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RESOURCE INTENSIFICATION AND ENVIRONMENTAL VARIABILITY: Subsistence Patterns in Middle and Late Period Deposits at CA-SBA-225, Vandenberg Air Force Base, California

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The nature of and responses to population-resource imbalances have played an important role in debates surrounding the development of complexity among Chumash populations of the Santa Barbara Channel region. Faunal assemblages from Middle and Late Period deposits at CA-SBA-225 were analyzed to evaluate whether people occupying the Vandenberg coastline experienced conditions similar to those interpreted for mainland and island populations to the south. Regional data indicate that residents responded to stressful periods promoted by limited terrestrial productivity and increased population densities in the Late Period. However, reliance on lower-ranked shellfish species at CA-SBA-225 and other sites through time does not conform precisely to expectations, thereby requiring additional explanation. It is argued that natural variation in resource availability and abundance contributes significantly to the character of these faunal assemblages. In sum, this analysis highlights the necessity of understanding local environmental variability before invoking models of resource intensification to explain subsistence data.

Researchers have devoted considerable attention to developing explanatory models of complexity among Chumash hunter-gatherers based on changes in subsistence and socioeconomic strategies through time, emphasizing the role of severe population-resource imbalances during the later half of the Middle Period (1500-850 B.P.) and late period (Arnold 1992a; King 1981; Kennett 1998). Of the potential responses to stressful periods, resource intensification has been inferred from the archaeological record of the Santa Barbara Channel region based on temporal shifts in subsistence foci from higher-ranked to lower-ranked species as well as resource diversification. However, it is important to note that large-scale population-resource imbalances differentially impacted people depending on local variations in species distribution and abundance as well as cultural factors such as population density, organizational structures, and technological innovations. Therefore, to understand fully cultural responses to stressful times and their possible role in stimulating complexity, shifts in resource exploitation among prehistoric Chumash populations need to be evaluated within their specific environmental and social contexts.

Faunal constituents from CA-SBA-225, situated near Purisima Point on the Vandenberg Air Force Base coastline (Fig. 1 and Fig. 2), were analyzed to evaluate temporal changes in resource exploitation among the prehistoric inhabitants of the Vandenberg region north of Point Conception. Radiocarbon dates indicate that different loci at the site were inhabited throughout the Middle

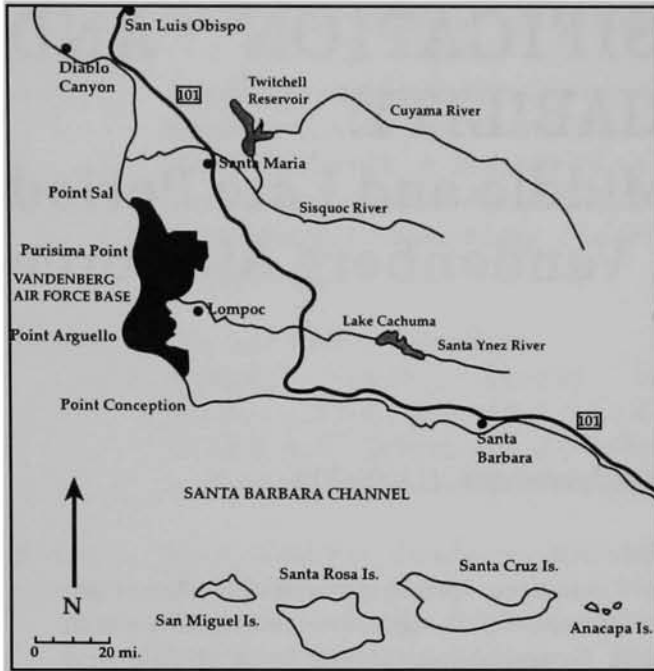


Figure 1. Location of Purisima Point

Period and during the Late Period, spanning the time in which dramatic organizational and technological changes are presumed to have occurred among Chumash populations (de Barros et al. 1994:5-114). The location of the site at Purisima Point as well as its sporadic occupation over 2500 years indicate that this projecting headland and its resources were part of the prehistoric settlement-subsistence system of the Vandenberg region. Furthermore, preliminary faunal analyses conducted by de Barros et al. (1994:6-6) suggested possible evidence for resource intensification during the later part of the Middle Period, specifically the unusual abundance of low-ranked shellfish species such as black turban (*Tegula funebris*) in midden deposits.

The main objective of this research was to evaluate whether people living near Purisima Point responded to inferred population-resource imbalances during the later half of the Middle Period through resource intensification. Detailed analyses of CA-SBA-225 shellfish constituents were conducted by the author and then integrated into previously existing analyses of fish and non-fish vertebrate remains (Hudson 1994 and Salls 1994). Subsistence patterns were

assessed through the overall dietary contributions of all animals identified in the excavated midden deposits, as well as species ratios among shellfish specifically, with emphasis on the relative importance of black turban and California mussel (*Mytilus californianus*). As first suggested by de Barros et al. (1994:6-6), resource intensification appears to be manifested in the inclusion of low-ranked black turban in the diet as well as subsistence diversification. However, the expectations and models used do not satisfactorily account for the relatively high abundance of black turban in midden deposits dating throughout site occupation. In this paper it will be argued that rather than accounting for trends in faunal assemblages solely through models of resource intensification, the dietary contributions of individual species may be explained in part as reflecting natural variation in resource distribution and abundance in the Vandenberg region.

Regional Chronology

Researchers have focused on understanding the nature of complexity during the Late Period, from 850 B.P. to European contact, through the investigation of earlier mechanisms and conditions stimulating changes in socioeconomic and political organization (Arnold 1992a, King 1981, and Kennett 1998). Organizational and technological responses to depressed resource productivity are considered to be the proximate conditions enabling and/or promoting the subsequent elaboration of economic exchange, craft specialization, leadership, and differential wealth accumulation and status (Arnold 1992a). Based on differing interpretations of existing paleoenvironmental data, depressed subsistence conditions are debated as having been stimulated by combinations of the following: lowered marine productivity induced by El Niño-Southern Oscillation (ENSO) events, limited water and terrestrial resource availability due to drought conditions, and/or increased population density (Arnold et al. 1997; Kennett and Kennett 2000; Raab and Larson 1997). Most

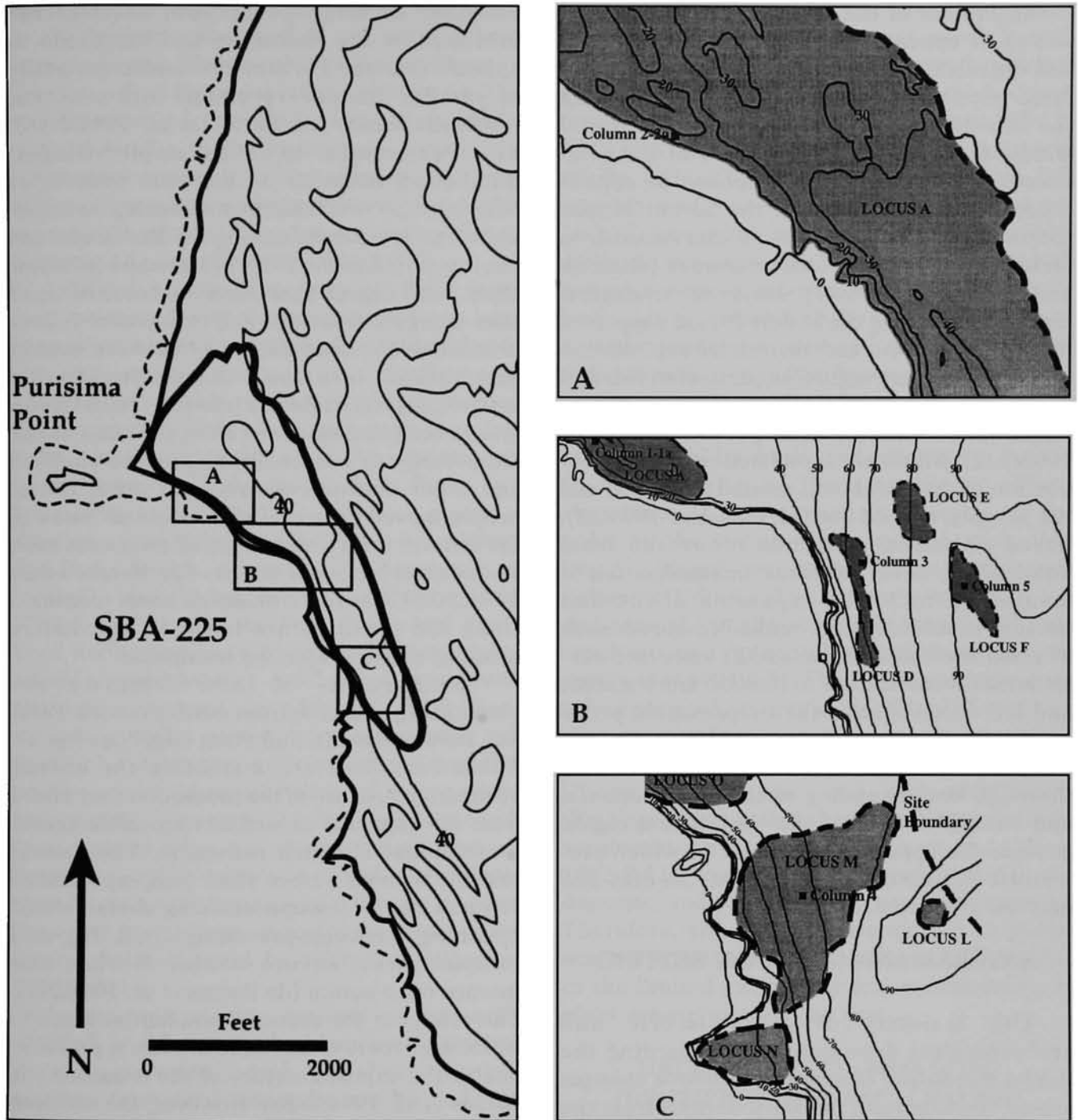


Figure 2. Location of CA-SBA-225

researchers cite climatic variability and increased population density as major factors in inducing population-resource imbalances during the later half of the Middle Period (Kennett and Kennett 2000; Raab and Larson 1997), with varying emphasis placed on events from 1100

to 700 B.P., (Arnold et al. 1997). Based on radiocarbon dates from different time intervals, Glassow (1996:104) argues that population density increased substantially in the Vandenberg region beginning in the late Middle Period, and was relatively high during the Late Period.

Regardless of the specific mechanisms involved, it appears that shifts in technological and organizational strategies were used to mediate population-resource imbalances during the late Middle Period (1100–850 B.P.) and Middle to Late Transition (850–700 B.P.) Resource intensification in response to subsistence stress is reflected in the advent of new technologies and expansion of diet breadth to include more diverse food resources (Glassow and Wilcoxon 1988:47). Major technological innovations during the Middle Period supported intensified marine and terrestrial exploitation in the Vandenberg region. In particular, fish and sea mammals increased substantially in dietary importance during this period (Glassow 1996:134), which are associated with the introduction of shell fishhooks around 2,500 B.P. and the harpoon around 800 B.P. (Glassow 1996:22). Based on faunal evidence recovered from Vandenberg sites, resource intensification is manifested in 1) the expansion of the diet breadth to include lower-ranked resources such as small shellfish species, and 2) increased subsistence diversification to include more marine and terrestrial species than represented previously (Glassow and Wilcoxon 1988). Faunal analyses at multiple sites in conjunction with a thorough understanding of the environmental and cultural setting of the Vandenberg region provide the appropriate context in which prehistoric subsistence patterns at CA-SBA-225 may be evaluated.

NATURAL AND CULTURAL SETTING

The majority of ethnohistoric and archaeological documentation regarding the timing and nature of major subsistence changes among the Chumash has been derived from the Channel Islands and Santa Barbara Channel coastline south of Point Conception. The Purisimeño Chumash, who occupied the Vandenberg region north of Point Conception, are less understood and have often been compared to their better known neighbors to the south, the Barbareño and Ventureño Chumash (de Barros et al. 1994:2-17). In

contrast to large permanent settlements inhabited by the Barbareño and Ventureño, it appears that the Purisimeño resided primarily in smaller temporary camps and seasonal residential bases (de Barros et al. 1994:2-16). The Purisimeño lived in small villages, numbering between 30 and 200 people, as compared to settlements numbering as many as 500 to 800 people among the Barbareño and Ventureño (Glassow 1996:14). Spanne (Glassow 1984:2-22) argues that the abundance of small sites along the coastline and in adjacent valleys is indicative of seasonal travel between coastal and inland locations. According to his settlement-subsistence model, Purisimeño groups occupied locations along the coast either temporarily or seasonally to procure shellfish and other marine resources. At other times, people moved to seasonal residential bases in the interior to exploit terrestrial resources such as deer, rabbits, and acorns (de Barros et al. 1994:2-16). The few residential bases identified along the coastline are located immediately south of major projecting headlands.

Three points of land dominate the Vandenberg coastline from north to south: Point Sal, Purisima Point, and Point Arguello (Fig. 1). These locations are attractive for human occupation because of the protection they afford from the elements as well as immediate access to abundant shellfish resources. The coastal climate is more severe than that experienced south of Point Conception, being characterized by strong northwest-prevailing winds, fog, cool temperatures, severe winter storms, and intense wave action (de Barros et al. 1994:2-1). The tendency for seasonal residential bases to be situated more often in the interior is probably due to the exposed nature of the coastline (de Barros et al. 1994:2-16). However, the south to southwest facing expanses of coastline adjacent to Point Sal and Point Arguello provide protection from the strong northwesterly winds and heavy surf (Glassow 1984:2-11). Due in part to more hospitable conditions, long stretches of productive rocky intertidal habitat extend along the lee sides of these points. Furthermore, abundant freshwater is available immediately

north of Point Arguello and adjacent headlands in the largest watershed in the Vandenberg region, Honda Creek, as well as in Shuman Creek south of Point Sal (Glassow 1996:6). The significance of these resource-rich, well-watered locales in the Purisimeño settlement-subsistence system is indicated by the presence of large, dense archaeological deposits and their association with two major historic villages, Nocto and Lospe (Glassow 1984:2-21).

Of the three locations, Purisima Point is the least protected, and therefore would not have been occupied as intensively, but rather visited intermittently during the settlement-subsistence cycle to procure marine resources. There are two large drainages near Purisima Point: the San Antonio Creek three kilometers to the north and the Santa Ynez River five kilometers to the south. A saltwater marsh is situated at the mouth of the Santa Ynez River, and Barka Slough, a large freshwater marsh, is located about 13 km inland (de Barros et al. 1994:2-3). The San Antonio Creek and Santa Ynez drainages would have provided access to reliable freshwater as well as terrestrial and riverine resources. In addition, the valleys served as direct routes between coastal and interior locations that were inhabited depending on the seasonal availability of marine and terrestrial resources. As Spanne observed, "populations from the inland villages moved down the major valleys in which the villages were located and then moved either up or down the coast to locations of rocky intertidal zones where shellfish could be collected" (Glassow 1984:2-22).

In general, marine resources, primarily shellfish and fish, are abundant near Purisima Point in intertidal and nearshore locales, whereas terrestrial resources are limited to a few animal species. The dominant marine habitat near the site is the rocky intertidal zone (Salls 1993:D2-3). As noted by Glassow and Wilcoxon (1988:38), "the lee sides of headlands north of Point Conception characteristically contain rocky shores having not only some protection from the wind but also sufficient water turbulence to create conditions for high

biotic productivity in the nearshore and intertidal zones." Open-coast sandy beach species also reside near the site within gravel and cobble shoals between several bedrock prominences (Cagle 1993:E-6; Glassow 1984:9-111) and at a small bay located to the north (Salls 1993:D2-3). In addition, several fish species are found in nearby ocean waters, including rockfish and surfperch (Salls 1993). Although site inhabitants exploited sandy beach resources, rocky intertidal habitat would have been more attractive because it is more abundant near the site and more productive with respect to potential biomass yield.

In contrast to the abundance of marine resources, terrestrial resources such as plants and deer, rabbits, birds, and rodents are limited in the vicinity of Purisima Point. Plant abundance is constrained significantly on the coast by the strong winds and fog, with oaks being extremely rare within 10 km of the coast (Glassow 1996:6). The primary vegetation on and around the site is coastal strand and sage scrub situated on unstable sand dunes (see de Barros et al 1994:2-5). The results of preliminary paleobotanical studies at CA-SBA-225 indicate that people living near the point harvested plants primarily from woody chaparral habitat. Chaparral (Prunus sp.) and elderberry (Sambucus sp.) rather than nearby coastal sage scrub and dune species (Hammett and Carter 1993:F-11) were the only plants identified in site deposits, and were probably used as firewood. Therefore, the dietary contribution of plants was not considered in the present analysis due to the limited availability and contributions of plant resources near the site.

DATA RECOVERY, SHELLFISH IDENTIFICATION, AND ANALYSIS

Data Recovery and Preliminary Analysis

Archaeological sites in the vicinity of Purisima Point were first recorded in 1951 by an anonymous archaeologist who described CA-SBA-225 as a "village site, chert outcrop, and workshop" (de Barros et al. 1994:5-52). Site visitations by Ernest Wubben in 1979 and a site

record update filed by Al Schilz in 1981 as part of a seismic testing program indicated that the midden deposits were much more expansive than at present, presumably having been destroyed by erosion caused by storms and wave action. In 1993, Chambers Group, Inc. evaluated the site along with nearby CA-SBA-224 at the request of the National Park Service to determine whether the sites were eligible for the National Register of Historic Places. The request was initiated in part by the natural exposure of five human burials at CA-SBA-225 and the need to protect them from sea cliff erosion. Survey, extensive surface mapping, and subsurface excavation were conducted to assess site significance, evaluate the nature and rate of site deterioration, and to recover and rebury the human remains (de Barros et al. 1994:1-1).

In March 1993, Chambers Group, Inc. documented and excavated a small sample of deposits at CA-SBA-225 (de Barros et al. 1994). Eighteen cultural loci ranging from deflated lithic scatters to subsurface shell midden deposits were identified near Purisima Point and extending southward within dune formations along the coast (de Barros et al. 1994:5-46) (Fig. 2). Initial testing and site boundary definition was accomplished through survey, surface observation units (SOUs), and excavation of shovel test pits (STPs). Thirty-one STPs at loci A, B, D, E, F, M, and P and seven 20 by 20 cm column samples at loci A, D, F, and M were excavated in arbitrary 10 cm levels to determine the presence of subsurface deposits (de Barros et al. 1994:5-69). The evaluation of CA-SBA-225 subsistence patterns is based on the analysis of faunal remains recovered from all of the column samples, except for Column 3, Locus D, due to lack of temporal assignment and shallowness of cultural deposits.

The majority of excavated materials were recovered from Locus A, which is referred to by de Barros et al. (1994:5-46) as one of the high-density cultural deposits at CA-SBA-225. It is located in the northern portion of the site adjacent to the sea cliff overlooking Purisima Point (Fig. 2). Several features were documented, including twelve cobble

concentrations, two hearths, and five burials. Furthermore, substantial subsurface midden deposits extending to about 340 cm in depth were identified through STPs, column samples (1, 1a, 2, and 2a), and two 2 x 2 m units excavated to expose the five human burials (de Barros et al. 1994:5-76). Based on the features recorded and the thickness of midden deposits, it appears that Locus A represents the most significant habitation at Purisima Point and has been interpreted as a seasonal residential base.

Site Integrity and Chronology

To varying degrees, each locus has been disturbed through a combination of natural and cultural processes, including wave action, wind deflation, rodent burrowing, and recent human activities. Of these factors, persistent winds have had the most severe effect on the shifting and mixing of cultural materials through deflation and dune migration (de Barros et al. 1994:5-64). Nonetheless, based on geoarchaeological analysis conducted by Morgan (1994:A-17) some loci, specifically Locus A, continue to retain a moderate to high degree of spatial integrity. As evidenced in sea cliff exposures, Locus A is characterized by the presence of three distinct cultural strata, designated as stratum II, V, and VII, that are separated from one another by sterile sand deposits ranging from about 50 to over 100 cm in thickness (de Barros et al. 1994:5-59-60). In contrast, subsurface deposits at Loci D, F, and M have been subjected to extensive wind deflation, with cultural constituents extending to no more than 30 cm in depth in the excavated areas.

Based on eight radiocarbon dates and temporally diagnostic artifacts, the loci investigated represent human activities around Purisima Point dating to the Middle and Late Periods. Due to the high density of cultural materials and level of spatial integrity at Locus A, most of the radiocarbon dates for the site were obtained from California mussel fragments recovered from Column 1-1a (see de Barros et al. 1994:5-114). Stratum VII, spanning 270-330

cm in depth, yielded two dates, $2,650 \pm 90$ RCYBP and $3,050 \pm 100$ RCYBP, derived from black turban and California mussel samples, respectively. One radiocarbon date, $2,280 \pm 70$ RCYBP, was taken from stratum V, which ranges from 180-210 cm in depth. Stratum II, extending from 20-70 cm in depth, yielded two dates: $1,470 \pm 80$ RCYBP and $1,350 \pm 70$ RCYBP. One radiocarbon sample, $1,260 \pm 80$ RCYBP, was obtained from stratum II in Column 2-2a, which supports the interpretation that stratum II deposits in Columns 1-1a and 2-2a are contemporaneous. All of these dates fall within the Middle Period, whereas Loci M and F date to the Late Period, possibly during historic times. Column 4 at Locus M and Column 5 at Locus F yielded comparable radiocarbon dates: 190 ± 70 RCYBP and 230 ± 80 RCYBP. However, given the lack of chronological resolution and historic artifacts, such as mission pottery and glass beads, it is difficult to ascertain whether these deposits represent human occupation prior to and/or following European presence in the region (de Barros et al. 1994:5-118).

Shellfish Identification and Analysis

Although Chambers Group, Inc. (de Barros et al. 1994) conducted thorough analyses of fish and non-fish vertebrate remains recovered from all of the column samples, they devoted minimal attention to the invertebrate remains. The shellfish analysis conducted initially was limited to basic identifications and visual estimations (de Barros et al. 1994:E-4). The present analysis includes genus/species identification, weight quantification, assessment of species proportions, and calculation of relative meat and protein yields of shellfish, providing the appropriate data through which shifts in subsistence strategies at CA-SBA-225 may be evaluated. Each bag of shellfish from every level of Columns 1, 1a, 2, 2a, 4, and 5, not including the 1/16 inch samples, was sorted, and each shellfish fragment was identified to genus and species level when possible.

Prior to analysis, it was anticipated that shellfish proportions would be considered based

on weight and minimum number of individuals (MNI) counts. MNI counts were determined for shellfish that exhibited non-repetitive elements such as hinges and spires. However, one problem encountered was that few of the shellfish fragments exhibited definitive characteristics that occur only once on the shell and, therefore, would be useful in determining MNI counts. Because of the low proportion of MNI relative to weight, it is argued that MNI does not provide an adequate representation of relative shellfish constituents at this particular site. Following her analysis of shellfish remains at the Castle Windy Mound in Florida, Claassen (1986:121) concluded that "the MNI statistic grossly underestimates the number of individuals in the discard population . . . Shellfish meat weights are an even more desirable comparative statistic but calculation is problematic." For an alternative perspective on the utility of MNI counts refer to Mason et al. (1998), as well as counter-arguments by Glassow (2000) and Claassen (2000) in support of weight as a valid and useful measure in shellfish analysis.

Therefore, comparisons of species ratios in different column samples and strata were based primarily on weight and calculations of meat and protein yields derived from the weight of shell and bone remains. The potential meat yield per individual shellfish relative to its weight is significantly smaller than that provided by fish and other vertebrates. However, shellfish contain significant quantities of protein and may have been procured to meet some of the dietary protein requirement (Erlandson 1988:103). Meat and protein yields were calculated for shellfish and then compared with yields from fish, sea mammal, terrestrial mammal, and bird components of the prehistoric diet at CA-SBA-225. Multipliers for the meat and protein yields of specific shellfish species and general faunal categories were obtained from Erlandson (1994:59) (Table 1).

The dietary contributions of different faunal constituents were calculated for each stratum and column sample, and evaluated in two ways to detect subsistence patterning on multiple

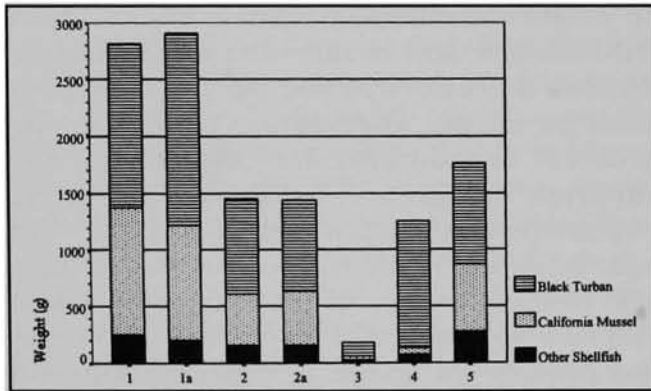


Figure 3. Major Shellfish Contributions by Column Sample

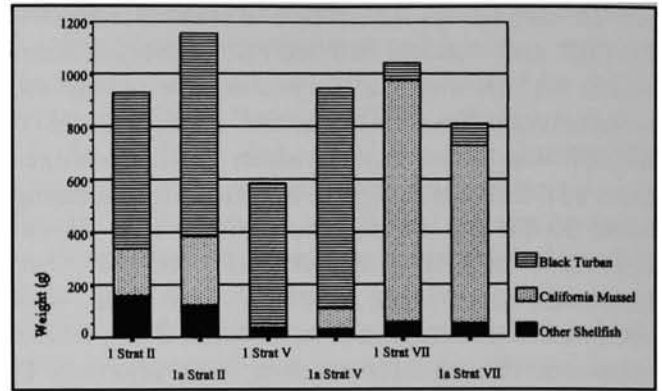


Figure 4. Major Shellfish Contributions by Stratum in Column Samples 1 and 1a

temporal scales. First, species ratios were compared between strata in Columns 1 and 1a to evaluate changes in resource exploitation during the Middle Period. Because Columns 1 and 1a are immediately adjacent to one another, strata II, V, and VII from each column were considered separately and together. Second, Columns 1, 1a, 2, and 2a at Locus A and Columns 4 and 5 at Loci M and F, respectively, were compared to evaluate differences in subsistence patterns between the Middle and Late Periods. In both cases, shellfish were analyzed separately to consider relative species contributions, specifically black turban and California mussel, and all faunal constituents were evaluated together to assess the overall diet.

RESULTS OF SHELLFISH ANALYSIS AND EVALUATION OF FAUNAL DATA

CA-SBA-225 faunal constituents were analyzed to consider exploitation strategies during and after an inferred period of population-resource imbalance. Based on intra-site subsistence analysis, there are several similarities in the proportions of shellfish species irrespective of time period or habitation type, which indicates the importance of natural species distributions in influencing subsistence patterns. The majority of shellfish identified occupy the rocky intertidal zone, including California mussel, black turban, giant chiton, mossy chiton, gooseneck barnacle, black and

red abalone, and several species of limpets (Table 2.) Sandy beach habitat is represented solely by small quantities of littleneck clam. Despite prehistoric occupants having access to sandy beach resources, it is evident that the rocky intertidal was the preferred habitat for shellfish exploitation.

Although twenty-two shellfish taxa and other invertebrates are represented in the column samples, two species, California mussel and black turban, dominate shellfish weight and meat and protein contributions (Fig. 3). Based on limited visual inspection in the lab, de Barros et al. (1994:5-101) concluded that the site is dominated by California mussel with respect to shellfish constituents. Detailed analysis of shellfish components from all of the column samples, however, indicates that black turban provided significant dietary contributions during different episodes of habitation. Their relative dietary importance shifts from heavy emphasis on California mussel in Stratum VII, Columns 1 and 1a, to intensive black turban exploitation in Strata II and V, Columns 1 and 1a, and Columns 2, 2a, 4, and 5.

In Columns 1, 1a, 2, and 2a, black turban comprises the majority (50%-60%) of the overall weight and dietary yield of shellfish, while California mussel (30-40%) is the next dominant species. When isolating these two species and comparing their proportions, two related conclusions may be drawn (Fig. 3 and Fig. 4). First, with the exception of one time interval represented by stratum VII, Columns 1 and 1a,

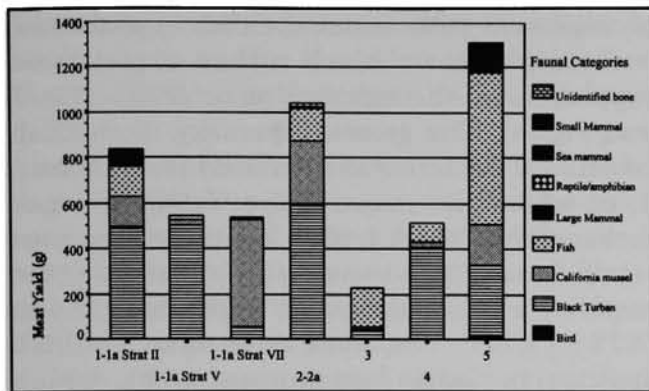


Figure 5. Meat Yield of Faunal Constituents by Column Sample

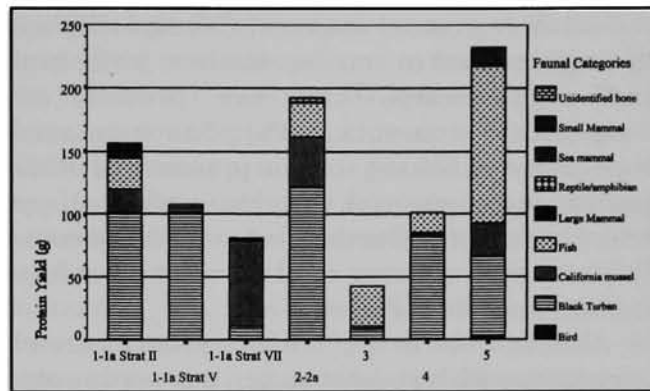


Figure 6. Protein Yield of Faunal Constituents by Column Sample

black turban was a significant dietary component regardless of time period. Second, the importance of California mussel appears to have declined considerably after the earliest episode of human activity as represented by stratum VII, Columns 1 and 1a. Its relative weight contribution is much smaller in the upper strata of Columns 1 and 1a, and Columns 2, 2a, 4, and 5 (5%-35%). The most dramatic shift in species ratios is represented by Column 4, in which most (90%) of the shellfish weight is composed of black turban.

This trend is more clearly supported by changes in the relative proportions of these two species between strata in Columns 1 and 1a (Fig. 4). In stratum VII of both column samples, California mussel accounts for most of the shellfish weight (88% and 83%, respectively), whereas there are much smaller black turban contributions (6% and 10%, respectively). In strata II and V, the trend is reversed with black turban as the dominant shellfish species. In stratum V, California mussel contributes limited quantities to the diet (3% and 8%) as contrasted with significant amounts of black turban (91% and 89%). In stratum II, California mussel composes a somewhat larger proportion of the total shellfish weight (19% and 23%). It appears that during early Middle Period occupation, as represented by stratum VII, California mussel was the most important shellfish constituent in the diet. After initial habitation, California mussel declined in importance, with some variation between occupations, while the

contribution of black turban increased substantially.

Based on analysis of all faunal constituents in Columns 1 and 1a, it is evident that shellfish gathering was one of the most important subsistence activities conducted by Locus A inhabitants (Fig. 5 and Fig. 6). In particular, California mussel and black turban provide most of the meat and protein contributions in all strata (over 77% throughout occupation of Locus A). Other food resources represented in smaller quantities include fish, sea mammals, large and small terrestrial mammals, birds, and reptile/amphibians. In stratum VII, shellfish comprise almost all of the meat (98%) and protein yields (97%), whereas fish, small mammal, and unidentified bone represent insignificant contributions. Relative proportions are similar in stratum V, in which shellfish dominate the diet (98% and 98%, respectively); fish is the only additional food resource. Therefore, it appears that the primary subsistence activity during the Middle Period was shellfish gathering in rocky intertidal habitats, while fish were occasionally procured from nearshore waters.

Stratum II of Columns 1 and 1a differs from other strata with respect to increased resource diversification. California mussel and black turban continue to provide the majority of the meat (75%) and protein yields (77%). However, fish is the second most important resource category based on meat (16%) and protein contributions (16%). Sea mammal (5% and 3%)

and small terrestrial mammal (3% and 4%) are also represented in small quantities, while bird and reptile/amphibian are present in insignificant amounts (<1%). The increased importance of fishing and the presence of other marine and terrestrial vertebrate remains are interpreted as reflecting increased resource diversity and reliance on fishhook technology during the Middle Period.

Although the rest of column samples are of importance with respect to general patterning, few trends were identified between levels in Columns 2, 2a, 4, and 5. Columns 2 and 2a, Locus A, consist of one cultural deposit about 40 cm in thickness. Given the stratification of Columns 1 and 1a, with three cultural strata segregated by sterile deposits, it is assumed that stratum II in Columns 2 and 2a represents one episode of deposition. No significant shifts were noted in shellfish proportions; overall the stratum is composed predominantly of black turban (58% in Column 2 and 56% in Column 2a) and California mussel (31% and 33%, respectively). Although there appears to be an increase in California mussel from the 30-40 cm to the 0-10 cm level, it is not significant enough to be considered indicative of subsistence change.

The relative proportions of vertebrates and invertebrates in Columns 2 and 2a are comparable to those observed in stratum II in Columns 1 and 1a, which are indicative of the increased importance of fishing and diminished focus on mussel collecting (Fig. 5 and Fig. 6). Shellfish gathering was the most important subsistence activity based on meat and protein yields (84% for both). Fishing was the next most significant (14% for both), while small terrestrial mammals and reptile/amphibians were also procured in small quantities (<1%). Increased diversity in dietary constituents, emphasis on shellfish gathering and fishing activities, and the thickness of stratum II deposits in Columns 1, 1a, 2, and 2a indicate that Locus A occupation during the late Middle Period was longer in duration and/or more intensive than previous and subsequent habitation at Purisima Point.

The dietary proportions in Column 4, Locus

M, represent substantial shellfish exploitation, with emphasis on black turban exploitation supplemented through fishing activities (Fig. 5 and Fig. 6). The greatest quantity of shellfish remains at the site was recovered from Column 4, of which the majority by weight is black turban (90%). Black turban represents the most significant dietary constituent, contributing the majority of both the meat (80%) and protein (82%) yields. The next dominant shellfish species is California mussel (5%), which represents only a minor dietary component (4% of meat and 3% of protein). Fish is the second most important resource with respect to meat (17%) and protein (16%) yields. No other faunal constituents were recovered from Column 4; however, sea mammal bone was observed on the surface of Locus M. The shallowness of the deposit, about 10 cm in thickness; a low density of lithic materials and lack of formal tools; and low diversity of faunal remains suggest that Locus M represents short-term habitation focused on shellfish collecting, with primary emphasis on black turban exploitation.

Column 5, Locus F, is more similar to Columns 1, 1a, 2, and 2a than Column 4 with respect to shellfish proportions (Fig. 5 and Fig. 6). Black turban does not dominate Column 5 dietary constituents, but does represent the most shellfish weight (50%), whereas California mussel is the second most important shellfish species (34%). Although the pattern of black turban exploitation in Column 5 is not as significant as that observed in the other column samples analyzed, it does indicate a strong preference for this species during the Late Period. However, shellfish gathering was not the primary subsistence activity at Locus F; other marine and terrestrial species were also important food resources (60% and 59% of the overall meat and protein yields, respectively).

There is considerable diversity among the faunal constituents recovered from Column 5, Locus F, which include shellfish and fish as well as sea mammals, large and small terrestrial mammals, and birds (Fig. 5 and Fig. 6). Fish provided the majority of the meat (51%) and protein (54%), which indicates that fishing was

the primary subsistence activity conducted. Black turban is the second most productive resource (25% of the meat and 28% of the protein yields) and California mussel is the next most important shellfish species (14% and 11%, respectively). The dominant shellfish species were supplemented primarily with giant and mossy chiton, of which giant chiton are higher-ranked rocky intertidal shellfish due to their relatively large meat package.

In contrast to the faunal remains identified in most of the column samples, sea mammal, including southern fur seal (*Arctocephalus townsendi*) and other unidentified pinnipeds, is the next most important dietary constituent in Column 5 following fish and shellfish. Stratum II in Columns 1 and 1a contains the only other sea mammal bone identified, which represents minor meat (5%) and protein contributions (3%). In Column 5, sea mammal is slightly more important (9% and 5%, respectively). Small mammal, including rabbit (*Sylvilagus* spp.), unidentifiable large mammal, bird and duck, and unidentifiable bone fragments represent only limited amounts of the overall meat and protein yields, of which none is an important part of the diet (<1% in all cases). Nevertheless, the presence of additional marine and terrestrial species in Column 5 indicates that site inhabitants exploited a more diverse range of resources at Locus F compared to earlier occupations.

DISCUSSION

There are several shifts in species ratios that may be accounted for using subsistence models relating to resource intensification and environmental change. Inherent in the use of these models to evaluate CA-SBA-225 faunal distributions is the assumption that changes in subsistence strategies will be represented by shifts in the relative proportions of species identified in the archaeological record. Claassen (1986:126) presents four general explanations for temporal changes in species ratios: "a) gastronomical whim, b) dietary shifts required by human exploitation, c)

technological advances that permit new harvesting techniques and consequently new prey, and d) environmental changes that extirpate some species and favor other species." With the exception of personal taste, the applicability of these models to faunal assemblages may be evaluated through specific archaeological and paleoenvironmental indicators. CA-SBA-225 subsistence patterns may be accounted for by a combination of cultural and environmental variables based on the following data sources: analysis of shellfish, fish, and non-fish vertebrate remains; natural distribution of marine and terrestrial resources; and local environmental conditions.

The explanatory models used to understand and interpret temporal changes in species ratios and their relationship to resource intensification are based on principles of optimal foraging theory. Two models subsumed within optimal foraging theory are applicable to the evaluation of CA-SBA-225 data: diet breadth and patch choice models (Bettinger 1991:84). In the diet breadth model, resource ranking predicts whether particular species will be included in the diet (Smith 1983:628). The patch choice model differs in its emphasis on patches ranked according to the resources available within a territory or area rather than evaluating individual species (Bettinger 1991:87-90). Whereas the diet breadth model is employed to account for shifts in the specific species exploited at CA-SBA-225, the patch choice model provides an interpretive framework through which the focus on marine resources may be explained (Colten 1987:26-27).

The Importance of the Rocky Intertidal and California Mussel

CA-SBA-225 subsistence patterns indicate that marine habitats, particularly the rocky intertidal, near Purisima Point were high-ranked resource patches because of high resource biomass and diversity (Yesner 1980:728-729). In particular, shellfish are attractive marine resources because they are "usually visible and compactly distributed over

corrugated surfaces so that collecting forays amongst them are likely to be short and more assured of success" (Anderson 1981:110). Shellfish gathering is a relatively low-effort subsistence activity in locales with large aggregations due to their abundance and predictability (Glassow and Wilcoxon 1988:41-42). It is argued that highly productive marine resource patches with concentrated resources, such as the rocky intertidal, as well as the absence of comparable terrestrial resources along the Vandenberg coastline, account for the inclusion of Purisima Point in settlement-subistence cycles.

Based on the relative dietary contributions of the loci analyzed, site inhabitants focused their subsistence activities primarily on rocky intertidal locales and the adjacent waters. Rocky intertidal shellfish and nearshore fish in shallow rocky reef and intertidal habitats represent the majority of dietary constituents throughout occupation (de Barros et al. 1994:D2-13). Considerable emphasis was placed on the procurement of black turban and California mussel, with dietary supplementation provided by black and red abalone, gooseneck barnacle, giant chiton, mossy chiton, several species of limpets, and several other minor shellfish species (Table 2). The specific shellfish species exploited and their relative proportions may be accounted for primarily by two variables, size and abundance, which may be viewed as yield and search time, respectively (Anderson 1981:113).

Some researchers evaluating the dietary contribution of shellfish have emphasized their small size and relatively high energetic investment per individual animal harvested, concluding that they are less productive than terrestrial species (Raab 1992:66; Waselkov 1987:122-123). However, based on faunal analyses and evaluation of nutritional yields, it has been argued that shellfish provided substantial protein contributions to the prehistoric diet (Erlandson 1988; Glassow and Wilcoxon 1988; Perlman 1980). Jones and Richman (1995:42) note that shellfish, especially California mussel, contain important

dietary elements, including essential vitamins and minerals. Therefore, rather than viewing shellfish as a substandard alternative to terrestrial resources, they may be regarded as attractive protein sources in certain environmental contexts.

Seasonal scheduling for shellfish gathering depended on various cultural and natural variables, including terrestrial productivity, seasonal peaks in fish availability, and events such as storms and red tides. Terrestrial plant and mammal species present in interior locales may have been exploited primarily during the summer and fall (Glassow and Wilcoxon 1988:44). Shellfish collection was emphasized during specific seasons, particularly during the winter because of low tides (Glassow 1984:9-113). Exploitation of California mussel was constrained during the summer due to periods of red tide, during which mussels become poisoned by toxins produced by large quantities of microscopic dinoflagellates (Jones 1991:435, Moss 1993:640-641; Ricketts et al. 1985:219-220). However, red tides are infrequent and of short duration, and along with storms, could have been avoided by observing changes in water conditions (Glassow 1984:9-113).

Despite the detrimental impact of red tides, California mussel is among the highest ranked shellfish resources in rocky intertidal areas due to its relative accessibility, predictability, high food value, and abundance (Jones and Richman 1995:50; Suchanek 1985:71). California mussels are large compared to other shellfish, ranking below only abalone and giant chiton with respect to potential meat yield per individual shellfish. California mussels may be viewed as attractive resources because of their propensity to live in dense aggregations in which individuals grow on rock surfaces or on other individuals up to several layers deep (Seed and Suchanek 1992:111). One characteristic promoting their abundance along the Vandenberg coast is their preference for heavy wave action, which produces an abundant food supply, including organic particles, dinoflagellates and other protozoa, and detritus (Jones and Richman 1995:34-37). In sum, their

large size and overall abundance in rocky intertidal habitats explains their intensive procurement along the California coast throughout prehistory.

Another characteristic promoting the attractiveness of California mussel as a food resource is its propensity to grow rapidly in comparison to other high ranked resources. California mussels can grow to lengths of 80-86 mm during their first year, 120 mm during their second year, and 140-150 mm during their third year (Shaw 1988:6). However, individual growth rates vary considerably according to mussel size, age, and genotype and are strongly influenced by environmental conditions such as temperature, salinity, food supply, tidal exposure, and wave action (Seed and Suchanek 1992:115-121). Furthermore, heavy wave action may promote mussel mortality from the impact of storm-generated waves, wave-driven logs, and other storm-related events (Dayton 1971:357; Suchanek 1985:90). Regardless, based on natural and archaeological shellfish distributions, it is evident that California mussel may be considered as a high ranked shellfish species that was exploited when encountered in rocky intertidal habitats.

Given the focus on rocky intertidal shellfish gathering, it was expected that California mussel would have provided significant dietary contributions throughout site occupation unless subject to environmental and/or cultural changes. As expected, based on the diet breadth model, mussel collecting was one of the most important subsistence activities during the early Middle Period, as represented by stratum VII in Columns 1 and 1a. During the late Middle Period and later, California mussel continued to be one of the primary resources exploited, but provided significantly less meat and protein yields than black turban. The dietary shift from California mussel to the dominance of smaller-size black turban appears to be consistent with the expectations of intensified shellfish exploitation.

Trends in Resource Diversification

Besides shifts in shellfish proportions,

resource intensification is reflected in the expansion of the overall diet breadth during the late Middle and Late Periods. First, the relative dietary contributions of minor species excluding California mussel and black turban were evaluated to detect minor shifts in exploitation strategies. Second, increased resource diversity was considered with respect to the total number of shellfish species as well as the overall number of marine and terrestrial animals exploited. While the diversity and relative proportions of shellfish species is constant, the presence of increased fish remains as well as sea mammals, terrestrial mammals, and freshwater aquatic birds in Columns 1, 1a, and 5, suggest expanding diet breadth during the late Middle and Late Periods.

Most of the column samples yielded only shellfish and nearshore fish remains, while minor amounts of small mammal and unidentified bone were also recovered from Stratum VII, Columns 1 and 1a, and Column 2. In contrast, Stratum II, Columns 1 and 1a, and Column 5 were the only samples in which other faunal constituents were identified, including sea mammal, terrestrial mammal, bird, and reptile/amphibian remains (see Fig. 5 and Fig. 6). In both cases, the combined meat and protein yields of these species represent small dietary contributions. However, the inclusion of these resources along with nearshore fish and shellfish indicates that occupants during the late Middle and Late Periods were exploiting diverse marine and terrestrial resources. Possible explanations for increased diet breadth include longer-term habitation at Locus A associated with depressed terrestrial productivity during the late Middle Period and high population density in the Vandenberg region during the Late Period (see Glassow 1980:3-13).

The Advantages of Black Turban

In contrast to mussel exploitation and resource diversification, which may be accounted for by expectations derived from optimal foraging theory, intensive reliance on

black turban throughout the majority of site occupation requires additional explanation. Due to its small size and low meat yield, black turban is ranked below other shellfish such as mussel, abalone, and giant chiton. Black turban grows to a maximum size of 30 mm, of which the first 20 mm of growth occurs within the first six years (Ricketts et al. 1985:39). However, as Raab (1992:77) observes, "in the event of an insufficient supply of higher value shellfish, their abundance alone may recommend *Tegula* [sp.] as a food item." Black turban has the tendency to live in crevices or on the sides of small rocks and, based partly on present intertidal community structure at Purisima Point, would have been available in large quantities (Glassow 1984:9-110; Ricketts, Calvin, and Hedgpeth 1985:38).

Based on the diet breadth model, substantial reliance on black turban through time suggests that larger marine and terrestrial resources were not locally available and/or were not procured in sufficient quantities for nutritional requirements. In these circumstances, prehistoric inhabitants may have viewed black turban as an attractive resource because of its abundance, potential protein yield, and immediate availability and predictability at Purisima Point (Raab 1992:77). Furthermore, the overall contribution of black turban meat and protein yields, which is unusually high for sites in the Vandenberg region, may be explained by environment conditions constraining mussel size and abundance (see Glassow 1996).

Whether specific marine resource patches are suitable for shellfish depend on interrelated environmental characteristics such as geologic composition, shoreline topography, and intensity of wave action (Engle 1994:15; Ricketts et al. 1985:450). The underlying geology of the Vandenberg region is the Tertiary Monterey Formation, which is defined by Morgan (1993:A-4) as siliceous shale, a fine-grained sedimentary rock that is unstable and has the tendency to erode in heavy surf. Geoarchaeological analysis near Purisima Point revealed that the Monterey Shale underlying

surface sediments has been truncated considerably by heavy wave action (Morgan 1993:A-18), which would impact shellfish size and abundance in nearby rocky intertidal habitats by crushing or dislodging shellfish in the intertidal below.

Although the growth and abundance of many shellfish populations are impacted by the erosion of suitable substrata, California mussels are impacted more strongly than species such as black turban because of several behavioral characteristics. Mussels have the tendency to aggregate in dense populations in which many individuals attach their byssal threads to other mussels rather than to the substrate (Dayton 1971:358). Mussel beds that are multiple layers in thickness are much less stable as a whole than less dense populations with more byssal attachments to the rock surface. In combination with unstable geologic conditions, this behavior enables severe damage to occur to populations when storm conditions break off living surfaces, rip off mussel clusters, and/or kill off entire mussel beds (Engle 1994:19; Harger and Landenberger 1971:197).

Once mussel beds have been disrupted or destroyed and the underlying substrate is exposed, their reestablishment is a relatively slow process (Jones and Richman 1995:40). Factors influencing the rate of recovery include "disturbance patch size, disturbance season, height on the shore, angle of substratum, thickness of mussel bed, and larval recruitment" (Suchanek 1985:93). Mussel beds take at least two and a half years to reestablish themselves; however, full recovery may take between eight to thirty-five years and even longer in some circumstances (Jones and Richman 1995:40). Consequently, in regions where there are frequent storms and/or heavy wave action that disrupt mussel beds, the average size mature mussels attain and the density of mussel beds are constrained by the amount of time separating significant storm episodes.

Moreover, several physical and behavioral characteristics enhance the relative survival of black turban during storm episodes. First, black turban does not have the propensity to live on

top of another in dense populations, and each individual maintains a direct attachment to the substrate. Second, black turban has the tendency to live in more protected places in the rocky intertidal, such as in cracks or on the sides of boulders, rather than on the tops of rock formations as is the case with mussels (Glassow 1984:9-110; Ricketts, Calvin, and Hedgpeth 1985:38). Third, its small vertical size in comparison to mussels provides more stability in heavy wave conditions. Fourth, unlike mature California mussels, black turban is a mobile shellfish species that can move to more protected locations when necessary. Because of its settlement strategy, size, and mobility, black turban has a distinct advantage over California mussel with respect of surviving harsh wave action.

Heavy wave action, strong offshore winds, and winter storms occur at Purisima Point, and it is expected that local California mussel and black turban populations are impacted differentially by these factors (de Barros et al. 1994:2-1). This argument is tentatively supported by a field visit to Purisima Point by Glassow and the author in April 1997 during which modern shellfish populations were evaluated in regard to distribution and individual animal size. It was observed that mussel beds are not present in great abundance. The largest mussels measured are smaller than expected based on observations of other mussels in modern and archaeological contexts. The largest individuals measure between 60 and 90 mm in length, whereas the majority of the mussel shells are considerably smaller. In contrast, substantial numbers of black turban occupy rock outcroppings around the point and tended to be large, between 20 and 30 mm on average. If current environmental conditions are even remotely reflective of the prehistoric situation, then the continued dietary importance of black turban at CA-SBA-225 may be accounted for by distinct environmental characteristics and animal behavioral traits rather than solely by resource intensification.

Regional Comparisons

To evaluate this argument further, California mussel and black turban proportions at excavated Vandenberg sites were compared based on the general regions in which prehistoric groups probably collected shellfish. It was assumed that sites around Shuman Canyon and along the coast close to and south of Point Sal represent shellfish collection activities in rocky intertidal areas near and at Point Sal. Sites near and in the San Antonio Creek drainage were considered along with sites at Purisima Point and in the immediate vicinity, and sites near Honda Canyon and around Point Arguello and nearby projecting headlands were evaluated together. Early through Late Period sites located near Point Sal and Point Arguello (CA-SBA-210, -530, -551, -552, -663, and -1179) are heavily dominated by California mussel (80%-98% based on weight, with the majority being over 95%) (Glassow 1984:9-130a; Glassow 1996:125).

In contrast, sites at Purisima Point and along the San Antonio Creek drainage (CA-SBA-225, -699, -706, -980, and -1070) have yielded relatively high black turban proportions (see Glassow 1984:9-130a; Glassow and Gregory 1998). CA-SBA-699 is located immediately southwest of CA-SBA-225 and is dated to the late Middle Period based on two radiocarbon dates, 1510 ± 60 RCYBP and 1470 ± 70 RCYBP (Glassow and Gregory 1998). Faunal constituents indicate that inhabitants focused primarily upon gathering California mussel and black turban, with both contributing roughly equally based on overall weight, with variation between levels (ranging between 35%-65% and 25%-50%, respectively) (Glassow and Gregory 1998). The observed shellfish species ratios and individual sizes are interpreted as reflecting intensified mussel exploitation. Glassow and Gregory (1998) propose that people focused on marine resource patches and individual high-ranked species because of depressed terrestrial conditions, namely drought, in combination with increased population density beginning in the late Middle Period.

Sites with higher proportions of black turban are also located inland, although to a lesser degree than those around Purisima Point. As discussed previously, the San Antonio Creek drainage provided a convenient access route from the interior to the coastline north of Purisima Point. CA-SBA-706, -980, and -1070 are situated about three km inland along the drainage, and date to 660 ± 70 RCYBP, 600 ± 50 RCYBP, and 730 ± 50 RCYBP, respectively. Chambers (1984:10-17) designates all three of these Late Period sites as seasonal residential bases based on the frequency and diversity of artifacts and faunal remains. Overall, black turban contributed as much to the diet as California mussel (31.3, 40.5, and 48.35% of the shellfish weight, respectively).

In addition, CA-SBA-2696 is located about 15 km inland along the San Antonio Creek drainage, which was occupied as a seasonal residential base during the Middle Period. Despite associated transportation costs, the site has yielded higher black turban proportions than sites situated on the coast (Colten et al. 1997:7-7). Unit 2 represents the highest black turban contribution (14% based on weight) and dates to the earlier half of the Middle Period based on three radiocarbon dates ranging between $2,030 \pm 70$ and $2,340 \pm 150$ RCYBP (Colten et al. 1997:5-3). Unit 3 dates to earlier in the Middle Period, with three radiocarbon dates clustered between 2560 ± 60 and $2,645 \pm 70$ RCYBP. Although black turban contributes much less to the diet (7% of the shellfish weight), the proportion is still higher than that observed in most of the dense middens around Point Arguello and Point Sal. Therefore, it is argued that groups gathering shellfish near Purisima Point relied on black turban regardless of temporal affiliation, which appears to be more indicative of the natural abundance of local black turban populations than resource intensification.

CONCLUSIONS

While it is argued that the nature of CA-SBA-225 resource exploitation was influenced

directly by environmental conditions impacting relative species abundance, similarities between sites along the Vandenberg coastline support the notion that prehistoric inhabitants may have been responding to population-resource imbalances during the late Middle and Late Periods. Increases in fish exploitation, black turban procurement, and resource diversity after the early Middle Period represent shifts in subsistence patterning reflective of intensified exploitation of rocky intertidal and nearshore habitats. Given the lack of abundant terrestrial resources in the vicinity of Purisima Point, high-ranked marine resource patches such as the rocky intertidal provided the majority of dietary constituents for local residents. Greater reliance on fishing and black turban collecting at the beginning of the Late Period are trends that have been identified in many sites along the Vandenberg coast, including CA-SBA-210, -551, and -670 (Glassow 1996:135).

However, before the impact of drought conditions, population growth, and other cultural variables on Vandenberg subsistence strategies may be evaluated, relative resource productivity must be considered within the particular ecological context of the site or collections being analyzed (Rudolph 1985:131-132). By comparing species proportions at CA-SBA-225 to other Vandenberg sites, it becomes evident that the presence of black turban as a significant dietary component may not be accounted for solely by arguments regarding resource intensification. California mussel beds in the Purisima Point region may have been less productive than commonly assumed because of local environmental conditions constraining mussel size and abundance. Due in part to the absence of high-ranked resources, it appears that black turban served as an abundant and reliable source of protein throughout human use of Purisima Point resources, regardless of temporal variations in dietary contributions, subsistence strategies, or resource productivity.

Nonetheless, while the presence of variables constraining mussel populations has been postulated for Purisima Point, there are shortcom-

ings that must be accounted for before developing a general model of variability in California mussel productivity. The specific factors that potentially contribute to limited mussel size and abundance at Purisima Point have not been documented beyond inferred causal relationships. To answer this question, nearby rocky intertidal habitats need to be documented formally with regard to the size, abundance, and distribution of California mussel and black turban populations. Environmental characteristics such as general location, size and orientation of boulders, and direction and intensity of wave exposure also should be recorded. Integral to the proposed research is the assumption that current environmental conditions at Purisima Point are relatively similar to that experienced over the past 3,000 years.

The relationship between environmental factors and mussel size and abundance should be evaluated, and then modern shellfish distributions compared to species proportions in archaeological deposits in nearby locales. By analyzing the range of archaeological sites and rocky intertidal habitats along the Vandenberg coastline, the nature and significance of the specific variables involved and their interactions with shellfish populations may be determined. The ultimate product of such research would be a general model of rocky intertidal shellfish exploitation that incorporates relevant environmental characteristics, which would be considered prior to cultural explanations when attempting to account for trends in archaeological faunal assemblages.

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Table 1
MEAT AND PROTEIN MULTIPLIERS FOR FAUNAL REMAINS¹

<u>Faunal Class: genus/species</u>	<u>Meat Yield</u>	<u>Protein</u>
<u>Mytilus californianus</u>	x .298	x .144
<u>Tegula funebris</u>	x .365	x .203
Birds	x 15.0	x .210
Fish	x 27.7	x .185
Sea mammals (pinnipeds)	x 24.2	x .100
Terrestrial mammals	x 10.0	x .210

¹ Adapted from Erlandson 1994:59

Table 2
HABITATS OF THE MAJOR INVERTEBRATE SPECIES REPRESENTED IN MIDDEN DEPOSITS AT CA-SBA-225¹

<u>Species</u>	<u>Habitat</u>
Black Abalone (<i>Haliotis cracherodii</i>)	Middle or lower intertidal on the undersides of rocks in surf-swept areas of the outer coast (McClellan 1978; Ricketts et al. 1985).
Red Abalone (<i>Haliotis rufescens</i>)	On undersides of rock ledges in the intertidal zone (Ricketts et al. 1985).
Limpet (<i>Acmaea</i> sp.)	Rocky shores; middle and low intertidal zones (Ricketts et al. 1985).
Brown Turban (<i>Tegula brunnea</i>)	In clusters in crevices and on the sides of boulders in the middle intertidal zone (Ricketts et al. 1985).
Black Turban (<i>Tegula funebris</i>)	In clusters in crevices and on the sides of boulders in the upper intertidal zone (Ricketts et al. 1985).
California Mussel (<i>Mytilus californianus</i>)	In masses in the upper intertidal zone on rocks exposed directly to surf (McClellan 1978; Ricketts et al. 1985).
Platform Mussel (<i>Septifer bifurcatus</i>)	Low intertidal zone beneath rocks on the outer coast (McClellan 1978; Ricketts et al. 1985).
Giant Chiton (<i>Cryptochiton stelleri</i>)	On rocks and intertidal pools on the outer coast (Ricketts et al. 1985).
Littleneck Clam (<i>Protothaca staminea</i>)	In packed mud or on gravel mixed with sand in bays (McClellan 1978; Ricketts et al. 1985).
Goose Barnacle (<i>Pollicipes polymerus</i>)	On exposed rocks along the open coast in the upper two-thirds of the intertidal (McClellan 1978).
Acom Barnacle (<i>Balanus</i> sp.)	On all rocky shores and pieces of rock in high and middle intertidal zones; on <i>Haliotis</i> sp. and <i>Mytilus</i> sp. Shells (Ricketts et al. 1985).
Crab (Family Decapoda)	Occur in a wide range of habitats including the low intertidal zones of rocky shores, and sand and mud flats (Ricketts et al. 1985).
Sea Urchin (<i>Strongylocentrotus</i> sp.)	On rocky shores and on hard surfaces in the low intertidal and subtidal zones (Ricketts et al. 1985).

¹ Adapted from de Barros et al. 1994:E-13