TECHNOLOGICAL ORGANIZATION OF THE MILLINGSTONE PATTERN IN SOUTHERN CALIFORNIA

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A Thesis

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Abstract

of

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The adaptive significance of the Millingstone Horizon (or Encinitas Tradition) in southern California has remained enigmatic because little progress has been made toward understanding cultural systems that characterized the pattern. Past explanations have used direct ethnographic analogies, artifact typologies, chronological data, subsistence remains, site typologies, and paleo-environmental data to interpret the appearance, persistence, and demise of the strategies that defined this pattern with little success. This thesis employed intensive macroscopic use-wear and formalization analyses of the primary artifact classes characteristic of Millingstone assemblages in order to better understand subsistence and settlement strategies. This provided a functional basis for evaluating the impact of different variables on cultural systems leading to more informed inferences regarding adaptive significance. The analysis revealed relatively low degrees of tool formalization, intensive use, and a high amount of functional overlap between different artifact classes in assemblage contexts characterized by low diversity. This suggested that site use was primarily geared toward regular re-occupation for a variety of processing tasks. The data are inconsistent with explanations of site use based on sedentism and high residential mobility. Assessments of chronological and paleo-environmental data suggest that neither climatic fluctuation leading to resource changes nor the dynamics of population density can account for the appearance of the Millingstone pattern. It is more probable that this pattern developed as a flexible and accommodating strategy in the early Holocene as an adjustment to existing southern California environments. The spatial and temporal variation of its termination is probably a factor of changes in social organization in response to population growth in the late Holocene.

________________________, Committee Chair
Mark E. Basgall

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Chapter 1:
INTRODUCTION

This thesis is concerned with a widespread archaeological pattern of southern California traditionally referred to as the Millingstone Horizon (Wallace 1955) or Encinitas Tradition (Warren 1968). For purposes of clarity, the Millingstone Horizon will be referred to as the "Millingstone pattern," unless the original terminology is used in its conventional sense. This will help avoid indirect reference to traditional cultural-historical connotations associated with the term "Millingstone Horizon." Technologically speaking, this pattern is characterized by an abundance of millingstones, handstones, core and cobble tools (scraper planes, hammerstones, choppers) with an apparent dearth of late stage bifacial implements and refined flaked stone in general. The objective of this study is to provide a better understanding of the adaptive strategies that produced this archaeological pattern with respect to subsistence-settlement and social organization.

Historically, variation in the interpretation of the Millingstone pattern reflected changes in both methodological and conceptual frameworks. Initial interpretations focused only on large, complex sites and were couched in a paradigm that relied heavily on ethnographic analogies. Later explanations, troubled by deficits in chronological and detailed artifactual data, have relied too much on restricted archaeological remains (i.e., shellfish) and created a biased perspective on settlement and subsistence. Other explanatory efforts have called upon the increasing understanding of prehistoric natural environments to find correlations that could help explain the existence of material culture patterns. In so doing, many interpretations include over-extended assumptions about the relationship between humans and their environment. The culminating result of the different approaches has been cultural-historical and temporal delineation of the Millingstone pattern.

Regional analyses that have sought to cross the methodological and theoretical chasms have seldom gone farther than to point out similarities in assemblage composition or landscape patterning. This is because there has been no basis for the generation and comparison of data that speak to functional associations between cultural systems and the landscape. Archaeologically, the relationships between different kinds of material remains have to be generally understood on a organizational level (including function, technology and condition) for an interpretation to be useful.

In order to characterize adaptive strategies of the Millingstone pattern, this thesis employs a methodology that highlights functional associations within and between the major artifact categories. The analysis is based on the understanding that the condition of groups of artifacts in the archaeological record is the result of a general context of use. This context is the cultural system that, if quantified correctly, can be understood by assessing the relationship between measured use-wear and form attributes. Within the context of use, the relative economic significance of any artifact class can be determined by comparing patterns of tool use and form.

This approach avoids the chronological and contextual problems inherent in many of the Millingstone pattern assemblages by sampling similar groups of artifacts from three of the four cultural complexes defined in the original Encinitas Tradition, La Jolla, Topanga, and Oak Grove (Warren 1968); the Pauma complex could not be sampled due to a variety of logistical problems. In addition, three sites attributed to the more recently defined Sayles complex (Kowta 1969) were selected in order to capture the full range of spatial and temporal variation in the Millingstone pattern.

The artifacts sampled from each of the sites were subject to a rigorous analysis intended to supplement other kinds of information such as stratigraphy, features, subsistence remains and the like that are printed in published accounts. All available information was integrated during the process of interpretation.

The purpose of this analysis was to generate data that could be used to develop a deeper understanding of the cultural systems that produced the Millingstone pattern. The approach taken deals with the functional association between humans and their environment through a detailed understanding of the use of tools. Theoretical premises guiding the methodology are outlined below.

Theoretical Background

The theoretical bias of this study derives from evolutionary theory. It is assumed that humans have evolved over time to behave under various circumstances in manners that will optimize the interaction of all variables affecting their survival. This assumption may not apply in every situation but it gives the archaeologist a template to develop expectations that can be tested against the material record, and allows an organized explanation of variation.

The idea of optimization facilitates an evaluation of the archaeological record in economic terms using cost/benefit models. Some of the more popular economic modes used concern subsistence-settlement dynamics relating to technological and social organization (Basgall et al. 1988; Bettinger 1991; Bettinger and Baumhoff 1982; Binford 1978, 1979, 1980, 1982; Kelly 1983, 1995). The relative economic importance of specific artifact classes that reflect human response to general environmental pressures (ecological and demographic) can be explained through the expected costs and benefits associated with their use in a specific context (Basgall and Hall 1990; Binford 1980; Horsfall 1987; Kelly 1988; Nelson 1991; Nelson and Lippmeier 1993). The degree to which humans can adjust under certain pressures is limited by their cultural history (Basgall 1987; Pye 1977; Trigger 1989). This does not underestimate the creativeness of humans, but suggests that inventions are still made in a cultural context under specific pressures and that no innovation is necessarily abstract from this context. It is also the case that innovations are hard to account for in the archaeological record unless they are visible as major patterns (Bettinger, Boyd, and Richerson 1996).

The evolutionary concept of adaptation carries a significant historical connotation in that any change in the frequency of a trait in a population is limited in part by the parent population. The same concept can be applied to cultural systems as adaptation should "encompass not only basic subsistence and demographic patterns, but also any organizational or structural imperatives that might influence the range of options available to a cultural system faced with a given set of constraints" (Basgall and Giambastiani 1995:15). There is a tendency among archaeologists working within an evolutionary framework to abuse the term adaptation, especially in context of an archaeological pattern. Cultural adaptation must be viewed as that which effects a change in the structure of a cultural system. Certain models, such as optimal foraging, suggest that there is a specific range of options available at any given time within the context of a cultural system. Many patterns which are parsimoniously explained as the result of cultural adjustments, are too often explained as cultural adaptations, when the system that is the context of this variation did not significantly change.

Since most of what archaeologists deal with are cultural residues that are far removed from their ideological context, explaining the archaeological record in evolutionary terms is best undertaken using a materialist perspective (Price 1982). Despite contrary arguments (i.e., Preucel and Hodder 1996), materialist perspectives do not claim that ideology had no effect on patterns observed in the archaeological record.

However, the degree to which ideology can be observed and measured in the archeological record is limited and the necessary assumptions remain problematic. Only after an economically functional account fails to provide a satisfactory explanation should ideological causes be primarily assumed; even then, ideological invocation can be problematic. Functional arguments tend to have less conceptual gaps or internal variation in explanation and should be employed before other approaches are taken. In the event that the former fail to explain particular patterns, the mistakes in reasoning can be more easily dealt with in that they are more visible and there is an existing structure that allows for their repair.

In evolutionary and economic terms, more can be learned about past human behavior with respect to subsistence and settlement systems in context of the environment. Binford (1978) viewed systems as groups of interacting variables within particular environments that maintained equilibrium, keeping the cultural system in a steady state until outside stimuli were sufficient to cause internal response, that lead to culture change. This notion is inadequate failing to account for internally stimulated change, requiring that the external environment provide the primary cause. General systems theory minimized the role of social interaction in the development of cultural variation and change. Thus, the notion of equilibrium is not valid in a general evolutionary framework which holds internal variation as an important source of change.

Cultural systems might then be viewed as organizations which encompass all the variables that interact and affect the development of a culture. In order to account for all variation that can result from any kind of internal or external stress, this definition needs to be general to have utility in archaeological explanation. Variation within and between these systems as viewed from the archaeological record can provide insight to the process of culture change. As Basgall and True (1985) argue, it is necessary to consider temporal control in conjunction with the reconstruction of human lifeways and the understanding of culture process in order to correctly assess patterns of cultural change and the development of variation. Without chronological placement of patterns there can be no differentiation between variation and change in the archaeological record.

Since the remains of exploitative strategies and habitation areas make up the majority of the archaeological record, those aspects of culture linked to subsistence-settlement systems can perhaps be most accurately assessed. The resulting patterns can then shed light on population dynamics and various cultural interactions. Instead of assuming that the cause of culture change is a singular phenomenon such as environment (Steward 1938, 1955) or the history of human behavioral interactions (Trigger 1989), it may be more useful to consider all possible sources of cultural variation that could have an affect. This arguably reflects more accurately the processes that govern the rate and scale of cultural change.

Although artifacts are static representations of human behavior, they can be viewed in a regional context as representative of the dynamics of human social and environmental interaction. This allows archaeologists to account for site formation processes that shape assemblage composition through human behavioral systems (Binford 1982). Locations of repeated human occupation, what archaeologists call sites, can be host to an array of behavioral episodes that may or may not be related (Binford 1979, 1982; Jochim 1976, Kelly 1995). Understanding the structure of subsistence-settlement systems that formed sites and assemblages is key to understanding the variation within and between areas of use. Sites must be viewed in a regional context, recognizing clustered and isolated artifact distributions, in order to more fully comprehend patterns of human behavior in the archaeological record.

From an archaeological perspective, theories are considered useful if testable hypotheses can be developed from them. The major problems with dominant theoretical frameworks of the past seems to have been their inability to account for cultural variation or explain processes of culture change. Current theoretical frameworks still have difficulties with the explanation of culture change, more and more archaeologists becoming dissatisfied with the depth of knowledge about culture process that can be explicated. This can be seen in the rise of post-processualism and neo-Darwinianism which are in their own ways trying to explain more about human behavior instead of focusing on aspects of material culture that might be explained by the current understanding of evolutionary theory.

The key difference between post-processualism and neo-Darwinianism is that the former is simply a criticism of processualist thought with no demonstrated solution. This renders post-processualism impotent as it seeks to show that any interpretation of the archaeological record is equally possible and hence, the scientific method has no place in archaeology (Hodder 1985; Bettinger 1995). The problem with this argument is that some assumptions are stronger than others based on empirical evidence, where any interpretation can be possible but only some are probable. In a commendable effort to restore validity to the ideas espoused in post-processual thinking, Hodder (1999) evaluates past and present archaeological theory from a logical perspective. In this process, Hodder attempts to show limitations of the scientific method in theoretical development by demonstrating problems inherent to testing data against the archaeological record. The major concern with his critique is that he assumes that science is about testing theories against data. Theories are not tested by science because by their very nature, they are not empirical (Brandon 1990). Theories are simply ideological frameworks by which questions can be logically developed, ordered, and tested; the results of which can be explained by how they vary from the expected outcome. In the context of scientific thinking, questions regarding any data set—physical, social, mental, or other—can be developed and addressed providing a quantitative or qualitative rationale for explanation. Hodder (1999:28) states that “culture limits the applicability of the natural sciences to human behavior because human intentionality intervenes.” While it is true that some theories developed to explain natural, as opposed to cultural, phenomena cannot account for certain cultural processes, “natural sciences” do not define what science is. Science is simply the perfection of knowledge (Dewey 1916), through which either natural and cultural processes or phenomena might be explained.

Hodder (1999) is correct in recognizing that archaeological data and the variation therein are largely influenced by preconceptions that cause subjective test results. No matter what the case, preconceptions are always affecting the development of tests and the gathering of data. Science is only objective insofar as it is ideally falsifiable. It is the position here that the logical ordering of ideas made possible through the scientific method is general enough to be unifying as a framework within which instances or ideas *of theories* can be developed and tested. This is because the scientific process is able to account for all variation in lines of inquiry.

In another contest, Hodder (1999) contends that archaeologists really do not perform tests against the archaeological record. He claims that reasoning in this discipline is largely hermeneutical in nature; self supporting. In many ways, this is true. However, studies that are based on principles gained from ethno-archaeology or extensions from modern anthropological studies are not so circular in nature. There are always going to be limitations with archaeological interpretations simply because the material record is never a complete record of human behavior—not everything humans do is materially manifested. Because of this, the idea that explanations are fit to the data (Hodder 1999) has some validity. This does not nullify the validity of testing in that it is still a parsimonious process of ordering logic.

Neo-Darwinianism seeks to account for human behavior and interaction in culture change by specifically applying evolutionary principles to the archaeological record. One of the stronger criticisms of neo-Darwinian perspectives is that the archaeological record is a set of averages far removed from the individual without weak assumptions (Ames 1996; Clark 1992; see also Boyd and Richerson 1985). The individualistic stance of this paradigm limits the utility of its processes in archaeology. Specifically, it tries to relate archaeological patterns to humans in terms of individual fitness. Even though evolutionary theory recognizes patterns within a population, and explains change through the individual after a pattern is recognized (Brandon 1990), it is still a highly assumptive process to link the effects of individual fitness to perceived archaeological patterns. This problem is amplified when chronological lags and the poorly understood process of cultural adaptation are considered.

Further theoretical development of culture processes can also be pioneered in the field of cultural/social anthropology rather than archaeology. Studies of current cultural issues allows for actual choices, behaviors, and consequences to be observed, at the individual, group, and population levels. There is also an opportunity to ask more specific research questions and be able to test them. It is in this realm where evolutionary theory has the potential to become an even more powerful explanatory framework in culture. When cultural processes are better understood in living populations, there will surely be implications for patterns in the archaeological record, thus widening the archaeologist's explanatory palate. These kinds of inquiries must be kept in perspective since the long term change that defines the archaeological record can't be measured among present populations. In any case, there does not need to be a new evolutionary mechanism conceived to account for culture change because culture can be viewed as its own selective (effective) environment where ideas survive or die.

Evolution of culture "units" through the process of natural selection is still viable since selection can occur at any level, so long as the effects of selective pressures at all other levels are masked (Brandon 1990). It is obvious that individuals in today's society behave in ways that are maladaptive at the physical level, although these same behaviors may have high fitness at the cultural level. Here, selection would be greatest at the cultural level, having the effect of masking selective pressures at all other levels, including the physical. The interplay of selective pressures at different levels most certainly plays a role in culture change as the physical constraints of individuals are balanced against their cultural needs. In the archaeological record, the variables that appear most significant in the pattern of change observed among cultural systems would be an indication of the kinds of pressures that those systems were primarily responding to. If the relationship between these variables is correctly assessed, then an evolutionary argument could be formulated based on the level of selection.

Though pioneered in biology, the theory of evolution is fully applicable to the cultural realm, precluding the need for the development of neo-evolutionary theory. The problem is, it must also be understood among present populations to strengthen its position as a relevant explanatory framework with prehistoric populations.

Choices and intentions that may not parallel behavior must factor in when culture is involved. The criticism then becomes one that questions the need for redundancy. As Bettinger and Richerson (1996:225) state: "We needn't (and shouldn't) invoke large-scale process to account for data more readily accounted for by functional hypotheses generated on the basis of clues provided by adaptive design, which are just too often prematurely ignored as 'adaptive just-so stories'." These "adaptive just-so stories" refer to current evolutionary models of human behavior which have been shown to have high utility in the archaeological record. It is unproductive to abandon one paradigm for another when it is more beneficial to bridge certain gaps in the archaeological record not accounted for using evolutionary theory with other explanatory frameworks that may prove useful. Archaeology needs to be flexible enough to allow for variation in field and analysis methods, but this flexibility needs to be grounded in a theoretical structure that allows for the development of reasoning.

Flexibility in analytical method must not bend so much as to be used out of context. Interpretations of data derived from any method of inquiry should not include assumptions that fail to tie in to the conceptual framework. This is why contextual information is so important to the understanding of all forms of archaeological material. Correlations do not become meaningful unless the relationship between the variables involved can be accounted for through the theory. Alexander (1964) suggests that "if we can invent an explanation for inter-variable correlation in terms of some conceptual model, we shall be much better inclined to believe the regularity, because we shall then know which kinds of extraneous circumstances are likely to upset the regularity and which are not." In this sense, statistical relevance may then be representative of a causal relationship.

Uncovering regularities (patterns) in the archaeological record and providing explanations for the cohesiveness within these patterns pinpoints the focus of this thesis. The theoretical premises outlined in this chapter facilitate the development of methods that have the potential find patterns in the material record. It also allows them to be explained with a sense of meaning that builds an understanding of the different variables that contributed to the stance of a cultural system. These variables include aspects of the physical environment (i.e., climate, biotic communities, geology), as well as the cultural environment (i.e., social organization, population density, technological organization, resource exploitation strategies). Methods that refine knowledge generated from archaeological remains afford a better opportunity to understand the details of cultural processes as they are manifest in the material world.

The materialist slant of the theoretical bias guiding this research fosters a methodology that focuses on the tools important in the everyday economic activities of past cultures. These artifacts are thought to be a reflection of the pressures that arose from resource exploitation and land-use strategies. Only by looking in detail at the uses of tools can the development of cultural variation and change be functionally assessed.

Since the condition of tools in the material record is thought to be the product of a specific trajectory of use, then understanding this trajectory would prove insightful toward an understanding how complexes of tools were organized spatially and temporally within cultural systems. The main goal of this research is to gain a deeper understanding of the technological organization of cultural systems related to the Millingstone pattern by assessing the patterns of tool manufacture and use. The primary issues addressed through this perspective relate to the degree of investment in the form of each artifact class, the relationship between intensive and extensive tool use and formalization, the generality of tool use, the diversity of functionally distinct tool types, and how these avenues of inquiry inform upon site formation processes, resource use, and mobility.

With subsistence-settlement issues being more fully addressed through an analysis of tool use and formalization, a discussion of the major contributing factors to culture change would be better informed. In essence, the adaptive significance of a particular resource/land-use strategy could be more accurately assessed in terms of the variables which had the most affect on that cultural system.

A perspective built upon such an analysis of tools allows for more productive speculation about other issues such as how much cultural systems of the Millingstone pattern were impacted by large scale environmental and climatological change (and if so, to what degree), the role of demographics, and its relationship with other cultural systems in southern California.

For the analysis method in this thesis, it is necessary to review the environmental, methodological, and ideological contexts such that the data generated in this study can be correctly interpreted. The following chapter is a review of the contextual information surrounding the sites sampled and previous thoughts regarding their usage in prehistoric times.

Chapter 2:

RESEARCH CONTEXT

California environments are difficult to generalize given their great variation. Variation in geomorphologic settings contributes to both climatic and biotic diversity, especially complex in southern California where over 5000 species of native vascular plants have been documented in ten major floristic regions across an array of geologic settings (Raven and Axelrod 1978). Given this complexity, contemporary environments will be reviewed according to the four general areas where the main archaeological complexes derive: Santa Barbara, Santa Monica Mountains, Cajon Pass, and San Diego. It is no coincidence that three of these regions correspond to three of the four cultural traditions ecologically defined by Warren (1968). Paleo-environmental information is also discussed, highlighting important changes that had varying effects on the four areas of concern.

Contemporary Environments

Santa Barbara

The Santa Barbara region is characterized by relatively limited areas of coastal plain due to the termination of the Santa Ynez mountains so close to the coast. The distance from the base of the mountains to the coastal edge of the plain ranges from two kilometers to only a few hundred meters in width. The coastline is marked by steep cliffs that see erosion on a regular basis, leaving most beaches rocky. The topography shows numerous canyons that slice the coastal plain; some, that are active watersheds, terminate in estuaries.

The close proximity of the mountains to the coast creates a climatic barrier that results in increased precipitation for the Santa Barbara region over that of more northern or southern areas. The average rainfall per year, falling mainly between October and April, is 45 cm at sea level while the high elevation of the Santa Ynez mountains witnesses an average of 75 cm (Johnson 1977). The marine layer tends to persist throughout the days of summer months, acting like fog which increases the annual effective moisture. The relatively moist nature of the area contributes to a very equable climate that sees average temperatures of 56^0 F for winter and 63^0 F for summer (Smith 1952:6). Overall, the climate is characterized as Mediterranean, with mild and wet winters and warmer, drier summers.

The Santa Barbara region is well known for its high biodiversity and biological productivity. Erlandson (1994) summarizes four main factors that contribute to local biotic diversity: biogeographically transitional habitats lead to increased species diversity (Aschmann 1959; Emery 1967); upwelling of nutrient-rich ocean currents supports numerous biotic communities; a temperate climate draws migratory species (Lantis et al. 1973); and the south-facing beaches are protected by the Channel Islands (Lantis et al. 1973; Hill 1984).

Biodiversity is represented among the numerous habitat types that include coastal sage scrub, coastal bluff scrub, coastal oak woodland, coastal dunes, grasslands, estuaries, marshes, riparian areas, and kelp beds (Smith 1952). Vegetal food stuffs that could be taken from the different habitats ranged from acorns and grass seeds to berries and reeds, among many others. The most visible of habitat types is the coastal oak woodland, which extends from the Santa Ynez Mountains across parts of the coastal plain. Though, few estuarine habitats in the area support many different plant and animal species in a relatively confined space making them attractive locations for human occupation. It is also the case that there are many locations for Pinnipedia species (notably seals and sea lions) to congregate. Some of the more economically important animals to inhabit these biotic communities probably included *Odocoileus hemionus* (mule deer), Lagamorphs, various species of Rodenta, carnivores, birds, reptiles, amphibians, sea mammals, shellfish (mainly species of Haliotis, Mytilus, and Saxidomus), and fish (Landberg 1965, Erlandson 1994).

Geology of the area made many different kinds of toolstone available to prehistoric populations (Fisher 1964:438-440). The most abundant type of material is sandstone, occurring in outcrops all over the Santa Barbara area. The Sespe, Franciscan, and Monterey formations provide different kinds of cryptocrystallines, basalts, and quartzitics that normally occur in cobble form and are most easily accessible in stream and river beds or drainage cuts (Erlandson 1994; Fisher 1964). Other stone includes igneous and metamorphic types that also tend to occur mostly in cobble form. The estuarine and beach areas would have had easy access to all forms of toolstone because it would have been easily located eroding out of cliff faces or drainages. Another type of stone widely used is fused siliceous shale that most likely comes from the nearby Grimes Canyon (Fisher 1964).

Santa Monica Mountains

The Santa Monica mountains are the southernmost protrusion of the Transverse Ranges. Topographic maps indicate that the south and western slopes are much more steep than those of the north and east-facing slopes. These mountain ranges are marked by numerous drainages with some of the major ones being Topanga, Malibu, and Arroyo Conejo canyons. Terminating at the Pacific ocean, the steep mountains cause constant erosion and create mostly rocky beaches that have a thin mantle of sand. The coastal side of the mountains generally has higher precipitation than the inland side due mostly to the rain shadow effect; steep mountain sides stop storms and marine layers from reaching the inland territories.

While still characterized by a Mediterranean climate, the Santa Monica Mountains are slightly more arid than areas to the north. Generally, there are pronounced seasonal differences as summers are hot and dry while winters are cool and wet (Raven et al. 1986). The amount of annual precipitation varies by location, the western end receiving 36 cm, the northern end receiving 41 cm, and the midpoint receiving 61 cm (Gamble and King 1997). Other sources of water include perennial creeks in the major canyons, along with numerous springs that have since been capped by wells. Private and commercial use of local watersheds has lowered the water table and resulted in the disappearance of many springs.

Characteristic of Mediterranean climates, vegetation communities are by chaparral, coastal sage scrub, grassland, southern oak woodland, riparian woodland, coastal strand, wetland, and coastal salt marsh (Raven et al. 1986). The wetland and salt marsh communities are relatively restricted in size, compared to those found in the Santa Barbara and San Diego areas. The steep western slopes of the Santa Monica mountains do not allow for large expanses of such areas, and the aridity of the interior slopes works to absorb excess moisture, preventing the formation of mature wetlands. Where marshes and wetlands do occur, they are usually in small locations at the mouths of creeks that open into small interior basins, or into the ocean. The latter locations present a diverse array of possible flora and fauna that could be exploited for food, along with fresh water.

Animal populations of the Santa Monica Mountains are like the plants in being typical of a southern Californian Mediterranean climate. Taxa worth emphasizing include various species of deer, rabbit, rodents, reptiles, birds, fish, and rocky shoreline shellfish. Excluding fish and shellfish, animal distributions are fairly regular with a slight bias in population size nearing the coastal margin; this may simply be a factor of the precipitation gradient. In any case, most terrestrial animal groups are resident populations without any major seasonal changes in community composition (Gamble and King 1997). The steep and unprotected nature of the coastline does not invite large rookeries of sea mammals, but the numerous kelp beds do provide habitat for many species of fish and the rocky shores give ample substrate for the growth of mussels.

The coastal side of the Santa Monica mountains provides many locations for the procurement of various kinds of igneous, metamorphic, granitic, basaltic, and cryptocrystalline stone (Diblee 1982). The most abundant type of stone in the area is sandstone which occurs naturally as large blocks in exposed outcrops and as isolated cobbles in adjacent drainages (Hoots 1931; King 1962; Treganza and Malmud 1950). Most other types of stone must be obtained from drainage bottoms or walls. Although cryptocrystalline does occur locally in the Monterey formation, it is not as abundant as the other types of stone (Hoots 1931; Treganza and Malmud 1950). The interior slopes are not as eroded as the coastal slopes, giving less access to the kinds of toolstone that occur in cobble form in drainages. Sandstone exposures are numerous though, and by no means are other kinds of stone scarce in the inland vicinities.

San Diego

The region around San Diego is extremely diverse, containing habitats that range from lagoons on coastal plains to desert-like mountain ranges. Most of the area is marked by low-lying hills and wide stretches of coastal plain that regularly terminate as abrupt cliffs at the coast. Compared to more northern areas, the beach shelf extends farther out to sea resulting in greater expanses of shallow water that tend to be warmer than northern localities.

Like the Santa Monica Mountains, the climate of San Diego witnesses a noticeable difference in precipitation and temperature on a seasonal basis. Generally, winters are wetter and cooler than summers, which tend to be very hot and dry. The annual precipitation for the San Diego area is limited to an average of about 18 cm per year (Kaldenberg 1982). Without mountains to hold in rainfall and fog, precipitation is spread over a large area, although it is biased toward the coast because of proximity to the ocean; that factor also leads to a considerable difference in summer temperatures between the coastal and inland areas. The average temperature for summer is 68^0 F while the average winter temperature is 52^0 F (Oakeshott 1971:22).

Even in light of generally low annual precipitation, the coastal plains contain three main lagoons aside from the San Diego harbors (Batiquitos, Agua Hedionda, and Buena Vista lagoons), and a number of small creeks and rivers, not all of which are tributaries to the lagoons. Most of the fresh water for the immediate area comes from the lagoons themselves and from the contributory watersheds. These hydrologic features have enabled development of diverse vegetation. In addition to the Mediterranean habitats such as coastal sage scrub, oak woodland, and patches of chaparral, there are also freshwater marshes, salt marshes, grasslands, beach and coastal strands, and marine communities such as kelp beds (Munz and Keck 1949). The lagoons and associated vegetation trend in an east-west pattern while most other vegetation communities are vaguely stratified in a north-south pattern going from west to east. This variation is characterized by chaparral and drier Mediterranean communities existing in the interior hills and mountains transitioning into the oak woodlands and grasslands moving toward the coast, which is then dominated by coastal sage scrub and numerous patches of coastal strand.

The high diversity in flora and fauna associated with the lagoons is due in large measure to the pronounced dry season which prevents the fresh and saltwater marshes from maturing (Emery 1967). This enhances new growth and biotic productivity through decomposition and flooding (Bailey 1966). Freshwater marshes may contain more consumable foods than do salt marshes, but this is not necessarily an indicator of productivity.

Diverse faunal communities include species of *Artiodactyl, Rodenta* (including rabbits and ground squirrels), desert wood rats (*Neotoma lepida*), carnivores such as bobcats and coyotes (*Felis rufus* and *Canis latrans*, respectively), reptiles, birds, fish, and shellfish (mainly sandy beach species) (Reddy 1999). Most animal communities are residential, only slightly shifting idistribution seasonally, but the lagoon habitats provide ideal settings for many migratory species such as birds and some sea mammals. Fauna that congregate near the lagoons certainly add to the appealing nature of such areas to humans, and the shallow offshore waters provide an ideal setting for the procurement of fish.

The geology of the San Diego area is much like the rest of southern California with sandstone being the most abundant stone type (Lein and Grant 1954; Hanna 1926). Granite, quartzitics, crypto-crystallines, and various fine-grained igneous stone types are easily located in cobble form eroding out of drainage walls or in riverbeds (Lein and Grant 1954). Fine grained basalt and obsidian tend to be rare with the nearest sources occurring at Obsidian Buttes to the east (Crabtree et al. 1963; Shumway et al. 1961).

Cajon Pass

Cajon Pass is geologically complex, sitting on the San Andreas fault that borders the San Gabriel and San Bernardino mountains of the Transverse Ranges. Generally speaking, the northern side of Cajon Pass gently slopes toward the north with deep drainages being more limited than on the southern side which is steep in nature. Precipitation and temperature varies from the northern to southern sides divided by Cajon summit, contributing to variability in plant and animal communities (Basgall and True 1985). Precipitation on the northern side averages about 12 cm per year, with temperatures varying widely by winter and summer (Vasek and Barbour 1977). This area tends to be more hot in the summer and cold in the winter than the southern section. From Cajon Pass going south, precipitation increases by elevation ranging from 25 cm to 127 cm, with temperatures becoming cooler at the higher elevations (Horton 1960; Paysen 1980).

Vegetation in the northern deserts is dominated by sage at the lower elevations followed by creosote communities with chaparral increasing toward the crest of Cajon Pass as yucca and juniper become dominant near the divide (Basgall and True 1985). South of the summit, there are coniferous communities at the highest elevations; Woodland Chaparral, Scrub Oak Chaparral, Chamise-Chaparral, Chamise-Ceanothus, Manzanita, and Coastal Sagebrush occupying various zones generally decreasing in order by elevation (Horton 1960). The biotic composition of the different areas is largely dependent on elevation and precipitation. Numerous seasonal springs allow for the persistence of riparian communities often dominated by Cottonwoods (Basgall and True 1985).

Fauna also vary by elevation and precipitation, most larger mammals distributed toward the higher elevations. Generally speaking, the fauna are characterized by deer, mountain lions, bears, rabbits, rodents, and birds with fish being limited only to the largest creeks that are less susceptible to annual drying (Basgall and True 1985). Reptiles are mostly limited to the northern desert slopes, although they are not uncommon elsewhere in the region (Basgall and True 1985).

The most abundant types of toolstone available are schist/gneiss, sandstone, and granite (Basgall and True 1985; Dibblee 1967). Schist and sandstone mostly occur in tabular form in various outcrops although they do occur as cobbles in drainages, where granitic cobbles are most abundant. Other types of metamorphic and igneous stone are also available in cobble form found mostly in creek bottoms. Volcanic materials, such as chert and obsidian, recovered from many archaeological sites in the region were imported from quarry locations in the northern Mojave Desert and southern Owens Valley (Basgall and True 1985).

This review of contemporary environments has sketched important physiographic characteristics of each region to provide a context for understanding the impacts of paleoenvironmental change across southern California. The Santa Barbara area is the most biotically diverse due to its temperate climate and unique geographic position. This region should be noted for its sizeable marine mammal, fish, and shellfish communities, along with other associated flora and fauna. Though relatively arid, the San Diego area also contains some productive habitats. These are mainly lagoons that are constantly renewing themselves through fluctuating volumes of fresh and salt water. Shellfish and fish of various kinds are readily available, as are many plant species that have developed with the lagoons. The Santa Monica Mountains do not stand out as very productive in terms of available foodstuffs, characterized mainly by grass seeds and smaller animals, with some marine resources (such as shellfish) available near the coastal margins. This area is very homogeneous in the kinds of resources available temporally and spatially. Slight spatial differences in the distribution of resources appear with the variability in precipitation from the northern to southern, and eastern to western slopes of the Santa Monica Mountains. Much like the Santa Monica Mountains in terms of climate and biotic composition, Cajon Pass shows slightly more stratified distributions of biotic communities. These communities tend to be susceptible in spatial distribution to changes in precipitation and temperature. Yucca and agave tend to be a characterizing feature of the local flora on the south side of the Transverse ranges. Most notable about Cajon Pass is the lack of freshwater or marine resources. The only resources adapted to a hydrologic environment that are readily available are the limited riparian areas.

Each of the four geographic regions discussed contain abundant seed-bearing plant communities complimented by a host of other common floral and faunal resources. However, there are certain environmental characteristics specific to each region that would have contributed to variability in the cultural exploitation of resources sets. The different biotic characteristics are defined by the differences in physiographic settings across the different regions. Santa Barbara and San Diego are complimented by estuarine and lagoon habitats linked to coastal areas while the mountainous topography and relatively arid conditions of Cajon Pass and the Santa Monica Mountains cause biotic communities to be more susceptible to changes in precipitation. What these differences mean is that in each region, there were probably different sets of resources making up the primary economic focus of the subsistence economies.

Paleoenvironments

There are often contradictions inherent in the comparison of different types of paleoclimatic data such that fine-grained, conclusive analyses are difficult to establish. Chronological resolution is also problematic in that reconstructions are often based on different kinds of data from different time intervals. Consequently, archaeologists must rely on more generalized climatic and vegetational patterns over large regions to speak to subsistence/settlement patterns. The most notable environmental changes that can be reliably documented are those related to lagoon/coastline formation in San Diego and estuarine/coastline changes in Santa Barbara. All other paleoenvironmental changes seem to have only caused minor changes in the distribution of biotic communities rather than compositional replacement. The latter includes effects of the globally recognized middle Holocene warming and drying trend or Altithermal (Antevs 1952, 1955).

The end of the Wisconsonin glaciation period marked the beginning of a warming and drying trend that started from 18,000 to 15,000 years ago. After this time, glaciers started retreating and pluvial lakes that covered much of the western/southwestern United States were beginning to desiccate. In southern California, many of the vegetal communities that exist at high elevations today were found at significantly lower levels. Wood rat midden analyses from the Mojave Desert suggest the area was essentially a coniferous forest dominated by juniper and sage at about 15,000 years ago (Spaulding 1983, 1999). With increased warming, these plant communities began to migrate northward into the adjacent mountains while the area was replaced by more desert-like vegetation dominated by sage in the lower areas and creosote in the higher areas. Ocean core sediments measuring both oxygen isotopes and pollen counts (COHAMP 1988; Huesser 1978; Kahn et al. 1979) from the Santa Barbara Channel indicate that the ocean surface temperatures were significantly lower than today during the late Pleistocene and began to increase later in time. As the warming trend continued, the rate of sea level rise continued at a rapid pace of probably one-meter per century into the Holocene (Inman 1983).

The Holocene is characterized by less climate oscillation than occurred in the Pleistocene. Though general warming and drying continued throughout the Holocene, there were important reversals during this span. The early Holocene (10,000-7500 BP) saw the stabilization of the major vegetation communities in terms of composition and overall distribution (Spaulding 1998; Emery 1967). The rapid sea level rise that continued into the middle Holocene was eroding the coastline and filling drainages and interior river valleys, creating and destroying estuaries and lagoons along the southern California coast (Emery 1967; Pierson et al. 1984). The effects of sea change were most prominent in Santa Barbara and San Diego. In Santa Barbara, beaches were replaced by rocky shores while drainages were flooded to create estuarine environments. Some suggest that these estuaries were most likely characterized by high biodiversity due to the fact that they were always in flux according to rises in sea level and erosion of drainages (Inman 1983; Hubb 1960; Emery 1967). Biodiversity may have been high because of increased opportunity for different species to develop after major fluctuations in the estuarine habitats but the notion that productivity was associated with such disturbance is questionable in that there would have been a limited amount of time for biotic communities to become established. The shoreline was not receiving very much sediment from the tributary rivers due to infilling by the rising ocean level, leaving behind a rocky substrate. These shores, combined with the close proximity of the continental shelf to the coast, provided sheltered environments where an abundance of animal taxa could be supported by the nutrient rich ocean waters that were vertically circulating on a regular basis.

In San Diego, the process of lagoon formation was much the same as for estuarine environments in Santa Barbara. The slope of the coast in San Diego is very slight and the nature of the landscape such that lagoon stabilization probably occurred at around 8000 years ago (Carbone 1991; Koerper 1986). The vertical rise in sea level submerged a large area of land due to the shallow costal slopes. As sea level rise began to slow, sediments began to be re-deposited on the beaches and lagoon margins, forming a substrate more suitable to sandy plant and animal communities (Warren and Pavesic 1963). The warmer temperatures of the water along with the openness of the coastline may have been favorable to different animal species than in Santa Barbara (smaller populations of seals/sea lions with larger populations of dolphins and porpoise).

The middle Holocene is recognized for a pronounced peak in warm temperatures and aridity, first proposed by Antevs (1952) as the Altithermal which he placed from about 7000 to 4500 years ago. The debate over the onset, duration, and magnitude of the Altithermal has been exhaustive with information pouring in from palynology, wood rat midden analysis, hydromorphology, dendrochronology, tree line fluctuations, ocean core testing, climatic simulations, and biological indicator analysis (Antevs 1952, 1955; Deevy and Flint 1957; Emery 1967; Martin and Mehringer 1965; Axelrod 1978; Spaulding 1983, 1999; COHAMP 1988; Wells and Jorgensen 1964; Wells and Berger 1967; Hall 1985; Adam 1985; Raven and Axelrod 1978; Martin 1963; LaMarche 1973, 1974; Carbone 1991; Pisias 1979; Kahn et al. 1979; Inman 1983). It seems most likely that the middle Holocene in southern California was characterized by a peak in the general warming and drying trend that varied spatially in onset, duration, magnitude, and overall environmental effectiveness. This is in contrast to the concept of an extended drought as a regionally defining characteristic (Antevs 1952, 1955; Kowta 1969). The general environmental response to warmer and drier conditions was both a compression of vegetation communities and a shift in distribution, as major speciation most likely did not occur (Spaulding 1998; Wells and Jorgensen 1964). Axelrod (1978) demonstrates that one of the most significant changes was the development and spread of Coastal Scrub vegetation through California.

Interior regions were not significantly affected by the Altithermal excepting distributional shifts and compressions of existing and overlapping floral communities. However, coastal areas did see some important changes. The rate of sea level increase slowed to its present rate of about 10cm per year at around 6000 years ago (Inman 1983). This decrease acted to establish the estuarine and lagoon areas that were being flooded during the earlier part of the Holocene. In San Diego, this most likely added to the maintenance of species diversity as the lagoons became more susceptible to the affects of the dry season, hindering community maturation. The dry season enhanced aerobic decomposition contributing to high nutrient stores with incoming tides and the flow of freshwater during the wet season (Bailey 1966; Kaldenberg 1982; Odum 1969). In Santa Barbara, the drop in the rate of sea level rise meant that the inflow of sediment from tributary watersheds pushed out any rocky margin habitats and established estuaries that were based on a sandy substrate (Erlandson 1994). The mature estuaries offered rich resources to be exploited by any migratory species that would favor the temperate climate. Even though the rate of increase in sea level slowed during the middle Holocene created some sandy beaches, many coastal areas remained rocky due to the steep contours of the underwater landforms, and the strong oceanic currents that flow through the Santa Barbara channel (Kahn et al. 1979).

Finally, the late Holocene is best characterized by variability in both precipitation and temperature, being wetter and cooler on average than during the middle Holocene. There is evidence for a few periods of drought and extremely cold temperatures (COHAMP 1988; Fritts 1974; Schulman 1947), but the last 3000 years has been characterized by many studies as relatively mild.

Paleoenvironmental data suggest that coastal southern California has been characterized by a Mediterranean climate since the early-middle Holocene with the spread of coastal scrub (Axelrod 1978). The effects of hotter and drier weather have most likely been overstated regarding exploitable resources in certain habitats, not considering the development of estuaries and lagoons.

Cajon Pass and the Santa Monica Mountains would have been most affected by decreases in precipitation because these areas supported animal communities that were more sensitive to the availability of water. In contrast, all of the resources available in the Santa Barbara and San Diego areas today were most likely available throughout the Holocene, with the latter area experiencing minor fluctuations in precipitation. The most substantial changes in economic resources across southern California relate to extinction of megafauna, the change in distribution of moderate sized animals (artiodactyls), and the development of specific niches along coastal southern California. The latter brought in a limited but diverse mosaic of wetland and estuarine plants and animals.

The implications that can be drawn for the reaction of human populations to these environmental changes are limited in utility because broad scale, intense environmental change seems to have been limited in terms of the effects on possible food resources. One of the more interesting issues that arises out of the review of paleoenvironments is whether or not the major resources that are said to have made the Santa Barbara and San Diego areas so attractive to human exploitation were used to an extent that the organization of settlement and subsistence regimes varied regionally during comparable time periods. Perceptions of those who have worked in southern California on the Millingstone pattern have largely been shaped by notions of environmental change, as is seen in the next section concerning previous research.

Previous Archaeological Research

Assemblages with compositions that reflect what has been traditionally defined as indicative of the Millingstone Horizon have been identified in numerous areas throughout California. As knowledge of the assemblage characteristics grew in southern California, researchers in northern parts of the state recognized striking similarities in tool types and relative frequencies at many sites with the pattern defined south of the Transverse Ranges. Fitzgerald and Jones (1999) provide a topical analysis of Millingstone pattern research north of Santa Barbara, repeating ideas of possible adaptive implications for the pattern. However, it still remains that the Millingstone pattern as an archaeological signature remains most visible, in southern California. In order to more completely address issues related to historical interpretation of the Millingstone pattern on a material basis, the focus of this thesis and the review of previous research will be on southern California. This review is not intended to be comprehensive, but to provide an overview of some of the more important perspectives that have helped shape the current understanding of past human lifeways in southern California.

South of the Transverse Ranges, Malcom Rogers (1929) was the first archaeologist to publicly document the wealth of milling equipment and cobble tools in a number of shell middens of San Diego County. The lack of finely finished flaked stone tools in the presence of large amounts of milling equipment (especially milling slabs and handstones), suggested to Rogers that this assemblage, which he later named the La Jolla phase, was characteristic of the earliest people that inhabited the area (M. Rogers 1929, 1945).

David Banks Rogers (1929) recognized the same “milling stone culture” in the earliest phase of his Oak Grove assemblage in Santa Barbara and Ventura Counties. Rogers named this complex after the assumption that the early inhabitants exploited the abundant oak trees within which his sites were located. Again, the composition of related artifacts in the milling stone assemblage lead D.B. Rogers (1929) to conclude that these artifacts were the products of the earliest occupants of the Santa Barbara region.

The primary antiquity of the Millingstone pattern reigned until an earlier complex, San Dieguito, was more fully recognized in a stratigraphic layer under a La Jolla assemblage along terraces bordering the San Dieguito river (Rogers 1938). San Dieguito artifacts have been described as most similar to early Holocene “hunting” assemblages of the Mojave desert (Warren 1968). Later milling stone phases differed from San Dieguito assemblages through the lack of large stemmed projectile points and other “hunting associated” tools along with the immense presence of milling equipment which was found to be in association with features containing small hard seeds (Warren and True 1961). However, it may be the case that these tools were more generalized than previously thought due to their association with a variety of different habitats.

Succeeding work in southern California lead to further definition of the Millingstone pattern and its characteristic artifacts such as various types of core and cobble tools (hammerstones), unifacially flaked tools (scrapers), and early stage bifacial points and blades (albeit in small numbers). Walker’s excavations at Porter Ranch (1936), Malaga Cove (1937) and other sites in the greater Los Angeles area (1951) repeated the pattern, while Heizer and Lemert (1947), Treganza and Malmud (1950), and Treganza and Bierman (1958) conducted research in Topanga canyon at the Tank Site (Lan-1) and adjacent rock shelters. The work in Topanga canyon was especially important due to its presumed similarities with the San Dieguito pattern in the abundance of scraper planes (45%) and the presence of a few crescents (Heizer and Lemert 1947). The Topanga Complex also resembled Oak Grove in overall assemblage composition, but this was the only comparison noted.

Wallace (1955) actually coined the term “Millingstone Horizon” after excavating the Little Sycamore site near Point Dume in 1954. His Early Man period was defined by San Dieguito components, followed by the Millingstone Horizon that was characterized by large numbers of various types of handstones, large basined milling slabs, and different kinds of core and cobble tools (Wallace 1955). Also important was the small number of bifacial tools, including projectile points. Wallace’s study lead to the acceptance of a widespread archaeological pattern which was thought to represent a continuous cultural tradition. This initiated further interest in the subject and led to subsequent publications on excavations in other areas of southern California by Rozaire (1960) at Encino, Lytton (1963) at Laguna Niguel, Curtis (1965) at Glen Annie Canyon, Hicks (1956) in Yucaipa, and Wallace (1966) in Hollywood, among others. These sites were being regularly dated to the middle Holocene.

Warren (1968) later divided the Millingstone Horizon into four complexes he termed the “Encinitas Tradition” after the archaeological signatures of the pattern that were originally recognized by M. Rogers (1929). Warren suggested that it was a turning point in the understanding of southern California archaeology since it synthesized Milling Stone Horizon sites into a unified cultural pattern. These four complexes were recognized as Oak Grove for the Santa Barbara and Ventura regions, Topanga for the Los Angeles area, La Jolla for coastal San Diego, and the Pauma Complex for the peninsular ranges of interior San Diego. Each complex was separated out by differences in biotic composition and subtle archaeological variation. The purpose of the four part scheme was to interpret the Millingstone Horizon based on how humans were adapting to ecological differences.

Similarly, Kowta (1969) postulated that the Cajon Pass region was occupied by people of the Millingstone Horizon who were adapting to a change in the distribution of agave and yucca. He based this on the abundance of scraper planes, millingstones, and handstones found at numerous locations in his “Sayles Complex,” that was supposed to be an inland manifestation of Warren’s (1968) Encinitas Tradition. Kowta’s work in the Cajon Pass region renewed notions of prehistoric population movements between the interior deserts and the coastal basin. He suggested that environmental conditions worsened during the middle Holocene, leading to an abandonment of the deserts as people followed the changing distribution of agave. This resource was primarily exploited using scraper planes as pulping tools, with further processing facilitated by other kinds of ground, battered, and flaked stone tools. The relative frequency of scraper planes to other kinds of tools was evidence not only of the intensity of agave exploitation but to the timing of occupation of the different southern California locales with respect to the spread of such plants during the middle and late Holocene.

Subsequent research saw the assignment of many more sites to those complexes defined by Warren, along with a revived interest in cultural history and ecological adaptation. This marked the beginning of a pattern of interpretation of the Millingstone Horizon that would be based on the search for environmental correlations. The search for assemblage variation according to geographic location was then in full swing. The reported assemblage distinctions between Millingstone Horizon sites from different regions were usually defined in terms of burial types, frequencies of the specific diagnostic patterns, and formerly on the basis of ethnographically known cultural boundaries. Those artifacts thought to be regionally and temporally diagnostic were basined millingstones and the various surface configurations, handstones and their many shapes, and the numerous types of scraper planes. Many of the artifact types never patterned out in a significant way, with only a few handstone shapes and scraper plane forms that did show some spatial integrity in distribution within sites. Some have argued that the basined milling surface depth increases with age (Treganza and Bierman 1958). Others have claimed that the surface shape is regionally specific with oval forms being dominant toward the north and round surfaces being more frequent in the south (Walker 1937). Burial patterns, which have been cited as regionally specific in most of the Millingstone Horizon literature, are actually highly variable and more recent studies have questioned the validity of segregating the cultural pattern based on this kind of evidence. In all cases, the formal similarity between all Millingstone Horizon sites related to the overall assemblage composition of generally basined millingstones, handstones, and core and cobble tools.

With the development of federally mandated cultural resource management in the early 1970’s, an increasing amount of information about sites with assemblage compositions similar to those of the Millingstone pattern has been accumulated. Basgall and True (1985) conducted investigations on previously excavated sites in Crowder Canyon; an area situated in the Transverse Ranges near Cajon Pass that was originally defined by Kowta (1969). This study was important in that it was located in a natural corridor between the Mojave Desert to the north and the rest of southern California. In their review of the Millingstone Horizon "concept," Basgall and True suggest a further segregation of the Topanga complex into interior and coastal complexes based on the absence of shell in interior sites. In addition to the late Holocene dates for some Millingstone pattern sites assigned to the La Jolla Phase of San Diego, new chronological data from Crowder Canyon helped to push the chronological boundary of the Millingstone pattern into the late Holocene. Perhaps more importantly, the total amount of work conducted among the Sayles Complex sites represents the most explored segment of all Millingstone Horizon areas ever recognized.

King (1996), and Gamble and King (1997), conducted research in the Santa Monica mountains and recorded a number of sites that are attributed to the Millingstone Horizon. They hold that the presence of large cemeteries (irrespective of the variability in burial style) at some sites indicate that they were permanent settlements (Gamble and King 1997). This lead to the conclusion that the Santa Monica mountains represented the hub of the Topanga manifestation of the Millingstone Horizon pattern.

Further research has raised awareness about the variation in exploited habitats such as lagoons and estuaries in Santa Barbara, Newport, and San Diego (Breschini and Haversat 1991; Colten 1987; Drover, Koerper, and Langenwalter 1983; Erlandson 1988, 1997; Fitzgerald 1992; Gallegos 1991; Glassow et al. 1988; Mason, Koerper and Langenwalter 1997; Masters and Gallegos 1997). The variation in middle Holocene assemblage contexts has lead many to support explanations of habitat and resource specialization based on the technological level needed to exploit some resources such as marine mammals and fish (Glassow et al. 1988; Gallegos 1991; Hildebrandt and Levulett 1997; Jones 1991).

The notion of habitat specialization and high degrees of sedentism has also resulted from the idea that some of the specialized resources such as shellfish and marine mammals were costly to exploit due to procurement and processing costs, and thus required more investment of time. This idea fit nicely into an environmental model that held the middle Holocene was a period of hot and dry weather affecting resources and creating stress on populations leading to either an expansion of diet breadth or specialization on specific resources.

More recent studies in the greater San Diego and Santa Barbara areas have produced evidence that extends the temporal boundary of the Millingstone pattern well into the early Holocene. Erlandson (1988, 1991, 1994) provides a summary of the more important early Holocene sites in the Santa Barbara and surrounding areas. Though not all have Millingstone pattern components, three that date before 7800 years BP are explained as part of a semi-sedentary settlement system (Erlandson 1994). Greenwood (1972) reported dates in excess of 8000 years BP in apparent association with a Millingstone pattern component which dominates the Diablo Canyon assemblage. It has been speculated that an earlier date of approximately 9000 years may be a separate phenomenon (Greenwood 1972). Nonetheless, the milling component does date to the early Holocene. Fitzgerald (2000) excavated a site at Cross Creek north of Santa Barbara which produced a Millingstone pattern component capped by stream sediments that tended to date between 9000 and 10000 years BP. This site is significant in that the Millingstone pattern is the earliest component with a lack of any evidence suggesting a contamination with would-be earlier material. In general, the Santa Barbara area provides evidence which suggests that sites of the Millingstone pattern overlap in time and space for about 1000 years with other earlier archaeological signatures.

Early Holocene studies in San Diego present a similar situation where there seems to be temporal and spatial overlap between the Millingstone pattern (La Jolla) and the earlier San Dieguito assemblages. Most early Holocene sites in the San Diego area are attributed to the San Dieguito pattern, such as the Harris site which does not appear to be a Millingstone pattern manifestation (Warren and True 1961; Gallegos 1987). Other sites, such as those studied at Agua Hedionda Lagoon (Moriarty 1966; Gallegos 1991) seem to either contain a mix of San Dieguito and La Jolla artifacts or are purely composed of the later. This overlap in time and space by about 1000 years sometimes at the same site, has lead to increased confusion about the relationship between San Dieguito and La Jolla assemblages, and the implications for social organization (Gallegos 1987).

The overlap between sites of the Millingstone pattern and other assemblages generally thought to be earlier, has been characterized as evidence of in situ development, or cultural evolution (Erlandson 1994, 1997; Gallegos 1987). This cultural evolution is said to be the result of adaptation to coastal resources with changing environments, rocky shorelines in the Santa Barbara region and estuaries/lagoons in the San Diego area.

The Millingstone pattern has been widely recognized as a highly visible and redundant archaeological pattern composed mostly of large quantities of ground and battered stone. Various forms of millingstones, handstones, and scraper planes have been interpreted as temporally and/or spatially diagnostic. The spillage of Millingstone-like assemblages into earlier and later timeframes has complicated the meaning of this cultural pattern with respect to the reason for its appearance and its relationship to other types of assemblages with which it overlaps.

This brief review has sought to point out the major studies that contributed to development of a tradition of archaeological interpretation. These approaches are characterized by a tendency to correlate the adaptive significance of the Millingstone pattern with ecological zones and paleoclimatic changes. It has lead to regional circumscription of the general pattern that has effectively limited communication of information between each of the complexes defined in the Encinitas Tradition. It became easy for researchers to avoid laboring through all of the reports generated on the topic by simply looking for similarities in their assemblages with the traits defined for their area of concern. Problems associated with earlier methodologies and concepts regarding research on the Millingstone pattern are explored below.

Interpretive Dilemmas

Methodological Problems

Perhaps the factors which most complicate the concept of a Millingstone Horizon are the methodological biases of the early researchers. Most early research focused on large complex sites. The immediate implication of this is that smaller sites and isolated artifacts were lost due to rapid development of southern California. In fact, many of the early excavated Millingstone pattern sites were salvage projects (i.e., Hollywood Rivera, Encino). In order to understand how a culture system functioned, the less spectacular smaller sites and distribution of isolates needs to be known. However, the theoretical bias of early researchers did not necessitate this kind of information because their proximate research questions were different.

Early research also focused only on the more complete, and oftentimes larger artifacts, disregarding fragments or refuse. This created a major bias in sample composition that proves formidable to current interests in analysis that focus on fragments and manufacture refuse. Reasons for this were not only based in the questions being asked, but also on the impracticality of collecting some of the larger items such as whole millingstones (Treganza and Malmud 1958).

Another problem that arose from early research concerns chronology. These archaeologists did not have many of the techniques available to their disposal for dating archaeological assemblages, such as through radiocarbon or obsidian hydration. Though recent salvage efforts at some of the still preserved sites have yielded some dates, there is still a tremendous lack in chronological information. Most dates have come from coastal shell middens (Glassow et al. 1988), creating another interpretive bias that will be discussed later.

Even as chronological information accumulates, methodological problems are arising concerning sampling method in light of interpretive value. Contrary to some arguments (Glassow 1997), selection of materials for dating (especially radiocarbon dating) needs to be less liberal and only considered in context of what the benefit will be for interpretation. Samples should not be taken if association is anywhere near ambiguous because there is a possibility of getting an inconsistent date. These are hard to dismiss, although they frequently are, based on any rationale since they were presumably taken to be in good association from the start. In instances of demonstrable association, inconsistent dates can then be interpreted rather than dismissed as aberrant. Bad dates are more of a detriment to interpretation than are undated assemblage contexts.

Interpretations of the Millingstone pattern have suffered greatly from methodological biases. Most detrimental have been the differential ways people have sampled the archaeological record. Earlier studies only collected artifacts thought to be representative of an entire artifact class or that were thought to have greater potential for analytical interests. Sampling today mainly suffers from the selection of materials for dating that cannot be explained in terms of association or meaning, and from the comparison of extremely fine-grained data (micro-screened faunal remains) to extremely course-grained data (frequencies of artifacts and the diversity of tool types). All sampling problems have contributed in one way or another to how much of the archaeological record related to the Millingstone pattern can be interpreted.

Conceptual Problems

The most widespread problem in explanations of the Millingstone pattern through current research has been the invocation of environmental change as the primary cause for perceived culture change. The Altithermal has been used to explain the appearance of Millingstone pattern assemblages ever since Antevs (1952) first published his findings. The warming and drying trend has been thought to have caused human populations to abandon highly mobile settlement strategies in order to cope with more harsh environments (i.e, Erlandson 1994). Currently, paleoenvironmental data support a temporally, spatially, and effectively variable Altithermal. With the accumulation and refinement of paleoenvironmental data, it is clear that estuaries and lagoons were fully developed in the San Diego area, while beaches were rapidly eroding into more rocky coastlines in the Santa Barbara region right at about 7000 years BP. However, fully developed Millingstone pattern assemblages appear well before these environmental changes (Erlandson 1988, 1991, 1994; Fitzgerald 2000; Glassow et al. 1988; Gallegos 1987, 1991), suggesting that their appearance is due to some other combination of factors.

Gallegos' (1991) explanation of the early Holocene arrival of groups from the interior deserts due to the desiccation of pluvial lakes is not reasonable since it has been shown that the Western Pluvial Lakes Tradition is an artifact of research bias that focused on Pleistocene lake shores (Basgall 1993a, 1993b). Populations in this area were using a wide variety of resources, many of which were not associated with pluvial lakes. Likewise, Erlandson's (1988) explanation of the appearance of people in the Santa Barbara region during the early Holocene based on the exploitation of shellfish is also problematic, due primarily to a sample bias. Though the use of shellfish appears during the early Holocene (Erlandson 1988, 1994; Fitzgerald 2000), it does not necessarily reflect the emergence of a coastal adaptation, or intensification, but an adjustment through the use of a *generally* lower ranked resource. This is especially true if the cultural system in question is considered to have been highly residentially mobile.

Explanations built upon environmental correlates have contributed to the circumscription of the Millingstone pattern based on the regional differences in ecological zones. This is evident in the different settlement and subsistence systems proposed for very similar assemblages from Orange County (Mason, Koerper, and Langenwalter 1964) and for La Jolla (Masters and Gallegos 1997).

Not only has the environment been cited as the cause for the appearance of the Millingstone pattern but also for its relationship to other earlier and later assemblages. Cultural sequences for the northern and southern regions of southern California have been explained in terms of uni-lineal evolution. This evolution was supposedly the result of cultural adaptations to the exploitation of different resources in changing environments. However, the rationale for the adaptive mechanism which supposedly brought about this cultural evolution has been based on little more than convenient correlations with paleoenvironmental change, or severely biased chronological data. This is further complicated by the notion that the Millingstone pattern predates and postdates the Altithermal, calling into question explanations of cultural change based on environmental correlation.

With increasing chronological data that suggests the Millingstone pattern and earlier assemblages (San Dieguito in San Diego) overlap in time and space for about 1000 years in southern California, the relationship between the systems that produced these patterns needs to be reconsidered. It might be the case that this spatial and temporal overlap may reflect the co-occurrence of two different systems that employed different social organization strategies. Whatever the case, there are implications for the origin of these systems.

If environmental changes are to be called out as the cause of an archaeological pattern, then the mechanism of this process must be specified. Humans do not primarily respond to climate unless it is severe or the system depends upon some specific climatic condition (such as water for crops); they respond to the changes in resources that their systems exploit. Thus, if environment is to be the cause, it must be specified what kinds of resources were affected, and more importantly, how economically important these resources were to the cultural system. The economic importance of any resource would be expected to be somewhat apparent in the archaeological record, through the use of artifacts and/or resource residues. Overall, the use of paleo-environmental data and ecological variability to explain the Millingstone pattern has set the foundation for regional definitions of the pattern.

Explanations of the development, persistence, and demise of the Millingstone pattern based on demographic data are also extremely biased. Recent studies of demographic patterns have relied on the number and distribution of radiocarbon dates, spatially and temporally, to grossly determine population density patterns (Erlandson 1991; Masters and Gallegos 1997; Glassow et al. 1988). These studies have relied on the assumption that the sample is at least representative of population densities seen from a relative sense regionally and over time. This may be helpful in understanding prehistoric demographies, but its utility is limited in regional application simply due to sampling biases in that not all contexts have equal preservation, and not everything gets preserved. Other population studies assign scores to sites in terms of size and assumed function (Erlandson 1997), then apply statistical models to find patterns of change. These studies can only be used as a proxy measure of population change because of the assumptions necessary to set up the original definitions of population structure by site type. Dealing with population specifics in the prehistoric past will always be severely limited because of the nature of the information available.

It is the case that arguably the largest part of Millingstone pattern subsistence economies, small hard seeds and some related technologies (Warren and True 1961), have not been preserved, leaving the dating burden on shellfish and faunal remains. Since preservation is usually good in coastal contexts becoming increasingly worse farther inland, shellfish remains represent the majority of dated materials (Glassow et al. 1988). Thus, a pattern based on radiocarbon dates has been recognized in southern California, but the extent to which this pattern can help explain sites on the interior is questionable (Glassow 1997). Perceived changes in the pattern on the coast may reveal more about settlement organization than population size at any given time. Presently, the use of population proxy data has contributed to the segregation of the Millingstone pattern into areas of research. The patterns of date distribution may not be real, thus distorting the understanding of the adaptive strategies.

Like environmentally based models, population driven models need to specify the mechanism of change as perceived in the archaeological record. For population to be used in the explanation of change, the systems before and after the change need to be understood, also, how population actually affected the system, and how it is evident in the archaeological record. The latter may be visible through the intensified use of specific artifact classes, resources, or land tracts, coupled with chronological information to show directionality. There are many factors which may interact in the archaeological record to precipitate change based on population pressure. This interaction needs to be understood, not taken at face value as a correlation. If the data are not present to speak to population pressure, then environmental correlates should not be used as a default explanation. The limitations of the data need to be considered.

Distributions of dated materials should only be considered supplemental to other methods of studying demographic trends. Primarily, in order to gain a more accurate idea of population densities, the settlement/subsistence strategy of the system in question needs to be understood. This involves a thorough treatment of the artifact classes compromising the assemblage which will contribute to understanding patterns of mobility. In this context, specific sites can be understood as part of a system which will help explain distributions of absolute dates, smaller sites, and isolated artifacts (Kelly 1983, 1995).

As Glassow (1997) points out, most archaeologists today are shying away from explaining middle Holocene patterns on a regional scale due to the general lack of well dated sites. Consequently, studies of Millingstone pattern sites in their immediate contexts have lead to interpretations that suggest large degrees of sedentism (Gamble and King 1997) or highly logistically oriented systems on a very small scale (Mason, Koerper, and Langenwalter 1997). These explanations are usually based on generic indicators such as the size of the deposit at large sites, the presence of cemeteries, and the presence of housepits (Erlandson 1997; Gamble and King 1997; Masters and Gallegos 1997). This site-specific approach to interpretation is nearly an historical throwback to the earlier part of the 20th century when strategies of material recovery were based on the identification of single sites.

Determination of various degrees of residential mobility based on any or all of these factors is problematic if mobility patterns are not more completely understood through data derived from the artifacts themselves. Thus, indicators in the archaeological record traditionally considered to be indicative of certain aspects of social/economic organization may have more or less meaning in another context. For instance, if sites are reoccupied on a more regular basis, housepits might even be expected (Kelly 1995). The presence of cemeteries and deep midden deposits must also be viewed in a mobility context because they can be differentially interpreted; especially since much variation exists with respect to the amount of cultural residue present in any site and the presence of burials (Basgall and True 1985). Many of these cemeteries are highly variable with respect to burial patterns, many of which are re-burials (Gamble and King 1997, Greenwood 1972, M. Rogers 1929, Treganza and Malmud 1958). Cemeteries, in relation to the associated assemblages, do not necessitate that people were living near them permanently, but were using the area regularly.

Some authors have tried to uncover “interaction spheres” (King 1991, Raab 1997) based on frequencies of ornamental, or other socially functional artifacts, such as *Olivella* shell beads. In context of the given explanations, these interaction spheres have limited utility to understanding a regional pattern. More complete analysis needs to be done regarding non-utilitarian artifact—or those described as such—distributions. These include cogged stones, polished stone artifacts, stone balls and the like which may reveal functional or cultural patterning (Greenwood 1972).

Conceptual problems in the interpretation of the Millingstone pattern range from how to interpret archaeological data (from artifacts to dates), to making valid arguments that might link patterns in the archaeological record to those of environmental or population change. The debate concerning the importance of environmental versus population pressures on a cultural system has historically been dichotomized because of the fact that most archaeologists have viewed culture change as either a result of replacement or in-situ evolution. It is not useful to dichotomize culture change nor view its mechanisms as uni-dimensional.

Methodological and conceptual problems of both early and later researchers have complicated the interpretation of the Millingstone pattern in southern California. The heavily biased data are subjected to gross correlations in an effort to explain such a monumental archaeological pattern. It may be that since the Millingstone pattern assemblages seem to be so grandiose in visibility that archaeologists feel the need to invoke large scale processes in order to account for it. This thesis works from a more materialistically functional standpoint to interpret archaeological patterns in an economic sense so that large scale correlations can have more context to derive meaning from.

Chapter 3:

RESEARCH GOALS AND METHODOLOGY

The primary objective of this study is to gain a better understanding of the organization of subsistence technologies of the Millingstone pattern. This is done through an in-depth analysis of specific use-wear attributes measured on millingstones, handstones, and those tools traditionally called scraper planes. Information gained from this analysis is used to draw implications for settlement mobility and to discuss the adaptive significance of the Millingstone pattern.

It is assumed that the condition of an artifact is the result of use in general economic activities, rather than purely a consequence of stylistic interpretations. Artifacts go through various stages during their use-life that have costs associated with the procurement of raw material, manufacture of the item, general use related costs (attrition), maintenance/recycling, and discard (Nelson 1991). For this reason, it is important to measure patterns of artifact use that carry implications for the relative economic importance of different artifact classes (Horsfall 1987; Nelson 1991; Shott 1986). All of these variables are dependent upon environmental (physical and social) conditions.

Past researchers have dealt with use wear patterning paying equal attention to all of these variables (Basgall and Hall 1995; Horsfall 1987; Kelly 1995; Nelson and Lippmeier 1993), while others have focused on specific aspects of artifact use (Bleed 1986; Schlanger 1991; Schneider 1993; Simms 1983). The commonality between each author is that they all relate patterns of observable artifact use to more broad implications of behavior. They have demonstrated that through logical and parsimonious expectations about the cost-effective use of technology in specific contexts the archaeological record has the potential to inform in greater detail upon social organization as it relates to settlement and subsistence. Nelson (1991) suggests that the archaeological record should be viewed as a set of behaviors manifest in material form.

Variation in use within and between different artifact classes is predictable within the context of specific cultural systems (Binford 1979). This predictability is not deterministic but allows for expectations about the relationship between behavior and artifact forms. Since the use of technology within a given context is predictable and observable, it follows that measuring traces of use among functionally distinct groups of artifacts in the archaeological record carries implications for social organization and resource exploitation strategies. Though seemingly circular, economic models regarding tool use and modification precede the explanation of attribute patterning because they are formed within a greater theoretical framework (Price 1982). In essence, quantifying varying degrees of tool use and modification allows for the evaluation of the relative economic significance of each artifact class (Horsfall 1987). When this is known, more can be inferred about resource and land use patterns in a general sense.

The attributes chosen for measurement in this study provide an empirically sound basis for describing past cultural systems. By quantifying tool use, this kind of analysis is less arbitrary and subjective than analyses which rely on morphological typologies or relative frequencies alone. The format provides a strong empirical basis for developing regional comparisons seeking to explain patterns of social organization. It should be made clear that there is *no recipe* which will equate one attribute or combination thereof to a specific cultural system. The use wear and formalization data must be interpreted within the greater assemblage context. Different kinds of data inform upon each other and all are necessary for a more wholistic interpretation.

Problems associated with assemblages of the Millingstone pattern have not been addressed through an analysis of this sort. This has fostered explanations of adaptive strategies that are based on ideas of artifact frequency and correlations with perceived demographic or environmental circumstances. Consequently, there has been a failure to demonstrate differences in the intensity of use between different tools and their assemblage contexts, and what the implications might be for cultural systems. Adaptive strategies cannot be fully understood in the archaeological record without knowing about the use of the artifacts that these strategies employed.

This analysis carries implications for the importance of population, environmental, or general economic stimulators of change in cultural systems. Data provide a basis for understanding the meaning of assemblage patterns and the relative importance of influencing factors such as those just mentioned.

Sampling

In order to conduct an analysis of the Millingstone pattern, artifacts were sampled from assemblages in an attempt to account for major variation in time and space. Well documented sites of traditionally defined cultural complexes of the Millingstone pattern in southern California were selected. These are the Oak Grove, Topanga, La Jolla, and Sayles complexes. The selected sites are listed in Table 3.1 along with the number of millingstones, handstones, and scraper planes sampled from each site. There were problems locating all artifacts from the Browne Site (CA-VEN-150, Oak Grove), and most artifacts from four Pauma Complex sites. The location of the Browne Site assemblage is somewhat of a mystery. Numerous institutions have a few artifacts from the site, but the location of the majority remains yet unknown. Assemblages from the Pauma Complex sites are easily located but they are neither fully cataloged nor stored together in an accessible manner. These problems precluded their use in the analysis. The lack of data from the Browne and Pauma sites means that the Millingstone pattern cannot be fully assessed for these regions.

The Glen Annie site (CA-SBA-142) was originally selected for analysis in order to represent one view of the Oak Grove Complex since it has been the center of debate for some period of time in the past (Owen et al. 1964; Owens 1964; Curtis 1965). The traditional perception of this site was intended to contrast that of the Browne Site which has been thought of as yielding the archetypal Oak Grove assemblage (Greenwood 1969). Unfortunately, this contrast can only remain speculative until use wear analyses can be performed on the Browne Site materials.

The Topanga Complex (and to an extent, the interior of Los Angeles County) has been defined by the two Tank Sites (CA-LAN-1 and CA-LAN-2). The first Tank Site (CA-LAN-1) stirred much interest in the functional morphology of scraper planes as they related to the extensive ground and battered stone assemblage that contained some artifacts which suggested extralocal affinities (cogged stones) and great antiquity (projectile points). The second Tank Site (CA-LAN-2) extended these interests and provided what seemed to be the later temporal components to the Topanga Complex.

Two sites were chosen to represent the La Jolla Complex, Batiquitos Lagoon (CA-SDI-603) and Scripps Estate (CA-SDI-525). Both sites contain traditional La Jolla assemblages as the literature attests (Crabtree et al. 1963; Shumway et al. 1961). However, the regional differences between the site at Batiquitos Lagoon and the coastal strand location of the Scripps Estate site cover most of the known environmental contexts for these kinds of assemblages. The early/middle Holocene dates recovered from both sites provides a good context for understanding the development of the Millingstone pattern in what has been assumed to be the location of its origin.

The Sayles Complex is represented in this analysis by three sites that were originally defined as separate loci of one larger occupation area; CA-SBR-421A, CA-SBR-421C, and CA-SBR-421D (Kowta 1969). The size, variable nature, and relatively good condition of the assemblages from these three sites suggest that the range of behavioral patterns in the Cajon Pass region is well represented in this analysis. These sites are also taken as a good indicator of cultural strategies at interior localities during the time of the Millingstone pattern. The late Holocene dates of most of these sites afforded the opportunity to explore the persistence of the pattern late in time.

The sites chosen for analysis only represent a sample of the potential locations that could have been studied. Additionally, because most previous research has been site or location oriented, the assemblages available for study only represent a limited sample of the broad behavioral patterns that characterized prehistoric use of southern

California. It is apparent that the analyzed portion of tools is yet only another sample that cannot be expected to account for all possible variation in behavior encompassed in the Millingstone pattern; it is intended only to capture the more economically significant patterns of technological organization.

Table 3.1. Artifact frequencies by site as reported and analyzed.

		Millingstones		Handstones		Scraper Planes		Total Analyzed
		Rep	Ana	Rep	Ana	Rep	Ana	
Glen Annie	CA-SBA-142	121	23	132	73	11	15	375
Topanga	CA-LAN-1	79	31	963	315	2007	301	3696
	CA-LAN-2	36	24	94	31	67	17	264
La Jolla	CA-SDI-603	44	5	104	36	19	22	63
	CA-SDI-525	21	24	21	20	24	17	61
Sayles	CA-SBR-421A	56	40	159	47	257	41	128
	CA-SBR-421C	61	50	363	49	285	40	139
	CA-SBR-421D	29	26	126	15	184	0	41
Total		447	223	1962	586	2854	453	1262

Note: Rep, reported artifact frequency; Ana, number of artifacts analyzed.

The sites chosen for analysis along with both assemblage and analysis sample sizes are illustrated in Table 3.1. The table provides a comparison of the number of artifacts reported contrasted the number of artifacts that were analyzed.

There were inconsistencies in some assemblages with the number of reported artifacts and the number that were actually located. In some cases this bias proved more formidable than in others. The reasons for the discrepancies range from loss to extension of loans for purposes of teaching. These specific issues are discussed in the following site-specific chapters.

Referring to Table 3.1, if all artifacts within a tool class were not analyzed, then they were sampled according to provenience to control for chronology. In an attempt to account for the possible regional variation within the selected artifact classes, Millingstone pattern sites were sampled from every major region known to contain such assemblages.

One problem that is not as easily avoided is the apparent selective recovery that permeates most of the collections acquired during early research. Where it is a problem (LAN-1 millingstones), mostly whole or near-complete artifacts were collected with many fragments being noting but not collected. This is detrimental to use wear analyses where the condition at discard is indicative of the intensity of use that artifacts witnessed. An assemblage with highly fragmented millingstones may mean that they were intensively used until exhaustion, or it could be a factor of post-depositional disturbance. In either case, whole artifacts may have been discarded before exhaustion. If only whole artifacts are analyzed, the picture may be severely biased with respect to relative economic significance of the artifact classes. In most cases, this problem did not seem too impacting on the analyses as there were many fragments analyzed that were not reported in published documents. In other cases, like Batiquitos Lagoon (SDI-603), selective recovery and curation put extreme limitations on the information that could be gleaned from millingstones. The specifics of this problem are addressed in each site section of this report.

Analysis of Core/Cobble Tools (Scraper Planes)

The term "scraper plane" has been traditionally used to refer to a general form of cobble tool which has been flaked on one side to produce an edge. The functional implication of this title was such that the tool was assumed to have been primarily used for pulping or horizontal scraping (see Kowta 1969; Salls 1983), in a sense much like a modern wood plane. The "scraper plane" title is kept here in order to provide consistency in the analysis of the originally defined artifact classes. Its use is not intended to carry the original functional implications. The fact that the general form of scraper planes varies greatly by site, and that the uses of these tools have never been accurately assessed, adds to the complexity of its classification as a tool. These same problems also complicate interpretation of data, hindering discussions of a rigorous model of use. The inherent difficulty in dealing with scraper planes was traditionally solved using typologies and the assignment of specific functions by form.

Kowta (1969:55) championed the notion that scraper planes were specifically manufactured for use as planning tools in order to produce pulp from *Agave* and *Yucca* that could then be processed with milling equipment. Salls (1983:6) conducted experiments with various types of scrapers as applied to the processing of these plants and found that scraper planes were the most efficient and that the use wear which developed was also seen on a third of the scraper planes recovered from the Liberty Grove site. Conversely, Jackson (1977) conducted a limited-scope technological reduction analysis on a sample of scraper planes to conclude that there is no evidence to suggest that scraper planes were anything more than cores; apparently not used as any kind of tool. All of the use wear observed was, in Jackson's opinion, a result of platform preparation. The study by Jackson (1977) does not solve the problem surrounding the function of scraper planes because his analysis was too limited in scope to fully interpret the types of use and/or damage seen on these tools. Despite this mild controversy, the work of Kowta and Salls has generally been accepted in terms of gross artifact function. Though replication experiments such as those performed by Salls (1983) are good for explaining what kinds of uses some tools may have been used for, they do not necessarily define the functional limits of a tool class. It is also the case that different kinds of use can produce the same use wear results.

Other assessments of the scraper plane tool class have been based on the development of formal typologies (Treganza and Malmud 1950; Treganza and Bierman 1958; Basgall and True 1985; Crabtree et al. 1963). The benefit of these typologies lies in the fact that they have highlighted the great amount of formal variation within the tool class, even though none of the types was ever found to be spatially or temporally diagnostic. However, these typological classifications have not satisfied the major question of the contribution of scraper planes to the general economy of the cultural systems over time. Neither have they been able to give meaning to the variation in scraper plane forms that were recognized. Studies of relative frequency fall under the same auspice, providing only enough information to say how many were manufactured and nothing about the intensity of use.

The weaknesses in replication and formal/typological classification studies underscore the importance of drawing explanations for the presence of scraper planes at sites from studies of use wear and the process of manufacture. The latter analyses allow for explanations to be couched in a relative economic perspective.

In this analysis, random samples of scraper planes were taken when collections were too large to make complete sampling practical. The main use wear attribute measured on scraper planes was polish on used ends and on the interior. Other attributes included original form (cobble, core, flake type, etc.), edge form, edge wear, edge angle, spine plane angle, maximum flake scar length, and step fracturing. The suite of attributes measured on scraper planes was taken from those set up to analyze various other kinds of flaked stone tools such as core tools, flake tools, and cobble tools (i.e., Basgall et al. 1988).

The orientation of polish helped clarify the primary function of 'scraper planes' since it is expected that any sort of planning activity should leave evidence (in the form of polish) near the ends of the contact surface or on the planning surface. When looking for polish, it usually occurred in the form of ground facets only seen on high spots, especially near the edge. Polish on the interior was much less frequent due to the irregular nature of the opposing (planning) surface. Many scraper planes exhibited mineral precipitates to a slight degree, obscuring any polish that may have been present. This did not, however, hinder the measurement of this attribute since it was observable in the form of ground facets.

The measurement of original form, edge form, and edge wear was done to highlight functional patterning. Step fracturing was taken as an indicator of heavy pounding or chopping and was analyzed as a present/absent characteristic. Measuring spine plane angle, edge angle, and maximum flake scar length helped to assess the intensity of use and the level of resharpening that was occurring. Edges that were resharpened were expected to have smaller maximum flake scar lengths, and an increase in disparity between edge and spine plane angles. Intensively used edges were also found to be blunted. If the item was a core, the maximum flake scar lengths were expected to be large, relative to the edge, and the edge angle was expected to have diverged little from the original spine plane angle.

Analysis of Milling Equipment

The term "millingstone" refers to a stone platform upon which things could be processed through grinding and/or pulverizing. Other terms commonly used to refer to such tools are millingslab and metate. The term "handstone" refers to a stone that has been traditionally associated with the millingstone as its smaller, moving counterpart during processing and is also commonly referred to as a mano. Its functions are thought to range from pounding to grinding, but these are not necessarily exclusive.

Morphological and typological studies have dominated previous inquiries of millingstones and handstones in archaeological assemblages from the Millingstone pattern (Treganza and Malmud 1950; Treganza and Bierman 1958; Crabtree et al. 1963; True 1958, 1980). The uses of these studies were directed at ascertaining patterns of tool manufacture in order to develop ideas concerning functional design and in some cases culture history. The result of such classifications was the assignment of specific functions to certain tool classes which were given functionally limiting names. Typologies did not serve interpretation well because formal variation did not pattern out significantly over time or space. The assumptions necessary to link specific functions to specific tools were also problematic because the pattern appeared very early during the Holocene in many different areas.

The typological approach among groundstone artifacts was overcome by various researchers working with non-Millingstone pattern assemblages in other areas of southern California. Basgall and others (et al. 1988; Basgall and Hall 1990) represent two such cases that focused on patterns of millingstone and handstone use. These were important analyses because they represented cases where the groundstone assemblages were able to significantly contribute to the reconstruction of settlement and subsistence regimes. The measured attributes were selected in order to ascertain levels of use and manufacture (Basgall and Hall 1990), as were those used in this analysis.

Millingstones and handstones share many measurable attributes since it is assumed that they were both used primarily for grinding and battering. Both millingstones and handstones were analyzed with respect to material, condition, basic metrical characteristics (length, width, thickness, depth of surface, etc.), shaping type and degree (see below), surface frequency, surface texture (smooth or irregular), surface shape (flat, slightly convex or concave, convex, basined), polish, pecking, striations, fire affection, and secondary modification.

Handstones were specifically analyzed for types of secondary use such as end battering, end polish, and anvil wear. Anvilling refers to semi-centralized to concentrated pecking that sometimes resulted in deep pitting on a surface of the handstone. End battering was observed as damage to the ends of a handstone, often resembling deep pock marks, while end polish was observed as smooth surfaces that accumulated through wear. These traces of use help discern the intensity and diversity of use. Specifically, battering is equated with pounding or pulverizing while end polish may be associated with use similar to that of a pestle. In order to clarify the latter suggestion, end polish was compared to metrical characteristics and other use wear to assess the origin and function of the end polish.

It is the expectation that certain attributes on artifacts are indicative of degrees of use intensity and investment. The more intensively an artifact is used, the higher degree of wear it should show. Measuring the specified attributes is expected to highlight patterns of artifact use after discard. More intensively used artifacts are expected to show multiple working surfaces that are smooth, and especially polished, pecked, and striated; given that the manifestation of any of these attributes varies with raw material type. Scattered pecking on the ground surface is thought to be evidence of surface rejuvenation but may be an indicator of intensive pulverization activities, depending on the other ground surface use wear evidence. Surface shape may be an indicator of surface function, or use intensity, depending on the artifact class and general condition. Secondary modification, or use outside of the primary functional context, may be indicative of an extended use life or of material recycling. Secondary modification was observed as anvilling, end battering, and abrading scars. Measuring shaping may have implications for original functional intention or duration of use life. Shaping could occur as a result of prolonged use which would alter the form through attrition and maintenance, or it could also occur as an investment in the form of the artifact in order to facilitate reliability.

The analysis of shaping is critical to the outcome of the analysis of millingstones because, if measured correctly, it can provide insight to patterns of manufacture and use. Where shaping was present it was analyzed with respect to type (ST, shaping type; 1, exterior flaking; 2, exterior grinding; 3, exterior pecking) and degree (SD, shaping degree; 1, low; 1-30% altered exterior, irregular form: 2, moderate, 30-70% altered exterior: 3, extensive, 70-100% altered exterior, regular form). Flake scars on the exterior of a millingstone that cannot be related to repair are assumed to be evidence of intentional shaping, as are regular pecking, and grinding. It is expected that the general intention of use can be understood in regards to portability and curation by taking this approach to shaping in light of other use wear attributes.

There are some general expectations regarding the patterning of variability of shaping among millingstones. Shaping diversity and degree resulting from manufacture are expected to be low on those millingstones that were not intended to be highly portable. As a result, shaping would occur more often as a product of use. The more an artifact is used, the more likely it is to accrue wear in secondary contexts, or through maintenance, affecting the form of the artifact. One exception is that a millingstone can have a higher degree of the exterior modified by flaking, where the form is not very regular. In actuality, these cases were limited in number and discussed specifically. It is expected that minimally shaped millingstones will tend to show exterior flaking more than those shaped to a higher degree. This type of shaping is most likely associated with the removal of unwanted mass or irregularities. Flake scars from shaping are expected to be minimalized by pecking and grinding as investment in form increases.

With an increase in intended portability, millingstones should show an increase in diversity and degree of shaping, in turn implying more initial investment in form. It is expected that the more portable a millingstone is intended to be, the more reliable it must be and the less mass it should have. Portable millingstones would tend to exhibit higher degrees of formalization through use and maintenance than non-portable ones. With an increase in residential mobility comes an increase in carrying cost, meaning that tool specialization must decrease, or be offset by some other gain (Kelly 1995).

High diversity and degree of shaping could also occur outside of the context of portability. High investment in the shape of an artifact may be the result of its economic significance, but patterns of tool use should always be understood with respect to the costs and benefits associated with the use lives of tools and access to raw material. For this reason, the data generated from analyzing millingstones, handstones, and scraper planes must be viewed in conjunction with other site and regional data.

In light of the condition of many of the millingstones at most sites, present in high numbers and exhibiting high degrees of formalization and use wear, the in-depth approach to shaping helped clarify the functional context of these artifacts. This makes it easier to understand whether they were characteristic of a more sedentary settlement system, or one that saw regular site reoccupation. In essence, type, degree, and overall intention of shaping should vary with respect to mobility strategies and relative economic significance of these tools. Measuring shaping as outlined above in light of all other attributes helped to determine overall investment in form through either manufacture or use.

The formalization present in any tool class is affected by both direct and indirect factors. Indirect formalization can occur as the biproduct of use. Two types of use characterize indirect formalization: extensive and intensive. Extensive use exposes tools to different use contexts (functions) resulting in different kinds of wear. Many artifacts that were part of a highly residentially mobile group were used for a variety of tasks in order to reduce carrying costs (Gould 1969). The shape of these tools is affected by the use wear accumulated in each context. Portable handstones often exhibit wear not directly tied to the ground surfaces, such as anvilling in the surfaces.

Intensive use exposes tools to increased levels of wear. As a tool is used more intensively, the more wear accumulates and affects its form. Intensive use of a tool is related to how expensive it was to manufacture the tool. Manufacturing expense is a product of direct formalization and of the cost of obtaining the raw material(s). As the manufacturing cost goes up, it is expected that the use intensity will also rise. Both extensive and intensive use affect the form of a tool through the accumulation of wear due to attrition and maintenance.

Direct formalization is the result of intentional modification in order to pre-fabricate a form that will ensure a certain degree of functionality. The form of a tool is affected by how much it is initially shaped. The intent of direct formalization varies from a need to increase portability to simply facilitating use in a specific location. It is affected by balancing the needs of reliability and maintainability (Bleed 1986). Direct formalization must be viewed on a scale, because varying degrees of shaping fit with different needs.

In the context of an assemblage, the degrees of formalization (direct and indirect) and use carry significant implications for the relative economic importance of specific tool classes (Horsfall 1987). The economic importance of an artifact class in an assemblage is reflected by a combination of formalization, use wear, and relative frequency. Individually, high degrees of shaping and use wear and high numbers of a specific tool, indicate that the tool class was economically important. However, in an assemblage context these dimensions are affected by the availability and use of raw materials in context of the greater settlement/subsistence system.

The nature of site use is expected to be reflected in the assemblage by the types of artifact classes and the degree to which shaping and use is manifest in each. Assuming that the assemblage is representative of a single settlement system, the diversity present in the assemblage is expected to be an indicator of the degree of occupation (Shott 1987). As a location is used more intensively, assemblage diversity is expected to increase as a result of an increase in the number of tasks being performed at a single location. If a location is used on a more extensive basis, the diversity of artifact types would decrease. This is the result of two factors. First, that more residentially mobile groups are expected to maintain only a limited number of tools. Second, because locations become more task oriented (Binford 1979; Kelly 1983; Shott 1986). Like artifacts themselves, features that occur at sites are expected to become more formalized with an increase in the intensity of site use. This is the result of the need for facilities to be reliable on a more regular basis.

With an increase in the intensity of site use and duration of occupation, the amount of formalization seen in the entire assemblage is expected to decrease. In this case, some artifact classes might be highly formalized as an adjustment to the specialized exploitation of a specific resource (Binford 1979), but most other artifact classes would not see high degrees of direct formalization. The degree of use reflected in an artifact class in a similar situation would vary according to raw material availability and the degree to which this material had to be initially modified to become useful. If raw materials were readily available and manufacturing costs low, then the degree of use seen among artifacts made from the local materials would be relatively low. If there were constraints posed by raw materials, whether availability or manufacturing costs, then the degree of use would be expected to increase.

If the settlement system is characterized by low intensity of site use and limited duration of occupation, then the amount of formalization present in the assemblage would be greater. With increased levels of residential mobility, different costs impose constraints on the form of artifacts. There is an increase in carrying costs, limiting the size and number of artifacts able to be maintained in a tool kit. If the exploitative strategy is such that certain specific tool forms are required then direct formalization increases. If the exploitative strategy is more generalized in nature, then there is expected to be less direct formalization. In both cases, indirect formalization is expected to be relatively high in order to more efficiently use raw materials with respect to availability and the cost of manufacture.

The formalization and use present in any artifact class is an indication of the nature of site use and of the overall settlement and subsistence system(s) that used the area. These dimensions of technological organization are affected by a number of constraints ranging from raw material availability to the economic importance of specific artifact classes.

Specifically, use wear and formalization patterns within artifact classes refer to combinations of attribute variables that are more or less robust. These patterns were mostly observable within the attribute tabulation provided in each site chapter, but at other times a Chi Square statistical analyses was needed to clarify the significance of a perceived pattern. The trends that were observed were interpreted based on how the attribute variables within a combination informed upon each other, giving meaning to the pattern. Battering on a millingstone surface could signify extensive maintenance to facilitate grinding, or the use of that surface primarily for pulverizing, depending on the type of battering observed and what the measurement of other attributes revealed. The final assessment of attribute patterning was achieved at the end of each chapter in a synthesis of all known information gleaned from the respective assemblage contexts. The implications of artifact use for the development of each site and larger questions concerning settlement and subsistence could then be assessed.

The data from the analyses are summarized in separate chapters according to site in order to deal with trends in artifact use in their specific contexts. This enabled the integration of all available information from each assemblage into the interpretation process. Following the site chapters, the data are synthesized into a regional review section in an effort to increase the scale of observation and ascertain the presence of larger scale patterns in artifact use.

Chapter 4:

Batiquitos Lagoon, CA-SDI-603

This site, CA-SDI-603, is one of many situated near Batiquitos Lagoon, in San Diego County, California. Dated between 3700 and 7500 years BP, it has been attributed to the La Jolla, Phase 1, period of southern California. Notwithstanding interpretative opinions, M. Rogers (1929) defined Phase 1 of the La Jolla tradition as representative of the earliest inhabitants of San Diego who used an abundance of unshaped millingstones, handstones, battered cobbles, and scraper planes. This differs from the later, Phase 2 La Jolla material which was thought to include more flaked stone implements and show a pronounced increase in artifact formalization (Rogers 1929). Crabtree et al. (1963) interpret the assemblage of SDI-603 as a result of intermittent occupation by non-sedentary groups. They base this on the low amount of diversity in the assemblage which seems to span the entire occupational history of the site. Sites such as SDI-603, situated on Batiquitos and other lagoons, have often been cited as demonstrating a cultural adaptation to lagoon and coastal environments because of the presence of shellfish remains and some aquatic bone (Masters and Gallegos 1997).

The site lies on the eastern margin of a low (20 m) northward protruding finger on the south side of the lagoon, looking toward a tributary watershed draining from the south (Crabtree et al. 1963). This watershed is the San Marcos Creek which drains the surrounding mesa and low bordering mountains to the east (Crabtree et al. 1963). Flooding of drainage mouths near the coast by rising sea level during the early Holocene resulted in the formation of such lagoons (Carbone 1991). The persistent development of lagoons is largely due to the reversal of drainage down cutting through siltation by rising sea level throughout the Holocene, and to the lowering of the water table by surrounding community development in more recent years (Crabtree et al 1963). High productivity is a hallmark characteristic of major lagoons in San Diego county. It is largely due to seasonal variability in precipitation which acts as a check on biotic community maturation. The dry season in particular promotes aerobic decomposition that returns nutrients to the lagoon environment stimulating future growth. The processes which contributed to the development of Batiquitos lagoon are responsible for the formation of the landform on which the site exists. The situation of the site is such that access to both freshwater and estuarine resources is relatively unrestrained.

Development of estuarine/lagoon plant and animal communities followed relatively soon after the formation of the lagoon habitats. The surrounding mesa which characterizes the San Diego coastal plain has always been composed of a dry climate biota, which saw only species disjunction in plant communities with changes in climatic conditions during the Holocene (Axelrod 1978). The plant communities which characterize the area today range from chaparral to coastal grasses and include “sumac, poison oak, sage, buckwheat, elderberry, manzanita, and California holly” (Crabtree et al. 1963:325). Though larger fauna generally left the area during the early Holocene, it could have supported moderate to small sized game throughout the last 8000 years. The estuaries, fully developed by the end of the early Holocene, were host to a number of fish, shellfish, and small animal species.

The chronology of SDI-603 is such that there seems to be an occupational gap between combined strata 1 and 2, and 3 and 4 (Crabtree et al. 1963). Strata 2 and above are dated between 3700 and 4100 years BP, but possibly extend into later times. The upper reaches of the deposit were found to have numerous fragments of pottery and a few temporally late projectile points on the surface. Strata 3 and 4 are bracketed between 6100 and 7500 years BP Two dates were from shell and are uncorrected and one is from charcoal (from Stratum 3). Since there does not seem to be a gap in occupational debris, it is unclear whether mixing of cultural strata provided a significant contribution to the overlap, or if the site was intermittently occupied from 3700 to 7500 years BP.

There were trends in artifact deposition that varied with depth, as illustrated in Table 4.1. These were originally characterized by decreases in scraper planes and flake scrapers with increases in formalized flake tools (small flake tools) and cobble tools (hammers and choppers) as depth increases (Crabtree et al. 1963). A review of Table 4.1 summarizes the artifact class frequencies by depth and only partially confirms the original observations. Some tools included in the small flake tool category are actually small domed scrapers. These formed flake tools are almost exclusively (10/11) located in Stratum 3 (Crabtree et al. 1963:342, and Table 4). The other small (unformed) flake tools actually decrease in proportion. Projectile points and bifaces tend to decrease with depth, as do cores. The initial interpretation of the site stratigraphy saw a break between strata 2 and 3, physically and chronologically. If Stratum 3 is thought to represent the Millingstone pattern, or La Jolla Phase 1 component, its assemblage composition closely resembles traditional definitions. However, the presence of a pronounced flaked stone assemblage in Stratum 3 seems to have gone unrecognized in previous assessments of the site itself. The importance of formed flaked stone tools (small domed scrapers) has been masked by typological rubric over the years and would be better served by a formal use wear analysis.

Table 4.1. SDI-603. Artifact Frequency by Stratum.

ART CLASS	SURF	STRAT 1	STRAT 2	STRAT 3	TOTAL
Handstone	12	13	31	48	104
Millingstone	3	6	15	20	44
Mortar	-	-	-	-	-
Pestle	-	-	-	-	-
Oth Grndstn	-	-	-	-	-
Scraper	6	4	3	6	19
Chopper	11	1	9	27	48
Hammer	5	10	14	40	69
Scraper	10	8	5	16	39
Core	3	2	4	4	13
Sm Flktl	2	14	21	38	75
Point/Biface	3	5	-	2	10
Oth Misc	-	1	5	6	12
Total	55	64	107	207	433

From Crabtree et al. 1963, Table 4; Chopper category includes cobble uniface, biface, and multiface; SM FLKTL, small flake tool.

Reports of subsistence remains from SDI-603 are ambiguous except to say that there was a sizeable amount of marine and lagoon shell along with an assemblage of terrestrial fauna that was not insignificant. The ambiguity is due both to the recovery methods used and to the availability of the midden analysis information. It is clear that both aquatic and terrestrial resources were used, although the latter were more limited.

Two types of features were recognized during the excavation of SDI-603. Twelve features characterize the first type, defined as possible hearths or ovens that consisted of closely arranged stones and tended to contain charcoal and/or fire-cracked rock (Crabtree et al. 1963). The second type, with ten examples, lacked consistent internal organization but consisted of loose aggregations of rocks interpreted to be refuse piles or badly disturbed fire pits (Crabtree et al. 1963). Two of these contained charcoal, while five were piles of mostly broken artifacts. Large rock cairns, characteristic of the Oak Grove pattern to the north, were not found at SDI-603 or any adjacent sites at Batiquitos Lagoon.

Only one burial was found at SDI-603, having no associated grave goods. The burial appeared to be a primary inhumation of a young adult female that was placed on her side in a slightly flexed position. The burial discovered in Stratum 4 extending into the subsoil with no visible intrusive pit in the upper strata (Crabtree et al. 1963).

From original reports, there is nothing to suggest that SDI-603 yielded an extensive or complex assemblage in terms of variation within or between artifact classes. The site has been cited as representative of the earlier part of the La Jolla pattern for southern California (Masters and Gallegos 1997), with only the obvious assemblage similarities with "Millingstone Horizon" sites being highlighted. The analysis of millingstones, handstones, and scraper planes, along with cursory observations of other artifact classes has revealed important artifact variation and assemblage diversity that has implications for the understanding of the Millingstone manifestation in southern California.

Millingstones

Only five millingstones were analyzed, because 39 could not be located (see Table 4.2) due to loans by the host facility to other institutions, use in teaching kits, and possible reburial (Fowler Museum, personal communication). This small sample, representing only 11.4% of the total number of millingstones is obviously deficient but cannot be remedied at this time. Data generated by Crabtree et al. (1963) regarding metrics and general descriptions are used to help understand the general nature of the millingstone assemblage.

The spatial distribution of millingstones at the site, outside of features and burials, is vague at best. From data published in the site report, summarized in Table 4.1, it can be seen that the highest frequency of millingstones appear to be from Stratum 3 (45.5%), decreasing in number within the upper strata (Crabtree et al. 1963). The distribution of shaped millingstones by depth is not very significant but shows them occurring more frequently in the lower Stratum 3 (2 examples), with one on the surface (Crabtree et al. 1963). There are three main clusters of millingstones by site area: Pit 3, 10 slabs; Pit 4, 15 slabs; Pit 16, 13 slabs (Crabtree et al. 1963). These may represent more intensive areas of vegetal processing at the site through time. Millingstones could also have been scavenged causing a localization of their distribution into these three clusters, though the evidence is circumstantial.

Table 4.2**. SDI-603. Millingstone attributes by shaping degree.**

SHP DEGREE		**0**	**1**	**2**	**3**	**IND**	TOTAL
MATERIAL							
	SCH	-	-	-	-	-	-
	GRN	-	1	-	-	-	1
	SST	-	2	2	-	-	4

	GRA	-	-	-	-	-	-
	SIL	-	-	-	-	-	-
	VOL	-	-	-	-	-	-
CONDITION							
	WHL/NC	-	1	-	-	-	1
	MRG	-	2	2	-	-	4
	END	-	-	-	-	-	-
	FRG	-	-	-	-	-	-
SURFACE FREQUENCY	1	-	2	2	-	-	4
	2	-	-	-	-	-	-
	IND	-	1	-	-	-	1
SURFACE SHAPE	B	-	2	2	-	-	4
	F	-	-	-	-	-	-
	SCV	-	-	-	-	-	-
	SCX	-	-	-	-	-	-
	IND	-	1	-	-	-	1
SURFACE TEXTURE	S	-	2	2	-	-	4
	I	-	-	-	-	-	-
	IND	-	1	-	-	-	1
POLISH							
	PRS	-	1	1	-	-	2
	ABS	-	1	1	-	-	2
	IND	-	1	-	-	-	1
STRIAE							
	PRS	-	1	1	-	-	2
	ABS	-	1	-	-	-	1
	IND	-	1	1	-	-	2
PECKING							
	PRS	-	2	2	-	-	4
	ABS	-	-	-	-	-	-
	IND	-	1	-	-	-	1
SECONDARY MODIFICATION	PRS	-	-	-	-	-	-
	ABS	-	3	2	-	-	5
FIRE AFFECTION	PRS	-	-	-	-	-	-
	ABS	-	3	2	-	-	5
SHAPING TYPE	IND	-	-	-	-	-	-
	0	-	-	-	-	-	-
	1	-	3	-	-	-	3
	2	-	1	2	-	-	3
	3	-	1	1	-	-	2
TOTAL		-	3	2	-	-	5

Note: see Appendix A for description of attributes.

Four of the five millingstones analyzed were margin fragments made from sandstone, while one was near-complete and granite. Two sandstone fragments refit (cat. #2871, 2872), leaving a total of only 4 artifacts. The refitting fragments were treated as separate pieces in the analysis since they were not recognized as refits in the original catalog.

The one whole granitic millingstone was shaped to SD-1 by flaking and pecking on the exterior and had a well worn basined surface, exhibiting polish, striations, and surface pecking, to a depth of 3.2 cm. There was also an intact ground platform surrounding the basin which was moderately ground upon, displaying polish. With a thickness of 8.4 cm, this slab fits within the lower range of block millingstones, and was unlikely a highly portable item, as its shaping characteristics demonstrate. Of the other four millingstones, two each were shaped SD-1 and SD-2, with flaking and pecking present on the exterior of the former, and pecking and grinding characterizing shaping of the latter. Observed use-wear, as seen in Table 4.2, was moderate with most surfaces (4 total) tending to be smooth (75%) and pecked (75%), but not always polished or striated (25% each). The pecking on working surfaces was more consistent with what is expected of surface sharpening, or maintenance, rather than large scars from heavy pulverizing.

Table 4.3. SDI-603. Average complete metrics by artifact class and shaping.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	-/0	-/0	-/0	0
Shp Deg 1	-/0	34.3 / 1	9.5 / 2	3
Shp Deg 2	-/0	-/0	10.7 / 2	2
Shp Deg 3	-/0	-/0	-/0	0
Avg Total	-	34.3 / 1	10.1 / 4	5
Handstones				
Shp Deg 0	11.6 / 14	8.3 / 17	5.7 / 17	17
Shp Deg 1	10.6 / 4	8.1 / 6	5.4 / 6	6
Shp Deg 2	10.6 / 8	8.3 / 9	4.9 / 9	9
Shp Deg 3	11.7 / 3	8 / 3	4.5 / 3	3
Avg Total	11.1 / 29	8.2 / 35	5.1 / 35	35
Scraper				
Form 1	8.1 / 3	5.2 / 3	2.7 / 3	3
Form 2	7.9 / 19	6.3 / 19	4.2 / 19	19
Avg Total	8 / 22	5.8 / 22	3.5 / 22	22

Note: Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.

Thickness measurements for the fragmented millingstones averaged 10.1 cm, which is consistent with those in the block category. This measurement portrays the shaping characteristics as evidence of shaping with the intent to make the slab more useable within the immediate vicinity of the site, without investing any effort in further formalization of the exterior to increase portability by reducing mass. Crabtree et al. (1963:332) found that the majority of measured millingstones had a thickness between 5 and 7 cm, with some larger specimens. This furthers the assumption that the sample of 5 analyzed here is not necessarily characteristic of all other millingstones at the site, but it may be large enough to account for use-wear/formalization traits of those millingstones between 8 and 12 cm in thickness.

Handstones

Thirty-five (33.6%) handstones were analyzed from SDI-603, including 32 whole specimens and three end fragments. Spatial patterning of handstones at the site (Table 4.1) is similar to that of millingstones, the highest frequency coming from Stratum 3 (46%), the heart of the cultural deposit, with a decrease in frequency in the upper strata. Shaped handstones were observed by the original authors to occur mostly in Stratum 3 (7 of 10), with two each from Stratum 2 and the surface. Although there were no significant differences in distribution of the different shaping degrees, handstones shaped in the second (SD-2) or third (SD-3) degree tended to occur in Stratum 3.

Nearly all handstones were made from locally available materials (see Table 4.4) (30 granite, 1 sandstone) with four others that could be from other, non-local sources (metavolcanic). All degrees and types of shaping were represented including 17 unshaped, six SD-1, nine SD-2, and three SD-3. Handstones which did show formalization were mostly shaped by pecking (89%) and just 22% were ground. The only notable difference in distribution of shaping type is that no SD-2 handstones were shaped by grinding. The raw material profiles for each shaping degree show no evidence of material preference according to form except for metavolcanic stone. That metavolcanic stone only occurs among handstones showing at least minimal traces of shaping may be the result of sample bias, but it more likely reflects the extended use of stone that is less available in the area than granite or sandstone. There is no evidence to suggest that metavolcanic stone needed more shaping than other materials to facilitate use.

The metrical summaries for handstones illustrated in Table 4.3 show consistent average lengths and widths for specimens among all degrees of shaping. The total average maximum length was 11.1 cm and the maximum width was 8.2 cm. The average thickness measurements, however, show a steady decrease from SD-0 to SD-3. There is an average loss of about one half of a centimeter with every increase in shaping degree, giving a final difference in thickness of 1.2 cm between SD-0 and SD-3. The decrease in thickness is evidence of a decrease in mass and is taken to be the result of extended use. The average maximum thickness for all specimens was 5.1 cm.

Surface frequency increases in proportion as shaping degree goes up, as does the occurrence of flat surfaces. Table 4.4 shows that among unshaped and SD-1 handstones, 23% were used on one surface, 68% were bifacial, and one had three ground facets. Among those shaped to the SD-2 and SD-3 degrees, none are unifacial, 88% were bifacial, and one was trifacial. Similarly, flat surfaces accounted for only 13% of the total for SD-0 and SD-1, while handstones shaped to the SD-2 and SD-3 degrees had flat surfaces accounting for 40% of the total. The increase in surface frequency and flat surface shapes by shaping degree is indicative of relative increased levels of use since the more a handstone is used, the more likely it is to be used on multiple surfaces. However, it may be the case that flat surfaces are more related to use on flat millingstone surfaces, which would suggest a functional difference among surface shapes and in this case, shaping degree.

A general trend of increased levels of use with increasing shaping degree is illustrated among the various other use wear attributes in Table 4.4. The trend is progressive from unshaped to SD-3. Unshaped and SD-1 handstones are more similar to each other in terms of use than they are to the higher degrees of shaping and the same holds true for SD-2 and SD-3. Unshaped and SD-1 handstones show 13% of their surfaces being irregular, 55% lacking striations, 45% lacking pecking on the surfaces, and all lacking end polish. By contrast, the SD-2 SD-3 categories have only one irregular surface, 28% lacking striations, 8% lacking surface pecking, and 50% lacking end polish. It is clear that the higher degrees of shaping accrued more regular evidence of intensive use. All degrees of handstone formalization exhibited polish on 100% of the surfaces.

It is interesting that end polish only occurred on handstones shaped to the SD-2 and SD-3 degrees. The occurrence of end polish coincided with a decrease in heavy end battering. This may be an indication of functional variation between shaping degrees.

Table 4.4. SDI-603. Handstone attributes by shaping degree.

SHP DEGREE		**0**	**1**	**2**	**3**	**TOTAL**
MATERIAL						
	SCH	-	-	-	-	-
	GRN	16	5	8	1	30
	SST	1	-	-	-	1
	META	-	1	1	2	4
	QZT	-	-	-	-	-
	QTZ	-	-	-	-	-
	IGN	-	-	-	-	-
	FEL	-	-	-	-	-
	GRA	-	-	-	-	-
	BAS	-	-	-	-	-
	RHY	-	-	-	-	-
CONDITION						
	WHL/NC	15	5	9	3	32
	MRG	-	-	-	-	-
	END	2	1	-	-	3
	MED	-	-	-	-	-
	FRG	-	-	-	-	-
SURFACE FREQUENCY	1	8	1	-	-	9
	2	8	5	8	3	24
	3	1	-	1	-	2
	4	-	-	-	-	-
SURFACE SHAPE	F	3	2	7	3	15
	CV	-	-	-	-	-
	CX	24	9	12	3	48
	IND	-	-	-	-	-
SURFACE TEXTURE	S	23	10	18	6	57
	I	4	1	1	-	6
	IND	-	-	-	-	-
POLISH						
	PRS	27	11	19	6	63
	ABS	-	-	-	-	-
	IND	-	-	-	-	-
STRIAE						
	PRS	11	6	13	5	35
	ABS	15	4	6	1	26
	IND	1	1	-	-	2
PECKING						
	PRS	12	9	17	6	44
	ABS	15	2	2	-	19
	IND	-	-	-	-	-
END POLISH						
	PRS	-	-	4	2	6

	ABS	17	6	5	1	29
	IND	-	-	-	-	-
SECONDARY MODIFICATION	PRS	13	6	9	2	30
	ABS	4	-	-	1	5
FIRE AFFECTION	PRS	9	1	6	1	17
	ABS	8	5	3	2	18
SHAPING TYPE	IND	-	-	-	-	-
	0	17	-	-	-	17
	1	-	-	-	-	-
	2	-	4	9	4	17
	3	-	2	-	2	4
TOTAL		17	6	9	3	35

Note: see Appendix B for attribute descriptions.

As formalization increases, there may be a need to avoid risk of damage, or the artifact may simply accumulate formalizing wear instead of battering as a difference in the use of end sections. Of course the reciprocal is also true where an end is used more for battering, it may be less likely to accumulate less obvious wear such as grinding. There is no metrical correlation with end polish suggesting that they were longer or wider (Table 4.3); such as characteristic would indicate their use as pestles.

Secondary modification was consistently observed among all degrees of shaping, with unshaped handstones having the highest percentage of specimens that were not used for other purposes (30%). Most handstones were end battered (77%), indicating some kind of pulverizing activity. Another kind of secondary use, fire affection, characterized nearly half (49%) of these tools indicating their re-use as possible hearth or heating stones. The nature of the raw material was such that it could not be discerned whether fire alteration resulted from direct burning through intended use as a cooking or hearth stone, or of other indirect causes. It was clear, though, that those that did show burning were exposed to fire at some point.

Scraper Planes

Crabtree et al. (1963) report the recovery of 19 scraper planes from SDI-603. This contrasts to the catalog curated at the Fowler museum, which has no entries for scraper planes. The most probable explanation for this discrepancy is a change in the labeling of artifact categories during curation as corrections to the catalog indicate. In order to solve this problem, a controlled sample based on predictable form of all artifact classes which resemble scraper planes (7 cores, 9 core unifaces, 2 large unifaces, 3 angled hammers, and 1 split cobble) were analyzed according to the attributes developed in the methods section of this report for scraper planes.

Originally, Crabtree et al. (1963) reported a decreasing frequency of scraper planes by depth. Table 4.1 does not support that observation because the number of scraper planes in Stratum 3 (6) is equal to the number on the surface (6), both being the highest recorded number. If strata 1 and 2 are lumped together, then the trend appears (13 from surface to Stratum 2; six from Stratum 3).

Four material types characterized a sample of 22 artifacts analyzed as scraper planes: six quartz, five quartzite, one basalt, and 10 of other materials (see Table 4.5). All of the materials occur locally in drainages and as cobble outcrops at the coastal shoreline, about one kilometer away (Crabtree et al. 1963). Most were manufactured from a cobble based form, three from flake blanks. Many resemble what have been called split cobbles in previous reports (Shumway et al. 1961).

Table 4.5. SDI-603. Scraper plane attributes by material type.

	BAS	CCR	QZT	QTZ	FEL	RHY	META	OTH	TOTAL
FORM									
1	-	-	-	1	-	-	-	2	3
2	1	-	5	5	-	-	-	8	19
3	-	-	-	-	-	-	-	-	-
Flk Type									
1	-	-	-	1	-	-	-	-	1
2	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	1	1
IND	-	-	-	-	-	-	-	1	1
E Freq									
1	1	-	5	6	-	-	-	7	19
2	-	-	-	-	-	-	-	3	3
E Form									
1	1	-	5	6	-	-	-	12	24
2	-	-	-	-	-	-	-	1	1
E Shap									
1A	-	-	-	-	-	-	-	-	-
1B	-	-	-	-	-	-	-	-	-
2A	1	-	5	2	-	-	-	9	17
2B	-	-	-	2	-	-	-	2	4
3A	-	-	-	1	-	-	-	-	1
3B	-	-	-	1	-	-	-	2	3
4	-	-	-	-	-	-	-	-	-
E Wear									
0	-	-	1	-	-	-	-	-	1
1	-	-	1	2	-	-	-	5	8
2	1	-	2	3	-	-	-	6	12
3	-	-	1	1	-	-	-	2	4
E Polish									
PRS	1	-	4	5	-	-	-	7	17
ABS	-	-	1	1	-	-	-	6	8
Stp Frac									
PRS	1	-	4	6	-	-	-	12	23
ABS	-	-	1	-	-	-	-	1	2
Int Pol									
PRS	-	-	1	2	-	-	-	3	6

ABS	1	-	4	4	-	-	-	7	16
Sec Mod									
PRS	-	-	-	-	-	-	-	2	2
ABS	-	-	-	-	-	-	-	8	8
TOTAL	1	-	5	6	-	-	-	10	22

Note: see Appendix C for attribute descriptions.

Based on Table 4.3, average measurements for scraper planes were separated by original form: form 1, flake based; form 2, cobble based. The sample was biased in frequency toward cobble based forms, making comparisons somewhat dubious. The greatest differences between forms 1 and 2 occur among average maximum widths and thickness. The average maximum width for form 1 scraper planes was 5.2 cm, while that for form 2 was 6.3 cm; a difference of 1.1 cm. For average maximum thickness, the difference is more pronounced being 1.5 cm, 2.7 cm for form 1 and 4.2 cm for form 2. These data show that scraper planes made originally from flakes were significantly narrower and thinner than those made from cobbles. The predominance of the cobble form is probably an indication of preference for certain dimensions. The total average maximum length was 8 cm. When viewed in light of the average widths and thicknesses, the picture that emerges for scraper planes is relatively long, narrow, and thin. All edges were unifacial save one which was bifacial. Three artifacts had two edges, bringing the total to 25 formed edges. The dominant edge shape was convex-regular (17), followed by convex-irregular (4), then straight-regular (3), and straight irregular (1). This high variation in edge shape did not pattern according to original catalog type. It suggests that the initial investment in edge form was minimal.

Edge wear did not pattern according to edge shape or degree of regularity. The most common type of edge wear observed was bifacial micro-chipping (12), followed by unifacial micro-chipping (8), with four that were battered until dull, and only one that had no edge wear. Most of the artifacts were edge polished (17) and step fractured (23), while only seven showed interior polish. Only two specimens were secondarily modified, both used as battered cobbles.

The mean angle measurements were 73.6^0 for edges, and 64.1^0 for the spine plane angle. Maximum flake scar lengths (MFSL) measured on the used edges averaged 1.67 cm . The difference in edge angle alone might suggest that there was a lower than average intensity of use of scraper planes at SDI-603, having less edge attrition and needing less resharpening. The low spine plane angle furthers this notion in showing that the original form of the edge was modified little after manufacture. The relatively low disparity between edge and spine plane angles (9.5^0) offers more evidence that edges were not used as intensively at this site. This disparity is expected to increase with greater use intensity and resharpening and edge attrition. The fact that the MFSL is so small is probably due to the fact that smaller flakes were taken off in the final stages of edge manufacture, most likely similar to the size needed to resharpen edges.

There is the possibility that the lower than average angle measurements may simply be a factor of the nature of the raw material, which occurs in stream cobble form. In this case, the variance in measurement would be due to manufacture differences. However, the fact that the disparity between edge and spine plane angles is low is still indicative of less intensive use because of less resharpening.

The artifacts analyzed as scraper planes are unique in that they are mostly expediently made from cobbles that have been split and modified on one edge. The nature of the local cobbles is such that the manufacture process has lead to a pattern of long, narrow, and thin scraper planes. The attribute and edge angle data does not indicate very intensive use or maintenance of edge form.

Non-Analyzed Tool Categories

A number of other tool categories besides millingstones, handstones, and scraper planes were recovered from SDI-603 (see Table 4.1) including small flake tools (64), points/bifaces (10), small domed scrapers (11), hammers (69), cores (13), choppers (48), and heavy scrapers (39) among a few others (Crabtree et al. 1963:Table 4). The original interpretation of the deposit separated Stratum 3 from strata 1, 2 and the surface on a cultural and physical basis. Taking this into account, there do seem to be significant distributional changes among the different artifact classes. Small, simple (unformed) flake tools and points/bifaces decrease in frequency from 36 to 28, and from eight to two, respectively (Crabtree et al. 1963:342, and Table 4). Additionally, cores and heavy scrapers also decrease in percentage (from 9 to 4%, and from 23 to 16%, respectively). Other artifact classes increase in proportion with increasing depth. Hammers increase in number from 29 to 40, choppers increase from 21 to 27, and small domed scrapers increase from 1 to 10 (Crabtree et al. 1963:Table 4).

In total, Stratum 3 seems to be characterized not only by relatively high numbers of handstones (48) and millingstones (20) but also by choppers, hammers, and small formed flake tools (domed scrapers). Hammers and choppers are typically associated with Millingstone Horizon assemblages and are assumed to be related to subsistence processing. Choppers were most likely associated with vegetal processing, while hammerstones have widely been assumed to be linked to flaked stone reduction (Basgall et al. 1988). The analyses of handstones and scraper planes held indications of secondary use such as battering or hammering that are associated with choppers and hammers. This suggests that there was some functional overlap between these tools.

General battered cobbles of all types have also been subject to less scrutiny due to their general form. Crabtree et al. (1963) note that the “hammerstone complex” is one that is highly variable and probably represents a continuum of tools which grade into one another, transforming tool type with continued use. The generality of these tools was recognized by True (1958) as he called out a separate type in San Diego county as the hammer-grinder, indicating their use in multiple functions including grinding and battering. An informal look at hammerstones and battered cobbles did reveal that specimens of both artifact classes sometimes exhibited ancillary grinding which was not consistent with previous use primarily as a handstone.

The presence of hammers and cobble tools in high proportion is telling of their expediently oriented function in that most cobbles can be used as both kinds of tools, eliminating the need to maintain them and creating a pattern of excessive discard. Cursory observations did reveal that many of the hammers and cobble tools were not used very intensively.

An interesting pattern is the presence of a previously unrecognized formed flaked stone component in Stratum 3, represented by small formed flake tools (domed scrapers). As stated before, these almost exclusively occur in Stratum 3 (Crabtree et al. 1963:Table 4). With only cursory observations regarding the size, form, and use of these flaked stone artifacts, it is clear that they were highly formalized and well used when discarded at the site. These artifacts are mostly made from fine-grained volcanics such as basalt, cryptocrystalline, and obsidian, all of which only occur in extralocal contexts. The fact that they do not represent a very significant portion of the overall assemblage (see Crabtree et al. 1963:Table 4) suggests that, during the primary use of the site, they were not the technological focus of economic activities. However, their presence in undeniable association with the Millingstone component is evidence that there are unknown dimensions of technological organization that have been hidden under morphological typologies and ignored based on relative frequency arguments.

The proportion of scraper planes, scrapers, and small flake tools in Stratum 3 should by no means be dismissed as insignificant. In each case, they form a sizeable percentage of the overall assemblage (Table 4.1). That small flake tools, points, and bifaces peak in frequency in the upper strata of the site where milling tools are generally low in number suggests some kind of functional shift in site use later in time, though limited in duration.

Summary and Conclusion

The stratigraphy at SDI-603 is such that the vertical distribution of the bulk of the cultural deposit correlates well with the radiocarbon dates from strata 2 and 3. The uppermost area of Stratum 3 was dated using charcoal from a hearth which dated to 6250 ± 150 BP while Stratum 2 dated to 3900 ± 200 BP from a shell sample (Crabtree et al. 1963). Millingstones and handstones are reported to account for 37% of the total number of artifacts recovered from Stratum 3 and 52 % of those recovered from Stratum 2 (Crabtree et al. 1963). It is probably safe to say that the peak deposition of millingstones, handstones and related assemblage constituents at this site post-dated the formation of Stratum 4 (7300 ± 200 BP) and continued until about 3900 BP. The presence of pottery and late Holocene projectile points is most likely separate phenomenon from the Millingstone component. Soil profiles from the site show moderate bioturbation and extensive mixing of the upper 12 inches by plowing. These two factors most certainly contributed to the vertical distribution of the smaller artifacts in the upper two strata while some of the moderate sized artifacts may have traveled upward in the deposit (scraper planes and handstones).

There are no major patterns of groundstone formalization or use that seem to be temporally sensitive within strata 2 and 3 except that moderately to highly shaped handstones tend to cluster in Stratum 3 . The discrepancy between millingstone and handstone deposition between strata 2 and 3, which is almost opposite between the two, is most likely due to the reuse of millingstones on site, delaying their final deposition. It is the case that millingstones are also horizontally localized in three clusters (excavation pits). This could be further evidence that they were scavenged. Overall, the association of millingstones and handstones with numerous hammerstones, choppers, and various scrapers, is typical of traditionally defined Phase 1 La Jolla assemblages. The addition of small domed scrapers and small flake tools has gone unrecognized in the past.

The number of millingstones that could be located for analysis was disappointing. The sample of five could only be representative of the larger, block millingstones from the assemblage. Since most millingstones were between 5 and 7 cm in thickness (Crabtree et al. 1963), the analyzed sample has only limited value to interpretation of the overall assemblage. Those that could be analyzed fit more with the notion of site furniture as shaping was generally low. The use wear attributes that were measured showed moderate levels of use all on basined surfaces. Since it is probably not the case that these millingstones were intended to be portable, they likely saw use characterized by repeated visits to the site. This explanation would correlate with the distributional information provided in the original report that may suggest scavenging behavior.

The handstones at SDI-603 tend to be not very formalized, being characterized by unshaped, or slightly shaped specimens with approximately one third that are moderately to highly shaped. Use wear patterning appeared to follow the different shaping degrees in a predictable manner with use intensity and regularity in form increasing with moderate to high shaping degrees. This artifact class does not seem to represent one that saw intensive use and maintenance in a tool kit but which saw moderate re-use on or near the site. The high number of whole handstones composed entirely of local material, and the high degree and variety of secondary modification is supportive of this observation. The fact that the more highly shaped handstones tended to occur in the lower areas of the deposit may be meaningful when correlated with the presence of a formalized flake tool assemblage occurring only in Stratum 3, possibly indicating a technological organization which could facilitate an increased level of residential mobility. Use-wear data on milling equipment is consonant with that thought to be produced by the processing of small, hard seeds and some pulpy material (Basgall et al. 1988). There is no evidence based on use-wear which suggests that either millingstones or handstones were used for acorn processing, or heavy pulverization.

Scraper-planes peaked in frequency in the upper deposits of the site, though the differences in number are minimal (Table 4.1). The fact that the soil profiles clearly show major bioturbation may account for the difference in scraper plane distribution as compared to handstones and millingstones in that they are relatively small to moderately sized artifacts. However, the higher number of scraper planes in upper levels cannot be ruled out as a temporally dependant aspect of the site. It may be the case that this artifact class became more economically important at the site later in time. If correct, it would necessitate the assumption that the scraper plane tool is less functionally linked to milling equipment than has been assumed in the past. The attribute patterns suggest that the artifacts analyzed were used similar to that of traditional scraper planes but less intensively. This is indicative of the relative economic importance of scraper plane-like tools in the vicinity of Batiquitos Lagoon.

Hammers, choppers, and heavy scrapers were most abundant in Stratum 3 but were not uncommon in the upper strata. Upon cursory observations, these tools were found to functionally overlap, as grinding and battering was found on specimens of each category. Additionally, this overlap extended into the handstone and scraper plane artifact classes that showed evidence of battering along with their primary uses. The overlap in use wear seen among these tools is evidence of their functional generality.

Though not a significant portion of the site assemblage, the presence of "small domed scrapers" and "flake scrapers" occurring in relative abundance in Stratum 3 (24% of the artifacts from this Stratum) could indicate the presence of an earlier (San Dieguito-like) component. However, they cannot be physically separated from the Millingstone component and may simply be evidence that exploitative strategies were more broad reaching, concerning resources and land use, than has previously been attributed to "Millingstone Horizon" sites. In fact, Stratum 3 is also where more highly shaped handstones peak in frequency. There is no evidence at this site which nullifies the association of these handstones with the formed flake tool class.

The two types of features recognized at the site, consolidated hearths and loose aggregates of stone, do not seem to represent formalized site features. They are more indicative of temporary cooking and secondary disposal facilities. The distribution and nature of the features by no means suggest long periods of continuous occupation but rather intermittent habitation areas. If continuous occupation was characteristic of the site, there would probably be more organization of these features into separate areas of living space, or more evidence of such activities (Treganza and Bierman 1958).

There is a consistent theme among millingstones, handstones, and scraper planes that has implications for site use. In context of the entire assemblage, these tools were manufactured from local materials, occur in high numbers, and are primarily represented by low-moderate degrees of formalization and moderate degrees of use. This pattern is most parsimoniously explained by a site use strategy that saw fairly regular site re-occupation where many tools were left on site. Millingstones were probably left in anticipation of re-use, biasing their distribution to certain locales. Handstones and scraper planes saw less re-use than millingstones due to the abundance of raw material available for new tools which might have been a better option than maintaining scavenged tools until exhaustion. This strategy would best account for the high proportion of handstones and scraper planes due to an increased rate of discard at the site.

The low amount of formalization within each artifact class is evidence that high residential mobility was not a primary characteristic of cultural systems which exploited the area of the site. Residentially mobile groups would be expected to have more formalized tools (at least handstones) to ensure reliability, even though some milling equipment might be used as site furniture. Conversely, the low to moderate use wear data suggest that this site was not host to highly sedentary groups of people. If more sedentary groups did stay at this site, an intensive use wear pattern would be expected to emerge. Sedentary groups would need to use more of the local resources in that cost of procurement of non-local resources would increase. Since there is not a large shellfish or other aquatic faunal assemblage at this site (comparatively speaking), the resources that would be expected to be used more would be small hard seeds and other relatively dry resources which need some kind of processing. Thus, use intensity of milling equipment would be reflected in use wear and greater deposition of these kinds of artifacts, which it is not.

Site SDI-603 does not represent what M. Rogers (1929) originally defined as La Jolla, Phase 1, where shellfish gatherers were living a sedentary lifestyle and subsisting on a limited number of resources. Neither does it fit with an interpretation of an aquatic *adaptation* (see Masters and Gallegos 1997) of any kind. The functional generality of the assemblage is indicative of the exploitation of numerous types of resources without specialization. The newly recognized diversity (small flake tools and small domed scrapers) adds an even more interesting dimension of subsistence and settlement that has yet to be fully explored. The presence of small formed flake tools becomes even more important to issues of settlement in light of the expedient nature of groundstone manufacture and what appears to be extensive re-use. Additionally, if this diversity were to be found among other La Jolla assemblages, there would be serious implications for the temporal and spatial overlap of what are perceived to be La Jolla and San Dieguito assemblages that could only be addressed through formal use wear analyses.

Chapter 5:

Scripps Estate, CA-SDI-505

The Scripps Estate site (CA-SDI-525) is located at about 110-120 ft in elevation on the southern margin of Sumner Canyon approximately 1/3 km from the Pacific Ocean (Shumway et al. 1961). Shumway et al. (1961) suggest that the site was continuously occupied by presumably sedentary people for approximately 2500 years. This was based on lines of inquiry such as the number of burials, population estimates according to artifact density, and the size of the site itself. Because of the nature of the deposit, the authors suggested that there did not seem to be a need to attempt segregation between Phases 1 and 2 of the La Jolla complex.

The surrounding topography is characterized by mesa with low mountains some distance to the east and sea cliffs to the immediate west. This portion of the coast is marked with numerous canyons and drainages opening toward the ocean. Sandstone outcrops occur regularly with other cobble conglomerates (including some volcanics and cryptocrystallines) becoming exposed in the canyon and sea cliff walls, but not directly on-site (Shumway et al. 1961). The situation of the site allows for easy access to fresh water in the canyons.

The vegetation of the surrounding area is characterized by semi-arid plant communities such as shrubs and grasses with the occasional grove of Torrey Pine. The drainages do not today support enough runoff close to the ocean to maintain habitats for aquatic animals, but the rocky reefs of the coast provide ample substrate for numerous types of shellfish and other marine species. The prehistoric composition of plant communities was probably much the same as today excepting changes in the distribution of some plants such as the pine groves and some xerophytic species (Axelrod 1978; Carbone 1991). Game in the area is marked by small to medium sized animals as larger species most likely migrated to the mountainous areas with climatic change during the Holocene.

The existing collection from SDI-525 is most certainly not representative of the general assemblage deposited at the site since it has been witness to extensive surface removal and other post-depositional disturbances. The sample, however, is likely a good indicator of the Millingstone pattern, which reflects the earlier occupation of the general area. It is characterized by 21 millingstones, 21 handstones, 24 scraper planes, 21 choppers, 12 hammers, about 200 scrapers, nine cores, 45 small flake tools, one point/biface, and 83 other miscellaneous artifacts (ornaments, etc.) (Basgall and True 1985; Shumway et al. 1961). The small flake tools, including highly formalized specimens, received no attention when SDI-525 was cited in previous research or descriptions. These tools represent an important aspect, economically and statistically, to the general Millingstone assemblage recovered from the site.

The assemblage itself cannot be used as a means for determining temporal polarity of major patterns for southern California because much of the structure of the site has been lost. Additionally, the information regarding the provenience of specific artifacts is vague, leaving interpretation of distributional patterns at the mercy of original observations and intuition. Since excavations were on a salvage basis, no definite features were recorded except for burials.

Four radiocarbon dates ranging from 7000 to 5000 years BP were obtained from mussel shell taken from the lower cultural Stratum (Shumway et al. 1961). In association with the La Jolla assemblage constituents, these dates suggest that the bottom portion of the site represents the earlier end of the Millingstone pattern in the San Diego area (Moriarty et al. 1959). The salvage-oriented nature of excavations inhibited any recovery of later assemblage components which could have been dated. Generally, Shumway et al. (1961) report two soil horizons, A and B, that contained the bulk of the cultural material from the lowest portions of the deposit. These strata were marked by carbonate accumulations, determined by the original researchers to have been derived primarily from the decomposition of shell in the last 5000 years (Shumway et al. 1961; Moriarty et al. 1959).

Subsistence remains were dominated by marine shell to such an extent that the burials were inundated with shell detritus. The shell remains included those of 56 species of gastropod and pelecypod mollusks, mostly from rocky shorelines and lagoon/bay habitats (Shumway et al. 1961:Table 3). The amount of terrestrial fauna and fish remains recovered is extremely small compared to shellfish (Shumway et al. 1961:Table 4). No sea mammal or pinniped remains were recovered. The subsistence remains recovered can only be viewed as a gross indicator of the major diet constituents of the earliest component at the site due to the fact that all remains were hand picked from screens, eliminating the possibility of recovering smaller fish remains. Additionally, the shellfish sample can not be assumed representative of the Millingstone component due to the fact that the earlier and possibly later components that were destroyed may have contributed a significant amount of shell to the midden. Nevertheless, it appears that shellfish did compose an economically important aspect of the subsistence system during the earlier occupations of the site.

Forty-six burials were recorded for the area in and surrounding SDI-525. Most seem to be concentrated toward the northern end of the site. The general trend in burial patterns is one of full flexing, typifying Phase 1 of the La Jolla pattern. Only two burials, however, were found to be in association with inverted millingstones. It is also the case that most of the burials represent full inhumations, rather than partial burials or reburials. Shumway et al. (1961) imply that the number of recovered burials and the number of possible burials yet uncovered are an indication that the site was used as a cemetery. The temporal position of most burials, whether associated with the lower La Jolla material or the later cultural deposits, is decidedly unknown.

In light of the context of this assemblage, the analysis of millingstones, handstones and scraper planes can only speak to the earlier part of the Millingstone pattern in southern California in terms of subsistence organization. Its relationship to later phases can not be directly assessed because of a lack of information.

Millingstones

From SDI-525, 24 millingstones were analyzed out of 21 reported by Basgall and True (1985). Shumway et al. (1961) estimated that about 60 millingstones were recovered from the site, including previous research. The number analyzed represents the total number located at the Fowler museum. Two millingstones were possible refits with others in the collection, leaving the presence of only one in excess of the original number. If additional millingstones did exist, they were either not curated, were reburied, relocated, or were miscounted in the estimate. There is no detailed information regarding the distribution of millingstones except to say that most came from burial contexts or adjacent areas, and all were from the soil horizons A and B that characterized the La Jolla component (Shumway et al. 1961).

All millingstones were manufactured from local sandstone and all were fragments of either margins (10), ends (2), or indeterminate sections (12) (see Table 5.1). Millingstones that could not be categorized by shaping degree accounted for 54% (13) of

Table 5.1. **SDI-525. Millingstone attributes by shaping degree and type.**

SHP		**0**	**1**	**2**	**3**	**IND**	TOTAL
MATERIAL							
	SCH	-	-	-	-	-	-
	GRN	-	-	-	-	-	-
	SST	-	4	6	1	13	24
	GRA	-	-	-	-	-	-
	SIL	-	-	-	-	-	-
	VOL	-	-	-	-	-	-
CONDITION							
	WHL/NC	-	-	-	-	-	-
	MRG	-	2	6	1	1	10
	END	-	2	-	-	-	2
	FRG	-	-	-	-	12	12
SURFACE FREQUENCY	1	-	3	2	-	10	15
	2	-	1	4	1	3	9
	IND	-	-	-	-	-	-
SURFACE SHAPE	B	-	-	-	-	-	-
	F	-	1	3	1	5	10
	SCV	-	4	6	1	10	21
	SCX	-	-	1	-	1	2
	IND	-	-	-	-	-	-
SURFACE TEXTURE	S	-	4	10	2	14	30
	I	-	1	-	-	1	2
	IND	-	-	-	-	1	1
POLISH							
	PRS	-	4	3	2	10	19
	ABS	-	1	6	-	6	13
	IND	-	-	1	-	-	1
STRIAE							
	PRS	-	-	-	-	-	-
	ABS	-	5	9	2	15	31
	IND	-	-	1	-	1	2
PECKING							
	PRS	-	5	8	1	15	29
	ABS	-	-	2	1	1	4
	IND	-	-	-	-	-	-
SECONDARY MOD	PRS	-	-	-	-	2	2
	ABS	-	4	6	1	11	22
FIRE AFFECTION	PRS	-	2	-	-	4	6
	ABS	-	2	6	1	9	18
SHAPING TYPE	IND	-	-	-	-	12	12
	0	-	-	-	-	-	-
	1	-	4	3	-	-	7
	2	-	3	6	1	1	11
	3	-	-	4	1	-	5

TOTAL	-	4	6	1	13	24

Note: See Appendix A for description of terms.

the specimens while four were shaped to SD-1, six were shaped to SD-2, and one was shaped to SD-3.

Millingstones at this site seem to at least be moderately formalized, implying some investment in form of the artifacts. Complete maximum thickness measurements could be taken on 16 specimens, only 11 of which could be categorized by shaping degree. The mean maximum thickness according to shaping categories was 5.5 cm, with a standard deviation of 1.7 cm (see Table 5.2). The average of the other four fragments was 5.4 cm. These averages fit within the lower range of thick millingstones that include thicknesses from 5.4 to 8.7 cm. Table 5.2 also shows a trend of decreasing thickness (reflecting mass) with increasing shaping degree, although the numbers are small. This suggests that even though sandstone in the area is naturally thin, the correlation of lower thickness measurements with higher shaping degrees begs of a functional relationship between millingstone thickness and degree of formalization. The lack of complete length and width measurements prohibits any further discussion of the relative volume or mass of millingstones.

Out of 11 millingstones categorized by shaping degree, 63% were SD-2 and SD-3, while the rest had at least minimal evidence of exterior modification. The one millingstone shaped by pecking and grinding to SD-3 showed use wear evidence typical of highly formalized millingstones. It had one flat, and one concave surface which were both smooth and polished with only the latter showing rejuvenation pecking. In general, there was not any variation in use wear according to surface shape.

Moderately shaped millingstones (SD-2) were mostly bifacial (four of six) showing variation in surface shape with three flat surfaces, six concave, and one convex. All surfaces were smooth, while only three exhibited polish, and eight were pecked for surface maintenance. All forms of shaping were relatively common as three were flaked, six were pecked, and four were ground on the exterior.

Millingstones shaped to SD-1 followed much the same trend in use wear. The only real difference is the higher frequency of unifacial millingstones (three of four) relative to the more formalized specimens that tended to be used on two opposing surfaces. It was found that surfaces were either flat (1) or concave (4) and tended to be smooth (4), polished (4), and pecked (5). Shaping type was characteristic of the slightly shaped millingstones with most specimens exhibiting flake scars on the exterior (4), and as well as surface pecking (3).

Indeterminately shaped millingstones exhibited use wear characteristic of the entire tool class in that, out of 16 surfaces (10 unifacial, 3 bifacial), most tended to be concave (10) or flat (5), smooth (14), polished (10) and pecked (15). Roughly a third of these fragments were fire-affected. The data do not suggest that the fragments witnessed an increased level of use intensity in terms of vegetal processing but that they were subject to more reuse as hearth or cooking stones.

Table 5.2. SDI-525. Average complete metrics by artifact class and shaping.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	- / 0	- / 0	- / 0	0
Shp Deg 1	- / 0	20.4 / 2	6.2 / 4	4
Shp Deg 2	- / 0	- / 0	5.9 / 6	6
Shp Deg 3	- / 0	- / 0	4.4 / 1	1

Avg Total	- / 0	20.4 / 2	5.5 / 11	11
Handstones				
Shp Deg 0	- / 0	- / 0	- / 0	0
Shp Deg 1	- / 0	8.2 / 2	4.9 / 3	4
Shp Deg 2	10.7 / 4	8.7 / 4	4.5 / 6	7
Shp Deg 3	- / 0	7.9 / 1	4.9 / 1	1
Avg Total	10.7 / 4	8.3 / 7	4.7 / 10	12
Scraper				
Form 1	6.6 / 4	5.4 / 4	2.8 / 4	4
Form 2	7.4 / 12	5.8 / 12	4.2 / 12	12
Avg Total	7 / 16	5.6 / 16	3.5 / 16	16

Note: Includes only those artifacts complete enough to be categorized by form, does not include indeterminate fragments; Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.

The observed use wear patterns indicate moderate intensity of use. The high occurrence of unpolished ground surfaces (13 of 32) may be more reflective of the nature of the sandstone which is easily weathered. However, intensive grinding on the surface of a sandstone slab would produce a hard enough polished surface to leave at least remnant surfaces that show polish. In this context, it is probably a combination of both weathering and moderate use which left some surfaces unpolished. The low average thickness of millingstones combined with the moderately high degree of formalization suggests that some these tools did have a degree of portability. Whether they to the nature of the sandstone outcrops.

Handstones

Twenty handstones from SDI-525 were analyzed out of 21 reported for the site (Basgall and True 1985). Shumway et al. (1961) estimate that 300 were recovered, including the excavations of Moriarty et al. (1959). The twenty handstones located for analysis represent all that could be found, implying that the estimate of 300 was either exaggerated or fell victim to any number of circumstances. Distributional information is lacking except to say that nearly all handstones were recovered from the primary La Jolla component either in burial contexts or adjacent exposures.

Material profiles show that handstones were overwhelmingly represented by granite (17), with two of sandstone and one of metavolcanic material; all occur locally in nearby drainages (Shumway et al. 1961). Whole specimens numbered six, while most tended to be fragments of either end (10) or margin (4) portions (see Table 5.3).

Formalization of handstones seemed to be moderately distributed among the different degrees of shaping with a majority falling into SD-2 (7) or SD-1 (6). Unshaped handstones were represented by four specimens, while only one was shaped to SD-3 and two could not be catergorized. Grinding characterized the SD-1 category (5), while those of SD-2 were all shaped by pecking around the perimeter. In the former case, shaping seems to have taken place as an indirect result of use while handstones shaped to SD-2 probably saw more intentional formalization; most of these (7) were pecked on the perimeter.

Basic measurements of handstones did not pattern at all by shaping degree (see Table 5.2). Aside from the fact that incomplete measurements hinder a complete analysis, the available measurements from complete specimens show consistent width and thickness averages across all shaping degree categories. The average maximum thickness for SD-1 was the same as that for SD-3 at 4.9 cm, with the average for SD-2 being slightly lower at 4.5 cm. The lack of variation by shaping degree is evidence of a low amount of variability in use intensity between the different levels of formalization. In support of this, the average maximum thickness for handstones that could not be assigned to shaping categories was 4.5 cm, fitting with the other averages and implying that these tools were used similarly before being discarded as the more complete specimens. The amount of validity that can be placed on these measurements is obviously hindered by the small sample, but they do reflect low regularity in form brought about through use or manufacturing processes.

Table 5.3. SDI-525. Handstone attributes by shaping degree.

SHP		**0**	**1**	**2**	**3**	IND	**TOTAL**
MATERIAL	SCH	-	-	-	-	-	-
	GRN	3	6	5	1	2	17
	SST	-	-	2	-	-	2
	META	1	-	-	-	-	1
	QZT	-	-	-	-	-	-
	QTZ	-	-	-	-	-	-
	IGN	-	-	-	-	-	-
	FEL	-	-	-	-	-	-
	GRA	-	-	-	-	-	-
	BAS	-	-	-	-	-	-
	RHY	-	-	-	-	-	-
CONDITION	WHL/NC	1	2	3	-	-	6
	MRG	1	1	1	-	-	3
	END	2	3	3	1	2	11
	MED	-	-	-	-	-	-
	FRG	-	-	-	-	-	-
SURFACE	1	-	-	-	-	1	1
FREQUENCY	2	4	6	7	1	1	19
	3	-	-	-	-	-	-
	4	-	-	-	-	-	-
SURFACE	F	-	2	4	-	-	6
SHAPE	CV	-	-	-	-	-	-
	CX	8	10	10	2	3	33
	IND	-	-	-	-	-	-
SURFACE	S	8	11	14	2	3	38
TEXTURE	I	-	1	-	-	-	1
	IND	-	-	-	-	-	-
POLISH	PRS	8	11	12	2	3	36
	ABS	-	1	-	-	-	1
	IND	-	-	2	-	-	2
STRIAE	PRS	6	10	10	2	1	29
	ABS	2	2	2	-	2	8
	IND	-	-	2	-	-	2
PECKING	PRS	6	9	13	2	3	33
	ABS	2	3	1	-	-	6
	IND	-	-	-	-	-	-
END POLISH	PRS	1	3	3	1	-	8
	ABS	3	2	4	-	2	11
	IND	-	1	-	-	-	1

SECONDARY MOD	PRS	2	2	6	1	-	11
	ABS	2	4	1	-	2	9
FIRE AFFECTION	PRS	2	4	4	-	1	11
	ABS	2	2	3	1	1	9
SHAPING TYPE	IND	-	-	-	-	2	2
	0	4	-	-	-	-	4
	1	-	-	-	-	-	-
	2	-	1	7	-	-	8
	3	-	5	-	1	-	6
TOTAL		4	6	7	1	2	20

Note: see Appendix B for descriptions of terms.

There is surprisingly little variation in use between the different shaping degrees. The most notable differences exist among pecking and secondary modification. Pecking, as an indication of surface maintenance or rejuvenation, was observed on 75% of SD-0 and SD-1 handstones. This percentage increased to 93% among SD-2, and further increased to 100% for SD-3. Secondary modification in the form of end battering also saw an increase in observance from 33% on SD-1 to 86% on SD-2.

All other attributes were proportionately represented in each of the formalization categories. All handstones, save one indeterminately shaped fragment, were used on two surfaces which tended to be convex (85%) and smooth (97%). Polish was seen on 97% of the surfaces and striations were observed on 78% of the surfaces. The high visibility of striations is likely due to the high frequency of granite that has a propensity for holding use wear in the face of weathering. In fact, 50% of the sandstone surfaces lacked striations, compared to only 18% for that of granite surfaces.

End polish was relatively frequent, exhibited on 42% of the classifiable ends. Interestingly, seven of eight specimens that were end polished were shaped by grinding of some kind on the perimeter, indicating that shaping and the presence of end polish was linked in some fashion. It is unclear whether the handstones were ground directly on the ends or whether polish accrued indirectly through contact with the concave surfaces of the millingstones. End polish was observed as an independent characteristic of the ends which makes the former assumption (direct end grinding) more probable as a cause. That end polish and shaping appear to be functionally related at some level lends support to the idea that handstone shaping is due more to use rather than manufacture at this site. Regrettably, the metrical data do not support a size correlation with end polish that would indicate whether this attribute was the result of use in pestle-like contexts. However, the observed end polish did not seem to indicate that handstones were primarily used or recycled as pestles.

Fire-alteration was relatively common, with nine out of 20 handstones showing evidence of direct burning. Since no features were reported to have been discovered during excavation, it is assumed that these tools were recycled as cooking or heating stones but were recovered from contexts that saw no consolidation in such facilities.

All categories of shaping degree seem to have been similarly used with moderate intensity. The fact that most handstones are fragments is probably a combination of use and post-depositional processes.

Scraper Planes

Out of 24 reported scraper planes, 17 were analyzed according to the attributes set forth in the methods section. The actual number of scraper planes recovered from

SDI-525 is open for debate since intuitive discussions of these artifacts by Shumway et al. (1961) give the impression that they were significantly more frequent. The remaining portion that was and was not reported may is assumed to be missing because of changes in terminology during post-excavation analyses. Like handstones and millingstones, the distribution of scraper planes is vague with the only information being that they were recovered from the La Jolla component in soil horizons A and B.

Most of these artifacts were manufactured from quartzite (14), followed by basalt (2) and rhyolite (1) (see Table 5.4). All except basalt occur in local conglomerate contexts and are among the harder raw materials available in the area. The original form of these tools was predominantly cobble based (12), with four made from flakes of either secondary decortication or interior percussion, and one that could not be categorized to form. Basic measurements of scraper planes, demonstrate the difference in size and mass between those made from flake blanks versus cobble blanks (Table 5.2). The average maximum length for form 1 scraper planes was 6.6 cm, the average width was 5.4 cm, and the average thickness 2.8 cm. Form 2 scraper planes (cobble based) had an average maximum length of 7.4 cm, a maximum width of 5.8 cm, and a maximum thickness of 4.2 cm. These data show that scraper planes made from cobbles contain more mass overall than those made from flakes. The predominance of the cobble form over the flake form probably indicates a preference for certain dimensions in order to increase functional efficiency. It is also the result of an expedient manufacture process whereby splitting a cobble is more efficient than manufacturing a suitable flake blank. The split cobble form of scraper plane is supposed to be typical of the La Jolla pattern (Shumway et al. 1961).

Edge forms were generally unifacial (13), characterized by a variety of shapes that include seven convex regular, eight convex irregular, and one each straight regular and straight irregular. The diversity in edge shapes and their irregularity is indicative of an expedient use trajectory. More regularly used tools should show an increased tendency toward regularity in form and use wear patterns. The most common edge wear observed was unifacial microchipping (10), followed by bifacial microchipping (4), and edge battering (3) to the point of dulling. Though all edges exhibited step fracturing, only six each showed edge and interior polish.

Table 5.4. SDI-525. Scraper plane attributes by material type.

	BAS	CCR	QZT	QTZ	FEL	RHY	META	OTH	TOTAL
FORM									
1	1	-	3	-	-	-	-	-	4
2	1	-	10	-	-	1	-	-	12
3	-	-	1	-	-	-	-	-	1
Flk Type									
1	-	-	-	-	-	-	-	-	-
2	-	-	1	-	-	-	-	-	1
3	-	-	-	-	-	-	-	-	-
5	1	-	1	-	-	-	-	-	2
IND	-	-	1	-	-	-	-	-	1
Edge Freq									
1	2	-	14	-	-	1	-	-	17
2	-	-	-	-	-	-	-	-	-

<u>Edge Form</u>									
1	2	-	11	-	-	-	-	-	13
2	-	-	3	-	-	1	-	-	4
<u>Edge Shape</u>									
1A	-	-	-	-	-	-	-	-	-
1B	-	-	-	-	-	-	-	-	-
2A	2	-	4	-	-	1	-	-	7
2B	-	-	8	-	-	-	-	-	8
3A	-	-	1	-	-	-	-	-	1
3B	-	-	1	-	-	-	-	-	1
4	-	-	-	-	-	-	-	-	-
<u>Edge Wear</u>									
0	-	-	-	-	-	-	-	-	-
1	2	-	7	-	-	1	-	-	10
2	-	-	4	-	-	-	-	-	4
3	-	-	3	-	-	-	-	-	3
<u>Edge Polish</u>									
PRS	2	-	4	-	-	-	-	-	6
ABS	-	-	10	-	-	1	-	-	11
<u>Step Fracture</u>									
PRS	2	-	14	-	-	1	-	-	17
ABS	-	-	-	-	-	-	-	-	-
<u>Int Pol</u>									
PRS	2	-	4	-	-	-	-	-	6
ABS	-	-	10	-	-	1	-	-	11
<u>SEC MOD</u>									
PRS	-	-	2	-	-	-	-	-	2
ABS	2	-	12	-	-	1	-	-	15
<u>TOTAL</u>	2	-	14	-	-	1	-	-	17

Note: see Appendix C for description of terms.

Some patterning of wear and polish is evident among the different edge shapes. For those with convex-regular edges, the majority tended to exhibit unifacial microchipping (5 of 7) and nearly half (3) showing polish. For edges that were convex-irregular, there was a higher diversity of observed wear (4 unifacially microchipped, 3 bifacially microchipped, and 1 battered) with a lower occurrence of polish (2). This is repeated among straight regular and straight irregular edges with the former showing unifacial microchipping and edge polish and the latter showing bifacial microchipping without polish.

Edge angles averaged out at 75^0 while spine plane angles showed a mean measurement of 69^0. Maximum flake scar lengths for this site averaged 1.33 cm. The low disparity between edge and spine plane angles suggests that scraper planes at SDI-

525 saw a more incipient use trajectory as edge angles do not seem to have been modified through use or maintenance much past the original spine plane angle. This is corroborated by attribute patterning which shows wear consistent with some kind of plane/scraping activity to a low/moderate degree reflected by the high diversity in edge shapes. The low disparity between edge and spine plane angles does suggest that these tools were not used and resharpened until exhaustion; they appear to have been discarded fairly early in their use-lives. The data indicate that the regularity of edge shape is related to more regular types of wear. In essence, edge formalization increases along with the regularity of wear.

Non-Analyzed Tool Categories

In addition to the millingstones, handstones, and scraper planes, other seemingly important artifact classes include flake tools (45), hammers (12), cores (9), and choppers (21), along with unknown numbers of scrapers and smaller flaked stone tools. Since data on the distribution of artifacts is relatively scant, little can be said about the association of these tools except that they were all, most likely, involved in some kind of vegetal processing which was the primary focus of the earlier component of the site.

Limited observations on hammers and choppers revealed considerable functional overlap with each other as well as the handstone category. Both hammers and choppers sometimes had incipient ground facets, some hammers were flaked and used as choppers, and a handful of choppers were battered on unworked margins. The scraper plane category also overlapped in function with hammers and choppers in that edges were occasionally found to be battered (5 total). The generality of function for hammers and choppers speaks to the economic importance of general subsistence processing tools at the site whether indirectly in terms of manufacturing tools (hammers), or directly for purposes of pulping, scraping or chopping. The presence of a yet to be located assemblage of scrapers might well compliment this suite of tools upon analysis.

It is interesting that small formed flake tools are present in the amalgam of tools that seem to date to the earlier context of the La Jolla pattern. Informal observations made on these flake tools revealed that most are made from fine-grained volcanics, are highly formalized and were probably discarded fairly long into their use lives, leaving little material to be maintained. Some of these tools resemble miniature scraper planes, in form and in use wear in that edges and would be planning surfaces tend to show polish. Since these artifacts occur in apparent association with the stereotypical Millingstone tool kit, it would be parsimonious to conclude that some formal flaked stone tools were functionally involved in the economic activities of the site.

Summary and Conclusion

A sizeable Millingstone assemblage was retrieved from what were essentially burial salvage excavations. Most of the artifacts are typical of La Jolla complexes in San Diego with a small flaked stone assemblage. The entire assemblage was recovered from a highly weathered shell midden that yielded no discernable features but contained about 46 burials. It is unclear what amount of shell or what number of burials actually derive from the La Jolla component due to the lack of a surface deposit.

The tools recovered from SDI-525 that seem to date somewhere near 7000 and 5000 years ago present a picture typical of what has been traditionally defined as La Jolla. The data available for artifact distribution are scant making the sample from this site less significant in terms of interpretation of the occupational history for the area around Scripps Estate.

Use wear information for millingstones and handstones indicates that these artifacts were used intensively with little variation according to degrees of formalization. This pattern correlates with the moderate degree of formalization present among millingstones and the moderate shaping of handstones. Additionally, the number of millingstones and handstones recovered in comparison to other tool categories is evidence that they represent the primary technological focus of economic activities surrounding the site.

Scraper planes were subject to relatively low levels of use, but the high number of so many tools similar to scraper planes is an indication that functions associated with these tools were somewhat important. The low-moderate levels of use observed may simply be an indication of a technological strategy that allowed for the manufacture of these tools when needed, not necessitating intensive use of each tool when others could be easily fabricated. More expedient use is reflected in the diversity of edge shapes and use wear characteristics.

The kind of use and manufacture pattern seen among scraper planes is also evident in core tools and hammerstones. These last two categories have significant functional overlap with both handstones (with respect to grinding and end battering) and scraper planes (with respect to chopping and battering), and represent an important yet general technological strategy.

The presence of formalized flaked stone tools is confusing but may be evidence of a broad subsistence regime which may have entailed moderate levels of residential mobility. This is in opposition to ideas about scavenging. It could very well be the case that other, cultural systems (i.e. San Dieguito) were using the area near the time of the Millingstone (La Jolla) groups, but there is little evidence to support the notion that entirely separate cultural systems were inhabiting the same area. If this were the case, then the deposition of other tools associated with a formalized tool kit would be expected to be recovered. Such tool kits have yet to be well defined in terms of composition or use wear/ formalization patterns. Until this occurs, it is unlikely that a true definition of a cultural system such as San Dieguito apart from Millingstone systems is possible. Few tools can be a defining characteristic of San Dieguito or La Jolla culture histories but artifact frequencies coupled with use wear patterns can. Thus, the formed flaked stone tools recovered from the site are assumed to be associated with the general La Jolla tool kit.

The assemblage-wide trend that includes millingstones, handstones, scraper planes, hammers and choppers, is characterized by high frequencies, low-moderate use wear, and low-to-moderate formalization. The degree and type of formalization present in millingstone, handstone, and scraper plane tool classes is characteristic of the type of settlement which would be consistent with reoccupation in the context of easy access to raw materials. This type of occupational strategy would promote expedient manufacturing of tools that would in turn favor new production in the face of extended tool use and prolonged maintenance. The addition of a formalized flaked stone component speaks against permanent occupation in the context of the other assemblage constituents.

The initial interpretation of the site as a sedentary, continually occupied settlement does not fit with use wear and formalization data in the general assemblage context. The assemblage is redundant in terms of use wear and formalization patterning, generally lacking in diversity of tool types. The data more readily speak to an occupational history that was characterized by intensive and prolonged, yet intermittent episodes of site use. In this case, the regular use of the site for similar purposes would produce an assemblage that is characterized by many of the same artifacts used in a similar manner. The idea that some of the millingstones and handstones may have seen a dimension of portability is suggestive of at least low levels of residential mobility. If the small number of formalized flaked stone tools were functionally related to the general processing assemblage, it is even more likely that the cultural system was fairly broad-reaching in its settlement strategy. This would also present an interesting slant on the interpretation of the reality of the San Dieguito/ La Jolla dichotomy. The presence of shellfish remains in abundant quantities is an indication that these were an economically important resource during site occupation. It is not unreasonable to think that a generalized gathering/processing economy, which is reflected in the assemblage of the site, would exploit easily procured resources such as shellfish. In fact, the site was probably situated such that all gatherable resources in the area could be easily exploited. However, there are no artifact classes or traces of use that would indicate a specialization on any aquatic resource.

Chapter 6:

The Tank Site, CA-LAN-1

The Tank site, CA-LAN-1, is one of two loci that exist upon a ridge approximately 400 meters in elevation near two springs on the eastern side of Topanga Canyon in the Santa Monica Mountains (Treganza and Malmud 1950). The consensus of most who have directly studied and written about this site is that it represents a permanent settlement spanning thousands of years and mostly occupied during the middle Holocene (Gamble and King 1997:67,70; Treganza and Malmud 1950:130). This conclusion was based on an assumption that the site was situated in a defensive location, and that it contained massive quantities of ground and battered stone, large rock features, and burials.

The local environment of the site is characteristic of the southwestern portion of the Santa Monica mountains which offer numerous passages between the inland basins and the Pacific Ocean. The coastal side of the Santa Monica mountain range is marked by higher precipitation than the inland side, averaging 61 cm per year (Raven et al. 1986). The precipitation level has contributed to greater erosion in the drainages creating long, deep canyons that leave most habitable locations on ridge tops (Diblee 1982; Raven et al. 1986; Gamble and King 1997). Other livable areas are most evident along the canyon bottoms, where riparian or limited wetland habitats exist.

The vegetation in this area is characterized by chaparral, coastal sage scrub, southern oak and riparian woodlands, grassland, and the occasional wetland and coastal salt marsh, along with coastal strand vegetation (Raven et al. 1986; Axelrod 1978). Some of the foodstuffs available to human exploitation are “acorns, islay, chia, grasses, red maids, toyon, manzanita, blue dicks, and yucca” (Gamble and King 1997:62). Evidence from surrounding regions to the north and south suggest that the middle Holocene may have been marked by a period of warmer and drier climates (Heusser 1978). The only difference in vegetation was most likely a slight shift in species distribution, as grasses may have been more common than oak, scrub, and manzanita communities (Axelrod 1978).

The geology of the area is such that many coarse-grained igneous rocks are available, mostly in drainages, while the underlying sandstone regularly occurs in surface outcrops. Cryptocrystalline silicates are commonly found as cobbles in the Monterey and Calabasas formations and more readily in exposures near the coastline and in drainages.

The stratigraphy at LAN-1 appears fairly simple judging by available soil profiles (Treganza and Malmud 1950). All soil has been built up from a sandstone base upon which decomposed sandstone has mixed with other soils. The depth of this base varies according to location within the site, but is generally closer to the surface near the highest portions of the ridge, getting deeper proceeding away from the ridgeline. In some areas, the soils have deflated and left little matrix atop the sandstone bedrock. Above the basically sterile layer of mixed sandstone gravels and soil (Stratum C), exists Stratum B which contains the bulk of the cultural deposit. This Stratum is thickest in profile, and is characterized by green, light gray clay-like soil. Directly above this layer is Stratum A, also containing high amounts of certain artifacts but lacking definite midden colors because it has been exposed to wildfires, erosion, and mixing of sediments.

Heavy carbonate coatings on most artifacts, especially those of basalt, characterizes the entire deposit. Treganza and Bierman (1958:68) have suggested that this mineralization represents the remains of decomposed shell. However, the close proximity of the site to a nearby spring suggests that the mineralization might be more associated with changes in the water table and soil chemistry.

The coating of stone with carbonates in the matrix at LAN-1 has been cited as the chief indication of antiquity for the cultural material recovered from the site. Heizer and Lemert (1947) equate this mineralization alongside heavy erosion and soil deflation with extreme age. If mineralization is more related to changes in the local water table, then its association with assemblage antiquity is very problematic.

Chronology was estimated based on the different types of artifacts recovered form the Tank site. Heizer and Lemert (1947) determined cultural affiliation to be associated with the San Dieguito chronology proposed by Rogers (1945). The latter had an estimated age range of 3200-1100 years BP for its first four phases. More recent estimations of the earlier phases of the San Dieguito pattern place it within the early Holocene, mainly occurring prior to 7500 BP (Warren 1968; Warren and True 1961; Mason et al. 1997). The earlier positioning of San Dieguito is based mainly on formal similarities of representative tools with those of the Mojave desert that tend to date to the early Holocene (see Basgall 1993a). This affiliation may be more real than has been subsequently believed due to the recognition of a formed flake tool assemblage during this analysis that tends to typify early phases of San Dieguito as perceived by many today. However, the temporal range of these tools in association with Millingstone pattern assemblages is not understood. It may be the case that they are indications of site occupation during the early/middle Holocene.

Cursory observations of some of the artifacts cataloged as points and bifaces may indicate a greater age for the deposit as some have formal affinities with the Pinto projectile form of the southern Great Basin. Pinto projectile points in the Mojave Desert are thought to date between 7500 and 4000 years BP (Basgall and Hall n.d. 1), but the temporal span for the Pinto form south of there is largely unknown. The other points range from large Lanceolate forms, to smaller triangular, diamond-shaped, contracting-stem, eared-stem, and wide-stem forms, among others. Treganza and Bierman (1958:plates 21-23) offer a glimpse of the variation present among the point and biface shapes. Many of these point forms are not good time markers in southern California because of the dearth of associated radiocarbon and hydration dates, and because they tend to occur in many different temporal contexts. However, there seems to be some stratigraphic patterning among the different sizes of points (Treganza and Bierman 1958:Table 4).

The points were originally segregated into two phases (Treganza and Bierman 1958). The first phase includes large blade points of all recognized forms except the lozenge- or diamond-shape. The second is characterized by much smaller points that tend to have side or basal indentations that may take the form of notches, have contracting-stems, or tend to be diamond-shaped. The Phase 1 points tend to be associated with the lower levels of the deposit as deep as 54 inches, while the Phase 2 points tend to cluster near the surface, never going below the 12-18 inch level. The only chronological implication this has is that larger points were used at the site earlier in time with considerable overlap. If all hydration readings were available, the meaning of the spatial patterning might be more discernable.

Other discussions of certain artifact classes, such as cogged stones, have lead some researchers to conclude that the general Millingstone component from LAN-1 was more representative of the early to middle manifestation of the pattern in southern California (Basgall and True 1985:3.44). However, these are poorly dated artifact forms and the presence of so few is not very helpful to figuring out the occupational history of the site. Johnson has placed the earliest of his three-phase Topanga complex at 8000 years BP based on assemblage composition and burial patterning. The latest phase extends into the late Holocene, terminating with the available radiocarbon dates retrieved from CA-LAN-2 nearby.

Obsidian hydration data taken from the few obsidian projectile points are limited in application to a discussion of chronology in that no sourcing data have been obtained. This is in addition to the fact that hydration rates for Obsidian Buttes material are largely unknown. The three published hydration readings on obsidian from LAN-1 are 4.6, 5.6, and 4.5 microns (Meighan 1988). Cursory visual observations indicate that the obsidian is most likely from the Coso volcanic field which has been assigned a revised rate that accounts for effective hydration temperatures for the southern third of California (Gilreath and Hildebrandt 1995). If this rate is applied to the above rim readings, the absolute dates fall within the last 1000 years. There were many other obsidian tools cut for the measurement of hydration rims but these data are not readily available. If located, they would serve to better the understanding of obsidian use in the form of points and bifaces over time at the site.

The lack of radiocarbon dates and well-dated point typologies south of the Transverse Ranges hinders any further chronological inferences. The chronological estimates for LAN-1 should all be taken with caution in that there have been no absolute dates determined for the site outside of the hydration readings. It can be said that the nature of the deposit suggests that it spans a considerable amount of time. The lack of any affinities with later, Chumash-like assemblages in the area (Treganza and Bierman 1958) suggests that it preceded the development of such cultural systems.

The Tank site yielded a very extensive accumulation of artifacts and other cultural debris. Excavations over three different field seasons demonstrated this with estimates that 835 m^3 of matrix was moved (Treganza and Bierman 1958:46; 232 m^3). This estimate is certainly a conservative number, given later subsurface testing. The size of the assemblage is a rarity in the area, causing it to be the focus of attention in recent years. It is composed mostly of millingstones, handstones, battered cobbles (hammerstones), scraper planes, core tools, and other less numerous, yet important constituents (Table 6.1).

The numbers of artifacts reported do not necessarily match the number curated in that many fragments of artifacts were reburied due to methodological demands and collection size constraints (Treganza and Bierman 1958). Some of the less visible artifacts such as small flake tools were not collected if they did not fit into typological groupings. This bias in recovery techniques places limitations on the determination of relative economic importance of each artifact class.

Table 6.1. LAN-1. Artifact frequency by depth.

Art Class	0-6	6-12	12-	18-	24-	30-	36-	42-60	IND	Total
Handstone	239	349	229	101	33	9	1	1	1556	2518
Millingstone	-	-	-	-	-	-	-	-	330	330
Mortar	-	-	-	-	-	-	-	-	3	3
Pestle	-	-	-	-	-	-	-	-	5	5
Other	-	-	-	-	-	-	-	-	46	46
Scraper	464	601	465	242	119	65	30	22	-	2008
Chopper	200	173	146	76	26	10	9	9	-	649
Hammer	339	422	429	154	93	17	18	15	-	1487
Scraper	278	199	135	73	28	14	8	9	-	744
Core	-	-	-	-	-	-	-	-	-	-*

Sm. Flake	34	35	20	9	4	1	3	-	747	853**
Point /	40	31	17	2	1	2	-	5	-	98
Other Misc.	-	-	-	-	-	-	-	-	-	12
Total	1594	1810	1441	657	304	118	69	61	2687	8532

Note: *, not defined separately in original report; **, includes formed and simple flake tools not originally separated; Table taken from numbers presented by Heizer and Lemert 1947, Treganza and Malmud 1949, and Treganza and Bierman 1958.

Distributional information in Table 6.1 indicates that most tool types peak are most abundant between 6 and 12 inches where the cultural midden was supposed to have existed (Treganza and Malmud 1950; Treganza and Bierman 1958). Exceptions to this rule include small flake tools, points/bifaces, and most of the ornaments which tend to cluster in the upper 12-18 inches of the deposit. Associated with these tools in the upper 18 inches are the majority of cogged stones, although a few were found below 30 inches. Other trends that were not quantified include the biased distribution of basined millingstones and higher shaped handstones toward the lower areas of the deposit (Treganza and Bierman 1958:63).

A total of 32 features of varying type was found at LAN-1. Feature types ranged from small articulated caches to large aggregates of unworked stone and fragmented artifacts. Two of the most notable features were F-14 and F-25 (Treganza and Bierman 1958:Plates 19 a and b). These were caches of four and six manos, respectively, tightly arranged and in clear association. Two other notable features were F-15 and F-23, comprising large aggregations of unused stone and broken artifacts. Feature F-15 contained a tightly organized group of 12 highly symmetrical unused stones from an off site location, in addition to millingstones, handstones, and cores. Isolated finds of human bone within this accumulation suggest that this may have been one or more overlapping burials. Feature F-23 was the largest concentration of stone on site. It was composed mostly of fragments of millingstones, handstones, scraper planes, scrapers, choppers, and abraders, with the occasional occurrence of unworked cobbles. The condition of the artifacts in this feature and its lack of organization suggests that it is actually a large refuse pile.

Nineteen burials were found at the site. Many burials were highly fragmentary in nature, confusing interpretation of the original context. Six burials were probably primary inhumations, four were partial reburials, and nine were fractional burials. The fractional burials were mostly articulated long bones in positions suggesting the whole body was never associated in the same grave (Treganza and Bierman 1958). Gamble and King (1997) have interpreted the burials as a cemetery for the surrounding region during prehistoric times.

Subsistence remains were limited in quantity and kind. There were only a handful of mammal, rodent, and bird bones collected. Shellfish remains were decidedly rare (Treganza and Bierman 1958:68). Areas of “calcareous residue” were noted as possible evidence of “highly altered” shell, although there were not enough occurrences of such altered soil to suggest that shell was deposited regularly or in any significant quantity (Treganza and Bierman 1958:68).

The data from analyses of millingstones, handstones, and scraper planes in this study within the context of the site demonstrates that all of the lines of evidence used to determine permanence of settlement by the former researchers more accurately reflect settlement strategies other than sedentism.

Millingstones

Millingstones located for analysis numbered 31 (about 10% of the number original recorded number). Treganza and Bierman (1958) noted that many of the fragmented millingstones were recorded in the field and then backfilled due to the cost of permanent curation. This could explain the low number of millingstones presently available for study.

Information on millingstone spatial distribution was not reported quantitatively in any of the published reports. According to the primary catalog, there was hardly any information about vertical distribution, while data on horizontal patterning showed that most were associated with burials or were evenly dispersed from the center of the site towards the margins. Treganza and Bierman (1958) implied that basined forms tended to be biased toward the lower depths of the deposit. Consequently, little information is available regarding the patterning of shaping or use wear by depth.

All millingstones were made from naturally abundant sandstone which occurs in block form. Sixteen were whole/near complete, seven margin fragments, and eight were end fragments. All degrees of shaping are well represented, including three SD-0, 10 SD-1, 10 SD-2, and seven SD-3 forms; one could not be assessed for degree of shaping (See Table 6.2). There are clear biases in the type of shaping according to formalization. Six of 10 SD-1 specimens were flaked on the exterior, while only one SD-3 artifact was flaked. Conversely, only two SD-1 forms were ground on the exterior, while seven SD-3 specimens were ground. The reversal in the type of shaping indicates that as formalization increases, the shaping methods became more refined.

Average measurements only revealed significant differences for maximum thickness (see Table 6.3). Measurements for average maximum length and width by shaping degree are listed in Table 6.3. Except for unshaped millingstones, which had an average maximum thickness of 7.4 cm, this measurement decreased in value from SD-1 specimens (10.5 cm), to SD-2 (9.7 cm), and SD-3 millingstones (6.7 cm). Unshaped millingstones all had flat surfaces while the primary surface of most shaped millingstones was basined or concave, necessitating more mass. When all thickness measurements are compared to Figure 1, every thickness grouping is relatively well represented with five that are thin, 11 thick, eight block, and seven boulder sized.

Thickness measurements also pattern out by surface shape. Of 15 complete thickness measurements on millingstones with basined surfaces, the average maximum thickness was 11.0 cm; the same measurement for 11 millingstones with a flat primary surface was 6.4 cm. This difference is primarily related to material demands of each kind of surface. Basined surfaces need a thicker block of stone to exist than do flat surfaces. Flat surfaces are more correlated with lower degrees of shaping, three occurring on SD-0 millingstones, three on SD-1, and two each on SD-2 and SD-3 implements. Conversely, basined surfaces tend to be associated with higher degrees of shaping, as seven occur on SD-1 specimens, seven on SD-2, and three SD-3 forms. The association of the different surface shapes with their relative degrees of shaping is most likely related to the need to reduce mass. The larger the stone, the more shaping would be required to make the tool efficient.

Table 6.2. LAN-1. Millingstone attributes by shaping degree.

SHP DEG		0	1	2	3	IND	TOTAL
MATERIAL							
	SCH	-	-	-	-	-	-
	GRN	-	-	-	-	-	-
	SST	3	10	10	7	1	31
	GRA	-	-	-	-	-	-

	SIL	-	-	-	-	-	-
	VOL	-	-	-	-	-	-
CONDITION							
	WHL/NC	3	5	5	3	-	16
	MRG	-	1	2	3	1	7
	END	-	4	3	1	-	8
	FRG	-	-	-	-	-	-
SURFACE FREQUENCY	1	3	8	4	-	-	15
	2	-	2	6	7	1	16
	IND	-	-	-	-	-	-
SURFACE SHAPE	B	-	7	7	3	-	17
	F	3	5	6	7	2	23
	SCV	-	-	3	3	-	6
	SCX	-	-	-	1	-	1
	IND	-	-	-	-	-	-
SURFACE TEXTURE	S	1	11	12	14	2	40
	I	2	1	4	-	-	7
	IND	-	-	-	-	-	-
POLISH							
	PRS	2	12	10	14	2	40
	ABS	1	-	6	-	-	7
	IND	-	-	-	-	-	-
STRIAE							
	PRS	-	2	2	11	-	15
	ABS	3	10	14	3	2	32
	IND	-	-	-	-	-	-
PECKING							
	PRS	1	9	12	14	2	38
	ABS	2	3	4	-	-	9
	IND	-	-	-	-	-	-
SECONDARY MODIFICATION	PRS	1	1	1	-	-	3
	ABS	2	9	9	7	1	28
FIRE AFFECTION	PRS	1	-	-	2	-	3
	ABS	2	10	10	5	1	28
SHAPING TYPE	IND	-	-	-	-	1	1
	0	3	-	-	-	-	3
	1	-	6	6	1	-	13
	2	-	9	8	7	-	24
	3	-	2	4	7	-	13
TOTAL		3	10	10	7	1	31

Note: See Appendix A for description of terms.

Aside from individual measurements, if the average length, width, and thickness measurements are multiplied, the resulting number is an indication of relative volume. The average volume for SD-0 millingstones is 4856 cm^3, for SD-1 artifacts is 12884 cm^3, for SD-2 is 17600 cm^3, and for SD-3 forms is 4885 cm^3. Excluding SD-3 specimens, the pattern of increased relative size with increasing shaping degree indicates that as the stone increased in size, the amount of formalization that had to be invested to make the stone useful also increased. The fact that SD-3 specimens have a low relative volume is probably an indication of selective behavior in order to minimize the amount of investment needed to shape the tool. The basic metrics, frequencies of thickness types, and relative volumes of millingstones indicates that these tools were generally massive items.

The sharpest contrast regarding shaping is that the most shaped specimens show the most regular use wear patterns (see Table 6.2). All SD-3 millingstones possessed two wear facets that were smooth (100%), polished (100%), striated (79%), and pecked (100%). The wear surfaces were predominantly flat (7), with three each slightly concave and basined; one was slightly convex. The trend among ground surfaces on SD-3 forms was toward a flat or slightly concave surface. This is either a factor of the thickness limitations, hindering a deep basin, or a functional difference between these and the less shaped specimens. The latter would seem more probable in light of the metrical characteristics outlined above.

Millingstones of SD-2 and SD-3 forms also tended to be manufactured from what appears to be harder, more consolidated sandstone. Harder sandstone would better suit highly formalized millingstones in ensuring reliability in form and function by reducing the risk of breakage. It is unlikely that these tools saw less weathering since they came from the same deposit as the larger millingstones that showed higher degrees of weathering. The softer sandstone, which characterizes the lesser shaped, and mostly larger, millingstones is coarse-grained. This could have enhanced the grinding speed with a concurrent increase in the rate of attrition.

Millingstones of SD-1 and SD-2 forms showed similar patterns of use wear differing only in the number of surfaces (2 bifacial in the former, 6 bifacial in the latter) and diversity of surface shapes (7 basined, 5 flat in the former; 7 basined, 6 flat, 3 concave in the latter). Otherwise, in a combined sense, the surfaces of these millingstones tended to be smooth (82%), polished (79%), and pecked (75%), but generally lacked striations (14%). Two of these slabs were used for secondary purposes such as anvilling and abrading, which is not seen among the highly shaped millingstones.

The percentages of observed use wear attributes for SD-1 and SD-2 millingstones are noticeably lower than those of SD-3 implements. This trend is perpetuated when SD-0 specimens are compared. All SD-0 millingstones (3) were unifacial with flat surfaces. Irregular surface texture was dominant (33%) with one surface lacking polish, all surfaces lacking striations, and 67% of surfaces lacking pecking. The decrease in observed use wear from highly shaped to unshaped millingstones is thought to be evidence of a decrease in use intensity.

Table 6.3. LAN-1. Average complete metrics by artifact class and shaping*.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	31.1 / 2	21.1 / 3	7.4 / 3	3
Shp Deg 1	40.1 / 5	30.6 / 7	10.5 / 10	10
Shp Deg 2	48 / 4	37.8 / 4	9.7 / 10	10
Shp Deg 3	32.7 / 3	22.3 / 3	6.7 / 6	7
Avg Total	37.9 / 14	27.9 / 17	8.6 / 29	30
Handstones				
Shp Deg 0	12.6 / 30	8.8 / 46	5.5 / 62	69
Shp Deg 1	12.4 / 36	9.3 / 71	4.3 / 87	88
Shp Deg 2	13.4 / 44	8.5 / 95	4.7 / 103	107
Shp Deg 3	13.0 / 46	9.2 / 49	4.8 / 50	50
Avg Total	12.8 / 156	8.9 / 261	4.8 / 302	314
Scraper				
Form 1	7.1 / 92	5.7 / 93	3.4 / 93	93

Form 2	7.3 / 199	5.8 / 199	4.6 / 199	199
Avg Total	7.2 / 291	5.7 / 292	4 / 292	292

Note: *Includes only those artifacts complete enough to be categorized by shaping degree or form, **does not** include indeterminate fragments; Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.

Other trends in use wear are surface specific. Heavy battering characterizes the large basined millingstones from the Tank site. It seems as though battering of the surface in a manner not consistent with surface resharpening was occurring just as much as milling on the surfaces, if not more so. Only the basins from SD-0 forms were used much more for grinding, as the only battering on the surfaces was sparse, shallow, and defined; this is suggestive of resharpening. This difference in surface use is probably functional where the large basined slabs were intensively used for heavy processing while the smaller, more formalized slabs were used more intensively for grinding.

Handstones

A large number of handstones (n=2518) were originally recorded at the Tank site, but it is unclear how many were curated and how many were backfilled at the conclusion of excavation. Handstones from the original catalog totaled 640, presumably accounting for the entire curated collection from this site. The horizontal distribution of handstones was relatively well known, ensuring that the sample of 315 handstones selected for analysis was representative of the entire deposit.

The vertical distribution is interesting in that roughly one-third of each shaping degree category comes from the levels below 12 inches, while two-thirds of each comes from 0-12 inches. It is also the case that moderate to low levels of shaping best characterizes the handstones from the lower levels. Under 12 inches, there are a total of 96 handstones, 13 of which (14%) are SD-3, 33 (34%) are SD-2 forms, 29 (30%) are SD-1, and 21 (22%) are SD-0 handstones. These percentages do not match those for the total amount in each shaping category (see Table 6.4), suggesting that there is variation in the use and formalization by depth.

All handstones were made from materials that were available in the Santa Monica Mountain range in various contexts from outcrops to drainage bottoms to beach settings. In all, were made from sandstone (188), with granite being the second most frequent (97), followed by various coarse-grained igneous materials (30).

A large number were whole/near complete (166, 53%), followed by end fragments (128), medial fragments (13), and margin fragments (8). The condition of handstones is only obviously different among the SD-0 category, where 77% were whole. In all other shaping degree categories, there are equally dominant numbers of whole specimens and end fragments.

This artifact class is characterized by high diversity in shaping degree (see Table 6.4). There were 69 SD-0 handstones, 88 SD-1, 107 SD-2, 50 SD-3, and one that could not be classified. Pecking and grinding were observed on artifacts with all shaping degrees. SD-1 handstones saw 69% shaped by pecking and 75% shaped by grinding, those of SD-2 saw 71% shaped by pecking and 82% shaped by grinding, and the SD-3 category saw 92% shaped by pecking and 98% shaped by grinding. Shaping by pecking was measured separately from any used surfaces such that it represented intent to form the tool. That pecking as a form of shaping occurs in significantly high percentages indicates that the stone used for handstones was being modified during manufacture. Grinding on the perimeter occurred both as a result of use and direct formalization (intent).

General measurements of average maximum length, width, and thickness showed no real trends (Table 6.3). All measurements for the length were within 1 cm, for width within 0.8 cm, and for thickness within 1.2 cm for all shaping degrees. These size ranges demonstrate that no directional trends are present in terms of size.

Directional differences in the frequency of observed use wear attributes occur across the categories of shaping (Table 6.4). No SD-3 specimens were used on only one surface. Thirty-eight were bifacial, 10 were trifacial, and two were quadrafacial; yielding a total of 114 surfaces. Surface shapes were either flat (42%) or convex (58%) and all except one surface was smooth and polished. Striations were observed on most (58%) surfaces, as was pecking (89%).

Handstones of SD-2 were mostly bifacial (87), with 14 others that were trifacial and five that were unifacial; this brings the total number of surfaces to 221. Surfaces were predominately convex (73%), although flat surfaces were not uncommon (27%). Surfaces were characterized by smooth textures (94%) that exhibited polish (96%). Striations were present on a minority of wear facets (38%), but 82% were pecked in a manner consistent with resharpening..

The majority of SD-1 handstones had two wear facets (90%) with only a handful (4%) being trifacial and unifacial (6%). Surfaces, one hundred seventy-five total, were overwhelmingly convex in shape (73%) with the rest being flat. Textures tended to be smooth (86%) and polished (92%), while only 27% were striated. Rejuvenation of the surfaces was evidenced by 70% that were pecked.

A significant amount of SD-0 specimens were unifacial (40%), the rest bifacial (60%). A majority of surfaces were convex (79%), only 16% flat and the rest (5%) concave. The texture of most surfaces was smooth (80%) and polished (93%) although irregular surfaces were not uncommon (20%). Only 23% of the wear facets showed striations an a relatively low amount were pecked (43%).

Table 6.4. LAN-1. Handstone attributes by shaping degree.

SHP DEG		0	1	2	3	IND	TOTAL
MATERIAL							
	SCH	-	-	-	-	-	-
	GRN	32	25	25	15	-	97
	SST	29	58	72	28	1	188
	META	8	5	5	4	-	22
	QZT	-	-	5	-	-	5
	QTZ	-	-	-	-	-	-
	IGN	-	-	-	3	-	3
	FEL	-	-	-	-	-	-
	GRA	-	-	-	-	-	-
	BAS	-	-	-	-	-	-
	RHY	-	-	-	-	-	-
CONDITION							
	WHL/NC	53	39	47	27	-	166

	MRG	2	3	3	-	-	8
	END	13	42	49	23	1	128
	MED	1	4	8	-	-	13
	FRG	-	-	-	-	-	-
SURFACE FREQUENCY	1	28	5	5	-	1	39
	2	41	79	87	38	-	245
	3	-	4	14	10	-	28
	4	-	-	-	2	-	2
SURFACE SHAPE	F	18	48	60	48	1	175
	CV	4	-	1	-	-	5
	CX	88	127	160	66	-	441
	IND	-	-	-	-	-	-
SURFACE TEXTURE	S	89	151	207	113	1	561
	I	21	24	14	1	-	60
	IND	-	-	-	-	-	-
POLISH							
	PRS	103	161	212	113	-	589
	ABS	7	14	9	1	1	32
	IND	-	-	-	-	-	-
STRIAE							
	PRS	26	48	85	66	-	225
	ABS	84	126	136	46	1	393
	IND	-	1	-	2	-	3
PECKING							
	PRS	48	123	181	102	-	454
	ABS	62	52	40	12	1	167
	IND	-	-	-	-	-	-
END POLISH							
	PRS	1	9	41	34	-	85
	ABS	68	73	55	15	1	212
	IND	-	6	11	1	-	18
SECONDARY MODIFICATION	PRS	33	72	94	48	-	247
	ABS	36	16	13	2	1	68
FIRE AFFECTION	PRS	17	32	58	26	1	134
	ABS	52	56	49	24	-	181
SHAPING TYPE	IND	-	-	-	-	1	1
	0	69	-	-	-	-	69
	1	-	-	-	-	-	-
	2	-	48	76	46	-	170
	3	-	52	88	49	-	189
TOTAL		69	88	107	50	1	315

Note: See Appendix B for description of terms.

These summaries of the use wear attribute data (illustrated in Table 6.4) outline a pattern of decreasing frequency in the observance of each attribute as shaping degree decreases. Not only do the number of surfaces per handstone decrease, but the surfaces become less regular in shape, texture, and wear (polish, striations, and pecking).

Four types of secondary modification were observed across all degrees of shaping. End polish was observed on a total of 85 (27%) of all handstones. This attribute had a highest relative frequency among the SD-3 category (68%), decreasing to 43% among SD-2, to 11% of SD-1, and to 1% among SD-0 specimens. There are no metrical correlations with end polish which would suggest that handstones with end polish were used in a manner consistent with that associated with pestles. The pattern of association with higher formalization is thus thought to be the result of a wider range of uses associated with the higher degrees of shaping.

Anvilling and end battering were also very common. Anvilling was observed on the ground facets of 12% of all handstones, not associated with any particular shaping degree. Anvilling was probably the result of flaked stone reduction, although hulling of seeds may have also been associated with such a feature. End battering was very common among all shaping categories suggesting that pulverizing was an important function. Fire alteration is the last type of secondary modification that was observed 42% of the time. Relative frequencies showed a higher bias among the SD-2 and SD-3 handstones (Table 6.4), lending more impetus to the idea that more formalized handstones saw use in a wider range of contexts.

The original researchers set up a formal typology that has been extensively used by others investigating sites of this nature. A comparison of the original types with the analysis data reveals that some of the types represent a functionally distinct category, while others have no observable integrity. Original types were defined according to the number and shape of wear facets in addition to gross indications of formalization. It seems as though handstones originally categorized as Type 2B1, 2B2, and 3A are each distinct in terms of grinding motion that produced certain surface configurations (see Treganza and Bierman 1958, for examples). The Type 2B1 is characterized by low to moderate wear while 2B2 and 3A are characterized by high degrees of formalization. Treganza and Bierman (1958) make the observation that many have one flat surface and one convex surface, the former being more heavily worn than the latter. This observation was confirmed in this analysis. It is not clear whether the handstones were simply being used more on one surface than the other or if it was more a factor of variability in use with one side used more often on flat millingstones and the other used more often in basined forms.

Scraper Planes

As many as 2008 scraper planes were recorded at LAN-1, though not all were curated. A sample of 301 was taken from the 900 or so curated with the collection. This artifact class is second in size only to handstones. All of the randomly selected sample of analyzed scraper planes were whole. This is significant when considered in light of the functional orientation of the artifact class, and patterns of discard.

The distribution of scraper planes shows no deviation from the patterning of most other artifact classes, horizontally or vertically (Treganza and Bierman 1958: Table 2). Eighty percent of the total number were recovered from the top 18 inches, where the bulk of the cultural deposit existed. Similarly, there were no significant trends in vertical distribution of the various types of scraper planes defined by Treganza and Bierman (1958).

A wide range of material types is represented among scraper planes including basalt (257), quartzite (9), quartz (1), metavolcanic (3), granitic (2), sandstone (1), and cryptocrystalline silicate (9) (Table 6.5). The only observable difference in use is seen among those made from cryptocrystalline, where battering, common among all other material types, was not observed on any specimens. Those made from silicates were probably cores in their primary function and then used as scrapers and scraper planes. This would account for the polish observed on the edges and interior of the artifacts. It is not necessary to re-classify them as other kinds of tools because their use fits within the range of variation for this artifact class.

Scraper planes made from materials other than cryptocrystalline closely correlate in terms of observed use wear and will be discussed together. A high number of these tools had multiple working edges (59). Most (66%) were made from a cobble based form with a significant amount that were made from flakes (31%;Table 6.5). Metrics for scraper planes show interesting differences between those made primarily from flakes (form 1) and those made primarily from cobbles (form 2; Table 6.3); nine could not be categorized to original form. Scraper planes made from flakes, numbering 93, had an average maximum length of 7.1 cm, a width of 5.7 cm, and a thickness of 3.4 cm. Cobble based forms held the majority with 199 specimens and were larger overall with the average maximum measurements for length being 7.3 cm, 5.8 cm for width, and 4.6 cm for thickness. The greatest variation is seen amongst the different thickness measurements as flake based forms are thinner by 1.2 cm on average than cobble based forms.

Table 6.5. LAN-1. Scraper plane attributes by material type.

	BAS	**CCR**	**QZT**	**QTZ**	**FEL**	**RHY**	**META**	**IGN**	**OTH**	**TOTAL**
FORM										
1	84	1	6	1	-	-	-	-	1	93
2	164	8	22	-	-	-	3	-	2	199
3	9	-	-	-	-	-	-	-	-	9
Flk Type										
1	21	-	-	-	-	-	-	-	-	21
2	41	1	4	-	-	-	-	-	1	47
3	5	1	-	1	-	-	-	-	-	7
5	-	-	-	-	-	-	-	-	-	-
IND	23	-	2	-	-	-	-	-	-	25
E Freq										
1	196	7	19	1	-	-	3	-	2	228
2	61	2	9	-	-	-	-	-	1	73
E Form										
1	217	11	36	1	-	-	3	-	3	271
2	38	-	1	-	-	-	-	-	1	40
E Shap										
1A	13	1	3	-	-	-	-	-	-	17
1B	2	-	-	-	-	-	-	-	-	2

2A	172	6	26	1	-	-	2	-	3	210
2B	54	2	3	-	-	-	-	-	1	60
3A	38	2	5	-	-	-	-	-	-	45
3B	12	-	3	-	-	-	-	-	-	15
4	20	1	2	-	-	-	1	-	-	25
E Wear										
0	6	-	-	-	-	-	-	-	-	6
1	41	5	11	-	-	-	1	-	1	59
2	113	7	11	-	-	-	-	-	1	132
3	102	-	15	1	-	-	2	-	2	122
E Polish										
PRS	171	8	16	1	-	-	3	-	1	200
ABS	140	4	19	-	-	-	-	-	3	166
Stp Frac										
PRS	249	8	31	1	-	-	3	-	2	294
ABS	62	4	4	-	-	-	-	-	2	82
Int Pol										
PRS	92	4	13	1	-	-	3	-	1	115
ABS	164	5	15	-	-	-	-	-	2	186
SEC MOD										
PRS	39	1	16	-	-	-	1	-	-	57
ABS	218	8	12	1	-	-	2	-	3	244
TOTAL	257	9	28	1	-	-	3	-	3	301

Note: See Appendix C for description of terms.

Those scraper planes made from flakes tended to be made from primary (21) or secondary (47) decortication flakes, manufactured through heavy percussion (Table 6.5). Though the tendency in the past has been to define scraper planes based on the fact that they are unifacial artifacts, it is the case that 40 (13%) were found to have been bifacially formed on the working edges.

The predominant edge shape was convex-regular (210), with others clustering mostly around convex-irregular or straight (Table 6.5). A significant proportion (25) were used on the perimeter. Edge wear was mostly observed as bifacial microchipping (132), followed by battering until dull (122), then unifacial microchipping (59). The second attribute (battering) is consistent with the importance of battering implements at the site as seen in the millingstone, handstone, and battered cobble tool categories. Contrary to previous opinion (Treganza and Malmud 1950), edge grinding was observed on 54% of the edges. Though most were mineralized, the layer was thin enough that ground surfaces could be observed if present on most specimens. Chemical decomposition did affect the ability to observe detailed use wear, however, there were areas on nearly every scraper plane that could be read for such wear. These areas were either simply unaffected areas or relatively large crystal inclusions.

Interior polish was also fairly common, occurring on 38% of all scraper planes. This last attribute is heavily dependent on the shape of the surface which faces the planning area. Finally, step fracturing was seen on 76% of all edges, indicating at least light use.

Attribute patterning suggests that scraper planes saw use ranging from light to heavy, most being suggestive of light to moderate duty. The variability in edge shapes provides evidence that investment in the form of the edges was not high, and probably not critical to the intended function.

The large sample of scraper planes available for analysis of edge characteristics (251) is very important in developing an understanding of how these tools were made, used, and maintained. Average edge and spine plane angles for scraper planes made on flakes differ from those made on cobbles. Flake based scraper planes had an average edge angle of 78^0, an average spine plane angle of 66^0, and an average maximum flake scar length of 1.4 cm. For cobble based scraper planes edge angles averaged 82^0, spine plane angles 69^0, and maximum flake scar lengths 1.5 cm. These measurements show that flake based scraper planes were generally more acute than cobble based specimens but witnessed the same edge attrition and maintenance on cobble based tools. The difference in edge characteristics is indicative of a resharpening process where the original spine angle is modified through attrition and maintenance. The low maximum flake scar measurement for both forms of scraper planes is too small to suggest that the flakes removed last were used as tools. None of the flake tools from the site have a size profile consistent with the small flake scar average of the scraper planes, indicating they were not being used as cores.

The only important difference in edge characteristics between material types is seen among scraper planes made from cryptocrystalline. The scraper planes made from cryptocrystalline are generally smaller in size and typically show more acute edge and spine plane angles than the scraper planes made from the local igneous materials. The average edge angle for silicate scraper planes is 83^0 and the average spine plane angle 76^0. The disparity of 7^0 is half that for all others from the site, which is 13^0. Specimens made from cryptocrystalline represent the best case for the recycling of cores or core shatter for use as scraping and battering implements.

There are no differences in use or form modification that would suggest the various original types represent any functional reality. Each type seems to show use wear that is consistently similar, with spine plane angles showing the only real deviaion. Even the latter observation is a factor of original form, as some scraper planes were made from large percussion flakes, naturally producing more acute angles before edge formation.

Non-Analyzed Tool Categories

Other tool categories that were not analyzed in this study included pestles (5), mortars (3), small flake tools (852), points/bifaces (98), crescents (1), hammers (1478), choppers (649), cogged stones (7), discoidals (13), ornaments (11), and one piece of modified bone (see Table 6.1). The mortars found are questionable as to whether they represent portions of basined millingstones. In any case, the mortar/pestle technology is, relatively speaking, of no significance to the main component of this site, and is undoubtedly part of a later settlement/subsistence strategy that left only traces. Refined flaked stone tools are not well represented, given that those recovered only represent 1.2% of the entire assemblage.

Some of the artifacts cataloged as small flake tools have a very regular form due to use and re-touching. It is estimated that about 15% of the small flake tools were highly formalized and tended to be made from high quality cherts, and, rarely, obsidian.

These were probably used for a wide range of purposes. The majority of flake tools had edges that were not re-touched indicating very little concern for formal investment. Although the local igneous stone accounts for most of the flake tools (especially basalt), there is a significant number that were made from chert percussion flakes. This information cannot be quantified at this time because no formal analysis was conducted. The nature of the flake tool artifact classes appears to suggest that they were primarily geared toward complimenting a vegetal exploitation strategy, fitting within a pattern of expedient, redundant manufacturing and limited use (see Gilreath and Jackson 1985).

Variation in the hammerstone artifact class would seem to suggest that some were used for flaked stone reduction while others seem to have been used for heavy pulverizing. A small number of hammers and choppers have ground surfaces indicating they were used for multiple tasks, directly or as a result of recycling. Casual observations showed that neither of these tool categories exhibited high or moderate levels of shaping, indicating that they were expediently manufactured and used, most likely seeing early discard and reuse. Scrapers share grossly similar forms to both hammers and choppers of various kinds. Though this tool category was not formally analyzed, cursory observations indicate that some were battered, and others seemed to have edges that were formalized, indicating resharpening. There seems to be considerable functional overlap between hammers, choppers, and scrapers.

A gross overview of the bifaces and flake tools revealed that there is considerable variation represented in this aspect of the assemblage. Many of the projectile points were made from obsidian, some coming from Obsidian Buttes, others deriving from the Coso volcanic field. Projectile point typologies have not proved useful as tight time markers in this region in previous studies, making it hard to ascertain the possibility of different components. If it is assumed that the various forms among the projectile points are grossly contemporaneous with similar forms from other locations, there may be considerable time depth represented at the site by because there is a trend toward larger stemmed points with an increase in depth at the Tank site. This can only be left to speculation until further research establishes projectile point chronologies.

Analyses of discoidal stones revealed that they were highly formalized through pecking and grinding and saw a form of use that resulted in high degrees of polish. The ground surfaces were normally not pecked for resharpening, suggesting use in a sense other than what is traditionally associated with handstones. The dearth of discoidals recovered from the site is confusing with respect to understanding their economic importance. The only thing that can be said about these artifacts is that use wear indicates that they were used extensively for what was probably light duty grinding.

Summary and Conclusions

The deposit at LAN-1 was ambiguous in regards to stratigraphic separation, the main distinction between them seen as boundaries between the upper, eroded soils, the less altered middle of the cultural deposit, and the transitional bottom layer that mixed with decomposing stone. Essentially, the cultural matrix is unseparable according to stratigraphy, made worse by biological and natural disturbances over the past several millennia. The carbonate accumulation that permeated the entire deposit is most likely due to the leaching effects and water table transitions of the local spring until it was capped in historical times. No evidence exists to suggest that this mineralization stems from decomposed shell, nor to support claims of great antiquity.

The chronological history of site occupation is as vague as the deposit itself. Certain artifacts indicate that the site has seen numerous occupation episodes from a wide range of time that possibly extended into the early-middle Holocene, up to the late Holocene. Since point typologies in the local area are not firmly established, the only temporal inferences are dependent on correlations with extralocal indicators, such as the Pinto projectile points of the southern Mojave Desert (7500-4000 years BP). Cogged stones are often cited as indicators of relatively early occupations but there are no established chronologies for such items because they seem to be found in numerous temporal contexts. The fact that none of the later point forms found at LAN-2 were found at LAN-1, and the lack of late Holocene artifact types suggest that LAN-1 was variably used for a long period of time before the last 2500 years.

The descriptions and pictures of features (Treganza and Malmud 1950, Treganza and Bierman 1958) reveal a low level of formality and consistency. The various features recorded at LAN-1 probably range from refuse piles (i.e. F-23), to caches (i.e. F-15). The larger aggregates of artifact fragments and unused stone accumulated as a result of the need to clear living or burial areas. Other features were informal cooking areas while others still were burials that have since lost identifiable remains. Totally, none of the features were organized in a manner that would suggest long-term investment in the spatial segregation of the site.

The predominance of fractional burials and reburials (totaling 13, 68%) may be an indication that burial patterns were embedded in a settlement system that saw reoccupation of LAN-1. If the site represented a cemetery as some have indicated (Gamble and King 1997), then it might be expected that bodies would be disposed of in whole condition. At least it might be expected that scattered human remains outside of the burials would have been found more often than they were. The point is that there can be many explanations for the condition and patterning of burials at the site. There is no doubt that LAN-1 was an important location for disposal of the dead, but the extent to which this informs upon settlement patterns is limited. The current understanding of burial patterns before the late Holocene is sketchy at best. In light of the variation in burial types seen at LAN-1, the frequency of burials cannot be used as an indicator of settlement permanence. If anything, this variation speaks to changing or overlapping settlement strategies.

The analyses conducted on millingstones, handstones and scraper planes, along with observations made on other tool types provide a stronger basis for the interpretation of all information pertaining to the Tank site. Though some information, such as artifact distribution, is not as clear as might be hoped for, some of the emergent patterns have economic implications. The overlap of basined millingstones with handstones that saw limited use and formalization, against these same types of artifacts that seem to have been used differently in the upper reaches of the deposit, suggest some kind of functional difference in site use that is temporally sensitive. Though the economic processes may have been the same, the intensity of site use seems to have increased with later occupational episodes.

The use wear and formalization data on millingstones from the Tank site suggest that there was functional diversity that patterns out by shaping degree, surface shape, and overall size. Large, basined millingstones seem to have been used for heavy battering, in addition to grinding. Smaller, highly shaped millingstones were used primarily for grinding and hardly at all for battering. This is most likely an indication of functional variability amongst millingstones. Associated with the heavy battering of basined millingstones is the high number of hammers, choppers, scraper planes and handstones that exhibit battering on one or more edges/ends. It speaks to he importance of heavy processing. With respect to shaping, highly formalized millingstones were shaped and used in a manner consistent with what is expected from portable millingstones. The increase in relative volume from SD-0 to SD-2 millingstones suggests that most formalization of these tools was done in order to modify the stone for more efficient use on site. Some (Horsfall 1987) have suggested that increased surface area is linked to greater grinding efficiency. It may be the case that stones at the Tank site were selected in order to maximize processing efficiency. The selection of more coarse grained sandstone for the large slabs at the site would certainly support that argument. The selection of harder sandstone for more shaped specimens indicates that durability was associated with greater investment. Overall, the formalization of all millingstones up to the moderate (SD-2) level seems to be more linked to a need to prepare the tool for use; the larger the stone, the more trimming needed to be done.

The handstone artifact class is the largest single constituent of the LAN-1 assemblage. If only an inclusive view is taken, an important amount of diversity and variability is masked. The separation of handstones by shaping degree has revealed the variables necessary to speak to different ways of using handstones that apparently took place at this site. It is clear from the data that some handstones were used incipiently on-site, while others probably saw a more extensive and wide-ranging use life. Coupled with the variability seen in the millingstone category, it seems that there were multiple occupations which differed in respect to the intensity of processing per episode. This difference is highlighted by the vertical patterning of handstones. Those handstones found in the lower levels were used for grinding with less intensity and incurred less formalization than those recovered from the upper 12 inches.

When the use wear and angle data are considered, it is apparent that scraper planes were primarily manufactured as tools and maintained through their use lives. Some could have served as cores in the beginning, and then used as scraper planes. It is not inconceivable to think that a strategy existed that served two needs; the need for large percussion flakes as expedient tools, and the need for a general unifacial tool. In fact, the large number of flake tools made from the same material as most scraper planes suggests that a portion of the latter were used in some sense (direct or indirect) as cores. However, the number of scraper planes is nearly three times that of all flake tools collected. This gives more weight to the notion that the majority of scraper planes were manufactured primarily to serve as tools, not cores. None of the scraper planes seems to have been used very intensively because there is no evidence they were discarded at exhaustion. They seem to have been intended for more expedient use as battering and scraping implements. The edge and interior polish is an indication that they were used for processing of some kind. The form of these tools is consistent with what is characteristic of vegetal processing tools in other contexts (Basgall et al. 1988). However, it is probably the case that scraper planes at the Tank site saw a wide range of battering, chopping, and scraping functions. It is possible that some saw use as millingstone resharpening tools. It is also possible that these tools were related to the heavy battering recorded on the surfaces of large basined millingstones. Whatever the case may have been, it is clear from the use wear and metrical data that scraper planes are non-diagnostic generalized processing tools.

The high numbers of hammers, choppers, and scrapers are indicative of their economic importance to the processes that contributed to site formation. Considerable functional overlap between these artifact classes along with handstones and scraper planes is represented through battering and grinding. This is also evidence of functional generality where certain tasks could be accomplished using various tools. An expedient manufacturing strategy is indicated by the lack of formalization and intensive use among hammers, choppers, and scrapers. These tools were most likely quickly made, intended for heavy processing in the immediate area.

Surficial observations on small flake tools revealed two different strategies. The first is represented by simple, unmodified used flakes. In the assemblage context, these tools were probably made to compliment the overall subsistence technology geared toward vegetal exploitation. The second kind of small flake tool is represented by highly formalized types that entered the deposit in an altered state through use and repair. These tools probably saw a greater range of use contexts and prolonged maintenance in a tool kit. In order to define the functional parameters of such tools, quantitative use wear analyses must be conducted.

Projectile points and bifaces are not well represented but nonetheless important. The high formalization, attrition, evidence of maintenance, and condition at discard hints at a dimension of subsistence organization that has broad reaching implications in terms of settlement. Though points seem to go from large wide-stemmed forms, to bifurcated-stemmed dart points with decreasing depth, they all seem to have been discarded at or near exhaustion (though no quantitative information is available at present regarding condition).

There is a common pattern repeated in the most abundant artifact classes. It is one of redundancy and generally moderate use. Millingstones, handstones, scraper planes, hammers, choppers, and scrapers seem to have been mostly intended for use in the immediate area of the site. Formalization is characterized by that which was necessary to modify the artifact in such a way that it would be useful. This does not mean that things were made to be portable. Only portions of the tools were modified in order to reduce mass and create a more regular, reliable form. The mass quantities of heavy tools would best fit with a technological strategy that included more expedient manufacture of tools on site that were mostly not intended for use in contexts that would necessitate high degrees of reliability. The lack in diversity of tool types in the assemblage suggests the site was occupied and used for a general set of activities that went largely unchanged. It also means that the permanence of any occupation episode was limited; this is not consistent with a sedentary occupation. If the people occupying the site had stayed on a near-permanent basis, a greater range of artifact types would be expected. The Tank site does not resemble late-period village sites in terms of assemblage composition, which tend to have a greater variety of artifact classes (Treganza and Malmud 1950).

Gamble and King (1997) use various lines of evidence to suggest the Tank site is an early-period permanent village. One of these is a perceived pattern of site placement on top of ridges, situated for defensive purposes. Their idea is that, because of smaller group size and less cohesive community ties, groups needed to inhabit areas with a good view for protective reasons. There are numerous problems with this assumption. The most obvious is that some of the best places to occupy as living spaces in Topanga Canyon are on top of ridges, which have access to numerous types of resources and avoid the non-facilitative slopes of the drainages.

It seems most likely that the Tank site was characterized by occupational episodes that were not of short duration, but not sedentary either. These occupations saw intensive exploitation of vegetal resources in the area, using tools that were mostly manufactured for use on site with limited initial investment in form. Some artifacts were probably used in contexts off-site, indicated by the highly formalized millingstones and handstones. Reoccupation of people using the area in a similar fashion is the best account for the redundant assemblage patterning. That the settlement system included some residential mobility is also indicated by the projectile points/bifaces and some small flake tools. It is also true that most points and bifaces were made from extralocal materials. Thus, previous interpretations of the Tank site as representing an early period village site are not accurate from the perspective of this study. The site did see intensive occupation, but not in the same manner as late-period sedentary villages. The implications of site feature frequency, assemblage components, and data on use wear and formalization must be considered in unison to accurately assess the occupational history of a site such as LAN-1.

Chapter 7:

Lower Tank Site, CA-LAN-2

Site CA-LAN-2 exists on the same ridge in Topanga Canyon as LAN-1, only 350 meters to the northwest, and about 50 meters lower in elevation. Treganza and Bierman (1958) interpret LAN-2 as a later continuation of the Tank site occupation. This is based on similarities in projectile point types which occur only in the upper 18 inches of the Tank site, and completely characterize those from LAN-2. Their assumption of a later period site is further based on the presence of mortars and pestles, though they are significantly less frequent than the millingstones and handstones. Similar to LAN-1, LAN-2 has been interpreted as a late-early period village based on burial data, the abundance of manos and metates, site situation, and assemblage size (Treganza and Bierman 1958).

The situation of LAN-2 had the same advantages as LAN-1 in terms of resource access. There are two springs situated near LAN-1 which most certainly fed the drainages bordering the ridge that these two sites occupy. The environmental characteristics of the two sites are identical in terms of precipitation and surrounding resources. The important characteristics to reiterate are that the area is fairly dry, having about 61 cm of precipitation per year, and that the vegetation communities are defined by chaparral, various oak woodlands, coastal sage scrub, various grasses, and some riparian communities (Raven et al. 1986).

The distribution of the assemblage constituents is largely unknown in that original provenience data are very hard to acquire, those which are accessible remain vague. From what has been published, it seems that the stratigraphy at LAN-2 was not culturally stratified or complicated by post-depositional disturbance in the matrix. There was a midden identified at LAN-2 that was loosely consolidated and friable. Most of the matrix was made up of a decomposing and chemically altered sandstone base.

Two cultural phases were identified based on a three part sequence for Topanga Canyon (Johnson 1966). Only the middle and upper phases of this sequence were identified at LAN-2. The middle portion of the sequence was characterized by projectile points similar to those found in the upper 18 inches of the deposit at LAN-2 (Treganza and Bierman 1958). The late phase was represented by the mortar/pestle technology and a few other supposed late period artifacts.

The chronology at LAN-2 is based on two radiocarbon dates obtained from charcoal samples recovered from excavated features. The first date was measured at 2450 ± 150 BP and the second was 2700 ± 150 BP (Basgall and True 1985:Table 3.1). There do not seem to be any crucial complications with the radiocarbon dates in terms of association or sampling and it is assumed that these dates represent the approximate middle phase of the occupational history of LAN-2. It is probably not the case that the two dates bracket either the middle or late phases as defined, but represent a gross estimate.

Obsidian hydration measurements have been made on numerous obsidian points from LAN-2 but this information remains elusive. Most of the obsidian seems at first glance to be from the Coso volcanic field to the north, however, some may have derived from the Obsidian Buttes quarry. Others have suggested that some of the poor grade obsidian may derive from a small quarry near Fillmore, a town in Ventura County, California (see Treganza and Malmud 1950). If the hydration readings were to become available, it would greatly contribute to the chronology of site use since the Coso obsidian hydration rate has been satisfactorily defined for most of southern California (Gilreath and Hildebrandt 1995).

One point recovered from LAN-2 is very similar in morphology to the Great Basined Stemmed form of Owens Valley and surrounding locations. The latter point type has a temporal range of about 9000-11000 years BP in the northern Great Basin. The specimen recovered from LAN-2 seems to be made from Coso obsidian and was cut for a hydration reading; unfortunately the measurement is not available. Other points recovered from LAN-2 resemble bifurcate base Pinto Series of the southern Mojave Desert that is grossly dated between 7500 and 400 years BP.

From excavations at both LAN-1 and LAN-2 three phases of projectile points have been developed that are assumed to represent rough chronological sequences based on superposition (Treganza and Malmud 1950; Treganza and Bierman 1958; Johnson 1966). Phase 1 points are defined as large blades including some stemmed versions that tend to occur lower in the deposits ranging from the 12-18 inch level to the 54-60 inch level at LAN-1, and are absent at LAN-2. Phase 2 points are more variable in morphology but can be described as large dart sized specimens that may or may not have stems. These are most abundant in the upper levels of LAN-1 (0-12 inches) and in the lower half of the LAN-2 deposit. The third phase of points overlaps significantly with the morphology of Phase 2 specimens but tend to be smaller in size and are biased toward basal concavity. Phase 3 points are not present at LAN-1.

In that late Holocene point chronologies have not been temporally defined for California south of the Transverse Ranges, it is somewhat of a stretch to link the points recovered from LAN-1 to those outside of the area. An analysis of the hydration data and a statistical comparison of projectile points with those of similar form in nearby locations, would go far toward clarifying the chronology of this site.

One other note on the chronology of LAN-2 is that there was less mineralization and chemical alteration of the soils and stone tools at this site than at LAN-1. This lead Treganza and Bierman (1958) to conclude that the LAN-2 was younger. The decreased amount of such alteration is most likely due to the distance of LAN-2 from the springs, meaning that the site would have been less exposed to leaching and saturation.

The assemblage recovered from LAN-2 is very similar to that of LAN-1, except on a smaller scale. The assemblage is dominated by heavy processing tools such as handstones (94), millingstones (36), scraper planes (67), hammers (78), choppers (18), and scrapers (39), followed by a host of other tools such as small flake tools (36), points/bifaces (35), and a few other miscellaneous artifacts such as mortars (4) and pestles (3) (Treganza and Bierman 1958; Treganza and Malmud 1950; Heizer and Lemert 1947; Johnson 1966). It is important to note that the small flake tool category includes both unmodified used flakes (simple flake tools) and those that are very regular in form due to use and maintenance (formed flake tools). The latter have been largely overlooked in the past in terms of economic significance.

Eight features recorded at LAN- were mostly large concentrations of unmodified rock with only limited amounts of tools/tool fragments included (Johnson 1966). Most rock contained in these features was burned and the highest concentrations of charcoal were found in association with features. Only one feature was likely associated with a burial, the majority seem to have been cooking facilities. A few are simply large concentrations of unaltered stone that may represent refuse resulting from clearing living areas.

Seven burials were identified at LAN-2 (Treganza and Bierman 1958; Johnson 1966). All were in a flexed position, one was associated with a rock cairn directly on top of the body. Most bones are reported to have been in poor condition and grave goods were absent.

In context of the available data concerning site and assemblage structure, the analyses of millingstones, handstones, and scraper planes elicit strong implications for interpretation of subsistence organization and site use.

Millingstones

Out of 36 millingstones recorded for LAN-2, 24 were located for analysis. The remaining 12 were either loaned to other institutions, discarded as fragments, or reburied as grave goods. Nonetheless, the sample of 24 is probably sufficient to reflect the variation of the entire assemblage. The distribution of millingstones at the site is poorly understood. Aside from a rather amorphous cultural stratigraphic profile, locational information is scant. There were no noted trends of biases in millingstone form or surface shape by depth or site area. Millingstones were distributed throughout the entire deposit in significant numbers, whether whole or fragmentary.

All millingstones were made from the local sandstone with the exception of one made from igneous stone. The majority were margin fragments (17), ends (3), and indeterminate pieces (2); two were whole/near complete (see Table 7.1).

Millingstones were not very formalized. One was unshaped (SD-0), 12 were shaped to the first degree (SD-1), nine were shaped to the second degree (SD-2), and two could not be classified in such terms. The type of shaping among SD-1 millingstones was evenly split between flaking and pecking which were both observed on eight specimens, not necessarily together. The SD-2 category only contained two formed by flaking, with most being pecked (8), or ground (6) on the exterior. The decrease in proportion of flaking with an increase in pecking and grinding is an indication of increased formal regularity. That flaking was observed on at least some of the SD-1 and SD-2 specimens is evidence that excess bulk had to be removed in order to make the tool useful.

The majority (14) fell within the thick range. The rest were either block (6) or thin (3) forms. According to these categories, there were no correlations between different thickness types and shaping degree categories. The average maximum lengths, widths, and thicknesses are summarized in Table 7.2.

Table 7.1. LAN-2. Millingstone attributes by shaping degree.

SHP DEGREE		**0**	**1**	**2**	**3**	**IND**	TOTAL
MATERIAL							
	SCH	-	-	-	-	-	-
	GRN	-	-	-	-	-	-
	SST	-	12	9	-	2	23
	GRA	-	-	-	-	-	-
	SIL	-	-	-	-	-	-
	VOL	1	-	-	-	-	1
CONDITION							
	WHL/NC	1	1	-	-	-	2
	MRG	-	10	7	-	-	17
	END	-	1	2	-	-	3
	FRG	-	-	-	-	2	2
SURFACE FREQUENCY	1	1	11	6	-	2	20
	2	-	1	3	-	-	4
	IND	-	-	-	-	-	-

SURFACE SHAPE	B	-	8	8	-	-	16
	F	-	1	3	-	1	5
	SCV	1	4	1	-	1	7
	SCX	-	-	-	-	-	-
	IND	-	-	-	-	-	-
SURFACE TEXTURE	S	1	13	12	-	2	28
	I	-	-	-	-	-	-
	IND	-	-	-	-	-	-
POLISH							
	PRS	1	8	11	-	2	22
	ABS	-	5	1	-	-	6
	IND	-	-	-	-	-	-
STRIAE							
	PRS	-	2	3	-	-	5
	ABS	1	11	9	-	2	23
	IND	-	-	-	-	-	-
PECKING							
	PRS	1	13	11	-	2	27
	ABS	-	-	1	-	-	1
	IND	-	-	-	-	-	-
SECONDARY MODIFICATION	PRS	-	-	-	-	-	-
	ABS	1	12	9	-	2	24
FIRE AFFECTION	PRS	1	8	6	-	-	15
	ABS	-	4	3	-	2	9
SHAPING TYPE	IND	-	-	-	-	2	2
	0	1	-	-	-	-	1
	1	-	8	3	-	-	11
	2	-	8	8	-	-	16
	3	-	-	6	-	-	6
TOTAL		1	12	9	-	2	24

Note: See Appendix A for description of terms.

Not enough specimens were complete enough to form a discussion of variability in lengths or widths but most were complete enough to get an accurate measure of maximum thickness. The maximum thickness for the single unshaped millingstone was 6 cm, while an average maximum of 7.9 cm characterized SD-1, and 6.9 cm was the average maximum thickness for SD-2 examples. The decrease in thickness from SD-1 to SD-2 millingstones is probably related to material selection rather than use in that both degrees of formalization show nearly identical patterns of use.

Use wear data indicate that there were few differences in use between SD-1 and SD-2 shaping categories. This lack of variation in use wear attributes among the shaping degrees is illustrated in Table 7.1. Slight differences are indicated in the higher percentage of surface polish and the increased occurrence of flat surfaces (25% vs. 8%) for SD-2. Even the lone unshaped millingstone has a surface that was used similarly to those on shaped specimens. For this reason, the following discussion of use wear patterning will lump millingstones within all three shaping categories.

Use wear data for millingstones from LAN-2 (Table 7.1) shows that most had only one ground surface (83%). The majority of surfaces were basined in form (57%), followed by slightly concave (25%) and flat (18%) surface shapes. The ground surfaces tended to be smooth in texture (100%), exhibiting polish (79%) and pecking (96%), but generally lacking striations (18%).

The difference in intensity of use indicated by the use wear attributes did not vary by surface shape. Basined, concave, and flat surfaces were all highly polished and pecked but only lightly striated. The only difference among surface shapes was that basined surfaces tended to be more battered than ground, making it difficult to see any striations that may have accumulated through grinding wear. In this case, pecking on the basined surfaces was more consistent with heavy battering rather than surface resharpening; the latter characterizes flat and slightly concave surfaces. Millingstones from LAN-2 were not very weathered, eliminating this as a factor biasing the observability of use wear. The heavy battering of most basined surfaces seems to be a characteristic of use, since it is combined with traces of grinding. This suggests that basined surfaces acquired their shape through use, rather than intentional shaping. It is unlikely that all surfaces were on their way to becoming basined forms. There are flat and slightly concave surfaces which were used with moderate intensity primarily for grinding instead of battering, and that exhibit different patterns of formalization. The data indicate gross functional differences between some of the different surface shapes in terms of primary function.

There is a high occurrence of fire alteration among millingstones, 63% showing discoloration, weathering, and burning characteristic of prolonged heating or burning.

Table 7.2. LAN-2. Average complete metrics by artifact class and shaping*.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	19 / 1	16.3 / 1	6 / 1	1
Shp Deg 1	44 / 1	31.5 / 1	7.9 / 11	12
Shp Deg 2	- / 0	- / 0	6.9 / 9	9
Shp Deg 3	- / 0	- / 0	- / 0	0
Avg Total	31.5 / 2	23.9 / 2	6.9 / 21	22
Handstones				
Shp Deg 0	12.5 / 4	9.6 / 7	4.8 / 9	9
Shp Deg 1	- / 0	9.2 / 2	5.9 / 4	6
Shp Deg 2	14 / 1	9.9 / 3	5 / 8	10
Shp Deg 3	- / 0	14 / 2	4.4 / 3	5
Avg Total	13.3 / 5	10.7 / 14	5 / 24	30
Scraper				
Form 1	7.9 / 2	5.8 / 2	3.4 / 2	2
Form 2	6.3 / 15	5.2 / 15	4.8 / 15	15
Avg Total	7.1 / 17	5.5 / 17	4.1 / 17	17

Note: *Includes only those artifacts complete enough to be categorized by shaping degree or form, **does not** include indeterminate fragments; Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.

Handstones

Out of 94 handstones originally recorded at LAN-2, 30 were selected for analysis. The distribution of handstones has not been accurately quantified in any published report and the original catalog information regarding provenience information is confusing. It does appear that handstones occurred regularly throughout the deposit.

The majority of handstones (60%) were made from granite, the rest from sandstone. Both materials occur locally but granite was most likely procured off-site in the nearby drainages. The dominance of granite in the sample is not unexpected in that harder materials last longer as handstones. Only six were whole/near complete. Most were end (19) and margin (5) fragments of various sizes.

The different categories of shaping were all well represented in the sample with nine SD-0, six SD-1, 10 SD-2, and five SD-3. The type of shaping was biased toward pecking on SD-1 handstones, switching to grinding for SD-3 specimens. Some seem to have become shaped through use, though the majority seem to have been altered purposely to produce a more regular form. This is evidenced by the fact that the margins exhibited pecking and grinding that is not consistent with use as a grinding stone.

According to metrics (Table 7.2), handstones became wider and thinner as shaping degree increased. The average maximum width of SD-1 handstones was 9.2 cm, 9.9 cm for SD-2, and 14 cm for SD-3. The average maximum thickness of SD-1 handstones was 5.9 cm, decreasing to 5.0 cm for SD-2, and to 4.4 cm for SD-3. The difference in width may reflect local stone sizes and selection according to intended use while the decrease in thickness may indicate prolonged use with increasing formalization. That unshaped handstones fall in the middle for both measurements probably reflects the natural average size of toolstone in the area. There were no other metrical correlations with any specific type of use wear or original handstone type.

Use wear becomes more regular and observable as shaping degree increases. Unshaped handstones show a greater number of specimens used only on one surface (45%). There is more irregularity in surface texture (14%), a general absence of striations (72%), and a high number of specimens lacking evidence of pecking on the surface (36%).

Handstones shaped at the SD-1 level have mostly convex surfaces (83%), with two that are flat, while all (100%) except one obscured surface were smooth in texture. Polish was observed on 92% of the surfaces, pecking on 83%. Striations were comparatively rare, observed only 42% of the time.

The regularity in surface form and use increases for SD-2 and SD-3 handstones (Table 7.3). Those of SD-2 are all bifacial with surfaces either being convex (70%) or flat (30%). All surfaces were smooth and most were polished (95%) and pecked (95%). Striations were observed on 40% of the surfaces.

Finally, SD-3 handstones had the most regularly observed use wear attributes. All surfaces were bifacial, convex, smooth, and polished. Most were striated (80%) and pecked (90%). The fact that striations are not very common among some of the handstones is probably a result of the differences in raw material selection. Out of 25 surfaces showing striations, 23 were found on granitic handstones. Sandstone does not hold traces of striations very well, especially in light of weathering.

TABLE 7.3. LAN-2. Handstone attributes by shaping degree.

SHP DEGREE		**0**	**1**	**2**	**3**	IND	TOTAL
MATERIAL							
	GRN	5	5	3	5	-	18
	SST	4	1	7	-	-	12

CONDITION							
	WHL/NC	4	1	1	-	-	6
	MRG	-	1	2	2	-	5
	END	5	4	7	3	-	19
	MED	-	-	-	-	-	-
	FRG	-	-	-	-	-	-
SURFACE FREQUENCY	1	4	-	-	-	-	4
	2	5	5	10	5	-	25
	3	-	1	-	-	-	1
	4	-	-	-	-	-	-
SURFACE SHAPE	F	2	2	6	-	-	10
	CV	-	-	-	-	-	-
	CX	12	10	14	10	-	46
	IND	-	1	-	-	-	1
SURFACE TEXTURE	S	12	12	20	10	-	54
	I	2	-	-	-	-	2
	IND	-	1	-	-	-	1
POLISH							
	PRS	14	11	19	10	-	54
	ABS	-	1	1	-	-	2
	IND	-	1	-	-	-	1
STRIAE							
	PRS	4	5	8	8	-	25
	ABS	10	7	12	2	-	31
	IND	-	1	-	-	-	1
PECKING							
	PRS	9	10	19	9	-	47
	ABS	5	2	1	1	-	9
	IND	-	1	-	-	-	1
END POLISH							
	PRS	-	-	1	1	-	2
	ABS	9	5	7	2	-	23
	IND	-	1	2	2	-	5
SECONDARY MODIFICATION	PRS	4	4	8	3	-	19
	ABS	5	2	2	2	-	11
FIRE AFFECTION	PRS	3	5	8	4	-	20
	ABS	6	1	2	1	-	10
SHAPING TYPE	IND	-	-	-	-	-	-
	0	9	-	-	-	-	9
	1	-	-	-	-	-	-
	2	-	5	7	3	-	15
	3	-	4	7	5	-	16
TOTAL		9	6	10	5	-	30

Note: See Appendix B for description of terms.

Secondary modification took three forms: end polish, end battering and burning. End polish was on observed on two handstones; one each, SD-2 and SD-3. No aberrant metrical characteristics correlated with the two tools. Nearly two thirds (19) of handstones were end battered. This trait is a hallmark characteristic of the major tool categories present at LAN-2. Battering was evidently an economically important function of many of the tools discarded at the site. There is most likely a functional connection between the battering of handstones and basined millingstone surfaces. It is probably an indication of heavy pulverization. The other type of secondary modification, fire-alteration, was observed on two thirds (20) of all handstones.

Scraper Planes

A total of 17 (25%) scraper planes was selected for analysis from an originally recorded number of 67. There appeared to be no bias in distribution of these tools throughout the deposit that could not be accounted for through rodent disturbance.

Basalt was the most common material in the sample represented by 14 specimens, followed by quartzite (2) and cryptocrystalline (1) (see Table 7.4). Only two scraper planes were made from complex interior percussion flakes, the rest made directly from cobbles. Average maximum measurements of scraper planes indicate that the two made from flakes were longer and wider than those made from cobbles, but they were also thinner by 1.4 cm. The latter measurement is a factor of the thin nature of flake based forms as opposed to those made from cobbles. Overall, scraper planes had an average maximum length of 7.1 cm, a width of 5.5 cm, and a thickness of 4.1 cm for all 17 specimens.

All edges were unifacially formed. Edge shapes tended to be convex-regular (9), or convex-irregular (5), with one that was straight-irregular and two that covered the entire perimeter of the tool. Edge wear did not vary significantly according to edge shape. Irregularity in the accumulation of wear is evidenced by the fact that of all convex-regular edges, all types of wear were seen while unifacial and bifacial microchipping were observed on all convex-irregular edges.

Evidence of edge wear was most commonly that of unifacial microchipping (9), while three exhibited bifacial microchipping and five were battered on the formed edges until dull. Other use wear indications were that of edge grinding, step fracturing, and interior polish. Edge grinding was present on 12 edges and step fracturing was found on all specimens. Interior polish was less common, occurring on only seven of the scraper planes.

Table 7.4. LAN-2. Scraper plane attributes by material type.

	BAS	CCR	QZT	QTZ	FEL	RHY	META	IGN	OTH	TOTAL
FORM										
1	1	-	1	-	-	-	-	-	-	2
2	13	1	1	-	-	-	-	-	-	15
3	-	-	-	-	-	-	-	-	-	-
Flk Type										
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-
5	1	-	1	-	-	-	-	-	-	2
IND	-	-	-	-	-	-	-	-	-	-
E Freq										
1	14	1	2	-	-	-	-	-	-	17
2	-	-	-	-	-	-	-	-	-	-
E Form										
1	14	1	2	-	-	-	-	-	-	17
2	-	-	-	-	-	-	-	-	-	-
E Shap										
1A	-	-	-	-	-	-	-	-	-	-

1B	-	-	-	-	-	-	-	-	-	-
2A	7	-	2	-	-	-	-	-	-	9
2B	4	1	-	-	-	-	-	-	-	5
3A	-	-	-	-	-	-	-	-	-	-
3B	1	-	-	-	-	-	-	-	-	1
4	2	-	-	-	-	-	-	-	-	2
E Wear										
0	-	-	-	-	-	-	-	-	-	-
1	9	-	-	-	-	-	-	-	-	9
2	1	1	1	-	-	-	-	-	-	3
3	4	-	1	-	-	-	-	-	-	5
E Polish										
PRS	10	-	2	-	-	-	-	-	-	12
ABS	4	1	-	-	-	-	-	-	-	5
Stp Frac										
PRS	14	1	2	-	-	-	-	-	-	17
ABS	-	-	-	-	-	-	-	-	-	-
INT										
PRS	7	-	-	-	-	-	-	-	-	7
ABS	7	1	2	-	-	-	-	-	-	10
SEC										
PRS	2	-	-	-	-	-	-	-	-	2
ABS	12	1	2	-	-	-	-	-	-	15
TOTAL	14	1	2	-	-	-	-	-	-	17

Note: See Appendix C for description of terms.

Edge angle, spine plane angle, and maximum flake scar length measurements of the edges of scraper planes provided strong evidence that these tools were being resharpened as tools. The mean edge angle was 82^0 and the mean spine plane angle was 72^0. The disparity between the two measurements being about 10 degrees speaks to attrition resulting from use. The unique characteristic of the scraper planes from LAN-2 is that the maximum flake scar length averaged at 0.88 cm. This is very low compared to other sites for which the measurements were taken. Scraper planes were definitely being resharpened and saw a relatively intensive degree of use.

The smaller flake scars on the edges of tools from LAN-2 suggest that they were resharpened during their use lives. The diversity in edge shape and types of edge wear present indicate that there was not a great deal of investment in the form of the edges and that they were used for a variety of tasks from scraping to battering.

Non-Analyzed Tool Categories

Tool categories not sampled for analysis included hammers (78), choppers (18), scrapers (39), mortars (4), pestles (3), small flake tools (26), small domed scrapers (10), cores (2), and points/bifaces (35), among other less represented artifacts. It is assumed that mortars and pestles are most likely late introductions to the site and probably reflect a separate and limited occupation of LAN-2 primarily because of their low frequency and occurrence in the upper levels of the site. This assumption is consistent with other explanations of the use of such tools in the Santa Monica Mountains (Gamble and King 1997).

The abundance of hammers and choppers is testimony to the importance of heavy battering, chopping, and general pulverization to the economies that exploited the area of the site. The high number of end battered handstones and the presence of edge battering on some scraper planes testifies to the importance of such functions. The high number of scrapers also fit well within a heavy processing regime in that these tools were generally large and crudely fashioned. There seems to have been some functional overlap between hammers, choppers, and scrapers in that each one can satisfy to some degree the primary function of the others.

Informal observations of the small flake tools revealed that many were made from cryptocrystallines which are available in locations off-site. Few were formed flake tools and most were simply used on an unmodified edge. Though there are no data to support these observations, the flake tools exhibited very little wear suggesting prolonged use or exposure to harder materials. Their use is reminiscent of those that are normally associated with processing of softer materials such as vegetal material (see Gilreath and Jackson 1985). The formed flake tools (small domed scrapers) were more formalized than the small flake tools. The edges of the formed flake tools were steep, probably resulting from attrition and edge sharpening. These tools may have been kept and maintained in a tool kit for some time, being exposed to many uses. The paucity of cores at the site probably resulted from categorization as tools, and of their re-use as scraper planes, choppers, and various other processing implements. A lack of debitage recovered from the site prohibits discussion of the relative importance of cores.

Due to the ease of access, 14 projectile points and 21 bifaces were analyzed. The attributes and associated measurements are listed in Appendix 4. No significant trends in the deposition of these particular tools could be noted. The most interesting observations made on these artifacts are those related to material and condition. For projectile points, seven were made from obsidian, five were made from cryptocrystalline, one from quartzite, and one from quartz. Basic measurements showed an average maximum thickness of 8.2 mm which suggests that the points were most likely dart tips instead of arrows. Most points were whole/near complete (12) with two proximal and one distal fragment. The condition call is somewhat deceiving, as most of the whole points were very small and awkwardly reworked, indicating that they were discarded at or near an exhausted state. Use wear was observed on every projectile point. The most common forms of use were edge grinding (10) and bifacial microchipping (10), while four were burinated. The observation of use wear on so many of the edges, given that these represent finished and discarded specimens, suggests that the projectile points were also being used as cutting or scraping tools.

Bifaces were mostly made from cherts (15), followed by obsidian (4), basalt (2), and felsite (1). There were four that were whole, two distal fragments, 10 indeterminate ends, four medial sections, and 1 proximal fragment. Thirteen bifaces were probably points (4 of them obsidian). Without a database of point measurements for comparison, the original form of these bifaces cannot be determined. It was found that 10 specimens were stage 3 bifaces, 11 were stage 4, and one was a stage 5 biface. The clustering around stages 3 and 4 in light of the high amount of probable point fragments may indicate that these points are dart fragments. The average maximum thickness of the bifaces was 8.8 millimeters. This thickness would most likely put the points beyond the maximum thickness of most points used on arrows. Use wear was observed on all but one biface. Most bifaces tended to show edge grinding (13) and bifacial microchipping (11), with some showing unifacial microchipping (4) or burination scars (2). The majority of bifaces were made from a flake base (14), while three were made from biface blanks and five could not be assessed as such. The relatively high amount of edge grinding and edge microchipping may suggest that the bifaces were being used as tools, if they represent broken point fragments. It is most certainly true that edge preparation also contributed to damage on the edges, especially among bifaces.

Summary and Conclusions

The deposit from LAN-2 can be characterized by flexed burial patterns, a number of loosely organized hearth or cooking features, small dart-sized projectile points (Johnson 1966), and an abundance of processing equipment, which is all tied to two radiocarbon dates that range from 2300 to 2850 years BP This evidence has been used to interpret the site as a late early period village site that saw the beginnings of the transition into the mortar/pestle economy. The analyses conducted in this report highlight important variation in both site features and artifact use that provide a stronger basis for the understanding of the organization of subsistence technology and settlement.

The flexed burial pattern at LAN-2 is only unique in its consistency. It has only been interpreted in context of the adjacent site LAN-1, which does not show any real burial pattern except that most were associated with rock features and had poor internal organization. The difference between the two sites has led to the conclusion that LAN-2 is a later manifestation of the cultural system which occupied LAN-1. The problem with drawing this distinction is simply that the burials from LAN-1 are in such bad and disassociated condition, probably due in part to the chemical weathering brought about by the nearby spring.

Features at LAN-2 are mostly hearths or cooking facilities that are very loose in structural organization and site placement. The lack of formality in the feature inventory suggests that little was invested in maintaining a consistent site structure as would be expected of a more permanent occupation.

The analyses of millingstones, handstones, and scraper planes presents an interestingly diverse picture of the organization of subsistence technology. The millingstones were used such that they accrued moderately intensive wear with low to moderate degrees of formalization. There does not seem to have been a portable millingstone component at LAN-2 as most of the shaping was done in order to facilitate on site use. With the majority of surfaces being basined in form, the primary function of these tools appear to have been associated with heavy vegetal processing that included a significant amount of battering. The use of battering to process materials on millingstones is supported by the high occurrence of battering on both handstones and scraper planes, in addition to the high number of hammerstones and choppers. The abundance of raw material available for manufacturing millingstones would preclude extremely long use of individual millingstones in that it would be more beneficial to make a new one rather than dealing with decreasing functionality. Flat and concave milling surfaces imply that there were different processing techniques taking place in the vicinity of the site. None of the millingstones exhibited enough formalization to suggest that there was any pattern of off-site use.

Unlike millingstones, the handstones from LAN-2 show a variety of degrees of formalization. There are handstones that seem to have been used on an expedient basis while there are also those which have enough shaping and use wear to suggest that they were used in other contexts off site. The fragmentary condition of most handstones suggests that they were used with some degree of intensity and discarded in a well used and sometimes exhausted state. Nearly all of the moderately to highly shaped handstones were fragments of some kind.

The scraper planes, though not very formalized, showed moderate degrees of use and edge maintenance. The 10^0 disparity in edge and spine plane angles and the small maximum flake scar length of 0.8 cm is consistent with the idea that tools were resharpened as they experienced attrition through use. However, use of scraper planes was not intensive in that they were not discarded in an exhausted state. The diversity in edge shapes and types of wear suggests that they were quickly manufactured to serve immediate processing needs.

The additional analysis of points and bifaces revealed a previously unseen dimension of tool use at the site. The material and condition observations alone are enough to see that the points were being discarded on-site in near exhausted form, implying the occupants were not trading for the extralocal raw materials (something that might be addressed by looking at debitage profiles). When the use wear observations are considered, it seems as though these tools were also being used for purposes other than piercing, such as cutting and scraping. The points and bifaces were probably used for a number of tasks, fitting within the very generalized technological organization that characterizes LAN-2.

Cumulatively, the millingstones, handstones, and scraper planes form a cohesive vegetal processing regime, complimented by most of the other artifact classes, such as hammerstones, choppers, and most likely, flake tools. Heavy processing is indicated by the overlapping functions in terms of battering and grinding wear that was observed across each tool class. The low to moderate amount of formalization, and the type of formalization of most ground and battered stone is consistent with a process of tool use that saw expedient manufacture of millingstones, handstones, scraper planes, and the other processing tools to solve immediate needs when the site was occupied. Those ground and battered stone tools that did show greater investment in form may have seen higher degrees of portability which is also implied by the analyses of points and bifaces.

The original interpretation of LAN-2 as a late early period village site does not hold up under the data gathered from the analyses. A more probable scenario sees multiple occupations of a generalized but intensive nature. This explanation more readily accounts for the mass quantities of ground and battered stone where some tools would have been reused or quickly manufactured and left on site, while others still were used in a wider range of contexts. Sedentism was probably not a characteristic of the settlement strategy. The use wear and formalization data, along with the assemblage composition, do not fit with the associated expectations that come with permanent occupation. The LAN-2 assemblage is characterized by low diversity in assemblage composition even though variation in each tool category is present. However, the use of processing tools on a more extensive basis makes the other artifact classes (namely formed flake tools) seem more economically important. No resource specialization can be implied from the analyses. That this site was an important residential hub is not in question. However, the proposition that it represents a sedentary village is highly questionable in light of this analysis. It certainly does not look like late period Chumash sedentary village sites that are well known for highly diverse artifact types.

Chapter 8:

Sayles Site, Locus A; CA-SBR-421A

The Sayles Site Complex was originally defined by Kowta's (1969) excavations of SBR-421, Locus A. The Sayles Complex represented a late interior manifestation of the Millingstone pattern in that it had an abundance of scraper planes, millingstones, and handstones. Original interpretations of Locus A fit within a broader view of the entire Sayles Complex. Kowta (1969) suggests that the sites resulted from semi-sedentary populations that were primarily exploiting specific vegetal resources (agave and yucca) that spread through southern California with changing climates. More recent interpretations have suggested that the Sayles loci represent locations of repeated human occupation that were redundant in nature, but not sedentary. The latter were based on a subsequent investigation of the Crowder Canyon area funded by Caltrans (Basgall and True 1985:10.15) that afforded the opportunity to revisit the assemblages generated by Kowta and others. Because of the intensity of archaeological investigation in the area, the assemblages recovered provide the most wholistic view of the Millingstone pattern in contrast to the rest of southern California.

The Crowder Canyon area is characterized by chamise-chaparral vegetation communities that surround the adjacent riparian communities of the Crowder Creek drainage. Elderberry bush and sycamore trees characterize these drainages and are an indication of subterranean moisture. Though juniper trees are found on-site, they are more prevalent at the higher elevations a few miles to the northeast. Local vegetation communities are largely defined by an irregular precipitation pattern; partially affected by the complex topography of the Transverse Ranges. Average precipitation can range from 25 to 75 cm (Bailey 1966). The faunal communities in the area are characterized by such mammals as mule deer, ground squirrels, woodrats, jackrabbits, and wild cats, along with other small rodents, reptiles and birds (Kowta 1969). In the late prehistoric past, the biotic communities were much the same as today, with only slight compression of ecological zones toward the upper elevations due to decreased precipitation. The now-dry perennial spring near SBR-421 Locus D shows indications of being more active prehistorically.

With no radiocarbon dates available, Kowta (1969) gave a chronological assessment of 1000 to 3000 years ago for the primary occupation of the site based on tectonic uplift in conjunction with assessments of assemblage similarity with other regions. He postulates that the Cajon Pass region was first exploited between 5000 and 3000 years ago based on the presumption that the interior desert areas were witnessing thinning populations due to the drying effects of the Altithermal. He subsequently suggests that Cajon Pass saw the mixing of southern California Millingstone pattern strategies with Mojave Desert Pinto traditions (Kowta 1969).

Basgall and True (1985), in a more recent analysis that included obsidian hydration data suggest a time span that fits well within Kowta's original assessment. Hydration readings were obtained on eight Coso obsidian bifaces; seven of which yielded consistent enough readings (from 4.0 to 5.0 microns) to estimate that the primary occupation of the site occurred between 1800 and 2400 years BP. An earlier occupation may have occurred at around 2850 BP. but this date was not taken to represent the main component of the site (Basgall and True 1985:9.3). This time frame is very late considering its apparent affiliations with the Millingstone pattern.

There does not seem to have been any temporal polarity in the assemblage according to stratigraphy. Kowta (1969) defined three strata, the upper two holding the entire cultural deposit. The first Stratum is described as a 12 inch thick loosely consolidated light brown sandy soil with evidence of rodent activity. This Stratum has most likely been exposed to high turnover resulting from bioturbation and aeolian processes. The second Stratum is the thickest (generally between 12 and 30 inches thick) and is characterized by the highest levels of cultural material contained in a darker gray compact midden-like deposit; though organic remains in noticeable quantities were lacking. The separation between strata 1 and 2 is not clearly seen among the artifact distributions as there does not appear to be a break in frequency. The only differences relate to soil color and condition. It may be the case that the physical separation between the first two strata is due to different erosional and chemical alteration. The third Stratum is a culturally sterile formation upon which the upper two strata rest. Though profiles of the interface between strata 2 and 3 do not show a clear distinction, the difference lies in the lack of cultural material from Stratum 3 and the light colored sandy sediment that contrasts its upper counterpart. Subsistence remains were mostly lacking from all strata excepting a small amount of fragmented bone. The lack of such remains may be a methodological result, or it may be that such remains were never deposited.

The assemblage from Locus A is dominated by millingstones, handstones, scraper planes, hammerstones, and various other heavy processing tools (Table 8.1). Other assemblage components include formed flake tools and other small flaked stone artifacts.

Table 8.1. SBR-421A. Artifact frequency by depth.

Artifact	Surface	0-6	6-12	12-18	18-24	24-30	30-48	Total
Handstone	9	27	53	30	20	12	8	159
Millingstone	8	2	15	11	12	5	3	56
Mortar	-	-	-	-	-	-	-	-
Pestle	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-
Scraper	34	49	79	50	22	18	5	257
Chopper	9	12	10	5	7	-	-	43
Hammer	5	18	25	19	16	12	2	97
Scraper	5	38	46	35	27	15	5	171
Core	11	52	87	56	54	30	14	304
Small Flake	-	-	-	-	-	-	-	*
Point/Biface	7	34	26	24	28	20	8	147
Other Misc.	-	12	14	15	7	7	4	59
Total	88	244	355	245	193	119	49	1293

Note: *, not defined separately in original report; Artifact frequencies taken from Kowta (1969: Table 6).

Table 8.1 shows that most of the assemblage comes from Stratum 2 of the deposit that is generally present from 12-30 inches in depth. Besides this pattern, Kowta (1969) asserts that there was a decrease in the frequencies of ground and battered stone followed by an increase in flaked stone (namely points and bifaces) from Stratum 2 to Stratum 1 (0-12 inches). Kowta also split the site into four loci (A-D), not to be confused with the overall SBR-421 site complex where Loci A-D comprise individual sites. Actual excavations by Kowta focused on his loci A and B. The segregation of

SBR-421 Locus A into two smaller areas was based on the distribution of artifacts on the surface.

No defined hearths or cooking facilities were discovered at SBR-421A. Kowta (1969) recorded only four subsurface features from the site two of which were clusters of groundstone fragments and two others composed of both groundstone, flaked stone tools, and unmodified rock. Kowta notes that two of the features involved what appeared to be deliberate placement of the millingstones on top of each other in a manner that would suggest that these were cached in anticipation of later use.

The assemblage composition at SBR-421A suggests that it has affinities to other traditionally defined Millingstone pattern sites. Previous interpretations of the assemblage as resulting from either a specialized (Kowta 1969) or generalized subsistence organization (Basgall and True 1985) are clarified by the analyses of millingstones, handstones, and scraper planes in this report.

Millingstones

A majority of millingstones (40 of 56) were located for analysis from SBR-421A. The absence of the remaining 16 specimens is probably due to inter-institutional loan and/or use in teaching collections.

The distribution of millingstones is slightly biased toward the lower reaches of the deposit. Thirty-one millingstones could be positively assigned to Stratum 2 (12 inches and below), while 25 were from the upper Stratum. The high amount of bioturbation in the matrix could account for this discrepancy as the heavier millingstones might have migrated lower in the deposit over time. Kowta (1969:13) mentions that none of the millingstone types pattern stratigraphically, making it difficult to ascertain functional differences in millingstone surface use over time.

All millingstones were made from the local schist/gneiss, save one which was made from granite. Only six were whole/near complete, most being margin (20), end (9), or indeterminate fragments (5). The condition of these tools seems to have been affected by use and post-depositional processes. Seven specimens were burned and many were weathered.

The great majority of millingstones were not very shaped. Most were shaped to SD-1 (21), with 10 exhibiting enough formalization to be categorized as SD-2 (see Table 8.2). The remainder comprised three SD-0, one SD-3, and five millingstones that were too fragmentary to ascertain such modification. The type of shaping present on millingstones was mostly flaking (23), followed by grinding (15) and pecking (12). Flaking is a very crude type of shaping, used for the removal of larger quantities of mass, followed by pecking which removes less material. Grinding is thought to be associated with light duty shaping or finishing. The dominance of flaking and pecking suggest that millingstones were being manufactured in a way that minimized investment in the general form. The situation was probably one that saw procurement of the local schist that was quickly modified by removing and/or dulling protrusions. The degree of shaping in light of the distribution of shaping types does not imply that modification of these tools took place to facilitate transportation.

Some slight differences in metrics are observable among the different degrees of formalization (Table 8.3). The most notable of these differences is manifest through thickness where those of SD-1 had an average maximum thickness of 6.3 cm compared to 4.7 cm for SD-2 specimens. That millingstones at this site were not very large is supported by their fit with thickness groupings defined in Figure 1. Thirty-four millingstones were complete enough to be categorized by maximum thickness categories. The majority of these tended to be thin (17) or thick (14), with only three that were thick enough to fit within the block range (See Appendix A for complete thickness measurements). Schist in the area of the site tends to naturally occur within both the thin (0-5.5 cm) and thick (5.5-8.7 cm) ranges in that it is exfoliative and plate-like. The relative thinness is thought to be a natural characteristic rather than purely a consequence of use.

In addition to thickness patterns, the relative volume, though not very significant in light of the sample sizes for length and width measurements, was 6683 cm^3 for SD-1 millingstones, and 3709 cm^3 for SD-2 forms. The greater size of SD-1 millingstones becomes significant when compared to the frequency of concave versus flat surfaces (Table 8.2). Those of SD-1 tend to have either basined (8) or concave (9) ground surfaces , with only six that were flat. The SD-2 millingstones are characterized by flat surfaces (11) with only five that were basined and one concave. It is easy to think that millingstones with concave or basined surfaces need to have a minimum thickness to accommodate such use. The correlation of flat surfaces with moderate degrees of shaping suggests that their form was in some way affected either indirectly or directly by use. None of the shaping observed overlapped with ground surfaces at the extreme margins of the tools. That is to say that none of the shaping appeared to be the result of repair. This would suggest that flat surfaces are indeed functionally associated with slightly higher degrees of formalization.

There were only moderate differences in use and formalization between SD-1 and SD-2 millingstones. These differences are seen among surface shapes as discussed above, and surface frequency (Table 8.2). The SD-1 millingstones tended to have only one ground surface (90%), while SD-2 specimens tended to have two ground surfaces (80%).

Table 8.2**. SBR-421A. Millingstone attributes by shaping degree.**

SHP DEGREE		**0**	**1**	**2**	**3**	**IND**	TOTAL
MATERIAL							
	SCH	3	21	10	1	4	39
	GRN	-	-	-	-	1	1
	SST	-	-	-	-	-	-
	GRA	-	-	-	-	-	-
	SIL	-	-	-	-	-	-
	VOL	-	-	-	-	-	-
CONDITION							
	WHL/NC	-	4	2	-	-	6
	MRG	2	10	7	1	-	20
	END	1	7	1	-	-	9
	FRG	-	-	-	-	5	5
SURFACE FREQUENCY	1	3	19	2	1	4	29
	2	-	2	8	-	1	11
	IND	-	-	-	-	-	-
SURFACE SHAPE	B	2	8	5	1	3	19
	F	1	6	11	-	1	19
	SCV	-	9	1	-	2	12
	SCX	-	-	1	-	-	1
	IND	-	-	-	-	-	-
SURFACE TEXTURE	S	3	19	15	1	6	44
	I	-	4	3	-	-	7

	IND	-	-	-	-	-	-
POLISH							
	PRS	3	23	18	1	6	51
	ABS	-	-	-	-	-	-
	IND	-	-	-	-	-	-
STRIAE							
	PRS	2	7	5	1	4	19
	ABS	1	16	13	-	2	32
	IND	-	-	-	-	-	-
PECKING							
	PRS	3	19	13	1	6	42
	ABS	-	4	5	-	-	9
	IND	-	-	-	-	-	-
SECONDARY MODIFICATION	PRS	-	1	-	-	-	1
	ABS	3	20	10	1	5	39
FIRE AFFECTION	PRS	-	4	2	-	1	7
	ABS	3	17	8	1	4	33
SHAPING TYPE	IND	3	-	-	-	5	5
	0	-	-	-	-	-	3
	1	-	17	6	-	-	23
	2	-	6	5	1	-	12
	3	-	5	9	1	-	15
TOTAL		3	21	10	1	5	40

Note: See Appendix A for description of terms.

The correlation of bifacial use and flat surface shape exhibited among SD-2 millingstones may be an indication of functional variability in type and intensity/ extensity of use among the different shaping degrees.

Since there are no apparent differences in use of the ground surfaces by shaping degree, all other use wear data will be discussed together. There were equal numbers of flat and basined milling surfaces (19 each), with 12 that were slightly concave (Table 8.2). Surface textures tended to be smooth (44), exhibiting polish (51) and maintenance pecking (42). Striations were only observed on 19 surfaces. Secondary modification in any form was largely lacking.

Table 8.3. SBR-421A. Average complete metrics by artifact class and shaping*.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	0 / -	0 / -	5.4 / 2	3
Shp Deg 1	39 / 2	27.2 / 5	6.3 / 18	21
Shp Deg 2	34.1/ 2	25.9 / 2	4.2 / 10	10
Shp Deg 3	0 / -	0 / -	4.1 / 1	1
Avg Total	36.4 / 4	26.6 / 7	5 / 31	35
Handstones				
Shp Deg 0	13.1 / 12	8.6 / 15	4.5 / 17	21
Shp Deg 1	12.7 / 4	8.4 / 5	4.8 / 9	11
Shp Deg 2	12.4 / 7	8 / 7	4.8 / 7	11
Shp Deg 3	11.7 / 3	7.4 / 3	3.5 / 3	3
Avg Total	12.5 / 26	8.1 / 30	4.4 / 36	46

Scraper				
Form 1	8.4 / 2	6.5 / 2	4.3 / 2	2
Form 2	10.3 / 39	7.1 / 39	5.5 / 39	39
Avg Total	9.4 / 41	6.8 / 41	4.9 / 41	41

Note: *Includes only those artifacts complete enough to be categorized by shaping degree or form, does not **include indeterminate fragments; Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.**

All of the flat surfaces were used in a traditional grinding manner and pecking on these surfaces was consistent with surface resharpening. However, four basined surfaces were used differently. These basins were very small in diameter (avg. 15.5 cm), with a large ground platform. The use wear suggests that they were used for battering just as much as they were for grinding. The lack of pronounced margins on the basined edges, obscured by grinding into the basin, is evidence that they were probably not used in the traditional sense of a mortar. All other basins were typical in terms of grinding use wear.

Overall, the milling surfaces from Locus A were used with moderate intensity. There does not seem to have been a tendency to use these artifacts until exhaustion. The fragmentary nature of the assemblage is most likely the result of the weakness of schist which is highly susceptible to weathering. The low amount of formalization and the preponderance of crude shaping types used is an indication that millingstones were being expediently manufactured. That there is functional variation in the use of millingstones is evident by the high number of flat and concave surfaces. Flat surfaces tended to be associated with moderate degrees of shaping on millingstones that were used bifacially and that were smaller in size than the specimens with basined surfaces. Basined surfaces were used in two different ways, but all tended to be linked to slightly shaped millingstones that did not have auxiliary ground facets. These had the greatest mass of all millingstones at the site. Since the flat surfaces exhibited equal amounts of use wear, it does not seem to be the case that flat surfaces were evolving into basin forms. The implication of the variation in use by surface shape, shaping degree, and size is that there was functional variation in the use of millingstones at the site.

Handstones

Roughly a third (47 of 159) of the handstones recovered during excavations at SBR-421A were analyzed for evidence of use wear and formalization. The distribution of handstones was relatively split between strata 1 and 2 with a bias toward the upper 12 inches. In Stratum 1 (Horizon 2) there were 89 handstones, while the other 70 came from below 12 inches in Stratum 2. There did not seem to be any horizontal or vertical patterning of the different types defined by Kowta (1969).

Many handstones were in whole/near complete condition (26), together with 21 fragments of margins, ends and indeterminate sections. There is a considerable amount of diversity in the material profiles. Schist was the most widely represented with 19 specimens, followed by granite (14), quartzite (12), and sandstone (2). All of these materials occur in the geologic deposits near the site and in nearby drainages.

Variation in formalization was high with a slight bias towards low levels of shaping. There were 21 SD-0 handstones, 11 SD-1, 11 SD-2, and three SD-3 (see

Table 8.4). The SD-0 and SD-1 handstones were mostly made from the local schist or quartzite. Conversely, those of SD-2 and SD-3 were mostly made from granite.

Table 8.4. SBR-421A. Handstone attributes by shaping degree.

SHP DEGREE		0	1	2	3	IND	TOTAL
MATERIAL							
	SCH	10	6	2	-	1	19
	GRN	3	2	6	3	-	14
	SST	-	-	2	-	-	2
	META	-	3	1	-	-	4
	QZT	-	-	-	-	-	-
	QTZ	8	-	-	-	-	8
CONDITION							
	WHL/NC	13	4	6	3	-	26
	MRG	1	4	4	-	-	9
	END	7	3	1	-	-	11
	MED	-	-	-	-	-	-
	FRG	-	-	-	-	1	1
SURFACE FREQUENCY	1	10	2	3	-	1	16
	2	11	9	7	3	-	30
	3	-	-	-	-	-	-
	4	-	-	1	-	-	1
SURFACE SHAPE	F	-	-	-	-	-	-
	CV	16	8	8	5	-	37
	CX	-	-	-	-	-	-
	IND	16	12	13	1	1	43
SURFACE TEXTURE	S	24	15	20	6	1	66
	I	8	5	1	-	-	14
	IND	-	-	-	-	-	-
POLISH							
	PRS	32	20	21	6	1	80
	ABS	-	-	-	-	-	-
	IND	-	-	-	-	-	-
STRIAE							
	PRS	14	10	16	5	1	46
	ABS	18	10	5	1	-	34
	IND	-	-	-	-	-	-
PECKING							
	PRS	17	15	19	6	1	58
	ABS	15	5	2	-	-	22
	IND	-	-	-	-	-	-
END POLISH							
	PRS	-	1	4	3	-	8
	ABS	21	8	6	-	-	35
	IND	-	2	1	-	1	4
SECONDARY MODIFICATION	PRS	6	5	5	3	-	19
	ABS	15	6	6	-	1	28
FIRE AFFECTION	PRS	5	3	5	1	-	14
	ABS	16	8	6	2	1	33
SHAPING TYPE	IND	-	-	-	-	1	1
	0	21	-	-	-	-	21
	1	-	-	-	-	-	-
	2	-	2	5	3	-	10
	3	-	9	10	3	-	22
TOTAL		21	11	11	3	1	47

Note: See Appendix B for description of terms.

This difference in material selection was probably due to issues concerning material quality and durability. Granite is more durable than any other material represented, followed by quartzite, then sandstone and schist. Even though quartzite is hard, it does not function as well as the other materials for grinding because of its fine grained texture. The type of shaping was mostly grinding (22), while 10 had evidence of shaping through pecking.

Complete measurements of maximum length, width, and thickness are averaged by shaping degree in Table 8.3. These measurements exhibit a pattern of decreasing size with increasing shaping degree. When the average maximum measurements are multiplied together for each category an indicator of relative volume illustrates this decrease in size. The volume is 512 cm^3 for SD-1 handstones, 476 cm^3 for SD-2, and 303 cm^3 for SD-3 forms. The decrease in size is thought to be primarily the result of an increase in use intensity and regularity of form. It may also be due to raw material selection patterns where higher formalization is correlated with granite specimens. However, there are no quantitative data available from the area to speak to natural differences in size between schist and granite.

The variability in use wear patterns out very clearly among the shaping degree categories. As formalization increases in degree, the regularity of use wear also increases. This point is best illustrated when the attributes are compared by SD-0 and SD-1 handstones versus those in the SD-2 and SD-3 categories. SD-0 and SD-1 handstones were used on more than one surface 62% of the time. Surface shapes were split between flat (46%) and convex (54%), exhibiting smooth surface textures 75% of the time. These surfaces are usually polished (100%), with slightly more than half being pecked (61%), and slightly less than half showing striations (46%). Only one specimen shows end polish and only 11 were secondarily modified.

Conversely, SD-2 and SD-3 handstones have a greater percentage of specimens showing wear on more than one surface (71%). Surface shapes pattern similarly, being split between flat (48%) and convex (52%). There were a greater amount of smooth surfaces (96%) that were polished (100%), striated (78%), and pecked (93%). End polish was observed on 50%, with 57% being secondarily modified in some way. These data indicate that regularity of use wear increases with formalization.

Secondary modification occurred in four different ways: anvilling, end battering, end polish, and fire-alteration. Anvilling was observed on 6% of all handstones, such wear is presumably linked to some kind of hulling of seeds or to flaked stone reduction where the surface was used as a platform. The low occurrence of this attribute is an indication of its relatively low economic importance. The high frequency of handstones showing end battering (36%) and end polish (17%) hints at variability in the use of the end portion of handstones. Since end polish occurs mostly on the more formalized handstones, it is probably not the case that these tools represent incipient pestles, unless they were recycled, which is entirely possible. The end polish does not seem to be the result of indirect use wear but intentional use of the end for grinding. There is no pattern of a particular size correlation with end polish. On the other hand, battering is not uncommon and cannot be linked to the processing of a specific resource. This characteristic does attest to the importance of battering in the general processing regime in that it is seen in other tool categories.

The handstones from Locus A show a considerable amount of variation in use which patterns by the degree of formalization. Though most seem to have been used on a more expedient basis, there are those which seem to have been used more regularly and intensively. Unfortunately, there is not enough information available to discuss the patterning of attributes by location or depth. Excavation was limited at Locus A, as was the stratigraphy (Basgall and True 1985), suggesting that little could be learned from this information.

Scraper Planes

A sample of 41 scraper planes of 257 recovered from Locus A was analyzed. Roughly two thirds come from the surface and upper 12 inches of the deposit. The other 95 were recovered from Stratum 2. In that the separation of strata 1 and 2 is somewhat arbitrary in terms of assemblage patterning, the significance of this distributional bias is limited. This is especially true given the high amount of post depositional disturbance created by rodent action.

The majority of scraper planes were made from locally available igneous stone (29), with others made from basalt (1), cryptocrystalline (3), quartzite (3), quartz (2), felsite (1), and rhyolite (2). The material profiles closely match those of the entire tool class. Only basalt and cryptocrystalline are extralocal in origin. It is probably the case that the latter materials were scavenged for secondary use as scraper planes and battering implements.

No significant differences were observed according to use wear or form between the different material types, largely due to sample size. The most variation is seen within the igneous material category since it contains the highest frequencies. Aside from the material separations, there is variability in use present in the scraper plane sample (Table 8.5).

Table 8.5. SBR-421A. Scraper plane attributes by material type.

	BAS	CCR	QZT	QTZ	FEL	RHY	META	IGN	OTH	TOTAL
FORM										
1	1	-	-	-	-	-	-	1	-	2
2	-	2	3	2	1	2	-	25	-	35
3	-	1	-	-	-	-	-	3	-	4
FLK TYPE										
1	1	-	-	-	-	-	-	1	-	2
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-
IND	-	-	-	-	-	-	-	-	-	-
EDGE FREQ										
1	1	3	3	2	1	2	-	29	-	41
2	-	-	-	-	-	-	-	-	-	-
EDGE FRM										
1	1	3	2	2	1	2	-	29	-	40
2	-	-	1	-	-	-	-	-	-	1
EDGE SHP										
1A	-	-	-	-	-	-	-	-	-	-
1B	-	-	-	-	-	-	-	-	-	-
2A	1	-	1	1	-	1	-	14	-	18

2B	-	3	2	1	-	1	-	11	-	18
3A	-	-	-	-	1	-	-	2	-	3
3B	-	-	-	-	-	-	-	2	-	2
4	-	-	-	-	-	-	-	-	-	-
E WEAR										
0	-	-	-	-	-	-	-	3	-	3
1	1	2	1	1	1	1	-	18	-	25
2	-	1	1	-	-	1	-	5	-	8
3	-	-	1	1	-	-	-	3	-	5
E POLISH										
PRS	1	1	3	2	1	2	-	23	-	33
ABS	-	2	-	-	-	-	-	6	-	8
STP FRAC										
PRS	1	2	2	2	1	1	-	24	-	33
ABS	-	1	1	-	-	1	-	5	-	8
INT POLISH										
PRS	1	1	1	-	1	1	-	7	-	12
ABS	-	2	2	2	-	1	-	22	-	29
SEC MOD										
PRS	-	1	1	2	1	-	-	6	-	11
ABS	1	2	2	-	-	2	-	23	-	30
TOTAL	1	3	3	2	1	2	-	29	-	41

Note: See Appendix C for description of terms.

Thirty-five scraper planes were made from a cobble base, two from primary decortication flakes, and four could not be assessed to original form (see Table 8.5). Metrical summaries of average maximum length, width, and thickness separated by original form are listed in Table 8.3. These measurements show that scraper planes made from cobbles tend to be larger than those made from flakes. The average maximum length of flake-based scraper planes is 8.4 cm, 6.5 cm for width, and 4.3 cm for thickness. When these measurements are multiplied, the resulting average maximum volume for flake-based scraper planes is 235 cm^3. The average maximum length of cobble-based scraper planes is 10.3 cm, with a width of 7.1 cm, and a thickness of 5.5 cm. The average maximum volume for cobble-based scraper planes is 402 cm^3.

Cobble-based specimens have an average of 167 cm^3 more volume than those made from flakes. The preponderance of cobble-based forms suggests that it was a more preferred form in terms of functional capabilities. If these tools were used for heavy processing, then the larger mass might include a functional advantage by reducing the work required to process certain resources. None of the typologies suggested by Kowta (1969) were found to be associated with specific metrical tendencies.

All edges were unifacial in form, a characteristic historically used to identify this tool type. There are a diversity of edge shapes on scraper planes with all but a perimeter edge shape being accounted for. Edge shapes mainly took two forms;

convex-regular (18), and convex-irregular (18). A minority of edges were straight regular (3) and straight irregular (2). There were no correlations between any one type of edge shape or indication of edge wear.

Diversity in edge wear is also relatively high with all types exhibited on at least some specimens. The great majority of edges exhibited unifacial microchipping (25) while bifacial microchipping and battering until dull were not uncommon (8 and 5 specimens, respectively). The diversity in edge shapes and edge wear implies that edges in general were not very formalized either through initial manufacturing, use, or maintenance.

The occurrence of edge polish and step fracturing were both observed on 33 edges while interior polish was not as common, occurring on only 12 of the opposing surfaces. The observance of polish and step fracturing on the edges is an indication that they were exposed to some degree of downward and lateral pressure.

The measurement of edge angles, spine plane angles, and maximum flake scar lengths revealed that these tools were being resharpened by edge flaking. The mean edge angle was 83^0 and the mean spine plane angle was 69^0. The large disparity of 14 degrees suggests an altering of the original edge form over time. Statistically, edge angles saw greater variation in form than did spine plane angles. The latter is characterized by a standard deviation of 7.5^0 while the standard deviation for edge angles was 13^0. This suggests that the original edge form of the tool defined by its spine was relatively regular while the change in edge angles over time was more irregular; some being altered with use and maintenance more than others. In six cases (seen in Appendix C), the edge and spine plane angles were within 5^0, indicating relatively little alteration. In essence, edges did not experience high degrees of formalization. A maximum flake scar length average of 1.57 cm is much smaller than the kind of flake tools recovered (depicted in Kowta 1969), suggesting that the last flakes removed from scraper planes were not intended to be used as tools, but were more likely the result of edge sharpening. This correlates well with the disparity between edge and spine plane angles of 14^0. The greater the disparity, the more likely it is that there was an altering of the edge over time with use.

Overall, scraper planes at the site saw variation in the regularity of manufactured form and edge form caused by use. This is indicated by the high diversity of edge shapes, edge wear, and edge metrical characteristics. These tools did not experience high degrees of formality through use. However, the use wear does indicate that they were exposed to at least moderate levels of use intensity, short in duration as it may have been. Whether these tools originated as cores is not clear; a question that can only be answered by an analysis of the debitage profiles which are not available. It is clear that scraper planes were used as tools before being discarded.

Non-Analyzed Tool Categories

Other artifact classes that were not analyzed are listed in Table 8.1. Those that appear to have functional overlap with handstones and scraper planes include choppers (43), hammers (97), and some kinds of scrapers (171). Handstones not only have ground wear facets but were also battered and ground on the ends. Similarly, scraper planes were also used for battering on occasion. Informal observations on hammers and choppers revealed that the majority seem to have been battered (that which characterizes their primary function) but some also had auxiliary ground facets on flat surfaces and sometimes on the ends. The scraper tool class has affinities to the more bulky scraper plane although the kind of scraping activities were probably different. Little investment in the form of choppers, hammers, and most scrapers is indicated by the fact that these tools were not very regular in terms of form or edge characteristics. In any case, the general functions of battering and scraping seem to cross cut the aforementioned tool categories and attest to the economic importance of such activities at the site. The stratigraphic occurrence of these tool categories shows that they correspond to the general assemblage pattern of being concentrated in the main cultural strata.

The strong presence of a more formalized flaked stone component at this site is felt among the numerous projectile points and bifaces (147), cores (304), and flake tools that were grouped as scrapers and could not be separated out for this report. These tools were noted to have been more refined in form and were predominantly made from chert, quartz, and obsidian (Kowta 1969; Basgall and True 1985). All of these materials are extralocal to the region. The flaked stone analysis conducted by Gilreath and Jackson for other sites of the Sayles Complex revealed that cherts were mainly imported in reduced core form with some coming into the area in bifacial/tool form (see Basgall and True 1985:Appendix A). Obsidian was exclusively imported in the form of tools. Kowta (1969) notes that formalized flaked stone tools tend to cluster in the upper reaches of the deposit, possibly indicating a functional shift in site use primarily toward a faunal procurement system later in the occupational history of the site. He illustrates this in a comparison between his loci b and a where the separation between strata 1 and 2 occurs at 6 inches in the former and 12 inches in the latter. The validity of this claim is offset by the high amount of post depositional disturbance that most likely had an effect on the vertical distribution of all artifacts. It is also the case that most handstones and scraper planes occur in the upper 12 inches of the deposit. In that the difference between strata 1 and 2 is ambiguous, the proposed shift looses significance. Kowta also equates most of the scraper types with animal processing duties. The technological analysis of nearby sites speaks against this claim, suggesting that the majority of flake tools were manufactured and used in a manner consistent with vegetal processing. Whatever the case, it is clear that the high frequencies of points and bifaces indicate that they were an economically significant component of subsistence activities.

Summary and Conclusions

The deposit of SBR-421, Locus A, is characterized by a cultural matrix ambiguously divided into two strata which overlay a sterile basal substrate. The difference between Stratum 1 and 2 is best explained as resulting from natural processes that altered the upper layers through the combined action of plants, rodents, aeolian, and chemical processes. This would better account for the difference in soil color, composition, and compaction. This does not preclude the notion that the darker character of Stratum 2 is the result of a more extensive history of site use. The lack of a well defined break between the two strata prohibits fine grained discussion of the vertical distribution of the different assemblage constituents. As Table 8.1 clearly shows, differences in artifact frequency by 6 inch levels does not support any claims of functional shifts in site use by the vertical patterning of different artifact classes.

The lack of any cooking facilities at the site is very significant in light of the low amount of subsistence remains recovered. Though the poor recovery of ecofactual material may have been due to methodological constraints, had there been deposition of such material, it would imply that such resources were being processed on-site. This would further support the expectation of the occurrence of processing facilities. The kinds of features that were present took two forms. Two were probably refuse piles and two were caches of millingstones. The latter is significant in that it implies the anticipation of return. The logical extension of this is that the occupants were not occupying the area full time.

The site SBR-421, Locus A, has an assemblage that consists mainly of processing tools such as millingstones, handstones, scraper planes, choppers, hammers, and scrapers. The analyses of millingstones and handstones revealed important functional variation. Though the majority of millingstones seem to have been prepared for use in the immediate vicinity, indicated by the low levels of formalization, some may have seen use in other contexts. The latter are mostly associated with specimens that are smaller on average and tend to be bifacial with surfaces that are flat. On the other hand, some basined millingstones seem to have been used as pulverizing basins in the middle of a ground platform while other basined millingstones were large and used mostly for grinding. These different millingstone characteristics do not pattern spatially, suggesting that the kind of processing activities that characterized the main occupation of the site varied widely. This is supported by the analysis of handstones which show a wide variety of shaping degrees. Handstone use ranged from those that were expediently manufactured and incipiently used to those that saw moderate to high levels of formalization and were relatively intensively used. The preponderance of higher quality materials among more refined handstones suggests that they were intended to be more durable and reliable, possibly intended for use in off-site contexts.

Variation in use is also present among the analyzed sample of scraper planes. Most of these tools were informally manufactured but had a consistent spine plane angle that only varied by 7.5^0. This angle was differentially modified among all scraper planes, seeing edge angles that averaged 83^0 but varied each way by 13^0. The variety of edge shapes and edge wear attests to the low regularity exhibited among the working edges of scraper planes. All of this adds up to a picture of manufacturing for quick yet moderate to intensive use. It is probably not the case that these tools were intended to be maintained in a tool kit for prolonged periods of time; also indicated by the whole condition of all specimens and the use of local materials.

Points, bifaces, formed flake tools, and other flaked stone artifacts make up a very significant portion of the assemblage. These tools tend to be made from materials uncommon to the area. Most of the points, bifaces, and heavily retouched flake tools were discarded in a well-used and nearly exhausted state. Most of the more formed tools were most likely maintained in a tool kit for long periods of time, used in a variety of contexts. The lack of information regarding certain kinds of flake tools inhibits discussion of reduction strategies and raw material use. Many of the tools described by Kowta (1969) resemble those analyzed by Gilreath and Jackson (1985) as being manufactured, used, and discarded on-site. It may be the case that they were made from imported prepared cores of chert/chalcedony to compliment a vegetal processing regime. Whatever the case, the implied variation in flaked stone tool usage is important to the interpretation of subsistence activities involving the site. Some of this variation probably stems from a more residentially mobile aspect of the cultural system, while the redundant patterning of the more simple flake tools in terms of manufacturing and use facilitated food processing while the site was occupied.

The original interpretation given by Kowta (1969) of the Sayles site complex defined as an intense specialization on the processing of agave does not hold up under the implications of the analyses of certain artifact classes. If the primary reason for occupying this site and nearby locations was for such a purpose, then the assemblage would be expected to reflect very little variation in terms of both artifact manufacture and use. Contrarily, there is a relatively good amount of functional variation within and between tool kinds. The millingstones seem to have been used in three distinct ways and manufactured for two different purposes. Some seem to have been quickly made for light duty pulverizing in the immediate vicinity while others saw slightly more investment in form with surfaces that were more used for flat grinding. Handstones reflect as much with some that have evidence of auxiliary functions on the ends and others were probably made for prolonged and unpredictable use.

More directly related to Kowta's (1969) hypothesis, the scraper planes experienced very little formalization and saw a wide range of uses, ranging from planning to battering. The lack of high degrees of regularity in use and form goes against the idea that they were made solely for the purpose of exploiting a singular resource. If scraper planes were only used for the intensive exploitation of agave, then it would be expected that the tools were more regular in form, and exhibited highly regular patterns of use. Of course, this interpretation does not preclude the use of scraper planes for the processing of agave or yucca. This probably was one of the many uses of scraper planes and other processing implements at the site as replication analyses suggest (Kowta 1969; Salls 1983).

The functional overlap between scraper planes, heavy scrapers, hammers, choppers, and end battered handstones speaks to the overall generality of the bulk of this assemblage. At most, this generality indicates that many subsistence demands were solved through the use of these tools, rather than made to suit a particular exploitation strategy. The high frequency of all of these kinds of tools attests more to the extensity of site occupation and a strategy that favored expedient manufacturing followed by at least moderate use. When the formalized flaked stone component is added to the picture, it suggests that the settlement system employed at least moderate degrees of residential mobility. The sheer size of the assemblage speaks to its importance as some kind of residential hub.

The data on use wear and formalization corroborate the conclusions of Basgall and True (1985), who suggested that the site was host to a number of occupations with similar exploitative strategies. Some artifacts probably saw much reuse as others were expediently manufactured for use on-site. The redundant nature of the different occupational episodes resulted in the gross accumulation of ground and battered stone implements. The technological organization of the occupants who used Locus A was primarily geared toward intensive vegetal exploitation. A number of different vegetal resources were probably exploited. The time frame for occupation of 1000 to 3000 years ago places the use of the site during a time when resource exploitation strategies in surrounding areas were diversifying, and in some cases, intensifying on specific resources such as acorns. It is not impossible to think that the slight evidence of functional variation evident on some of the artifacts may be evidence of one of these strategies, but no single resource exploitation strategy can characterize the use of this site.

Chapter 9:

Sayles Site, Locus C; CA-SBR-421C

The Sayles Site, Locus C (CA-SBR-421C), has been frequently cited as an important component of the Sayles Complex. This site exists in the Crowder Canyon area of the Transverse Ranges near Cajon Pass. White (1973) and Binning (et al. 1981) summarize their initial excavations of the site that occurred under the guise of the California Department of Transportation. More recent investigations by Basgall and True (1985) revisited the collections in an effort to better understand the prehistoric use of the area. Much of the distributional information and stratigraphic interpretation is taken from Basgall and True (1985) who exhaustively reviewed the available data; some information has been lost since the collection was initially acquired and curated.

The Sayles site complex represents a late inland occurrence of the Millingstone pattern that seems to have reached its climax during the last 2500 years. Kowta (1969) originally interpreted sites associated with the Sayles Complex as the result of semi-sedentary populations that specialized on the processing of yucca and agave. Later interpretations suggest that more sporadic and generalized use lead to site formation based on assemblage patterning (Basgall and True 1985).

The general area around the site is characterized by chamise chaparral plant communities which include such plants as chamise, yucca, sparse grasses, manzanita, and some larger sycamore trees near the adjacent Crowder Creek (Basgall and True 1985). Local access to juniper and other pinon zone resources exists in the higher elevations. Fauna in the area include both large and small mammals along with numerous taxa of reptiles and birds. Ecofactual remains recovered from the site are most represented by juniper seeds and deer bone, suggesting that these were some of the most economically important subsistence resources.

Kowta (1969) assessed the prehistoric use of the entire Sayles Complex based on geologic processes and assumed cultural/assemblage affiliation. He offered a temporal range for the primary occupation of the area of 1000 to 3000 years ago. During this time Kowta suggests that desert traditions were mixing with the inland coastal basin groups.

More specific to Locus C, the chronology has been assessed by radiocarbon and obsidian hydration dating, along with time sensitive artifacts (Basgall and True 1985:7.6). The one radiocarbon determination came from a small sample that yielded a date of 5370 ± 220 years BP The authors note that this sample was small enough to have been subject to contamination, especially given the lack of refined methods at the time of sampling. A total of 21 obsidian hydration readings were taken with the majority coming from the Coso volcanic field (18), one from Obsidian Buttes, and two from an unknown source. Those samples from the Coso locality suggest a time span of 1650 to 2800 years BP (Basgall and True 1985:7.9). The estimates of chronology based on projectile points are somewhat divergent. Seven points are noted to either belong to the Elko or Pinto/Little Lake series. Elko points are known to date between about 1350 and 3150 BP, while Pinto series forms are thought to date primarily between 4000 and 7500 years BP in the southern Mojave desert. Overall, chronometric data from Locus C indicate that the site was primarily occupied between 1650 and 2800 years BP, with sporadic earlier occupations possibly occurring around 5000 years BP. These data closely parallel the estimate offered by Kowta who was only working with rates of tectonic uplift and presumed cultural patterning.

The site is about 200 m long (N/S) and about 110 m wide (E/W), with two distinct clusters of occupation debris, one at the datum and one to the south approximately 35 meters (Basgall and True 1985). Locus C has witnessed extensive surface disturbance from the insertion of a pipeline. The presence of unkempt roads and installed utility lines are indicated on site maps (Basgall and True 1985:7.2). The ease of access to the area could have had some effect on the surface assemblage that would have been exposed to scavenging. In light of the extensive disturbance, excavations were focused on a smaller concentrated area towards the southern end of the site where the subsurface deposit seems to have been mostly intact. The available stratigraphic and subsurface distributional data does not account for the entire deposit but represents a sample of the more intensively occupied areas. It is probably true that some distributional variation has been lost from the interplay of both archaeological and commercial excavation such that the available data cannot speak to the full range of occupational history for this location.

The subsurface is characterized by cultural debris being recorded to depths of up to 95 cm in two strata (Basgall and True 1985:7.3). The first Stratum is light gray in color which existed above a much darker true midden deposit. Stratum 1 primarily exists below a five centimeter thick overburden and ranges from 12-50 cm in depth; averaging 20-30 cm thick. Most cultural debris was reported to have come from Stratum 2 which rested on a lower, sterile subsoil. The thickness of Stratum 2 ranges from 25-70 cm and overlaps with Stratum 1 in a transitional zone that can be approximately 10-20 cm thick. The separation between the two strata is not definite in composition or depth and is described as a gradient (Basgall and True 1985:7.3). Some mixing is also thought to have occurred because of burrowing activity. However, the more prominent artifact distributions are thought to be intact. The most developed, or least disturbed, midden component was located at the southern portion of the site where most excavations were concentrated.

Extensive surface and subsurface collection lead to the compilation of a large assemblage dominated by millingstones, handstones, battered cobbles, scraper planes, and numerous flaked stone artifact classes, among others (Table 9.1). The distribution of artifacts at Locus C followed the three defined strata. While the uppermost Stratum 1 contained a fair amount of artifactual remains, the highly developed midden of Stratum 2 held the majority of artifacts and ecofacts, with some spillage into the lower, mostly sterile, Stratum 3. Other spatial variation within and between artifact classes was noted during mitigation and is addressed in each analysis section.

Table 9.1. SBR-421C. Artifact frequency by recovery method.

Artifact	Control Units	1974 Trench	Surface	Unknown	Total
Millingstone	15	24	17	5	61
Handstone	124	149	79	11	363
Mortar	-	-	-	-	-
Pestle	-	1	-	-	1
Oth.	5	10	7	1	23
Scraper	61	44	180	-	285
Chopper	16	5	17	-	38
Hammer	40	18	78	-	136
Scraper	84	13	99	-	196
Core	-	-	-	-	*
Sm. FLKTL	7	-	8	-	15*
Point /	25	2	2	-	29
Other Misc.	-	-	-	3	3

Total	377	266	487	20	1150

Note: *, the separation of formed and simple flake tools is vague, while the actual number of cores is unknown; Artifact Frequencies taken from Basgall and True (1985, chapter7).

Four subsurface features were found at SBR-421C. One is a concentration of groundstone, fire-affected rock, and unaltered stone, another a cluster of four millingstones, one handstone, and some fire-affected rock, and the third a concentration of fire affected rock in an apparent hearth context. Only the second of these three has any structural integrity suggesting that it was some kind of processing facility. The fourth feature was named as a burial but no substantive evidence exists to support this claim.

Separate investigations of SBR-421C in Crowder Canyon have lead to a variety of site interpretations. The wealth of multilevel information provided by these studies in addition to that generated through analyses of millingstones, handstones, and scraper planes, is conducive to developing a more whollistic understanding of the organization of technology that characterized this site and the greater Sayles Complex.

Millingstones

Fifty millingstones out of 61 recovered from SBR-421C, were located for analysis. The remaining 11 could not be found, most likely due to inter-institutional loan from the host facility.

The distribution of all millingstones from the site is reported to have been biased with respect to surface shapes though no quantitative information is available (Basgall and True 1985:7.26). Flat surface millingstones dominated the site's surface contexts and were most frequent in the upper reaches of the deposit. Conversely, basined millingstones were dominant in the lower strata and were rarely observed on or near the surface. The large size of millingstones in general suggests that their post-depositional location would change little according to natural processes except being biased toward the lower levels to some degree. Their distribution is assumed to mostly reflect the reality of post-use deposition.

A large portion of millingstones (41) were made from schist, while others were made from granite (7), sandstone (1), and rhyolite (1). All of the materials were locally available. Only two were complete enough to be classified as whole or near-complete. Most were fragments of margins (27), ends (7), or indeterminate pieces (14). Schist is not very resistant to weathering and could have been broken easily while in use, or in post depositional contexts.

Thirty-three millingstones could be classified by complete maximum thickness measurements according to Figure 1. Thin millingstones were most represented, numbering 18, followed by those that were thick (12), with two classified as block and one as boulder. Metrical summaries (Table 9.3) show that millingstone thickness is slightly biased according to shaping degree. The difference in average maximum thickness of SD-0 and SD-2 millingstones is not great, at 2.0 cm. The difference is enough to show that thinner millingstones were more shaped. The preponderance of thin millingstones, categorically and metrically is most likely a factor of the nature of schist, which tends to occur thin, and which also tends to exfoliate, becoming thinner with weathering.

Millingstones are mostly SD-0 (25) or SD-1 (8) forms, with only two SD-2 specimens; 15 could not be classified by degree of shaping (see Table 9.2). The type of shaping observed was restricted to flaking on five specimens and grinding on eight specimens. This may be explainable in terms of material type in that the exfoliative nature of schist is such that flaking of protrusions is incredibly easy, as is ephemeral grinding of sharp protrusions. Thus, pecking is not really necessary as a means of more expedient shaping. Battering of protrusions may have actually been detrimental to the tool in that it could have caused fracturing within the material and premature breakage.

Use wear did not really pattern by shaping degree in that most could be categorized as SD-0 or SD-1. The SD-2 millingstones (2) did tend to show more intensive wear in that striations and pecking were observed on the surfaces. SD-0 and SD-1 millingstones tended to be used on only one surface (81%) though some were bifacial. Flat and basined surfaces were relatively proportional in frequency (33% and 43%, respectively), but when slightly concave surfaces are factored in at 24%, the use of any kind of concave surface seems to have been more preferred. Most of the ground facets on SD-0 and SD-1 ground surfaces were smooth (79%), polished (100%), and pecked (70%), but generally lacked striations (61% without). Likewise, evidence of secondary use is nearly absent observed only as fire affection. Since schist and gneiss tend to show striations more often with less intensive use, the lack of observance of this attribute on most milling surfaces has functional implications either related to kind or intensity of use.

The fragments that could not be categorized by shaping degree exhibited attribute frequencies much the same as the other millingstones. Most were unifacial (80%) as only three specimens had ancillary surfaces that were only slightly used. Interestingly, 13 out of the 18 surfaces were flat and only five were basined in shape. The proveniences of these fragments are unknown, eliminating the possibility of determining vertical distribution.

Table 9.2. Millingstone attributes by shaping degree.

SHP DEGREE		**0**	**1**	**2**	**3**	IND	**TOTAL**
MATERIAL							
	SCH	18	8	1	-	14	41
	GRN	5	-	1	-	1	7
	SST	1	-	-	-	-	1
	GRA	-	-	-	-	-	-
	SIL	-	-	-	-	-	-
	VOL	1	-	-	-	-	1
CONDTION							
	WHL/NC	2	-	-	-	-	2
	MRG	20	5	1	-	1	27
	END	3	3	1	-	-	7
	FRG	-	-	-	-	14	14
SURFACE FREQUENCY	1	20	7	2	-	12	41
	2	5	1	-	-	3	9
	IND	-	-	-	-	-	-
SURFACE SHAPE	B	10	3	2	-	5	20
	F	13	4	-	-	13	30
	SCV	7	2	-	-	-	9
	SCX	-	-	-	-	-	-
	IND	-	-	-	-	-	-

SURFACE TEXTURE	S	23	8	2	-	14	47
	I	7	1	-	-	4	12
	IND	-	-	-	-	-	-
POLISH							
	PRS	30	9	2	-	18	59
	ABS	-	-	-	-	-	-
	IND	-	-	-	-	-	-
STRIAE							
	PRS	13	2	2	-	6	23
	ABS	17	7	-	-	12	36
	IND	-	-	-	-	-	-
PECKING							
	PRS	19	8	2	-	11	40
	ABS	11	1	-	-	7	19
	IND	-	-	-	-	-	-
SECONDARY MODIFICATION	PRS	-	-	-	-	-	-
	ABS	25	8	2	-	15	50
FIRE AFFECTION	PRS	7	1	1	-	6	15
	ABS	18	7	1	-	9	35
SHAPING TYPE	IND	-	-	-	-	15	15
	0	25	-	-	-	-	25
	1	-	4	1	-	-	5
	2	-	-	-	-	-	-
	3	-	6	2	-	-	8
TOTAL		25	8	2	-	15	50

Note: See Appendix A for description of terms.

Surfaces tended to be smooth (78%), polished (100%), and pecked (67%) but lacking striations (67% w/o). Fire-alteration was found on 40% of the fragments. Aside from the dominance of flat surfaces, those of indeterminate fragments were used in the much the same way as those categorized by shaping, giving no reason to think that their condition is the result of more intensive use than the more complete specimens.

There are differences in use between the different surface shapes. Although polish was observed on all surfaces, 67% of flat surfaces were smooth, 89% of slightly concave surfaces (SCV) were smooth, and 100% of basined surfaces were smooth. This latter category is evidence that basins were used for grinding more than pulverizing. Striations occurred on 40% of flat surfaces, 78% on those which were slightly concave, and on 30% of basins. Pecking for surface maintenance was seen on 53% of flat surfaces, 55% of slightly concave surfaces, and on 100% of basin surfaces. These numbers seem to indicate an increase in use intensity as surfaces become more concave. This is not taken as evidence of surface evolution from flat to basined surfaces. Flat surfaces are thought to have been used differently than basined surfaces in terms of grinding motor function (Basgall and True 1985). In fact, the high percentage of striations observed on flat millingstones in contrast to basined millingstones is evidence of this difference in function. Obviously, basined millingstones had to become concave either through direct shaping of the surface or through use. A combination of basin shaping and use is the most likely scenario, but weeding out which millingstones are predecessors to basined forms is extremely problematic.

Approximately 30% of the basined surfaces are atypical. These tend to be small in diameter (between 10 and 20 cm, average 16 cm) and moderate in depth (average 4 cm). They do not have defined margins but are slightly melded with the surrounding ground flat surfaces through grinding. The wear on these basin surfaces is consistent with light pulverization and intensive grinding. They can be described as resembling portable cupule mortars in a gross sense but were used more like millingstones.

The millingstones from SBR-421C exhibit no evidence to suggest that high investment in the exterior form was a commonly employed strategy when manufacturing these tools. The nature of schist in the area is such that little would need to be done in order to reduce mass. The use wear data indicate that millingstones saw at least moderate degrees of use. Whether they were more extensively or intensively used is a question that can only be answered in context of the other tool categories. The variability in use and deposition of the different milling surface shapes indicates that functional variation existed in the use of these tools; this is most likely a temporal phenomenon.

Handstones

Handstones represent the single largest category of artifacts recovered from SBR-421C (Table 9.1). Of 363 recovered from the site, 49 (14%) were selected for analysis. Among all handstones, there seems to be a some patterning in deposition according to surface shape. Those handstones with flat surfaces occur more on the surface than in subsurface contexts, and those with convex surfaces occur more in subsurface contexts than on the surface (Basgall and True 1985:7.26). Overall, the majority of handstones were found in subsurface midden contexts. This vague pattern can only be suggestive of what the occupation of the site would have revealed barring disturbance.

Table 9.3. SBR-421C. Average complete metrics by artifact class and shaping*.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	29.6 / 3	18.3 / 4	6.3 / 21	25
Shp Deg 1	0 / -	25.3 / 2	4.4 / 6	8
Shp Deg 2	0 / -	13.5 / 1	4.3 / 2	2
Shp Deg 3	0 / -	0 / -	0 / -	0
Avg Total	29.6 / 3	19 / 7	5 / 29	35
Handstones				
Shp Deg 0	10.2 / 15	8.1 / 4	5 / 20	20
Shp Deg 1	10.4 / 13	8 / 16	5.4 / 19	20
Shp Deg 2	11.6 / 4	8 / 6	5 / 7	7
Shp Deg 3	11.7 / 1	8.5 / 2	4.9 / 2	2
Avg Total	11 / 33	8.2 / 28	5.1 / 48	49
Scraper				
Form 1	8.5 / 3	7.8 / 3	4 / 3	3
Form 2	9.2 / 36	7.2 / 36	5.2 / 36	36
Avg Total	8.9 / 39	7.5 / 39	4.6 / 39	39

Note: *Includes only those artifacts complete enough to be categorized by shaping degree or form, **does not** include indeterminate fragments; Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.

Material profiles show that granite was the most represented (59%), followed by sandstone (20%), schist/gneiss (12%), and igneous (9%). These material profiles essentially parallel those for the entire handstone assemblage with all materials being available in the local vicinity (Basgall and True 1985:7.23). Most handstones were whole or near-complete (34, 69%), while the others were fragments of margins (11, 22%), ends (1 example), or medial sections (1 example). Proportionately, no material type contained more fragments than another.

Little investment in the form of handstones was observed. SD-0 (41%) and SD-1 handstones (41%) accounted for the majority, followed by SD-2 (14%) SD-3 (4%) specimens (Table 9.4). Metrical summaries provided in Table 9.3 show an interesting pattern among the shaping degrees. As shaping degree increases, the overall size of the handstone according to length and width increases. The differences are most pronounced when SD-0 and SD-1 handstones are compared to SD-2 and SD-3 specimens according to length. SD-0 and SD-1 categories are characterized by lengths of 10.2 and 10.4 cm; SD-2 and SD-3 handstones have length measurements of 11.6 and 11.7 cm, respectively. Overall, there is a 1.5 cm difference in length between SD-0 and SD-3 handstones. Though not a drastic change, it becomes significant in light of the fact that end polish was nearly exclusively observed on SD-2 (30%) and SD-3 (100%) handstones. The correlation of greater average maximum lengths and end polish with higher degrees of formalization is indicative of functional variation among the different shaping degrees. Basgall and True (1985:Table 7.7) noted 12 handstones in the collection that were typed as “pestle ended” indicating that some tools were probably used in a manner not inconsistent with that of a pestle. Though less significant in terms of sample size, all five handstones that exhibited end polish had convex ground surfaces. The exact provenience of these particular handstones is unknown, making the correlation with the deposition of convex surfaces toward the lower strata purely speculative. The increase in formalization was most likely not the result of modification for portability, because of the size increase. It was more likely linked to a need for increased perimeter modification due to the increase in tool size and additional functional demands.

Aside from end characteristics, only slight differences in use were observed between the shaping degree classifications. Shaping degrees SD-2 and SD-3 were all bifacial with surfaces that were convex (100%), smooth (94%), polished (100%), striated (94%), and pecked (94%). In fact, there was only one surface on a handstone shaped to the second degree which was irregular and lacked evidence of use wear beyond polish.

Handstones that were SD-0 or shaped to the first degree exhibited use wear patterns not unlike the higher shaped specimens, but included more variation. The tendency among these handstones was toward bifacial use (75%), with surfaces characterized by convex shapes (86%), smooth textures (87%), polish (97%), striations (81%), and pecking (70%) (Table 9.4).

Table 9.4. Handstone attributes by shaping degree.

SHP DEGREE	0	1	2	3	IND	TOTAL
MATERIAL						

	SCH	4	1	1	-	-	6
	GRN	11	13	3	2	-	29
	SST	3	5	2	-	-	10
	META	-	-	-	-	-	-
	QZT	-	-	-	-	-	-
	QTZ	-	-	-	-	-	-
	IGN	-	-	-	-	-	-
	FEL	2	1	1	-	-	4
	GRA	-	-	-	-	-	-
	BAS	-	-	-	-	-	-
	RHY	-	-	-	-	-	-
CONDITION							
	WHL/NC	17	12	4	1	-	34
	MRG	1	-	-	-	-	1
	END	2	6	2	1	-	11
	MED	-	-	1	-	-	1
	FRG	-	-	-	-	-	-
SURFACE FREQUENCY	1	8	2	-	-	-	10
	2	12	18	7	2	-	39
	3	-	-	-	-	-	-
	4	-	-	-	-	-	-
SURFACE SHAPE	F	2	7	-	-	-	9
	CV	-	1	-	-	-	1
	CX	30	30	14	4	-	78
	IND			-	-	-	-
SURFACE TEXTURE	S	25	36	13	4	-	78
	I	7	1	1	-	-	9
	IND	-	1	-	-	-	1
POLISH							
	PRS	32	36	14	4	-	86
	ABS	-	1	-	-	-	1
	IND	-	1	-	-	-	1
STRIAE							
	PRS	26	31	13	4	-	74
	ABS	6	6	1	-	-	13
	IND	-	1	-	-	-	1
PECKING							
	PRS	16	33	13	4	-	66
	ABS	16	4	1	-	-	21
	IND	-	1	-	-	-	1
END POLISH							
	PRS	1	-	2	2	-	5
	ABS	18	19	4	-	-	41
	IND	1	1	1	-	-	3
SECONDARY MODIFICATION	PRS	13	17	5	2	-	37
	ABS	7	3	2	-	-	12
FIRE AFFECTION	PRS	5	13	4	2	-	24
	ABS	15	7	3	-	-	25
	IND	-	-	-	-	-	-
SHAPING TYPE	0	20	-	-	-	-	20
	1	-	-	-	-	-	-
	2	-	13	7	2	-	22
	3	-	12	7	2	-	21
TOTAL		20	20	7	2	-	49

Note: See Appendix B for description of terms.

The slight decrease in the percentage of observation for each attribute is an indication that they were subject to slightly less intensive use.

Secondary modification was manifest in all shaping classifications with respect to end battering and fire-alteration. End battering was recorded on 77% of all handstones analyzed, with the majority of those lacking end battering coming from the SD-0 category (7 specimens, 59%). This attribute is relatively common and speaks to the generalized nature of this tool. Exactly half were fire-affected, the majority of those lacking fire affection again coming from the SD-0 category (15 handstones, 62%). Burning is evidence of use in secondary contexts such as hearth or heating stones. That the SD-0 handstone category contains the most specimens not used in secondary contexts probably relates to the idea that the longer a handstone is used, the more likely it is to be used in different contexts which produce different kinds of wear attrition.

Use wear did not vary by surface shape. Flat surfaces exhibited attribute patterning equal to that of convex surfaces. This suggests that there was a functional difference in the use of the two types of surface shapes. This gives more meaning to the biased distribution of handstones observed by Basgall and True (1985), suggesting that there may have been a temporal shift in processing strategies later in the history of site occupation.

Though most handstones lacked signs of significant modification, variation in use is indicated through correlations of size with end polish, and of flat surface shapes with shallow deposition contexts. The use wear data generally indicate that handstones were subject to moderately intensive use that decreased slightly among the lesser shaped specimens.

Scraper Planes

Out of 285 scraper planes collected from SBR-421C, 40 (14%) were selected for analysis. The distribution of all scraper planes parallels that of the entire flaked stone assemblage in that the majority came either from Stratum 1 (63%) or Stratum 2 (37%) (Basgall and True 1985). This distribution is significant in that its majority is tied to the preponderance of flat millingstones on the surface. The correlation, however, cannot be assumed to have any great functional connotations with regards to the link between scraper planes and flat millingstones.

Material profiles for the analyzed portion match those for the entire collection in that most were made from fine-grained igneous material (18 felsite, 4 rhyolite), followed by quartzitics (12 quartzite, 5 quartz). Basalt and cryptocrystalline materials were not represented in the sample because they accounted for only 2% each in the original collection. The under-representation of cryptocrystalline and basalt can also be explained by the fact that these only occur extralocally.

All but three scraper planes were manufactured from a cobble base (Table 9.5). The three made from flakes originated from either primary or secondary decortication flakes and tended to be smaller on average than their cobble-based counterparts. The average maximum volume for flake-based scraper planes was 265 cm^3 while that for cobble-based scraper planes was 344 cm^3 (Table 9.3). The dearth of flake-based specimens speaks to what was probably an increased functionality of the cobble-based forms in terms of manufacturing cost and working mass.

Typically, most scraper planes had unifacial working edges (36); a characteristic which seems to be part of the definition of this tool category (Table 9.5). Scraper planes were not separated based on typologies because the form of these tools was not regular enough to determine such classifications. The numbers in Table 9.5 show that most edges (21) were convex-regular with lesser amounts being convex-irregular (9), straight, or concave. The diversity of edge shapes presents a picture of edge and form irregularity.

All edges were used in a very similar manner such that the discussion of use wear attributes does not need to be separated by edge shape. Edge wear was evenly distributed among the various types (unifacial and bifacial microchipping, and battering until dull), with only four that showed no signs of edge modification through use (Table 9.5). Other types of wear that were also observed were edge polish (67%), step fracturing (87%), and interior polish (44%). Edge polish and step fracturing occurred more regularly than did interior polish, both in terms of frequency of observance and distribution on the working surfaces of the scraper planes. The low occurrence and irregular distribution of interior polish is due to two factors, use intensity and shape of the ‘planning’ surface. First, the more this tool is used for planning and scraping the more likely it will be that polish will accumulate on the side which contacts the material being processed or the bottom stone. Second, the shape of the planning surface will greatly determine the accumulation of polish in that irregular surfaces, or those which are concave will not come in contact with materials or a netherstone surface without extreme attrition of the leading edge.

Table 9.5. SBR-421C. Scraper plane attributes by material type.

	BAS	CCR	QZT	QTZ	FEL	RHY	META	OTH	TOTAL
FORM									
1	-	-	2	-	1	-	-	-	3
2	-	-	10	5	17	4	-	-	36
3	-	-	-	-	-	-	-	-	-
Flk Type									
1	-	-	1	-	-	-	-	-	1
2	-	-	1	-	1	-	-	-	2
3	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
IND	-	-		-	-	-	-	-	-
E Freq									
1	-	-	12	5	18	4	-	-	39
2	-	-	-	-	-	-	-	-	
E Form									
1	-	-	11	4	17	4	-	-	36
2	-	-	1	1	1	-	-	-	3
E Shap									
1A	-	-	1	-	-	-	-	-	1
1B	-	-	-	-	1	-	-	-	1
2A	-	-	9	3	8	1	-	-	21
2B	-	-	2	1	5	1	-	-	9
3A	-	-	-	-	2	-	-	-	2
3B	-	-	-	1	2	2	-	-	5
4	-	-	-	-	-	-	-	-	-
E Wear									
0	-	-	1	-	3	-	-	-	4
1	-	-	4	2	4	1	-	-	11
2	-	-	4	1	5	2	-	-	12

3	-	-	3	2	6	1	-	-	12
E Polish									
PRS	-	-	9	3	11	3	-	-	26
ABS	-	-	3	2	7	1	-	-	13
Stp Frac									
PRS	-	-	10	4	17	3	-	-	34
ABS	-	-	2	1	1	1	-	-	5
Int Pol									
PRS	-	-	6	2	7	2	-	-	17
ABS	-	-	6	3	11	2	-	-	22
SEC MOD									
PRS	-	-	3	-	5	1	-	-	9
ABS	-	-	9	5	13	3	-	-	30
TOTAL	-	-	12	5	18	4	-	-	39

Note: See Appendix C for description of terms.

The average edge angle measurement for scraper planes was 83.1^0 while the average spine plane angle was 69.5^0. Additionally, the average maximum flake scar length was 1.6 cm. The large disparity between edge and spine plane angles, and the small maximum flake scar lengths indicate that scraper planes from SBR-421C were being resharpened. The 1.6 cm average flake scar size is too small to represent any whole flake tool in the assemblage. Most debitage from the site was of sizes greater than 3.8 cm (Basgall and True 1985:6.13).

Interestingly, it was found that four tools categorized as scraper planes in the original catalog were found to be battered cobbles first and foremost. Measurements were taken on these artifacts anyway and significant differences did appear. The angle measurements for the edges and spines of the artifacts were the same in all four cases. Also, the flake scar lengths of these battered cobbles were found to be significantly larger than those for scraper planes (2.7, 4.0, 3.5, and 2.4 cm for the 4 battered cobbles).

The average length for the four battered cobbles was 3.15 cm, a full 1.51 cm larger than the average for scraper planes. This suggests that the edges of battered cobbles were not being maintained by resharpening. The observed edge wear was battering until dull. It is the case that battering occurred on more than one edge/margin to the same degree. The use wear and form attributes of these battered cobbles is evidence of functional overlap between scraper planes and other battering implements.

This functional overlap is supported by the fact that nine exhibited battering on ancillary edges or margins. This battering is similar to that seen on hammerstones (battered on the cortex, or unintentionally shaped edge). Use in secondary contexts speaks to the generalized nature of this tool class.

Scraper planes were probably used for a number of tasks including scraping, resharpening of millingstones (battering on the formed edge), and hammering (secondary modification). The irregularity in form and edge wear speaks to more expedient use and manufacture, but evidence of resharpening suggests that use was at least moderately intensive.

Non-Analyzed Tool Categories

There are a considerable number of artifacts from SBR-421C which could not be analyzed, most of it flaked stone (Table 9.1). Many functional/typological artifact classes were recognized in the flaked stone inventory but all were separated into one of three groups; debitage, casual artifacts or formal artifacts (Basgall and True 1985:7.12). Formal artifacts, totaling 46, included points (10), finished bifaces (11), performs (8), steep unifaces (7), flake unifaces (8), and drills (2) (Basgall and True 1985:Table 7.5). Most formal artifacts were made from fine grained volcanics (34)(basalt, rhyolite, cryptocrystalline, obsidian) or fine grained igneous stone (9), with few being made from quartz. In fact, the majority were made from extralocal cryptocrystallines (22) or obsidian (2). Not common in the area, basalt and rhyolite were also well represented (10) among formal tools. The preponderance of points, finished bifaces, and performs were all made from fine grained volcanics. All formal tools exhibited evidence of use wear, while that of maintenance (resharpening/repairing) was not uncommon. These tools generally entered the deposit in an exhausted or well-used state, many being broken or very small (especially those made from cryptocrystalline or obsidian) (Gilreath and Jackson 1985).

Casual flaked stone tools, ignoring scraper planes, included various kinds of scrapers (196) (Basgall and True 1985:Table 7.5). Local materials dominated the ‘casual’ artifact classes with most being made from fine-grained igneous (174) and quartz (35). Basalt, rhyolite and cryptocrystalline were represented by 27 implements characterized as ‘casual scrapers’. Generally, these implements seem to have been used for vegetal processing in a more expedient manner, entering the deposit in whole condition with little attrition (Gilreath and Jackson 1985). These tools were a greater aspect of the technological strategy that was geared toward vegetal processing than were more formal flaked stone tools.

Various kinds of hammers (136) and choppers (38) almost exclusively made from local material, were also recovered from the site and thrown into the casual artifact category. Representing a large portion of the assemblage, the importance of these artifacts cannot be determined solely on their own frequency because of the high number of scraper planes, cores, and other larger artifacts which exhibit secondary wear consistent with that which defines hammers and choppers.

The debitage profiles pattern out significantly among the different material types (Gilreath and Jackson 1985). The debitage analysis demonstrated that fine grained igneous material and quartzitics, representing the large majority, were reduced primarily to produce flakes for expedient use and many “casually” formed tools, while the resulting cores also tended to be used as tools. Most of the debitage from this material was of sizes larger than 38 mm (Basgall and True 1985:6.13). In contrast, cryptocrystalline and obsidian were used very differently, primarily due to the fact that these materials were imported from some distance. Cryptocrystalline seems to have been imported in somewhat reduced-or prepared core-form to be used for the production of casual flake tools, formed flake tools, and some bifaces. The debitage from this material was mostly all under 26 mm in size, suggesting that tools were mostly being maintained and formalized on site (Basgall and True 1985:6.13). Obsidian debitage recovered from the site is so small and innumerous that it speaks only to on site rejuvenation or repair of already formed tools. This fits with the fact that only formal obsidian tools in greatly reduced form were recovered from the site.

The flaked stone inventory seems to have been primarily geared toward vegetal processing through the production of less formalized and expedient tools on site. However, a small portion of the assemblage was used in a manner more consistent with faunal exploitation, on a broad reaching scale (distance-wise). The two strategies were most likely concurrent because the obsidian tools and debitage occurs primarily in the same cultural deposit as the rest of the assemblage, and tend to date to the same general time frame through hydration data.

Summary and Conclusions

SBR-421C is not a very complex site in terms of structure and composition. The four features at the site do not resemble formal and maintained cooking or processing facilities. The lack of such features may be the result of recovery methods but taken as a sample, the lack of even one feature with structural integrity is significant.

The only variation in the distribution of assemblage constituents is seen among millingstones, handstones, and scraper planes. Flat surfaces of both millingstones and handstones seem to be biased toward the upper reaches of the deposit and the site surface while basined forms and convex handstone surfaces dominate the lower areas of the deposit. The differential distribution of flat versus basined milling surfaces and flat versus convex handstone surfaces most likely represents functional variation that was temporally sensitive. This patterning may even be evidence that not every millingstone is on a path toward basined surfaces. The evolution of the basined surface over time is more specific, functionally, than previously thought. It was demonstrated in the analysis section that the use intensity of flat versus basined milling surfaces was essentially the same, supporting a functional separation. The anomalous basined surfaces that were small and ground provide even more evidence for functional variation. Similarly, flat and convex handstone surfaces were used with equal amounts of intensity, speaking against surface evolution from convex to flat.

That the highest number of scraper planes exist on the surface and in the upper levels may be related to the difference in processing techniques exhibited by millingstones and handstones. However, it is much more speculative to make the functional connection between scraper planes and, specifically, flat milling surfaces.

The analysis of millingstones, handstones, and scraper planes produced use wear and formalization data which has important implications for the settlement/ subsistence strategies of the cultural system. Millingstones and handstones are characterized by very low levels of formalization on local materials. Both groups of tools show use wear trends which suggest a moderate level of use intensity where artifacts were being discarded before incurring great maintenance costs or high levels of attrition. These artifacts, save a few millingstones and handstones, were probably mostly used in the immediate vicinity of the site and were witness to use that is best characterized as both extensive (reuse) and intensive.

Scraper planes show similar trends in use as traces of use wear and maintenance were moderate and diverse. The irregularity in the form and edge characteristics suggests that these tools were expediently manufactured for immediate use in the area. The attrition and maintenance of the edges means that they were used for moderately intensive processing. The variety of edge wear characteristics and the presence of battering on unformed edges is consistent with a generalized use strategy that functionally overlapped with hammers, scrapers, and choppers.

Those artifact classes which could not be analyzed, namely flaked stone tools and debitage, support the importance of vegetal processing in the area of the site primarily through the manufacture of a diverse array of numerous expedient tools. These tools, termed ‘casual’ by the original researchers, were not used very intensively; this was probably the result of an abundance of raw material and intended use trajectory (Basgall and True 1985). There was a small formal flaked stone inventory which does hint at a far-reaching settlement pattern, though limited in degree. The tools that characterize this dimension of resource exploitation consist largely of unifacial flake tools, bifaces, performs, and points, which were all intensively used and maintained (Basgall and True 1985).

Most ecofactual remains were recovered from the primary midden deposit (Stratum 2), paralleling the distribution of the entire assemblage. Floral remains were dominated by juniper while artiodactyl remains represented the great majority of the faunal collection. Both of these resources were significant in terms of subsistence economy but were most likely complimented by a range of other resources that were either not recovered, not deposited, and/or not preserved.

The high number of millingstones, handstones, and scraper planes at the site relative to other artifact classes indicates that they were an economically important technological aspect of the cultural system. However, the degrees of formalization and use present on these tools suggests a regular pattern of expedient manufacture and extensive use. Such a pattern is seen among other tool categories such as hammers, choppers, scrapers, and small ‘casual’ flake tools that also occur in relatively high numbers. This pattern of artifact manufacture, use, and discard is best explained by a pattern of regularized site reoccupation, which best accounts for the redundant accumulation of such tools.

The lack of formalized processing and cooking facilities in addition to a highly formalized flaked stone tool component supports the idea that the site was not the focus of a permanent settlement. Formed flake tools have indications of a broad reaching settlement system that utilized exotic resources in a context that required high degrees of shaping and maintenance before being discarded. Thus, although the most significant pattern of settlement and subsistence was vegetal exploitation through repeated and intensive site occupation, some residential mobility was also employed in order to exploit a wide spectrum of faunal and floral resources.

The interpretation of the organization of subsistence technology and settlement is consistent with that provided by Basgall and True (1985), who saw the site as one in a complex that was intermittently yet intensively occupied. It is not consistent with the semi-sedentary settlement pattern and a specialized vegetal exploitation strategy proposed by Kowta (1969). The variation in use and form among millingstones, handstones, and scraper planes (the primary tools associated with Kowta’s agave exploitation scheme) supports a generalized and variable economic strategy geared toward a wide range of vegetal resources.

Chapter 10:

Sayles Site, Locus D; SBR-421D

Locus D of SBR-421 is another component of the greater Sayles site complex lying approximately 200 meters north east of Locus C (Basgall and True 1985). Surface observations preclude any full separation between loci C and D in that cultural debris was scattered continuously between the two areas, albeit in decreased density. Following subsurface testing, it became clear that the midden deposit at locus D, situated in the northeast section of the site, did not extend into Locus C (White 1973). Surface boundaries enclosed cultural debris in about a 14300 m^2 area while subsurface deposits were concentrated in a 1700 square meter area to the northeast. This suggests that Locus D of the Sayles Site is probably a separate entity (Basgall and True 1985). The most recent investigations of this site have interpreted its assemblage in association with the Sayles Complex as an area that was intensively used on an intermittent basis (Basgall and True 1985). The Sayles Complex was originally seen as part of an inland manifestation of the Millingstone pattern that specialized on the processing of agave and yucca because of the high number of core and cobble tools (Kowta 1969).

White (1973) and Binning (et al. 1981) provide a summary of the initial excavations at Locus D. The data they provide regarding site structure are similar in nature to the other adjacent loci with the same kinds of strata defined (Basgall and True 1985). Though modern disturbances seem to have been more limited at Locus D than other locations, there are nearby access roads that have been used for some time and would have looting of the site surface (Basgall and True 1985:map 8.1). The nature of this impact cannot be measured and it is assumed that the deposit represents a good sample of the occupational history.

Bordered to the east by the seasonal Crowder Creek, which is fed by a perennial spring, water was immediately available and probably an important resource driving site occupation. The surface of Locus D is dominated by manzanita and chamise which characterizes the entire surrounding region (Basgall and True 1985). Juniper trees become frequent as elevation increases, slowly transitioning into a pinon zone at the highest elevations among the surrounding mountain tops. During the Holocene, the area has seen vertical changes in the distribution of vegetation communities as effective moisture has diminished. The most prominent changes were most likely seen in the northern portion of the Transverse Ranges, where desert plant communities characterized by creosote migrated up slope.

Initial chronological assessments of sites associated with the Sayles Complex have placed their primary occupation between 1500 and 3000 BP (Kowta 1969). These dates were based on a suite of information that included rates of tectonic uplift, climatic changes, and possible interactions between northern desert and southern basin communities. Though the accuracy of information used to reach this assessment can presently be questioned, the range of occupation is consistent with radiometric, obsidian hydration, and temporal indicator data that has been more recently available.

Locus D has been dated by radiocarbon, obsidian hydration, and temporally diagnostic artifacts, all of which have major commonalities. Two acceptable radiocarbon determinations suggest an occupation ranging from 2280 ± 100 BP (charcoal, Feature 17b, 30-40cmbs), until 2690 ± 130 BP (charcoal, unit N30/E52, 70-80 cmbs) (Basgall and True 1985). The carbon samples were taken from the upper and lower boundaries of Stratum 2 and are thought to grossly represent the primary occupation span of the site.

Twenty-three samples of obsidian were analyzed for hydration rims. It is reported that this accounts for 40% of the entire collected sample of obsidian from the site (Basgall and True 1985:8.11). All but one piece was from the Coso source; the other was from Obsidian Buttes. Obsidian hydration measurements for the Coso sample indicate a range of 1650 to 2650 years BP for this component if the earliest and latest readings are excluded (Figure 8.2, Basgall and True 1985). These dates roughly coincide with the radiocarbon determinations and may provide a better indicator of the last half of the occupational history.

A mixture of temporally diagnostic artifacts tends to agree with the dates from radiocarbon and obsidian hydration. A single stone bead found in midden contexts has been dated elsewhere between about 3000 and 1250 BP (Basgall and True 1985:8.11). Projectile points are dominated by the Elko series (4), which range from 3150 to 1350 BP in the adjacent Mojave desert, coinciding with all other forms of dating at the site. One Pinto series form was also found, thought to date between 7500 and 4000 BP in the southern Great Basin (Basgall and Hall, n.d.). The condition of this point (highly reworked and exhausted) in context of its age, and other earlier dated artifacts at the site, may represent an earlier occupation. This conclusion would not be inconsistent with the occupational history of the Sayles Site, Locus C. However, scavenging cannot be ruled out for the presence of this point.

All sources of chronological data indicate that the site was primarily occupied between 1650 and 2650 BP Some kinds of data including a large rim reading from an obsidian biface (7.0 microns) and the presence of a Pinto series projectile point, suggest the site may have witnessed earlier, yet limited use.

The stratigraphy at Locus D is fairly straightforward (Basgall and True 1985:8.4-5). The first of these strata begins as a loose overburden of light colored soil and plant detritus from 3-15 cm below surface. Stratum 1 is characterized by light brown loosely consolidated soil that does not have a definite lower boundary but terminates between 20-25 cm. The second Stratum was not clearly delineated from the first but was recognized by its dark gray midden characteristics and that it held the bulk of the cultural refuse. Stratum 2 has a more obvious lower boundary due to the difference in soil composition, but the actual level of this boundary is variable, generally terminating at 50-80 cm below surface. The boundary between the midden and Stratum 3 was marked by an obvious change in the composition and color of the matrix with the latter being light brown and more compact, largely lacking in cultural residues. Since the transitions between the strata are somewhat ambiguous, further complicated by rodent burrowing activity, the changes in artifact frequency by depth must be interpreted in a gross manner. There were other distributional patterns that were specific to certain types of tools and these will be discussed in the following analysis sections.

The artifact inventory of Locus D is dominated by a processing tool kit composed of millingstones, handstones, battered cobbles, unifacial cobble tools, and simple flake tools (Table 10.1). Though formal flaked stone artifacts are present, they occur only in relatively small numbers. Most artifacts were made from local materials, with a small, but interesting amount deriving from extralocal cryptocrystalline and obsidian.

Seventeen features of three different types were found at Locus D. These types were defined as rock concentrations, rock concentrations associated with discolored soil, and discolored soil without rock. No doubt some of these features represent hearths or cooking areas, though some are probably the artifacts of more intensive processing areas, seeing higher numbers of discarded tools. No features had impeccable structural organization but those defined as soil discolorations with associated fire-affected rock and flaked/ground stone material tended to be the most formalized of any feature type recorded.

Table 10.1. SBR-421D. Artifact frequencies by site area.

Artifact	Block	W.	Non-	Surface	Unknown	Total
Millingstone	10	6	2	-	5	23
Handstone	93	54	12	16	6	181
Mortar	-	1	-	-	-	1
Pestle	-	-	-	-	-	-
Oth.	7	3	1	-	-	11
Scraper	26	19	5	38	7	95
Chopper	9	5	2	4	1	21
Hammer	38	13	5	16	3	75
Scraper	38	10	3	28	7	86
Core	-	-	-	-	-	*
Sm. Flktl	11	8	1	6	2	28*
Point /	21	9	3	10	-	43
Other Misc.	6	6	3	-	-	15
Total	259	134	37	118	31	579

Note: *, the number of formal versus simple flake tools was not indicated in original report, and the number of cores is unknown; Artifact frequencies by area adapted from Basgall and True (1985).

Initial interpretations of the occupational history of Locus D within the greater Crowder Canyon project see two possible scenarios for the use of this site (Basgall and True 1985). The first is that Locus D was occupied intensively for a relatively short period of time. The second is that the site witnessed intermittent occupations that were not very intensive in terms of local resource exploitation. Similar sites in the area that have been characterized as components of the Sayles Complex have been interpreted as specialized processing sites. Kowta (1969) suggests that these sites are the result of intensive exploitation of the agave plant as its ecological zone shifted with changing environments. The analysis of use wear data in this report will provide a new basis for evaluating resource use and site occupation.

Millingstones

Three millingstones more than the reported number of 23 were located for analysis, bringing the total analyzed sample to 26. The large number is most likely due to the breakage of one or more millingstones after cataloging. The distribution of millingstones at Locus D goes little farther than to point out that almost all came from the cultural strata in the upper reaches of the deposit. However, some (Basgall and True 1985; Kowta 1969) have indicated that basined forms may occur higher in the deposit than flat slab forms. The small sample surely plays a role in this patterning and inhibits discussion regarding the functional significance of both forms.

Fragments of margins (12), interior sections (8), and ends (4) were most abundant; only two that were whole. All were made from locally abundant schist/gneiss.

Seventeen millingstones could be grouped by shaping degree (Table 10.2). Two were classified as SD-2 forms, 10 are SD-1 specimens, and five were SD-0 specimens. All types of shaping were observed, though not necessarily on every specimen. Four millingstones had evidence of flaking, five were pecked, and eight were ground on the exterior. Only five showed combinations of either flaking and grinding, flaking and pecking, or grinding and pecking; evidence that the diversity of shaping types on most specimens was relatively low.

The fragmentary condition of millingstones is such that no parallel could be found between shaping and thickness categories. Of 17 complete enough to be categorized according to thickness groupings (Figure 1), 14 millingstones fit within the thin group (<5.45 cm). The other three were grouped as thick (between 5.5 and 8.8 cm). It is worthy of note that the millingstones at this site do seem have a naturally different thickness grouping with seven that measure below 3 cm. This preponderance of extremely thin millingstones is due in some cases to the natural occurrence of the stone, and in at least three cases to use on opposing surfaces.

Table 10.3 shows metrical summaries by shaping degree. The only significant pattern among these measurements is that average thickness is greater for SD-0 millingstones as compared to those shaped to the first and second degrees. It is probably not the case that shaping directly contributed to a decrease in thickness, but that those which were shaped to some degree were either thinner on average from the beginning of use or became thinner as a result of increased use intensity. From the measurements listed in Appendix A, the average maximum thickness for fragments unclassified by shaping degree was 2.7 cm (6/8 specimens complete enough to determine a maximum thickness). This extremely thin profile for indeterminately shaped fragments is probably linked to the nature of use in that seven of ten possible surfaces were flat (Table 10.2). From the few measurements for maximum lengths, widths, and thicknesses, it was possible to multiply the average maximum values and arrive at an estimate of volume of 3833 cm^3. This volume for schist millingstones does not give the impression that such tools were massive.

Table 10.2. SBR-421D. Millingstone attributes by shaping degree.

SHP DEGREE		0	1	2	3	IND	TOTAL
MATERIAL							
	SCH	5	10	2	-	9	26
	GRN	-	-	-	-	-	-
	SST	-	-	-	-	-	-
	GRA	-	-	-	-	-	-
	SIL	-	-	-	-	-	-
	VOL	-	-	-	-	-	-
CONDITION							
	WHL/NC	1	-	1	-	-	2
	MRG	4	6	1	-	1	12
	END	-	4	-	-	-	4
	FRG	-	-	-	-	8	8
SURFACE FREQUENCY	1	5	9	1	-	8	23
	2	-	1	1	-	1	3
	IND	-	-	-	-	-	-
SURFACE SHAPE	B	-	6	1	-	1	8
	F	2	3	1	-	7	13
	SCV	3	2	1	-	2	8
	SCX	-	-	-	-	-	-

	IND	-	-	-	-	-	-
SURFACE TEXTURE	S	5	11	3	-	10	29
	I	-	-	-	-	-	-
	IND	-	-	-	-	-	-
POLISH							
	PRS	5	11	3	-	10	29
	ABS	-	-	-	-	-	-
	IND	-	-	-	-	-	-
STRIAE							
	PRS	-	7	1	-	4	12
	ABS	5	4	2	-	6	17
	IND	-	-	-	-	-	-
PECKING							
	PRS	4	9	2	-	8	23
	ABS	1	2	1	-	2	6
	IND	-	-	-	-	-	-
SECONDARY MODIFICATION	PRS	-	-	-	-	1	1
	ABS	5	10	2	-	8	25
FIRE AFFECTION	PRS	-	1	-	-	4	5
	ABS	5	9	2	-	5	21
SHAPING TYPE	IND	-	-	-	-	9	9
	0	5	-	-	-	-	5
	1	-	3	1	-	-	4
	2	-	4	1	-	-	5
	3	-	6	2	-	-	8
TOTAL		5	10	2	-	9	26

Note: See Appendix A for description of terms.

There was very little variation in use characteristics as all millingstones, including indeterminately shaped fragments, were used similarly (Table 10.2). Notable variation exists among the SD-0 specimens which completely lack any bifacially used specimens, basined surfaces, or evidence of striations. It is also the case that the majority of flat surfaces (7/13) come from indeterminately shaped fragments that tend to be very thin on average (2.7 cm). The majority of basined surfaces are from the SD-1 category (6/8) that had an average 4.7 cm in thickness. However, both flat and basined surfaces show no diversion in the amount of observed use wear attributes, suggesting that one is not necessarily the predecessor of the other, that both were used in functionally separate contexts.

If all shaping categories are considered together, including indeterminately shaped fragments, it is clear that all but three were used on only one surface with the rest having two ground surfaces (Table 10.2). Flat surfaces were most abundant, totaling 13, followed by basined (9) and concave (8) surfaces. Excepting SD-0 millingstones that were not basined, the amount of diversity in surface shapes for each degree of shaping was proportionate. Millingstones were used in such a way that most surfaces became smooth (29) and polished (29), with only 12 showing striations. Surface maintenance was common and 23 ground facets exhibit pecking.

The use of surfaces for purposes other than grinding (such as anvilling, abrading, etc.) was uncommon, observed on only one specimen as battering on a broken edge. Fire-alteration was rarely observed, present on only five specimens which were associated with features, indicating their reuse as possible hearth or cooking stones. All but one of these was an indeterminately shaped millingstone that was very thin and the evidence of direct burning was very obvious. It may be the case that some flat millingstones were actually directly used as cooking stones.

Some of the basined surfaces of millingstones at Locus D tended to be small and inset in a larger flat or slightly concave surface. Four of the nine basined millingstones have small diameter basins (avg. 15 cm) surrounded by large platforms. The use wear on millingstones from Locus D is such that the basins resemble cupules without pronounced shoulders; grinding extends from the platforms into the basins. This wear suggests that grinding was a more primary function than mortar-like pounding.

Overall, millingstones were well used but saw little to no investment in form. The abundance of raw material would preclude the need for extensive shaping if the tools were mostly used on-site. In addition, the nature of schist is such that excessive flaking or pecking of the exterior would most likely lead to premature failure of the tool. Schist in the area of the site seems to be exfoliative and soft, making it even more predisposed to weathering. In essence, it seems that schist would not be a very good material to rely on for portablility because it lacks durability. The variability in surface forms, which were all used to at least moderate degrees, suggests a wide range of functions associated with the use of millingstones at the site. The extreme thinness and burning may be indicative of direct use as cooking stones.

Table 10.3. SBR-421D. Average complete metrics by artifact class and shaping*.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	31.2 / 1	27.2 / 1	5.4 / 3	5
Shp Deg 1	30 / 4	34.6 / 1	4.4 / 7	10
Shp Deg 2	27 / 1	20.1 / 1	4.6 / 1	2
Shp Deg 3	0 / -	0 / -	0 / -	0
Avg Total	29.4 / 6	27.3 / 3	4.8 / 11	17
Handstones				
Shp Deg 0	11.5 / 4	9.5 / 6	5.5 / 7	10
Shp Deg 1	13 / 2	9.6 / 3	6.1 / 3	3
Shp Deg 2	13.7 / 1	0 / -	6.8 / 1	1
Shp Deg 3	15.5 / 1	10 / 1	3.2 / 1	1
Avg Total	13.3 / 8	9.7 / 10	5.4 / 12	15
Scraper				
Form 1	-	-	-	-
Form 2	-	-	-	-
Avg Total	-	-	-	-

Note: *Includes only those artifacts complete enough to be categorized by shaping degree or form, **does not** include indeterminate fragments; Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.

Handstones

Out of 126 handstones reported by Basgall and True (1985), roughly 50 were located, while only 15 (12%) could be analyzed due to time and access constraints. The location of the remaining portion of handstones is unknown but it is probable that the collection boxes were stored in another location within the museum. At the time of analysis, collections were being re-organized into new shelving space. Though small, provenience information for this sample indicates that it is representative of the material profiles of all handstones recovered from the site. The majority follow a distributional pattern of other assemblage constituents. Most came from the block exposure, followed by those in the general midden and site surface, while nothing notably different patterned out vertically (Table 10.1). The analysis sample is too small to speculate regarding the patterning of different shaping degrees/use wear attribute groupings.

Whole/near complete specimens hold the majority (7), followed by fragments of ends (5), medial sections (2), and margins (1). Granite (8) and gneiss (5) dominate the material categories, followed by one each of sandstone and felsite.

The handstones at Locus D tended to be SD-0 (10) or SD-1 (1), with only three from the SD-2 category and one SD-3 specimen. The average maximum measurements shown in Table 10.3 present a trend of increasing size for handstones as the degree of shaping increases. This is best seen when average volumes are compared. When the lengths, widths, and thicknesses are multiplied, the average volume for SD-0 is 623 cm^3, that of SD-1 handstones is 761 cm^3, 1155 cm^3 for SD-2 (using an incomplete thickness measurement of 12.4 cm for ease of comparison), and 496 cm^3 from SD-3. For handstones other than those which were highly formalized, the increase in shaping degree that accompanies size is more likely the result of a need to alter the stone in order to increase use efficiency. This is supported by the fact that perimeter pecking is the most observed form of modification (Table 10.4).

Use wear patterned somewhat by shaping degree (Table 10.4). The significance of the difference in observation of use wear by shaping category is limited due to sample size. Nonetheless, SD-0 and SD-1 handstones were more/less equally unifacial (5) and bifacial (6) with surfaces tending to be convex (13) and four that were flat. Roughly two thirds (12/17) of the surfaces were smooth and striated (12/17), while most were polished (16/17). Pecking on the surface was only observed on 7/17 of the SD-0 and SD-1 handstones. Secondary modification in any form was relatively uncommon with only two of 11 showing end battering and four of 11 being fire-affected.

Of SD-2 (1) and SD-3 (1) handstones, both were used on two opposing surfaces. Surfaces were either flat (3) or convex (1) with most tending to be smooth (4), and polished (4). Striations were observed on one surface of each specimen and pecking was observed on both surfaces of only one SD-3 handstone.

Basgall and True (1985:8.45) mention that about 2% of the handstones at Locus D were classified as mano/pestle combination tools. Only the one SD-3 handstone may reflect this pattern; a probable result of sample bias.

There seem to be two different patterns regarding handstone use and formalization. The majority seem to have been used on a more expedient basis, seeing only slight degrees of shaping and moderate use.

Table 10.4. SBR-421D. Handstone attributes by shaping degree.

SHP DEGREE	0	1	2	3	IND	TOTAL

MATERIAL							
	SCH	4	1	-	-	-	5
	GRN	5	1	1	1	-	8
	SST	1	-	-	-	-	1
	META	-	-	-	-	-	-
	QZT	-	-	-	-	-	-
	QTZ	-	-	-	-	-	-
	IGN	-	-	-	-	-	-
	FEL	-	1	-	-	-	1
	GRA	-	-	-	-	-	-
	BAS	-	-	-	-	-	-
	RHY	-	-	-	-	-	-
CONDITION							
	WHL/NC	4	2	-	1	-	7
	MRG	1	-	-	-	-	1
	END	3	1	1	-	-	5
	MED	2	-	-	-	-	2
	FRG	-	-	-	-	-	-
SURFACE FREQUENCY	1	5	1	-	-	-	6
	2	5	2	1	1	-	9
	3	-	-	-	-	-	-
	4	-	-	-	-	-	-
SURFACE SHAPE	F	3	1	1	2	-	7
	CV	-	-	-	-	-	-
	CX	12	4	1	-	-	17
	IND	-	-	-	-	-	-
SURFACE TEXTURE	S	10	3	2	2	-	17
	I	5	2	-	-	-	7
	IND	-	-	-	-	-	-
POLISH							
	PRS	14	5	2	2	-	23
	ABS	1	-	-	-	-	1
	IND	-	-	-	-	-	-
STRIAE							
	PRS	11	1	1	1	-	14
	ABS	4	4	1	1	-	10
	IND	-	-	-	-	-	-
PECKING							
	PRS	7	3	-	2	-	12
	ABS	8	2	2	-	-	12
	IND	-	-	-	-	-	-
END POLISH							
	PRS	-	-	-	1	-	1
	ABS	10	3	1	-	-	14
	IND	-	-	-	-	-	-

SECONDARY MODIFICATION	PRS	1	3	1	-	-	5
	ABS	9	-	-	1	-	10
FIRE AFFECTION	PRS	4	1	-	1	-	6
	ABS	6	2	1	-	-	9
SHAPING TYPE	IND	-	-	-	-	-	-
	0	10	-	-	-	-	10
	1	-	-	-	-	-	-
	2	-	2	1	1	-	4
	3	-	1	-	1	-	2
TOTAL		10	3	1	1	-	15

Note: See Appendix B for description of terms.

A small but important handstone grouping is seen in the SD-2 and SD-3 categories, that are dominated by the higher quality materials and show attribute patterning consistent with more intensive use.

Non-Analyzed Tool Categories

The flaked stone inventory was dominated by percussion shaped tools such as scraper planes (88), heavy scrapers (45), heavy flake tools (112), choppers (20), and hammers (72). Small bifaces (43) and small unifaces (26) do not compose large constituents of the assemblage but their presence is significant. As with other sites in the area, most of the flaked stone artifact classes are dominated by quartzitics and fine-grained igneous materials that are not of very high quality. These local materials account for 56% of the flaked stone artifacts and 67% of the debitage. Extralocal materials (cryptocrystalline and obsidian) make up 44% of the tools and 34% of the debitage. These percentages mean different things when the technological organization of their use is considered. Local materials are mainly represented by tools such as modified cobbles, shatter, and cores. These tools were mainly formed by percussion flaking with the intention of producing core tools and large cortical flakes (Gilreath and Jackson 1985). They were mostly used for heavy battering and chopping purposes, evidenced by use wear. Conversely, cryptocrystalline was imported to the site in reduced form (shatter) whereby new tools could be made from interior flakes. As a result, the silicate material is represented by small modified flakes, bifaces, and smaller debitage (Gilreath and Jackson 1985). The tools made from cryptocrystalline were most likely used for lighter duty cutting and scraping tasks, along with more specialized tools such as projectile points. Obsidian was only represented by repair/rejuvenation flakes along with discarded tools. Obsidian was indirectly imported to the site in the form of shaped tools and entered the deposit only through attrition and repair.

Overall, the flaked stone assemblage from SBR-421D seems to have been primarily geared toward complimenting vegetal exploitation interests. Use wear on the most represented artifact classes (battered cobbles, scraper planes, etc.) corroborates this claim, being consistent with expectations arising from the processing of vegetal material (Gilreath and Jackson 1985). The presence of tools traditionally associated with faunal exploitation (projectile points, etc.) indicates that animals were not an insignificant part of the resource exploitation strategy. That cryptocrystalline is present in such large quantities is significant in that it shows the importance of its use for smaller flake tools, and the range of the procurement system.

For those tools made from local materials, wear is consistently irregular, suggesting light to moderate use. Tools made from extralocal materials entered the deposit in a well used and often exhausted state, implying something regarding the relative value of the material and economic importance of these artifact classes (Gilreath and Jackson 1985).

Summary and Conclusions

The analysis of the millingstone tool category revealed that formalization was not an important aspect of these tools. The nature of the material these artifacts were made from hinders high degrees of shaping because it breaks apart easily, but its local availability lowers the cost of its use on or near the site. Use wear data indicate that they were used with moderate intensity in a variety of ways that included different degrees of pulverizing and grinding.

Likewise, handstones saw little in the way of shaping. The great majority of handstones exhibited low degrees of formalization that was coupled with use wear patterns suggesting use on a more expedient basis. The fact that handstones and millingstones represent a very economically significant aspect of the economy that incorporated them is seen in the sheer numbers of milling tools present in the assemblage.

The analyses of flaked stone artifact classes suggest that they were manufactured and used in a manner that would primarily compliment a vegetal processing economy (Basgall and True 1985:Appendix A). Many of the flake tools were fashioned from prepared cores of extralocal material and were probably used for immediate purposes. Other flake tools saw a wider range of uses in other contexts that contributed to their regular form and exhausted state.

The most robust pattern evident in the entire Locus D inventory is reflected by large quantities of simply and expediently manufactured tools that saw limited use; save for the millingstones which were used moderately and may have seen more reuse. Overall, the relative diversity of tool types and variability in tool use is low. If diversity and variability in an assemblage are indicators of the degree of permanence of settlement (Basgall and True 1985), then Locus D, like many of the surrounding sites, most certainly does not represent a location that was inhabited for long periods of time. This is supported by the presence of so much extralocal material in the flaked stone artifact classes. It is most likely the case, as originally offered by Basgall and True (1985), that Locus D was primarily used on a more sporadic basis for a variety of unspecialized vegetal processing tasks. The volume and redundancy of the assemblage is then considered to be an indicator of the degree of site reoccupation, which is thought to be moderate. Reuse of the site for a general set of vegetal exploitation practices would be expected to produce a large (artifact size and number) and redundant tool assemblage.

Chapter 11:

Glen Annie Canyon, CA-SBA-142

The Glen Annie Canyon Site (CA-SBA-142) exists just north of Goleta in the greater Santa Barbara area of the California coast. Excavated by Owen (et al. 1964), this site has been the topic of much debate concerning the definition of the Oak Grove manifestation of the Millingstone pattern (Owen et al. 1964, Curtis 1965, Erlandson et al. 1988). With three corrected dates between approximately 6000 and 8000 years BP, Owen claimed that the people who inhabited the site were highly mobile and exploited a diverse array of resources. This conclusion is directly opposite that of Rogers (1929), Wallace (1955), and Curtis (1965), who defined the Millingstone pattern as the result of mostly sedentary gathering people. Erlandson et al. (1988) later concluded that two or more components were inter-mixed at the Glenn Annie site, thereby limiting its explanatory value for prehistory in the area.

The site is situated near one of the many north-south waterways that drain into the Pacific Ocean. The Santa Barbara area in general is widely noted for its high biodiversity and productivity in terrestrial, estuarine, and marine habitats. The temperate climate and relatively high humidity provide a welcoming haven for many migratory species as well as resident populations of large and small mammals, birds, and various other kinds of animals. Average precipitation is about 18 inches and temperatures range from 42^0 to 53^0 F in the winter and from 60^0 to 67^0 F in the summer. The nutrient rich upwelling of cold marine waters in the Santa Barbara channel along with the sheltered coastline afford the opportunity for large populations of sea mammals to permanently reside and flourish. Shellfish species that inhabit both rocky and sandy substrates are found along the open coast and in the estuaries, as are many types of fish. During the middle Holocene, the environment was probably much the same as it is today in terms of resources available and climate. Most of the major estuarine changes were complete by the end of the early Holocene.

The chronology of SBA-142 was originally assessed by Owen et al. (1964:210), based on four radiocarbon determinations on marine shell that ranged between 7270 ± 120 and 6380 ± 120 years BP These dates were all associated with the Millingstone aspect of the site, thought to be the only component at that time. Owen did not sample the upper reaches of the deposit, citing heavy farming and rodent disturbance that would have contributed to turnover in the deposit. The temporal span of 6300-7400 BP offered by Owen has not been contested as representing the earlier aspect of the Millingstone pattern present at the site. However, Owen extended these dates to account for the entire deposit recovered from the site excepting a relatively limited amount of probable late material (Owen 1964). More recent investigations have expressed concerns about these early dates representing certain aspects of the assemblage including some artifact types and more importantly, the increased presence of bone in the upper levels of the deposit (Erlandson et al. 1988).

In an effort to demonstrate that temporally separate cultural components were present, Erlandson (et al. 1988) re-assessed the assemblage in terms of composition, distribution, and chronology. To measure this assumption, two *Chione* shell fragments from the 6-12 inch level of the midden area were dated between 1490 ± 80 and 1250 ± 87 years BP while 13 *Chione* fragments from the nonburial surface area of the site yielded a range of 4490 ± 80 years BP (Erlandson et al. 1988:242). Both of these time frames gave credence to the notion that multiple components were present. This was supported by the few late Holocene artifacts recovered from the upper 12 inches, including most pestles and bowl fragments and the presence of side-notched projectile points that tend to date to the middle Holocene in the Santa Barbara area (Erlandson et al. 1988).

The primary occupation of the site seems to have been concentrated in the early-middle Holocene that is bracketed by the dates of 6300-7400 BP and characterized by a typical Millingstone pattern assemblage. It is also true that sporadic later use of the site occurred as indicated by the middle and late Holocene dates generated on shellfish remains. These later occupations were most likely very limited in duration and intensity since the assemblage only contains faint traces of tools that are functionally distinct from the Millingstone component. It is probably true that the existing assemblage represents but a sample of the occupational history for the site because excavations were concentrated in a relatively small area (Owen 1964). However, this sample can be taken as representative of the Millingstone component.

The stratigraphy of the site is not very well defined. There is evidence of heavy rodent and farming disturbance that has had a major impact on the deposit, especially in the upper 6 to 12 inches. Two separate areas were defined at the site as burial and nonburial areas. Midden deposits that contained the highest amounts of ecofactual material and artifact frequencies tended to define the burial area. Quantitative data on the distribution of the assemblage constituents are provided in Table 11.1.

Table 11.1. SBA-142. Artifact distribution frequencies by area and level.

Artifact Class	**General Surface**	**Site Grading**	**Burial Area**			**Nonburial Area**					**Site Totals**
			0-6	6-12	12-clay	0-6	6-12	12-18	18-24	24-30	
Handstones	7	12	1	7	77	1	1	7	16	3	132*
Millingstones	6	3	-	3	84	-	1	5	10	9	121*
Mortars	-	-	-	-	-	-	-	-	-	-	-*
Pestles	-	3	-	-	-	-	1	-	-	-	4*
Oth Grndstn	-	1	-	-	-	-	-	-	-	-	1*
Scraper	2	-	1	2	3	-	2	1	-	-	11*
Chopper	-	-	-	-	-	-	-	-	-	-	35**
Hammer	-	5	-	5	21	-	-	6	3	1	41*
Scraper	-	-	-	-	-	-	-	-	-	-	-*
Core	-	-	-	-	-	-	-	-	-	-	-*
Sm Flktl	10	24	14	12	14	9	7	7	3	4	104*
Point/Biface	4	-	3	1	2	-	2	-	-	1	13*
Other	-	7	9	9	11	-	5	16	5	1	63*
Total	29	55	28	39	212	10	19	42	37	19	525

Note: *, artifact frequencies taken from Erlandson et al. 1988:Table 1; **, artifact frequencies taken from Basgall and True 1985:Table 3.2.

The assemblage from SBA-142 is in every way typical of the Millingstone pattern in that the proportions of artifacts are biased toward millingstones (121), handstones (132), scraper planes (11), choppers (35), and hammers (41). Flake tools also make up a significant portion of the assemblage, numbering 104, but tend to be less recognized in the shadow of the physically obvious ground and battered stone accumulations. The presence of a later and functionally different component is indicated by the presence of pestles (4), a steatite bowl, and a few mid to late Holocene projectile points. The high number of ornaments (102) may also be indicative of the later component but these artifacts have been found in association with Millingstone assemblages in other areas (Kowta 1969) and cannot be excluded from such contexts.

Subsistence remains are characterized by a variety of terrestrial game including mule deer, rabbits, rodents, and birds. Minimal amounts of bony fish, seal, and sea lion were recovered from the uppermost levels of the site. Shellfish remains, mostly lagoon species, tend to dominate the ecofactual material although some rocky and sandy shoreline species were also recovered (Curtis 1965:10-12). Erlandson (et al. 1988:Table 3) revisited the issue of subsistence remains and demonstrated that shellfish tended to dominate in all levels of the deposit with bone increasing in frequency in the upper 6-12 inches. Although bone never represented the majority of subsistence remains, its increased significance later in time (higher in the deposit) is represented by the change in shell-bone weight ratios. For example, the shell-bone ratio for the 12-18 inch level of Unit 17 was 73:1, decreasing to 8:1 in the 0-6 inch level (Erlandson et al. 1988:Table 3). The significance of the changes in shell-bone weight ratios is slightly undermined by the nature of the deposit and of the subsistence remains. First, the available data only represent a small portion of the site itself and may be biased indicators of subsistence behavior over time. Second, shell is much more durable than bone and the fact that bone decreases in observance deeper in the deposit is partially a factor of decreased preservation, in addition to changes in faunal exploitation.

Burial and feature data for SBA-142 are scant and impressionistic. Most burials were highly fragmented and disturbed by post-depositional processes (Owen 1964). A total of eight burials was completely identified, some associated with aggregates of ground and battered stone that may have been burial cairns. The site does not seem to have been the location of numerous burials adhering to a noticeable pattern that would warrant calling it a cemetery. The apparent localization of the recovered burials may simply be the product of sampling bias since a large portion of the site was not investigated. Since people were buried here, the only thing that can be assumed is that the site was a relatively important economic aspect of one or many settlement systems over time.

The Glen Annie Canyon site does seem to have at least two components as Erlandson et al. (1988) suggest, but the great majority of the assemblage is consistent with the general Millingstone pattern. In fact, it is possible to pick out those artifacts that belong to the later component, as Erlandson (et al. 1988:241) demonstrates. For this reason, the use wear analyses of millingstones, handstones, and scraper planes are warranted in order to provide further clarification of at least one instance of the Oak Grove pattern in the Santa Barbara area. These analyses are thought to represent the primary occupation of SBA-142 and are interpreted as such.

Millingstones

Erlandson et al. (1988) report the recovery of 121 millingstones while Basgall and True (1985:Table 3.2) note that only 33 were originally found; the latter estimate is consistent with original excavation reports. The surplus reported by Erlandson (et al. 1988:Table 1) is most likely the result of the inclusion of what were cataloged as miscellaneous ground stone. During analyses, 33 millingstones were located and analyzed along with an additional 23 miscellaneous groundstone fragments. The latter had enough exterior and ground facet surface left to permit positive assignment to the millingstone category.

Fully 71% of the 121 millingstones were from the burial area; most of these (84 of 87) were from the lowest stratigraphic unit (12-clay) (Table 11.1). The dominance of millingstones in the burial area is not surprising because the majority of excavation took place in this concentrated location. This was most likely an area which saw occupational overlap, creating a dense accumulation of artifacts. Millingstones also tended to occur in the lower levels of the site in the non-burial area (12-30 inches), suggesting that the lowest levels represent the bulk of the Millingstone component.

All 56 millingstones analyzed were of naturally occurring sandstone and were represented by eight whole specimens, 26 margins, 12 ends, and 10 unidentifiable fragments.

Shaping degree was biased toward SD-0 (12) and SD-1 (23) millingstones, with a moderate number being SD-2 (10) forms (Table 11.2). Only two were highly shaped on the exterior. For those formalized to some degree, the method used to alter the exterior varied. Flaking on the exterior was observed on 35% of SD-1 millingstones and 10% of SD-2 forms. Conversely, pecking and grinding, two of the more light duty shaping methods, increased from 78% and 30%, respectively, from SD-1 to 100% and 90% for SD-2. These percentages suggest that as the degree of shaping increased, the regularity of the exterior form also increased as refined methods were used to alter more of the exterior surface.

Interestingly, thickness measurements tended to fall mostly within the range of block (10) and boulder (13) for all shaping degrees except SD-3 (see Appendix A for thickness measurements and Figure 1 for thickness classification). Block and boulder slabs account for a large portion of measurable millingstones (67%). It may be the case that fragments on which true thickness measurements could not be measured (having 2 intact opposing surfaces) are those which represent the thinner millingstones. However, a review of incomplete measurements demonstrates that most of these fragments at least fit within the thick category. The complete measurements are thus taken to be representative for all millingstones. The thick nature of the raw material available near the site is reflected among the SD-0 millingstones and is further indicated in the other degree classifications in that the selection of thinner blocks of stone may not have been possible. It is noteworthy that thin and thick millingstones do increase in number from SD-0 to SD-1. This is most likely the result of the need to eliminate mass. Block and boulder sizes were relatively big in whole form and were probably not easily moved.

Metrical characteristics that attest to the size of millingstones are provided in Table 11.3. The most striking pattern relates to the increase in the average maximum thickness as shaping degree increases. This probably means that the degree to which tools had to be modified was primarily governed by the natural thickness of the stone. The larger the stone, the more mass had to be removed in order to facilitate its use. Since the sample of specimens complete enough to be measured by length and width are limited, the relative volume can only be used as a proxy measure for size. The volume of SD-0 millingstones was 3322 cm^3, 10263 cm^3 for SD-1 millingstones, and 8320 cm^3 for SD-2. The increase in volume that accompanies shaping degree is probably the result of a need to reduce more mass. These metrical data along with shaping type and degree classifications suggest that the direct shaping of millingstones resulted from a need to quickly reduce the mass during the manufacture process. It does not seem that millingstones were being prepared for portability.

Use wear data indicate that there were differences in use between the shaping degree categories (see Table 11.2). SD-0 millingstones tended to be used on only one surface (83%). The diversity of surfaces was high with four that were basined, five that were flat, two slightly concave, and three slightly convex. Most were smooth in texture

(79%), polished (92%), and pecked (85%). Striations were observed on less than half of all surfaces (46%).

The sample of SD-1 millingstones also tended to be used on only one surface (82%), but surfaces became more regular (Table 11.2). Most surfaces were basined (61%), with 19% that were flat, 15% that were slightly concave, and 4% that were slightly convex. Irregularity in surface texture was almost non-existent (1 irregular surface) and all that could be analyzed (26 of 27) were polished. Pecking and striations reached similar levels as SD-0 millingstones, occurring on 85% and 46% of the surfaces, respectively.

Table 11.2**. SBA-142. Millingstone attributes by shaping degree.**

SHP DEGREE		**0**	**1**	**2**	**3**	**IND**	TOTAL
MATERIAL							
	SCH	-	-	-	-	-	-
	GRN	-	-	-	-	-	-
	SST	12	23	10	2	9	56
	GRA	-	-	-	-	-	-
	SIL	-	-	-	-	-	-
	VOL	-	-	-	-	-	-
CONDITION							
	WHL/NC	1	3	3	1	-	8
	MRG	5	14	4	1	2	26
	END	4	5	3	-	-	12
	FRG	2	1	-	-	7	10
SURFACE FREQUENCY							
	1	10	18	6	1	7	42
	2	2	4	4	1	2	13
	IND	-	1	-	-	-	1
SURFACE SHAPE							
	B	4	16	10	2	6	38
	F	5	5	2	-	4	16
	SCV	2	4	-	1	1	8
	SCX	3	1	2	-	-	6
	IND	-	1	-	-	-	1
SURFACE TEXTURE							
	S	11	25	14	3	11	64
	I	3	1	-	-	-	4
	IND	-	1	-	-	-	1
POLISH							
	PRS	13	26	13	3	11	66
	ABS	1	-	-	-	-	1
	IND	-	1	1	-	-	2
STRIAE							
	PRS	6	11	9	3	4	33
	ABS	7	13	4	-	7	31
	IND	1	1	1	-	-	3
PECKING							
	PRS	12	22	14	3	9	60
	ABS	2	4	-	-	2	8
	IND	-	1	-	-	-	1
SECONDARY MODIFICATION							
	PRS	6	3	10	-	-	19
	ABS	6	20	-	2	9	37
FIRE AFFECTION							
	PRS	6	14	4	1	8	33
	ABS	6	9	6	1	1	23
SHAPING TYPE							
	IND	-	-	-	-	9	9
	0	12	-	-	-	-	12
	1	-	8	1	1	-	10
	2	-	18	10	2	-	30
	3	-	7	9	2	-	18
TOTAL		12	23	10	2	9	56

Note: See Appendix A for description of terms.

Finally, SD-2 millingstones see a further increase in the regularity of surface form and use. Almost half (4 of 10) had two working surfaces. Seventy-one percent of the surfaces were basined, with only 14.5% each being flat and slightly convex. All surfaces that could be analyzed (one obscured for polish) were smooth, polished, and pecked. The majority of these (69%) were striated. The two SD-3 millingstones further the pattern of increasing regularity in surface shape and use. With one having two ground facets, two surfaces were basined and one was concave. All were smooth, polished, striated, and pecked.

The use wear data indicate that as the investment in form increased the associated surfaces were used more, resulting in an increase in the regularity of surface characteristics. The SD-0 millingstones were the most incipiently used and SD-3 forms were the most intensively used for grinding. There are no biases in use between basined, concave, and flat surfaces in terms of function. All were primarily used for grinding although deep peck marks in the basins of larger millingstones suggests that they may have been used also for more heavy pulverization.

The relatively high number exhibiting secondary modification among all shaping degrees except for the highest degree is an important clue to their economic orientation and use. At least six millingstones were used as abraders, two as anvils, and some other fragments were battered after they had been broken. The frequent use of these tools or fragments thereof is evidence of their functional generality. It is also true that 33 specimens were burned. Burned tools were probably scavenged for use as hearth or cooking stones, although there is a lack of such well defined features at the site.

Table 11.3. SBA-142. Average complete metrics by artifact class and shaping*.

Artifact	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
Shp Deg 0	24 / 12	12.7 / 2	10 / 6	12
Shp Deg 1	38.4 / 6	25.7 / 6	10.4 / 18	24
Shp Deg 2	37 / 1	19.9 / 3	11.3 / 7	10
Shp Deg 3	0 / -	0 / -	0 / -	2
Avg Total	20.4 / 19	19.4 / 11	10.6 / 31	48
Handstones				
Shp Deg 0	12.4 / 5	8.9 / 6	6.1 / 10	14
Shp Deg 1	14.8 / 2	8.9 / 4	5.5 / 11	13
Shp Deg 2	13.2 / 5	8.3 / 7	5.3 / 12	24
Shp Deg 3	11.9 / 8	8.5 / 12	4.8 / 15	22
Avg Total	13 / 20	8.6 / 29	5.4 / 48	73
Scraper				
Form 1	0 / -	0 / -	0 / -	0
Form 2	9 / 15	7.5 / 15	4.2 / 15	15
Avg Total	9 / 15	7.5 / 15	4.2 / 15	15

Note: *Includes only those artifacts complete enough to be categorized by shaping degree or form, does not **include indeterminate fragments; Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.**

Overall, the low regularity in exterior form and ground surface characteristics, along with the high amount of secondary modification present, probably indicates that millingstones were used more extensively than intensively. This generalization does not speak for the few that were probably used intensively in other contexts.

Handstones

The number of handstones analyzed from SBA-142 was nearly 100% of the total reported by Basgall and True (1985:Table 3.2), 73 of 76. However, Erlandson (et al. 1988) report a total of 132 handstones, which would bring the analyzed sample to approximately 55% of the total. Similar to the case with millingstones, the larger number presented by Erlandson (et al. 1988) probably includes some artifacts that were cataloged as miscellaneous groundstone, or a number of handstone fragments that may not have been included in the original count.

Most (78%) were found below 12 inches in depth, and roughly three quarters of these were from the burial area (Table 11.1). Like most artifacts found at the site, the high frequency of handstones in the burial area is both a product of excavation sampling and of variability in site structure.

Sandstone was the dominant material type, represented by 70 specimens, with three handstones are granite. Both sandstone and granite are known to occur locally in surrounding outcrops and drainages. Whole or near-complete handstones numbered 18, fragments of either margins (24) or ends (32) dominating the assemblage.

High formalization characterizes this tool class, with SD-3 (22 specimens) and SD-2 (24 specimens) compromising 63% of the total. SD-0 and SD-1 handstones were not uncommon, with 14 in the former and 13 in the latter, accounting for a combined total of 37% (See Table 11.4). The type of shaping did not vary significantly according to shaping degree. In all cases, pecking was less common than grinding as a form of shaping.

The average maximum length, width, and thickness for handstones is listed in Table 11.3 by shaping degree only for those complete enough to yield such information. Length tends to decrease about one and a half centimeters per shaping category going from SD-1 to SD-3. Interestingly, SD-0 handstones are smaller than those of both SD-1 and SD-2. According to width, only a small difference (about one half of a centimeter) is noted between the first two categories of shaping and the last two.

Table 11.4. SBA-142. Handstone attributes by shaping degree.

SHP DEG		**0**	**1**	**2**	**3**	IND	**TOTAL**
MATERIAL	SCH	-	-	-	-	-	-
	GRN	1	-	2	-	-	3
	SST	13	13	22	22	-	70
	META	-	-	-	-	-	-
	QZT	-	-	-	-	-	-
	QTZ	-	-	-	-	-	-

	IGN	-	-	-	-	-	-
	FEL	-	-	-	-	-	-
	GRA	-	-	-	-	-	-
	BAS	-	-	-	-	-	-
	RHY	-	-	-	-	-	-
CONDITION							
	WHL/NC	4	2	5	7	-	18
	MRG	4	3	11	5	-	23
	END	6	8	9	9	-	32
	MED	-	-	-	-	-	-
	FRG	-	-	-	1	-	1
SURFACE FREQUENCY	1	7	1	1	2	-	11
	2	6	12	18	10	-	46
	3	1	-	2	4	-	7
	4	-	-	3	6	-	9
SURFACE SHAPE	F	-	8	16	18	-	42
	CV	6	1	-	-	-	7
	CX	16	15	39	40	-	110
	IND	-	1	-	-	-	1
SURFACE TEXTURE	S	22	23	55	58	-	158
	I	-	1	-	-	-	1
	IND	-	1	-	-	-	1
POLISH							
	PRS	22	25	54	58	-	159
	ABS	-	-	1	-	-	1
	IND	-	-	-	-	-	-
STRIAE							
	PRS	5	4	24	39	-	72
	ABS	17	20	31	19	-	85
	IND	-	1	-	-	-	-
PECKING							
	PRS	12	18	42	56	-	128
	ABS	10	6	13	2	-	31
	IND	-	1	-	-	-	1
END POLISH							
	PRS	-	2	7	16	-	25
	ABS	10	8	8	2	-	28
	IND	12	3	9	4	-	28
SECONDARY MODIFICATION	PRS	7	9	15	14	-	45
	ABS	7	4	9	8	-	28
FIRE AFFECTION	PRS	4	7	12	8	-	31
	ABS	10	6	12	14	-	42
SHAPING TYPE	IND	-	-	-	-	-	-

0	14	-	-	-	-	14
1	-	-	-	-	-	-
2	-	7	10	16	-	33
3	-	9	24	22	-	55
TOTAL	14	13	24	22	-	73

Note: See Appendix B for description of terms.

The most straightforward pattern is seen among differences in thickness measurements, which decrease steadily from SD-0 to SD-3 handstones. Overall, the relative volume decreases by shaping degree indicating a decrease in mass. Aside from SD-0 handstones that have a relative volume of 673 cm^3 which does not correlate with the general size trend, SD-1 forms had a volume of 724 cm^3, SD-2 handstones had a volume of 580 cm^3, and SD-3 had a volume of 485 cm^3. The decrease in size probably resulted from more intensive/extensive use. There were no metrical patterns according to specific characteristics of use, such as end polish. In the latter case, handstones that exhibited end polish had an average maximum length of 11.2 cm, while those without end polish were an average of 14.1 cm long. The fact that handstones with end polish are smaller than the overall average length of 13 cm is explainable by the fact that end polish tends to occur among the SD-2 and SD-3 categories.

Variation in use wear between shaping degrees is marked. From Table 11.4, it can be seen that the only use wear attributes which remain constant among all degrees of shaping are surface texture and surface polish, which tend to be observable beginning with low-moderate degrees of use, especially on softer materials. The rest of the attributes pattern differently, showing concurrent increases in use wear intensity and formalization. Among SD-0 handstones, the majority were unifacial (50%), with 42% bifacial and one trifacial (Table 11.4). Most surfaces were convex (73%) as 27% were concave. In addition to the smooth and polished surface textures, there were a relatively high number that lacked striations (77%) and pecking (45%). None of these were end polished.

Handstones of SD-1 form show an increase in the regularity of surface use as nearly all (92%) were bifacial. Surfaces were predominantly convex (60%), or flat (32%), although one surface was concave. The smooth and polished surfaces were generally lacking striations (83%) but surface pecking was common (75%). Only two ends out of eight measurable were found to be polished.

SD-2 handstones were even more regular in surface use than the lesser shaped ones. There was a diverse range of surface frequencies per tool with 75% bifacial, 8% trifacial, 13% quadrafacial, and only one (5%) that was used on a single surface. Surfaces were mostly convex (71%), although a good number were flat (29%). Nearly all surfaces were smooth and polished, yet striations were present on nearly half (44%), and pecking was present on the great majority (76%). End polish was not uncommon occurring on 46% of those for which this attribute could be measured.

The SD-3 handstones are the most regular both in terms of overall form and in terms of use wear. The number of surfaces per specimen increased over SD-2 forms, with only 9% unifacial, 45% bifacial, 18% trifacial, and 27% quadrafacial. Surfaces were either convex (68%) or flat (32%) and all were smooth and polished. Additionally, the majority were striated (67%) and nearly all were pecked (97%). The presence of end polish was positively associated with 16 (89%) handstones.

The use wear data shows directional patterning for the intensity of use associated with the different degrees of shaping. The regularity and intensity of use definitely increases with increasing formalization.

Use in secondary contexts was relatively common in all degree classifications, occurring more among formalized handstones. Totally, anvilling occurred on 8% of those handstones analyzed, end battering was seen on 80%, and end polish was present on 47% (53 artifacts could be analyzed for end polish). The only type of secondary modification that patterned by shaping degree was end polish which occurred primarily among SD-3 specimens (SD-3, 89%; SD-2, 46%). End polish is most likely the result of intentional grinding on the ends, although some probably accumulated through indirect contact with the sides of a basined milling surface. The latter is probably not the primary source of end polish since 30% of all surfaces on SD-2 and SD-3 handstones were flat. Flat surfaces resulted from a combination of factors including increased intensity of use and functionally distinct use on a flat millingstone surface. The fact that both flat and convex surfaces on handstones show relatively equal amounts of wear suggests that they were used for different kinds of grinding functions.

One type of secondary modification, fire-alteration, did not pattern by formalization type but was observed on 42% of all handstones, indicating their use as cooking or hearth stones. This is not an uncommon occurrence on large sites which often see overlapping occupations and scavenging.

The whole continuum of use seems to be represented in the handstone artifact class. SD-0 handstones were used in a more expedient manner with use intensity increasing to moderate levels for SD-1. Handstones forms SD-2 and SD-3 were used with a high level of intensity, biased more among those which were most formalized. Since the majority saw intensive use and high degrees of formalization, it is probably the case that they were used in a variety of contexts, on and off site.

Shaping was observed as both intentional and indirect. Intentionally shaped handstones tended to show regularized pecking of the margins in a manner that is inconsistent with use. Handstones that were indirectly shaped seem to have been formalized through grinding use on multiple surfaces, causing the form to become more regular with time. It is unclear whether the highly formalized handstones seemingly indirectly shaped through use were initially shaped by direct alteration of the margins.

Scraper Planes

There are conflicting accounts of the number of scraper planes present at SBA-142. Basgall and True (1985:3.28) report that there were 14 scraper planes recovered from the site, while Erlandson et al. (1988) account for 11. According to the curated catalog at the Santa Barbara Natural History Museum, there are no artifacts listed as scraper planes. In light of the above problems, the collection was intensively inspected for artifacts that might have been originally called out as scraper planes. Fifteen artifacts were found having morphologies consistent with those of scraper planes from other Millingstone sites; one was cataloged as undifferentiated flaked stone, 14 others as miscellaneous flaked stone. It is highly possible that the specimens chosen for analysis represent the originally defined scraper planes.

Apart from quartzite specimens, all were made from shale. Both materials are locally available at SBA-142. All 14 of these artifacts were made from a cobble base. As such, there can be no comparisons between the size of flake and cobble based implements. Aside from that, the average maximum length was 9 cm, the width was 7.5 cm and the thickness was 4.2 cm (Table 11.3). By themselves, these measurements can offer little information. When multiplied together, the resulting volume of 264 cm^3 suggests that these tools were relatively small. In fact, they have about 221 cm^3 less volume than the smallest handstones (Table 11.3).

Edges were all unifacially formed by percussion flaking with edge shapes tending to be convex regular (9) or convex irregular (5) (Table 11.5). In that most scraper planes were made from shale, the best illustration of the variation within this tool class is seen when the convex regular edges are compared against the convex irregular edges. Convex regular edges tend to be battered on the edges (78%), with the rest showing bifacial microchipping. These edges also exhibited end polish (66%) and step fracturing (89%). Interior polish was only observed on one of these edges.

Table 11.5. SBA-142. Scraper plane attributes by material type.

	BAS	CCR	QZT	QTZ	FEL	RHY	META	IGN	OTH	TOTAL
FORM										
1	-	-	-	-	-	-	-	-	-	-
2	-	-	2	-	-	-	-	-	13	15
3	-	-	-	-	-	-	-	-	-	-
Flk Type										
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-
IND	-	-	-	-	-	-	-	-	-	-
E Freq										
1	-	-	2	-	-	-	-	-	13	15
2	-	-	-	-	-	-	-	-	-	-
E Form										
1	-	-	2	-	-	-	-	-	13	15
2	-	-	-	-	-	-	-	-	-	-
E Shap										
1A	-	-	-	-	-	-	-	-	1	1
1B	-	-	-	-	-	-	-	-	-	-
2A	-	-	2	-	-	-	-	-	7	9
2B	-	-	-	-	-	-	-	-	5	5
3A	-	-	-	-	-	-	-	-	-	-
3B	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-
E Wear										
0	-	-	-	-	-	-	-	-	1	1
1	-	-	-	-	-	-	-	-	2	2
2	-	-	-	-	-	-	-	-	3	3
3	-	-	2	-	-	-	-	-	7	9
E Polish										
PRS	-	-	2	-	-	-	-	-	8	10
ABS	-	-	-	-	-	-	-	-	5	5
Stp Frac										
PRS	-	-	2	-	-	-	-	-	10	12
ABS	-	-	-	-	-	-	-	-	3	3
INT										
PRS	-	-	-	-	-	-	-	-	2	2
ABS	-	-	2	-	-	-	-	-	11	13
SEC										
PRS	-	-	2	-	-	-	-	-	4	6
ABS	-	-	-	-	-	-	-	-	9	9

TOTAL	-	-	2	-	-	-	-	-	13	15

Note: See Appendix C for description of terms.

Conversely, convex irregular edges showed a diverse array of use wear including one that was battered, two that were unifacially microchipped, one bifacially microchipped, and one that had no wear. Sixty percent were polished on the edges and step fractured and only one edge showed interior polish. These differences indicate that the regularity of the edge shape is positively correlated with increased levels of use wear.

The pattern of use wear increasing with regularity in edge shape is corroborated by the differences in angle measurements. Convex regular edges had an average edge angle of 73^0 and an average spine plane angle of 63^0, with 3 of 9 edges having edge and spine plane angles that were within 5 degrees of one another. Convex irregular edges had an average edge angle of 63^0 and a spine plane angle of 60^0, with 4 of 5 edges within 5 degrees of one another. Convex irregular edges have very little disparity between one another while convex regular edges are more typical of scraper plane wear.

Overall, the average edge angle was recorded at 70^0 and the average spine plane angle was 62^0. The average maximum flake scar length of 1.6 cm indicates that some resharpening was taking place, though to a lesser degree on the less regular edge shapes. The reason for the more acute edge and spine plane angles at this site is unclear, but it is probably due to the nature of the raw material. It is not due to the average thickness of 4.1 cm, because this closely parallels the average of all sites which is 4.4 cm. The disparity between edge and spine plane angles is large enough to suggest that edges were blunted by use and resharpened. The latter is supported by the flake scars on the edges which are too small to indicate flake removal for use as tools, as there is no micro-lithic assemblage present at SBA-142.

Use wear data indicate that these tools were used as battering and scraping implements, but not until exhaustion. Those that had more regular edge shapes tended to exhibit more regular wear than those that were irregular in shape. Scraper planes at SBA-142 were most likely expediently manufactured for lighter duty scraping, planning, and/or battering in the immediate vicinity.

Non-Analyzed Tool Categories

Other artifact classes recovered from SBA-142 include points/bifaces (15), drills (4), gravers (12), flake tools (104), hammerstones (41), choppers (35), pestles (4), bowls (1), charmstones (5), and ornaments (41) (Table 11.1, Erlandson et al. 1988:Table 1, Owen et al. 1964). Most hammerstones and choppers, along with a significant portion of flake tools (42%) were found below 12 inches, in association with the portion of deposit that produced the highest numbers of handstones and millingstones. These tool classes are consistent with the Millingstone pattern. Both hammers and choppers did not seem to represent tools that were used with great intensity, as cursory observations revealed. Their use seems to overlap with handstones in terms of battering, and with scraper planes according to both battering and chopping. This overlap is evidence of the general nature of the majority of processing implements at the site.

The flake tools, in many cases, have been overlooked as intrusive or unimportant aspects of many Millingstone sites, but are probably intimately tied to the pattern. Most flake tools are unmodified in form, suggesting that their use on site was more expedient in nature, and probably tied to vegetal processing. The presence of points and bifaces, which are normally thought to be associated with faunal exploitation, are not represented by large numbers. Surely they are an indication of a subsistence component which saw the exploitation of various faunal resources, but their frequency alone as compared to the vegetal processing component of the site, suggests that they were not as economically important.

The small number of pestles, the single bowl, and the several dozen bone awl fragments (Curtis 1965) were all found in the upper 12 inches of the site during surface grading and most likely represent a later component which included some flake tools, points/bifaces, a few handstones and millingstones, and some ornaments. Post depositional disturbance surely contributed to some of the component mixing that confuses the assignment of certain ecofactual and artifactual material to either one, but the extreme polarity (upper or lower areas of the deposit) was determined.

Summary and Conclusion

The internal structure of SBA-142 has been obscured by heavy disturbance in the upper layers and at least minor rodent disturbance of the lower parts of the deposit. Nevertheless, the later component that was found to exist in the assemblage is still relatively confined to the upper 12 inches of matrix. Even at that, the evidence of this component is relatively limited compared to the earlier assemblage present at the site. The difference in the subsistence remains recovered, illustrated by Erlandson (et al. 1988), may be an indication that several cultural components are represented in the assemblage. They were able to show that most of the terrestrial fauna recovered was from the first 6-12 inches, dramatically decreasing in quantity and relative proportion to shellfish remains with increasing depth. A sample bias must exist in that shell is one of the most durable materials with respect to subsistence remains, followed by bone, with possibly the least durable being seeds. In any case, the differential proportions by depth are grossly meaningful in terms of economic focus.

The high amount of shell recovered from the site does not necessarily mean the occupants were primarily geared toward the collecting of shellfish. Clearly, the abundant presence of processing equipment suggests that other kinds of gathering and processing were also occurring to at least comparable levels of that reflected by the shellfish remains. If anything, the presence of shellfish simply reflects that the gathering economy employed at the site included a broad spectrum of resources. There is no evidence to suggest that any strategic focus on a particular foodstuff was occurring at the site.

That the early and late components are separable to a certain extent is reflected in the relationship between millingstones, handstones, and other ground and battered stone with the radiocarbon dates. Millingstones and handstones tend to be vertically biased toward the lower levels (below 12 inches; Table 11.1), correlating with the distribution of early radiocarbon dates (Erlandson et al. 1988:Table 2). Four dates taken on marine shell range between approximately 6000 and 7500 years BP. All but one date was taken from burial contexts. Additionally, one of the radiocarbon dates sampled by Erlandson (et al. 1988) clearly reflects a later occupation between about 1200 and 1500 years BP What the very gross component separation suggests is that there is no conclusive evidence to associate the preponderance of what might be a faunal procurement technology (points and bifaces) with the earlier and more robust milling technology.

The difference in formality between millingstones and handstones puts a twist on the interpretation of settlement strategies. On the one hand, millingstones were probably used for more than one purpose (though mainly grinding) at the site. On the other hand, a high number of handstones (2/3) were moderately to highly formalized and used with relative intensity; the other 1/3 were used on a more expedient basis. Since millingstones do not seem to have been used to the same degree as handstones, a large portion of the latter probably saw more use in contexts off site in addition to the local area. The fact that most handstones were made from locally available material does not pose a problem in this interpretation because sandstone is the dominant material type in the greater area around the site, and could have been procured elsewhere.

The artifacts analyzed as scraper planes were used to a low-moderate degree for battering and scraping purposes. These artifacts are characterized by low formalization, being expediently manufactured. The discard patterns associated with scraper planes are mimicked by hammerstones and choppers which were also used for a wide range of purposes. These artifacts are present in relatively high numbers with low degrees of formal investment and discard patterns that suggest they were not used until exhaustion. Most of these artifacts probably served an immediate and moderately intensive purpose, after which they were discarded without concern for reuse.

The mixing of the upper layers of matrix, and the numerous krotovina that riddled the lower deposit make the association of most projectile points and flake tools with the Millingstone component problematic. However, these tools are known to exist with such assemblages in other site contexts. It is probably the case that some flake tools and bifaces were used in the earlier occupations either directly or indirectly complimenting the processing activities characterizing the site. Either way, it neither helps nor hinders the overall interpretation of the main component of the site. Contrary to previous opinions (Owen 1964, Curtis 1965, Erlandson et al. 1988), the assemblage diversity is still relatively low compared to late prehistoric Chumash sites in the area.

The use wear analysis of millingstones, handstones, and scraper planes in the greater assemblage context does not fit with an interpretation of high mobility (Owen et al. 1964) or semi-sedentism (Curtis 1965; Erlandson et al. 1988). The major assemblage constituents are internally redundant. Variation is seen in the differential use of some tools with differences in formalization.

It can be said with relative certainty that the assemblage characterizing the Millingstone pattern was primarily geared toward generalized processing and gathering, with a lesser emphasis placed on faunal procurement. A total picture of the data generated from the analysis of millingstones, handstones, and scraper planes, in light of the whole assemblage, would fit best within an occupational history characterized by intensive, yet intermittent occupations occurring in regular intervals. This accounts for the accumulation of a generally redundant assemblage that saw low amounts of formal investment in most artifact classes. Sites such as this were probably important residential hubs where logistical mobility was common, but integrated in a wider scheme of occupying similar sites. The extent to which the Glen Annie site can speak for the Oak Grove Millingstone pattern is limited in that detailed information regarding other types of information such as burials and features that have become hallmarks of Oak Grove are lacking. In fact, a definition of the Oak Grove pattern has been elusive in previous research. The analyses of the primary technological constituents of the site can only serve to create a foundation for better defining the Oak Grove pattern and understanding the implications for social and technological organization.

Chapter 12:

Cumulative Analysis

This chapter offers a regional perspective of the use wear and formalization data generated for all millingstones, handstones, and scraper planes. Variation within and between regions demonstrates that different orientations of a common technological strategy characterize each region. This variation is explainable in functional terms that highlight regional differences in processing intensity and diversity. The various data suggest that the Millingstone pattern is simply a generalized strategy flexible enough to solve a range of processing needs without having to develop a specialized tool kit.

Millingstones

In the analysis of millingstones from each region, major variation in surface use and formalization seems to have been due primarily to functional issues, while variation in size and the intensity of processing wear is best explained by the natural characteristics of the local raw materials.

The number of millingstones from all sites that were analyzed totals 256. The majority came from the Sayles sites (45%), followed by Oak Grove (22%) and Topanga (22%), and finally La Jolla (11%). Variation in the size of millingstones from each region seems to be primarily a factor of raw material selection. This inference is best illustrated using raw material profiles, metrical summaries, and thickness groupings. Material profiles demonstrate that millingstones in all regions were made from locally abundant stone. Except for the Sayles sites, nearly all were made from sandstone; single specimens from La Jolla and Topanga were granitic and volcanic, respectfully. Of those from the Sayles sites, 92% were schist, 7% granitic, and one each was made from sandstone and volcanic material. All materials represented were locally available and the type primarily used was the most locally abundant in each case. Overall, material profiles were dominated by relatively soft stone comprised mostly of sandstone (54%), followed by schist (41%); just nine specimens made from granite and two from volcanics. Granite and volcanic stone was common enough in all but the Oak Grove regions that if material selection was random, then these would be better represented.

The overwhelming use of softer stone is assumed to be the result of intentional selection for two main reasons. First, sandstone and schist are more coarse-grained than other, harder materials and might have been more efficient for immediate grinding purposes than less abrasive stone. Second, softer materials are more easily modified through mass reduction and may have been more cost-effective during the manufacturing process for immediate use. These considerations would lessen the importance placed on tool durability because the softer materials would be more susceptible to higher rates of attrition through use and damage. If it were true that softer stone was intentionally used for immediate grinding and manufacturing efficiency, it must also be assumed that long term-durability was not a primary concern.

Regional variation in size is best illustrated when individual maximum thicknesses are sorted by the thickness groupings defined by Figure 1; a histogram that exhibits the relative average thickness groupings that occur in the assemblage. It is assumed that thickness is a general indicator of size, the four thickness categories defined as Thin (less than 5.5 cm), Thick (5.5-8.4 cm), Block (8.4-12.1 cm), and Boulder (12.1 cm and higher). It is clear that Block and Boulder sizes are most common in absolute frequency and proportion among Topanga and Oak Grove assemblages (Table 12.1). Conversely, La Jolla and Sayles specimens are defined primarily by the Thin and Thick categories. In terms of inter-regional variation, Topanga and

Oak Grove millingstones tend to be most diverse in thickness types, followed by Sayles and finally La Jolla (Table 12.1).

Table 12.1. Maximum thickness profiles for millingstones by region.

Thickness Type	La Jolla	Topanga	Oak Grove	Sayles
Thin	9	8	6	49
Thick	7	25	5	29
Block	6	15	9	5
Boulder	0	7	12	1

Note: Includes only those millingstones for which maximum thickness measurements could be determined.

The patterning of thickness types is assumed to be a factor of two variables: the nature of the local raw material and the type of ground surface desired. It happens that the Topanga and Oak Grove regions have the thickest natural outcrops of stone, occurring in both boulder and plate-like form. Raw material from the Sayles and La Jolla settings is naturally thinner and outcrops mostly in plate-like form. The differential occurrence of raw material certainly contributed in some part to the general size of millingstones in that the assemblages reflect these differences. However, there were a large number of millingstones in the Topanga and Oak Grove locales that were Thin and Thick, suggesting that the range of thickness types may have also had a functional link to the type of surface used.

The frequency of different millingstone surface shapes by region is illustrated in Table 12.3. If it is assumed that the thickness of a stone must increase to accommodate increases in surface concavity, then basined surfaces would be expected to correlate with the thicker millingstones. Basined surfaces represent 44% of the Topanga surfaces and 56% of those from Oak Grove, while only 11% of the La Jolla surfaces were basined. The basined surfaces from Sayles contexts cannot be factored because of the significant portion that were very small in diameter, inset in a larger flat surface. When the maximum thickness measurements of basined versus flat and concave milling surfaces are compared for Topanga and La Jolla millingstones, it is apparent that larger sizes are correlated with increases in surface concavity. The average maximum thickness for Topanga millingstones with basined surfaces was 10.8 cm (17 specimens) versus 10.1 cm (4 specimens) for La Jolla examples. Both of these measurements (being very similar) are higher than the average maximum thickness of 7.8 cm reported in Table 12.5. The thickness of millingstones with concave and flat surfaces from Topanga were both 6.0 cm (21 and 10 specimens, respectively), while the same measurements for La Jolla were 5.7 cm (14 specimens) and 2.4 cm (1 specimen) for concave and flat surfaced millingstones. The fact that these profiles look very similar seemingly contradicts the thickness types in Table 12.1 but this is resolved when the relative frequencies of basined versus concave and flat surfaces are compared.

Topanga Canyon has a high number of all three surface types while La Jolla is dominated by concave surfaces. The average maximum thickness seen in Table 12.5 is taken to be a factor of the relative proportions of flat and concave surfaces in contrast to the number of basins present in each region. The comparison of different surface shapes from Topanga and La Jolla demonstrates that millingstone size, represented by thickness, increases with increased surface concavity. Thus, the diversity in thickness types seen in Table 12.1 reflects the diversity of surface shapes from each region in addition to the size of local stone. It is likely that the depth of concave surfaces was constrained by the natural thickness profiles of the local stone.

The size of millingstones, indicated by volume, in conjunction with the patterning of shaping type, tends to be correlated with shaping degree in a way that would suggest most millingstones were subject to a more expedient manufacturing process. Table 12.5 contains metrical data for millingstones by shaping degree. When the length, width, and thickness measurements are multiplied together an assessment of the average maximum volume by shaping degree results. The volume of unshaped (SD-0) millingstones is 3389 cm^3, 8394 cm^3 for SD-1 millingstones, and 8961 cm^3 for SD-2 millingstones. The increase in volume is an indication of an increase in size with shaping degree. The implication of this is that as the blank selected for the manufacture of a millingstone increased in size, more mass was reduced. The situation of SD-3 millingstones having a smaller than average volume of 6752 cm^3 is an indication that they were modified to a point beyond simple mass reduction that involved a higher amount of investment in the exterior form.

Table 12.2. Millingstone shaping type by shaping degree.

	SD-1	SD-2	SD-3
Flaking	58%	41%	18%
Pecking	44%	78%	100%
Grinding	29%	72%	100%

Note: SD-1, shaping degree 1; SD-2, shaping degree 2; SD-3, shaping degree 3.

When the profile of shaping type is held against that of shaping degree, the differences in volume become more significant. Table 12.2 contains the percent of each shaping type occurring by shaping degree. Flaking is the most crude form of shaping whereby large sections are removed. Pecking of the exterior is considered to be more refined as a method of shaping because more control can be exercised when removing small amounts of mass. Grinding is taken to be the most refined method of exterior formalization that involves removing the least amount of mass in the most controlled manner. Flaking is very common among SD-1 and SD-2 millingstones but is rare among SD-3 specimens. Pecking was relatively common among all degrees of shaping, but tended to increase on the order of 30% per degree category until it was observed on all of the SD-3 artifacts. Grinding exhibited a pattern very similar to that of pecking but was less frequent than pecking on SD-1 millingstones. Summarily, flaking decreased with increases in shaping degree while pecking and grinding increased.

Table 12.3. **Millingstone attributes by regional complex.**

		La Jolla	Topanga	Oak	Sayles	Cumulative
SHAPING DEGREE	IND	13	3	9	29	54
	0	-	4	12	33	49
	1	7	22	23	39	91
	2	8	19	10	14	51
	3	1	7	2	1	11
SHAPING TYPE	IND	12	3	9	29	53
	0	-	4	12	33	49
	1	10	24	10	32	76
	2	14	40	30	22	106
	3	7	19	18	31	75
MATERIAL	SCH	-	-	-	106	106
	GRN	1	-	-	8	9
	SST	28	54	56	1	139
	GRA	-	-	-	-	-
	SIL	-	-	-	-	-
	VOL	-	1	-	1	2
CONDITION	WHL/NC	1	18	8	10	37
	MRG	14	24	26	59	123

Table 12.3. **Millingstone attributes by regional complex.**

		La Jolla	Topanga	Oak	Sayles	Cumulative
	END	2	11	12	20	45
	FRG	12	2	10	27	51
SURFACE FREQUENCY	1	19	35	42	93	189
	2	9	20	13	23	65
	IND	1	-	1	-	2
SURFACE SHAPE	B	4	33	38	47	122
	F	10	28	16	62	116
	SCV	21	13	8	29	71
	SCX	2	1	6	1	10
	IND	1	-	1	-	2
SURFACE TEXTURE	S	34	68	64	120	286
	I	2	7	4	19	32
	IND	2	-	1	-	3
POLISH	PRS	21	62	66	139	288
	ABS	15	13	1	-	29
	IND	2	-	2	-	4
STRIAE	PRS	2	20	33	54	109
	ABS	32	55	33	85	205
	IND	4	-	3	-	7
PECKING	PRS	33	65	60	105	263
	ABS	4	10	8	34	56
	IND	1	-	1	-	2
SECONDARY MODIFICATION	PRS	2	3	19	2	26
	ABS	27	52	37	114	230
FIRE AFFECTION	PRS	6	18	33	27	84
	ABS	23	37	23	89	172
TOTAL		29	55	56	116	256

Note: See Appendix A for description of terms.

When the relative volume of millingstones by shaping degree is considered together with the profile of shaping types, the intent of manufacture can be assessed. It was demonstrated that the volume of millingstones increases with shaping degree. Also more crude forms of shaping were significantly present on SD-1 and SD-2 millingstones, but were not frequently observed among SD-3 specimens. These patterns indicate that, for the majority of millingstones, the manufacturing process seems to have been more expedient and geared toward a basic reduction of mass. Since most of these tools were very bulky, it is unlikely that they were being prepared for transportation off-site but were intended to be used in the immediate vicinity. The degree of investment in exterior form (excluding SD-3 forms) would then be an indication not only of how much the local stone had to be modified to facilitate use, but also of the intent to re-use the tool over time with subsequent occupations. If planned re-use of the tool was intended, the level of formalization would be expected to increase so that it would be more reliable in terms of manageability, and possibly durability by the elimination of irregularities that might invite damage.

The small sample of SD-3 millingstones have a smaller average volume and have been modified enough on the exterior that if flaking was used as a form of shaping, it has been obliterated in most cases. These tools saw a great deal of investment in exterior form and may have been intended for use in off-site contexts since they would have been more portable. The regular form is also expected to confer a higher degree of reliability because there are less irregularities that might hinder handling or use. It is assumed that these were not shaped with the intention of being left on-site because the abundance of local stone would have lowered the cost of manufacturing a new one in light of exhaustively maintaining another.

It is assumed that investment in the form of a millingstone was incremental such that the evidence of less refined methods of shaping would be expected to be obliterated by techniques intended to increase formal regularity. In other words, flaking is not expected to be frequently observed among SD-3 millingstones. This does not mean that the categories of lower formalization (SD-1 and SD-2) represent unfinished versions of the higher shaped millingstones because this implies that all millingstones were intended to have a regular outline. What it does mean is that there were different methods at the disposal of the manufacturer to contribute to formal regularity, the degree of which was relative to the functional needs for that tool. This dilemma is clarified when shaping degree is compared to use wear, which shows that even the SD-0 and SD-1 millingstones were used to similar degrees as the higher shaped specimens.

A Chi Square test was used to compare the proportions of surfaces from each category of shaping that exhibited smooth textures, polish, striations, and rejuvenation pecking. The test results indicate that variation in surface wear by shaping degree could have occurred randomly between 70 and 50 percent of the time [$P_{0.70}$ (6.39) < X^2 (7.84) < $P_{0.50}$ (8.34), df=9]. Essentially, all surfaces, regardless of shaping degree, were subject to equitable levels of processing use, supporting the notion that lesser shaped millingstones were not simply unfinished versions of those shaped to higher degrees.

The variability in formalization by region may have been partially a factor of the constraints posed by raw material morphology, but there are no patterns that would clearly support this assumption. Most millingstones from each region tended to be of SD-1 and SD-2 form (Table 12.3). Oak Grove and Sayles sites had the highest proportions of unshaped (SD-0) millingstones (25% and 38%, respectively), while Topanga had the highest amount of SD-3 examples (13%).

Variability in millingstone use according to shaping degree takes on the most meaning when compared to surface frequency and surface shape. The presence of two surfaces per millingstone increases dramatically with shaping degree. Unshaped and SD-1 millingstones each show bifacial wear on about 13% of specimens, while 51% of SD-2, and 82% of SD-3 were bifacial. This suggests that as the investment in form increased, it may have been more economical to turn the millingstone over and use the opposing surface than to invest in the manufacture of another tool. The costs associated with making a new tool include procuring new raw material, transporting this material to the location of use, and altering the form according to intention. The proportions of bifacial specimens by shaping degree become more interesting when compared to the frequency of SD-2 and SD-3 millingstones in conjunction with surface frequency by region. Topanga and La Jolla have the highest percentage of SD-2 and SD-3 millingstones and also the highest percentage of bifacially used millingstones (Table 12.3). The higher number of surfaces per millingstone is thought to be an indication of increased intensity/extensity of processing.

Surface shapes also exhibit trends according to shaping degree (Table 12.4). It is evident that SD-3 millingstones have lower proportions of basined surfaces and higher proportions of flat surfaces than SD-1 and SD-2. This is probably a result of the fact that millingstones shaped to the highest degree tended to have the least amount of volume and could not accommodate large basins.

Table 12.4 also shows that there are slightly more concave surfaces among SD-3 millingstones, suggesting that the lack of a deep basin was accommodated by the use of shallow dished surfaces. The fact that 45% of the surfaces of SD-0 implements are flat is biased by the fact that most of these came from the Sayles sites where the millingstones tend to fit within the Thin category, and that flat surfaced use dominated the processing strategy at these sites.

Aside from millingstone formalization, the greatest regional variability rests in the functional differences of surface use. These differences are best illustrated using surface shape. In the previous site chapters, it was shown that basined and flat surfaces are functionally distinct in that both exhibited attributes consistent with comparable levels of use, and yet their shapes are very different.

Table 12.4. Frequency of millingstone surface shapes by shaping degree.

Shaping Degree	Basin	Flat	Concave	Convex
0	16	24	13	3
1	50	26	22	1
2	35	25	12	4
3	6	8	5	1

It is also assumed that the concave surfaces are more functionally related to basins than they are to flat surfaces. If this is true, then concave surfaces of any kind represent the majority within each region (Table 12.3). However, flat surfaces are most frequent among Sayles (45%) and Topanga (38%) assemblages, being less frequent among La Jolla (27%) and Oak Grove (24%) samples. When subject to a Chi Square test, it is indicated that the difference in proportion of flat surfaces by region is unlikely to result from chance or sample bias [$P_{0.05}$ (7.82) < X^2 (10.4), df=3]. Since flat and basined/concave surfaces are assumed to be functionally distinct, these proportions are telling of slight differences in the stance of the general processing regime by region.

Basined surfaces may have been more exposed to battering in addition to grinding that would have contributed to their shape. Inter-regional surface use wear data do not show clear patterns that would support a functional difference between basined and flat surfaces because both kinds were subject to equitable levels of use. It is also the case that some flat surfaces were simply ancillary, not acting as the primary processing surface of the tool. However, the differences were highlighted in the site chapters where the supporting data were not masked by the lumping effects of a regional perspective. The basined surfaces from Topanga exhibited extensive surface battering that was not consistent with maintenance. These surfaces were exposed to heavy battering that almost obliterated evidence of intensive grinding. In fact, only 16% of the battered basins exhibited the entire suite of attributes indicative of intensive grinding use (smooth, polished, striated, and pecked). The minimum number of millingstones having all attributes is limited to the attribute with the lowest observation in this case striations. Conversely, 30% of the flat surfaces (excluding 4 that were ancillary surfaces) had that suite of attributes. Even though the small sample size may present a bias, the difference between the two surfaces lies in the type of battering observed. Overall, the use wear data indicate that flat surfaces from Topanga were used for general grinding purposes, while the basins were primarily used as pulverizing containers.

Some basined surfaces from the Sayles sites were anomalous in form. These surfaces were generally small in diameter (between 13 and 20 cm), inset in a larger ground platform. The margins of the basins were not sharp but blended in with the flat surfaces through grinding. They resemble portable hopper mortars in appearance but seem to have been used for both battering and grinding in relation to the flat ground surface. For the Sayles region, there may be a functional relationship between these small basins and the surrounding flat surfaces that is not duplicated in other regions. Their function may have been related to a subset of handstones that tended to have pestle-like use on the ends.

The millingstones from La Jolla and Oak Grove are more similar to one another than to Topanga or Sayles. Basins from the former two locales seem to have been used primarily for grinding. If battering did contribute to the shape of surfaces, it was obscured by more intensive grinding, suggesting that the latter was the primary function of the surface. The suite of use wear attributes that measure grinding intensity (surfaces that are smooth, polished, striated, and pecked) is present on 63% of the basins from Oak Grove. This same measure for La Jolla basins is subject to sample bias because of the small number of deep basins present and because much of the sandstone from the Scripps Estates site has seen extensive weathering and carbonate buildup, obscuring detailed observation. The difference in basin surface use between Oak Grove and Topanga was subject to a Chi Square test, the results of which suggest that the difference in basin use between the two regions is due to variation in use rather than chance [$P_{0.01}$ (6.64) < X^2 (13.5), df=1].

Summarizing regional differences in surface use, Oak Grove and La Jolla millingstones look very similar in terms of basin wear and the proportion of surface shapes. Their surfaces exhibit use more indicative of intensive grinding, such that if battering contributed to the surface shape, it was obliterated by the evidence of grinding. These areas had the lowest frequency of flat surfaces. The Topanga millingstones show differences both in the proportion of surface shapes, having 38% flat surfaces, and in the functional use of these surfaces. Basined millingstones from Topanga seem to have been more battered than ground, while the flat and concave surfaces were subject to more grinding than battering. The Sayles millingstones have the highest proportion of flat surfaces (45%) and the basins have a tendency to be small in diameter within a flat ground platform. The anomalous basin shape may have been functionally related to a class of handstones that had pestle-like use on the ends. The regional differences are assumed to indicate slightly different emphases on functional processes. Millingstone assemblages that exhibited a high degree of battering may have been used for the pulverization of pulpy or fibrous materials in addition to grinding of small hard seeds that characterized the flat-surfaced millingstones.

Four main attributes were used for the measurement of surface use intensity: surface texture (smooth or irregular), and the presence or absence of polish, striations, and pecking. Polish and striations are thought to be indicative of increased, prolonged pressure from grinding, and pecking is assumed to represent surface maintenance by making it more abrasive. The positive measurements of these attributes (smooth surfaces that exhibited polish, striations, and pecking) were analyzed with the Chi Square test in order to determine whether the amount of variation by region was significant, indicating differences in surface use intensity. The test indicated that there was probably a non-random factor contributing to the variation [$P_{0.05}$(16.92) < X^2 (19.7) > $P_{0.01}$ (21.67), df=9]. Referring to Table 12.3, it can be seen that only two (6%) surfaces from the La Jolla assemblage exhibited striations. This stands in contrast to the average proportion of 38% observed among the other three assemblages. In order to assess whether or not the small number of striated surfaces from La Jolla was the major contributing factor to the large Chi Square value, the number of striated surfaces from La Jolla was adjusted to the average value of the other three regions, 38%, and the Chi Square test was performed again. If the low occurrence of striations for this region was biasing the test, its correction to the average for the other regions should eliminate this bias. The second Chi Square test revealed only enough region that it could be accounted for by chance [$P_{0.30}$ (10.66) ≈ X^2 (10.6), df=9]. In the absence of the extremely low occurrence of striations from La Jolla, the variation in surface use intensity between regions can not reliably be explained as functional variation.

Table 12.5. Average complete metrics by artifact class, region, and shaping.

Artifact Class	Max L / #c	Max W / #c	Max TH / #c	Total #
Millingstones				
La Jolla	-/0	27.4 / 3	7.8 / 15	15
Topanga	34.7 / 16	25.9 / 19	7.8 / 50	52
Oak Grove	33.1 / 19	19.4 / 11	10.6 / 31	48
Sayles	31.2 / 13	25 / 17	4.9 / 71	87
Mean	33 / 48	24.4 / 50	7.8 / 167	202
Shap Degree				
0	27.2 / 9	18.6 / 11	6.7 / 36	50
1	38.3 / 17	28.1 / 25	7.8 / 74	92
2	40.8 / 10	28.9 / 11	7.6 / 48	52
3	31.5 / 4	22.1 / 4	9.7 / 9	12
Handstones				
La Jolla	10.9 / 33	8.3 / 42	4.9 / 45	47
Topanga	13 / 161	9.8 / 275	4.9 / 326	344
Oak Grove	13 / 20	8.6 / 29	5.4 / 48	73
Sayles	12.5 / 67	9 / 68	5.1 / 96	95
Mean	12.4 / 281	8.9 / 414	5.1 / 515	559
Shap Degree				
0	12.1 / 107	8.8 / 128	5.3 / 148	165
1	12.4 / 66	8.8 / 109	5.1 / 139	154
2	12.4 / 70	8.5 / 128	4.7 / 153	177
3	12.7 / 42	8.8 / 68	4.3 / 178	88
Scraper				
La Jolla	7.5 / 38	5.7 / 38	3.5 / 38	38
Topanga	7.2 / 308	5.6 / 309	4.1 / 309	309
Oak Grove	9 / 15	7.5 / 15	4.2 / 15	15
Sayles	9.2 / 80	7.2 / 80	4.8 / 80	80
Mean	8.2 / 441	6.5 / 442	4.2 / 442	442
Form				
1	7.3 / 106	5.8 / 107	3.4 / 107	107
2	7.9 / 332	6.2 / 332	4.7 / 332	332

Note: Max L, average maximum length; Max W, average maximum width; Max TH, average maximum thickness; #c, number of specimens with complete measurements; Total #, total number of specimens; Shp Deg, shaping degree; Avg Total, average total; all measurements in centimeters.

The sandstone from which millingstones were made in the La Jolla region tended to be weathered and coated with calcium carbonates to a point that might obscure the observance of striations. It is also true that the sandstone is coarse grained and somewhat friable such that striations may not have accumulated with as much regularity as would occur on harder, more fine grained material. In any case, the relatively high amount of surfaces that were smooth, polished, striated, and pecked for all regions suggests that milling surfaces were being used to similar levels. Whether the use wear is due more to processing intensity or extensity is best resolved when compared to all other aspects of millingstone use.

No complete interpretation of millingstone use can be obtained outside the physical context of the assemblage. Within each site chapter, these assemblages were explained as resulting from an occupation strategy characterized by regular site occupation on a non-sedentary basis. The degree of re-occupation and duration of stay would then be the major contributing factors of tool wear. The assemblages from Topanga and Oak Grove were thought to have resulted from occupation intervals that were slightly longer than those from La Jolla, with the Sayles sites seeing the most sporadic use and shortest occupation spans. Almost all millingstones were probably subject to re-use, planned and scavenged, over time.

The best evidence for extensive millingstone use (or re-use) comes from relative proportions of shaping degree and from various types of secondary modification. Excluding SD-3 millingstones, SD-1 and SD-2 artifacts may have been prepared for use as site furniture intended to be used periodically over time. In this case, limited investment in the exterior form would benefit long term periodic use by making it somewhat more manageable in the immediate vicinity. Short distance portability would increase and there would be less obstructive mass that might hinder processing by getting in the way. Most millingstones were SD-1 (45%) and SD-2 (25%) forms, accounting for 70% of the total number.

Secondary modification is another measure of re-use that provides an indication of the general function of millingstones and of the extensiveness of scavenging. In all, 43% of millingstones were secondarily modified. A large portion of these were used as cooking or heating stones (33%, Table 12.3). The rest were used as abraders (9), anvils (9), and battering implements on broken edges (8 specimens). Direct reuse of millingstones is best supported by their use as abraders and anvils, cooking/heating stones to a lesser extent. Battering on broken edges and some fire-alteration is most certainly due to scavenging. The evidence of secondary modification does pattern out by region. Other than burning, which characterizes the majority of re-use in all areas, millingstones from Oak Grove have the highest proportion of specimens used as abraders, anvils, and battering implements (Table 12.3). Only five specimens from Topanga, two from La Jolla, and two from the Sayles sites were used for these purposes. It is interesting that over half of the millingstones from Oak Grove were used as cooking/heating stones, while only 33% from Topanga, 23% from Sayles, and 20% from La Jolla were used in this manner. These proportions may indicate differences in scavenging behavior.

It is also notable that secondary modification was only observed on SD-0 through SD-2 millingstones. In addition, SD-2 millingstones had twice as many specimens showing secondary use as those within either the SD-0 or SD-1 categories. These patterns may be more evidence that millingstone shaping resulted from an intention to re-use them over time. Of course, it could also be the case that it was functionally economical to use the site furniture millingstones for other than the primary uses than it would have been to use the highly shaped millingstones. Use of the latter in secondary contexts might have been too risky considering the high amount of investment placed in their form to ensure reliability for primary uses.

Millingstones from all regions tend to fit within a common manufacture and use trajectory. Low to moderate degrees of formalization suggest that most were manufactured for immediate, local use, indicated by correlations between shaping type, millingstone size, and raw material characteristics. Only a limited number, mostly from Topanga and Oak Grove, witnessed enough formalization correlated with smaller size and intensive use that might indicate an intention of portablility. Trends in surface use also exhibit little inter-regional variation in that millingstones from all regions and of all kinds seem to have been used intensively for many different kinds of processing. Variation in observed use-wear is best accounted for through regional differences in raw material. That which is not accounted for by raw material characteristics is functionally and regionally specific; such as the heavily battered basins from

Topanga, the small diameter basins from the Sayles sites, and the relative proportion of different surface shapes.

Handstones

Regional handstone use is most variable with regard to formalization and functional orientation. In some areas, handstones witnessed greater amounts of shaping that tended to correlate with slightly different use trajectories. Additionally, some assemblages exhibited traces of use that were locally specific, indicating a unique, yet general, function. However, there is little difference in the general intensity of handstone use from region to region. All handstones can be said to have been exposed to a wide range of functions that overlap with functionally distinct tool categories such as battered cobbles. The sample of analyzed handstones numbered 584, those from La Jolla accounting for 55, 345 from Topanga, 73 from Oak Grove, and 111 from the Sayles localities.

Variation in handstone morphology is due mostly to the effects of manufacture and use since the raw material profiles demonstrate that nearly all materials used were local. From Table 12.7, it can be seen that certain material types are more frequent in some regions than others, and that the diversity of stone types varies regionally. The material profiles for each region are simply cross sections of the relative abundance of the different types of stone indicating that the diversity reflects that which was available in the local areas; not the importation of extralocal materials. However, this does not mean that some handstones were not made from stone procured in off-site locations and discarded in their final context. It is also true that the materials which define the sites that represent each regional complex also define the larger regions such that the materials recovered from the Tank sites represent those for the entire region of Topanga Canyon and the surrounding Santa Monica Mountains. What the raw material profiles represent are larger patterns of stone usage within the greater regions; not simply site specific use, although the latter may characterize some regions.

Table 12.6. Handstone metrics by material type and condition.

	Whole/Near Complete			Fragments
Material Type	Max. Length	Max. Width	Max. Thickness	Max. Thickness
Granite	11.7	8.8	5.2	5.1
Sandstone	12.9	8.7	4.7	4.7
Schist	13.5	9.0	4.9	5.1

Note: all measurements in cm.

Table 12.7. **Handstone attributes by regional complex.**

		La Jolla	Topanga	Oak	Sayles	Cumulative
SHAPING DEGREE	IND	2	1	-	1	4
	0	21	78	14	51	164
	1	12	94	13	34	153
	2	16	117	24	19	176
	3	4	55	22	6	87
SHAPING TYPE	IND	2	1	-	1	4
	0	21	78	14	51	164
	1	-	-	-	-	-
	2	25	185	33	36	279
	3	10	205	55	45	315
MATERIAL	SCH	-	-	-	30	30

Table 12.7. **Handstone attributes by regional complex.**

		La Jolla	Topanga	Oak	Sayles	Cumulative
	GRN	47	115	3	51	216
	SST	3	200	70	13	286
	META	5	22	-	4	31
	QZT	-	5	-	-	5
	QTZ	-	-	-	8	8
	IGN	-	3	-	-	3
	FEL	-	-	-	5	5
CONDITION	WHL/NC	38	172	18	67	295
	MRG	3	13	23	11	50
	END	14	147	32	27	220
	MED	-	13	-	3	16
	FRG	-	-	1	1	2
SURFACE FREQUENCY	1	10	43	11	32	96
	2	43	270	46	78	437
	3	2	29	7	-	38
	4	-	2	9	1	12
SURFACE SHAPE	F	21	185	42	47	295
	CV	-	5	7	7	19
	CX	81	487	110	95	773
	IND	-	1	1	43	45
SURFACE TEXTURE	S	96	615	158	161	1030
	I	6	62	1	30	99
	IND	-	1	1	1	3
POLISH	PRS	99	643	159	189	1090
	ABS	1	34	1	2	38
	IND	2	1	-	1	4
STRIAE	PRS	64	250	72	134	520
	ABS	34	424	85	57	600
	IND	4	4	-	1	9
PECKING	PRS	77	501	128	136	842
	ABS	25	176	31	55	287
	IND	-	1	1	1	3
END POLISH	PRS	14	87	25	14	140
	ABS	40	235	28	90	393
	IND	1	23	28	7	59
SECONDARY MODIFICATION	PRS	41	266	45	61	413
	ABS	14	79	28	50	171
FIRE AFFECTION	PRS	28	154	31	44	257
	ABS	27	191	42	67	327
TOTAL		55	345	73	111	584

Note: See Appendix B for description of terms.

The three main materials used from all four regions (granite, sandstone, and schist) are thought to have been used with relatively proportionate amounts of intensity. Variation in the number of whole specimens per type would seem to speak to the contrary because 68% of granite handstones were whole, compared to 52% of schist and 39% of sandstone (Table 12.7). However, a statistical analysis of metrical data according to raw material revealed no significant variation in size (Table 12.6). Also, a comparison of the complete maximum thickness measurements for fragments versus whole or near-complete handstones revealed no significant changes that would suggest one material was subject to more intensive use than another; this assumes that handstones used with more grinding intensity would become thinner than those subject to less use (Table 12.6). Since the metrical data do not support an explanation of condition through variation in raw material use, it is probably the case that variation in condition is primarily a factor of the durability of the raw material. Granite is harder than sandstone which is harder than schist. Though a simple explanation, it may be true that harder materials survived use and post-depositional alteration more than softer materials. All handstones were extensively end battered; this function could have contributed to premature breakage. Harder materials might have survived battering more than softer stone.

Handstone morphology revealed little variation in size by region. If the average maximum lengths, widths, and thicknesses are multiplied to get volume as an estimate of size, La Jolla handstones have a volume of 443 cm^3, while the average volume for Topanga is 624 cm^3, 604 cm^3 for Oak Grove, and 574 cm^3 for Sayles specimens. With the latter three being very similar in size, the smaller size of La Jolla handstones is probably reflective of the nature of the local stone, which tends to occur as smaller beach/drainage cobbles. There do not seem to be any use wear or formalization patterns that vary enough from the norm which would explain the smaller size of La Jolla handstones.

Variation in handstone morphology assessed by metrical data is highlighted when compared to shaping degree. Table 12.5 contains the average maximum thicknesses for handstones by shaping degree. Handstone thickness decreases from 5.3 to 5.1 to 4.7 to 4.3 cm going from SD-0 to SD-3, respectively. This variation is not taken to be a factor of raw material biases for two related reasons. First, none of the average thicknesses for any raw material (given in Table 12.6) were small enough to bias the drop from 5.3 to 4.3 cm. Second, every major material category except schist was well represented among SD-2 and SD-3 handstones. For granite, there were 25% SD-2 and 13% SD-3 specimens, for sandstone there were 38% SD-2 and 17% SD-3 forms, and for metavolcanic there were 32% SD-2 and 21% SD-3 handstones. These data suggest that the drop in thickness according to shaping degree is a function of an increasing use life or use intensity as formalization increased.

Handstone shaping varies significantly by region reflecting both direct and indirect formalization. Table 12.7 shows that Oak Grove and Topanga tend to have the highest proportion of SD-2 and SD-3 handstones (63% and 50%, respectively); conversely, La Jolla and Sayles tend to have the highest proportion of SD-0 and SD-1 handstones (64% and 77%, respectively). Interestingly, Oak Grove and Topanga have the highest proportions of handstones with more than two surfaces observed (22% and 9%). This means that indirect formalization played a greater role in the shaping of these tools than it did among the La Jolla and Sayles assemblages. It is assumed that the more surfaces present on a handstone, the more regular the general outline will become. It is also important to note that non-maintenance related pecking of the margins was frequently observed on specimens from all regions (Table 12.7). Pecking as a form of shaping is easier to ascertain as a form of direct shaping on handstones than is grinding because the latter may be associated with ground wear facets.

A suite of attributes used to measure surface use (surface texture, polish, striations, and maintenance pecking) were compared against shaping degree and subject to a Chi Square test in order to determine the significance of the variability between categories. Variation in surface use between shaping degrees is most likely not the result of chance, as results indicate [$P_{0.01}$ (21.67) < X^2 (43.73), df=9]. When the data were revisited, four attribute values were found to present a bias which would account for all of the significant variation. Polished surfaces SD-0 handstones were more prevalent than expected, while pecked surfaces on SD-0 and SD-1 specimens were less frequent than expected. The high amount of polish suggests that unshaped handstones were used with at least moderate levels of intensity which would have resulted in polish accumulation. The lower than expected levels of pecking among SD-0 and SD-1 specimens suggest that these surfaces were not being used to a point where re-sharpening was necessary. Conversely, the higher than expected observance of striations on SD-3 handstone surfaces suggests that they were being used more intensively for grinding. Overall, the variation in surface use according to shaping degree suggests that the regularity of grinding intensity increased with higher degrees of formalization.

For the most part, the use of surfaces did not show significant variation according to region. Using the data from Table 12.7, the positive observance of smooth, polished, striated, and pecked ground surfaces was compared across the four regions using a Chi Square test. Results indicate that something other than random processes has to account for the variation [$P_{0.01}$ (21.67) $< X^2$ (39.12), df=9]. It can be seen in Table 12.7 that all significant variation is characterized by the higher than expected positive observance of striations among La Jolla and Sayles surfaces and the lower than expected value for the same attribute among Topanga surfaces. If striations are ignored, then the variation in the presence of smooth, polished, and pecked surfaces becomes insignificant and the distribution can be accounted for by chance [$P_{0.95}$ (1.64) $< X^2$ (1.75) $> P_{0.90}$ (2.20), df=6]. This reflects the similarity between regions concerning the regularity of processing intensity.

The differential observance of striations by region is complicated by a couple of factors. First, schist within the Sayles assemblages has a tendency to hold striations better than any other material among all handstones and biases its observance. For Sayles handstones then, this attribute cannot be taken to represent increased grinding intensity. Second, the higher than expected observance of striations among La Jolla handstones is assumed to mean that they may have been used with more regular grinding intensity for what was probably a fine-grained resource, similar to those from Oak Grove. The lower than expected number of striated surfaces from Topanga is also taken to be a function of use. The latter may be a result of the fact that the basined milling surfaces from Topanga were more battered than ground. Drawing this distinction between the presence of striations on handstone surfaces and the difference in millingstone surface use between regions is assumptive, but seems to be supported by the entire picture of ground and battered stone use.

The data on surface wear according to surface shape do not reveal significant patterns that would support regional variation. The two most frequent surface shapes, flat and convex, show nearly identical use wear patterns. A full 96% of all flat surfaces were smooth, 99% polished, 50% striated, and 83% were pecked. Similarly, 96% of convex surfaces were smooth, 100% polished, 48% striated, and 77% were pecked. The only deviant in surface use is the concave surface, which by its very nature is not expected to show high amounts of use because of its anomalous configuration that would have a hard time immediately matching traditional flat or concave millingstone surfaces. Thirty-nine percent of these were smooth, 47% polished, 21% striated, and 21% were pecked. These seem to have been incipiently used in comparison to the flat and convex surfaces. The lack of variation between the two primary surface shapes may simply be a product of a certain level of use that produces a regularly worn surface once attained. Subsequent use of the surfaces would then only serve to cause additional attrition to the tool rather than leaving new kinds of wear. The ability to assess functional differences in ground surfaces may only be addressed by the difference in wear patterns by region as discussed above. It is certainly true that convex surfaces can perform the duty of a flat surface, but maybe not vice versa.

While surface shapes may have been used to similar degrees of intensity, they may be functionally distinct. If the frequencies of surface shapes for millingstones and handstones are compared (Tables 12.3 and 12.7, respectively), some interesting patterns emerge. First, in all regions concave and basined millingstones, together with convex surface handstones represent the majority never falling below 60% in either case. When the relative proportions of these surfaces decrease according to region, the number of flat surfaces on both millingstones and handstones increase. It can only be assumed that flat handstone surfaces would be more efficient when used on a flat millingstone surface and concave handstones would be more efficient when used on concave millingstone surfaces. In support of this idea, the proportion of flat millingstone and handstone surfaces tend to co-vary by region. For instance, the Sayles sample has the highest proportion of flat millingstone surfaces (45%) and flat handstone surfaces (32%). Similarly, La Jolla assemblages have nearly the lowest proportion of flat millingstones (27%) which correlates with the lowest proportion of flat handstones (21%). These corresponding differences in surface shape by region indicate that slightly different kinds of processing characterize the assemblages. It may be the case that basined millingstones were used mainly for processing large or pulpy material, the flat surfaces primarily for small hard seeds (see Basgall and True 1985; Bettinger 1989).

End polish was also characterized for handstones. This attribute was measured as grinding on the ends resulting in polish separate from that of direct shaping or the extension of a primary ground surface over the edge. End polish was more frequently observed in some regions, being most prevalent among Oak Grove handstones (47%), followed by La Jolla and Topanga (26% each), and then Sayles (13%). The use of end portions seems to have been functionally distinct between regions.

Table 12.8. Handstone end polish by metrics and shaping degree.

	Max. Length	Max. Width	Max. Thickness	SD-0	SD-1	SD-2	SD-3
		Cm			%		
Handstones with End Polish	12.6	8.6	4.5	2	12	43	43
Handstones without End Polish	12.2	8.8	5.1	40	32	23	5

Note: SD-0, shaping degree 0; SD-1, shaping degree 1; SD-2, shaping degree2; SD-3, shaping degree 3.

Sayles handstones saw end use correlated with lower degrees of shaping and specific metrical characteristics that were assumed to have been related to an anomalous millingstone basin configuration suggesting that their use was not unlike that of a pestle (Chapters 8-10). These particular specimens may be the result of scavenging during later occupations. In the other regional assemblages, end polish was more associated with higher degrees of shaping with no other evidence linking it to specialized functions. In this case, the use of ends for grinding may indicate that handstones were subject to more extensive use because more area of the tool was used for processing before being discarded.

Overall, end polished handstones tend to be longer, narrower, and thinner on average than handstones without end polish (Table 12.8). If the relative volumes are compared, handstones with end polish have slightly less mass at 487 cm^3 than those without, at 547 cm^3. Aside from the specimens in the Sayles sample, end polish tends to be associated with higher degrees of shaping (Table 12.8). In fact, the trend of end polished handstones increasing by shaping degree is nearly opposite that of handstones without the attribute. Because of the association of end polish with higher degrees of shaping, it is inferred that the former attribute is a characteristic of more extensive use that accompanied handstones subject to greater formalization. The association of end polish with lesser amounts of mass likely relates to this feature occurring on higher shaped specimens. Recall that maximum thickness tended to decrease as the degree of shaping went up.

Because of the association of end polish with higher degrees of shaping rather than with specific functions, it is likely that this attribute is an indication that handstones saw a wide range of uses, especially those that were kept and used for longer periods of time.

The extensive functional range of handstones is illustrated using the secondary modification attribute (Table 12.7). Secondary modification of handstones took two forms; end battering and anvilling. End battering was the most common form of secondary modification in all regions. Approximately 75% of both la Jolla and Topanga handstones were end battered, followed by 54% of those within the Sayles assemblages, and 44% of those from Oak Grove. End battering is a relatively common characteristic of most handstones. The differential occurrence of this trait is simply a gross measure of the relative importance of battering and pounding activities.

Anvilling was especially common among Topanga handstones, observed on 12% of the surfaces, but was decidedly rare at other locations; it was present on only six surfaces from Oak Grove, eight from Sayles, and was absent on those from La Jolla. Anvilling is commonly referred to in Millingstone literature as "pitting" and suggestions for their function have ranged from handholds to acorn hullers and flake stone reduction platforms. Anvilling, as observed in this analysis, was probably related to both flaked stone reduction and vegetal processing (seed hulling).

Variation in secondary modification by region is a factor of differences in the range of uses. Traditionally, handstones have been viewed in a limited sense as general grinding tools. The presence of so much evidence of other than grinding use seems to have contributed to the definition of handstones at every site studied. Specifically, end battering, anvilling, and even end polish are evidence of functional overlap with other kinds of general processing tools such as hammerstones, battered cobbles, etc. In any case, the decision to use a handstone for any other purpose would be affected by the immediate availability of raw material, the need to protect the shaping investment in the tool, and the amount of recycling or scavenging that was occurring at the specific location. That handstones were used for secondary purposes relates to the fact that most were probably intended for locally intensive use in a context that saw a high degree of site re-occupation where much of the local stone was made into tools that were then recycled. Evidence of secondary modification is also common among millingstones, scraper planes, and even non-analyzed tool categories such as hammerstones, choppers, flake tools, and others.

The use of handstones varied according to two factors: formalization and functional orientation. Most of the variation in surface use intensity was significantly correlated with variation in shaping degree. As the degree of shaping increased, the ground surfaces exhibited more regular wear patterns. The differential proportion of shaped handstones by region is telling of slightly different intentions of use. The Topanga and Oak Grove locales may have witnessed a more significant dimension of handstone use that saw use in off-site contexts. Conversely, handstones from the La Jolla and Sayles areas were biased toward the lower categories of formalization. The functional orientation of handstones seems to have varied according to surface shape and region. Flat surfaces may have been primarily used in association with flat millingstone surfaces and convex handstones with basined or concave millingstones due to the fact that they co-vary. These surface shape associations also tend to co-vary by region, possibly indicating differences in processing techniques.

Scraper Planes

There has been some debate as to whether scraper planes were actually used as tools or if they were simply expended cores. Salls (1983) conducted experimental analyses on scraper planes to reproduce the types of wear observed on the edges of actual tools. He found that using them for scraping, planning, and chopping activities in the processing of pulpy and fibrous material successfully resulted in producing the kinds of wear seen on scraper planes recovered from the Liberty Hill Site (CA-SBR-901). In a separate study, Jackson (1977) conducted microscopic analyses of scraper planes from the Sayles sites and flaked stone reduction experiments to determine that no use was found on scraper planes and apparent edge damage was a by-product of reduction activities. Essentially, his interpretation was that scraper planes were nothing more than cores.

These macroscopic analyses of scraper planes from all regions, including the Sayles Complex, demonstrates that at the time of discard, scraper planes were indeed used as tools in a variety of functions from chopping and battering to scraping and planning. The intensity of use was found to vary according to region and raw material type, implying that their relative economic importance also varied by region. The evidence for this is illustrated in the comparison of form and use wear attributes that follows (Tables 9 and 15). There were 39 scraper planes recovered from La Jolla contexts, 318 from Topanga, 15 from Oak Grove, and 80 from the Sayles complex, yielding a total of 452 analyzed scraper planes (Table 12.9).

Raw material use across all regions seems to have been highly localized and geared toward the harder, more fine-grained types of available stone. It is immediately evident that there are no scraper planes made from granite, sandstone, or schist; the three materials that dominated the millingstone and handstone assemblages (Table 12.9). These stone types are either coarse-grained (sandstone and granite), or soft (sandstone and schist) compared to the types of stone used as scraper planes. Other than these, a wide range of materials are represented in the entire assemblage but this diversity does not characterize every region. The Sayles scraper planes account for all recognized stone types except for metavolcanic and "other" types of stone, being biased toward igneous (40%), felsite (24%), and quartzite (19%). Topanga is second in the amount of diversity with the majority being made from basalt (85%) and quartzite (9%). La Jolla scraper planes tended to be made from quartzite (49%) and other kinds of stone (26%), with lesser amounts made from quartz (15%), basalt (8%), and rhyolite (3%). Oak Grove scraper planes were primarily made from a material characterized as "other" (87%), which was most likely shale, while only 13% were made from quartzite. In all regions, the types of stone used were mostly locally available. The only extralocal material type in all cases was cryptocrystallines (CCR), which never attained high percentages. The relative diversity between regions is an indication of availability and the fact that the form and function of scraper planes was not very limited by material constraints except that harder, fine-grained materials were preferred.

The use of shale from Oak Grove is interesting in that these tools were primarily battered (Table 12.9). This material is not very durable but is more fine grained and easier to shape than the accompanying sandstone and granite. Its use also reflects the need for a general battering/chopping implement that only needs to serve more immediate purposes. The fact that not many were recovered from Oak Grove is an indication that their economic importance was relatively limited; this issue will be addressed in more detail later.

There seems to have been a general desired form of scraper planes biased toward a cobble-based tool that had a unifacial working edge. The form of all scraper planes was more affected by attrition through use and the characteristics of the local stone because none were highly formalized through the process of manufacturing. The evidence to support these statements is illustrated using relative proportions according to original form, metrical summaries, and edge form.

The base from which scraper planes were made was overwhelmingly biased toward the cobble form (Table 12.9). Only 18%, 30%, and 7% of scraper planes from La Jolla, Topanga, and Sayles regions (respectively) were made from a flake base. All specimens from Oak Grove were made from cobbles. The fact that flake-based scraper planes were a minority in each region is probably a factor of functional constraints that could not easily be satisfied by most flakes. The edge of a scraper plane, as discussed later, tended to be formed at a very steep angle. The nature of most flakes is such that this steep angle might not have been attained. It is also true that flakes do not have the centralized mass that cobbles do. This may limit their efficiency for purposes such as battering and chopping.

For scraper planes made from flakes, the type of flake used in each region was largely indeterminate (Table 12.9). Otherwise, they were mostly made from primary and secondary decortication flakes, then cortical shatter and interior percussion flakes. The flake type profiles demonstrate that the larger flake types were those primarily selected, presumably to obtain the greatest mass.

Metrical summaries provided in Table 12.5 show clear differences in tool form both by region and original form. When average maximum lengths, widths, and thicknesses are multiplied to get a volume estimate, La Jolla scraper planes are the smallest with a volume of 149 cm^3, followed closely by Topanga scraper planes at 165 cm^3; Oak Grove specimens were considerably larger with a volume of 283 cm^3, and Sayles scraper planes were larger still at 317 cm^3. These differences in size are due primarily to the nature of the raw material in each area and to the investment in form. La Jolla scraper planes were literally split cobbles with a few flakes removed from one side to create a working edge. The Topanga scraper planes were smaller mainly because they seem to have seen a heightened degree of reduction through use and maintenance. The larger size of Oak Grove and Sayles scraper planes is largely due to their irregular form that resulted from a very expedient manufacturing process. In both cases, only enough mass was reduced to produce an edge that seemed to minimally meet functional demands, making the size a factor of the original size and form of the natural stone.

The size of scraper planes also varied by form. Flake-based scraper planes had an average volume of 144 cm^3 ,while those made from cobbles had an average volume of 230 cm^3 (Table 12.5). Flake-based scraper planes are expected to be smaller in that they represent an already reduced form of raw material while cobbles generally start out with more workable mass. Since cobble-based specimens account for 76% of the total, it is assumed that cobble forms were preferred due to their larger size.

Edges were primarily unifacial in form in all regions. Bifacial edges were observed on only 12%, 13%, and 5% of all scraper planes from the La Jolla, Topanga, and Sayles regions, respectively (Table 12.9). The fact that most edges are unifacial is assumed to be a functional phenomenon. This is supported by the observance of edge and interior polish which indicates that a large number of scraper planes were being used in a manner that saw contact of the underside (unflaked side) with some kind of surface in a scraping or grinding manner. That some edges were bifacial is probably related to nuances in the manufacturing process that necessitated flakes being removed from both sides in order to achieve a desired edge form.

Table 12.9. Scraper plane attributes by regional complex.

Complex		La Jolla	Topanga	Oak Grove	Sayles	Cumulative
Material	BAS	3	271	-	1	275
	CCR	-	10	-	3	13
	QZT	19	30	2	15	66
	QTZ	6	1	-	7	14
	FEL	-	-	-	19	19

Table 12.9. Scraper plane attributes by regional complex.

Complex		La Jolla	Topanga	Oak Grove	Sayles	Cumulative
	RHY	1	-	-	6	7
	META	-	3	-	-	3
	IGN	-	-	-	29	29
	OTH	10	3	13	-	26
Form	1	7	95	-	5	107
	2	31	214	15	71	331
	3	1	9	-	4	14
Flake Type	1	1	21	-	3	25
	2	1	47	-	2	50
	3	-	7	-	-	7
	5	3	2	-	-	5
	IND	2	25	-	-	27
Edge Freq	1	36	245	15	80	376
	2	3	73	-	-	76
Edge Form	1	37	288	15	76	479
	2	5	40	-	4	49
Edge	1A	-	17	1	1	19
	1B	-	2	-	1	3
	2A	24	219	9	39	291
	2B	12	65	5	27	109
	3A	2	45	-	5	52
	3B	4	16	-	7	27
	4	-	27	-	-	27
Edge Wear	0	1	6	1	7	15
	1	18	123	2	36	179
	2	16	135	3	20	174
	3	7	127	9	17	160
Edge	PRS	23	215	10	59	307
	ABS	19	176	5	21	221
Step	PRS	40	309	12	67	428
	ABS	2	82	3	13	100
Interior	PRS	12	122	2	29	165
	ABS	27	196	13	51	287
Sec Mod	PRS	4	59	6	20	89
	ABS	35	259	9	60	363
Total		39	318	15	80	452

Note: See Appendix C for description of terms.

Scraper planes with two edges were rare, accounting for only 8% of those from La Jolla and 23% of those from Topanga (Table 12.9). The use of more than one edge on a tool is a method of avoiding maintenance and manufacturing costs. In the case of La Jolla scraper planes, the small amount of specimens with two edges probably reflects the use of an opposing edge in order to prevent maintenance of the other edge. This is supported by edge and spine plane angles where on all three specimens, the auxiliary edge and spine plane angles were equal while those of the original edge showed a disparity which is evidence of attrition. The disparities between edge and spine plane angles on the primary edge for the three scraper planes were 21^0, 12^0, and 3^0, while the lack of disparity is seen in the equal edge and spine plane angles of the auxiliary edges of 88^0,

90^0, and 79^0. Among Topanga scraper planes, such lack of disparity in the auxiliary edges was not seen, suggesting that the increased number of edges is due to more intensive use.

Scraper plane use was not intensive enough to result in highly regular edge shapes. This is indicated by the diversity of edge shapes relative to the four regions. Irregular edge shapes account for 38% of La Jolla scraper plane edges, 30% of Topanga, 33% of Oak Grove, and 43% of those from the Sayles complex. Topanga scraper planes have the highest diversity of edge shapes (all 7 types), followed by the Sayles specimens (6 edge shapes), then La Jolla (4 edge shapes), and finally Oak Grove (3 edge shapes) (Table 12.9). In every case, convex-regular edges are the most common, then convex-irregular, with lesser amounts of straight, concave, and perimeter edges. The diversity in edge shapes suggests that the tasks for which these tools were meant could be accomplished using multiple kinds of edges. It also means that investment in the form of the edge to a point of high regularity was not a primary concern. The difference in diversity between regions is evidence of different levels of use intensity of the scraper plane tool in general.

Three types of edge wear were recognized: unifacial microchipping, bifacial microchipping, and battering until dull. A surprisingly small amount of scraper planes exhibited no form of edge wear. Only one from La Jolla, six from Topanga, one from Oak Grove, and seven from the Sayles complex did not have edge wear (Table 12.9). Unifacial and bifacial microchipping are thought to be evidence of light use wear on the edges as small flakes were forced off through pressure. These accounted for 72% of the worn edges from La Jolla, 66% from Topanga, 38% from Oak Grove, and 67% of worn edges from the Sayles complex. Battering until dull was most common among Topanga (32%), Oak Grove (60%), and Sayles (20%) scraper planes, but was decidedly low among those from La Jolla (14%). Battering on the formed edge is considered to be the most intensive form of use that scraper planes saw in that it caused the most damage. It is not easily confused with edge preparation as this form of battering effectively ruined the working edge.

Edge polish was measured as the presence of ground surfaces on the edge of the scraper planes. Sometimes this was only observable when looking at small inclusions because of the eroded nature of some of the tools. Nonetheless, edge polish was fairly common, exhibited on 55%, 55%, 66%, and 74% of La Jolla, Topanga, Oak Grove, and Sayles scraper planes, respectively. That it was not observed on a sizeable portion of each assemblage indicates some degree of irregularity in use. Excessive beveling of the edge was not very common in that only a select few were subject to such intensive use.

Interior polish was measured as ground areas on the underside of the scraper plane, that opposed to the formed edge. Unlike edge polish, interior polish was not as common. Only 28%, 31%, 13%, and 36% of scraper planes from La Jolla, Topanga, Oak Grove, and the Sayles complex exhibited interior polish. Accordingly, only 37% of the entire scraper plane sample had interior polish. This statistic is largely due to the irregularity of the underside surface of most scraper planes, where little area would have come in contact with a platform or processed material if the tool was used in a planning manner. In fact, most interior polish was witnessed on small protrusions or inclusions which extended out from the surface. What this measurement does indicate is that at least some of these tools were being used in a manner consistent with planning, though not to a degree that would have contributed to a more regular ground surface.

A full 80% of all scraper planes exhibited step fracturing on the edges (Table 12.9). Step fracturing was measured macroscopically, like all other use wear attributes, and indicates excessive force applied to the edge. This attribute provides evidence that edges were not only used for planning purposes but also for chopping, as other attributes indicate. The high amount of step fractured edges from all regions suggests that at least light battering was an important function of the scraper plane.

Edge polish, step fracturing, and interior polish were considered together as a suite of attributes that measures the regularity of scraping/planning use and were subject to a Chi Square test to evaluate the significance of the regional variation. It turns out that the variation is slight enough that randomness in the sample could account for the differences about 60% of the time [$P_{0.70}(3.83) < X^2\ (4.29) < P_{0.50}(5.35)$, df=6]. The one variable removing the confidence from the 90% level is the low occurrence of interior polish among Oak Grove scrape planes (Table 12.9). Notwithstanding this variable, the regularity of scraping and planning use seems to have been relatively consistent among the various regions.

Though the regularity of edge use varies little, the intensity of edge use measured by attrition and repair reveals significant regional differences. The mean edge and spine plane angles, along with maximum flake scar lengths used to assess attrition and repair are listed in Table 12.10. The variation in the edge angles and spine plane angles by region is testimony to the difference in the general form of these tools that is a factor of raw material, manufacturing investment, and attrition. There seems to have been a need for a general spine plane angle as the range of average measurements by region is only 8^0. The use of these edges does not seem to have been as regular by region as the range of edge angles by region is 13^0.

Differences in edge use are indicated by disparities between edge and spine plane angles that occurred as a result of attrition and edge re-sharpening. The greater the disparity, the greater attrition and re-sharpening occurred. Edges from La Jolla and Oak Grove scraper planes seem to have been used with the least amount of intensity. The edge angles were 74^0 and 70^0 for La Jolla and Oak Grove scraper planes, respectively, while the spine plane angles were 66^0 and 62^0, respectively. Both assemblages had a disparity of 8^0; relatively low compared to that of Topanga and Sayles scraper planes. Topanga edges measured 81^0 and the spine plane angles measured 70^0. Even more divergent were the edges from Sayles scraper planes which measured 83^0 on the edges and 69^0 on the spine plane angles.

Table 12.10. Scraper plane edge measurements by region.

	La Jolla	Topanga	Oak Grove	Sayles	Mean
Edge Angle	74	81	70	83	77
Spine Plane Angle	66	70	62	69	67
MFSL	1.5	1.1	1.6	1.6	1.4

Note: MFSL, maximum flake scar length, measured in centimeters; Edge and Spine Plane Angles measured in degrees.

The greater disparities between edges and spines of scraper planes from Topanga and Sayles correlates well with other use wear and form data that suggest these groups of tools were used and resharpened with more intensity than those from La Jolla and Oak Grove contexts. The low maximum flake scar length for each region does suggest that at least some re-sharpening was occurring in all regions, though not to the same degrees of regularity.

The number of scraper planes from each region with edge and spine plane angles within 5^0 of one another is a measure of the expediency of tool use. Among La Jolla and Oak Grove scraper planes, the lack of disparity between edge and spine plane angles was an especially common phenomenon at 31% and 47%, respectively. Scraper planes from Topanga had just 21% that lacked disparity in angle measurements, while those from the Sayles region only reached

12%. The higher proportion of these tools among La Jolla and Oak Grove assemblages compared to the other samples further supports the idea that scraper planes from the former localities were not used with as much regularity or intensity as those from the Topanga and Sayles complexes.

In some locations, the use of scraper planes as battered cobbles on unformed edges was relatively common. Forty percent of Oak Grove scraper planes were so modified, followed by 25 % of those from the Sayles sites, 18% from Topanga, and 10% from La Jolla contexts. The use of scraper planes as battering implements is evidence of their functional overlap with handstones, battered cobbles, choppers, and hammers which speaks to the importance of battering to the economic strategy that characterized each regional assemblage. The variation in frequency of scraper planes used for secondary purposes is most likely a factor of the balance between raw material procurement and manufacturing costs as it relates to using existing tools or scavenging for discarded ones. This variation is not extremely significant in that none of the scraper planes exhibited high degrees of investment in form that would have constrained their use in secondary or destructive processes.

The form and use wear data for scraper planes from all four regions presents a scenario of use that was characterized by an expedient manufacturing process to achieve a very gross form. These tools witnessed use that varied regionally in intensity but never reached the point of exhausting the tool or leading to highly regularized edges. The lack of regularity in the original form and edge form of all scraper planes attests to the functionally general nature of these tools. The presence of use wear such as edge and interior polish, step fracturing, microchipping, battering, and edge alteration does imply that scraper planes were primarily intended as tools. It does not matter whether scraper planes were manufactured from spent cores or fresh raw material because the use wear indicates they were used as tools; some as scraping and planning stones, some as chopping and battering implements. This certainly negates Jackson's (1977) claim that all scraper planes were simply expended cores with no evidence of use as other kinds of tools. Though this analysis tends to agree with the experimental results of Salls (1983), it is likely that scraper planes were used for a wide range of processing activities involving battering, chopping, scraping, and planning of numerous kinds of resources. It is unlikely that scraper planes were only used—or were originally developed for—the processing of yucca and agave.

Summary

The cumulative analyses of millingstones, handstones, and scraper planes reflect very similar technological strategies across the regional complexes of La Jolla, Topanga, Oak Grove, and Sayles. There is an underlying theme among the three classes of tools that is biased toward a manufacturing process geared toward a degree of modification that would prepare the tools for immediate and locally intensive use. A subset of millingstones and handstones seem to have witnessed a higher degree of intentional investment in form. Some of these were probably prepared for re-use as the sites saw subsequent occupation and others were probably intended for use in extra-local contexts. This subset was primarily associated with the Oak Grove and Topanga Complexes, although less significant amounts were found among La Jolla and Sayles assemblages. The variability in tool use by region testifies to the difference in orientation of a common technological organization that accommodated a very general processing regime. The high amount of secondary modification on the three classes of analyzed tools speak to their generalized nature and ability to solve a wide range of functional needs.

The majority of other tool classes from all Millingstone assemblages sampled reflect a very similar shaping and use trajectory, albeit with less use intensity. The most obvious of these are various cobble tools (hammers, choppers, core tools) that were probably used for pulverizing, battering, pulping, chopping, planning, and grinding. These types of tools reached comparatively high frequencies but were not used with as much regularity as those which were formally analyzed. All cobble tool types did exhibit multiple types of wear indicating their functional overlap with other processing tools. The functional overlap seen across every site assemblage serves to lessen perceived intra-assemblage diversity.

Simple flake tools were also a major component of each assemblage. These tools (also described as casual flake tools, utilized flakes, and flake scrapers) were not modified through manufacture or maintenance after the flake blank was produced. Though often ignored in early research, those that have been collected were defined as scrapers, blades, or knives (see Crabtree et al. 1963). At SDI-603 and at SBR-421A, C, and D, simple flake tools were given a relatively high amount of attention while only examples were originally collected at Topanga and Oak Grove sites. An analysis of such tools from the Sayles sites by Gilreath and Jackson (1985) revealed that use wear found on the edges was consistent with what is expected from light duty vegetal processing (also see Andrefsky 1998; Keely 1974; Keely and Newcomer 1977). The expedient manufacture process and use trajectory that appears to define simple flake tools also fits with the general processing theme exhibited by heavier processing tools.

One artifact class that has not been widely recognized as associated with Millingstone assemblages is formed flake tools. These are flake based tools that have highly regular edges due to intentional manufacture and/or regular wear and maintenance (see Basgall et al. 1988). If collected, formed flake tools have been described as various scrapers in previous reports (see Crabtree et al. 1993 and Treganza and Bierman 1958). In each Millingstone context that they appear (notably La Jolla and Topanga, then Sayles), their presence is indicative of a dimension of use reflected only in the small number of highly formalized millingstones and handstones. The formed flake tools are all made from fine grained volcanic and igneous stone that is extra-local. In addition, they appear to have been discarded in a well-used, reduced form. Without intensive analyses (save for the Sayles sites), all observations of this tool class suggest that it represents a component of the technological strategy that was broad reaching and probably reflects a higher degree of mobility than other assemblage constituents.

Even in light of formed flake tools, the assemblages from all four regions are limited in diversity. The redundant nature of tool use and manufacture suggests that a multitude of gathering and processing tasks was solved using a relatively limited range of tool types that functionally overlapped. The enormous amount of tools at each location indicates that these tasks were performed on-site frequently.

Chapter 13:

Strategies, Adjustments, and Adaptations

The analysis of millingstones, handstones, and scraper planes confirms a pervasive idea that the Millingstone pattern is characterized by a very general and flexible technological organization. The goal of this thesis sought to go beyond such notions by providing data that could enable an understanding of the causal relationship between the intended use of tools and their context of use, which are subsistence and settlement systems. Such an approach provides greater opportunity to develop a more complete understanding about the adaptive significance of cultural strategies by evaluating the more important variables affecting their emergence and persistence.

Technological Strategies and Adjustments

There have been many attempts to explain the organization of Millingstone technology, but most have been topical treatments of inter-assemblage similarity in terms of environment, site structure, and tool-type frequency. While these elements are no doubt critical to understanding technological organization, without knowing how tools were used the range of possible explanations regarding cultural systems is extremely broad and indeterminate. A review of the literature reveals that such a problem has caused the adaptive significance of the Millingstone pattern to remain somewhat of an enigma. Figuring out the intention of manufacture and use helps determine which explanations are most probable.

The previous chapter (Chapter 12) explored in some detail the intricacies of tool manufacture and use within and between regions in an effort to provide the best picture of Millingstone technological organization. It was found that, despite important variation, millingstones, handstones, and scraper planes mimicked a common theme of low to moderate levels of formalization, intensive use for a wide range of processing tasks, and the overwhelming use of local materials. The majority of these tools were probably intended for immediate and intensive use in their local area. This theme is reflected in the abundance of various cobble tools (hammers, choppers, core tools) and simple flake tools that reach relatively equitable frequencies. The latter provide evidence of the primacy and variability of processing tasks that define at least the larger locations of Millingstone occupation. The parallels in use that cut across nearly all tool classes attest to the simplicity and redundancy of processing goals. There is no material evidence of a specialized resource exploitation strategy simply because most tools seem to have been used for a variety of purposes.

The similarity in technological strategies characterizing Millingstone pattern sites seems to have resulted in an inter-regional pattern of assemblage composition. At each of the sites analyzed, and apparently at most other Millingstone locations that were not, assemblages are defined by uncommonly high numbers of robust processing equipment with low relative diversity. This suggests these kinds of sites were frequently used for similar purposes.

The frequency of site occupation has been frequently debated during the history of Millingstone research because of its power to inform upon subsistence and settlement strategies. Unfortunately, a complete picture of Millingstone subsistence/settlement cannot be attained due to biases in the kinds of locations known to be associated with the pattern. Most of these locations are extensive cultural deposits of uncertain association to smaller, possibly more task-oriented sites. This thesis does nothing to resolve the distributional problem because it samples only well-known, large Millingstone sites. However, the nature of occupation that characterized these sites can still be assessed on the basis of assemblage content.

Figuring out Millingstone settlement patterns mostly involves ruling certain strategies out according to their articulation with what is known about technological organization. Many have argued that particular Millingstone sites represented sedentary (permanent) occupations (Curtis 1965; Erlandson 1997; Gamble and King 1997; Masters and Gallegos 1997; Shumway et al. 1961; Treganza and Bierman 1958; Wallace 1955). The assessment of technological organization provided by this analysis does not fit with what would be expected from permanent or semi-permanent occupations. Sedentary occupations are generally thought to produce assemblages having relatively high diversity based on the assumption that year-round occupation would necessitate the exploitation of many different resources that would require the use of a wide range of tools including those not associated with vegetal processing (Chatters 1987; Gilreath and Jackson 1985; Kelly 1983, 1995; Shott 1987). This analysis revealed limited diversity in Millingstone assemblages inasmuch as nearly all tools were geared toward solving similar processing tasks. The range of processing uses these tools encountered was probably wide but the primary uses were characterized by grinding and battering. This observation would seem to run counter to the typological classification schemes of the mid-twentieth century (see Chapter 2, this thesis).

Since it is often problematic to ascribe specific functions to particular artifact forms (Gould 1969; Hayden 1977; Keely 1974; Keely and Newcomer 1977), measuring the functional diversity of assemblages is difficult. This problem is mitigated when the generality of tool use is measured in gross terms. The number of different tasks that tools were used for can be assessed by the different kinds of wear observed. Variation in wear ranges from variation in the kinds of functional areas (i.e., edges and surfaces) to secondary modification (i.e., use outside of the primary context). Tools associated with the Millingstone pattern were found to have considerable overlap in their range of observed use wear, indicating that tool function for most artifact classes was very general. The generality of these tools serves to reduce assemblage diversity past what can be seen in simple tool counts because the number of tool types decreases since it becomes harder to recognize functional distinction.

Some studies concerned primarily with flaked stone assemblages (Binford 1979; Goodyear 1979; Parry and Kelly 1987) have linked patterns of artifact formalization to relative degrees of residential mobility. They generally agree that high residential mobility tends to be associated with high degrees of tool formalization. High mobility necessitates a reliable technology in order to maximize resource exploitation and use of raw materials. Residentially sedentary groups are thought to invest less in the form of a tool because of an increased level of predictability of the timing of tool use, and a decreased need for portability and maintenance. Though these patterns may normally reflect flaked stone usage, tools that are bulky (ground and battered stone) would be more susceptible to use as site furniture (Binford 1979). Thus, patterns of low formalization among the latter could either reflect residentially sedentary or mobile settlement patterns. Among residentially mobile groups, expedient milling equipment may simply reflect limited, sporadic use of particular locations (see Basgall and Hall 1990; see also Basgall and Hall 1993, 1994). In the case of Millingstone assemblages, the relatively low degree of formalization is thought to reflect preparation for immediate, local use and it need not speak to degrees of mobility outside of the assemblage context. The low diversity characteristic of Millingstone assemblages suggests that the lack of formal investment does not reflect sedentary occupations.

Tool formalization also informs upon site and assemblage size with respect to patterns of discard. The size of Millingstone sites and their assemblages have been used to support explanations of sedentism (see Treganza and Bierman 1958). The massive quantities of robust processing equipment does not seem indicative of permanent settlement because the investment in formal regularity and the nature of tool use suggests that most were intended for immediate, local use with little concern for durability. Such intentions could result in the mass accumulation of redundantly used tools in context of intensive, intermittent occupations. This is especially true given the wealth of suitable raw material in the immediate vicinity of each site, lessening the concern for conservation and increasing the probability of tool discard prior to exhaustion.

Residentially mobile settlement strategies can also be discounted as characteristic of Millingstone sites. Strategies of this nature are thought to be associated with smaller task-oriented locations because groups are expected to move consumers to resources for immediate, low intensity exploitation (Binford 1979, 1980; Kelly 1995). Resulting assemblages reflect either expedient use, or those discarded after having exhausted use-lives (Parry and Kelly 1987). Tool formalization is expected to be high as a result of manufacture and maintenance, due primarily to a need for raw material conservation. Again, the relatively low levels of tool formalization characteristic of Millingstone assemblages run counter to this expectation. The patterns of use also suggest that they were used in a wide range of processing duties with at least moderate intensity. This implies that occupations were relatively intensive, without reference to frequency.

If data concerning tool use and formalization in the context Millingstone assemblages do not reflect residentially sedentary or highly mobile occupations, then the answer must lie somewhere in the middle of the continuum. The problem with defining a pattern of site occupation for Millingstone locations is that they were most likely used for a number of different reasons over time. Many studies have demonstrated the probability of site functional variability (Binford 1979, 1980, 1982; Kelly 1995). Such concerns demand that assemblage associations be thoroughly demonstrated in order to evaluate relative diversity of different assemblage components. Although it cannot be said that all Millingstone assemblages represent single components (and many clearly have multiple components; see Erlandson et al. 1988), it is likely that they represent highly similar strategies of location and resource use.

The pattern of site use that best accounts for Millingstone technological organization is one of site re-occupation where the frequency of occupations was highly regular but the duration of stay probably varied. This likely explains the massive accumulations of processing tools that were intensively used and maintained but exhibited only enough investment in form to facilitate immediate use in the local context. The degree to which this explanation accounts for the entire Millingstone settlement strategy is limited because the sample of sites known to be associated with the pattern are characterized by large assemblages of ground and battered stone. Problems in the kinds and amounts of chronological data inhibit the association of smaller, task-oriented locations that were probably used in Millingstone systems. However, the frequency of large sites suggests that regular, intensive use of such areas was a significant aspect of Millingstone subsistence and settlement systems.

The variation in geographic locations associated with the Millingstone pattern suggests that generalized exploitation of different resource sets was a major characteristic. Since the technological organization reflected in assemblages of different regions is essentially the same, their geographic positioning does not necessitate the assumption that they were associated with an adaptation to a specific resource as some have argued (Erlandson 1994; Kowta 1969; Wallace 1955; Warren 1968). Use of resources that range from shellfish to agave by Millingstone systems does not mean that they reflect coastal or inland adaptations, respectively, but that the systems were geographically adjusted. Adjustment (plasticity in biological evolutionary terms) in the context of cultural systems is the degree to which a system can adjust to certain pressures without fundamentally changing. There is no evidence to suggest that Millingstone assemblages in geographically different environments were fundamentally different in terms of technological organization. Minor variation in tool use and formalization that is regionally specific probably reflects the relative degree of adjustment to localized ecological conditions.

Adaptive Significance

In order to contribute to an understanding of culture process, an understanding of the adaptive significance of cultural systems needs to be developed. This helps determine how groups of people respond to different kinds of stress. In the archeological record, it is usually only the basic economic processes of human life that can be evaluated in such terms because of the difficulty in assigning higher level cultural phenomena to a limited number of material remains (Price 1982). These processes are usually grouped under subsistence and settlement systems, from which a limited number of inferences concerning social organization can be obtained.

The subsistence/settlement systems of the Millingstone pattern seem to represent an economic adaptation that can function in a wide range of contexts because of its ability to accommodate different kinds of stress by incorporating flexibility and generality into the organization of technology. This assessment echoes previous studies seeking to define the temporal and cultural placement of the Millingstone pattern (see Basgall and True 1985; Crabtree et al. 1963; Warren 1968, among others). The question of why this kind of land and resource use seems to dominate much of Holocene prehistory in southern California has been subject to numerous interpretations that can generally be grouped under either environmentally or demographically driven models.

Those who have chosen to cite changes in the physical environment as the driving factors in the development of the Millingstone pattern (Erlandson 1994; Gallegos 1991; Glassow et al. 1988; Jones and Waugh 1997), have based their arguments on global climatic change associated with the Altithermal (Antevs 1952, 1955). The Altithermal is described as a warming and drying trend that spanned the middle Holocene (7000-4500 BP), with a peak in these conditions at about 6000 BP. The problem with this argument is twofold. First, paleoenvironmental data (see Chapter 2, this thesis) reveal that the Altithermal was a highly variable phenomenon that may not have caused large-scale changes in biotic communities across the southwestern United States. This is inconsistent with the widespread drought conditions proposed by (Antevs 1952, 1955). The only changes that can be reliably said to have taken place were the development and spread of coastal scrub that was complete by about 6000 years ago, which is the approximate time that the rate of sea level rise slowed to its current pace and the changes in lagoon/estuarine habitats were nearly finished. With these changes came only slight shifts in biotic communities in terms of their species composition. Overall, with the exception of the end of the Wisconsonin glaciation at 10000 BP, widespread climatic changes in southern California seem to have been limited in degree and variable in onset, magnitude, and environmental impact. Localized ecological changes may have been more important to the associated cultural systems in terms of specific resource distributions. In fact, the latter probably contributed to some of the variation seen in use-wear and formalization between regional manifestations of Millingstone assemblages.

The second problem with environmentally driven models is that there is increasing chronological information indicating that the Millingstone pattern both pre- and post-dates major climatic changes in southern California. Some of these sites are from Diablo Canyon (Greenwood 1972), while Erlandson (1994) identifies sites dating in excess of 7800 BP that have well developed ground and battered stone assemblages. Fitzgerald (2000) reports numerous dates between 9000 and 10000 years BP from a site dominated by basined millingstones, handstones, and cobble tools. Six dates in the 8000 year range are also associated with a very typical Millingstone assemblage from the Rancho Park North site (Kaldenberg 1982). In addition to absolute dates, many Millingstone assemblages contain formed flake tools that were historically attributed to supposed earlier cultural patterns that dated elsewhere to the early Holocene (i.e., San Dieguito). If the association of this technological component was more widely known, it is likely that there would be little question as to the early Holocene antiquity of the Millingstone pattern. Nevertheless, chronological data clearly indicate that this pattern pre-dates major Holocene climatic change suggesting that its appearance was not dependent on large-scale environmental fluctuation.

Population driven arguments have also been employed to explain the adaptive significance of the Millingstone pattern. Most of these have been based on analyses of chronological data or the assignment of relative densities to defined site types. The arguments based on chronological data (radiocarbon date distribution; Glassow et al. 1988; Masters and Gallegos 1997) are problematic simply because of preservation and collection biases. These arguments tend to be based on the clustering of dates by time and space. However, some locations offer better preservation than others, in addition to differential sampling efforts that create a regional bias. In southern California, most radiocarbon dates were obtained on shell from coastal locations (see Basgall and True 1985:Table 3.1) and perceived patterns of population densities were then extended to interior regions to make assessments of subsistence and settlement patterns (Glassow 1997; see also Jones and Waugh 1997:127).

The practice of assigning relative densities to site types in order to draw inferences of subsistence and settlement patterns is also inherently flawed; though the problems are often recognized by the researcher (Erlandson 1997). Although these studies can be good indicators of relative population densities, there are simply not enough data concerning archaeological sites in southern California to do justice to such models. This is exacerbated by the fact that many sites represent locations of repeated use that were subject to different exploitation trajectories. Measures of relative density will undoubtedly prove more useful toward understanding subsistence/settlement systems and changes in populations with the ongoing accumulation of much needed data in regions such as Vandenberg Air Force Base (see Glassow 1991; Glassow et al. 1991).

It is perhaps most detrimental to population driven models that they have been based on environmental dynamics of the Holocene (Erlandson 1997; Glassow 1997; Masters and Gallegos 1997) when they might prove more useful without such assumptions. Explaining perceived patterns of spatially and temporally variable population densities based on environmental correlates becomes more complicated when the relative importance of different subsistence technologies is not understood. As discussed above, it is unlikely that the assignment of certain technologies to specific resources reflects reality, making it more difficult to believe in the correlation of inter-regional environmental change with archaeological signatures in southern California. If enough data become available to support notions of early Holocene demographic change, there is still the issue that the Millingstone pattern predates changes in resource distribution which have been used to interpret population data.

There are numerous factors that complicate the discernment and correlation of environmental and demographic data with the appearance and persistence of the Millingstone pattern. It is likely that Millingstone cultural systems were responding to an interplay of changes in both resource sets and population density but the causal mechanism that would explain such a relationship has not been demonstrated. This is partly because the cultural systems of the Millingstone pattern and others of the Holocene in southern California are not well understood in terms of technological organization making it difficult to assess the impact of certain resource changes.

It is likely that the Millingstone pattern represents one of the earliest cultural systems of the Holocene to develop (excluding Paleoindians) in order to cope with existing California environments. In this sense, it was a tailored strategy from its inception instead of being a response to climatic changes or changes in population density. This suggestion would be more acceptable if the full range of subsistence technology was understood. This is in reference to the small formed flaked stone tools observed during this analysis that are undeniably associated with the Millingstone pattern. Others have also observed such associations (see Norwood and Walker 1980) which serves to further question traditional definitions of southern California cultural systems based on artifact typological classifications.

Perhaps the most productive way to understand the impact of various factors on Millingstone systems is to study its termination. The latest known dates for this pattern appear in La Jolla and Sayles contexts. Within these two regions, there are numerous chronological indicators that show the persistence of the Millingstone strategy into the late Holocene (Basgall and True 1985; Breschini, Haversat, and Erlandson 1992; Masters and Gallegos 1997; Warren 1968). Here, Millingstone assemblages seem to have been replaced by a technological organization that probably reflects higher degrees of residential mobility (Basgall and True 1985).

Millingstone assemblages in the Santa Barbara region tend to terminate with increasing use of acorns at or near the end of the middle Holocene, about 3500 BP (Erlandson 1997). The earlier termination of the Millingstone pattern is apparently associated with an increase in the use of mortars and pestles, along with the appearance of numerous other technologies related to the exploitation of marine resources. These subsistence and settlement strategies probably reflect a shift toward decreased residential mobility, though this has yet to be fully demonstrated (Erlandson 1997).

The question of why the Millingstone pattern terminates at different times within each region cannot be answered exclusively through a comparison of resource diversity and abundance. It was shown that Millingstone assemblages exhibited slight regional adjustments in the use of a common technology according to the ecological conditions of the different regions. However, if ecological conditions alone were the driving force behind the development of new cultural strategies, the reason for why the shift away from Millingstone systems did not occur earlier in the Holocene cannot be adequately accounted for.

The most probable alternative explanation for abandonment of Millingstone economies is characterized by local population dynamics. Population densities of the regional Millingstone systems may have reached threshold levels at different times, necessitating a shift in how people were organizing themselves across the landscape. Population thresholds do not refer to the carrying capacity of the environment, but of the cultural system. The thresholds of Millingstone systems were probably different according to each environment and may have reached thresholds at different times. In any case, it would not be the resources per se that were inducing the change. The resource composition of particular regions would have simply favored different kinds of alternative subsistence and settlement systems. This might explain the stark contrast in post-Millingstone strategies from Santa Barbara to La Jolla and Cajon Pass. To understand the shift away from Millingstone strategies would require an understanding of the technological organization characterizing succeeding cultural systems. This would allow for evaluation of the different variables that have impacted local economies in addition to providing an understanding of the nature of resource exploitation.

It has been demonstrated that the organization of people across the landscape is intimately tied to the distribution and variety of resources (Binford 1979, 1980). Changes in this organization can be spurred by changes in the resources that are exploited or in the groups that are exploiting them. In southern California, variability in a common exploitation strategy reflects different emphases but there are no data to suggest there were changes in resources exploited by Millingstone groups. It might be more productive to pursue issues related to social organization reflected through the uses of different technologies, as this thesis has done with Millingstone assemblages. Research of this kind would serve to augment other indicators such as chronological data and relative densities.

Chapter 13:

Strategies, Adjustments, and Adaptations

The analysis of millingstones, handstones, and scraper planes confirms a pervasive idea that the Millingstone pattern is characterized by a very general and flexible technological organization. The goal of this thesis sought to go beyond such notions by providing data that could enable an understanding of the causal relationship between the intended use of tools and their context of use, which are subsistence and settlement systems. Such an approach provides greater opportunity to develop a more complete understanding about the adaptive significance of cultural strategies by evaluating the more important variables affecting their emergence and persistence.

Technological Strategies and Adjustments

There have been many attempts to explain the organization of Millingstone technology, but most have been topical treatments of inter-assemblage similarity in terms of environment, site structure, and tool-type frequency. While these elements are no doubt critical to understanding technological organization, without knowing how tools were used the range of possible explanations regarding cultural systems is extremely broad and indeterminate. A review of the literature reveals that such a problem has caused the adaptive significance of the Millingstone pattern to remain somewhat of an enigma. Figuring out the intention of manufacture and use helps determine which explanations are most probable.

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The pattern of site use that best accounts for Millingstone technological organization is one of site re-occupation where the frequency of occupations was highly regular but the duration of stay probably varied. This likely explains the massive accumulations of processing tools that were intensively used and maintained but exhibited only enough investment in form to facilitate immediate use in the local context. The degree to which this explanation accounts for the entire Millingstone settlement strategy is limited because the sample of sites known to be associated with the pattern are characterized by large assemblages of ground and battered stone. Problems in the kinds and amounts of chronological data inhibit the association of smaller, task-oriented locations that were probably used in Millingstone systems. However, the frequency of large sites suggests that regular, intensive use of such areas was a significant aspect of Millingstone subsistence and settlement systems.

The variation in geographic locations associated with the Millingstone pattern suggests that generalized exploitation of different resource sets was a major characteristic. Since the technological organization reflected in assemblages of different regions is essentially the same, their geographic positioning does not necessitate the assumption that they were associated with an adaptation to a specific resource as some have argued (Erlandson 1994; Kowta 1969; Wallace 1955; Warren 1968). Use of resources that range from shellfish to agave by Millingstone systems does not mean that they reflect coastal or inland adaptations, respectively, but that the systems were geographically adjusted. Adjustment (plasticity in biological evolutionary terms) in the context of cultural systems is the degree to which a system can adjust to certain pressures without fundamentally changing. There is no evidence to suggest that Millingstone assemblages in geographically different environments were fundamentally different in terms of technological organization. Minor variation in tool use and formalization that is regionally specific probably reflects the relative degree of adjustment to localized ecological conditions.

Adaptive Significance

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The subsistence/settlement systems of the Millingstone pattern seem to represent an economic adaptation that can function in a wide range of contexts because of its ability to accommodate different kinds of stress by incorporating flexibility and generality into the organization of technology. This assessment echoes previous studies seeking to define the temporal and cultural placement of the Millingstone pattern (see Basgall and True 1985; Crabtree et al. 1963; Warren 1968, among others). The question of why this kind of land and resource use seems to dominate much of Holocene prehistory in southern California has been subject to numerous interpretations that can generally be grouped under either environmentally or demographically driven models.

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The second problem with environmentally driven models is that there is increasing chronological information indicating that the Millingstone pattern both pre- and post-dates major climatic changes in southern California. Some of these sites are from Diablo Canyon (Greenwood 1972), while Erlandson (1994) identifies sites dating in excess of 7800 BP that have well developed ground and battered stone assemblages. Fitzgerald (2000) reports numerous dates between 9000 and 10000 years BP from a site dominated by basined millingstones, handstones, and cobble tools. Six dates in the 8000 year range are also associated with a very typical Millingstone assemblage from the Rancho Park North site (Kaldenberg 1982). In addition to absolute dates, many Millingstone assemblages contain formed flake tools that were historically attributed to supposed earlier cultural patterns that dated elsewhere to the early Holocene (i.e., San Dieguito). If the association of this technological component was more widely known, it is likely that there would be little question as to the early Holocene antiquity of the Millingstone pattern. Nevertheless, chronological data clearly indicate that this pattern pre-dates major Holocene climatic change suggesting that its appearance was not dependent on large-scale environmental fluctuation.

Population driven arguments have also been employed to explain the adaptive significance of the Millingstone pattern. Most of these have been based on analyses of chronological data or the assignment of relative densities to defined site types. The arguments based on chronological data (radiocarbon date distribution; Glassow et al. 1988; Masters and Gallegos 1997) are problematic simply because of preservation and collection biases. These arguments tend to be based on the clustering of dates by time and space. However, some locations offer better preservation than others, in addition to differential sampling efforts that create a regional bias. In southern California, most radiocarbon dates were obtained on shell from coastal locations (see Basgall and True 1985:Table 3.1) and perceived patterns of population densities were then extended to interior regions to make assessments of subsistence and settlement patterns (Glassow 1997; see also Jones and Waugh 1997:127).

The practice of assigning relative densities to site types in order to draw inferences of subsistence and settlement patterns is also inherently flawed; though the problems are often recognized by the researcher (Erlandson 1997). Although these studies can be good indicators of relative population densities, there are simply not enough data concerning archaeological sites in southern California to do justice to such models. This is exacerbated by the fact that many sites represent locations of repeated use that were subject to different exploitation trajectories. Measures of relative density will undoubtedly prove more useful toward understanding subsistence/settlement systems and changes in populations with the ongoing accumulation of much needed data in regions such as Vandenberg Air Force Base (see Glassow 1991; Glassow et al. 1991).

It is perhaps most detrimental to population driven models that they have been based on environmental dynamics of the Holocene (Erlandson 1997; Glassow 1997; Masters and Gallegos 1997) when they might prove more useful without such assumptions. Explaining perceived patterns of spatially and temporally variable population densities based on environmental correlates becomes more complicated when the relative importance of different subsistence technologies is not understood. As discussed above, it is unlikely that the assignment of certain technologies to specific resources reflects reality, making it more difficult to believe in the correlation of inter-regional environmental change with archaeological signatures in southern California. If enough data become available to support notions of early Holocene demographic change, there is still the issue that the Millingstone pattern predates changes in resource distribution which have been used to interpret population data.

There are numerous factors that complicate the discernment and correlation of environmental and demographic data with the appearance and persistence of the Millingstone pattern. It is likely that Millingstone cultural systems were responding to an interplay of changes in both resource sets and population density but the causal mechanism that would explain such a relationship has not been demonstrated. This is partly because the cultural systems of the Millingstone pattern and others of the Holocene in southern California are not well understood in terms of technological organization making it difficult to assess the impact of certain resource changes.

It is likely that the Millingstone pattern represents one of the earliest cultural systems of the Holocene to develop (excluding Paleoindians) in order to cope with existing California environments. In this sense, it was a tailored strategy from its inception instead of being a response to climatic changes or changes in population density. This suggestion would be more acceptable if the full range of subsistence technology was understood. This is in reference to the small formed flaked stone tools observed during this analysis that are undeniably associated with the Millingstone pattern. Others have also observed such associations (see Norwood and Walker 1980) which serves to further question traditional definitions of southern California cultural systems based on artifact typological classifications.

Perhaps the most productive way to understand the impact of various factors on Millingstone systems is to study its termination. The latest known dates for this pattern appear in La Jolla and Sayles contexts. Within these two regions, there are numerous chronological indicators that show the persistence of the Millingstone strategy into the late Holocene (Basgall and True 1985; Breschini, Haversat, and Erlandson 1992; Masters and Gallegos 1997; Warren 1968). Here, Millingstone assemblages seem to have been replaced by a technological organization that probably reflects higher degrees of residential mobility (Basgall and True 1985).

Millingstone assemblages in the Santa Barbara region tend to terminate with increasing use of acorns at or near the end of the middle Holocene, about 3500 BP (Erlandson 1997). The earlier termination of the Millingstone pattern is apparently associated with an increase in the use of mortars and pestles, along with the appearance of numerous other technologies related to the exploitation of marine resources. These subsistence and settlement strategies probably reflect a shift toward decreased residential mobility, though this has yet to be fully demonstrated (Erlandson 1997).

The question of why the Millingstone pattern terminates at different times within each region cannot be answered exclusively through a comparison of resource diversity and abundance. It was shown that Millingstone assemblages exhibited slight regional adjustments in the use of a common technology according to the ecological conditions of the different regions. However, if ecological conditions alone were the driving force behind the development of new cultural strategies, the reason for why the shift away from Millingstone systems did not occur earlier in the Holocene cannot be adequately accounted for.

The most probable alternative explanation for abandonment of Millingstone economies is characterized by local population dynamics. Population densities of the regional Millingstone systems may have reached threshold levels at different times, necessitating a shift in how people were organizing themselves across the landscape. Population thresholds do not refer to the carrying capacity of the environment, but of the cultural system. The thresholds of Millingstone systems were probably different according to each environment and may have reached thresholds at different times. In any case, it would not be the resources per se that were inducing the change. The resource composition of particular regions would have simply favored different kinds of alternative subsistence and settlement systems. This might explain the stark contrast in post-Millingstone strategies from Santa Barbara to La Jolla and Cajon Pass. To understand the shift away from Millingstone strategies would require an understanding of the technological organization characterizing succeeding cultural systems. This would allow for evaluation of the different variables that have impacted local economies in addition to providing an understanding of the nature of resource exploitation.

It has been demonstrated that the organization of people across the landscape is intimately tied to the distribution and variety of resources (Binford 1979, 1980). Changes in this organization can be spurred by changes in the resources that are exploited or in the groups that are exploiting them. In southern California, variability in a common exploitation strategy reflects different emphases but there are no data to suggest there were changes in resources exploited by Millingstone groups. It might be more productive to pursue issues related to social organization reflected through the uses of different technologies, as this thesis has done with Millingstone assemblages. Research of this kind would serve to augment other indicators such as chronological data and relative densities.

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APPENDIX A

Millingstone Attribute Data Tables

Millingstone Attribute Descriptions

Note: SHP DEG, shaping degree; 0, none; 1, 0-30%; 2, 30-70%; 3, 70-100%; MTRL, material; SCH, schist; GRN, granitic; SST, sandstone; WHL/NC, whole/near complete; MRG, margin; MED, medial; FRG, fragment; SURF FREQ, surface frequency; SURF SHP, surface shape; B, basined; F, flat; CV, convex; CX, convex; IND, indeterminate; SURF TEXT, surface texture; S, smooth; I, irregular; PRS, present; ABS, absent; SEC MOD, secondary modification; FIRE AFF, fire affection; SHP TYPE, shaping type; 0, none; 1, flaking; 2, pecking; 3, grinding.

APPENDIX B

Handstone Attribute Data Tables

Handstone Attribute Descriptions

Note: SHP DEG, shaping degree; 0, none; 1, slight; 2, moderate; 3, high; MTRL, material; SCH, schist; GRN, granitic; SST, sandstone; META, metavolcanic; QZT, quartzite; QTZ, quartz; IGN, igneous; FEL, felsite; GRA, grawhacke; BAS, basalt; RHY, rhyolite; ; WHL/NC, whole/near complete; MRG, margin; MED, medial; FRG, fragment; SURF FREQ, surface frequency; SURF SHP, surface shape; B, basined; F, flat; CV, convex; CX, convex; IND, indeterminate; SURF TEXT, surface texture; S, smooth; I, irregular; PRS, present; ABS, absent; SEC MOD, secondary modification; FIRE AFF, fire affection; SHP TYPE, shaping type; 0, none; 1, flaking; 2, pecking; 3, grinding.

APPENDIX C

Scraper Plane Attribute Data Tables

Scraper Plane Attribute Descriptions:

Note: BAS, basalt; CCR, cryptocrystalline; QZT, quartzite; QTZ, quartz; FEL, felsite; RHY, rhyolite; META, metavolcanic; OTH, other; FORM, original form (1, flake; 2, cobble; 3, indeterminate); FLK TYPE, flake type (1, primary decort.; 2, secondary decort; 3, cortical shatter; 5, interior percussion); E FORM, edge form (1, unifacial; 2, bifacial); E SHAPE, edge shape (1, concave; 2, convex; 3, straight; 4, perimeter; A, regular; B, irregular); E WEAR, edge wear (0, none; 1, unif. Microchipping; 2, bif. Microchipping; 3, battering); E POLISH, edge polish; STP FRAC, step fracturing; INT POLISH, interior polish; PRS, present; ABS, absent.

APPENDIX D

Projectile Point and Biface Attribute Data Tables