Prince William Sound, Alaska. From there, the range extended south along the west coast of North America to Morro Hermoso (27 degrees, 32 minutes North Latitude) on the Pacific Coast of Baja California (Anderson et al. 1996:6-7; Estes 1980:2-3; Kenyon 1969:133; Ogden 1941:6-7; Riedman and Estes 1988:7-12, 1990:73-75).

Sea otters prefer waters near rocky coasts with points of land/islets, bays/estuaries, large, underwater reefs, and sandy beaches, often with offshore kelp beds (Kenyon 1969:57; Zeiner et al. 1990b). Originally, otters were locally abundant at many points along the California coast, especially in central and northern California (DeMaster et al. 1996:80[Table 1]; Fisher 1940; Grinnell et al. 1937:288-291; Kenyon 1969; Laidre et al. 2001; Ogden 1933, 1941; Riedman and Estes 1988, 1990). Historic population estimates for California, based upon carrying capacity studies (cf., California Department of Fish and Game 1976; DeMaster et al. 1996; Laidre et al. 2001), suggest between 16,000 and 20,000 otters were present along the California coast (see also Anderson et al. 1996:6-7; California Department of Fish and Game 1976; DeMaster et al. 1996; Ralls et al. 1983:215; Riedman and Estes 1990:73) before European contact.

Historically, otters were especially numerous in the San Francisco Bay Area. Evermann (1923:525) observed they were particularly abundant around the Farallon Islands and in San Francisco Bay. Ogden (1933:221, 228, 235-236; 1941:7) noted San Francisco Bay abounded in sea otters, which frequented tidal estuaries, and hauled out on land. They were particularly abundant along the shores in the southern part of the bay. Otters were also present at Point San Quentin, at the mouths of the Petaluma River and Sonoma Creek, and in the San Jose, San Mateo, and San Bruno estuaries. Skinner (1962:155-156) echos Evermann's and Ogden's observations.

Evermann (1923:524-526), Fisher (1940, 1941), Ogden (1932, 1933, 1941), and Skinner (1962) detail historic-period exploitation of the sea otter along the California coast. During 1784-1786, intensive otter hunting began. From that time on, Spanish, Mexican, Russian, English, and American hunters and traders made inroads upon the large sea otter populations. By 1868, intense exploitation had drastically reduced sea otter populations along the California coast. Evermann (1923:525) estimated more than 200,000 otters were taken off the California coast between 1786 and 1868, representing an average annual take of about 2,400 animals. In contrast, Ogden (1941) estimated that 100,000 otters were killed between 1776 and 1911, an average of about 800 per year.

Skinner (1962:156) summarizes the history of sea otter exploitation in San Francisco Bay, noting that Russians were primarily responsible for hunting sea otters in this area. In 1811, they reportably obtained 1,200 otter skins from San Francisco Bay. After that date, there is disagreement on the numbers taken. During 1812, Evermann (1923:525), and Skinner (1962:156) observe that during some weeks the Russians killed 700-800 otters. They also note that during the first five years of sea otter exploitation, the Russians took 50,000 skins, and about 5,000 annually thereafter until 1831. Bryant (1915:99) makes a more conservative estimate, stating the Russians officially took only about 13,000 pelts from California, a figure cited by Grinnell et al. (1937). Whatever the actual numbers, over-hunting during the first half of the nineteenth century caused sea otter populations to decline swiftly in San Francisco Bay. This decline was first noted around 1820 (Skinner 1962:156). For about 15 more years, sea otters remained fairly abundant in San Francisco Bay, and their exploitation continued. Following 1850, they were extremely rare in the Bay Area, and by 1900 sea otters were extirpated from the region.

Past Environmental Conditions

Kuchler (1977) notes the natural vegetation of portions of the San Francisco Bay Area surrounding Angel Island included redwood forest (Zinke 1988), mixed hardwood forest (Griffin 1988), blue oak-foothill pine forest (Griffin 1988), chaparral (Hanes 1988), valley oak savannah (Griffin 1988), coastal salt marsh (Macdonald 1988), coastal prairie-scrub mosaic (Heady et al. 1988), and northern seashore communities (Barbour and Johnson 1988; see also Bowermann 1944; Burcham 1957; Griffin and Critchfield 1972; Howell 1970; Howell et al. 1958; Mayer and Laudenslayer 1988; Mayfield 1978, 1980; Munz and Keck 1973; Sawyer and Keeler-Wolf 1995; Sharsmith 1945; Shuford and Timossi 1989; Thomas 1961). Anderson (1960:361-362[Table 1]), Kuchler (1977), Ripley (1969), and Schoenherr et al. (1999:386-390) note Angel Island originally fostered several plant communities. Among these were mixed evergreen/hardwood forest, grassland, northern coastal scrub, chaparral, coastal strand, and freshwater pond.

Originally, Angel Island was heavily forested with extensive stands of mixed evergreen forest, and received the early name of Wood Island (Schoenherr et al. 1999:386). Between approximately 1835 and 1850, most of this forest was cut for timber and firewood. Currently, the island's upper slopes are characterized by grassland and open chaparral. These merge into dense chaparral and mixed evergreen/hardwood forest on lower canyon slopes. The island is dissected by several steeply sloping canyons, that lead to rocky beaches. Streamlets are present in the larger canyons and contain water throughout most of the year. During historic times, extensive planting of trees and shrubs, especially eucalyptus, has occurred.

Adjacent portions of southeastern Marin County had salt marsh, coastal prairie-scrub, chaparral, mixed hardwood forest, and redwood forest associations. Similar distributions of comparable vegetation associations for the East Bay Area, Santa Clara Valley, and San Francisco Peninsula are depicted by Mayfield (1978:38, Map 6, 1980:19) in somewhat more detail than Kuchler (1977). Unfortunately, Mayfield's maps do not portray the vegetation of Angel Island.

Data on habitat preferences of the fish, reptile, bird and mammal taxa from CA-MRN-44/H are found in Table 16. Most typically inhabited the suite of habitats historically present at Angel Island and environs: offshore rocks/sea cliffs; sea beaches/reefs/coastal waters; bays/estuaries; tidal flats/salt water marsh; grassland; mixed hardwood forest; and chaparral. The fish taxa occur in various immediately adjacent San Francisco Bay marine habitats, including estuaries/bays, inshore shallow to deep water, rocky bottoms/shores, sandy/muddy bottoms/shores, and tidal flats. Not surprisingly, a general preference for rocky shores/bottoms is evident.

Garter snakes are often found in damp habitats near water. Cormorants commonly use offshore islands and sea cliffs for roosting and nesting. They also often occur in coastal waters, and on reefs, sea beaches, and tidal flats.

Mammals from CA-MRN-44/H that would commonly frequent grasslands include meadow mice. Deer are principally found in chaparral/woodland habitats. The deer remains may either represent animals living on the mainland or on Angel Island. The marine mammals (i.e., sea otters, sea lions, harbor seals) inhabited the waters of San Francisco Bay, and undoubtedly often hauled out along the shoreline of Angel Island.

Table 16. Habitat Preferences of Fish, Reptile, Bird, and Mammal Taxa Present at CA-MRN-44/H.

TAXA	HABITAT PREFERENCES
FISH	
Leopard Shark	Common in bays, shallow water, and along sandy beaches. Abundant in San Francisco Bay.
Bat Ray	Found in bays, sloughs, and along open coast (flat rocky bottom and sand patches among rocks). Common inshore and in bays, and sloughs. Abundant in San Francisco Bay.
White Sturgeon	Estuaries: Deep areas with soft bottoms. May go into internal areas to feed at high tide. Most abundant in brackish areas of estuaries and move in response to salinity changes.
Pacific Herring	Schooling fish, goes into bays in winter and spring to spawn on eel grass, kelp, rocks. Feeds in pelagic zone.
Pacific Sardine	Schooling fish. Occurs mainly offshore. Migrates along coast. Spawns off shore.
Northern Anchovy	Schooling fish. Occurs in bays, not usually found in inshore areas.
Chinook Salmon	Transits through San Francisco Bay during annual spawning runs.
Smelt	Mainly open ocean. Surf spawners on sandy beaches.

Table16. Habitat Preferences of Fish, Reptile, Bird, and Mammal Taxa Present at CA-MRN-44/H *continued*.

TAXA	HABITAT PREFERENCES
FISH CONTINUED	
Plainfin Midshipman	Common in bays and inshore shallow to deep water over muddy/sandy/rocky bottoms. Abundant in intertidal zone in muddy bottom areas.
Tom Cod	Especially abundant in 30-90 m of water, with a sandy or firm sandy mud bottom. Often found in shallower water at 3-7 m, just outside surf zone, or in bays.
Jacksmelt	Occurs in schools with top smelt. Abundant in San Francisco Bay. Most commonly found in 1.5 to 15 m of water over sandy/muddy bottoms.
Brown Rockfish	Common in shallow water and bays with rocky bottoms to depths of 55 m.
Ling Cod	Common in open sea. Adults at/near bottom in close association with rocky substrate. Most abundant at depths less than 100 m. Young fish often in bays where the bottom is sandy.
Kelp Greenling	Bottom dweller found in relatively shallow water along rocky coasts and in kelp beds. Common intertidally and fairly abundant up to 25 m.
Cabezon	Inshore bottom dweller found in rocky habitats from tide pools to 75 m.
Surfperch	Mainly occur inshore along coast, especially in the surf zone or in bays.
Rubberup Surfperch	Found along rocky shores and in quiet waters of harbors and bays where seaweed and mollusks are abundant.
Shiner Surfperch	Most abundant in bays/estuaries around eel grass beds and areas with sandy/muddy bottoms. Also numerous in shallow inshore ocean waters along sandy shores where they form loose schools/aggregations.
Striped Surfperch	Common in rocky areas/coasts, kelp, and seaweed.
Pile Surfperch	Common along sandy/rocky shores and around kelp.
REPTILES	
Western Garter Snake	Often found in damp environments near water. Occurs in a great variety of habitats: grassland, brushland, woodland, forest. Usually feeds near freshwater habitats.
BIRDS	
Cormorant	Ocean; Seacoast; Bays, estuaries, harbors; Freshwater marshes, streams, and large lakes; Islands, islets, and cliffs for nesting.
MAMMALS	
Meadow Mouse	Occurs in valley grassland, open meadows, marshes, wet lowland meadows, and moist streamsides.

Notes: *Fish Data Sources:* Bane and Bane (1971); Baxter (1974); Blunt (1980); Fitch and Lavenberg (1971, 1975); Leet et al. (1992); Moyle (2002); Roedel (1953); Skinner (1962). *Reptile Data Sources:* Schoenherr et al. (1999); Stebbins (1966). *Bird Data Sources:* Cogswell (1977); Grinnell and Miller (1944); Grinnell and Wythe (1927); Grinnell et al. (1918); Josselyn (1983); Miller (1951); Shuford (1993); Skinner (1962); Small (1974, 1994); Zeiner et al. (1990a). *Mammal Data Sources:* Burcham (1957); Cowan (1956); Dasmann (1968); Daugherty (1966); Grinnell (1933); Grinnell et al. (1937); Ingles (1965); Jameson and Peters (1988); Leet et al. (1992); Longhurst et al. (1952); Orr (1972); Orr and Helm (1989); Zeiner et al. (1990b).

Zoogeographic Considerations

Small numbers of western terrestrial garter snake (n=3), California meadow mouse (n=10), and black-tailed deer (n=7) remains have been identified from excavations at CA-MRN-44/H. Schoenherr et al. (1999:398-399[Table 27]) note two salamander, a tree frog, three lizard, four snake, and four mammal species currently occur on Angel Island. Among these terrestrial vertebrates are garter snakes, meadow mice, and deer.

Schoenherr et al. (1999:415) comment that garter snakes are good swimmers and have been known to be inadvertently transported on rafts. Therefore, their occurrence on Angel Island is not surprising, given its proximity to the mainland. Meadow mice may have been introduced to the island in bales of hay (Schoenherr et al. 1999:404). Deer are good swimmers, or may have been taken prehistorically/historically to Angel Island by people who introduced them for food (Schoenherr et al. 1999:416).

Hooper (1944:62-66, Map 17) assigns meadow mice on Angel Island to the subspecies/race *Microtus californicus eximius*. Examination of 31 specimens from the island revealed the population was characterized by a long, broad brain case (Hooper 1944:62-66). It was noted this characteristic might allow their placement within a separate, insular subspecies/race. However, the Angel Island mice also share traits with mainland populations of meadow mice to the north and south, especially the former. Since the island mice occupy an area located between these two mainland subspecies/races, and because occasional interchange of individuals between Angel Island and the adjacent Marin mainland might possibly occur, Hooper reassigned the Angel Island population of California voles to their own unique subspecies *Microtus californicus eximius*.

DISCUSSION – PALEOECONOMY

Dietary Composition and Resource Selectivity

Fish

Table 17 presents numbers and percentages of the principal fish taxa present in the three loci at CA-MRN-44/H. In all three loci, salmon dominate. Herring/sardines/anchovies are abundant in Locus A and B, and not present in Locus C. Surfperch are relatively abundant in all loci. Other fish (i.e., sharks, rays, sturgeon, plainfin midshipman, jack limited assemblage of fish remains, with only four of the nine taxa represented.

Changes through time in fish procurement at CA-MRN-44/H are evident when the fish assemblage from Locus A, dated to the Terminal Phase of the Middle Period, is compared to that from Locus B, assigned to Phase II of the Late Period. In both loci, salmon comprise the majority of the fish, herrings/sardine/anchovies are common, surf perch are relatively abundant, and all other fish taxa occur in low ratios. However, through time, percentages of salmon and herrings/sardine/anchovies decline slightly. The ratio of surfperch increases, and that of sturgeon slightly increases. This suggests a slightly lessened emphasis upon catching migrating anadromous salmon and inshore/intertidal spawning herring/anchovy; and greater emphasis upon resident inshore/open water fishes.

Table 18 and Table 19 contain numbers of shark/ray and bony fish remains collected from CA-MRN-44/H, compared to five mainland southeast Marin County sites/components. A variety of fish occur at all these sites. Numbers of fish remains are highly variable. In part, this is a consequence of differing recovery techniques. Sharks, batrays, sturgeon, salmon, jacksmelt, and surfperch are the most commonly represented fish at mainland Marin sites.

Table 17. Numbers and Percentages of Principal Fish Taxa Present at Locus A, B, and C, CA-MRN-44/H.

FISH TAXA	LOCUS A	LOCUS B	LOCUS C
Sharks	-	-	1 (0.1%)
Rays	12 (0.5%)	5 (1.1%)	1 (0.1%)
Sturgeon	60 (2.4%)	24 (5.4%)	-
Herrings/Sardines/Anchovy	739 (29.6%)	109 (24.8%)	-
Salmon	1,356 (54.3%)	226 (51.5%)	847 (96.3%)
Plainfin Midshipman	7 (0.3%)	-	-
Jack Smelt	60 (2.4%)	5 (1.1%)	-
Rockfish	22 (0.9%)	5 (1.1%)	-
Surf Perch	239 (9.6%)	65 (14.8%)	40 (4.5%)
TOTAL	2,495 (100%)	439 (100%)	889 (100%)

Table 18. Shark and Ray Frequencies at Marin County Sites.

	MRN-44/H	MRN-14 [a]	MRN-17 [b]	MRN-20 [c]	MRN-254 [d] (LATE)	MRN-254 [d] (MIDDLE/LATE TRANSITION)	MRN-254 [d] (INTERMEDIATE MIDDLE)	MRN-254 [d] (MID-LATE PHASE MIDDLE)	MRN-255 [e]
Elasmobranchiomorphi	30	-	7	-	-	-	-	-	-
Leopard Shark	1	15	289	45	-	-	1	2	-
Smooth Hounds	-	30	-	-	-	-	-	-	-
Requim Shark	-	-	-	-	-	-	-	-	4
Rajiformes	-	-	-	-	-	-	-	-	7
Bat Ray	18	57	813	17	2	15	3	88	11
TOTAL	49	102	1,109	62	2	15	4	90	22

Notes: [a] Follett (1974:146-149). [b] Scott and Millerstrom (2003:6.16 to 6.54). [c] Follett (1957:69-70). [d] Scott (1998:181-183[Table 33]). [e] Gobalet and Miller (2000:12.2[Table 12.1]).

Table 19. Boney Fish Frequencies from Marin County Sites.

	MRN-44/H	MRN-14[a]	MRN-17[b]	MRN-20[c]	MRN-254[d] (Late)	MRN-254[d] (Middle/Late Transition)	MRN-254[d] (Intermediate Middle)	MRN-254[d] (Mid-Late Phase Middle)	MRN-255[e]
Sturgeon: *Acipenser*	84	4	300	12	29	233	85	349	16
Ray-Finned Fish	11,238	-	3,135	-	-	-	-	-	-
Herrings: Clupeidae	75	-	-	-	-	-	-	-	-
Pacific Herring	37	-	-	-	-	-	-	-	-
Pacific Sardine	74	-	-	-	-	-	-	-	-
Northern Anchovy	665	-	-	-	-	-	-	-	-
Smelts: Osmeridae	1	-	-	-	-	-	-	-	-
Salmon	2,490	-	53	-	3	51	11	58	7
Chinook Salmon	37	1	239	-	-	-	-	-	-
Steelhead	-	4	-	-	-	-	-	-	-
Plainfin Midshipman	7	-	12	-	7	-	-	16	-
Pacific Tomcod	4	-	-	-	-	-	-	-	-
Silversides: Athernidae	20	-	158	-	-	-	-	-	-
Jack Smelt	45	8	2,420	-	-	1	1	-	-
Rockfish: *Sebastes*	27	1	3	-	-	-	-	-	-
Lingcod	2	-	-	-	-	-	-	-	-
Kelp Greening	3	-	-	-	-	-	-	-	-
Cabezon	6	-	-	-	-	-	-	-	-
White Sea Bass	-	1	7	19	-	-	-	12	-
Surf Perch: Embiotocidae	301	5	456	-	1	-	-	3	-
Rubber Lip Surf Perch	1	-	-	6	-	-	-	-	-
Black Surf Perch	-	5	245	1	-	-	-	-	-
Redtail Surf Perch	-	3	-	2	-	-	-	-	-
Shiner Surf Perch	4	-	-	-	-	-	-	-	-
Striped Surf Perch	28	-	-	-	-	-	-	-	-
Pile Perch	10	-	53	8	-	-	-	-	-
Starry Flounder	-	-	-	16	-	-	-	-	-
Total	15,159	28	7,081	64	40	285	97	438	23

Notes: [a] Follett (1974:146-147). [b] Scott and Millerstrom (2003:6.16 to 6.54). [c] Follett (1957:69-70). [d] Scott (1998:181-183[Table 33]). [e] Gobalet and Miller (2000:12.2[Table 12.1]).

Table 20 has numbers and a percentage of principal fish taxa occurring at CA-MRN-44/H and those in southeast Marin sites/components with fish remains total 100 plus specimens. In contrast to CA-MRN-44/H:

- Sharks are abundant at CA-MRN-14 and -20.
- Bat rays dominate at CA-MRN-14, and are relatively common at CA-MRN-17, CA-MRN-20, and the Middle-Late Middle component at CA-MRN-254.
- Sturgeon dominate the three Middle Period components at CA-MRN-254, and are somewhat common at CA-MRN-20.
- Salmon are relatively uncommon or rare at all the Marin mainland sites.
- At CA-MRN-17, jack smelt comprise the majority of the fish assemblage.
- Starry flounder is somewhat common at CA-MRN-20.

Differences between CA-MRN-44/H and the Marin mainland sites largely appear to result from CA-MRN-44/H's location on Angel Island, which is surrounded by relatively deep water, and fringed by a rocky shoreline. In contrast, all the Marin mainland sites are situated in close proximity to sandy beaches, relatively shallow waters with sandy/muddy bottoms, and tidal flats.

Table 20. Numbers and Percentages of Principal Fish Taxa Present in Southeast Marin County Sites.

	MRN-44/H	MRN-14	MRN-17	MRN-20	MRN-254 (Middle/Late Transition)	MRN-254 (Intermediate Middle)	MRN-254 (Mid-Late Phase Middle)
Sharks	1 (<0.1%)	45 (33.6%)	289 (5.7%)	45 (35.7%)	-	1 (1.0%)	2 (0.4%)
Rays	18 (0.5%)	57 (42.5%)	813 (16.1%)	17 (13.5%)	15 (5.0%)	3 (3.0%)	88 (16.7%)
Sturgeon	84 (2.1%)	4 (3.0%)	300 (5.9%)	12 (9.%5)	233 (77.7%)	85 (85.0%)	349 (66.1%)
Herrings/Sardines/Anchovy	851 (21.7%)	-	-	-	-	-	-
Salmon	2527 (64.4%)	5 (3.7%)	292 (5.8%)	-	51 (17.0%)	11 (11.0%)	58 (11.0%)
Plainfin Midshipman	7 (0.2%)	-	12 (0.2%)	-	-	-	16 (3.0%)
Jack Smelt	65 (1.7%)	8 (6.0%)	2,578 (51.1%)	-	1 (0.3%)	1 (1.0%)	-
Rockfish	27 (0.7%)	1 (0.7%)	3 (0.1%)	-	-	-	-
White Seabass	-	1 (0.7%)	7 (0.1%)	19 (15.1%)	-	-	12 (2.3%)
Surf Perch	344 (8.8%)	13 (9.7%)	754 (14.9%)	17 (13.4%)	-	-	3 (0.6%)
Starry Flounder	-	-	-	16 (12.7%)	-	-	-
Total	3,924 (100%)	134 (100%)	5,048 (100%)	126 (100%)	300 (100%)	101 (100%)	528 (100%)

With respect to temporal trends in fish procurement characterizing Marin mainland site/components, most date to the Middle Period, and the Middle-Late Transition (Table 21). At CA-MRN-254, the bay ray ratio decreases between the Middle period and Middle/Late Transition times. That of sturgeon increases slightly, and that of salmon increase approximately 150%. Differences between Middle period and Middle/Late Transition fish assemblages at CA-MRN-17, -254, and -20/254 respectively, are probably the product of site location and access to different suites of fishes.

The fish assemblages from CA-MRN-254 and CA-SFR-04/H, Yerba Buena Island offer an opportunity to compare assemblages from sites located within the San Francisco Bay. Fish remains from both sites were recovered using comparable methods (Gobalet et al. 2004). Both sites date to comparable time periods (Arrington, personal communication, 2004).

Table 21. Temporal Assignment of Southeast Marin County Sites.

SITE	TEMPORAL ASSIGNMENT	SOURCE
MRN-3	Late and Terminal Middle Period, Middle-Late Transition	Bennyhoff (1994c:85-86 [Figures 8.3 and 8.4])
MRN-14	Middle and Late Periods, c. 2000-600 BP	Moratto (1974:85, 1984:275).
MRN-17	Middle Period, Appears Contemporaneous with MRN-27	Pahl (2003)
MRN-20	Middle-Late Transition and Phase I of Late Period	McGeein and Mueller (1955:62); Moratto (1984:272-273)
MRN-27	Middle Period, Appears Contemporaneous with MRN-17	King (1970:6); Moratto (1984:276-276)
MRN-115	Late Period	Meighan (1953); Moratto (1984:272)
MRN-254	Middle Period, Middle Late Transition, and Late Period	Bieling (1998:137-146)
MRN-255	Middle Period	Bieling (2000:9.1-9.14)

Table 22 presents numbers and percentages of the principal fish taxa occurring at CA-MRN-44/H and CA-SFR-04/H. At CA-MRN-44/H, salmon dominate, herrings/ sardines/anchovies are common, surf perch somewhat common, and other fishes (i.e., sharks, rays, sturgeon, plainfin midshipman, jack smelt, rockfish) rare. In contrast, surfperch, jacksmelt, and rockfish co-dominate at CA-SFR-04/H. Herring/sardines/ anchovies are somewhat common, and salmon, along with sharks, rays, sturgeon, and plainfin midshipman, are relatively rare.

Differences in the fish assemblages from these two San Francisco Bay Island sites are best explained by their locations. Angel Island is surrounded by relatively deep water and directly adjacent the main Chinook salmon migration route through San Francisco Bay (Skinner 1962:Plate IV). Its rocky shores and inshore waters provide spawning grounds for Pacific herring, and possibly northern anchovies. In contrast, Yerba Buena Island is situated within an expanse of open water containing a mix of deep water and tidal flats, as well as sandy/muddy and rocky bottoms, which provide favorable habitats for surfperch, rockfish, and jacksmelt (Gobalet 1990:240; Skinner 1962:Plate I).

Table 22. Comparison of Number and Percentage of Principal Fish Taxa Present at Two Bay Island Sites CA-MRN-44/H and CA-SFR-04.

	MRN-44/H	**SFR-04** [a]
Sharks	1 (<0.1%)	401 (3.0%)
Rays	18 (0.5%)	141 (1.0%)
Sturgeon	84 (2.1%)	61 (0.5%)
Herrings/Sardines/Anchovy	851 (21.7%)	1,186 (8.7%)
Salmon	2,527 (64.4%)	333 (2.5%)
Plainfin Midshipman	7 (0.2%)	408 (3.0%)
Jack Smelt	65 (1.7%)	3,776 (27.8%)
Rockfish	27 (0.7%)	3,318 (24.4%)
Surf Perch	344 (8.8%)	3,969 (29.2%)
Total	3,924 (100%)	13,593 (100%)

Notes: [a] Gobalet et al. (2004:821-814[Table 2]).

Birds

Table 23 presents bird remains from CA-MRN-44/H and 17 southeast Marin sites/ components. A total of 41 bird taxa is represented. These are predominantly waterfowl, generally dominated by ducks and geese. Cormorants are commonly represented. Loons, grebes, shorebirds, and murres often are fairly common. Along with corvids, a number of raptor taxa are represented by generally small numbers of elements.

The identified bird bones from CA-MRN-44/H only include three cormorant elements. This sample is too small for meaningful quantitatively based analysis. In southeast Marin, four mainland sites have avifaunal assemblages large enough (i.e., more than 100 identified bird bones) for quantitative comparisons (Table 24)

At these sites, waterfowl remains dominate (Table 25). In general, those of ducks and geese are most abundant. Loons, grebes, and cormorants are somewhat common. Cranes, coots, and gulls only occur at CA-MRN-17. Shorebirds are present in low numbers at most sites. Alcids are generally absent or rare, except at CA-MRN-43, where they dominate. Duck-goose/cormorant ratios highly favor ducks/geese at the three mainland sites and are somewhat equal CA-MRN-43, also located on Angel Island.

Sites CA-MRN-17 and -27 are located in close proximity to one another, and much of their catchment areas overlap (cf., Brown 1982:Figures 4-6; King 1974:52, Map 2). Both sites also appear to have been occupied year-round, more-or-less contemporaneously during the Middle Period (see Table 21). Although similar in some respects, with comparable duck/goose, shorebird, and alcid ratios, the avifaunal assemblages from both sites differ. Cormorant representation at CA-MRN-27 is twice that at CA-MRN-17. At CA-MRN-17, herons/egrets are more common, as are raptors. Pelicans, cranes, coots, and gulls occur at CA-MRN-17, and are completely absent at CA-MRN-27. Differences in the avifaunal

Table 23. Bird Remains from Marin County Sites.

	MRN-44	MRN-42 [a]	MRN-43 [a,b]	MRN-45 [b]	MRN-3 [b]	MRN-14 [b]	MRN-17 [c]	MRN-20 [d]	MRN-27 [b]	MRN-39 [b]	MRN-76 [b]	MRN-115 [b]	MRN-254 (LATE) [e]	MRN-254 (M/L T) [e]	MRN-254 (I M) [e]	MRN-254 (M-L PM) [e]	MRN-255 [f]	MRN-92 [b]
Loon	-	-	-	1	4	-	16	6	10	4	-	-	-	-	-	-	2	2
Grebe (Podiceps)	-	-	-	-	-	1	12	-	9	-	-	1	-	-	-	-	7	-
Greb (Podilymbus)	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
Western Grebe	-	1	1	-	1	-	4	2	9	1	-	2	-	-	-	-	2	1
Albatross	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pelican	-	-	5	1	1	-	5	1	-	-	1	-	-	-	-	-	-	-
Cormorant	3	-	13	13	5	1	39	5	42	4	-	4	1	-	-	-	5	10
Ciconiiformes	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Great Blue Heron	-	-	-	-	-	1	4	-	2	1	1	-	-	-	-	-	-	-
Green Heron	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Green Egret	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Snowy Egret	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Anseriiformes	-	-	-	-	-	-	51	-	191	-	-	-	25	3	24	4	41	-
Swan	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Goose	-	1	4	1	7	2	100	3	-	20	7	8	-	-	-	-	-	7
Duck	-	1	12	12	9	10	183	12	-	44	42	84	-	-	-	-	-	2
Falconiformes	-	-	-	-	-	-	9	-	-	-	-	-	-	-	1	-	-	-
California Condor	-	-	-	-	-	-	1	-	1	-	2	-	-	-	-	1	1	-
Turkey Vulture	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	1	-
Kite	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Hawk-Accipiter	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Hawk-Buteo	-	-	1	-	-	-	7	1	5	-	7	-	-	-	-	-	-	-
Hawk-Circus	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Osprey	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Bald Eagle	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Golden Eagle	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Blue Grouse	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
California Quail	-	2	-	-	-	-	-	-	11	-	-	-	-	1	1	-	2	-
Sandhill Crane	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	-	-
Clapper Rail	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
Coot	-	-	-	-	-	-	12	-	-	1	-	-	-	-	1	1	1	-
Plover	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 23. Bird Remains from Marin County Sites *continued*.

	MRN-44	MRN-42 [a]	MRN-43 [a,b]	MRN-45 [b]	MRN-3 [b]	MRN-14 [b]	MRN-17 [c]	MRN-20 [d]	MRN-27 [b]	MRN-39 [b]	MRN-76 [b]	MRN-115 [b]	MRN-254 (LATE) [e]	MRN-254 (M/L T) [e]	MRN-254 (I M) [e]	MRN-254 (M-L PM) [e]	MRN-255 [f]	MRN-92 [b]
Scolopacid Shorebird	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gull	-	2	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tern	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-
Murre	-	1	59	4	2	-	12	2	2	7	-	-	-	-	-	-	-	-
Guillemot	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Murrelet	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Owl	-	-	1	-	-	-	13	-	1	-	-	-	-	-	-	-	4	1
Crow	-	-	2	-	-	1	2	3	2	-	1	-	-	-	-	-	-	-
Raven	-	-	-	-	-	-	4	4	4	3	2	-	-	-	-	-	-	-

Notes: M/L T – Middle/Late Transition; I M – Intermediate Middle; M-L PM – Mid-Late Phase Middle.
[a] Simons (1983:28-29[Table 1]); [b] Simons (unpublished data); [c] Zogg (2003:5-23 to 5-26[Table 1]); [d] McGeein and Mueller (1955:60[Table 1]); [e] Valente (1998:163-172[Tables 28a-28j]); [f] Valente (2000:11.17-11.28[Tables 11.4-11.15]).

assemblages at CA-MRN-17 and -27 are hard to explain. King (1970, 1974; see also Moratto 1984:275-276) postulates CA-MRN-27 was occupied by people with ascribed social ranking, reflected in their cemetery patterning (see Kautz 1972 for a critique). If true, this may have affected avifaunal exploitation in as yet undetermined ways.

Comparison of anatid/cormorant ratios from CA-MRN-17, -27, and -115 (Table 25) reveals cormorants are more abundant at the two Middle Period sites. This contrasts with the Late Period site (see Table 21), CA-MRN-115. Ducks/geese overwhelmingly dominate its avifaunal assemblage, and ratios of loon/grebe, cormorants, and shorebirds are low. As detailed below, similar declines in cormorant abundance between Middle Period and Late Period sites/components have been documented in other parts of the San Francisco Bay Area (cf., Broughton 1999, 2002a, 2003, 2004; Simons 2004; Simons et al. 2002). Middle Period exploitation of cormorants apparently severely impacted their rookeries in San Francisco Bay on Alcatraz, Angel, and Yerba Buena Islands. Consequence cormorant population reduction and resource depression might have led to increased emphasis upon taking ducks and geese.

Mammals

Table 26 presents economically significant mammal remains from CA-MRN-44/H, and 10 southeast Marin mainland sites/components. Cetacean, terrestrial carnivore, marine mammal, and cervid elements occur. Prominent mammal taxa include sea otters, harbor

Table 24. Bird Remains from CA-MRN-17, -27, -43, -44/H, and -115.

	MRN-17	MRN-27	MRN-43	MRN-44/H	MRN-115
Loon	16	10	-	-	-
Grebe	21	18	1	-	3
Albatross	-	-	1	-	-
Pelican	5	-	5	-	-
Cormorant	39	42	13	3	4
Herons/Egrets	13	2	-	-	-
Anseriformes	337	191	16	-	92
Falconiformes	29	7	1	-	-
Cranes	18	-	-	-	-
Coots	12	-	-	-	-
Plovers	12	-	-	-	-
Scolopacid Shorebirds	10	3	3	-	2
Gulls	31		2	-	1
Alcids	13	3	59	-	-
Owls	13	1	1	-	-
Ravens/Crows	12	6	2	-	-
TOTAL	581	283	104	3	102

Table 25. Ratios of Principal Water Bird Taxa Present at Southeastern Marin Sites.

	MRN-17	MRN-27	MRN-43	MRN-44/H	MRN-115
Loon/Grebe	37 (7%)	28 (10%)	1 (1%)	-	3 (3%)
Cormorant	39 (8%)	42 (16%)	13 (14%)	3 (100%)	4 (4%)
Duck/Goose	337 (68%)	191 (72%)	16 (17%)	-	92 (92%)
Crane/Coot	30 (6%)	-	-	-	-
Shorebirds	10 (2%)	3 (1%)	3 (3%)	-	2 (2%)
Gulls	31 (6%)	-	-	-	-
Alcids	13 (3%)	3 (1%)	59 (64%)	-	-
TOTAL	497 (100%)	267 (100%)	92 (100%)	3 (100%)	101 (100%)

Table 26. Economically Significant Mammal Remains from Marin County Sites.

	MRN-44/H	MRN-3 (0-3 Feet)[a]	MRN-3 (3-6 Feet)[a]	MRN-3 (Feet Plus)[a]	MRN-17[b]	MRN-27[a]	MRN-254[c] (Late)	MRN-254[c] (Middle/Late Transition)	MRN-254[c] (Intermediate Middle)	MRN-254[c] (Mid-Late Phase Middle)	MRN-255[d]
Cetacea	-	-	-	1		-	-	-	-	-	-
Porpoise	-	-	-	-	17	-	-	-	-	-	-
Carnivora	2	-	-	-	-	-	-	-	-	1	3
Dog/Coyote	-	2	2	11	24	48	1		1	4	14
Gray Fox	-	-	-	-	1	2	-	-	-	-	-
Grizzly Bear	-	-	-	1	-	-	-	-	-	-	-
Black Bear	-	-	-	-	1	1	1	-	-	-	2
Raccoon	-	-	-	-	3	4	1	1	2	1	5
Striped Skunk	-	-	-	-	-	4	1	-	-	-	-
Sea Otter	6	5	25	28	110	90	-	-	-	-	2
Mountain Lion	-	1	-	1	-	2	-	-	-	-	2
Bobcat	-	-	-	-	3	8	-	-	-	-	-
Pinniped	1	-	-	-	-	-	-	-	-	-	-
Steller Sea Lion	-	-	-	1	-	-	-	-	-	-	-
California Sea Lion	3	7	40	16	9	-	-	-	-	-	-
Harbor Seal	7	8	10	5	110	48	-	-	-	-	-
Elephant Seal	-	-	-	-	-	5	-	-	-	-	-
Artiodactyl	5	-	-	-	-	-	16	4	25	14	27
Cervidae	1	-	-	-	-	-	2	-	3	2	15
Elk	-	2	4	2	13	25	-	-	1	-	2
Deer	2	38	67	179	197	189	25	2	20	17	24
Total	27	63	148	245	488	426	47	7	52	39	95

Notes: [a] Simons (Unpublished data). [b] Brandli et al. (1981:15-16[Figures 3-4]); Brown (1982:Figure 1). [c] Valente (1998:163-172[Tables 28a-28j]). [d] Valente (2000:11.17-11.28[Tables 22.4-11.5]).

seals, and deer. Dog/coyote, sea lion, and elk remains are often relatively abundant. A variety of terrestrial carnivores occur in small numbers.

The sample of economically significant mammal remains (n=27) from CA-MRN-44/H is too small for meaningful quantitative analysis. Numbers and percentages of mammal taxa present at three southeast Marin mainland sites located along the shores of Richardson's Bay are presented in Table 27. As noted previously, CA-MRN-17 and -27 largely share the same catchment, and appear to have been occupied year-round (more or less) contemporaneously during the Middle Period (see Table 21). Site CA-MRN-3 appears to have been inhabited during the Terminal Middle Period, and the Middle-Late Transition (see Table 9).

As with their avifaunal assemblages, the mammal assemblages from CA-MRN-17 and -27 exhibit both similarities and differences. Their sea otter and deer ratios are similar. Porpoise and sea lion remains occur at CA-MRN-17, and are absent at CA-MRN-27. Terrestrial carnivore and elk elements are more common at CA-MRN-27 than at -17. Elephant seal bones occur at CA-MRN-27, and are not present at CA-MRN-17. As with birds, these differences likely reflect differing exploitative emphases by the inhabitants of both sites conditioned by as yet unknown social, cultural, and environmental factors.

Table 27. Ratios of Mammal Taxa Present at Southeastern Marin Sites.

	MRN-3 (0-3 Feet)	**MRN-3 (3-6 Feet)**	**MRN-3 (6+ Feet)**	**MRN-17**	**MRN-27**
Porpoise	-	-	-	17 (3%)	-
Terrestrial Carnivore	3 (5%)	2 (1%)	13 (5%)	31 (6%)	69 (16%)
Sea Otter	5 (8%)	25 (17%)	28 (12%)	110 (23%)	90 (21%)
Sea Lions	7 (11%)	40 (27%)	17 (7%)	9 (2%)	-
Harbor/Elephant Seal	8 (13%)	10 (7%)	5 (2%)	110 (23%)	53 (12%)
Elk	2 (3%)	4 (3%)	2 (1%)	13 (3%)	25 (6%)
Deer	38 (60%)	67 (45%)	179 (73%)	197 (40%)	189 (44%)
Total	63	148	244	487	426
Sea Otter	5 (12%)	25 (27%)	28 (14%)	110 (36%)	90 (32%)
Deer	38 (88%)	67 (73%)	179 (86%)	197 (64%)	189 (68%)
Total	43	92	207	307	279
Elk	2 (5%)	4 (6%)	2 (1%)	13 (6%)	25 (12%)
Deer	38 (95%)	67 (94%)	179 (99%)	197 (94%)	189 (88%)
Total	40	71	181	210	214

Site CA-MRN-3, dug in three-foot levels, offers an opportunity to monitor changes in mammal exploitation occurring during the Terminal Middle Period and Middle-Late Transition. In the lowermost levels (six feet plus) of the site, deer dominate. Sea otter are somewhat common, terrestrial carnivores and sea lions less so, and harbor seals and elk rare. In the 3-6-foot level, deer decline to less than half the total mammal assemblage, terrestrial carnivores drop markedly, and seals/sea lions and elk greatly increase, along with sea otters. The topmost level, 0-3 feet, is characterized by deer regaining their dominance, elk remaining steady, terrestrial carnivores rebounding, harbor seals doubling their representation, and sea otters and sea lions dropping in numbers after their 3-6-foot level highs. Through time, total numbers of mammal bones decline by about two-thirds.

Following Broughton (1994, 1999, 2002a, 2002b, 2003) and Simons (1992), initial emphasis upon exploitation of terrestrial mammals at CA-MRN-3 during Terminal Middle Period times may have produced local population depression of deer and terrestrial carnivores. As a consequence, marine mammals were increasing emphasized. By Middle-Late Transition times, however, sea otter and pinniped populations were apparently depressed. Easing of hunting pressure on terrestrial mammals possibly produced population rebound, and hunting deer, elk, and terrestrial carnivores were again emphasized. Similar phenomena have been postulated for other parts of California and the Great Basin (cf., Broughton and Bayham 2003; Byers and Broughton 2004; Carpenter 2002; Hockett 2005; White 2005). Late Holocene climatic improvements have also been proposed as a possible contributing factor.

The majority of the economically significant prehistoric fish, birds and mammals present at CA-MRN-44/H probably were obtained from portions of San Francisco Bay lying within the catchment immediately surrounding the site. These include the fish, cormorants, and marine mammals. Terrestrial carnivores and cervids most likely were derived from chaparral and woodland habitats located on Angel Island or the adjacent Tiburon Peninsula. This is inferred from species habitat preferences (see Table 16) and their relatively small numbers in the faunal assemblage.

Angel Island may have provided a “platform” from which prehistoric peoples fished and hunted/harvested birds and mammals frequenting San Francisco Bay. Prey most likely often frequented the shoreline, inter-tidal zone, tidal flats, and deeper waters around the island. Other islands in the central part of San Francisco Bay, including Yerba Buena Island, Brooks Island, Alcatraz Island, and the Marin islands, also may have been “platforms” for harvesting fish, birds, and marine mammals. Detailed analysis of fish (Gobalet et al. 2004) and bird and mammal (Simons 2004) remains from Yerba Buena Island, and preliminary analyses of bird and mammal remains from CA-CCO-290 on Brooks Island (G. Coles, personal communication, 2001; Simons, unpublished data), CA-MRN-42, -43, and -44/H on Angel Island (Simons 1983; Simons unpublished data), and -611 on East Marin Island (Luby 1994) suggest this was the case.

Chronological data from these island sites (cf., Arrington, personal communication 2004; Banks and Orlins 1981:3.44-3.48; Hines 1983; Luby 1994) indicate they were initially occupied during the Late Middle and Middle-Late Transition Periods, approximately 1,300 years BP, with occupancy apparently often increasing in intensity through Late Period times. This use of island sites may be related to marine resource intensification/depression noted through time at mainland San Francisco Bay shore sites (cf., Broughton 1994, 1995, 1997, 1999, 2002a, 2002b, 2003, 2004; Lightfoot 1997; Simons 1992).

Vertebrate Exploitative Strategies

Fish

Gobalet (1990:239[Table 3], 1994:126[Table 1]) and Gobalet et al. (2004:812-814[Table 2]) present numbers of fish elements recovered from a large suite of prehistoric sites located along the shores of the San Francisco Bay: on the east side in Contra Costa and Alameda Counties, at the north end of the San Francisco Peninsula, Yerba Buena Island, and southeast Marin County. In general, sharks, rays, sturgeon, herrings/sardines/anchovies, salmon, jacksmelt, and surfperch are well represented at these sites. Sites in the Richmond vicinity, along Wildcat and San Pablo Creeks and the shore of Richmond Harbor, often have high numbers of sturgeon, salmon, bat ray, herring/sardine, and/or jacksmelt remains. Gobalet (1994:126-127) proposes that prehistoric peoples inhabiting some of the Richmond area sites should be termed “sturgeon eaters.” Given the preponderance of sturgeon remains at CA-MRN-254, the “sturgeon eaters” sobriquet has also been applied to its prehistoric inhabitants by Scott (1998:180).

Broughton (1997, 1999:42-48, 2002a, 2002b, 2003) analyzed fish remains from the Emeryville Shellmound, CA-ALA-309. This site contains an abundant zooarchaeological assemblage assignable to the time period of about 2800 and 700 BP Sturgeon remains dominate the fish assemblage (Broughton 1997:852[Table 3]). Bat rays, requiem sharks, and salmon also are abundant. Herring, jacksmelt, white seabass, and surfperch bones occur in very small numbers. The lack of representation of these taxa probably results from coarse-grained recovery methods, which prevented recovery of these small taxa.

Broughton focuses his analysis of the Emeryville fish upon sharks, bat rays, salmon, and sturgeon. To measure fishing efficiency through time, he computes a sturgeon index for each stratigraphic/temporal unit at CA-ALA-309. When plotted against time, the sturgeon index declines (cf., Broughton 1997:854[Figure 3], 1999:112[Figure 7.1], 2002a:67[Figure 3], 2002b:51[Figure 3.2], 2003:78[Figure 3]). This suggests lessened encounter rates for sturgeon, and decreasing efficiency of fish exploitation. It is postulated that human harvest pressure, and/or changes in the estuarine paleoenvironment of San Francisco Bay, caused sturgeon population decline.

Broughton discounts environmental change as a cause of sturgeon decline. He plots the distribution of sturgeon dentary widths by stratum at Emeryville (cf., Broughton 1997:857[Figure 5], 1999:114[Figure 7.4], 2002a:72[Figure 7], 2002b:51[Figure 3.3], 2003:81[Figure 6]). Both mean and maximum dentary widths decline significantly through time. It is concluded this indicates a significant decrease in the mean and maximum size of sturgeon caught through time by the inhabitants of the Emeryville shellmound occurred. This is regarded as additional support that the declining abundance of sturgeon through time at CA-ALA-309 was due to increasing fishing pressure. As time progressed, ever-smaller fish were caught.

Broughton (1997:858-859, 1999:48) concludes by noting:

- Data from Emeryville support the hypothesis that sturgeon decline resulted from an increasing harvest rate.

- Decreasing size of sturgeon through time indicates decreasing profitability of this resource.

These observations are seen as supporting Hewes's (1947, 1973) model of the long-term dynamics of Pacific coast fisheries. Focusing upon salmon, Hewes argues prehistoric exploitation of Pacific coast fishes profoundly impacted their population sizes. Intensive Native American fishing produced fish populations significantly lower than potential pre-human abundances. During the early historic period, when Pacific coast Native American populations were decimated by conflict and disease, a "resting period" for fish populations occurred. With harvest pressure greatly reduced, fish populations rebounded to levels greater than had existed for millennia. In the late nineteenth century, increasing catch-per-effort characterizing early historic commercial fisheries was a direct consequence of the increase/rebound of formerly depleted fish populations.

Birds

Broughton (1999:67-68, 2002a, 2003, 2004) analyzes bird remains from the Emeryville Shellmound, using the resource depression model as an explanation for changes in exploitative emphases through time. Focusing upon anseriform waterfowl (i.e., ducks and geese) and cormorants, Broughton employs several indices to plot temporal changes in their exploitation. For ducks and geese, these include the goose index (Broughton 2002a:69[Figure 4], 2003:77[Figure 3], 2004:34[Figure 10]), the large goose index (Broughton 2004:35[Figure 11]), and the scoter index (Broughton 2004:36[Figure 12]). It is noted that, at Emeryville the relative abundance of geese to ducks declines through time. In addition, the representation of large geese declines and the amount of scoters increases (Broughton 2004:39). These patterns of change appear unrelated to environmental changes (i.e., episodes of cooler climate, such as the Neoglacial and Little Ice Age) affecting duck and goose populations in California or their breeding locations in high latitudes (Broughton 2004:37-38). Instead, intensive hunting of waterfowl at Emeryville and other Bay Area sites is seen as negatively affecting population sizes and availability of larger geese leading to increased use of more distant sea ducks.

In the case of cormorants, the cormorant index (Broughton 2002a:74[Figure 8], 2003:81[Figure 7], 2004:40[Figure 13]), the adult/subadult cormorant index (Broughton 2002a:74[Figure 9], 2003:82[Figure 8], 2004:41[Figure 14]), and the Brandt's/pelagic cormorant index (Broughton 2004:42[Figure 16]) reveal that profound changes in cormorant exploitation occurred over time at Emeryville (Broughton 2004:43). It is thought that intensive rookery-focused harvesting resulted in a depletion of cormorant populations. It follows that as they became less available, cormorants became less important in local diets, there was a shift in the age composition of birds being taken, and there was a change in the proportional abundance of various cormorant species. Primarily resulting from intensive rookery-focused human harvesting, these changes included marked decline in the relative dietary importance of cormorants, the age composition of the birds being taken, and the proportional abundance of various cormorant species. Specifically:

- A precipitous decline in the cormorant index occurs at Emeryville through time.
- Through time, young cormorants essentially vanish from the archaeological record, indicating severe disruption/abandonment of local breeding colonies.

- Through time, the representation of local double-crested cormorants falls in comparison to non-local species (i.e., Brandt's and pelagic cormorants).

Broughton (2004:41-43) argues these changes are not associated with environmental shifts, climatic events, or estuarine changes in salinity or temperature.

Simons's (2004) study of bird remains from CA-SFR-04/H, and Simons et al's (2002) analysis of bird remains recovered from recent excavations at CA-ALA-309 and -310 supports many of Broughton's (1999, 2004) conclusions regarding changes in bird exploitation at Emeryville and other Bay Area sites. These studies found that intensive exploitation of cormorant rookeries by the inhabitants of CA-ALA-309 about 2,000-2,800 years ago, led to their abandonment or outright destruction. This probably occurred as a consequence of predation, combined with disturbance of nesting cormorant colonies by mere human presence. The latter alone often produces significant levels of nesting failure in seabird nesting colonies (cf. Ainley and Boekelheide 1990; Anderson and Keith 1980; Feare 1984; Jehl 1984; Sowls et al. 1980). During the late nineteenth century, hunting and egg gathering by Anglos produced highly similar impacts upon seabird nesting colonies in the San Francisco Bay Area (cf. Ainley and Boekelheide 1990; Ainley and Lewis 1974; Doughty 1971, 1974; Ray 1909). The result was marked decline of nesting colonies of cormorants, murres, and other seabirds on the Farallon Islands, and virtually complete destruction of mainland rookeries, such as at Point San Pedro in San Mateo County, California.

The overwhelming majority of the contemporary cormorant population (about 25,000-30,000 birds) in the San Francisco Bay Area currently nest on the Farallon Islands (Ainley and Boekelheide 1990; Ainley and Lewis 1974; Sowls et al. 1980). Cormorants nest in lesser numbers at a number of localities situated along the outer coast from Point Reyes south to northern Santa Cruz County, with none currently nesting around San Francisco Bay inside the Golden Gate (Sowls et al. 1980:180-211). Given high travel costs for prehistoric peoples living at CA-ALA-309 and -310 associated with reaching outer coastal rookeries, and the virtual impossibility of obtaining birds from the Farallon Islands (located 40 plus kilometers west of the Golden Gate) it is highly improbable cormorant rookeries utilized by prehistoric peoples living at the Emeryville sites were located outside San Francisco Bay. In addition to Angel Island, several other islands within San Francisco Bay could have served as cormorant nesting sites (cf. Broughton 1999:68, 2004:39; Howard 1929:380; Simons et al. 2002). These include Yerba Buena Island, Brooks Island, Angel Island, Alcatraz Island, and Red Rock (see Schoenherr et al. 1999:377-349 for descriptions). Early accounts of Yerba Buena and Alcatraz Islands indicate both are particularly likely sites for prehistoric and historic cormorant rookeries.

In contrast to Broughton's (2004:41-43) conclusions, it is argued a significant factor militating against sustained productivity of cormorants as a resource is their high susceptibility to El Nino events. The effects of El Nino upon cormorant and other seabird populations living along the coast of Peru are well known (cf. Ainley et al. 1988; Duffy 1983; Idyll 1973; Paulik 1971; Schneider and Duffy 1988; Valdivia 1978). Only recently, however, have direct links between El Nino and periodic seabird breeding failures and die-offs has been recognized as occurring elsewhere in the world (Ainley et al. 1988:1747-1748), including California (Ainley 1976; Ainley and Lewis 1974; Ainley and Boekelheide 1990; Anderson and Anderson 1976). These were fully demonstrated during the major El

Nino event of 1982-1983, which devastated seabird breeding colonies and reproductive attempts in many localities (cf. Ainley and Boekelheide 1990; Ainley et al. 1988; Barber and Chavez 1983; Duffy et al. 1988; Glynn 1988:321-322; Merlen 1984; Rahn and Whittow 1984; Schreiber and Schreiber 1983, 1984, 1989; Tovar et al. 1987; Valle and Coulter 1987; Valle et al. 1987).

During the 1982-1983 El Nino event, many seabirds abandoned their breeding grounds, ceased feeding, and starved or died. Some localities had total reproductive failure. This often produced dramatic declines in the abundance of many seabird populations. The nesting success of cormorants and murres was exceptionally low on the Farallon Islands (cf. Ainley and Boekelheide 1990; Ainley et al. 1988; Boekelheide et al. 1983, 1985; Briggs and Chu 1987; Briggs et al. 1983; Kaza and Boekelheide 1984; Pearcy and Schoener 1987:14424-14425), and along the Oregon coast (Bayer 1986; Graybill and Hodder 1985; Graybill et al. 1983; Hodder and Graybill 1985; Pearcy and Schoener 1987:14424-14425).

The vulnerability of cormorants and other seabirds such as murres to El Nino events combined with prehistoric over-hunting at rookeries makes them poor candidates for sustained yield exploitation. However, ratios of murres at CA-ALA-309 and -310 steadily increase through time relative to those of anseriform waterfowl (Simons et al. 2002). At these sites, murre ratios peak ca. 1,300-800, and 550-350 years ago. The complete lack of juvenile murres in the avifaunal assemblages from CA-ALA-309 and -310 indicates murre rookeries probably were not exploited. Consequently, murre populations may have been more amenable to long-term sustained harvesting.

Goose and duck ratios fluctuate through time at CA-ALA-309 and -310 (Simons et al. 2002). Duck ratios generally increase as time progresses while those of geese decline, a trend that becomes more marked after about 2000-1900 BP. This may reflect Broughton’s (1999, 2002a, 2003, 2004) conclusion that geese are a more highly ranked resource than ducks and were therefore over-hunted early on. At CA-ALA-309, ducks attain their overall lowest percentage ratio relative to geese, cormorants, and murres, between approximately 1100 and 1300 BP (Simons et al. 2002). Ingram (1998:107-109) notes that this time period coincides with a prolonged dry period in California and low river inflow into San Francisco Bay (see also Byrne et al. 2001; Ingram et al. 1996a, 1996b; conflicting interpretations, however, are presented by Goman and Wells 2000). She further suggests that several Bay shore shellmounds, including the West Berkeley shellmound, CA-ALA-307, may have been abandoned during this time. At this time, duck populations were probably severely impacted by drought conditions, reducing population numbers.

At CA-ALA-310, geese attain their overall lowest percentage ratio 550-350 years ago (Simons et al. 2002). Contra to Broughton (2004:37-38), this time period is well within the time period known as the Little Ice Age, which occurred approximately 650 to 150 years ago (Burke and Birkeland 1983; Curry 1969, 1971; Davis 1988; Denton and Karlen 1973; Denton and Porter 1970; Fagan 2000; Fullerton 1986; Grove 1988; Porter and Denton 1967; Scuderi 1987a, 1987b, 1990, 1993; Stine 1996). Colder, wetter climatic conditions characterizing this period probably strongly impacted geese, whose North American populations generally breed and nest during the summer at high latitude arctic tundra habitats in Greenland, Canada, and Alaska (cf. Bellrose 1976; Johnsgard 1975, 1978; Todd 1996).

Sargeant and Raveling (1992) note that weather, particularly snow storms, hail, flooding, and cold temperatures are a highly important mortality factor for most species of geese breeding in the Arctic. The greatest impacts appear to be upon prefledged young birds, which are especially vulnerable to periods of excessive cold temperatures. Disruption of nesting by any of these events is devastating to Arctic breeding populations of geese because annual nesting of geese in this region is restricted to a single, highly synchronized event with limited or non-existent potential for renesting. Consequently, arctic nesting waterfowl are less buffered from perturbations reducing their abundance, and often do not have a great potential for rapid population recovery. Owen and Black (1990:121-125) reach similar conclusions, stating weather conditions are the most important factor determining annual recruitment variability among waterfowl populations.

Many studies of the effects of weather upon Arctic breeding populations of geese (cf. Barry 1962; Blokpoel 1974; Carriere et al. 1999; Cooch 1961; Dau and Mickelson 1979; Davies and Cooke 1983; Kerbes 1986; McLaren and Alliston 1985; MacInnes 1962, 1966; MacInnes and Kerbes 1987; Mickelsonm 1975; Raveling 1978; Ryder 1970, 1971, 1972) note climatic factors are critical to the nesting success of birds with a relatively long nesting cycle during a short Arctic summer, since the length of the summer season is a major factor affecting annual goose recruitment. In particular, an increase of permanent snow banks, incipient glaciers, and a long duration of ice cover on small lakes produce conditions highly unfavorable for the breeding success of geese.

A late spring, which probably occurred frequently during the Little Ice Age, would reduce nesting density, clutch size, and numbers of hatchlings, yielding lower numbers of young, fledgling birds. Additionally, when geese are forced to delay their annual breeding because of late snow melt, less nutrients are available for egg production. Consequently, the Little Ice Age (circa 650-150 BP) probably profoundly affected goose breeding, nesting success, and annual population recruitment. This would have reduced populations of adult geese migrating annually from mid-fall to mid-spring into California. The archaeological consequence appears to be a greatly reduced proportion of goose remains approximately 350-550 years ago.

Shorebird ratios relative to those of anseriform waterfowl rise throughout the time span represented at CA-ALA-309 and -310, reaching their peak level ca. 350-550 years ago at CA-ALA-310 (Simons et al. 2002). Following Broughton (1999, 2002a, 2003, 2004), this may represent increasing intensification through time upon a lower-ranked resource. An alternate interpretation, also based upon an optimal foraging-intensification perspective, suggests resource "co-harvesting" (Simons 1992:87-88; Yesner 1976, 1981) of shorebirds and anseriform waterfowl was practiced by prehistoric peoples living at the Emeryville sites. This would have been facilitated by occurrence of anseriform waterfowl and shorebirds within the same suite of habitats present within the Emeryville catchment, making opportunistic resource "co-harvesting" and/or "prey switching" (Dwyer 1982) via interlinkage of hunting techniques and easily pursued fowling options.

Ducks and geese were the principal birds hunted prehistorically at southeast Marin sites. A strong secondary hunting emphasis included taking other waterfowl, especially murres, cormorants, grebes, and loons. Since most of these waterfowl occur in the same estuarine habitats, they probably comprised a single "prey package." The flocking behavior of these birds would have made them more-or-less equally vulnerable to mass harvesting with nets. These "mass capture" techniques (cf., Madsen and Kirkman 1988; Madsen and

Schmitt 1998) would have greatly increased energetic return rates, dramatically affecting dietary rank.

Additionally, co-occurrence of many waterfowl species made them likely candidates for "coharvesting" (cf., Simons 1992; Yesner 1976:274-275, 1981:162), and/or "prey switching" (Dwyer 1982; Simons 1992). Colonial nesting seabirds (i.e., cormorants, alcids) also would have been a "clumped" resource during certain times of the year, highly amenable to "mass capture" techniques. The virtual non-occurrence of juvenile cormorant or alcid remains at southeast Marin sites indicates seabird rookeries were probably not exploited to any significant degree. Other waterfowl taxa (raptors and corvids), were taken in smaller numbers at southeast Marin sites. In addition to Emeryville and the southeast Marin sites, similar avifaunal assemblages are reported from other prehistoric San Francisco Bayshore sites (cf., Brooks 1975; Eschmeyer and Schonewald 1981; Hall and Simons 1988; Howard 1929; Lieberson 1988; Luby 1994; McCrossin 1982; Simons 1979, 1980, 1981, 1985; Simons et al. 2000, 2002; Wilson 1993), suggesting the presence of a regionally specific prehistoric fowling pattern.

Mammals

Those advocating various exploitive models have debated prehistoric marine and terrestrial mammal hunting along the California coast. One primary focus has been the manner in which resource intensification/depression has structured exploitation of terrestrial and marine mammals. Broughton (1994, 1995, 1999, 2002a, 2002b, 2003) addresses prehistoric Bay Area resource intensification/depression, especially as manifested in the mammal remains from the Emeryville shellmound, CA-ALA-309. He uses foraging theory to analyze prehistoric resource depression, concluding that through time declines in prey capture rates result from foraging activities of prehistoric hunters. Two principal lines of evidence document prehistoric resource depression: temporal declines in relative abundance of highly return/high ranked species in the zooarchaeological record and declines in the mean age of prey species.

Prey yielding the highest returns and consequently morel highly ranked are those that are typically the largest in size. Consequently, it is expected that through time the relative abundance of large prey will decrease. However, resource depression may produce an *increase* in both high-ranked prey abundances and mean age. These phenomena are linked to variations in the behavior and development of prey species. A critical assumption is that prey are searched for simultaneously within a homogeneous resource patch. However, if different prey species are clumped, variations in clump returns determine the extent to which they are exploited and their consequent abundance in the faunal record. Through time, one should first note the exhaustion of well-defined local patches and increasing use of distant, less-depleted patches.

At Emeryville, elk provide an example of the depletion of local patches, manifested by decline through time of the elk index (Broughton 1999:115[Figure 8.3], 2002a:68[Figure 2], 2003:77[Figure 1]). Increasing use of distant resource patches is reflected in the deer index, which initially decreases, and then increases through time (Broughton 1999:116[Figure 8.4], 2002a:70[Figure 5], 2003:78[Figure 4]). It is concluded this represents initial exploitation and exhaustion of local deer populations, followed by increasing use of more distant animals. Sea otter indices are characterized by initial increase, followed by decline and an increasing proportion through time of adults to juveniles

(Broughton 1999:119-120[Figures 8.11 and 8.13], 2002a:75-76[Figures 10 and 11]). These trends are seen as reflecting initial emphasis upon hunting aggregated females and young, and consequent disruption of breeding resulting from loss of breeding colonies. Through time, the "mean utility" indices for deer at Emeryville increase (Broughton 1999:117[Figure 8.7], 2002a:71[Figure 5], 2002b:55[Figure 3.6], 2003:79[Figure 5]). It is concluded that if the resurgence in deer through time at Emeryville indicates ever-increasing use of distant patches, it should be associated with increasing relative frequencies of high utility body parts, with field processing of deer carcasses at kill sites increasingly emphasizing removal of low-utility body parts from the transported carcass.

Citing earlier work (cf., Hildebrandt 1981, 1984; Jobson and Hildebrandt 1980), Hildebrandt and Jones (1992, 2002), Hildebrandt and Levulett (1997), and Jones and Hildebrandt (1995) contend prehistoric marine mammal hunting along the California coast is a classic example of a "tragedy of the commons." Through time, marine mammals were over-hunted. This led to the disappearance of easily accessible mainland breeding sites/rookeries, and increased hunting of smaller, more elusive species. A shift from an emphasis upon colonial migratory breeders (i.e., fur seals and sea lions) to resident breeders (i.e., sea otters and harbor seals) occurred. This was accompanied by a gradual increase in the sophistication of hunting techniques, as hunters were increasingly forced to pursue prey found in less accessible locations. The use of watercraft often was involved, reaching its zenith in Northwest California and the Channel Islands since elimination of mainland breeding colonies left offshore locations as the only viable pinniped breeding sites. Coastal areas without offshore rocks/islands were left with resident sea otters and harbor seals as primary prey. At sites located around estuaries, such as San Francisco Bay, resident breeders have always greatly outnumbered migratory breeders.

Lyman (1988, 1989, 1991a, 1991b, 1995) critiques the Hildebrandt-Jones thesis. He argues that (especially Lyman 1995:73) prehistoric hunting probably modified land-use patterns of marine mammals along the west coast of North America. He states however, the extent to which this occurred is unclear, owing to extensive disruption during the historic period of marine mammal populations in this region. Consequently, the Hildebrandt-Jones model needs to be tested using demographic data on prehistoric marine mammal populations. Lyman concedes migratory breeders probably could not reproduce at rates allowing prepredation levels to be maintained, and concludes this prehistoric "tragedy of the commons" may be most applicable to California.

Wake and Simons (2000) analyze mammal remains from Duncan's Point Cave (CA-SON-348/H) on the northern California coast, which was seasonally occupied through much of the Holocene. High numbers of juvenile seal and sea lion remains suggest mainland rookeries were accessible and exploited. Wake and Simons (2000:310) note both the Hildebrandt-Jones scenario of marine mammal exploitation and Broughton's resource intensification model are not supported by data from Duncan's Point Cave. Instead, changes in the site's shellfish and avifaunal assemblages suggest that during the Holocene, profound environmental and topographic changes occurred, especially those produced by sea level rise and coastal erosion. These are viewed as causing significant habitat changes within the site's catchment area, significantly affecting the exploitation of mammals as a food source.

Simons (1992) considers prehistoric mammal exploitation in the San Francisco Bay Area, as manifested at Middle and Late Holocene sites in southeastern Marin County, the northern San Francisco Peninsula, the Coyote Hills, and the Richmond-Oakland Bayshore. Through time, an overall decline in artiodactyls and an increase in marine mammals occur in the archaeological record. Sea otters increase through time relative to harbor seals, falling off again during the Late Period. Otters increase through time relative to deer, which decrease. These observations correspond to those noted by Broughton (1994, 1999, 2002a, 2002b, 2003) at Emeryville.

Simons (1992:82-84) argues intensification upon various mammal species, through time, was in large part a response to long and short-term resource predictability, which could profoundly affect prehistoric resource procurement. Through time, increasing emphasis appears to have been placed upon vertebrate resources buffered from interannual climatic variability most strikingly exemplified by El Nino events. Consequently, it could be argued that prehistoric Native Californians developed subsistence adaptations comprised of interlinked strategies and mechanisms, which worked, in concert to offset natural resource predictability problems. These included:

- Intensified focus upon key storable resources.
- Retention of a "broad spectrum" pattern of resource procurement.
- Use of coharvesting and prey switching hunting strategies.
- Use of different exploitive strategies as circumstances warranted.
- Simultaneous use of subsistence resources occurring within the same habitats by two or more groups.
- Employment of resource management techniques to enhance availability, productivity, and predictability of resources.
- Food-sharing.
- Maintenance of relatively small socio-political groups.
- Elaboration of trade and exchange.
- Development of managerial elites.

Through time, Native Californian subsistence adaptations were increasingly channeled into various resource intensification scenarios, which provided solutions to the resource predictability dilemma and associated manifestations of subsistence stress.

Simons (1992:86-87) suggests harbor seals and sea otters probably displayed the lowest degree of interannual unpredictability. Estuaries such as San Francisco Bay would have provided prime habitats for seals and otters and would have been major birthing areas and nurseries for young-of-the-year. The Bay would have provided abundant food, lesser natural predation than the open, outer coast, and habitats with relatively stable interannual predictability.

Lyman (1989:77, 1991a:157, 1995:59), citing Godsell (1988), Lawson and Renouf (1987), and Newby (1973, 1978), see also Fancher (1979), notes harbor seals form breeding colonies. Newborn seals often are found in nursery groups and breeding colonies, and nursing females frequently return to these loci to feed their young. These localities are reliable, predictability located resource patches. Broughton (2002a:73, 75), following Riedman and Estes (1990:48, 68) and Sandegren et al. (1973), notes sea otters form "nursery groups," in which resting mothers and pups aggregate and there is a tendency for otters to form tightly to loosely, generally sexually segregated groups, i.e., "rafts" (Estes 1980; Kenyon 1969; Riedman and Estes 1990:48-50).

Faurot (1985:337), Kenyon (1969:102-103), and Riedman and Estes (1990:24) note sea otters and harbor seals often haul out on the same rocks and rest or sleep near each other. Both species appear to ignore one another and seem to prefer slightly different resting places. Rocks frequented by seals and otters are characterized by low relief, and easy access to water. Otters are usually found on rocks with heavy algal growth, while seals haul out on rocks with or without algae. Sea lions, in contrast, usually prefer rocks with higher relief.

The behavioral attributes of harbor seals and sea otters suggest both were available to be hunted using a "coharvesting"/prey switching" strategy. Yesner (1981:162; see also Yesner 1976:274-275) defines "coharvesting" as follows:

Another feature of the Aleut exploitation pattern is what I term a "coharvesting" strategy. Optimal foraging theory predicts that any prey encountered that has a low handling cost, or a handling cost/benefit ratio below a given level, will be harvested. "Coharvesting" is a type of optimal foraging when additional species are obtained as part of the same general hunting procedure. For example, desert hunters returning unsuccessfully from a large mammal hunt may capture and kill a tortoise or porcupine that they discover along their path, so as not to return empty-handed. Ross (1978) has recently demonstrated that among Amazonian groups for which fishing is the major focus, mammals may be acquired when they are encountered during fishing trips. In the inter-island passes, large species such as albatrosses, yielding high return for handling costs, tend to congregate with smaller species, including both shearwaters and fulmars. Exploitation of shearwaters and fulmars would then be advantageous because of low additional handling costs to items already being harvested. In fact, a similar argument may apply to all of the birds being hunted in the island passes. All of these species were probably important primarily as dietary supplements, rather than as objects of specialized hunts. They may have simply been obtained in the island passes from boats returning empty-handed from sea mammal hunts at nearby rookeries. Thus, all of these species would have been exploited as part of an optimal "coharvesting" strategy.

Dwyer (1982) notes hunters often switch their efforts from pursuing one prey species to another as circumstances warrant, making hunting episodes highly opportunistic events. Simons (1992) argues these hunting strategies are critical elements of resource intensification/optimization.

As noted previously, at southeast Marin sites, the exploitation of marine mammals and terrestrial carnivores appears to have been emphasized. At CA-MRN-17 and -27, it has been noted previously that significant differences can occur between sites sharing spatial and temporal contexts. Broughton (2002b:58) acknowledges localized differences in the abundances of particular taxa of vertebrate prey can be important factors determining potential impacts of hunting on vertebrate population, and for long-term changes in hunter/gatherer foraging strategies. Important variables in this regard include presence/absence of resource patches within a site's foraging radius; the distance to patches containing particular prey taxa; and occurrence of inter-group "buffer zones" and other aspects of territorial boundary dynamics. Also as noted above, the mammal fauna from CA-MRN-3 apparently provides an example of artiodactyl "rebound" also witnessed at Emeryville (cf., Broughton 1999, 2002a, 2002b, 2003).

Seasonality of Exploitation

General Observations on Seasonality Determinations

Monks (1981) observes direct and indirect estimation techniques are utilized for seasonality studies in archaeology. The simplest, most commonly used direct method is noting presence-absence of seasonally available species. Monks (1981:180-185) profiles this technique with respect to different types of presence-absence data from which seasonality estimates have been made, ways in which presence-absence data have been interpreted, and archaeologically focused applications of these interpretations. Monks (1981:185) concludes his discussion with the following cautionary statement:

> An awareness of the limitations of the various data is thus critical in order to avoid spuriously accurate results. In particular, a healthy skepticism should be maintained with regard to the "usual" season or time of a species' availability or a phenomenon's occurrence. Seasonal events often occur over considerable periods of time, and complex factors may influence the times of their onset and cessation from year to year. In light of the foregoing considerations, it is evident that the investigator must exercise considerable care in estimating seasonality, even with the simplest of methods. [Monks 1981:185]

These concerns are echoed by Grayson (1984), Grayson and Thomas (1983), and Thomas (1986). In particular, they question extrapolation of data obtained from contemporary studies of migratory animals, especially birds, to prehistoric contexts.

In response to the Grayson-Thomas critique, Simons (1990:42) contends presence-absence seasonality data provides estimates of times of the year that procurement of particular resources took place. If these data are presented, analyzed, and interpreted in a systematic, detailed manner, they can be used to extrapolate seasonality of site occupation. Several variables must be examined to construct seasonality scenarios from presence-absence data. They include:

- Consideration of the annual cycle of abundance of particular species, with particular attention paid to critical factors affecting abundance such as migration and reproductive behavior.
- Inclusion, when relevant, of "negative" seasonality data such as absence of particular seasonally sensitive taxa at a site.
- Expression of seasonal abundance patterns in a relativistic fashion, rather than as absolute, all-or-nothing statements. This should be combined with analysis of seasonal abundance patterns in an ordinally based manner.

At CA-MRN-44/H, three principal sets of seasonality data can be developed from analysis of the bird and mammal remains:

- Presence-absence data regarding seasonality of occurrence of waterfowl and terrestrial bird taxa.
- Presence-absence data for the occurrence of marine mammals.
- Relative seasonal abundances of cervid species (i.e., tule elk and deer).

Seasonality of Occurrence of Fish, Waterfowl and Mammals at CA-MRN-44/H

Fish

Figure 58 presents the seasonality of occurrence of fish taxa present at CA-MRN-44/H. In general, all fish taxa are present to some degree throughout the year in the waters around Angel Island. With respect to the five most abundant fish taxa at CA-MRN-44/H:

- Chinook salmon is available in San Francisco Bay throughout the year. Migratory peaks occur in March, May-June, September-October, and December.
- Northern anchovies are available through the year. Inshore spawning takes place during spring.
- Surfperch are present through the year. Inshore spawning occurs from March to May/June. Some species form population aggregates from August to November.
- Herrings/sardines are available throughout the year. Herring spawn inter-tidally spawn along the shores of Angel Island from mid-December to mid-March.
- Jacksmelt are present throughout the year. They attain their greatest numbers from October to April.

"Ball park" estimates of the abundance of fish taxa from CA-MRN-44/H throughout the year indicate periods of maximum fish availability happen in March-April, September-October, and December. Annual low points of availability take place in February and in June-July.

Birds

Quantitatively based correspondence analysis of the monthly occurrences of waterfowl taxa can be used to interpret patterning of seasonal exploitation by prehistoric peoples (Avery and Underhill 1986). Specifically, a quantitatively based, relative degree of presence-absence model of seasonal abundance can be constructed from data indicating seasonal presence-absence of waterfowl. Many waterbirds occurring at archaeological sites in the San Francisco Bay Area display fairly marked degrees of seasonal abundance and availability (cf., Cogswell 1977; Grinnell and Miller 1944; Grinnell and Wythe 1927; Grinnell et al. 1918; Small 1974, 1994). The greatest degree of waterbird abundance in the San Francisco Bay Area occurs during late fall and winter. Populations subsequently decline through spring, reaching their annual lows from late spring to late summer. Abundance/availability increases during early-mid fall, until annual population zeniths occur. At CA-MRN-44/H, cormorants are abundant throughout the year, with a slight population decline occurring during late winter-early spring.

Mammals

Table 16 (see page 134) presents general seasonal profiles for California sea lions and harbor seals in San Francisco Bay. From mid-May until the beginning of August when rookeries begin to break up, California sea lions congregate at their southern California breeding grounds. Males then migrate north along the California coast, remaining there until spring when they return south for breeding. Consequently, during late spring and early summer in the Bay Area, California sea lions are virtually absent.

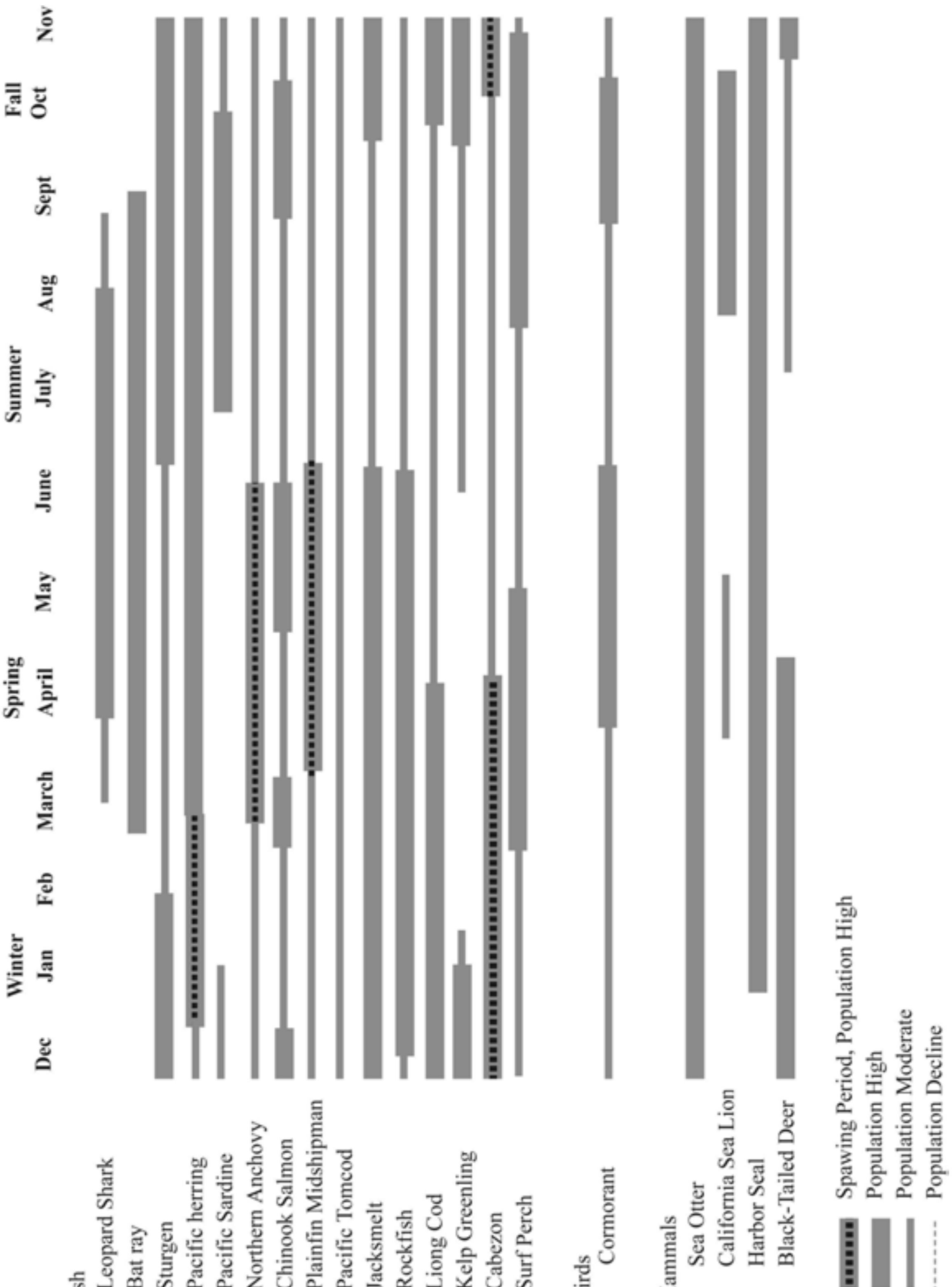


Figure 58. Seasonal Availability of Animals at CA-MRN-44.

In contrast, harbor seals are present throughout the year in San Francisco Bay. Their lowest numbers occur during mid-winter. Through late winter, spring, and early summer, harbor seal populations steadily increase. Mid to late summer marks their annual population high. This is followed by a gradual population decline during the rest of the year.

In summary, the annual pattern of marine mammal availability-abundance in the San Francisco Bay Area begins with a mid-winter population low. This is followed by a gradual increase in numbers during late winter and early spring. Annual population highs occur from late spring through summer into early fall. Pinniped populations decline from late fall into early winter.

Although resident in the Bay Area throughout the year, black-tailed deer display seasonal differences in abundance-availability (see Figure 58). As with pinniped mammals, these differences are closely tied to the annual reproductive cycle. Beginning in late fall, black-tailed deer herds attain their greatest sizes. Herds remain fairly intact through winter until mid-spring. Maximum dispersal of deer occurs during late spring as a consequence of females giving birth. During the subsequent summer and fall, small groups of deer reform.

In sum, the general pattern of deer availability is closely tied to annual herd formation, which is in turn strongly influenced by the annual reproductive cycle. Late fall to early spring is the period of herd formation, and consequent greatest abundance-availability, Due to the birth season, maximum dispersion of deer occurs during late spring and early summer. Small groups of animals are present from mid-summer until mid-fall.

Seasonality Summation

At CA-MRN-44/H, fish would have been available in a fairly consistent manner throughout the year. Their highest annual availability probably took place in early spring and early fall. Slightly lower fish availability would have occurred during late winter, and early to mid-summer. Cormorants were present throughout the year, slightly declining in late winter-spring. With respect to mammals, pinniped carnivores attain their annual population highs from late spring to early fall. In contrast, terrestrial cervids are most abundant from late fall to early spring. At CA-MRN-44/H, marine mammal exploitation probably was emphasized during summer, and cervid hunting in the winter. Taken *in toto*, seasonality data for fish, birds, and mammals suggest CA-MRN-44/H probably could have been occupied throughout the year. This is likely because fish, bird, and/or mammal resources of some sort are available-abundant throughout the year in the catchment area surrounding the site.

Effective exploitation of fish, birds, and mammals along with plant resources by the prehistoric inhabitants of CA-MRN-44/H and other southeast Marin sites required a detailed exploitative scheduling strategy, particularly, due to seasonal fluctuations in abundance-availability. Waterfowl and cervids would have been most abundant-available from mid-fall to mid-spring. Their frequently simultaneous availability-abundance of these resources coupled with their radically different habitats, would have produced serious scheduling conflicts for hunters. This may have been resolved in several ways, including formation of specialized hunter task group, and an emphasis upon the efforts of individual hunters, and/or presence of larger numbers of people at the site to carry out a variety of hunting and other resource procurement tasks. The simplest resolution would have been emphasis upon one of the conflicting targets. In the case of CA-MRN-44/H, this seems to have been focused upon fish, a decision undoubtedly facilitated by the proximate, abundant occurrence of fish at the site. Fishing at CA-MRN-44/H may have been largely done by a specialized task groups.

Simultaneous availability-abundance of plant and animal resources within different habitats also would have produced scheduling conflicts for prehistoric mainland southeast Marin gatherers/hunters. For example, emphasis upon early spring and early fall fishing would have produced marked scheduling conflicts with procurement of many important plant foods, especially acorns and other tree crops. In contrast, wintertime emphasis upon hunting waterfowl would have reduced potential scheduling conflicts with procurement of many important plant foods (i.e., greens, bulbs/roots, grass seeds, berries/fruits, tree crops), whose principal period of productivity and availability occurred from late spring until mid-fall. During this part of the year, bird hunting probably was an important subsistence activity, but likely was not emphasized to the extent it was during winter. Pinniped carnivore hunting, however, would have caused significant scheduling conflicts with the harvesting of many critical plant resources. This would have been exacerbated by the geographically dispersed habitats in which both occur. Scheduling conflicts may have been resolved by formation of specialized task groups for fishing, hunting waterfowl, hunting pinniped carnivores, and so forth.

As noted previously, many major animal resources were seasonally available-abundant throughout the year in the catchment area surrounding CA-MRN-44/H. Therefore, this site was probably occupied to some extent throughout the year. Fishing probably was the principal economic activity, and in order to effectively harvest fish, the population of the site may have been at a fairly constant level throughout the year. The summer peak in pinniped numbers probably attracted additional marine mammal hunters to the site.

Seasonality of occupancy projections have been made for other southeast Marin sites. Moratto (1974:85) concludes CA-MRN-14 was a seasonal camp, inhabited mainly during spring, summer, and possibly early fall. Scott and Millerstrom (2003:6-7 to 6.8), and Zogg (2003:5-19) note CA-MRN-17 probably was occupied year-round, with possible seasonal shifts in numbers of people. At CA-MRN-20, McGeein and Mueller (1955:59-60[Table 1]) note this site probably was not a permanent village site. Since over 50% of the identified bird bones were those of winter visitors, they concluded people mainly inhabited the site during winter, with some possibility of summer occupancy. Year-round habitation of CA-MRN-254 is postulated by Bieling (1998:218) and Valente (1998:160). This also was likely at CA-MRN-255 (Bieling 2000:13.5; Valente 2000:11.11).

Inference of a general pattern of year-round occupancy at CA-MRN-44/H, and many other southeast Marin sites, coincides with King's (1974:44-45) conclusion that the prehistoric inhabitants of CA-MRN-27 had access to most of the plant and animal resources available in every season annually. Therefore, there would have been little need for people living at this site to move about during the year. Individuals/small groups may have made short trips away from the site to the outer Marin coast, or to interior localities, to obtain resources not immediately available. King (1974:45[Table 1]) notes Bayshore Marin seasonal subsistence rounds may have been characterized by the following patterning:

- Residence along the shore throughout the year.
- Winter: Gathering shellfish, and hunting waterfowl.
- Spring: Anadromous fish (i.e., salmon) taken, upland plants and animals gathered and hunted.

- Summer: Expeditions by small task groups to upland hunting/gathering camps until the fall acorn harvest.
- Fall: Acorn harvest, gathering shellfish and hunting waterfowl begins.

Postulation of year-round occupancy at CA-MRN-44/H, and many other southeast Marin sites, supports previous conclusions regarding annual occupancy of prehistoric Bayshore shellmounds in the Richmond-San Pablo region (cf. Banks and Orlins 1981, 1985; Broughton 1994:390-391; Lightfoot 1997:136; Simons 1981:12.8-12.15, 12.18-12.19; Simons et al. 2000:371-375), which suggest multiseasonal or year-round site occupancy occurred. This pattern of prehistoric Bayshore site utilization conforms with the seasonal subsistence model postulated for prehistoric Ohlone peoples living in the East Bayshore region (cf. King 1974:42-45[Table 1]; Parkman 1980, 1994:47-50).

DISCUSSION – PROCUREMENT PRACTICES

Use of Watercraft

Tule rush raft boats known as balsas were frequently used on San Francisco Bay by the Ohlone and Coast Miwok (Follett 1975:80-81; Harrington 1942:11; Heizer and Massey 1953:291-293; Kelly 1978:419, 1996:210; Kroeber 1925:468, 813; Levy 1978:492; Margolin 1978:37-38, 54-56; Slaymaker 1977:44). These were often seen on the waters of San Francisco Bay by early Spanish parties (Milliken 1995:31-61). Balsas were about 3.0 to 4.6 meters long, 1.5 meters wide, and made from several bundles of rushes and dried grass lashed together into rolls which were then tied together (Follett 1975:98, Plate 6; Heizer 1974:92[Figure 3], 103[Figure 13], 104[Figure 15]; Heizer and Massey 1953:292[Figure 11]; Levy 1978:492[Figure 3]; Margolin 1978:55). They were powered by double-bladed paddles and anchored with stone anchors. The boats were used for transport, fishing, gathering bird eggs, and waterfowl hunting. They probably also served as a means of hunting marine mammals such as sea otters and pinniped carnivores.

Ethnographic Accounts of Fishing

Kelly (1978:415-416, 1996:139-143) comments upon Coast Miwok fishing techniques. Some good places for surf fish were privately owned. Wooden fish clubs and two-pronged fish spears were used. Net types included framed round nets and dip nets, and various sizes and meshes of seine nets. Salmon were mainly taken during winter, with fish traps and various types of nets, including dip nets. A salmon "singer" often accompanied fisher folk. During spring, rockfish found on the rocks at low tide were taken with apparent use of fish poison. Sturgeon, herring, and surfperch were caught in San Francisco Bay using a large seine net stretched between two tule balsas. These nets often belonged to two or three men. Depending upon what was being taken, mesh size varied. Pieces or wood were used for floats, and beach rocks provided sinkers. Sometimes nets were tied to poles in lieu of using sinkers.

Follett (1974:148-149) comments that sharks and bat rays, like those present at CA-MRN-14, were most likely caught using a seine net. A seine also may have been used to take sturgeon, white seabass, surfperch, and possibly jacksmelt. Salmon passing through San Francisco Bay during the spawning migrations would have been best taken from tule balsas. Rockfish were probably caught using hand lines cast from shore.

Follett (1975:80-86) also provides a detailed account of fishing methods probably used by the prehistoric inhabitants of the West Berkeley Shellmound at CA-ALA-307. Watercraft, tule balsas, and gill and seine nets were apparently preferred. Nets were probably weighed down with stone sinkers. Gill nets may have been used to catch sturgeon and Chinook salmon. A variety of fish, including leopard sharks, bat rays, sturgeon, jacksmelt, and plainfin midshipmen, could have been taken with seines. Although fishhooks and spears do not appear to have been as important as nets, Plainfin midshipmen, surfperches, and smaller leopard sharks, bat rays, sturgeon, and salmon also could have been caught on fishhooks. Gorge hooks would have served to take leopard sharks, bat rays, sturgeon, and salmon. Sturgeon could have been speared.

Following Follett (1974, 1975), Scott (1998:180), and Scott and Millerstrom (2003:6-11 to 6-12) conclude the prehistoric inhabitants of CA-MRN-17 employed a variety of ways to catch fish. Use of shallow water nets, spears, and seines appear to have been preferred. Watercraft would have facilitated fishing efforts.

Ethnohistoric Accounts of Bird Hunting

Ethnohistoric accounts of Ohlone fowling practices are somewhat superficial (Harrington 1942:6; Hildebrandt et al. 1984:52-53; Levy 1978:491, 492; Margolin 1978:37-40; Switzer 1974:10). Not surprisingly, waterfowl were the primary avian prey. Doves, quail, and hawks were also taken. Decoys made of tules or bird skins stuffed with straw were used to lure geese and ducks to hunters. These birds often were caught in large nets spread across rivers. Cagelike traps made of twigs were used to capture quail, which also were taken in nets. Slings and bolas consisting of two pieces of bone tied to a string were used for fowling, as well as with a bow and arrow.

In contrast to accounts of the Ohlone, Kelly (1996:129-132) presents detailed ethnohistoric information on Coast Miwok fowling practices (Kelly 1978:416, 418; Slaymaker 1977:42). Among the birds taken were ducks, geese, coots, pelicans, and gulls. Ducks, geese and coots were netted, the nets drug along the water’s surface, placed flat on the ground to catch the feet of birds, or supported with sticks and pulled with a cord to drop the net over the birds. Duck decoys were used to attract birds close enough to be shot with a bow and arrow. Bolas and slings also were used to take ducks. Quail were shot with bows and arrows, hunted with small-mesh nets, captured in traps, and taken by hand. They often were hunted in rainy weather when they would not fly. Various land birds were taken with nets, snares, and traps. Night hunting of birds with a light was sometimes practiced.

Ethnohistoric Accounts of Marine Mammal Hunting

Ethnohistoric accounts of marine mammal hunting by San Francisco Bay Area Native Peoples are limited. Kelly (1978:416) states sea mammals were not eaten by the Coast Miwok. Seals were hunted with bows and arrows, sometimes from cliff tops, but mostly from shore by hunters lying on rocks (Kelly 1996:139). They were also hit over the head with hardwood clubs, measuring about 18 inches long, which only were used to take seals. This was generally done in the summer when seals were available. Sea lions were not hunted, but obtained when they came on shore to die. Occasionally stranded whales were utilized. Except for pieces taken off each side of the jaw, they were not eaten, and their oil was not used.

Kelly's information regarding marine mammal hunting by the Coast Miwok is at variance with the limited data on marine mammal hunting by the Ohlone. Kroeber (1925:467) notes sea lions were hunted by Ohlone, although the precise manner is not known. He observes tule balsa watercraft would have been an unsatisfactory, dangerous way of reaching the rocks where these animals were. He further reports that there was no way of hunting whales, and beached whales were an irregular, undependable food source. However, Levy (1978a:491) notes the Ohlone ate sea lions and whales. Palou (in Engelhardt 1924:62-63) notes,

> They also avail themselves of the opportunity when a whale runs aground on the shore, which event they celebrate with great feasting, for they are very fond of the flesh, which is just pure grease or fat. They cut it into strips, roast them underground, and then suspend them from trees. Whenever they want to eat, they cut off a piece and eat it together with some other food. In the same manner they treat the flesh of the seal, of which they are not less fond than of whale meat, because it is all pure fat. [Palou cited in Engelhardt 1924:62-63]

Kroeber and Barrett's (1960:115-126) account of marine mammal hunting practices in northwest California provides proxy data suggesting how Bay Area Native Peoples may have hunted these animals. Seals, sea lions, and otters were speared with harpoons, shot with bows and arrows, and clubbed. Watercraft often played a role. Marine mammal hunting was strongly conditioned by local habitat. Pinnipeds most often were hunted on offshore rocks, and only occasionally taken on land. Otters were most easily hunted when they were asleep on offshore rocks, or loafing on the ocean's surface. Mammals were not netted.

Summary and Conclusions

The assemblage of faunal remains recovered from CA-MRN-44/H is mainly composed of fish. A very small number of bird and mammal remains are also present. Paleobiological observations of particular note include:

- Confirmation of the presence of terrestrial reptiles and mammals (i.e., garter snakes, meadow mice, deer) on Angel Island.
- Presence of extirpated mammal taxa (i.e., sea otters).
- Indication that prehistoric habitats on and in the vicinity of Angel Island probably were highly similar to those observed historically.

With respect to paleoeconomy, the following suppositions are significant:

- Prehistoric inhabitants of CA-MRN-44/H focused upon fishing, with salmon particularly emphasized. Birds and mammals were taken to a much lesser extent.
- Fishing and hunting strategies probably utilized "coharvesting" and "prey switching," strategies as components of an overall emphasis upon resource intensification resulting from resource depression as a consequence of resource overexploitation and interannual resource unpredictability.
- Along with other islands in the San Francisco Bay Area, Angel Island probably served as a prehistoric "platform" from which specialized task groups fished and hunted waterbirds and marine mammals.

- Seasonality data for fish, waterfowl, marine sea otters, pinniped carnivores, as well as terrestrial cervid herbivores suggest that CA-MRN-44/H was probably occupied to some extent throughout the year.
- Fish, birds, and mammals were probably procured in a number of ways, with netting and use of watercraft being especially significant.

The study of the fish, bird, and mammal assemblage from CA-MRN-44/H, a prehistoric/historic site located on an island in San Francisco Bay, is of particular interest because virtually all previous studies of faunal assemblages from sites in the San Francisco Bay Area have been conducted with materials from mainland sites. The CA-MRN-44/H faunal assemblage thus offers a unique opportunity to examine faunal materials from a permanent "platform" in the Bay. A limited amount of comparable data exists from a few other sites situated on islands in San Francisco Bay (i.e., Yerba Buena Island, Brooks Island, East Marin Island). Analysis of these data sets and comparison between them and the faunal assemblage from CA-MRN-44/H allows examination of the dynamics of resource intensification/depression and unpredictability through time in the San Francisco Bay Area.

Chapter 9: Plant Use

Eric Wohlgemuth, Ph.D.

INTRODUCTION

This section reports on charred plant remains recovered from flotation of 13 samples collected from three site loci during Sentinel Archaeological Research excavations at CA-MRN-44/H on Angel Island. A total of 14.7 liters of sediment was collected from seven features and three midden lenses spanning a depth of 45-180 centimeters below surface at Locus A. Five of six radiocarbon assays on features in the Locus A profile range from 1420 to 920 cal BP, which places the deposit firmly within the Late Middle Period (using nomenclature of Groza 2002). Two samples from Locus B (29.0 liters of sediment) and one from Locus C (30.0 liters) are chronologically problematic, and can be dated only to the Late Holocene. Because the Locus A samples represent a temporally coherent assemblage, these data are emphasized in interpretive discussion.

RESEARCH ISSUES

Little archaeobotanical research has been conducted at mainland sites in Marin County, and none on Angel Island. Limited data are available from Middle and Late period components at CA-MRN-254 in San Rafael (total of five flotation samples; Legare 1998), and from mixed Early and Middle periods, Late Period, and Late Period/Protohistoric deposits at three sites near Novato (total of 12 samples; Basgall et al. 2006). The data are insufficient to develop a local model for long-term stability or change in plant use as has been done in other regions of California (e.g., Wohlgemuth 1996a, 1996b, 1997, 2002). What can be said at this time is that acorn and bay were the principal nut crops throughout the sequence, with bay nutshell often more abundant than acorn residue; that small seeds are more common during the Late phases and Protohistoric period, with goosefoot (*Chenopodium* sp.) and hairgrass (*Deschampsia* sp.) the most widely used taxa; and that berry and root crops were insignificant.

Lacking a sequence of archaeobotanical data from Marin County, data gleaned from 162 samples from the East San Francisco Bay shoreline are most relevant (Wohlgemuth 2004). Plant use along the East Bay shore ran counter to trends from interior central California (a region defined as more than ten kilometers from the outer coast or San Francisco Bay), where acorns became the principal staple during the Middle Period and continued so during the Late Period. At sites on the East Bay shore, acorn use actually declines from the Middle Period to the Late Period. Again counter to interior central California, where small seed use increased dramatically during the Late Period, small seed use appears mostly unchanged from the Middle Period through the Late Period along the Bay shore. The archaeobotanical data are largely consonant with Lightfoot and Luby's (2002) observation that occupation peaked along the bayshore during the Middle Period, with more limited use during the Late Period. It is likely that Late Period communities relocated from the shore to the interior to focus on more productive plant resources, and only used the shore seasonally (Wohlgemuth 2004:120). Given this pattern from the East Bay we would predict, all other things equal, that the Late Middle Period CA-MRN-44/H deposit at Locus A should show intensive use of nuts without concomitant intensive use of small seeds.

However, all other factors are not equal in the CA-MRN-44/H case. With an area of only 740 acres, much in steep hills that would increase gathering costs of terrestrial foods, Angel Island has limited plant resources compared to the Marin mainland. We can predict that sites like CA-MRN-44/H were used primarily on a temporary seasonal basis, and principally to access aquatic resources of the bay (like fish and shellfish) rather than terrestrial plants and animals. This assertion implies, rather than reflecting intensive acorn use, that plant food residues at CA-MRN-44/H should show relatively little dietary use of plants in comparison to mainland Marin sites.

It is also possible that plant foods may have been brought from the mainland to Angel Island to help provision seasonal fishing and shellfish collecting camps. Plant residues may be present at CA-MRN-44/H that were gathered from the mainland and brought to the site and consumed.

In addition to research issues pertinent to CA-MRN-44/H and its insular setting, there are other, more generic concerns that can be addressed from plant remains. The most relevant concern is implications of the findings for the season or seasons of the year in which the site was used.

METHODS

A total of ten sediment samples was collected from a 2-x-2-meter excavation unit in Locus A. Most samples were collected from features, but three samples were from midden matrix between stratified feature samples. In all, 14.7 liters of sediment were flotation processed from Locus A. Two samples, totaling 29.0 liters, were collected from the 170-180-centimeter level of two excavation units in Locus B, as well as one 30.0-liter sample from 500 to 550 centimeters in Trench 13 at Locus C.

Flotation was conducted by Aaron Buehring using a manual tub technique used to process hundreds of samples in northern and central California (Wohlgemuth 1989). Buoyant light fraction is collected using 40 mesh/inch (0.4-millimeter) screen, and heavy fraction washed through 1/8-inch (3-millimeter) and window screen (1-millimeter) mesh. Inasmuch as recovery effectiveness measured at other sites ranges from 85 to 95% of dense nutshell and berry pits, and more than 98% of small seeds, only the buoyant light fraction material was sorted for charred plant remains.

The author did all sorting and identification of light fraction constituents. Light fraction was size-sorted using 2-millimeter, 1-millimeter, 0.7-millimeter, and 0.5-millimeter mesh. All seed and fruit remains, including unburnt contaminants, were removed from the sorted portions of samples. Nutshell and berry pit fragments were sorted only to the 0.7-millimeter grade, while small seeds were sorted to the 0.5-millimeter grade. Unidentified non-grain pieces (not wood charcoal, nutshell, or seeds) were sorted only from the 2-millimeter grade. Wood charcoal was sorted from the 2-millimeter and 1-millimeter grades. In the Locus B and C samples, the abundance of wood charcoal and other bulk light fraction material dictated a subsampling strategy to reduce redundancy. Subsampling was largely confined to grades smaller than two millimeters. Counts and weights of constituents sorted from subsamples were multiplied by the appropriate factor in computing their estimated total frequency for the given flotation sample.

While all segregated constituents were counted, nutshell and wood charcoal were weighed to 0.1 milligram. Constituents were stored in translucent hard plastic centrifuge tubes with acid-free paper tags denoting site trinomial, sample number, size grade, and a code for constituent type. All items of a single type or taxon were stored (in separate centrifuge tubes for each provenience and size grade) in two-millimeter plastic bags with acid-free paper labels. All tags were labeled with #2 pencil.

RESULTS

Flotation and analysis of sediment samples from Locus A produced 126 nutshell fragments identified to five genera, one berry pit, and 19 small seeds identified to six genera of grasses and forbs. An additional 14 small seeds could be identified only to plant family (Table 28). Sorting of Locus B samples produced 42 nutshell fragments identified to four genera, three berry pits, and 20 small seeds identified to eight genera; 15 additional small seeds could be identified only to plant family (Table 28). The Locus C sample yielded 14 nutshell fragments identified to four genera, three berry pits, and only three small seeds comprising three genera (Table 28). These plant remains are similar to those identified throughout central California (Wohlgemuth 2004), as well as in Marin County (Basgall et al. 2006; Legare 1998), and are consistent with cultural residues, most likely dietary debris. Information on attributes and ethnographic uses of identified taxa is summarized in Table 29.

DISCUSSION

This section will describe variability between samples, characterize the assemblage, and assess the CA-MRN-44/H data in light of the research issues identified above.

Locus A Inter-sample Variability

There is a fair degree of variation between the different flotation samples from Locus A, but no obvious patterning that would suggest specific feature function or directional change in plant use within the Late Middle Period occupation span at CA-MRN-44/H (Table 28). Some features have relatively high frequencies of nutshell, some have moderate counts, and one lacks any altogether (Feature 5). The same variation is apparent for small seeds. It may be of some interest that Feature 5 lacks nutshell, small seeds, and has very little wood charcoal; Feature 7 is similar, with only traces of nuts and seeds. These two features do not seem to have been used to process plant foods, or at least to have been the

Table 28. Frequency and Weight of Plant Taxa Present in Loci A, B, and C.

	Locus A											Locus B			Locus C
Unit	**S1/W1**	**S1/W0**	**S1/W1**	**S2/W1**	**S1/W0**	**S1/W1**	**S1/W1**	**S1/W0**	**S1/W0**	**S2/W0**	**Mean**	**S0/W2**	**S0/W4**	**Mean**	**Trench 13**
Depth (cm)	45-50	60-70	90-100	100-110	110-120	130-140	140-150	156-160	160-170	170-180	-	170-180	170-180	-	500-550
Feature	4	-	5	7	-	10	13	16	-	18	-	-	-	-	-
Sample Volume (liters)	1.0	0.8	1.2	0.8	1.1	2.1	1.3	2.0	2.4	2.0	-	14.0	15.0	-	30.0
Sample Number	7	6	3	8	4	10	1	5	9	2	-	11	12	-	13
Taxon (Common Name)															
Nutshell															
Quercus sp. (Acorn)															
count	4.0	8.8	-	1.3	1.8	0.5	0.8	0.5	-	2.0	2.0	-	11.2	5.6	0.7
mg	0.9	8.0	-	0.3	0.6	0.1	0.2	0.1	-	4.0	1.4	-	4.6	2.3	0.5
Umbellularia californica (Bay)															
count	2.0	11.3	-	3.8	23.6	-	0.8	-	3.8	1.0	4.6	2.6	4.7	3.7	0.4
mg	0.5	4.5	-	1.0	10.8	-	0.2	-	0.8	0.3	1.8	2.3	3.9	3.1	0.1
Aesculus californica (Buckeye)															
count	1.0	-	-	-	-	-	-	4.0	-	-	0.5	0.1	-	0.04	0.1
mg	0.3	-	-	-	-	-	-	22.6	-	-	2.3	0.3	-	0.2	0.01
Corylus rostrata (Hazel)															
count	4.0	1.3	-	-	0.9	-	-	-	5.4	1.5	1.3	0.5	0.4	0.5	0.1
mg	60.2	15.3	-	-	0.5	-	-	-	68.5	24.6	16.9	7.6	3.3	5.4	2.0
Marah sp. (Wild cucumber)															
count	-	-	-	-	-	1.0	-	6.0	3.3	-	1.0	-	-	-	-
mg	-	-	-	-	-	3.2	-	7.8	4.0	-	1.5	-	-	-	-
Total															
count	11.0	21.3	-	5.0	26.4	1.4	1.5	10.5	12.5	4.5	9.4	3.2	16.3	9.7	1.4
mg	61.9	27.8	-	1.3	11.9	3.3	0.4	30.5	73.3	28.9	23.9	10.2	11.7	11.0	2.6
Roots															
Unidentified	-	-	-	-	-	-	-	0.5	-	-	0.1	-	-	-	-
Small Seeds															
Bromus sp. (Brome)	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.1	-

Table 28. Frequency and Weight of Plant Taxa Present in Loci A, B, and C *continued.*

	Locus A											Locus B			Locus C
Unit	S1/W1	S1/W0	S1/W1	S2/W1	S1/W0	S1/W1	S1/W1	S1/W0	S1/W0	S2/W0	Mean	S0/W2	S0/W4	Mean	Trench 13
Chenopodium sp. (Goosefoot)	-	-	-	-	-	1.0	-	1.0	-	-	0.2	-	1.7	0.8	-
Clarkia sp. (Farewell to spring)	1.0	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Deschampsia sp. (Hairgrass)	-	-	-	-	0.9	-	-	-	-	-	0.1	1.4	1.3	1.4	-
Eriogonum sp. (Buckwheat)	-	-	-	-	-	-	-	-	-	-	-	-	0.7	0.3	-
Galium sp. (Bedstraw)	-	-	-	-	0.9	-	-	-	-	-	0.1	-	0.5	0.3	0.1
Phacelia sp. (Phacelia)	-	-	-	-	-	-	-	-	-	-	-	-	0.6	0.3	0.1
Phalaris sp. (Maygrass)	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.2	-
Plantago sp. (Plantain)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1
Sambucus sp. (Elderberry)	-	-	-	-	-	-	-	0.5	-	-	0.1	-	-	-	-
Scirpus sp (Tule)	-	1.3	-	-	-	1.4	4.6	-	-	-	0.7	-	0.7	0.3	-
Solanum sp. (Nightshade)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.4
Trifolium sp. (Clover)	-	-	-	-	0.9	-	-	-	-	-	0.1	-	-	-	-
Vulpia sp. (Fescue)	-	-	-	-	-	-	-	-	-	-	-	0.7	1.1	0.9	-
Cyperaceae (Sedge family)	1.0	-	-	-	0.9	-	-	-	-	-	0.2	0.7	1.3	1.0	-
Fabaceae (Bean family)	-	-	-	-	-	-	1.5	-	0.4		0.2	-	-	-	-
Papaveraceae (Poppy family)	-	-	-	-	0.9	-	-	-	-	-	0.1	1.1	4.3	2.7	-
Poaceae (Grass family)	2.0	-	-	-	1.8	0.5	0.8	-	0.8	-	0.6	-	-	-	-
Unidentified seeds	-	-	-	-	0.9	-	0.8	-	0.4	-	0.2	-	0.3	0.1	0.1
Unidentified seed fragments	5.0	2.5	-	2.5	2.7	-	3.1	0.5	0.4	-	1.7	0.7	4.7	2.7	-
Unidentified embryos	-	-	-	-	0.9	-	1.5	-	0.8	-	0.3	-	1.0	0.5	-
Total Identified to Genus	1.0	1.3	-	-	2.7	2.4	4.6	1.5	-	-	1.3	2.1	7.2	4.7	0.7
Total Identified to Family	4.0	1.3	-	-	6.4	2.9	6.9	1.5	1.3	-	2.4	3.9	12.9	8.4	0.7
Wood Charcoal															
grams (to 1 mm)	9.0	3.9	0.1	0.2	2.4	7.5	2.7	6.5	3.2	1.6	3.7	27.1	10.0	18.6	0.3
Non-grain pieces	18.0	10.0	3.3	1.3	4.5	95.2	-	0.5	9.2	8.0	15.0	2.1	2.8	2.5	0.5
Constituent Ratios															
Nutshell:wood	6.9	7.2	0.0	6.7	5.0	0.4	0.1	4.7	23.2	18.1	6.5	0.4	1.2	0.8	-
Small seeds:wood	0.4	0.3	0.0	0.0	2.7	0.4	2.6	0.2	0.4	0.0	0.7	0.1	1.3	0.7	-
Nutshell:small seeds	15.5	22.2	-	-	1.9	1.2	0.1	20.3	58.7	-	9.9	2.6	0.9	1.8	-

Table 29. Ethnographic Use, Seasonal Availability, and Habitats of Charred Native Plant Taxa.

	Common Name	Growth Habit [a]	Habitats [a]	Ethnographic Use [b]	Seed Seasonal Availability [b]	Disturbance Follower? [c]
Aesculus californica	Buckeye	Shrub	Shaded slopes and canyons	Nut eaten	Fall	??
Chenopodium sp.	Goosefoot	Herb	Dry slopes and plains	Leaves eaten	Spring or summer	Yes
Clarkia sp.	Farewell to spring	Herb	Varied, grasslands	Seed eaten	Late spring/ early summer	Yes
Corylus cornuta californica	Hazelnut	Shrub	Shaded slopes and canyons	Nut eaten	Fall	??
Deschampsia sp.	Hairgrass	Grass	Seasonal wetlands, vernal pools	None noted	Summer	??
Galium sp.	Bedstraw	Herb	Varied	Leaf used for medicine	Late spring/ summer	No
Marah sp.	Wild cucumber	Vine	Varied, shaded places	Seed used for medicine, beads, sometimes eaten	Summer	??
Quercus sp.	Oak	Tree	Varied	Nut eaten	Fall	??
Sambucus sp.	Elderberry	Shrub	Varied, mostly riparian areas	Berry eaten	Summer	??
Scirpus sp.	Tule	Herb	Marshes, wet areas	Seed eaten, important in weaving	Summer	??
Trifolium sp.	Clover	Herb	Grasslands	Leaves, seed eaten	Spring	Yes
Umbellularia californica	Bay	Tree	Moist canyons, riparian zones	Nut eaten	Fall	??

Notes: [a] Munz (1968); Hickman (1993); [b] Barrett and Gifford (1933); Bocek (1984); Chesnut (1902); Dubois (1935); Duncan (1963); parentheses indicate secondary season; [c] Stebbins (1966); Timbrook et al. (1982); personal communications from Michael Barbour, John Menke, Grady Webster, Jon E. Keeley, and Fred Hrusa.

locus of deposition of charred remains. The most distinctive sample may be from Feature 16, which has very high counts of buckeye and wild cucumber. The three midden samples are slightly more homogenous in that all three contain relatively high or moderate amounts of nuts, but they vary markedly in the frequency of small seeds. Finally, there are no obvious distinctions by depth of sample excepting the restriction of wild cucumber to the three samples from below 130 centimeters.

Assemblage Characterization

Seed and fruit remains from Locus A are rather sparse, with an average of only 9.4 nutshell fragments and 2.4 small seeds (identified to family) per liter of sediment. With such low frequencies, the ubiquity, or proportion of all samples in which particular taxa are present, is informative in characterizing plant use. Only two taxa, acorns and bay nuts, are found in more than half the samples (8 of 10 and 7 of 10 samples, or 80% and 70%, respectively). Only hazelnut is found as frequently as half the time. All other nuts, small seeds, and the single berry (elderberry) are found in only 10-30% of the samples. The most ubiquitous small seeds are tule (30%) and goosefoot (20%); all other small-seeded genera were found only once. Unidentifiable grass seeds were found in half the samples. With only two and one samples from loci B and C, respectively, ubiquity is an unreliable measure of assemblage variability.

In contrast to nut and seed residues, wood charcoal is rather common in most CA-MRN-44/H samples. The average weight of burnt wood larger than one millimeter at Locus A is 3.7 grams per liter, which is far more than the 0.3-1.0 gram/liter found at most Middle Period village sites investigated to date (Wohlgemuth 1997). The excellent preservation of wood charcoal implies good preservation of charred nutshell and small seeds as well. Further, the dearth of small seed residue in tandem with the high frequency of wood suggests that the relatively ubiquitous unidentifiable grass seed fragments may have been used more for tinder in starting fires than for food. Summarizing, plant use at Locus A was oriented largely towards nuts, with little use of small seeds, and even less of berries or roots.

Characterizing plant remains is more tentative at loci B and C due to few sampled contexts and substantial mixing of strata, but there appears to be significant differences from the Locus A data. Locus B has similar nut frequency to Locus A, but the mean frequency of small seeds is more than three times that of Locus A, and wood charcoal is more than five times as common. The higher frequency of wood charcoal at Locus B, however, suggests the apparently higher seed frequency is not necessarily significant, since the ratio of small seeds to wood is identical to that of Locus A (see Table 28). The apparently greater richness of the small seed assemblage at Locus B (eight genera vs. six at Locus A) is probably insignificant as well, owing to the greater sample volume processed at Locus B (nearly twice that at Locus A). Greater reliance on nuts at Locus A, however, is suggested by the much lower ratios of both nutshell to wood and nutshell to small seeds for Locus B. In contrast, Locus C may be characterized as having very low frequencies of nuts, small seeds, and wood charcoal.

CA-MRN-44/H Plant Use vs. Marin Mainland Plant Use

Table 30 compares the CA-MRN-44/H plant remains to Middle and Late period components at CA-MRN-254 in San Rafael, as well as three sites near Novato that include a mixed Early and Middle periods area, Late Period components, and a mix of Late Period and Protohistoric components. While the mainland sites, all shell middens like CA-MRN-44/H, show much variability, some points can be made. First, it is clear that all the nut taxa identified at CA-MRN-44/H are present at most mainland sites (although hazelnut and buckeye are occasionally absent from mainland sites). Second, berries, particularly manzanita, are often present on mainland sites, but absent at CA-MRN-44/H excepting one elderberry and a three nightshade seeds. Third, small seed genera identified at CA-MRN-44/H are often found in Late Period or Protohistoric mainland sites, but many are absent from the older component deposits on the mainland.

More to the point is the difference in frequency between CA-MRN-44/H and the mainland deposits. Excepting the sparse Late Period/Protohistoric component at CA-MRN-194, nuts are much less common at CA-MRN-44/H than in mainland sites, by a factor as much as 30. Small seeds are less common than at all other mainland sites at loci A and C,

Table 30. Density per Liter of Sediment of Charred Plant Remains at CA-MRN-44/H and Mainland Marin Sites.

SITE (MRN-)	196	254	196W	254	327	194	327	44
Age Estimate	M & UA	UA	E	E	E1a-2c	UE/H	UE/H	LUA
Number of Samples	3	3	2	2	2	2	3	10
TAXON (COMMON NAME)								
NUTSHELL								
Quercus sp. (Acorn)								
count	13.6	33.5	15.5	29.6	137.2	0.3	50.6	2.0
mg	37.8	nd	14.2	nd	240.2	1.3	246.9	1.4
Umbellularia californica (Bay)								
count	18.0	67.0	32.6	15.9	167.3	9.6	107.7	4.6
mg	43.5	nd	33.9	nd	425.5	15.7	600.0	1.8
Aesculus californica (Buckeye)								
count	0.6	-	1.7	0.4	4.0	-	0.5	0.5
mg	1.9	-	1.9	nd	63.3	-	3.6	2.3
Corylus rostrata (Hazel)								
count	-	0.2	0.3	0.5	0.3	-	-	1.3
mg	-	nd	12.6	nd	1.6	-	-	16.9
Marah sp. (Wild cucumber)								
count	0.7	0.7	-	1.1	2.0	0.2	0.6	1.0
mg	14.0	nd	-	nd	15.0	0.7	11.3	1.5
Total								
count	32.9	101.4	50.1	47.5	310.8	10.1	159.4	9.4
mg	97.2	nd	62.6	nd	745.6	17.7	861.8	23.9
BERRIES								
Arctostaphylos sp. (Manzanita)								
count	0.2	-	-	0.5	0.4	-	0.7	-
mg	1.1	-	-	nd	14.2	-	41.0	-
Sambucus sp. (Elderberry)	-	-	-	0.2	-	-		0.1
SMALL SEEDS								
Chenopodium sp. (Goosefoot)	0.4	1.0	2.7	-	6.4	-	2.2	0.2
Clarkia sp. (Farewell to spring)	-	-	2.3	-	0.6	-	-	0.1
Deschampsia sp. (Hairgrass)	0.4	-	1.5	0.2	17.4	-	8.1	0.1
Galium sp. (Bedstraw)	-	0.2	-	0.1	0.5	-	0.1	0.1

Table 30. Density per Liter of Sediment of Charred Plant Remains at CA-MRN-44/H and Mainland Marin Sites *continued*.

SITE (MRN-)	**196**	**254**	**196W**	**254**	**327**	**194**	**327**	**44**
Age Estimate	M & UA	UA	E	E	E1a-2c	UE/H	UE/H	LUA
Number of Samples	3	3	2	2	2	2	3	10
TAXON (COMMON NAME)								
Scirpus sp. (Tule)	-	-	-	-	5.1	-	2.6	0.7
Trifolium sp. (Clover)	-	-	-	-	0.1	-	0.3	0.1
Cyperaceae (Sedge family)	-	-	-	-	0.7	-	0.2	0.2
Fabaceae (Bean family)	0.5	-	0.3	0.9	5.6	-	2.1	0.2
Poaceae (Grass family)	6.4	1.4	29.0	3.4	125.0	1.4	51.3	0.6
Unidentified seed fragments	10.4	12.1	47.8	9.9	225.1	87.9	96.3	1.7
Total Identified to Genus	2.3	5.5	14.0	4.8	84.9	8.8	36.3	1.3
Total Identified to Family	9.8	7.0	47.3	9.9	227.4	10.5	95.5	2.4
Number of Nut Genera	4	4	4	5	5	3	4	5
Number of Berry Genera	2	1	-	2	2	-	2	2
Number of Small-seeded Genera	5	9	8	6	20	2	18	6

Notes: M – Middle, UA – Upper Archaic, E – Emergent, UE – Upper Emergent, H – Historic, LUA – Late Upper Archaic.

but Locus B has comparable numbers to the contemporaneous Middle Period component at CA-MRN-254, or the mixed Early/Middle area at CA-MRN-196. Unfortunately, there are no data on charcoal frequency from the mainland. But it is clear that plant food residue is generally much less common at CA-MRN-44/H than in mainland sites. This finding supports the hypothesis that plant foods were relatively unimportant at the site.

Insular Gathering vs. Mainland Provisioning

Addressing this research issue depends upon determining if the CA-MRN-44/H assemblage includes mainland taxa that are absent or rare on Angel Island. At this point, there is no way to distinguish mainland from insular origin from the charred remains themselves, since the respective taxa are common to both. Internet sources on the flora of Angel Island describe oak woodland (including oak and bay trees, nuts of each found in CA-MRN-44/H flotation samples) and coastal scrub communities (Angel Island Association 2006; California State Parks 2006), while “localized” stands of chaparral are described on the island in Howell’s *Marin Flora* (1970:11). Perhaps the most relevant source is a 1902 description of the vegetation by John Finley, a captain in the US Army. Taxa identified at CA-MRN-44/H noted by Finley (1902) include live and scrub oaks, hazelnut, buckeye, and wild cucumber. Collectively, these sources show that all nuts identified in flotation samples at CA-MRN-44/H could have been gathered from local stands on Angel Island.

Finley's notes do not describe small-seeded and berry taxa identified at CA-MRN-44/H, but Howell's plant association descriptions for oak woodland and coastal scrub note phacelia, nightshade, plantain, bedstraw, elderberry, and farewell-to-spring (Clarkia) as common constituents. He further notes that hairgrass is common in coastal grasslands, which can form patches within the coastal scrub. Finally, some species of tule are adapted to the salt marsh association that may have been present adjacent to CA-MRN-44/H (Howell 1970:8-19).

A few genera identified in the samples from CA-MRN-44/H cannot be definitively shown to grow or have grown on Angel Island with the sources at hand. These include fescue, goosefoot, brome, buckwheat, maygrass, and clover. Of course it is possible that there may be or may have been local populations of these plants on Angel Island. In any case, they are represented at CA-MRN-44/H by a total of only 13 seeds; even if they were brought from the mainland, these few small seeds could not represent a significant contribution to provisioning the people who used CA-MRN-44/H.

In summarizing, whether mainland plant foods were used to provision seasonal use of CA-MRN-44/H cannot be ascertained with certainty from current data, since all of the archaeologically common taxa and most of the uncommon ones grow on both Angel Island and the mainland. However, the present data set suggests that if mainland plant foods were brought to the site, they did not make a substantial dietary contribution.

Seasonal Indicators

Assuming that plant food residues found at CA-MRN-44/H were gathered on Angel Island, the abundance of fall-ripening acorns, bay, and hazel suggests most intensive use of the site during autumn since these nutshells were the primary botanical residue on soil samples submitted. Spring season indicators are limited to 17 seeds of seven genera, which would imply little use during spring. Summer-ripening indicators also include seven genera, but none with ubiquity greater than 30% at Locus A. Some only reflect finds of single seeds. Further, some of the summer-ripening taxa identified can also linger on plants into the fall, including elderberry, goosefoot, nightshade, and tule.

Finley's description of native economic species on Angel Island should be noted here. These plants are often found archaeologically elsewhere in central California but are lacking in the flora record at CA-MRN-44/H: manzanita, wild rose, blackberry, and cacomites (corms of the genera often grouped as *Brodiaea*, also including *Dichelostemma* and *Triteleia*). Their absence not only has implications for the narrow range of plants used, it can serve as evidence for lesser or minimal site use during summer, when berries ripen and corms were typically dug (Barrett and Gifford 1933).

However, given the assumed lesser role of plant foods in the diet at CA-MRN-44/H and the possibility that mainland plants might have been used occasionally to provision the occupation, it is likely that the plant remains may not necessarily be good indicators of occupational seasonality. For example, if faunal seasonal indicators strongly suggest occupation primarily during spring and/or summer, the clear fall gathering emphasis of the ubiquitous nut crops at Locus A may actually comprise evidence of some level of provisioning using stored plant foods, as acorns and other nut crops are well-documented as critical food stores throughout California (e.g., Barrett and Gifford 1933; Chesnut 1902;

Dubois 1935; Duncan 1963). This case may be established particularly for the several discrete features from which plant remains were collected.

Conclusion

Flotation and analysis of 13 sediment samples from the three loci at CA-MRN-44/H produced a well preserved but sparse assemblage of seed and fruit remains. Plant taxa identified are familiar throughout central California and largely consistent with dietary debris. The emphasis in the plant component of the diet at Locus A was on nuts, with very few small seeds, and only one finding of berry remains. Locus B may reflect greater use of small seeds, with a frequency comparable to older site components on the mainland Marin bayshore. Locus C shows little evidence of plant food consumption.

The few comparative archaeobotanical data from mainland Marin shell middens show that CA-MRN-44/H has a lower diversity and frequency of plant food residue relative to mainland sites. Plant foods were less important than fish and shellfish at CA-MRN-44/H, and probably less important than were plants at the mainland sites.

Due to the high overlap of the flora of Angel Island and the mainland, there is no clear indication of provisioning of CA-MRN-44/H with mainland plant resources. It is possible, however, that the bulk of the CA-MRN-44/H seasonal indicator evidence, suggesting predominately fall use, may imply some degree of provisioning if countered by faunal data suggesting occupation primarily in spring and/or summer.

Chapter 10: Shellfish Remains

Alex DeGeorgey and Karin Goetter

INTRODUCTION

This chapter analyzes marine invertebrate remains recovered during archaeological investigations at CA-MRN-44/H. Since the pattern of preference for gathering marine shells is assumed to reflect local environmental conditions studies of the marine shells present evidence about the prehistoric habitat adjacent to Angel Island. During the Terminal-Late Phase of the Middle Period (about AD 500-1000), the principal species found at the site include *Mytilus trossulus* (Bay mussel), *Macoma nasuta* (Bent-nosed clam), and *Nucella lamellosa* (Frilled dogwinkle). The ratio of *M. trossulus* to other shellfish species drops significantly during the Late Period (about AD 1500). The explanations offered for this pattern include resource depression and shifts in human exploitation strategies.

METHODS

A substantial amount of shellfish remains (52.9 kilograms) were recovered from excavations at CA-MRN-44/H. An intensive invertebrate analysis was conducted on samples collected from two areas of the site, loci A and B. In Locus A, a 20 cm^3 soil sample was taken from each unit level. A total of 35 samples, constituting two complete soil columns from Units S1/W0, 0-170 centimeters and S2/W0, 0-180 centimeters, was analyzed. A total of 25.4 kilograms of shell was analyzed from Locus A. The total volume of soil was 0.7 m^3. In Locus B, a 50 cm^3 soil sample was taken from just two units S0/W2, 170-180 centimeters, and S0/W4, 170-180 centimeters. A total of 1.6 kilograms of shell was analyzed from Locus B.

Soil samples were bagged in the field, transported to the laboratory, and wet-screened through 1/4-inch and 1/8-inch mesh screens. Shellfish remains were sorted and bagged separately for each unit, level, and screen size. The 1/8-inch fraction was only weighed and catalogued, with no attempt to identify species. The 1/4-inch fraction was separated by taxon, analyzed for cultural modifications such as burning, identified to the lowest taxonomic level, and individually bagged, weighed, and catalogued. Karin Goetter completed identifications of marine shellfish. To assist in identification, a comparative collection of whole shells was taken from various levels within the units at CA-MRN-44/H. Appendix E provides the data sheets for shellfish identification.

RESULTS

The faunal invertebrate analysis recognized 24 taxa, 18 of which could be identified to the Genus level or better (Table 31). In order of their prevalence at CA-MRN-44/H, shellfish include *Mytilus trossulus* (Bay mussel), *Macoma nasuta* (Bent-nosed clam), *Nucella lamellosa* (Frilled dogwinkle), *Mytilus californianus* (California mussel), *Clinocardium nuttallii* (Nuttall's cockle), *Ostrea lurida* (Pacific oyster), *Balanus* sp. (Barnacle), Class Crustacea (crab), *Protothaca staminea* (Pacific littleneck clam), *Panopea*

Table 31. Weight and Relative Percentage of Marine Shellfish Species at CA-MRN-44/H.

SPECIES	COMMON NAME	LOCUS A		LOCUS B	
		WEIGHT (G)	REL. %	WEIGHT (G)	REL. %
Acmaea mitra	White-capped limpet	-	-	0.2	0.0
Balanus sp.	Barnacle	199.3	2.3	14.3	0.9
Class Crustacea	Crab	197.5	2.3	3.8	0.2
Class Gastropoda	Unidentified univalve	1.8	0.0	-	-
Class Pelecypoda	Unidentified clam	10.2	0.1	-	-
Class Polyplacophora	Unidentified chiton	0.6	0.0	-	-
Clinocardium nuttallii	Nuttall's cockle	305.9	3.5	27.1	1.7
Collisella digitalis	Fingered limpet	0.2	0.0	-	-
Collisella limatula	File limpet	3.1	0.0	-	-
Family Acmaeidae	Unidentified limpet	0.6	0.0	-	-
Family Mopaliidae	Unidentified chiton	0.2	0.0	-	-
Macoma nasuta	Bent-nose clam	2,018.8	23.4	673.7	42.0
Mopalia muscosa	Mossy mopalia chiton	4.3	0.0	0.4	0.0
Mytilus californianus	California mussel	609.7	7.1	159.9	10.0
Mytilus trossulus	Bay mussel	3,102.1	35.9	28.4	1.8
Notoacmea persona	Mask limpet	0.3	0.0	-	-
Nucella lamellosa	Frilled dogwinkle	1,950.3	22.6	629.5	39.3
Nucella lima	File dogwinkle	-	-	0.8	0.1
Ostrea lurida	Native Pacific oyster	163.8	1.9	42.5	2.7
Panopea generosa	Pacific geoduck	11.6	0.1	4.5	0.3
Protothaca staminea	Pacific littleneck clam	34.9	0.4	12.0	0.7
Saxidomus nuttalli	Common Washington clam	-	-	2.3	0.1
Tegula funebralis	Black turban	7.5	0.1	1.2	0.1
Tresus nuttallii	Pacific gaper clam	12.1	0.1	2.0	0.1
TOTAL WEIGHT (G)		8,634.8	100.00	1,602.6	100.00

Notes: Rel. – Relative.

genererosa (Pacific geoduck), *Tresus nuttallii* (Pacific gaper clam), Class Pelecypoda (unidentified clam), *Tegula funebralis* (black turban), *Mopalia muscosa* (Mossy mopalia (unidentified clam), *Tegula funebralis* (black turban), *Mopalia muscosa* (Mossy mopalia chiton), *Collisella limatula* (File limpet), *Saxidomus nuttalli* (Common Washington clam), *Nucella lima* (File dogwinkle), Family Mopaliidae (unidentified chiton), Class Polyplacophora (unidentified chiton), Family Acmaeidae (unidentified limpet), *Notoacmea persona* (Mask limpet), *Acmaea mitra* (White-capped limpet), and *Collisella digitalis* (Fingered limpet).

Shellfish remains at CA-MRN-44/H were derived from three habitat types: Open Coast, Protected Coast, and Bay/Estuary (Table 32). Open Coast is represented by one species *Mytilus californianus* (California mussel). *M. californianus* live on exposed rocky coasts within the surf and tidal zone of the Pacific coast and are only available on the outer coast. Protected Coast species are moderately more common, particularly *Balanus* sp. and crab. Bay/Estuary species are most common and represent the greatest abundance and diversity of species. This pattern is not surprising, given the geographic position of Angel Island situated within the waters of the San Francisco Bay. While there appears to have been some use of the open coast, species that inhabit the local bay and estuary environment dominate the shellfish assemblage.

Table 32. Shellfish Environments for Species Recovered at CA-MRN-44/H.

SUBSTRATE	OPEN COAST	PROTECTED COAST	BAY/ESTUARY
Rocky	*Mytilus californianus*	*Acmaea mitra*	*Collisella digitalis*
		Balanus sp.	*Collisella limatula*
		Crab	*Mytilus trossulus*
		Mopalia muscosa	*Notoacmea persona*
			Nucella lamellosa
			Nucella lima
			Ostrea lurida
			Tegula funebralis
			Protothaca staminea
Sand			*Clinocardium nuttallii*
Mud			*Macoma nasuta*
			Saxidomus nuttalli
			Tresus nuttallii
			Panopea generosa

Notes: Data adapted from Huddelsen (1998:Table 37).

DISCUSSION

CA-MRN-44/H Invertebrate Faunal Assemblage

A spatial analysis of shell distributions was examined to assess any intra-site differences and identify change in the use of shellfish through time (Figure 59). Both vertical and horizontal analyses were performed. Two loci (A and B) of CA-MRN-44/H, representing two temporal components, were selected for comparative purposes. Site occupation in Locus A dates to the Terminal-Late Phase of the Middle Period (about AD 500-1000). Chronological control in Locus B is less reliable and has been ascribed to the Late Period (about AD 1500) based solely on obsidian hydration rim values.

Figure 59 presents a comparison of *Macoma nasuta* (Bent-nosed clam), *Mytilus trossulus* (Bay mussel), and *Nucella lamellosa* (Frilled dogwinkle) in Locus A and B at CA-MRN-44/H. Some of the important features represented in Figure 59 are:

- Mussel is dominant during the Terminal-Late Phase of the Middle Period.
- Mussel drops out of use during the Late Period.
- Clam and Frilled Dogwinkle track one another in both components.

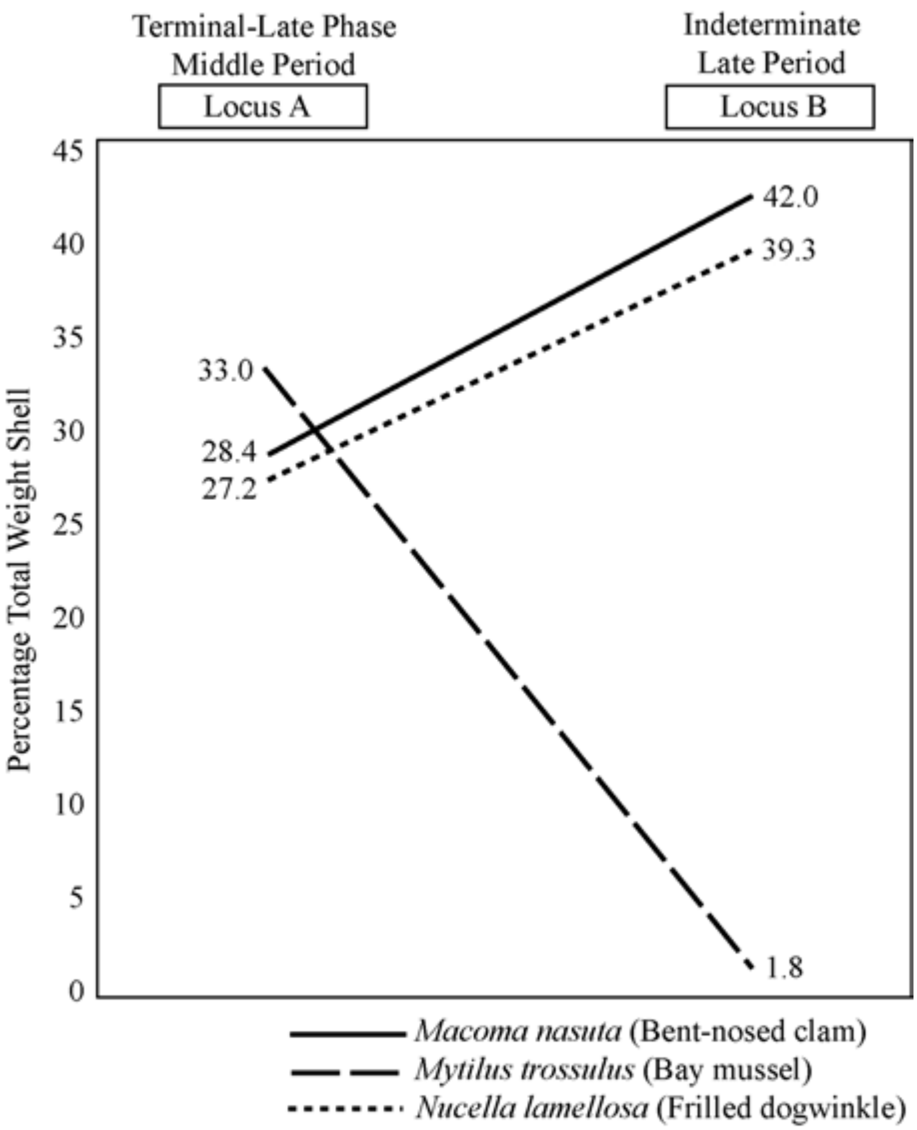


Figure 59. Comparison of Principal Shellfish Species at CA-MRN-44/H.

Ecological context of shellfish has its implications on human exploitation strategies and is useful for understanding the pattern of prehistoric mollusk use at CA-MRN-44/H. *Mytilus trossulus* is commonly found in protected habitats with rocky shores, occurring as dense clusters of shells attached to rocks, often having hundreds of specimens in a single colony. *Macoma nasuta* occur in the sandy mud of bays. *Nucella lamellosa* inhabit the rocky intertidal area of bays. In contrast to mussel, both *M. nasuta* and *N. lamellosa* tend to occur as isolated organisms.

Due to their relatively small size and preference to grow in colonies, the most effective means of gathering bay mussel is to remove them *en masse* (Jones 1997:17). Removal of whole colonies of mussel would involve little, if any, selectivity or culling. On Angel Island, the decrease in mussel populations during the Late Period is likely the result of mass-harvesting techniques, which resulted in human-induced resource depression. Some indices suggesting that mass harvesting occurred at CA-MRN-44/H include: (1) a high percentage of very small-sized mussels; (2) the presence of "riders" (species that live within mussel colonies); and (3) a high frequency of baked clay endocasts from dead or dying mussels that were filled with mud and subsequently cooked. Baked clay objects were recovered in higher numbers from Locus A (n=819) than from Locus B (n=24). The disproportionate amount of baked clay endocasts present in Locus A is indicative of intensive collection (i.e., stripping)

Environmental and cultural processes can produce significant changes in the size of individual mussels and beds (Jones 1997:9). Intensive harvesting of bay mussel can result in overexploitation, which occurs when the rate of harvest exceeds the recovery rate. Overexploitation quickly reduces the amount of mussel locally available. When a mussel bed is cleared, it takes anywhere from five to 100 years to reestablish itself. The importance of mussel to forager diets was variable relative to accessibility and to other available food commodities. It is likely that as mussel populations on Angel Island became depleted from over-harvesting, other species, such as clam and frilled dogwinkle, became more important food items.

Researchers elsewhere in California have analyzed the implications of prehistoric mussel collection on intertidal ecology (Basgall and Bouey 1991; Jones and Richman 1995; White 1989). At MacKerricker State Park on the Mendocino coast, White (1989) completed a seminal study of the effects of prehistoric mussel harvesting strategies on ecology and human behavior. Two alternative strategies for harvesting mussels were proposed: "plucking," an efficient strategy where larger individual mussels were selectively gathered, and "stripping," a less efficient method where whole mussel colonies were removed en masse (White 1989). White attributed the pattern of increased mussel collection through "stripping" to human-induced resource depression and economic intensification.

Subsequently, Basgall and Bouey (1991) questioned White's conclusions regarding the relative efficiency of alternative harvesting techniques based on findings on the Central California coast. Mussel shell collected from archaeological sites at Piedras Blancas in San Luis Obispo County showed evidence of a continuous plucking strategy through time suggesting that no economic intensification occurred.

In order to evaluate the conflicting perceptions about the efficiency of mussel shell harvesting strategies, Jones (1997) completed an experimental quantitative study of the different collection techniques. Experimental data indicate that plucking is always the preferred strategy (Jones 1997:17). In addition, experimental data show that human collection influences the value of the resource over time leading researchers to conclude that intensive collection (ie, stripping) will affect the population and deflate the total food value available to subsequent collectors.

Southeast Marin County Invertebrate Faunal Assemblages

Table 33 presents a summary comparison of the shellfish taxa present at eight temporally discrete cultural components defined at three separate sites in southeastern Marin County. In order to make reasonable comparisons from differently sized samples, the raw weight from each taxa was converted to the percentage of the total weight of shellfish from the component.

Table 33. Shellfish Weight Percentage Per Temporal Component.

	MRN-17		MRN-254				MRN-44	
	Early Period	Middle Period	I Phase Middle Period	M-L Phase Middle Period	M/L Trans.	Late Period	M-L Phase Middle Period	Late Period
Balanus sp.	5	12.7	6.5	7.4	3.9	6	2.3	0.9
Crab	[a]	[a]	-	-	0.1	0.1	2.3	0.2
Clinocardium nuttallii	0.8	2.9	-	-	0.2	-	3.5	1.7
Nucella lamellosa	-	-	-	-	-	-	22.6	39.3
Macoma nasuta	41.6	68.1	1.7	0.4	54.9	2.5	23.4	41.9
Mytilus sp.	2.8	7.8	87.5	91.7	28.1	90.4	43	11.8
Ostrea lurida	48.2	4.1	4	0.4	12.8	0.6	1.9	2.6
Protothaca staminea	1.5	2.1	-	-	-	-	0.4	0.7
Tresus nuttallii	-	1.3	-	-	-	-	0.1	0.1

Notes: [a] Crab not analyzed at MRN-17. I – Intermediate; M-L – Mid-Late; M/L – Middle/Late; Trans. – Transition.

At Marin County sites, the most common taxa are *Mytilus trossulus*, *Macoma nasuta*, and *Nucella lamellose*. *M. trossulus* (Bay mussel, reclassified from *M. edulis*) and *M. californianus* were identified at CA-MRN-44/H. However, these species are not distinguishable as juveniles and therefore are lumped together in Table 33. Similarly, several species of *Balanus* sp. were identified to the level of genus.

The shellfish assemblage from DeSilva Island (CA-MRN-17) was arbitrarily divided into two cultural components representing the Early Period and indeterminate Middle Period. Shellfish recovered from 0 to 400 centimeters depth were included in the indeterminate Middle Period. Shellfish recovered from below the 400-centimeter level were lumped into the Early Period. Shell weight percentages for CA-MRN-254 (located in San Rafael) were adapted from Huddleson (1995:Table 46).

Figure 60 presents a summary of shellfish use for the three principal taxa: *Mytilus* sp. (Mussel), *Macoma* sp. (clam), and *Ostrea lurida* (Native Pacific oyster) found at prehistoric sites in southeastern Marin County. Stark shifts in shell fish use are apparent through time. The Early Period, as represented at CA-MRN-17, is characterized by high percentages of oyster and clam. Mussel makes up a small percentage of the shell fish. During the Terminal-Late Phase of the Middle Period oyster and clam use declines sharply and mussel becomes the dominant shellfish species (CA-MRN-44/H, -254). The Middle/ Late Transition (CA-MRN-254) indicates a decrease in the use of mussel, and an increase in use of oyster and clam. During the Late Period (CA-MRN 44/H, -254) mussel is the dominant species. Clam continues to be important and oyster is present in small frequencies. The most salient features represented in Figure 60 are:

- During the Early Period, oyster and clam are the dominant species. Mussel is of minor importance.
- During the Terminal-Late Phase of the Middle Period, oyster and clam are less important. Mussel is the dominant taxa.
- During the Late Period, mussel remains important, oyster falls out of use, and clam continues to be relatively important.

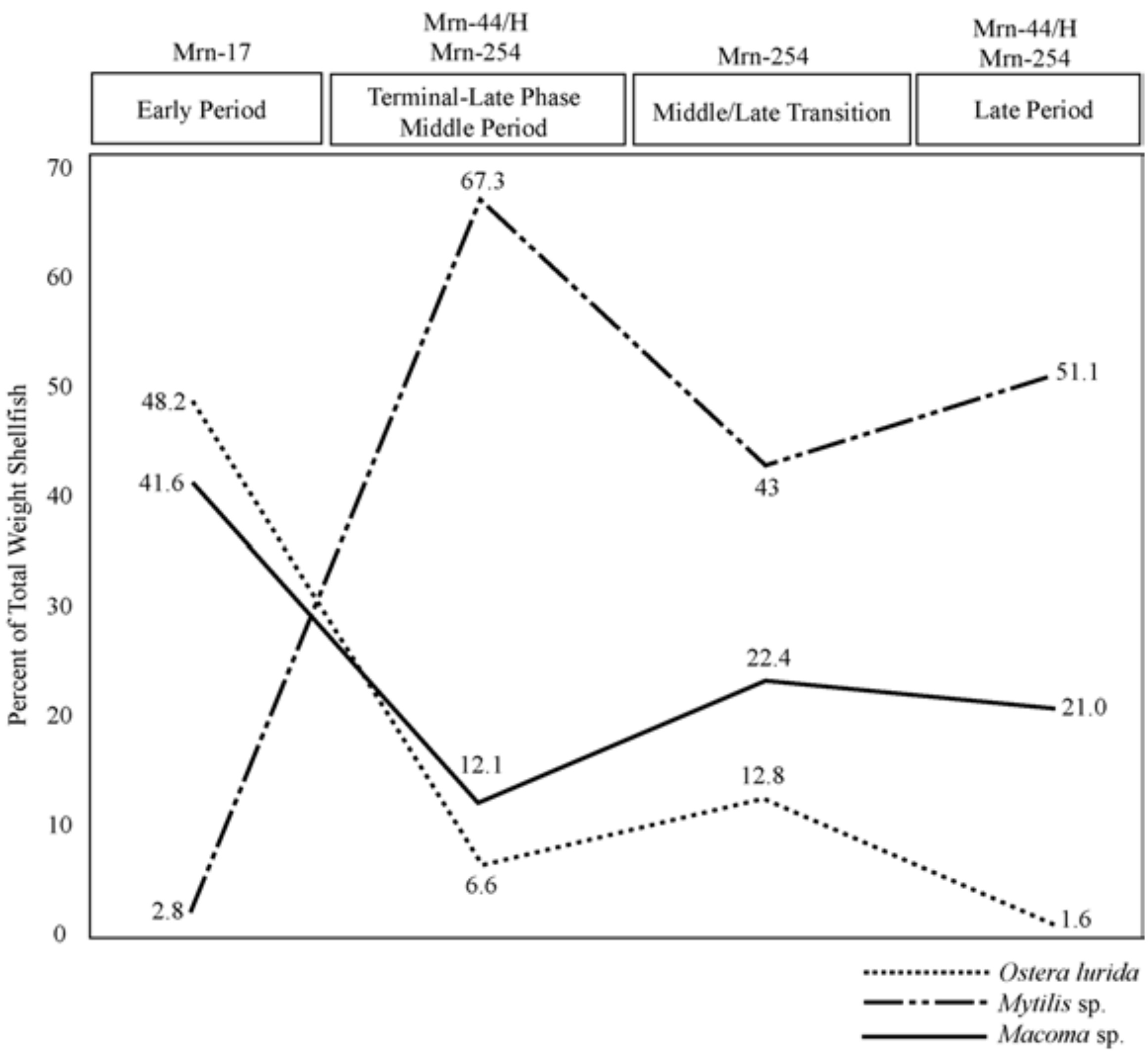


Figure 60. Principal Shellfish Taxa at Three Marin County Sites.

Paleoenvironmental and archaeological studies in the region indicate that the San Francisco Bay has undergone considerable environmental change during the mid- to late-Holocene. Originally the bay was characterized as a rocky intertidal zone, but by about 4500 BP, the tidal marshes were well established in the north and east bay (Bickel 1978).

Story et al. (1965:49) postulates that "marshes developed in the tidal area at the same time that mud was being deposited in the deeper zones, and oyster beds began to flourish where favorable conditions existed." Radiocarbon dating of oyster shell and peat found within bay mud near the San Mateo bridge indicate that oyster beds (*Ostrea lurida*) experienced a population explosion about 2,500 years ago (Story et al. 1965:48), with the greatest population of oysters existing for a 200-year span between 2500 and 2300 BP. It is about this time that many Bay Area shell mounds begin to appear along the bayshore (Lightfoot 1997; Lightfoot and Luby 2002).

Beginning about 2300 BP and continuing to the present, the oyster populations in the southern part of the San Francisco bay began to decline in both number and areal extent (Story et al. 1965:48). This was most likely caused by rising sea levels, which changed the local environment to one more typically characterized by mud and sandy bays. Oysters are a reliable index of ecological change and their relative abundance in the San Francisco bay sites should be greater earlier in time (Greengo 1975). Oyster was the dominant mollusk found in the basal components of many mounds, with the upper portions dominated by boring clams (Gifford 1916; Nelson 1909; Wallace and Lathrap 1975). Moratto (1984) attributed this pattern to changing conditions of the bottom of the San Francisco Bay, (gravel to mud) which ultimately favored clams over oysters. As sedimentation of the bay increased, the frequency of oyster beds was reduced.

CONCLUSION

Shellfish recovered from column and grab samples suggest that three taxa were commonly processed at CA-MRN-44/H: *Mytilus trossulus*, *Macoma nasuta*, and *Nucella lamellosa*. These species were an important part of the diet of the local prehistoric inhabitants. The majority of species present in the assemblage were derived from the local San Francisco Bay habitat. *Nucella lamellosa* is a species uncommon to other sites in southeastern Marin County, and may be a local adaptation to the habitat surrounding Angel Island. Distribution of shellfish from Locus A (circa AD 500-1000) and Locus B (AD 1500) were analyzed to address shifts in shellfish use through time. A large amount of *M. trossulus* was recovered from Locus A and very small quantities from Locus B (see Figure 59). Methods of *M. trossulus* procurement appear to have been dominated by stripping in mass from rocky habitats. This intensive method of harvest may have led to population depletion and resource depression of *M. trossulus*.

Analysis of shellfish remains from three southeastern Marin County archaeological sites (CA-MRN-17, -44/H, -254) confirms the dietary importance of oysters during the Early Period and a subsequent population reduction during the Middle and Late Periods (see Figure 60). The dramatic decrease in *Ostrea lurida* populations during the Middle and Late Periods is probably associated with the formation of a muddy bottom in the San Francisco Bay (Moratto 1984). As *O. lurida* populations decreased during the Middle Period human exploitative strategies were redirected toward gathering the *M. trossulus* and various species of clam.

Chapter 11: Discussion and Conclusions

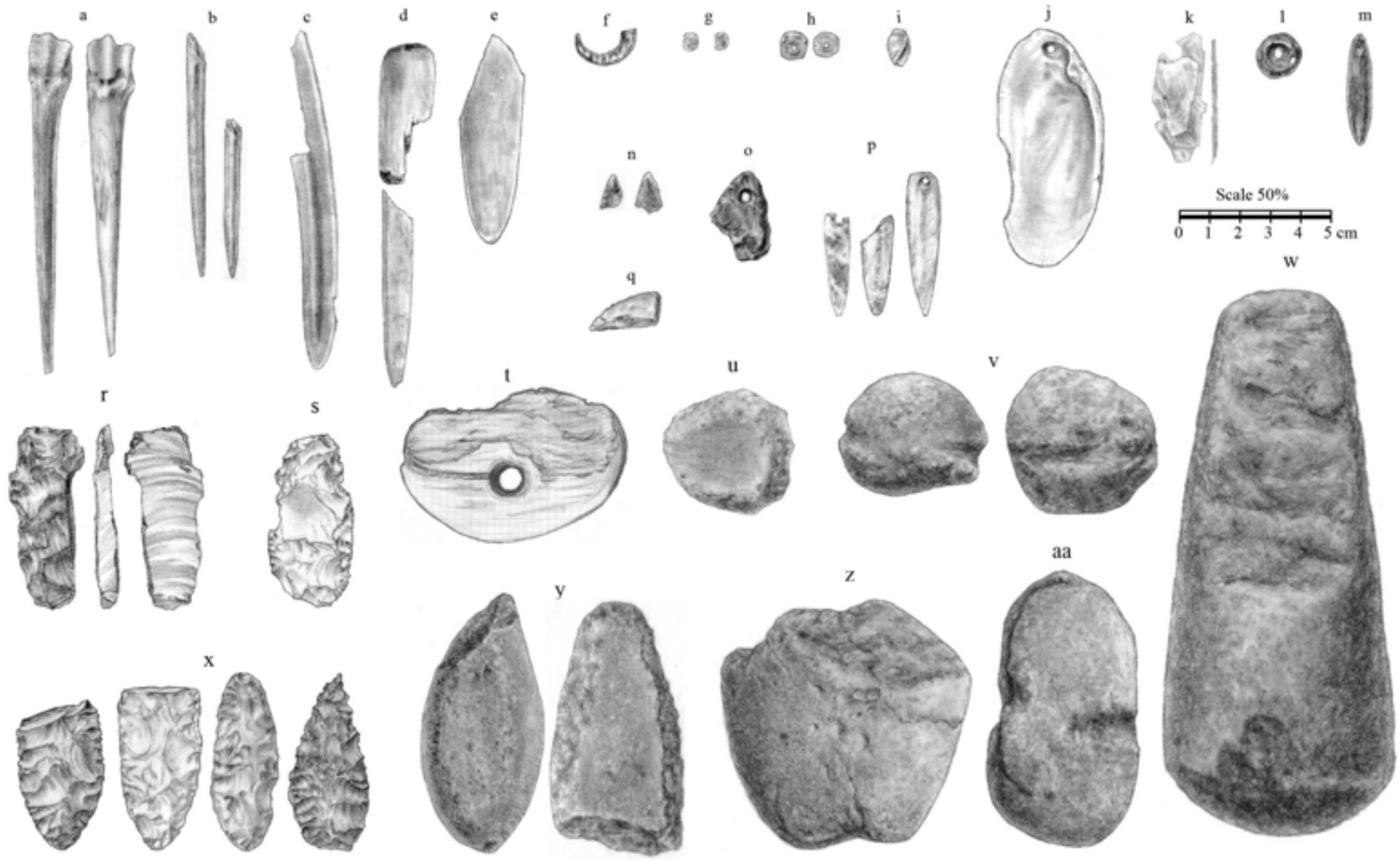
The research objectives developed for investigations at CA-MRN-44/H focused on three basic domains: (1) cultural chronology; (2) settlement system; and (3) subsistence strategy. Investigations at CA-MRN-44/H yielded data sets directly applicable to understanding past lifeways specified in the research design. In this chapter, a series of discussions are presented to address results of these research pursuits as well as describe the problems and prospects of their interpretation.

Evidence for the age and span of human occupation is revealed through three independent lines of chronological evidence. Radiocarbon dates associated with temporally diagnostic artifact types are generally considered to be the most reliable analytical data available. Obsidian hydration analyses are used as a comparative tool to provide chronological control. The potential error inherent in an individual hydration sample is offset by examining the overall hydration sample. Individual hydration results are less statistically reliable than the sample population as a whole.

In this chapter we will employ the temporal units of Bennyhoff and Hughes (1987), as refined by Groza (2002), who divided the chronology into the following periods: Early (3000 to 500 BC), Early/Middle Transition (BC 500 to AD 200), Middle (AD 200 to 1100), Middle/Late Transition (AD 1100 to 1265), Late Phase I (AD 1265 to 1500), and Late Phase II (AD 1500-1700). Three cultural components were identified at CA-MRN-44/H. Figure 61, Figure 62, and Figure 63 show the types of artifacts per component.

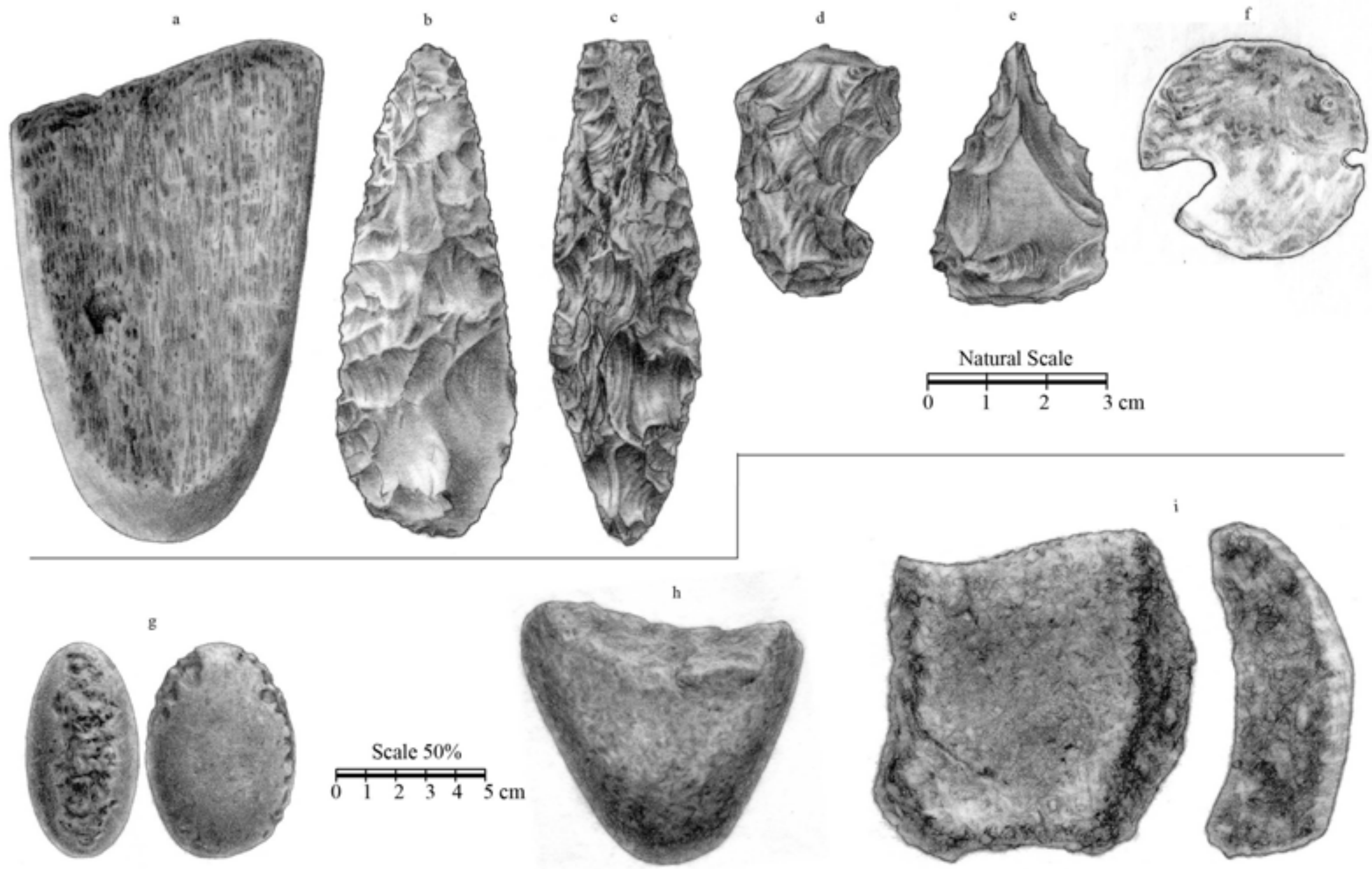
TERMINAL-LATE PHASE OF THE MIDDLE PERIOD

Locus A represents the Terminal-Late Phase of the Middle Period component (ca AD 500-1000) with a high degree of integrity. This component has a coherent set of radiocarbon dates, obsidian hydration rim values, and artifact types distinctive of this period. Six radiometric dates averaging 1180 cal BP (1015-1335 cal BP), were recorded. The primary obsidian source represented in this component is dominated by Napa Valley (>98%), with Annadel showing up very rarely. Hydration rim values, averaging 2.7 microns (1.5 to 3.7 microns), confirmed a tight single



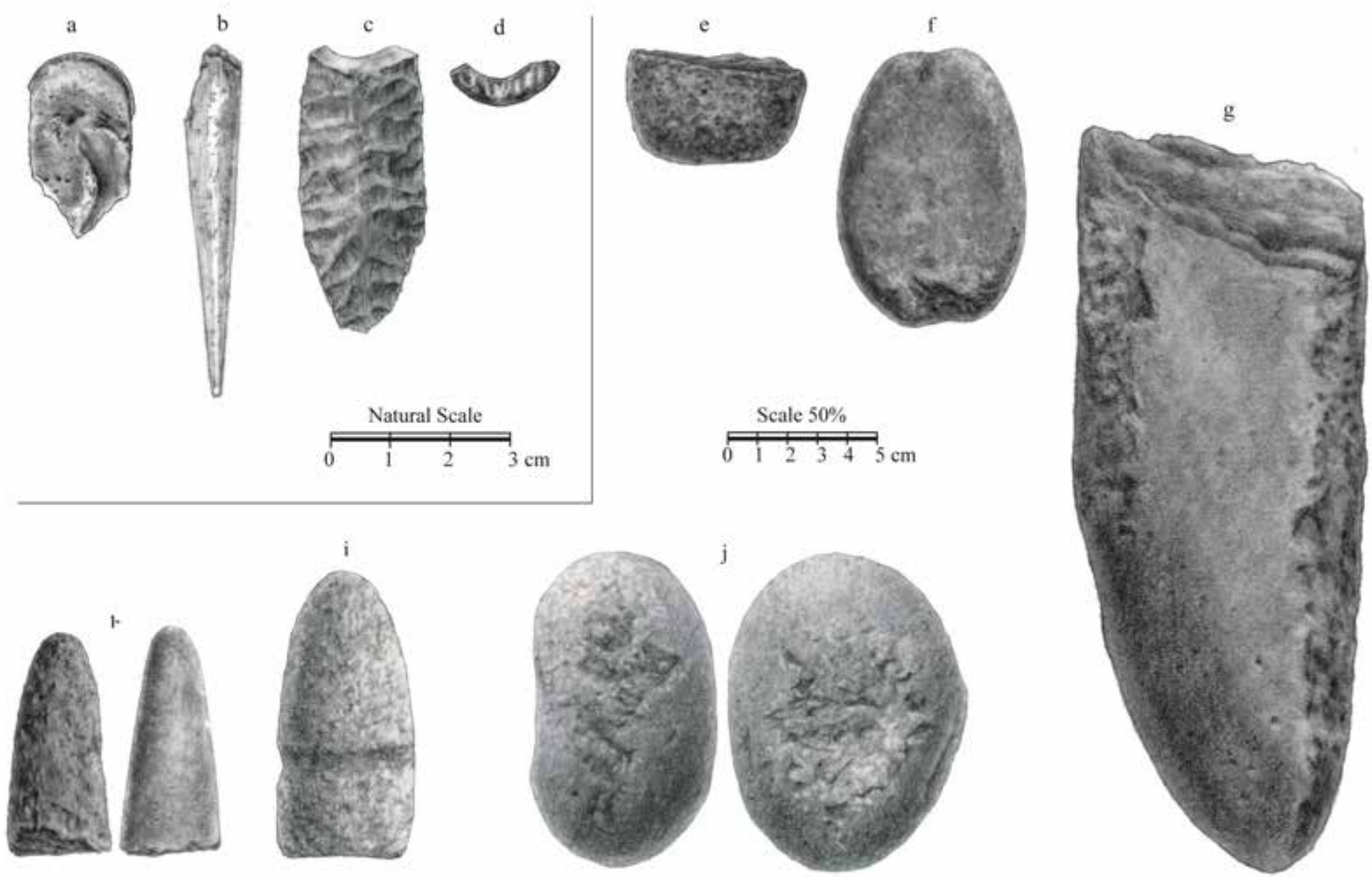
Terminal-Late Phase of the Middle Period Assemblage, MRN-44/H Locus A
a-split cannon bone awls, b-bone needle, c-split polished bone item, d-small flat bone hair pin, e-large flat bone pin, f-J-shaped *Mytilus* sp. fishhook, g-F3b series *Olivella* beads, h-F3a series *Olivella* beads, i-A1b *Olivella* bead, j-end perforated *Siliqua patula* ornament, k-perforated mica ornament, l-biconically drilled steatite bead, m-perforated schist pendent, n-end perforated *Mytilus trossulus* ornament, o-end perforated *Mytilus californianus* ornament, p-tear drop shaped *Haliotis rufenscus* pendants, q-incised edge *Haliotis rufescens* ornament, r-bipolar reduced obsidian biface, s-Napa obsidian biface, t-perforated and incised steatite amulate, u-sandstone abrader, v-sandstone fishing weights,w-pestle, x-Excelsior Foliate series obsidian projectile points, y-charmstones, z-end-notched net weight, and aa-notched net weight.

Figure 61. Terminal-Late Phase of the Middle Period Assemblage CA-MRN-44/H, Locus A.



Middle/Late Transition Period Assemblage, MRN-44/H Locus C
a-bone wedge b-Excelsior Foliate series Napa obsidian projectile point, c-bipointed shoulder notched Napa obsidian projectile point, d-obsidian biface, e-chert drill, f-*Haliotis rufescens* ornament, g-pitted hammerstone, h-sandstone pestle, and i-cobble mortar.

Figure 62. Middle/Late Transition Period Assemblage CA-MRN-44/H Locus C.



Indeterminate Late Period Assemblage, MRN-44/H, Locus B.
a-split cannon bone awl, b-bone needle, c-Excelsior Foliate series Napa obsidian projectile point, d-J-shaped *Mytilus* fishhook, e-cylindrical sandstone pestle, f-end notched sandstone net weight, g-large steatite pestle, h-sandstone pestles, i-collared sandstone pestle, and j-pitted handstone.

Figure 63. Indeterminate Late Period Assemblage CA-MRN-44/H Locus B.

modal distribution and resulted in a calibrated date of 1086 cal BP (Rosenthal 2006). Diagnostic artifact types indicative of this time period include F3a and F3b series *Olivella* beads. Other assemblage traits corresponding to this time period include a subsistence economy focused on mollusks and fish, a well-developed bone tool industry, non-perforated charmstones, Excelsior Foliate projectile points, stone net weights, mortar and pestle technology, shell fishhooks, and *Haliotis* pendants and ornaments. The artifact assemblage from Locus A is consistent with the late Berkeley Pattern, which is found throughout the Bay Area, southern North Coast Range, and Sacramento Delta region.

MIDDLE/LATE TRANSITION PERIOD

Locus C is tentatively ascribed to the Middle/Late Transition Period (ca. AD 1200). A total of four widely diverging radiometric dates were derived from a variety of materials (acorn hull, faunal remains, and abalone shell) that were recovered from this component. The intercept of the radiocarbon age with the calibration curve for the four samples are: 310, -670, -1530, and -1810 cal BP (Beta-217284, -218548, -220058, and -216692 respectively). The dates range over a 1,500-year time timespan with an approximate mean of 1080 cal BP (870 AD).

This component has poor chronological control because the radiocarbon results are so scattered. The variability in radiocarbon dates from this component is probably the product of contaminated the soils. It is known that crude oil was deposited on this landform in the historic period between 1910 and 1940 when the area was part of the Angel Island Immigration Station. Soils and artifacts recovered from Locus C show evidence of contamination from crude oil. Radiometric age estimates affected by such contamination are considered to be unreliable. As a result of unreliability of the radiocarbon dates, obsidian hydration analysis was the primary means for assigning this component to the Middle/Late Transition Period. Obsidian sources were dominated by Napa Valley (>98%), with Annadel making up a small percentage. Hydration rim values averaged 2.4 microns (1.3 to 4.8 microns), demonstrated a single modal distribution, and resulted in a calibrated date of 858 cal BP (Rosenthal 2006). The artifact assemblage consisted of Napa Glass Mountain obsidian bifaces, a large bipointed shoulder-notched obsidian projectile point, bowl mortar and pestle, a large bone wedge, a battered hammerstone, chert drill, and a circular *Haliotis* ornament. Use of local chert toolstone for expedient tools characterized this assemblage. Organic preservation was remarkable as demonstrated by the presence of a carved wooden stake, an acorn hull, and other organic materials observed within the artifact-bearing stratum. The good organic preservation and anaerobic environment appears to be the result of rapid sediment deposition, which covered the site with soil and protected it from weathering. Salmon fishing and hunting of medium-large mammals were important subsistent pursuits. Animals were intensively processed and the faunal assemblage is characterized by a relatively large amount of small burnt fragmentary elements. The most salient feature of this component is the lack of marine shell, signaling a transformation in subsistence orientation, settlement strategy, and site function from the previous period.

Due to the paucity of identified sites on the bay shore that date to this time period, it is difficult to affiliate this assemblage with any known cultural pattern. However, the salmon-deer subsistence orientation and a settlement strategy characterized by low population densities and short-term site occupation is generally consistent with Augustine

Pattern assemblages identified in the north bay. Further sampling in this locus is likely to reveal a full assemblage of artifacts, reliable datasets for dating, and intact stratigraphic contexts for studying site formation processes, landscape evolution, and Paleoenvironmental reconstruction.

INDETERMINATE LATE PERIOD

Locus B has been tentatively ascribed to an indeterminate Phase of the Late Period (ca. AD 1500). Testing yielded a total of four radiometric dates, averaging 1554 cal BP (730-2730 cal BP). Again, this component has very poor chronological control due to highly divergent radiocarbon dates, which range more than 2,000 years. As at Locus C, the problem with the variability in radiocarbon dates appears to be associated with crude oil contamination and by default obsidian hydration analysis became the primary means for dating this component. Obsidian originated from the Napa Valley geological source. Hydration rim values averaged 1.7 microns (1.1 to 2.5 microns). Calibration of hydration dates resulted in an age estimate of 430 cal BP (Rosenthal 2006).

Subsistence remains recovered from this component are indicative of an economy focused on fishing and gathering mollusks. Artifacts associated with this component include notched net weights, a pitted handstone, roughly shaped charmstones, a collared pestle, one Napa Valley obsidian Excelsior projectile point, a mussel shell fishhook, *Haliotis* ornaments, and a polished bone needle. The artifact assemblage is consistent with Berkeley Pattern assemblages found elsewhere in the region.

Researchers in the Bay Area have observed that many of the shell mounds on the bayshore were abandoned during the Late Period. Therefore, assignment of this component to the Late Period is problematic and the actual chronological signature of this component may be considerably older. Additional investigations of this component should be conducted to recover elements of the artifact assemblage, identify stratigraphic contexts useful for understanding vertical and horizontal relationships to other site components, and to derive a reliable data set for temporal assignment.

TEMPORAL TRENDS

The most intensive occupation of the site occurred during the Terminal and Late Phases of the Middle Period (ca. AD 500-1000). During this time the site served as a residential village focused on shellfish gathering and fishing. It was in this time that the shell mound accumulated rapidly. The shell mound village was a center of economic activities, residential settlement, and a location of ritual and ceremonial significance. Detailed analysis of mollusk, faunal, and plant remains strongly suggest that the village was occupied for most of the year with the most intensive use during the fall (Simons et al. 2000; Wohlgemuth 2004).

This Middle Period fishing village can be best described as a “salmon and shellfish economy.” Although a diverse range of foods was processed and consumed, the economic emphasis was on fishing for salmon and gathering mussels, clams, and Frilled dog-winkle. Bay mussel is the most common constituent of CA-MRN-44/H during the Middle period. Important large fish included salmon, sturgeon, and bat rays. Capture of small schooling fish was also essential as demonstrated by the high number of northern anchovy, sardine, herring, silversides, jack smelt, and surfperch, which were probably harvested with large nets. Marine mammals such as harbor seal and California sea lion were hunted in low numbers. Birds and reptiles played an insignificant role in subsistence pursuits. Cooking hearths, ovens, baking pits, and fire-affected rock were frequent residential features linked with this period. Cannon bone awls, needles, small flat hairpins, spatula, and incised bird bone tubes signify that bone artifacts served both utilitarian and social functions and that the bone tool industry was highly developed. The fishing village was also a site of ritual practices and a place to bury the dead. Human burials of men and women were interred in the shell mound, signifying the ceremonial importance of the site. Objects of social and ritual significance were recovered from the site including *Olivella* and *Haliotis* beads and ornaments; mica, schist, and steatite pendants; incised bird bone tubes; and finely formed charmstones. A cache of several hundred unmodified Frilled dog-winkle shells identified in the lower levels of the shell mound is a probable ceremonial offering.

There is evidence for a significant change in settlement pattern and subsistence economy at CA-MRN-44/H during the Middle/Late Transition Period (ca. AD 1200). The most striking trait of this period is the absence of marine shellfish in subsistence pursuits, a largely unrecognized pattern on the San Francisco Bay shore. Occupation during this time period does not appear to be as intense or continuous as during preceding periods. In addition, the shell mound area of the site seems to have been completely abandoned during this time. During the Middle/Late Transition Period the site probably functioned as a short-term camp centered on salmon fishing and hunting of medium-large sized mammals, presumably deer.

The Middle/Late Transition Period at CA-MRN-44/H is best described as a "salmon-deer economy." The site was probably occupied during the spring and summer months when salmon were available in greater numbers. Analysis of the vertebrate assemblage indicates that a less diverse range of foods were exploited than during the Middle Period. Animals were more intensively processed, as indicated by the higher relative frequency of small fragmentary and burnt elements. Acorn processing may also have been an important food source as indicated by the presence of a bowl mortar, pestle, and an acorn hull. The bone tool industry, which was an important element of the Middle Period, is nearly absent during the Middle/Late Transition Period on Angel Island. The presence of an intact human burial, an adult male who was interred with no apparent associated grave goods, indicates that the site also served as a funeral place.

DISCUSSION

Analysis of the temporal trends at CA-MRN-44/H yielded evidence for a transformation of settlement and subsistence strategies on the bay shore between the Middle and Late Periods. This cultural transformation correlates with a time of environmental degradation brought on by a series of extreme and persistent droughts.

The archaeological record at CA-MRN-44/H represents a transformation in use and function of the bay shore through time. During the Middle Period, the site served as a shell mound village, which was apparently deserted and then later reused as a special-purpose site during the Middle/Late Transition Period. In the San Francisco area, researchers have made similar observations about abandonment of the bay shore at the end of the Middle Period (Banks and Orlins 1985:34; Elsasser 1978:43; Jones 1992:12-13; Lightfoot and Luby 2002). For instance, in the east bay, sites appear to have been abandoned between AD 500 to 700

(Banks et al. 1984:21), and in the Los Vaqueros region of Contra Costa County, a significant shift in subsistence and settlement occurred during the Middle-Late Transition period (AD 450 to 1250; Meyer and Rosenthal 1997:V8). Jones (1992:13) performed a broad scale settlement study of the Bay Area, which demonstrated the abundance of bayshore components that date to the Middle Period and a considerable decrease in components for the duration of the Late Period. Similar findings from the Richmond area of the east bay are presented by Lightfoot and Luby (2002), who cite evidence for abandonment of residential places before or during the Middle/Late Transition Period between AD 700 to 1100. Populations may have been more evenly distributed across the landscape, with residential habitation occurring in a variety of coastal, riparian, and oak-woodland settings. There are few sites on the bay shore that date to this period and no large residential bases, suggesting low population densities, small short-term settlements, and periodic land use.

The abandonment of the large residential village at CA-MRN-44/H during the Middle/Late Transition Period may be linked to environmental degradation and drought conditions. Beginning about AD 900 and lasting to about AD 1350, temperatures have been recorded in many parts of the world as much warmer and drier relative to phases before and after (Briffa et al. 1992). Environmental and cultural responses have been traced to this period, known as the Medieval Climatic Anomaly (MCA), or Medieval Warm Period. The MCA reduced the amount of fresh water input into the Bay Area, which affected sediment flows and salinity of bay waters. The paucity of Late Period residential sites on the bay shore may be a product of these effects, either through landscape evolution processes or archaeological visibility. The Late Holocene was a time of significant shifts in temperature and precipitation: cooler-wetter periods associated with extensive alluvial deposition punctuated by intervals of warmer-drier periods with minimal deposition. These climatic and depositional oscillations probably affected the archaeological visibility of sites in the region.

In the east bay some Late Period sites have been documented as being buried under one to three meters or more of Late Holocene alluvium (Ingram 1998; Meyer and Rosenthal 1997; Wiberg 1996, 1997). These significant episodes of alluvial deposition can be correlated with three periods of cooler-wetter conditions that occurred about 850 to 750 BC, AD 50 to 450, and AD 1300. These cooler periods of high sediment load were punctuated by intervals of warmer, dryer conditions. The most extreme warm-dry period was the MCA that produced drought conditions across much of California from AD 650 to 850 and AD 1150 to 1250 (Jones et al. 1999; Stine 1994). An unconformity was identified by Ingram (1998:108) present in much of the south San Francisco Bay Area that is 1.5 to 1.8 meters deep and dates to AD 450 to 750. This unconformity represents a stable surface or "palesol" that developed as a consequence of a prolonged period of decreased sediment deposition. Additional evidence of drought conditions during the Late Holocene are demonstrated in stable isotope analysis of sediment cores from San Francisco Bay marshes (Frances and Imgram 2004). Four periods of higher than average salinity were identified: AD 400-700, AD 1000-1200, AD 1700-1800, and AD 1850 to present. The higher than average levels of salinity were used to suggest reduced freshwater inflow in the bay and warmer-drier conditions characterized these times.

The archeological record at CA-MRN-44/H demonstrates significant transformation in site use and function through the Late Holocene that correlates with the larger pattern noted in the San Francisco Bay Area. A comparison of the timing of environmental events with the archaeological record from the Bay Area reveals that climatic conditions, landscape evolution, and human behavior are inter-related processes. Any understanding of the archaeological record cannot be complete without knowledge of these independent yet interconnected systems.

CONCLUSION

Archaeological investigations at CA-MRN-44/H on Angel Island revealed a unique and significant cultural resource as defined under Section 21083.1 of the California Environmental Quality Act. This conclusion is supported by the presence of numerous features, complex cultural and natural stratigraphy, a rich artifact assemblage, temporally discrete occupational components, human skeletal remains, grave associated funerary objects, and a data set capable of addressing important research questions about local and regional prehistory.

In addition, the archaeological record at CA-MRN-44/H contains evidence of significant cultural transformations involving shifts in settlement strategy, subsistence orientation, and economic activities. The material record contained at the site has the potential to yield information relevant to paleoenvironmental reconstruction and human adaptation to a rapidly changing environment. Large areas of intact cultural deposits still exist at CA-MRN-44/H and the material record has the potential to yield information applicable to numerous contemporary research issues. The State of California DPR should make efforts to preserve the site and protect it from any future adverse effects or vandalism. In the case of unavoidable impacts that may result from future development, a qualified professional archaeologist should be retained to evaluate potential site disturbances and determine an appropriate course of action.

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