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#### **Authors**

Codding, Brian F  
Jones, Terry L

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# History and Behavioral Ecology during the Middle-Late Transition on the Central California Coast: Findings from the Coon Creek Site (CA-SLO-9), San Luis Obispo County

**BRIAN F. CODDING**

Department of Anthropology, Stanford University  
450 Serra Mall, Building 50, Stanford, CA 94305-2034

**TERRY L. JONES**

Department of Social Sciences, California Polytechnic State University  
1 Grand Avenue, San Luis Obispo, CA 93407-0329

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*As the focus of intense debate concerning the possible effects of environmental variability on Native populations, the Middle-Late Transition (MLT) is an exceptionally important period in California prehistory. Recent salvage excavations at the Coon Creek Site (CA-SLO-9) on the San Luis Obispo County coast revealed a single, highly discrete component dating cal A.D. 900–1300 which is largely synchronous with most definitions of the MLT. With a recovery volume of 23.2 m<sup>3</sup>, this is the first component to yield artifact and faunal assemblages substantive enough to establish the culture historical markers for this period in this region, and to define corresponding subsistence and technological patterns. Artifacts from a proposed Coon Creek Phase show a blend of Middle and Late Period cultural traits (with a heavier contribution from the former) as well as some unique MLT diagnostics. Faunal remains suggest a landscape in which foragers exploited robust invertebrate populations, cormorants, sea otters, and rabbits, and “de-intensified” their fishing practices, all of which imply an organization of labor different from that of previous periods.*

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The Hunting People, as a whole, was [sic] never driven from this locality, but, after holding it undisturbed for several centuries, a portion of them, at least amalgamated with the [Canaliño], who were in full possession of the entire region as early as the year 1000 AD. Several of the former great village sites of the second culture period appear, in the course of time, to have been totally abandoned, as they yield no evidence of ever having harbored others than this one people... [Rogers 1929:366].

With this description in one of the first scientific treatments of California culture history, David Banks Rogers recognized the period commonly referred to today as the Middle-Late Transition as a time of highly visible culture change, marked by, among other things, widespread site abandonment. Rogers interpreted variations in material culture between what he called the “Hunting People” (also referred to as the “Hunting Culture,” or the second of three cultures identified in the

Santa Barbara Channel) and the “Canaliño” (or “third culture”) as evidence of the immigration of new people, the possible introduction of disease, and the blending of two previously distinct cultural complexes. While few if any archaeologists who have followed Rogers in the Santa Barbara Channel area accept the idea of a recent immigration of Chumashan-speaking peoples, other aspects of Rogers’ seminal account of the Middle-Late Transition have proven remarkably insightful and empirically valid, including his estimate for the chronology of these changes at ca. A.D. 1000.

Since Rogers’ time, the chronology of the Middle-Late Transition (MLT) has been further refined and has also become the focus of intense debate concerning emergent socio-political complexity and its possible relationship to environmental variability (Arnold 1992a, 1992b, 1995, 1997, 2001; Arnold and Munns 1994; Arnold et al. 1997; Colten and Arnold 1998; Erlandson and Rick

2002; Gamble 2002, 2005; Gamble and Russell 2002; Johnson 2004; Jones and Kennett 1999; Jones et al. 1999; Kennett 2005; Kennett and Conlee 2002; Kennett and Kennett 2000; Raab and Bradford 1997; Raab and Larson 1997). While no clear consensus has emerged from this debate, a number of independent studies indicate that the period between cal A.D. 800 and 1350, known as the Medieval Climatic Anomaly (MCA), was marked by unusually prolonged droughts and low terrestrial productivity throughout much of western North America (Graumlich 1993; LaMarche 1974; Stine 1994). At the same time, sea surface temperatures off the southern California coast were cool and marine productivity was relatively high, especially between cal A.D. 950 and 1550 (Kennett 2005; Kennett and Kennett 2000; for reviews of human reaction to large scale climatic conditions, see deMenocal 2001). While it is certainly inappropriate to assume that these broad-scale environmental trends had widespread and uniform effects on all local human populations in western North America, research in central California has produced fairly compelling evidence for settlement disruption during the Middle-Late Transition (Jones et al. 1999, 2007; Jones and Ferneau 2002a) akin to the pattern first described by Rogers in 1929. While Jones et al. (1999) and others have attributed this disruption to demographic problems associated with drought, efforts to further understand human responses to apparent environmental problems during the MCA have been hampered on the central coast by a dearth of clearly delineated MLT components with sufficient faunal and artifactual materials to distinguish dietary and technological patterns. In other areas, like the Santa Barbara Channel, variability in subsistence residues has been found to complement climatological findings, showing evidence for a high reliance on marine resources during the time of the Medieval droughts (Erlandson and Gerber 1993; Kennett 2005). Osteological collections from the Santa Barbara and other areas have also provided evidence for increased violence (Jones and Schwitalla 2007; Lambert 1994), subsistence change (Pilloud 2006), and health problems (Jones and Schwitalla 2007; Wiess 2002). On the central coast, faunal assemblages representing the Middle-Late Transition have been either absent or too small to allow an adequate assessment of subsistence patterns (e.g., CA-SBA-935 [Harro et al. 2000]; CA-MNT-1233 [Jones 2003]) or component resolution has been poor.

Recent salvage excavations at CA-SLO-9, the Coon Creek site, on the coast of San Luis Obispo County, revealed a highly discrete component dating cal A.D. 900–1300 (Coddling and Jones 2006), effectively spanning most of the Medieval Climatic Anomaly. This component provides an excellent opportunity to refine local culture history and examine subsistence practices during the Middle-Late Transition, in order to further evaluate the Medieval drought hypothesis. In this paper we use the findings from this component to propose a Coon Creek Phase within the regional cultural sequence. Faunal residues and the technological implications of the artifacts used to define this phase are then used to evaluate subsistence practices and the overall adaptation represented at CA-SLO-9, with particular emphasis on the possible effects of climatic variation related to drought. Interpretations are viewed through the lens of human behavioral ecology.

### THE COON CREEK SITE

First recorded in the 1960s, CA-SLO-9 is a shell-rich coastal midden located near the mouth of Coon Creek in Montaña de Oro State Park, San Luis Obispo County (Fig. 1). It is situated on a coastal terrace at an elevation of about 40 feet above sea level, and covers an area of approximately 4000 m<sup>2</sup>. Historically, the site area was impacted by cattle grazing, and it is currently subject to severe erosion caused by undercutting of the cliff by the Pacific Ocean. The midden is underlain by alluvial and colluvial sediments derived from low hills 0.5 km. to the east.

#### *Field Methods*

Excavations were initiated at CA-SLO-9 in the spring of 2004 to salvage some of the western edge of the deposit before it was lost to erosion. The investigations were facilitated by a cooperative agreement between California Polytechnic State University (Cal Poly) and the California Department of Parks and Recreation (DPR), and were conducted as two Cal Poly archaeological field methods classes. The 2004 class was taught by Terry Jones and the 2005 class was taught by Nathan Stevens. Excavation was restricted to the severely eroding portion of the site, where a series of units was excavated in 10 cm. increments. A total of 23.2 m<sup>3</sup> of deposit was

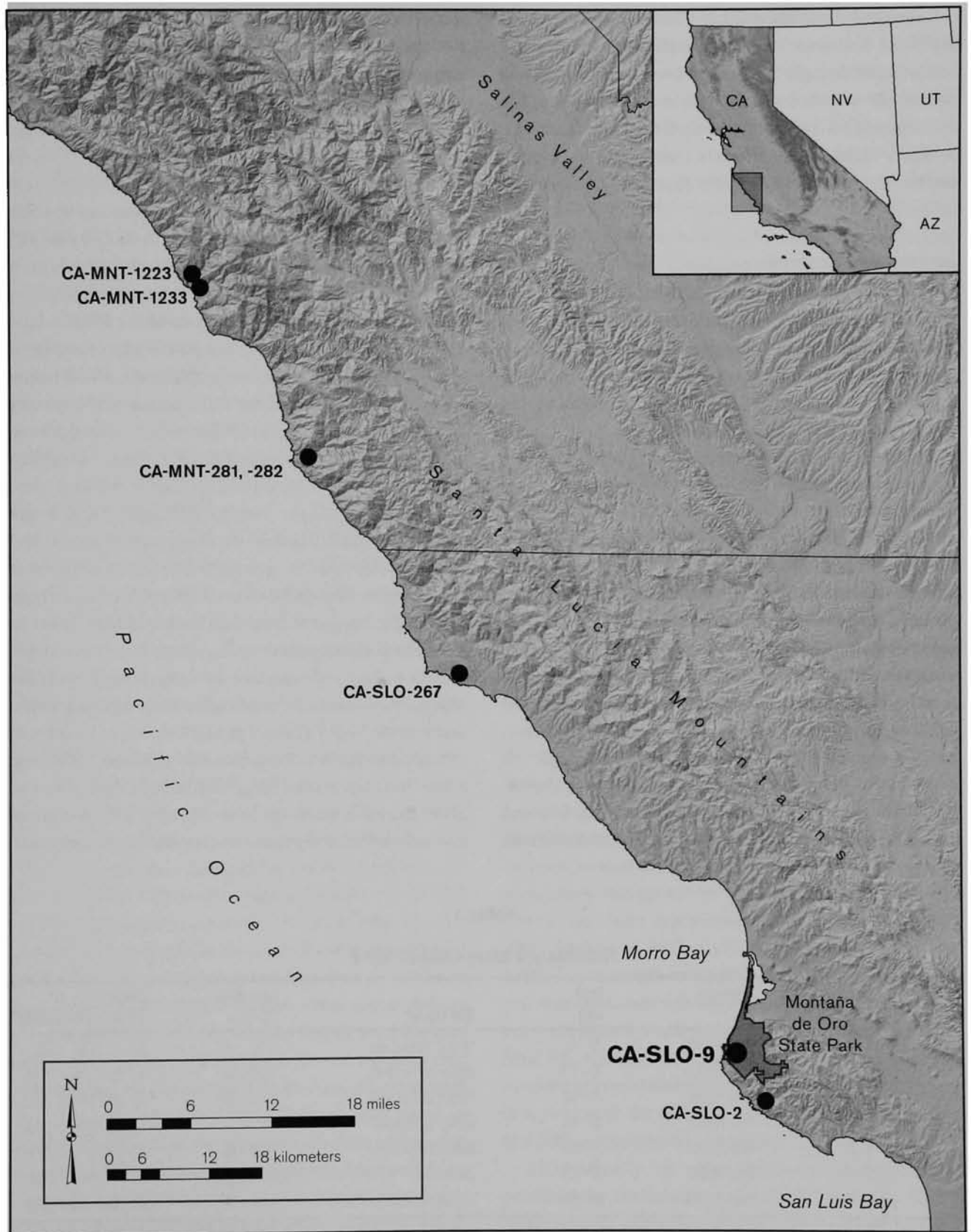


Figure 1. Location of CA-SLO-9 and other important sites mentioned in text.

recovered, of which the majority (20.4 m<sup>3</sup>) was processed dry in the field with 3 mm. (1/8 inch) mesh. Two column samples and a single 1 x 1 m. unit were also excavated, processed with water, and sorted in the laboratory. The columns and 1 x 1 m. unit were used to obtain controlled samples of microconstituents that might have been under-represented in sediments that were dry-screened in the field.

### Structure and Chronology

The deposit had an average depth of 80 cm. and was fairly homogeneous. It was marked by a single very dark grayish brown (10 YR 3/2) stratum. No features of any type were identified. As is common on the central coast, evidence of rodent activity in the form of krotavina and rodent bones was fairly common. In some instances, excavation was extended to a depth of 120 cm. to recover materials from rodent burrows that were present below the main deposit.

Seven radiocarbon dates obtained from depths between 10 and 90 cm. show that the portion of the deposit investigated in 2004 and 2005 represented an occupation between cal. A.D. 920 and A.D. 1290 (one sigma probability) (Table 1), which is nearly synchronous with the Middle-Late Transition Period (ca. A.D. 1000–A.D. 1250) as defined previously for the central coast region (Jones 1993; Jones et al. 2007). The dates show no signs of superposition, which is consistent with deposits that have been impacted by rodent disturbance. The date intercepts range between cal A.D. 990 and A.D. 1240 and bracket the Middle-Late Transition almost

perfectly. The dates indicate that this relatively shallow, homogeneous deposit essentially represents a single component marking the Middle-Late Transition and most of the Medieval Climatic Anomaly.

## THE COON CREEK PHASE

With such a discrete, single component occupation indicated by the radiocarbon results, CA-SLO-9 provides an exceptional opportunity to refine local culture history. Here we propose a Coon Creek Phase (*sensu* Willey and Phillips 1958:22) representative of the Middle-Late Transition on the San Luis Obispo County coast, based on the CA-SLO-9 artifact assemblage described below. The chronological sequence for this area was originally established by Greenwood (1972) on the basis of evidence from Diablo Canyon, 8 km. south of Coon Creek, where she identified local variants of the three archaeological cultures identified previously by Rogers (1929) in the Santa Barbara Channel—Millingstone, Hunting, and Canalño. The value and accuracy of Greenwood's seminal contribution cannot be overestimated, particularly in light of the limited radiocarbon data available to her in 1972. Since Greenwood's work, efforts have been made to refine the local sequence by integrating it with the *Olivella* bead-based horizons identified originally in the Sacramento Valley (Lillard et al. 1939) and subsequently extended to the San Francisco Bay (Elsasser 1978) and Santa Barbara areas (King 1981, 1990). More recently, attempts have been made to develop a fine-grained and fully integrated culture history for the central coast,

Table 1

### RADIOCARBON DATES FROM CA-SLO-9

Unit	Specimen No.	Laboratory No.	Depth (cm)	Shell species <sup>a</sup>	Conventional <sup>14</sup> C Age	Calibrated age B.C. 1 sigma (ΔR = 290 + 35) <sup>b</sup>
1	1-2a	Beta-199103	80-90	<i>Mytilus californianus</i>	1,720 + 40	AD 920 (990)-1030
4	4-19b	Beta-198050	10-20a	<i>Mytilus californianus</i>	1,510 + 80	AD 1074 (1203)-1282
4	4-4a	Beta-199104	30-40	<i>Mytilus californianus</i>	1,610 + 40	AD 1030 (1060)-1160
4	4-5a	Beta-199105	30-40	<i>Mytilus californianus</i>	1,470 + 40	AD 1190 (1240)-1290
4	4-68b	Beta-198051	70-80	<i>Mytilus californianus</i>	1,570 + 60	AD 1043 (1126)-1214
5	5-12b	Beta-198052	10-20a	<i>Balanus</i> sp.	1,670 + 80	AD 952 (1027)-1109
5	5-59b	Beta-198053	80-90	<i>Mytilus californianus</i>	1,510 + 80	AD 1074 (1203)-1282

<sup>a</sup>All samples were single shells

<sup>b</sup>Calibrated following Ingram and Southon (1993) using CALIB version 4.3 (Stuiver and Reimer 2000).

defining it as the region encompassed by Monterey, Santa Cruz, San Luis Obispo, and San Benito counties. Preliminary observations by Dietz et al. (1988), Jones and Hylkema (1988), and Jones et al. (1989), eventually culminated in an integrated regional sequence proposed by Jones (1993) and subsequently updated by Jones et al. (2007).

### *Artifacts*

Based on findings from CA-MNT-1233 and CA-MNT-281, Jones (1993:25) proposed the Highland Phase (A.D. 1000–1200) for the Middle-Late Transition Period in the Big Sur Region. Beads recovered from CA-MNT-1233 included Barrels (B3), Tiny Saucers (G1), Regular Saucers (G2), Large End-ground (B2c), and Cupped (K1) types (see Bennyhoff 1994:74; Bennyhoff and Hughes 1987; Elsasser 1978; Jones 1993; Milliken and Bennyhoff 1993). Types B3, G1, and G2 are all consistent with King's (1981, 1990) Middle Period, while types B2c and K1 are early Late Period types. The absence of the Split-punched (Class D) and Thin Rectangle (Class M) types that mark the Middle-Late Transition elsewhere in central California was notable. These types apparently do not occur south of Big Sur on the coast (Hughes and Milliken 2007) or west of the Central Valley, and this absence demonstrates the need to establish local phase sequences. As with the Highland Phase, beads from the Coon Creek site show an overlap of Middle Period and Late Period types, and also lack Class D and Class M examples. While the bead assemblage is small owing to a lack of grave lots, it is typologically cohesive and consistent with other conceptualizations of the Middle-Late Transition in this region. Specifically, the CA-SLO-9 assemblage consisted primarily of limpet rings (N=45) and Normal Saucers (G2; N=16) with two Cupped beads (K1) and single examples of the Tiny Saucer (G1) and steatite disk (Table 2, Fig. 2). Limpet rings are temporally non-diagnostic, as are Tiny Saucers, while Callus Cupped beads and steatite disks are Late Period markers that were absent from important Middle Period components in the region (e.g., CA-SLO-267; Jones and Ferneau 2002b). While it would be imprudent to draw substantive conclusions from such a small sample, the bead collection is consistent with the Middle-Late Transition being a blend of Middle and Late Period markers, albeit dominated by the former (G2 Saucers).

Contracting-stemmed and small leaf-shaped types were the most abundant projectile points at CA-SLO-9 (Table 2, Fig. 2). Contracting-stemmed points are most frequently recovered from Middle Period contexts (e.g., CA-MNT-521, CA-MNT-282, CA-SLO-175, CA-SLO-179, and CA-SLO-267; see Jones 2003; Jones and Ferneau 2002b; Jones and Waugh 1995) on the central coast, but are also common in Early Period contexts (e.g., CA-MNT-391 and CA-MNT-1228; see Jones 1993, 2003). They were part of the Middle-Late Transition expression identified on the Big Sur coast (Highland Phase) at CA-MNT-1233 (Jones 2003). While the contracting-stemmed type is temporally ubiquitous, findings from CA-MNT-1233 show that it began to co-occur with smaller leaf-shaped points during the MLT in the central coast region. In the Santa Barbara Channel area, small leaf-shaped points, commonly interpreted as early arrow points, began to appear slightly earlier, ca. cal A.D. 500–600 (Lambert 1994). At CA-SLO-9, small leaf-shaped points were the second most abundant type and appear to be diagnostic markers of the Middle-Late Transition (e.g., CA-SLO-179; see Jones and Ferneau 2002b). While these small pointed bifaces could have served as tips for harpoons or atlatl darts, the traditional interpretation of the small leaf-shaped type as an arrow point remains most probable. Two other point types were each represented by single examples: the double-side notched and large side-notched. The recovery of the former seems to confirm the type as a Middle-Late Transition marker, as suggested by findings from CA-SLO-175 (Jones and Waugh 1995) and CA-SLO-179 (Jones and Ferneau 2002b). The latter, however, is most common in early-middle Holocene sites as originally recognized by Greenwood (1972) at Diablo Canyon and later confirmed at Cross Creek (Fitzgerald 2000; Jones et al. 2002) and CA-SBA-530 (Lebow et al. 2007). The large side-notched example is the only artifact that is inconsistent with the rest of the chronometric data from CA-SLO-9, which indicate an occupation during the MLT. The point probably represents either the presence of an older ephemeral occupational component somewhere in a portion of the site that was not investigated in 2004 and 2005, or prehistoric scavenging.

Expediently manufactured notched stones were particularly abundant at CA-SLO-9 (N=15). These items exhibit either unifacial or bifacial notches and were apparently wrapped with cordage, as indicated by

Table 2

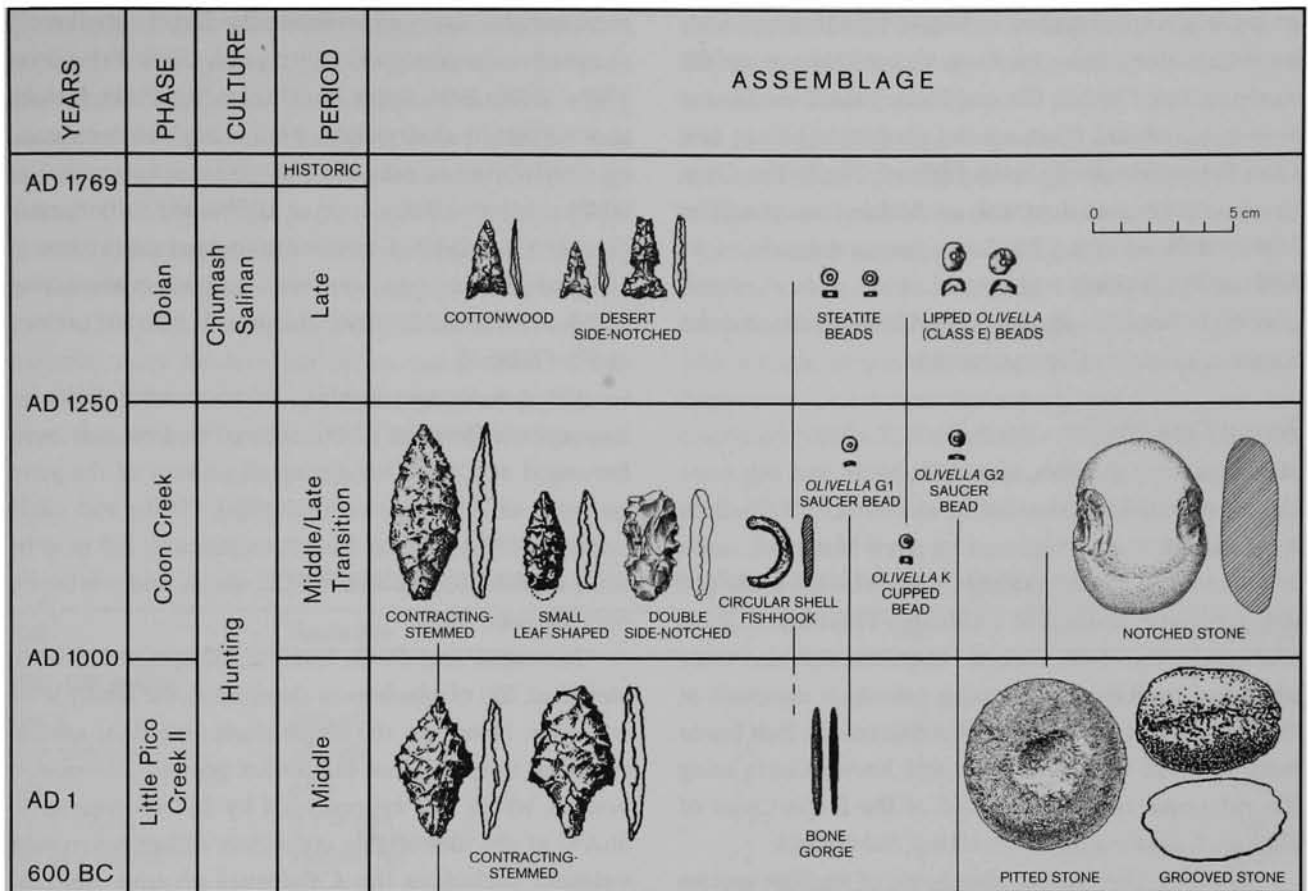
## COMPARISON OF CA-SLO-9 WITH KEY MIDDLE, MIDDLE-LATE, AND LATE PERIOD COMPONENTS IN THE CENTRAL COAST REGION

Artifact	CA-SLO-267 (Middle Period Little Pico II Phase)	CA-MNT-282 (Middle Period Willow Creek Phase)	CA-SLO-9 (MLT Coon Creek Phase)	CA-MNT-1233 (MLT Highland Phase)	CA-MNT-1223 (Late Period Dolan Phase)
<i>Olivella</i> B2 bead	4	0	0	1	0
<i>Olivella</i> B3 bead	2	0	0	2	1
<i>Olivella</i> E1 bead	0	0	0	0	11
<i>Olivella</i> E2 bead	0	0	0	0	6
<i>Olivella</i> K1 bead	1	0	2	1	5
<i>Olivella</i> G1 bead	2	0	1	6	0
<i>Olivella</i> G2 bead	3	0	16	3	1
<i>Olivella</i> G5 bead	1	0	0	0	0
Limpet ring	3	0	45	0	0
Steatite disk	0	0	1	0	8
Circular shell fishhooks	1	0	9	5	1
Contracting-stemmed point	27	20	11	5	0
Square-stemmed point	1	0	0	1	0
Small leaf-shaped point	1	0	7	2	0
Double Side-notched point	0	0	1	0	0
Large concave base point	2	1	0	0	0
Large Side-notched point	1	0	1	0	0
Cottonwood point	0	0	0	0	3
Desert Side-notched point	1	0	0	0	13
Pestles	15	2	0	2	0
Bowl mortar	2	0	0	0	1
Hopper mortar	0	0	0	1	0
Handstone	0	0	0	1	1
Milling slab	0	0	0	1	0
Grooved stone	11	6	0	0	0
Notched stone	0	0	15	0	0
Pitted stone	258	1	1	0	0
Steatite pendant	9	0	0	0	1
Bone awl	3	0	2	3	20
Bone gorge	12	0	1 <sup>a</sup>	0	0
<b>Total</b>	<b>360</b>	<b>30</b>	<b>113</b>	<b>34</b>	<b>72</b>

<sup>a</sup>Tentative classification

asphaltum staining on two of the specimens. Their high frequency supports the notion that they are Middle-Late Transition markers on the central coast, as first noted by Pohorecky (1976) at Willow Creek, where a basal Middle Period component (CA-MNT-282) produced only grooved stones and the upper MLT midden (CA-MNT-281) produced only notched stones. This pattern is further supported in the San Luis Obispo area by the absence of notched stones from well-sampled

and well-documented Middle Period components (e.g., CA-SLO-267; see Jones and Ferneau 2002b), which also produced only grooved stones. The co-occurrence of notched stones with circular shell fishhooks at CA-SLO-9 and also at Diablo Canyon (CA-SLO-2) suggests that notched stones were used as line weights in hook and line fishing. This is further supported by the near dearth of both hooks (N=1) and notched stones (N=0) from the Middle Period component at CA-SLO-267.



**Figure 2. Assemblage summary for the proposed Coon Creek Phase (MLT) relative to the Middle Period Assemblage from CA-SLO-267 (Little Pico Creek II Phase) and the Late Period (Dolan Phase).  
Artifact drawings by Rusty van Rossmann and Jerry Doty.**

While the single-piece circular shell fishhook certainly has greater antiquity in other regions of California (see Rick et al. 2002), the large number found at Coon Creek suggests that circular hooks did not dominate fishing technology along the San Luis Obispo coast until the Middle-Late Transition. Nine specimens were recovered from the Coon Creek site, while only a single specimen was recovered from the substantial Middle Period component at CA-SLO-267. Circular hooks were also abundant in the MLT component at CA-MNT-1233 on the Big Sur coast.

Bone tools found at Coon Creek include awls and one bipointed object. While the awls and bipointed gorges are common for certain time periods on the central coast (see Jones 2003), the bipointed object from CA-SLO-9 is more asymmetrical than most gorges and may have served one of several alternative functions, ranging from fishing equipment to nose sticks (Gifford 1940:176). It also bears some similarity to elements of King's

(1981) compound bone fishhooks and bone harpoon barbs, although it lacks the definitive distinguishing characteristics to be positively classified as such. Even if this object is classified as a gorge, the low frequency of gorges at CA-SLO-9 stands in contrast with Middle Period assemblages (e.g., from CA-SLO-267) where they were the dominant artifact associated with line fishing.

In summary, findings from the Coon Creek Site indicate that the Middle-Late Transition in San Luis Obispo County is marked by an overlap of artifact types from the Middle and Late periods, as Rogers (1929) originally suggested for the Santa Barbara Channel. The proposed Coon Creek Phase is marked by contracting-stemmed projectile points and G2 *Olivella* saucer beads as holdovers from the Middle Period, and circular shell fishhooks, notched stones, and small leaf-shaped projectile points that originate during the MLT or perhaps slightly earlier during the late Middle Period. Grooved stones and bipointed bone



gorges which are abundant in Middle Period components are largely absent from the Coon Creek Phase, as are the common Late Period (Dolan Phase) markers: Desert Side-notched and Cottonwood projectile points, and Class E Lipped *Olivella* beads (Table 2, Fig. 2). The Coon Creek data are consistent with the Middle-Late Transition Highland Phase in the Big Sur region as defined at CA-MNT-1233, and further help to elucidate general cultural continuity between the San Luis Obispo coast and the southern Monterey County coastline.

### Faunal Remains

Remains from shellfish, mammals, birds, and fish were the most abundant constituents at CA-SLO-9. Shellfish were identified and measured by April Matthews, Justin Housman, and Brian Codding using reference shells and size templates housed at California Polytechnic State University, San Luis Obispo. Mammal remains were identified by Judy Porcasi using reference materials at the UCLA Cotsen Institute of Archaeology. Fish bones were analyzed by Ken Gobalet and Jereme Gaeta using the reference collection housed at the Department of Biology, California State University, Bakersfield.

**Shellfish.** The relative abundance of shellfish species was determined by analyzing materials from two spatially segregated 20 cm. x 20 cm. column samples excavated in arbitrary 10 cm. levels. All shell retained in 3 mm. mesh wet-screens was identified, weighed, and converted into

meat weights using experimentally-derived shell:meat conversion factors (see Dietz et al. 1988; Erlandson 1988a, 1988b; 1994; Jones 2003; Koloseike 1969). Results showed that by shell weight, the midden was dominated by California sea mussels (*Mytilus californianus*) at 60.4%, abalone (*Haliotis* sp.) at 12.9%, and turban snails (*Tegula* sp.) at 15.1%. Conversions to meat weights reveal a slightly different pattern, with mussels representing 32.7% of the available flesh; abalones 31.9%; and urchins 11.8% (Table 3).

Oxygen isotope analysis of 13 mussel shells by Kennett and Bottman (2006) showed that mussels were harvested at CA-SLO-9 during all seasons of the year, but with an emphasis on the spring (54%) and early summer (23%) months. Late summer/early fall months were represented by 15% of the shells, and winter by only 8% (one shell).

**Mammals and Birds.** Some 2,332 specimens were identified, 500 of which were classified to the family level or better. However, the single most abundant animal identified to species was the pocket gopher (*Thomomys bottae*), which was represented by 282 specimens or 56.4% of the identifiable collection. Other burrowing animals, including the California ground squirrel (*Spermophilus beecheyi*), California vole (*Microtus californicus*), southern grasshopper mouse (*Onychomys torridus*), desert pocket mouse (*Chaetodipus penicillatus*), pocket mouse (*Perognathus* sp.), white footed mouse

**Table 3**

#### SUMMARY OF SHELLFISH REMAINS FROM CA-SLO-9

Group	Taxon	Total Shell Weight (g) <sup>a</sup>	% Shell Weight (g)	Total Meat Weight (g) <sup>b</sup>	% Meat Weight (g)
Mussels	<i>Mytilus californianus</i>	1,309.07	60.39	390.10	32.68
Abalones	<i>Haliotis</i> spp.	2,79.61	12.90	381.11	31.92
Urchins	<i>Strongylocentrotus purpuratus</i>	60.07	2.77	140.74	11.79
Barnacles	<i>Balanus</i> spp.	105.91	4.89	100.83	8.45
Turban snails	<i>Tegula</i> spp.	326.65	15.07	81.01	6.79
Chiton		43.91	2.03	50.89	4.26
Limpets	<i>Collisella</i> spp.	17.83	0.82	27.07	2.27
Crabs		21.28	0.98	20.26	1.70
Clams		3.50	0.16	1.84	0.15
<b>Total</b>		<b>2,167.83</b>	<b>100.00</b>	<b>1,193.85</b>	<b>100.00</b>

<sup>a</sup>Quantified from two column samples; total recovery volume = 0.064 m<sup>3</sup>; all residues retained in 3 mm mesh, water-processed.

<sup>b</sup>Meat weight conversions made following Erlandson (1988a), Koloseike (1969), Dietz et al. (1988), Jones and Haney (1992), and Jones and Ferneau (2002b).

(*Peromyscus* sp.), mole (*Scapanus latimanus*), pocket gopher (*Thomomys bottae*), wood rat (*Neotoma fuscipes*), and southern alligator lizard (*Elgaria multicarinata*), accounted for 9.9% of the collection. In total, 71.6% of the elements identifiable to the family level represent animals that live at least part of their life in holes in the ground, and are most likely intrusive. While some fraction of the burrowing animals may have been part of the prehistoric diet, it is equally clear that some, if not the majority, were modern intrusions, and there is no way to distinguish modern/recent specimens from prehistoric ones. A specimen from a cow (*Bos taurus*) that was

collected from the surface was also obviously modern. These intrusive/modern specimens, and the 16 additional specimens identified only to the family level (fur seals and sea lions [*Otariidae*], fur seals [*Arctocephalinae*], and swans/ducks/geese [*Anatidae*]), were removed from further consideration in order to focus only on non-intrusive taxa identified to the genus level or better. The resulting sample includes 125 specimens that were considered economically significant (Table 4). This collection was dominated by rabbits (*Sylvilagus audubonii*, *Sylvilagus bachman*, and *Sylvilagus* sp. combined; NISP=37, 29.6%; MNI=29, 27.3%), cormorants

Table 4

ECONOMICALLY SIGNIFICANT BIRD AND MAMMAL REMAINS FROM CA-SLO-9

Taxon	Common Name	NISP	% NISP	MNI	% MNI	Bone Weight (g)
<b>TERRESTRIAL MAMMALS</b>						
<i>Canis</i> sp.	Dog/Coyote	14	11.2	12	11.3	6.92
<i>Lepus californicus</i>	Jack rabbit	1	0.8	1	0.9	0.20
<i>Lynx rufus</i>	Bobcat	1	0.8	1	0.9	0.49
<i>Mephitis mephitis</i>	Stripped skunk	1	0.8	1	0.9	0.30
<i>Odocoileus hemionus</i>	Black-tailed deer	6	4.8	3	2.8	2.92
<i>Procyon lotor</i>	Raccoon	2	1.6	2	1.9	0.23
<i>Sylvilagus audubonii</i>	Cottontail rabbit	12	9.6	10	9.4	1.70
<i>Sylvilagus bachmani</i>	Brush rabbit	3	2.4	2	1.9	0.61
<i>Sylvilagus</i> sp.	Rabbit	22	17.6	17	16.0	1.95
	Subtotal	62	49.6	49	46.2	15.32
<b>MARINE MAMMALS</b>						
<i>Callorhinus ursinus</i>	Northern fur seal	1	0.8	1	0.9	5.38
<i>Enhydra lutris</i>	Sea otter	18	14.4	18	16.9	19.74
<i>Phoca vitulina</i>	California harbor seal	2	1.6	2	1.9	3.19
<i>Zalophus californianus</i>	California sea lion	1	0.8	1	0.9	36.19
	Subtotal	22	17.6	22	20.8	64.50
<b>BIRDS</b>						
<i>Anser albifrons</i>	White fronted goose	1	0.8	1	0.9	1.27
<i>Diomedea immutabilis</i>	Laysan albatross	1	0.8	1	0.9	6.35
<i>Fratercula cirrhata</i>	Tufted puffin	1	0.8	1	0.9	0.27
<i>Gavia</i> sp.	Loons	1	0.8	1	0.9	0.33
<i>Mimus polyglottos</i>	Northern mockingbird	1	0.8	1	0.9	0.07
<i>Phalacrocorax</i> sp.	Cormorants	30	24.0	26	24.5	19.58
<i>Ptychoramphus aleuticus</i>	Cassin's auklet	2	1.6	2	1.9	0.37
<i>Uria aalge</i>	Common murre	4	3.2	2	1.9	1.07
	Subtotal	41	32.8	35	33.0	29.31
	<b>Total</b>	<b>125</b>	<b>100.0</b>	<b>106</b>	<b>100.0</b>	<b>109.13</b>

(*Phalacrocorax* sp.; NISP=30, 24.0%; MNI=26, 24.5%), and sea otters (*Enhydra lutris*; NISP=18, 14.4%; MNI=18, 16.9%). Looking at broader classes, the collection was dominated slightly more by marine mammals and birds (NISP=63, 50.4%; MNI=57, 53.8%) than terrestrial mammals (NISP=62, 49.6%; MNI=49, 46.2%).

*Fish.* Because many fish elements are small, the representation of fish bone in an assemblage is highly influenced by sampling/recovery techniques, and the excavation strategy employed at CA-SLO-9 was designed to try to sample fish bones as effectively as possible. One

test unit (1.8 m<sup>3</sup>) was excavated with 6 mm. (1/4 inch) mesh screens, while the remainder of the recovery volume (21.4 m<sup>3</sup>) was processed with 3 mm. (1/8 inch) mesh screens. The 3 mm. recovery volume further included 0.96 m<sup>3</sup> of material from two column samples and a 1 x 1 m. unit processed with water and sorted in the laboratory. These wet-screened microsamples were specifically intended to provide a controlled sample of fish remains.

A total of 2,260 fish elements was recovered, including 670 specimens identified to the family level or better (Table 5). The overall sample was dominated by

Table 5

## SUMMARY OF FISH REMAINS FROM CA-SLO-9

Taxon	Common Name	1/4" (6 mm)	1/8" (3 mm)	1/8" (3 mm)	Total NISP	% NISP	MNI	Bone Weight (g)
		Mesh Dry <sup>a</sup> NISP	Mesh Dry <sup>b</sup> NISP	Mesh Wet <sup>c</sup> NISP				
Atherinopsidae	Silversides	0	6	16	22	3.28	3	0.23
Clinidae	–	0	0	2	2	0.29	0	0.02
Clupeidae	Herrings	0	2	15	17	2.53	1	0.13
Cottidae	–	0	0	1	1	0.15	0	0.01
Elasmobranchiomorphi	Shark	0	1	0	1	0.15	1	0.03
Embiotocidae	Surfperches	0	22	18	40	5.97	12	1.29
<i>Gillichthys mirabilis</i>	Longjaw mudsucker	0	0	0	1	0.15	1	0.01
<i>Gibbansia</i> sp.	Kelpfish	0	2	0	2	0.29	1	0.05
<i>Hexagrammos</i> sp.	Kelp greenling	0	1	0	2	0.29	2	0.12
<i>Merluccius productus</i>	Pacific hake	0	2	0	2	0.29	2	0.08
<i>Ophiodon elongatus</i>	Lingcod	0	1	0	1	0.15	2	0.16
<i>Oxyjulis californica</i>	Senorita	0	21	25	46	6.86	31	2.06
<i>Parichthys notatus</i>	Plainfin midshipman	0	2	0	2	0.29	2	0.02
<i>Sardinops sagax</i>	Pacific sardine	0	3	3	6	0.89	5	0.07
Sciaenidae	Croakers	0	0	1	1	0.15	1	0.01
<i>Scorpaenichthys marmoratus</i>	Cabezon	20	146	26	192	28.65	118	37.20
Scorpaeniformes	–	0	1	0	1	0.15	0	0.04
<i>Sebastes</i> sp.	Rockfishes	13	220	59	292	43.58	177	32.96
Stichaeidae	Pricklebacks/Monkeyface	1	20	12	33	4.92	14	2.10
Triakidae	Hound shark	0	1	0	1	0.15	0	0.89
<i>Xiphister</i> sp.	Prickleback	0	4	1	5	0.74	5	0.40
	Subtotal	34	455	181	670	100.00	378	77.88
Actinopterygii	Bone fragments	6	762	752	1,520	–	1	71.45
Vertebrate	Vertebrate	2	47	12	61	–	0	3.86
Unidentified	–	0	8	0	9	–	0	0.39
	Subtotal	8	817	765	1,590	–	1	75.70
	TOTAL	42	1,272	946	2,260	–	379	153.58

<sup>a</sup>1/4" dry screen sample includes a single 2 x 1 m test excavation unit; recovery volume = 1.8 m<sup>3</sup>.

<sup>b</sup>1/8" dry screen sample includes 11 2 x 1 m test excavation units; recovery volume = 20.4 m<sup>3</sup>.

<sup>c</sup>1/8" wet screen sample includes 2 column samples and a 1 x 1 m control unit; recovery volume = 0.964 m<sup>3</sup>.

rockfish (NISP=292; 44%), cabezon (NISP=192; 29%), and seniorita (NISP=46; 7%). Cabezon and rockfish also dominated the overall assemblage when ranked by MNI (combined=295; 78%) and weight (combined=70.16; 90%). When considering recovery techniques, rockfish and cabezon dominate samples recovered by all three techniques: for 6 mm. dry mesh, cabezon = 58.8% and rockfish = 38.2%; for 3 mm. dry mesh, cabezon = 32.1% and rockfish = 48.4%; for 3 mm. wet screen, cabezon = 14.4% and rockfish 32.6%. Surfperches represent only 9.9% of the wet-screened sample and only 4.8% of the 3 mm. dry sample from CA-SLO-9. The density of identifiable elements recovered from the wet-screening was 117.5/m<sup>3</sup>, while the total overall for the wet-screened residues (including nonidentifiable specimens) was 605.8 elements/m<sup>3</sup>. Given the uniformity of the findings from all recovery techniques utilized, it is safe to conclude that the inhabitants of CA-SLO-9 focused their fishing efforts on cabezon and rockfish.

### **ADAPTIVE STRATEGIES DURING THE MIDDLE-LATE TRANSITION: A BEHAVIORAL-ECOLOGICAL PERSPECTIVE**

The dating of the initial settlement of CA-SLO-9 to around cal A.D. 900 and its abandonment around cal A.D. 1300 supports previous suggestions that the Medieval Climatic Anomaly was a distinctive period for foragers on the central coast and elsewhere in western North America (Jones et al. 1999; Jones and Ferneau 2002a). A synthetic examination of artifactual and faunal remains from the Coon Creek site in light of these climatic correlations and through the lens of human behavioral ecology (HBE) may further elucidate the behavior of human populations during this unusual interval.

Human behavioral ecology (HBE) is the study of adaptive, biological design in an ecological setting (Winterhalder and Smith 1992). It assumes that social and environmental conditions are the most important factors influencing and constraining human behavior, and as a consequence, human behavior varies in response to particular socioecological variables. Smith (2000) notes that behavioral ecologists generally assume that (1) variations in behavior are the result of variations in the socioecological environment, as opposed to variations in genes; that (2) the particular mechanisms causing

adaptive changes in behavior are irrelevant or ignorable (see Grafen 1984); and that (3) as humans are capable of adaptive phenotypic plasticity, it is likely that behavior should be well-adapted to the current environment, and should change in response to new environments with little lag time (see also Irons 1979; West-Eberhard 1989).

Subsistence practices are often the focus of behavioral ecological studies, as some degree of efficient subsistence is necessary for somatic success and is thus a prerequisite to reproductive success. Archaeologists commonly analyze subsistence strategies by viewing faunal remains through formal economic models such as the prey choice (or diet breadth), patch choice, or central place foraging models; when the specific predictions of these models are violated, other hypotheses are proposed and tested; however, the models themselves are never tested (see reviews in Bird and O'Connell 2006; Bettinger 1991). It is important to emphasize that it is never assumed that individuals will act according to the models; rather, the models act as tools to systematically investigate prehistoric subsistence strategies. Rigorous applications generally attempt to follow a strict hypothetico-deductive approach; however, in this paper the models are used more as a heuristic device in order to comprehensively examine the human behavior represented in the faunal and artifactual remains deposited at CA-SLO-9.

The dietary and technological changes that occurred during the MLT on California's central coast provide the basis for an ideal prehistoric case study of the adaptive flexibility of human behavior in relation to an altered environment. By analyzing dietary and technological changes through a behavioral-ecological framework and in concert with paleoclimatic data, the causes and consequences of the MLT can be systematically examined in order to understand the dynamic relationship between paleoecology and prehistoric human foraging on the central coast of California between cal A.D. 1000 and 1250.

#### *Shellfish Remains*

Researchers have utilized two basic behavioral-ecological models to examine prehistoric shellfish exploitation: the prey choice (or diet breadth) model and central place foraging models. The prey choice model (PCM) examines which resources a forager should take on encounter within a homogenous patch (Stevens and Krebs 1986). The model predicts that foragers should

preferentially select prey in order to maximize the rate at which resources are acquired; whether or not a resource should be taken on encounter depends on the abundance of the *highest* ranking resource. In other words, when searching the intertidal zone, a forager should always take the highest ranking resource on encounter, until encounter rates for that resource decline to a point where it is more profitable to take the next highest ranking resource than to continue searching for the highest ranking resource.

Unfortunately, precise post-encounter return rates are currently unavailable for most, but not all (see Jones and Richman 1995) littoral invertebrate resources along California's central coast, making objective rankings nearly impossible with the currently available data. Braje et al. (2007) have developed the most recent rankings for shellfish along the California coast, but their rankings include prey abundance, a measure that should affect the outcome of the model (i.e., the forager's encounter rate with that prey item), but one that should not be included in the rankings themselves (see Stevens and Krebs 1986). In the absence of fine-grained, quantitative resource rankings, we rely on average prey size as a proxy measure. Prey size should, at least with relatively immobile prey, be positively correlated with average post-encounter return rate as long as processing costs remain relatively constant between species (see Griffiths 1975; Sih and Christensen 2001; Stevens and Krebs 1986; Ugan 2005). Based on average size in millimeters (as reported by Braje et al. 2007:740) for each genus available to foragers on the central coast of California, abalone (*Haliotis* sp.) is the highest ranking resource, followed by mussels (*Mytilus* sp.), turban snails (*Astrea* sp.), limpets (*Lottia* sp.), sea urchins (*Strongylocentrotus* sp.), and turban snails (*Tegula* sp.). Based on the PCM, it is predicted that the foragers who occupied CA-SLO-9 should have targeted the highest ranking resource, moving to lower ranking resources only when encounter rates with the highest ranking resource decreased.

However, there is at least one problem with utilizing the PCM alone to examine shellfish exploitation; namely, that the shells of acquired shellfish are not necessarily deposited in archaeological sites. Researchers have noted that shellfish species are often processed in the field, with the shell being culled and only the meat being returned to camp; thus the representation of shellfish remains in

archaeological sites may differ from the taxa actually acquired due to differential field processing practices (Bird 1997; Bird et al. 2002, 2004; Meehan 1982). To deal with this problem, researchers have utilized central place foraging models (CPF) developed by Metcalfe and Barlow (1992; see also Orians and Pearson 1979), to examine which shellfish species in particular are expected to be underrepresented in archaeological sites (see Bettinger et al. 1997; Bird et al. 2002, 2004). CPF models assume that the goal of a forager is to maximize the rate at which resources are returned to a central place. Specifically, the models examine the tradeoffs between processing resources in the field prior to transport versus transporting whole resources (including inedible portions) back to the central place for later processing. The models predict that as the distance from the resource patch to the central place increases, foragers will gain greater benefits from field processing resources prior to transport. However, if distances are short, foragers would benefit more from making multiple round trips carrying unprocessed resources.

Assuming equal processing costs and shell value, Bird et al. (2002) suggest that California shellfish species with higher meat to shell ratios are less likely to be processed in the field than species with lower ratios, because those species with a greater percentage of shell vs. meat per load provide higher returns per unit of time spent field processing. Thus, as the distance between a central place and a shellfish patch increases, it is predicted that the shells from species with relatively low meat to shell ratios will be culled in the field, resulting in lower relative abundances in archaeological sites. For species represented on the central coast of California, mussel (*Mytilus* sp.) and turban snail (*Tegula* sp.) are most likely to be underrepresented in archaeological middens, as they have the lowest percentage of meat weight relative to shell weight, while urchin (*Strongylocentrotus* sp.), abalone (*Haliotis* sp.), and chiton (*Mopalia* sp.) are the least likely to be field processed, and thus are more likely to be over-represented in archaeological middens (see Erlandson 1988a, 1988b; Jones and Haney 1992; Koloseike 1969).

As discussed above, based on inferred biomass, the two most abundant shellfish species represented at CA-SLO-9 were mussel (*Mytilus* sp., 32.68%) and abalone (*Haliotis* sp., 31.92%), followed by urchin

(*Strongylocentrotus* sp., 11.79%), barnacle (*Balanus* sp. and *Pollicipes* sp., 8.45%), turban snail (*Tegula* spp., 6.79%), and chiton (*Ischnochiton* sp., *Mopalia* sp. and *Cryptochiton* sp., 4.26%) (Table 3). While there are some minor departures from the PCM's predictions, which may be due to actual prey abundance in the intertidal zone, the data overall show a relatively nice fit, with the highest ranking prey (mussel and abalone) being represented in the highest quantities and the other prey occupying varying ranks under the top two. However, this result is not typical for archaeological sites on California's central coast, with the most notable exception being the high proportion of abalone relative to mussel. At most sites on central California's exposed rocky coast, mussel shell tends to outweigh all other species by several orders of magnitude (see Jones 2003).

Based on the PCM and CPF models, these data lead to three possible conclusions; either (1) foragers encountered abalone in the intertidal zone at a higher rate than in previous time periods on the central coast, (2) foragers moved further out into the subtidal zone (where abalone are known to occur more frequently; see Morris et al. 1980) to acquire abalone at higher costs, or (3) foragers were differentially processing mussel to a greater degree, making the archaeologically visible portion of abalone greater, but not the dietary portion. In order to differentiate between these possible conclusions, we examined the size-frequencies of the two most abundant species, mussels and abalone. If mussel shells from CA-SLO-9 indicate a "plucking" strategy, then the relative abundance of abalone versus mussel may be due to the differential field processing of mussel shells (see Bettinger et al. 1997); however, if the shells indicate a "stripping" strategy, there is no reason to suspect that mussels were being differentially processed. If abalone shell size is significantly lower than in other time periods, this may be the result of foragers searching for abalone in the intertidal zone, for while abalone do occur in higher densities in the intertidal zone (Morris et al. 1980), their overall size may be smaller due to predation pressure from sea otters (Hines and Pearse 1982; Wendell 1994). However, if the average abalone shell size is larger at CA-SLO-9 than at other sites representing other time periods, then there is no reason to suspect that foragers were foraging in the intertidal zone and were probably obtaining abalone in higher relative quantities due to higher encounter rates.

**Mussel Size-Frequency Analysis.** White (1989) developed hypothetical cumulative proportion curves based on natural mussel populations defined by Suchanek (1981). Two alternative techniques for mussel collection were suggested: a *plucking* strategy (convex curve) where large individual mussels were selectively gathered, and an alternative *stripping* strategy (J curve) where whole beds of mussels were removed with little selectivity. Experimental studies performed by Jones and Richman (1995) provided support for the hypothetical curves generated by White (1989); a sharp J-curve represents a stripping strategy, while a gentler convex curve represents plucking (Fig. 3). Furthermore, their study revealed that plucking was the most efficient strategy, and that the advantage of a plucking strategy is greatest

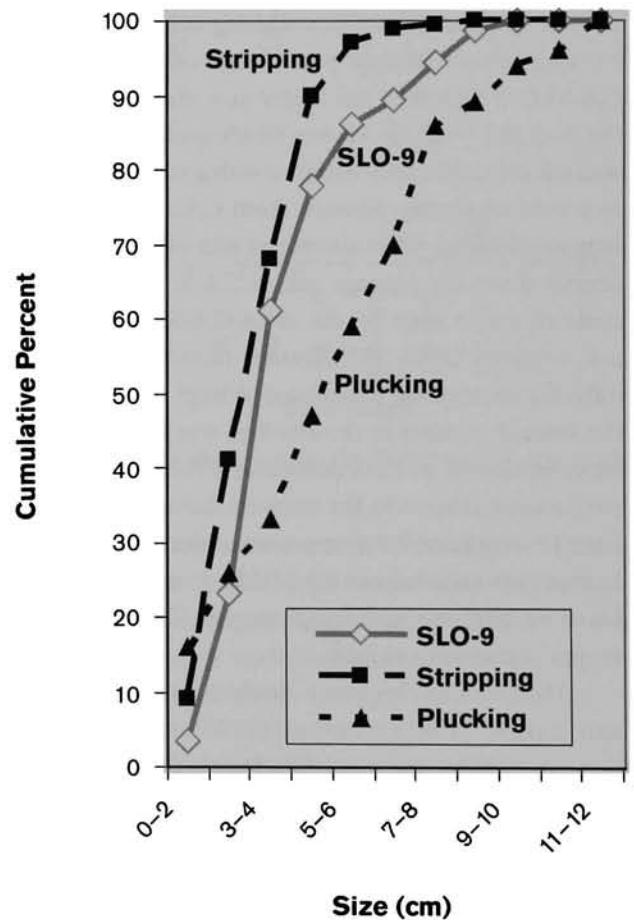


Figure 3. Cumulative proportion curves for archaeological mussel shell size frequency measurements from CA-SLO-9 compared with experimentally derived curves from the "pristine setting" of Big Creek.

in areas of infrequent harvest (Jones and Richman 1995:51). Jones (1996, 2003) subsequently showed that through most of the 6000-year sequence of human occupation at Big Sur, a stripping strategy was employed. Only the earliest (ca. 4,400 B.C.) and the most recent (ca. A.D. 1810) components showed evidence of more selective harvesting or possibly differential processing (see Bettinger et al. 1997).

Maximum length was recorded for all complete and nearly complete mussel shells from a single unit (No. 4) using the size template developed by White (1989). A total of 1,332 specimens met the criteria for analysis. The data, shown in Figure 3, reveal that the mussels deposited at CA-SLO-9 follow a J-curve, indicating a stripping strategy. This suggests that mussels were not being differentially processed (see Bettinger et al. 1997) and thus the high relative abundance of abalone at the site is not due to the differential processing of mussel remains. Furthermore, a higher percentage of mussels from CA-SLO-9 falls into the larger size classes, including the 8–9 and 9–10 cm. classes which are larger than the mussels experimentally reported with a stripping strategy in a pristine setting. Mussels from CA-SLO-9 are also larger on average when compared with other sites on the central coast; the average size at CA-SLO-9 is 4.7 cm., compared with only 3.1 cm. from CA-SLO-267 (Jones and Ferneau 2002b:187). Rather than representing a differing strategy, the abundance of large size classes and the limited number in the smallest size classes may be an indication of an environment at CA-SLO-9 that was particularly favorable for mussels during the Middle-Late Transition, or it may represent a decrease in overall human exploitation from the Middle Period to the MLT. Data on abalone size-frequency at CA-SLO-9 also support these suppositions.

*Abalone Size-Frequency Analysis.* Following Bouey and Basgall (1991), Ferneau (1998), and Jones and Ferneau (2002b), the maximum length of complete and nearly complete abalone shells was also measured. All sizeable abalone fragments were collected in the field, washed, cataloged, and sized using a template of average abalone measurements (grouped in 10 mm. size classes) that was developed for this project. Specimens that were too fragmentary for precise measurement were excluded. These data were then compared with the abalone size-frequency data from the Middle Period occupational

component at CA-SLO-267 reported by Ferneau (1998) and Jones and Ferneau (2002b).<sup>1</sup>

These data reveal that the *Haliotis cracherodii* exploited at CA-SLO-9 were significantly larger than those at CA-SLO-267 (Wilcoxon Test;  $P = 0.0025$ ) (Fig. 4). However, while *Haliotis rufescens* individuals from CA-SLO-9 were larger on average than those exploited at CA-SLO-267, the differences were just barely insignificant (Wilcoxon Test;  $P = 0.0581$ )<sup>2</sup>. While the second value is insignificant, the data do suggest that a greater number of small, juvenile abalone were exploited at CA-SLO-267 than at CA-SLO-9.

As there is a known link between abalone size (or age) and fecundity among California abalone populations (see Ault 1982; California Department of Fish and Game 2005; Leaf 2005; Leighton and Boolootian 1963; Rogers-Bennett et al. 2002, 2004; Rogers-Bennett and Leaf 2006), the greater exploitation of smaller abalone during the Middle Period may have served to drive down overall population sizes. As sea otters (*Enhydra lutris*) generally exploit subtidal abalone populations, driving down average abalone size (Hines and Pearse 1982; Wendell 1994), it is doubtful that human foraging in the subtidal habitat would result in an increase in the average size of abalone. Thus, the larger sizes harvested during the MLT at CA-SLO-9 may represent either a decrease in human predation pressures that allowed abalone populations to rebound, or an environment more favorable to abalone growth.

*Shellfish: Conclusions.* Of the three possible conclusions proposed above, the data suggest that foragers during the MLT were acquiring larger abalone at higher rates than during previous times on the central coast. Furthermore, the data suggest that during the MLT, foragers were harvesting larger mussels than those available either during the Middle Period or even at present in pristine settings on the exposed rocky coast of central California. These data further imply that foragers either (1) engaged in a less intensive exploitation of the littoral zone during the MLT, possibly resulting from lower human population densities; (2) experienced an environment more favorable for abalone during the MLT, possibly resulting from lower sea surface temperatures (see Morris et al. 1988); or (3) both. Klein et al. (2004), reporting on data from Middle and Later Stone Age shell middens in South Africa, view differences in invertebrate shell size as a proxy for foraging intensity

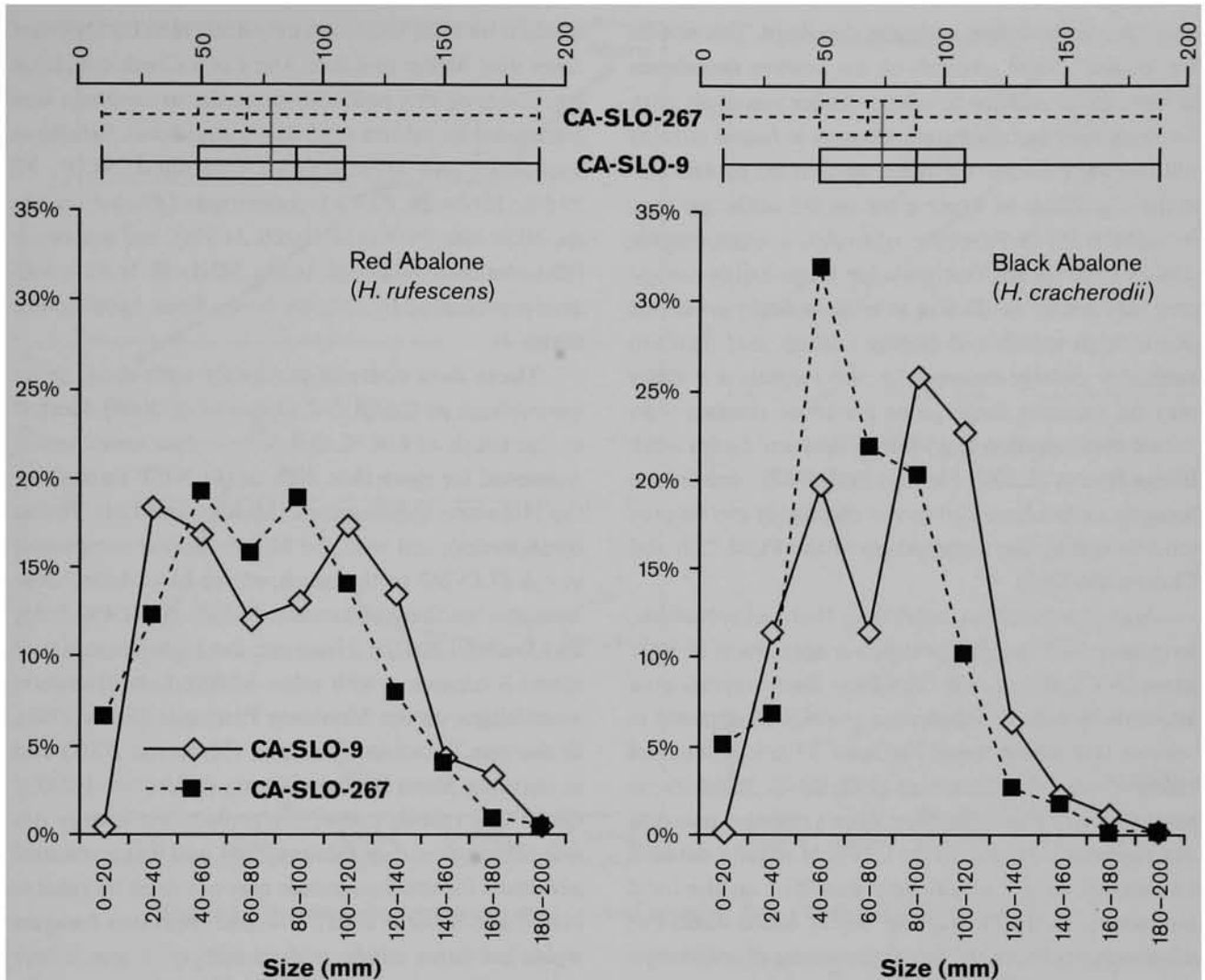


Figure 4. Size-frequency distribution of red (*H. rufescens*) and black (*H. cracherodii*) abalone from CA-SLO-9 and CA-SLO-267.

and thus forager population size. Applying this same logic to the data from California's central coast suggests that MLT population densities were lower, resulting in less pressure on invertebrate populations and allowing for larger growth. Recent paleoclimatic studies also suggest that upwelling was greater during the MLT, and that the marine environment was generally cooler and highly productive (Kennett 2005; Kennett and Bottman 2006; Kennett and Kennett 2000). These conditions may have allowed abalone to occupy locations higher in the intertidal zone in greater numbers (Morris et al. 1988). Taken together, the shellfish data from CA-SLO-9 and the paleoclimatic data suggest that the MLT was marked by both an overall decrease in foraging intensity (possibly due to decreases in population size), and a

productive marine environment favorable to shellfish, including cooler-than-average sea surface temperatures that allowed abalone to occupy locations higher in the intertidal zone that would have been easier for human foragers to access.

#### Mammal and Bird Remains

As originally applied to archaeological assemblages by Bayham (1979), applications of the prey choice model (PCM) commonly assume that resource acquisition efficiency scales with body mass (i.e., larger prey can be acquired more efficiently; see Griffiths 1975; Simms 1985; Ugan 2005). Based on this assumption, foragers should pursue large game whenever it is encountered and only pursue smaller game when the abundance of larger



game decreases below a certain threshold. This notion has focused recent research on the relative abundance of large game relative to other, smaller resources, with the prediction that diachronic changes in faunal remains will provide evidence for either an increase or decrease in the abundance of larger game on the landscape (e.g., Broughton 1994). However, quantitative ethnographic studies have shown that pursuing large, highly mobile prey may not be as efficient as is theoretically presumed due to high search and pursuit failures that result in extremely variable success rates; this suggests that males may be pursuing large game for other reasons than caloric maximization (e.g., Bliege Bird and Smith 2005; Bliege Bird et al. 2001; Hawkes 1991, 1993). Non-human foraging studies have also shown that highly mobile prey tend to violate the assumptions of the PCM (Sih and Christensen 2001).

Some researchers, extending these observations, have proposed that the prehistoric acquisition of large game in California and the Great Basin represented attempts by males to maximize prestige as opposed to calories (Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005; McGuire et al. 2007). While these proposals are plausible, they have yet to be tested in any rigorous way; and to do so would require detailed knowledge of the actual prey densities on the local landscape. In an attempt to better understand the relationship between the actual abundance of artiodactyls and their relative abundance in archaeological sites, Byers and Broughton (2004) and Byers et al. (2005) have shown that the relative abundance of artiodactyls in archaeological sites is correlated with regional environmental conditions, particularly moisture. As artiodactyl populations are known to be effected by local water availability (see Lawrence et al. 2004; Mackie et al. 1982, 2003), this suggests that—regardless of their motivation for doing so—foragers do take artiodactyls frequently when they are available and less frequently when they are less abundant.

The Coon Creek data seem to lend support for the hypothesis that prehistoric foragers will acquire large game like artiodactyls preferentially as long as they are abundant, but will not do so when they are less abundant. As Coon Creek was inhabited during a time of apparent drought (see Jones et al. 1999; Stine 1994), it is likely that deer would have been less abundant and thus

would have been taken less frequently than during other times with higher moisture. The Coon Creek collection corroborates this predication, as the assemblage was dominated by rabbits (*Sylvilagus audubonii*, *Sylvilagus bachmani*, and *Sylvilagus* sp. combined; NISP=37, 29.6%; MNI=29, 27.3%), cormorants (*Phalacrocorax* sp.; NISP=30, 24.0%; MNI=26, 24.5%), and sea otters (*Enhydra lutris*; NISP=18, 14.4%; MNI=18, 16.9%), with deer represented by only six bones from 3 individuals (Table 4).

These data contrast markedly with those from assemblages at CA-SLO-2 (Jones et al. 2008), located to the south of CA-SLO-9, where deer consistently accounted for more than 40% of the NISP throughout the Holocene (Millingstone, Middle, and Late Period components), and with the Middle Period component at CA-SLO-267 to the north, where black-tailed deer were also the dominant species (NISP=88, 31.4%; Jones and Ferneau 2002b). However, the high frequency of rabbit is consistent with other Middle-Late Transition assemblages on the Monterey Peninsula (Jones 1998), in the San Francisco Bay area (Hylkema 2002) and in northern Santa Barbara county (Harro et al. 2000). Given that rabbits potentially provide less energy per unit of time than deer (Simms 1985), and that communal net drives for small mammals may not even be reliable (Lupo and Schmitt 2002), it would seem that foragers would not target rabbits preferentially over deer, if deer were available. Some may argue that a decrease in the importance of deer during the MLT represented a shift in male competition during this time of social and ecological stress (Hildebrandt and McGuire 2002:249–250), but this seems less parsimonious than the explanation that deer were simply less abundant because of prolonged aridity. This conclusion is also supported by other researchers, who have found similar correlations between drought and a decrease in or absence of artiodactyls (e.g., Byers and Broughton 2004; Cannon 2003), and is in line with behavioral ecological data showing how decreases in local water supplies reduce recruitment rates of deer, which results in lower local population densities (Lawrence et al. 2004; Mackie et al. 1982, 2003).

Beyond correlations between the paleoclimatic record and terrestrial resources, recent research has shown that the Medieval period was not only marked by a warmer, drier, and less productive terrestrial

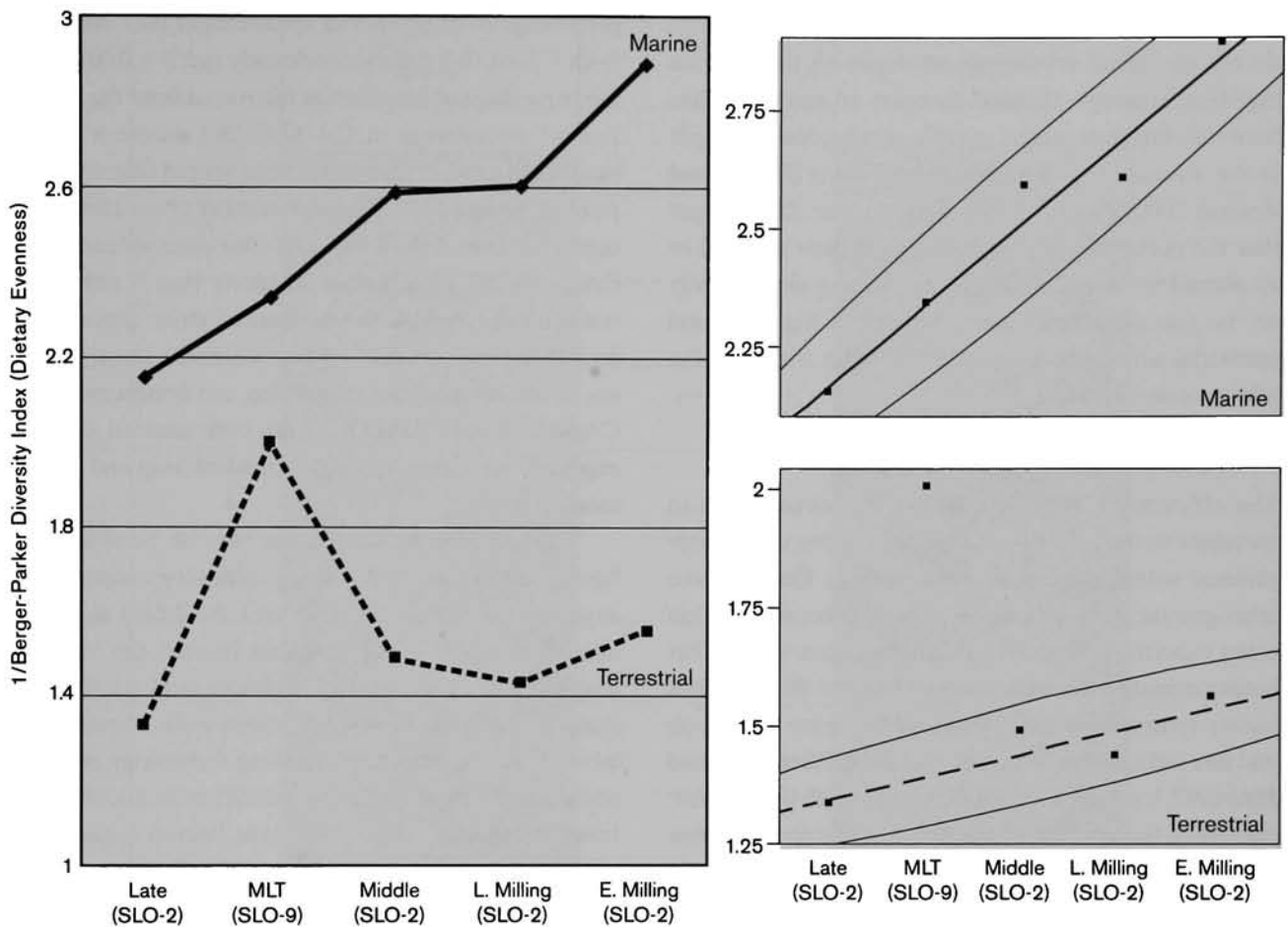


Figure 5. Diversity indices for marine and terrestrial resources from CA-SLO-2 and CA-SLO-9.<sup>3</sup>

environment, but also by increased upwelling which may have increased marine productivity (Jones et al. 1999; Jones and Kennett 1999; Kennett and Kennett 2000; Kennett 2005; Kennett et al. 2007). More locally, sea surface temperatures recorded with oxygen isotope levels in mussel shells show that the intertidal zone at CA-SLO-9 was slightly cooler than the historical average high temperature (Kennett and Bottman 2006). It seems that foragers adapted to these changing conditions as the inhabitants of CA-SLO-9 relied on a greater proportion of marine bird (i.e., cormorants) and mammal (i.e., sea otter) resources than the people represented by the Middle Period assemblages at CA-SLO-2 and CA-SLO-267.

Furthermore, a comparison of the Berger-Parker diversity index values (see Magurran 1988) from marine and terrestrial resources at CA-SLO-2 and CA-SLO-9 shows that the marine resource values from CA-SLO-9

fit within the general trans-Holocene trend of increasing specialization (decreasing evenness) in marine resources (Fig. 5). However, the terrestrial resource values from CA-SLO-9 show a significant departure from the general trans-Holocene trend, indicating a disruption in terrestrial subsistence strategies that fostered a less specialized terrestrial vertebrate diet (Fig. 5).<sup>3</sup> As deer (*Odocoileus hemionus*) comprised the terrestrial resource that foragers specialized in throughout the Holocene at CA-SLO-2 (i.e., deer were the most abundant species represented), the near absence of deer in the vicinity of CA-SLO-9 was potentially the main factor underlying the disruption in terrestrial resource subsistence patterns.

It remains possible that the lack of large game at CA-SLO-9 represents the adoption of a more logistically-oriented (*sensu* Binford 1980) foraging strategy adopted to cope with a low density of local deer populations. However, even if this is the case, the

lack of deer remains from CA-SLO-9 still indicates a change in overall subsistence strategies, in that a more logistical strategy allowed foragers to ease conflicts between differing gender-specific subsistence strategies in the absence of dense deer populations (Elston and Zeanah 2002; Zeanah 2004). Overall, the data suggest that the occupants of CA-SLO-9 may have adapted to an altered terrestrial landscape by focusing more heavily on the marine environment and smaller, highly fecund terrestrial animals that were able to better withstand the effects of drought.

### *Fish Remains and Fishing Technology*

The efficiency with which fish are acquired seems to correlate strongly with the types of fishing technology utilized within various marine patches. Quantitative ethnographic observations and formal economic models using experimental and historical data have shown that indiscriminate mass collecting of smaller fish provides higher return rates than single catch fishing with hook and line technology (Bettinger et al. 2006; Bliege Bird and Bird 1997; Ugan et al. 2003). Bettinger et al. (2006) show that when the amount of time spent in fishing increases, it becomes economically viable to invest more time in the production and maintenance of more expensive technologies which provide higher returns per unit time of investment. The initial investment in such technologies can be extremely high, requiring many subsistence hours just to break even. But, as this sort of technological intensification may allow foragers to extract resources from the same area at a higher rate, the high up-front labor costs may be worth it in the long run, and may in fact be necessary to sustain a growing population (see Boserup 1965). In this way, intensifying the focus on fishing can be equated with an adoption of a more expensive technology (in terms of labor costs) and the acquisition of fauna associated with such a technology.

Fish remains from CA-SLO-9 were dominated by rockfish (*Sebastes* sp.) and cabezon (*Scorpaenichthys marmoratus*). Together, these line- or spear-caught species (see Love 1996; Pletka 2001; Salls 1988) dominate the assemblage, whether measured by NISP (484; 72.23%), MNI (295; 78%), or bone weight (70.16; 90%) (Table 5). While cabezon and rockfish do dominate many assemblages along central California's exposed rocky coastline (see Gobalet and Jones 1995), the high

percentage of large, line- or spear-caught taxa recovered from CA-SLO-9 differs significantly ( $\chi^2$ ;  $P < 0.001$ ) from the percentage of fish remains recovered from the Middle Period assemblage at CA-SLO-267, where a higher number of smaller species are represented (Fig. 6). These results also agree with the large number of shell fishhooks recovered from CA-SLO-9 and their near absence from CA-SLO-267. This further suggests that if nets were not used at CA-SLO-9, the notched stone artifacts are probably best classified as line weights.<sup>4</sup> These results are probably not due to varying environments, since CA-SLO-9 and CA-SLO-267 are both situated along an exposed rocky coastline with abundant kelp and nearby sandy beaches.

Comparisons between these two fish bone assemblages and the associated fishing technology represented suggest that the inhabitants of CA-SLO-9 were not intensifying their fishing practices. Instead, the evidence suggests that some sort of technological "de-intensification" occurred in which foragers were investing less labor in the manufacture of fishing technology, and as a consequence were acquiring resources at a lower rate; however, the end result may have been a higher total output per person hour (Boserup 1965:43).

The apparent switch in fishing practices from the Middle Period through the Middle-Late Transition seems consistent with demographic perturbations in the local population (Jones et al. 1999). While netting is more efficient than hook and line technology, netting fish from the ocean can only be accomplished by a collective group, and returns must be shared between multiple individuals. A decrease in the total population, in the population of fishers, or the population of fishers willing to cooperate could result in the high costs of netting being no longer viable. Similarly, Alvard and Nolan (2000) note that while cooperative fishing generally provides higher returns per individual, it requires complex organization between individuals to be successful. Such pre-arranged organization is extremely susceptible to external and internal disruptions, leading to the collapse of the system, and requiring individuals to engage in other strategies, including more individualistic modes of fishing.

Regardless of whether or not droughts were the prime mover underlying the shift in technology and subsistence, changes in fishing practices during the MLT at CA-SLO-9 suggest a reorganization of labor among

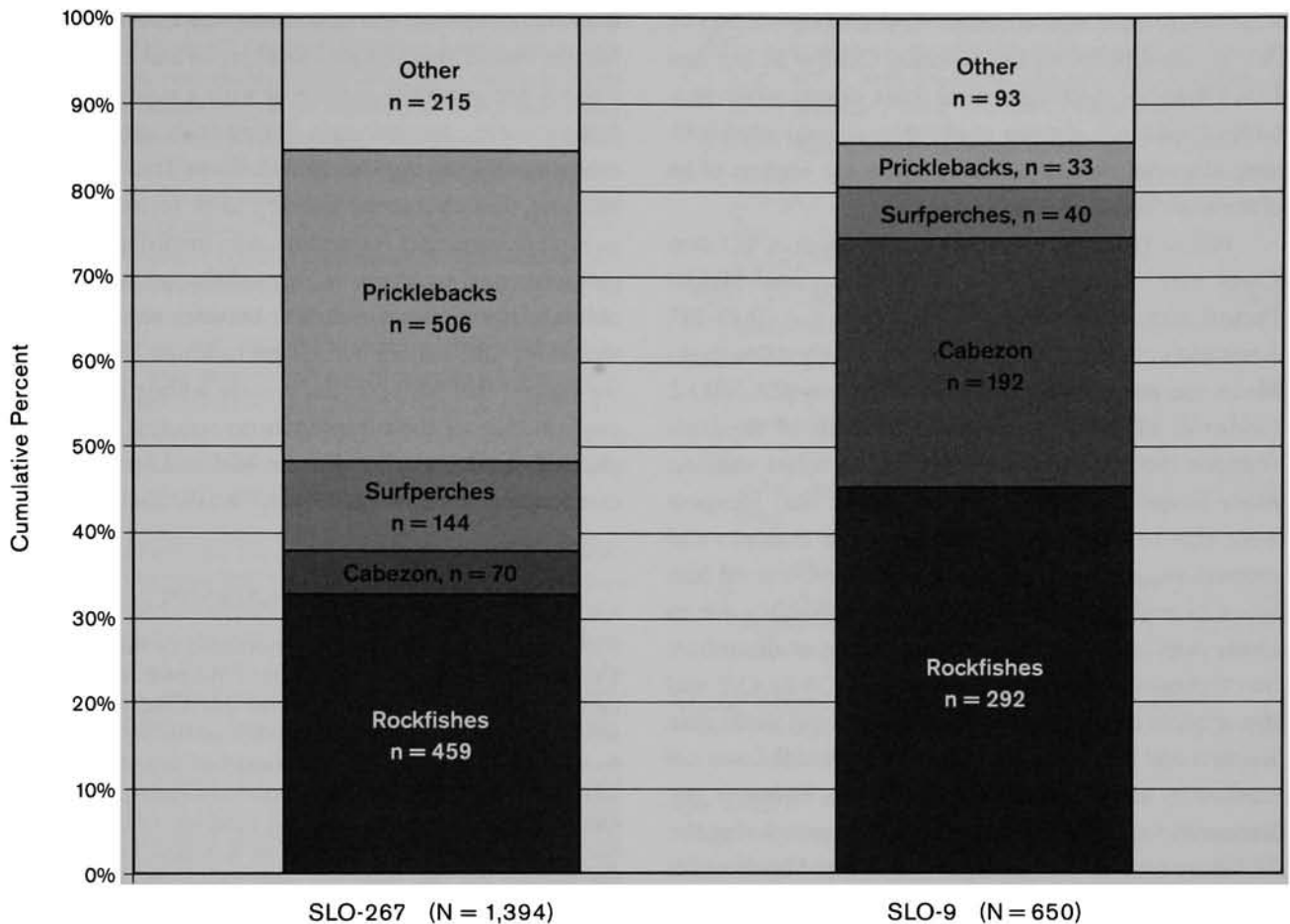


Figure 6. Summary of fish remains from CA-SLO-267 and CA-SLO-9.

coastal foragers in central California. These changes in subsistence strategies and technology, and the associated implications for changes in social organization, seem to support Jones and Ferneau’s (2002a) proposition of “de-intensification” during the MLT along California’s central coast.

### SUMMARY AND DISCUSSION

The portion of CA-SLO-9 investigated in 2004 and 2005 comprises an extremely cohesive component dating between cal. A.D. 900 and 1300. As this occupation falls within the Middle-Late Transition, generally dated to ca. A.D. 1000–1250 in central and southern California, site data serve to refine the characterization of this important period for the San Luis Obispo area of the central coast region. Typologically, the proposed Coon Creek Phase is marked by the co-occurrence of contracting-stemmed,

double side-notched, and small leaf-shaped projectile points, G2 *Olivella* saucer beads, K1 *Olivella* Cupped beads, circular shell fishhooks, and distinctive notched stone fishing weights. As indicated by their high numbers at CA-SLO-9 and by the fish remains recovered from the midden, the latter were probably used together with the hooks as line weights. The phase is also distinguished by a paucity of the pitted stones and bone gorges which are ubiquitous in earlier contexts. With the exception of the notched stones, double side-notched points, and perhaps the small leaf-shaped points which seem to be distinctive MLT traits, none of the other artifacts are restricted to the MLT, but occur also in either the Middle (e.g., contracting-stemmed projectile points, G2 *Olivella* saucer beads) or Late (e.g., K1 *Olivella* Cupped beads, circular shell fishhooks) periods. In this regard, the Coon Creek Phase seems to mark an overlap between the Middle and Late Periods, although it shares more traits

with the former and might be best conceptualized as the terminal phase of the Hunting Culture in the San Luis Obispo area of the central coast, during which new technologies (e.g., circular shell fishhooks and small leaf-shaped points) were introduced within the context of an altered environmental landscape.

Faunal remains from the MLT component at Coon Creek vary significantly from single component Middle Period assemblages in the region (e.g., CA-SLO-267, Jones and Ferneau 2002b) and from relatively stable trans-Holocene patterns represented at nearby CA-SLO-2 (Jones et al. 2008). A detailed analysis of shellfish remains indicates that foragers encountered abalone more frequently during the MLT, and that foragers were able to acquire larger than average abalones and mussels, suggesting a favorable marine environment and lower overall human predation pressure, possibly due to lower population densities. The presence of the robust invertebrate populations exploited at CA-SLO-9 and the analysis of oxygen isotopes from mussel shells (see Kennett and Bottman 2006) suggest that the MLT was *not* marked by elevated marine temperatures. However, the terrestrial resources exploited at other times during the Holocene may have been negatively affected by droughts associated with the MCA. Large terrestrial vertebrate remains, ubiquitous in other contexts throughout the Holocene, are nearly absent at CA-SLO-9. In their place, foragers focused on highly fecund small mammals, marine birds, and marine mammals. However, despite the apparent emphasis on marine birds and mammals, it appears that fishing practices “de-intensified” during the MLT, as suggested by the fish remains and the associated fishing technology. This “de-intensification” seems to reflect some sort of demographic perturbation, resulting in perhaps smaller or less organized groups, leading in turn to a change in the social organization of fishing, perhaps involving males spending more time fishing as a solo pursuit rather than hunting.

Overall, we propose that CA-SLO-9 was a year-round residential base, as inferred from artifact assemblage diversity and seasonality measured through the oxygen isotope analysis of *Mytilus californianus*. The site was occupied by a small but complete social group that was heavily involved in the exploitation of marine birds, marine mammals, and small terrestrial mammals. Ultimately, this population abandoned CA-SLO-9 entirely ca. A.D. 1300.

Contrasts between the assemblage at CA-SLO-9 and Middle Period assemblages elsewhere in San Luis Obispo County are generally consistent with a model in which foragers were experiencing a change in their surrounding environment during the Middle-Late Transition, and meeting that change by altering their technology and subsistence strategies. As in most cases involving a possible environmental *causation* of cultural change, we are only able to demonstrate *correlations* between environmental variability and human behavioral residues. Nonetheless, we suggest that such correlations are adding up. Further confirmation of these explanations requires additional research involving other discrete Middle-Late Transition components with substantive faunal and artifact samples.

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### NOTES

<sup>1</sup>Comparisons with modern abalone populations also lead to interesting conclusions. Many modern abalone populations have suffered from decreases in average size and overall numbers as a result of both withering syndrome and the reintroduction of sea otter (*Enhydra lutris*) populations (see California Department of Fish and Game 2005; Cox 1962; Hines and Pearse 1982; Wendell 1994). While modern abalone researchers often consider these populations to be “decimated” and in need of restoration

(see California Department of Fish and Game 2005), data from CA-SLO-9 reveal that prehistoric size-frequencies during the MLT were remarkably smaller than those of modern red abalone populations from the Channel Islands National Parks (Dan Richards, personal communication 2006) and Bodega Bay (Rogers-Bennett, personal communication 2006). Furthermore, black abalone size-frequencies from CA-SLO-9 are strikingly similar to those of modern black abalone populations at Hopkins Marine Life Reserve (HMLR), a population that is considered to have been at equilibrium with sea otter (*Enhydra lutris*) predation pressure for the last fifteen years (Hines and Pearse 1982; see also Wendell 1994). Taken together, these data suggest that abalone were smaller and less numerous prehistorically than at modern reserves, and that the level of exploitation of black abalone at CA-SLO-9 may have been sustainable, as similar exploitation by sea otters is occurring today while abalone populations remain stable.

<sup>2</sup>For comparison with the CA-SLO-267 data (Ferneau 1998; Jones and Ferneau 2002b), the CA-SLO-9 abalone size-frequency data were collapsed into 20 mm. size classes. Statistics were calculated using JMP IN 5.1 statistical software based on mid-point values for each size class. As the data were shown to deviate significantly from a normal distribution (Shapiro-Wilk W Test;  $P < 0.05$ ), a nonparametric test was chosen for analysis.

<sup>3</sup>The Berger-Parker Diversity Index (BPDI) is calculated as the number of individuals (NISP) of the most abundant species over the total number of individuals; values are shown as  $1/BPDI$  to ensure that the value increases with diversity (see Magurran 1988). Independent values were calculated per component for marine (mammal, bird, and fish) and terrestrial (mammal and bird) vertebrate resources. Using JMP IN 5.1, BPDI values for each CA-SLO-2 component were used to calculate 95% confidence ellipses, to which the CA-SLO-9 values were compared to check for significant departures. While the marine value for CA-SLO-9 falls within the 95% confidence ellipse, the terrestrial value departs significantly.

<sup>4</sup>The apparent expediency with which notched stone artifacts were produced suggests that they would not be used with labor intensive nets. However, labor intensive, grooved stone artifacts that occur frequently in Middle Period contexts do seem to be a good match with nets, as they would be curated longer than line weights. The high number of grooved stone artifacts recovered from CA-SLO-267 and the abundance of smaller fish taxa further suggest their association. Experimental studies have shown that line weights themselves become snagged and are lost more frequently than even hooks (Dustin McKenzie, personal communication 2006), suggesting a possible desire to use expendable tools to weight down lines.

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