

THE DIABLO CANYON FAUNA: A COARSE-GRAINED RECORD OF TRANS-HOLOCENE FORAGING FROM THE CENTRAL CALIFORNIA MAINLAND COAST

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Decades ago the Diablo Canyon site (CA-SLO-2) on the central California mainland revealed one of the oldest and longest sequences (ca. 9400 radiocarbon years ago to contact) of coastal occupation on the shore of the northeastern Pacific. The artifacts from these important deposits were reported in detail by Greenwood (1972), but only a fraction of the site's faunal collections was analyzed in the original site report. Acquisition of 30 additional radiocarbon dates and analysis of the complete vertebrate fauna have produced a coarse-grained record of human foraging on the California mainland from 8300 cal B.C. to cal A.D. 1769. The temporally controlled faunal matrix, constituting one of the largest trans-Holocene records from western North America, speaks in a meaningful way to two significant issues in hunter-gatherer prehistory: early Holocene foraging strategies and economic intensification/resource depression over time. The site's earliest component suggests a population invested in watercraft and intensely adapted to the interface of land and sea along the northeastern Pacific coastline. While boats were used to access offshore rocks, terrestrial mammals (e.g., black-tailed deer) were also of primary importance. Dominance of deer throughout the Diablo occupations is inconsistent with recent generalizations about big-game hunting as costly signaling in western North American prehistory. Diachronic variation, correlated with superimposed burials that show growth in human populations through the Holocene, includes: (1) modest incremental changes in most taxa, suggesting resource stability and increasing diet breadth; (2) gradual but significant variation in a few taxa, including the flightless duck which was hunted into extinction and eventually replaced by sea otters; (3) punctuated, multi-directional change during the late Holocene related to historic contingencies of the Medieval Climatic Anomaly and protohistoric disruptions.

Hace décadas, el sitio de Cañón de Diablo (CA-SLO-2) en el continente central de California reveló uno de las sucesiones más viejas y más largas (ca. 9400 años del radiocarbono hace contactar) de la ocupación costera en la costa pacífica del noreste. Los artefactos de estos depósitos importantes fueron informados con todo detalle por Greenwood (1972), pero sólo una fracción de las colecciones de faunal de sitio fue analizada en el informe original del sitio. La adquisición de 30 fechas adicionales de radiocarbono y análisis de la fauna completa del vertebrado ha producido un registro de grano gruesa del humano que adentra en el continente de California de 8300 B.C. al 1769 A.D. La matriz temporalmente controlada de faunal, constituyendo uno de los registros más grandes de trans-Holoceno de Norteamérica occidental, habla en una manera significativa a dos asuntos significativos en la prehistoria de cazador-recolector: Holocene temprano que adentra las estrategias, y la depresión económica del intensificación recurso con el tiempo. El componente más temprano del sitio sugiere a una población invertida en el watercraft e intensamente adaptado al comunica de la tierra y el mar por el litoral pacífico del noreste. Mientras los barcos fueron utilizados para conseguir acceso a piedras cercanas a la costa, mamíferos terrestres (por ejemplo, venado de negro-tailed) fueron también de primordial importancia. La dominación de venado a través de las ocupaciones de Diablo es contradictoria con generalizaciones recientes acerca del juego grande que caza señalar como costoso en la prehistoria norteamericana occidental. La variación diacrónica, tuvo correlación con entierros sobrepuestos que muestran el crecimiento en poblaciones humanas por el Holocene, incluyen: (1) los cambios de incremento modestos en la mayoría de las tasas, sugiriendo la estabilidad del recurso y la anchura creciente de la dieta; (2) la variación gradual pero significativa en unas pocas tasa, inclusive el pato incapaz de volar que fue cazado en la extinción y finalmente reemplazado por nutrias de mar; (3) el cambio puntuado y multi-direccional durante el tarde Holocene relacionó a contingencias históricas de las interrupciones Climáticas Medievales de Anomalía y protohistoric.

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Over the last 20 years the California coast has emerged as a major testing ground for hunter-gatherer theory. Optimal foraging, economic intensification, extensification, overexploitation, neo-Marxism, costly signaling, and other theories have been applied to the California coast, all with varying degrees of credulity. With notable exceptions (e.g., Arnold's [1992a, 1992b, 2001] focus on beads and craft specialization and Basgall's [1987] artifact-based economic intensification model), most of these applications have focused on faunal remains, particularly those from highly stratified deposits on the Channel Islands. In the last two decades, Channel Island archaeologists have demonstrated that certain coastal resources (e.g., shellfish and fish) were exploited much earlier (ca. 10,000–8000 cal B.C.) than previously thought (Erlandson et al. 1996; Rick et al. 2001), and that their use varied over time. Even on the islands, however, long-term faunal sequences that provide critical tests for hunter-gatherer theory have been mostly pieced together with data from multiple, short-duration components, and trans-Holocene faunal collections from single sites are extremely rare. While sequences constructed from multiple sites can be quite valuable (e.g., Butler and Campbell 2004), assemblages from single sites avoid problems related to variability in habitats and methods of identification (see Gobalet 2001).

In this paper we present findings from CA-SLO-2, one of six sites excavated at Diablo Canyon on the central California mainland coast in 1968 (Figure 1). While the artifact collection from this site was described in detail (Greenwood 1972), only a portion of the faunal remains was identified in the original site report. The full collection reported here includes over 23,000 bird, mammal, reptile, and fish remains with over 12,000 identified to a meaningful taxonomic level (genus for mammals and birds; family for fish). Findings from two column samples are also available from the original site report in which an additional 12,165 fish bones were reported (Fitch 1972).

Originally dated with three radiocarbon assays, 30 additional dates now show that the faunal assemblage from CA-SLO-2 is derived from four intermittent occupations between ca. 8300 cal B.C. and historic contact (A.D. 1769), making this one of the largest trans-Holocene faunal collections from

western North America. Owing to the unfortunate realities of mainland environments (e.g., the presence of ground-burrowing animals), the sequence is more coarse-grained than those from the islands or the stratified caves of the Great Basin. Nonetheless, it speaks in a meaningful way to two significant issues in the hunter-gatherer prehistory: early Holocene adaptations, and economic intensification/resource depression over time. In contrast with the southern California islands, the Diablo Canyon fauna show very few dramatic changes, instead reflecting continuity of a broad-spectrum hunting strategy that incorporated both marine and terrestrial taxa. The site's initial Holocene component (8300–6500 cal B.C.) shows an intriguing coastal adaptation in which watercraft were used to access offshore rocks but terrestrial mammals were also of primary importance with a singular focus on black-tailed deer (*Odocoileus hemionus*). Dominance of deer throughout the Diablo occupations conflicts with recent generalizations about big-game hunting as costly signaling in western North American prehistory. Reconciliation of the variability in early Holocene hunting strategies represented by Diablo Canyon as well as certain diachronic patterns can only be accomplished by supplementing notions of optimality, efficiency, and other evolved aptitudes with recognition of local environmental factors, historical contingencies (e.g., coastal colonization and the Medieval Climatic Anomaly), and by considering artifact patterns in tandem with the faunal data.

Early Holocene Adaptations

Perceptions of the earliest coastal prehistory of the northeastern Pacific have advanced dramatically in the last 20 years as finds from the northern Channel Islands (Erlandson 1993, 2001, 2002; Erlandson et al. 1996, 2007; Johnson et al. 2002; Rick et al. 2001) have demonstrated that humans were using watercraft and exploiting fish and shellfish as early 10,000–9000 cal B.C. (Erlandson et al. 2007; Rick et al. 2001). Although issues remain concerning the technological bases of these early island adaptations (see Cassidy et al. 2004; DesLauriers 2005; Erlandson, Braje, Rick, and Peterson 2005; Erlandson et al. 2007; Rondeau et al. 2007), any interpretation of western North American prehistory must, based on the island findings, recog-

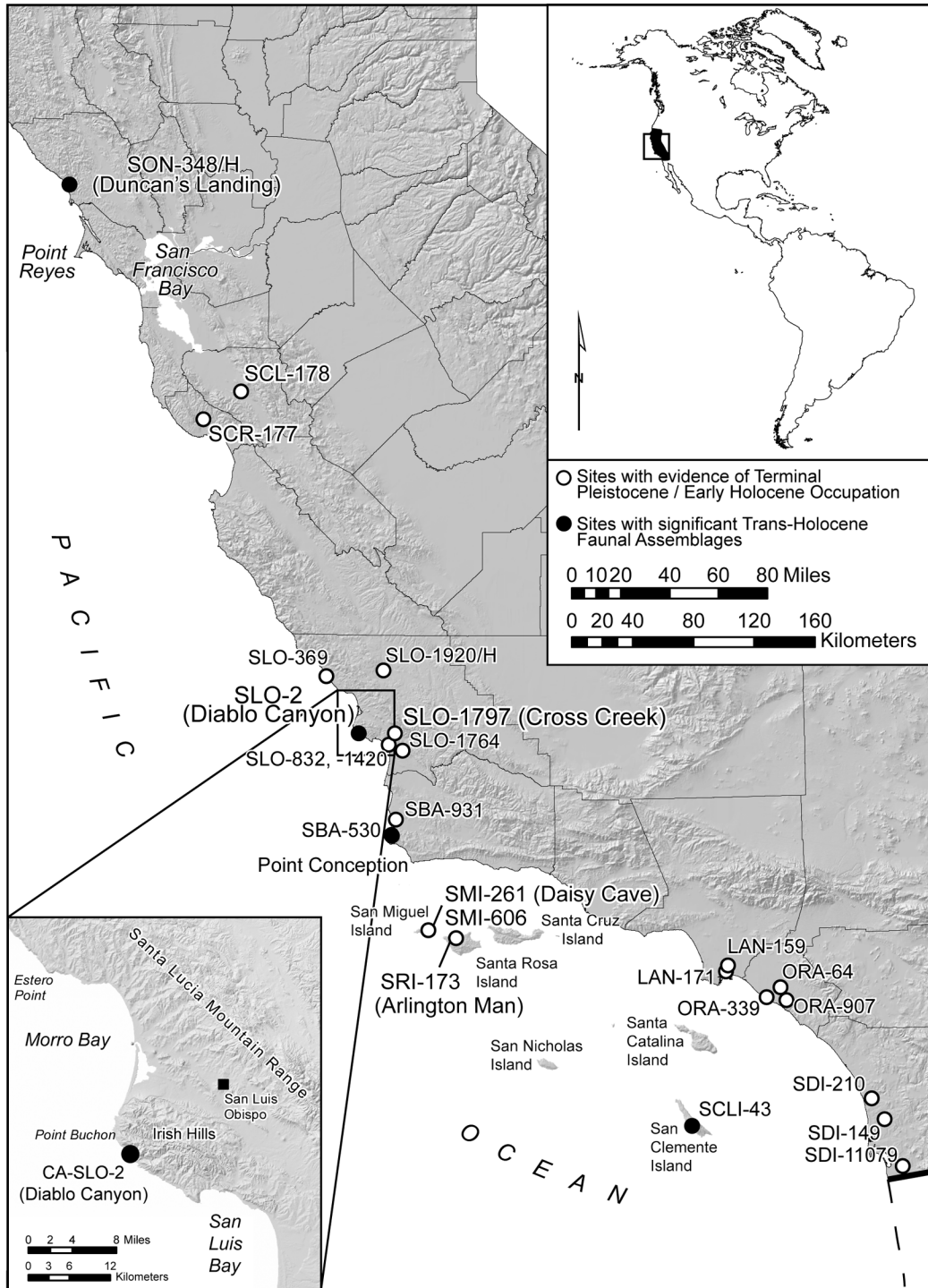


Figure 1. CA-SLO-2 and other Terminal Pleistocene/early Holocene sites on the California Coast.

nize the antiquity of nearshore and littoral adaptations, and the use of watercraft. Lacking terrestrial mammals after the extinction of megafauna, however, the islands alone may not provide a complete definition of the foraging strategies that accompanied initial human colonization of the northeastern Pacific. Data from mainland coastal contexts are needed to compliment the island findings since any possible coastal migration route into North America would have been marked by a much broader array of resources than the more limited suite found on the southern California islands.

Much discussion of the subsistence base associated with these earliest coastal populations has been framed in optimal foraging theory (e.g., Erlandson 1991; Jones 1991; Kennett 2005:120; Raab and Yatsko 1992; Rick et al. 2005). In most cases, researchers have sought to portray the diet of early colonists as a match for predictions of either a diet breadth or patch choice construct. Of late, such interpretations have focused heavily on the California Millingstone Culture that, as one of the oldest cultural complexes on the mainland, has been frequently characterized as an optimal adaptation focused heavily on gathered foods (e.g., shellfish, seeds, and yucca) (Erlandson 1991; Jones 1996; Jones et al. 2002) and small game (Hildebrandt and McGuire 2002; McGuire and Hildebrandt 1994). The importance of shellfish to early Holocene coastal populations has been repeatedly demonstrated from the California archaeological record (Erlandson 1994; Erlandson, Vellanoweth, Rick, and Reid 2005; Fitzgerald 2000; Fitzgerald and Jones 1999; Jones 2003; Jones et al. 2002), but the importance of small game is more ambiguous. Relying on certain ethnographic observations (e.g., Hawkes 1990, 1991, 1993), McGuire and Hildebrandt (1994; Hildebrandt and McGuire 2002) argue that trapping of small and medium-sized game (e.g., rabbits and birds) was the optimal subsistence mode for early Holocene foragers, and that the pursuit of big game (including deer) was actually a suboptimal activity that emerged only later when climatic amelioration and increased human population provided a viable arena for high levels of social competition via costly signaling. The basis of their model is the realization that while larger-bodied taxa tend to have higher average post-encounter return rates (e.g., Bayham 1979; Griffiths 1975; Simms 1985; Ugan 2005), actual hunting

success had been shown to be extremely variable in some ethnographic settings due to high search and pursuit failures (e.g., Hawkes 1990, 1991, 1993, 1996; Hawkes et al. 1991, 2001), which may be due to a prey's relative mobility (Sih and Christensen 2001). If nothing else, these challenges to typical archaeological applications of optimal foraging theory suggest that body mass is not a viable measure of prey rank and that to distinguish between reliable and variable hunting, researchers should pay close attention to local environmental circumstances (e.g., Elston and Zeanah 2002; Hockett 2005; Zeanah 2004).

CA-SLO-2 at Diablo Canyon is one of 23 coastal or peri-coastal sites in California that have produced radiocarbon evidence for occupation between 11,000 and 7000 cal B.C. (Erlandson et al. 2007; Porcasi 2008) (Figure 1), although only two of these (Daisy Cave and Arlington Man) have produced substantial evidence for pre-8000 cal B.C. habitation. The majority of the earliest coastal sites have yielded extremely small collections of bird and mammal remains. Many of the larger assemblages including those from CA-SON-348/H (Kennedy et al. 2005; Porcasi 2008; Schwaderer 1992; Wake and Simons 2000) and CA-SCL-178 (Fitzgerald and Porcasi 2003) are dominated by rabbits and conform with Hildebrandt and McGuire's generalizations about early Holocene faunal exploitation. Nonetheless, the available sample for the earliest Holocene is sufficiently limited that new findings from a substantial collection like that of Diablo Canyon are potentially meaningful and important, especially as they stand to shed light on the variable expressions of past human adaptations in response to local environmental conditions.

Economic Intensification and Resource Depression/Extirpation

Long-term faunal records are particularly valuable for their potential to evaluate diachronic predictions from optimal foraging and/or other behavioral ecological models (Bettinger 1991:100), and fauna-based regional models of hunter-gatherer resource intensification have become increasingly common in California (Broughton 1994a, 1994b, 1997, 1999, 2002; Perry 2004) and elsewhere (e.g., Butler and Campbell 2004; Lourandos 1983; Matson 1983; Zvelebil 1989). Many of these suggest that

increasing reliance on lower-ranked taxa through time was the result of localized suppression or extirpation of higher-ranked species as a result of over-exploitation (e.g., Broughton 1994a, 1994b, 1997, 1999, 2002; Hildebrandt and Jones 1992; Jones et al. 2004; Kay and Simmons 2002; Lyman and Wadley 2003; Salls 1992). In light of such efforts, economic intensification has become essentially an assumption of California prehistory despite less than compelling empirical support in some cases. In the absence of such evidence, recent models have challenged some of the prevailing assumptions about foraging efficiency over time. Hildebrandt and McGuire (2002) and McGuire and Hildebrandt (2005) in particular have proposed a logical diachronic extension of their characterization of early Holocene optimality, suggesting that increased pursuit of deer in western North America resulted from amelioration of climate and reduction of demographic stress at the end of the mid-Holocene climatic optimum. Increased environmental productivity ostensibly lessened pressures on individuals and provided male hunters the opportunity to engage in riskier hunting strategies with more variable return rates, thereby creating a new arena for social competition in which hunting success honestly signaled an individual's underlying qualities and could have ultimately resulted in the achievement of higher status (see Bliege Bird and Smith 2005; Bliege Bird et al. 2001; Grafen 1990a, 1990b; Smith 2004; Zahavi 1975). This interpretation was subsequently challenged on empirical grounds by Broughton and Bayham (2003) and Byers and Broughton (2004) who suggested that deer simply were not present in much of western North America during the mid-Holocene optimum (see also Hockett 2005; Zeanah 2004). Following the standard predictions of diet breadth (or prey choice) models (see Schoener 1971; Stevens and Krebs 1986), they state that mid-Holocene increases in deer exploitation reflect the greater availability of the species on the landscape. With an exceptionally large sample of deer remains from trans-Holocene contexts, the Diablo Canyon collection is extremely relevant to issues raised in this debate.

Limiting the value of diet breadth applications in California, however, is the fact that opportunities to record ethnographic animal exploitation practices and define resource return rates had long

passed by the time that optimal foraging theory was developed. There are no accurate ethnographically based resource return values for Native California foods and their absence limits the potential to apply optimal foraging constructs in a strict hypothetical-deductive framework. In the absence of such values, researchers have relied on estimates based on historical ethnography (Simms 1985), experimentation (e.g., Jones and Richman 1995; Jones and Ferneau 2002; Raab 1992), and ethnoarchaeological observations from other parts of the world (e.g., Bliege Bird and Bird 1997). In our treatment of the Diablo fauna we refer to these estimates, but treat the values as guides for interpretation rather than a basis for strict resource ranking. Given that the local failure rates for such taxa are unknown and that the site collection includes the remains of one extinct taxon (the flightless duck [*Chendytes lawi*]) and another (the sea otter [*Enhydra lutris*]) whose modern range and habitat differ considerably from pre-contact situations, developing or applying conjectural quantitative return values in a rigid fashion seems unwarranted.

The Diablo Canyon Site (CA-SLO-2) and Its Fauna

CA-SLO-2 is an unusually large (ca. 400 x 320 m), deep midden, situated on a narrow coastal terrace on the north bank of Diablo Creek in San Luis Obispo County, California. The site is one of nearly 50 shell middens on the coastal edge of a 20-km long peninsula that extends 8 km into the Pacific Ocean between Morro and San Luis Obispo bays (Figure 1). Low coastal mountains known as the Irish Hills rise to elevations of 550 m immediately to the east of the coastal terrace upon which CA-SLO-2 is situated. Covering an area of ca. 150 km², the Irish Hills consist of a series of narrow, steep ridges and intervening drainages covered with a dense mosaic of coastal oaks, chaparral, and occasional grassland. Few archaeological sites have been recorded in the Irish Hills, and the area today still has a low number of inhabitants and serves as an informal game refuge.

Excavation Sampling Methods

Of the six sites investigated by Roberta Greenwood in 1968 in anticipation of construction of Diablo Canyon Nuclear Power Plant, CA-SLO-2

was the deepest and most complex. The site was in the direct impact area of a road that was planned as an access to a power plant, and Greenwood's investigations were undertaken to mitigate the impacts of the road construction. She employed a mixed recovery strategy that was designed to sample artifacts, and micro- and macro-faunal remains effectively. In the area of her investigations, the site extended to a depth of 3.4 m. A total of 30 1-x-2-m units were excavated in arbitrary 10-cm levels and processed with 6 mm mesh. Two column samples were recovered for microanalysis: a .25-x-.25-m column excavated to the base of the deposit (.8 m³) that was water-processed with 1 mm mesh to recover fish bones, and a 1-x-1-m unit, processed with nested 6 mm and 3 mm ($\frac{1}{8}$ inch) mesh to recover shell remains. Greenwood (1972:5) reported a total recovery volume of 109 m³, but data from only 98.9 m³ were available for the current study due to attrition of the collection during its 35 years in storage. Findings from the fish column (Fitch 1972) and shell column were reported in detail in the 1972 monograph, as was the site's artifact collection (Greenwood 1972).

*Stratigraphy, Cultural Chronology,
and Distribution of Temporal Components*

As is often the case on the California mainland, Greenwood (1972) found that the deep midden at CA-SLO-2 was relatively homogeneous with little evidence of discrete layering or physical stratigraphy. Rather, she noted a gradual transition in soil color between the upper (0–150 cm; black), middle (150–250 cm; very dark brown), and basal (250–340 cm; very dark yellowish brown) levels. A distinct calcium carbonate precipitate (caliche) was noted below 150 cm, which is common in deposits of early and middle Holocene in the region. In the absence of physical stratigraphy, Greenwood relied on three radiocarbon dates and a robust assemblage of formal artifacts to define three cultural components: a basal variant of the California Millingstone Culture, dating ca. 9,400–5,000 years ago; a Hunting Culture component in the middle levels of the deposit, dating ca. 5,000–1,000 years ago; and a Late Period or Canaliño component, post-dating 1,000 years ago, above 120 cm. Two radiocarbon dates in excess of 9,000 radiocarbon years from the base of the deposit made CA-SLO-

2, at the time of its reporting, one of the oldest coastal sites in North America.

A total of 34¹ radiocarbon dates is now available from CA-SLO-2 (Table 1). This enhanced chronometric data base generally corroborates Greenwood's cultural-stratigraphic assessment of the site's occupational history, although four components can now be recognized rather than three (Table 2). Radiocarbon results also indicate some vertical, intercomponent mixing due to rodent activity and the presence of 66 human burials. The four temporal components exhibit reasonable superposition (Figure 2), but bioturbation from rodent activity is an unfortunate reality on the California mainland that forces researchers to rely on sequences more coarse-grained than those from the Channel Islands. Even the nearby Cross Creek Site, which is contemporaneous with the oldest levels at Diablo Canyon and exhibited exceptional physical stratigraphy, was also compromised by some intercomponent mixing (Fitzgerald 1998, 2000; Jones et al. 2002). The 33 radiocarbon dates that define the Diablo sequence show a distinctive trend toward superposition. On the most coarse-grained level, occupation below 200 cm marks the early Holocene between 8300 and 3000 cal B.C., while the late Holocene (1600 cal B.C.–contact) is represented above 200 cm. Of 16 radiocarbon dates obtained from below 200 cm, only one (1600 cal B.C.) reflects down-mixing of late Holocene materials into the early Holocene levels. Five early Holocene dates, however, were recovered from above 200 cm reflecting the upward movement of older materials into the late Holocene levels. The radiocarbon record further exhibits a distinctive occupational hiatus of 1,400 years separating the early and late Holocene occupations, but this period of abandonment is not distinguished by a visible soil stratum. These early and late Holocene macro-components can be further divided into shorter-duration cultural subcomponents. The lowest arbitrary levels (280–340 cm; component I) mark an early Holocene variant of the California Millingstone Culture, comparable to that found at the Cross Creek site (CA-SLO-1797; Fitzgerald 1998, 2000; Jones et al. 2002). A later, more substantive Millingstone expression dating 7000–3000 cal B.C. occurs between 200 and 280 cm (component II). Three human burials were associated with the Millingstone levels (one Early and two Late). Site use dur-

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Table 1. Calibrated R.A.D. iocarbon Dates from CA-SLO-2.

Unit	Specimen No.	Lab No.	Depth (cm)	Material	Species	Conventional 14C Age	Calibrated age A.D./B.C. 1 sigma (ΔR=290±35)	Reference
N7-W14		Beta-216557	0-10	Shell	<i>Tegula</i> sp.	1690±40	A.D. 970 (1015) 1050	
N4W2	3065A	Beta-197948	20-30	Shell	<i>Saxidomus nuttalli</i>	1020±40	A.D. 1510 (1560) 1650	
N4W2	3069A	Beta-206358	30-40	Shell	<i>Mytilus californianus</i>	2170±40	A.D. 460 (540) 600	
N10-W12	3402A	Beta-192958	30-40	Shell	<i>Mytilus californianus</i>	1740±100	A.D. 830 (970) 1050	
N1W1	2917A	Beta-197946	40-50	Shell	<i>Tegula</i> sp.	940±100	A.D. 1530 (1660) 1720	
N1 W5	3011A	Beta-204126	60-70	Shell	<i>Mytilus californianus</i>	2130±70	A.D. 470 (580) 660	
N10-W13	3444A	Beta-206359	70-80	Shell	<i>Mytilus californianus</i>	2140±40	A.D. 500 (570) 630	
N10-W1	3298A	Beta-192956	80-90	Shell	<i>Mytilus californianus</i>	6740±90	5090 (4980) 4850 B.C.	
S1W12	3620A	Beta-204128	90-100	Shell	<i>Cryptochiton stelleri</i>	2100±40	A.D. 550 (610) 660	
N10 W13	3453A	Beta-204129	110-120	Shell	<i>Mytilus californianus</i>	2360±40	A.D. 250 (320) 390	
S4W1	3670A	Beta-197951	110-120	Shell	<i>Mytilus californianus</i>	1660±90	A.D. 950 (1030) 1150	
N4-W5		UCLA-1686B	120	Bone		1010±85	A.D. 1510 (1590) 1660	Greenwood (1972)
S4W2	CHEN	Beta-206363	120-130	Bone	<i>Chendytes lawi</i>	7510±40	5770 (5720) 5680 B.C.	
N10-W4	3334A	Beta-192959	130-140	Shell	<i>Balanus</i> sp.	1870±80	A.D. 710 (800) 910	
S1-W1	3629A	Beta-216559	140-150	Shell	<i>Balanus</i> sp.	3270±40	830 (800) 770 B.C.	
S1 W12	3631A	Beta-204130	160-170	Shell	<i>Cryptochiton stelleri</i>	5130±40	3310 (3180) 3080 B.C.	
N1-W5	3017A	Beta-192960	170-180	Shell	<i>Mytilus californianus</i>	2880±90	400 (340) 190 B.C.	
S1-W1		Beta-170138	180-190	Shell	<i>Hinnites</i> sp.	6560±80	4850 (4770) 4680 B.C.	Farquhar (2003)
N1-W1		Beta-170137	200-210	Shell	<i>Haliotis</i> sp.	6090±80	4340 (4260) 4210 B.C.	Farquhar (2003)
S1-W1	3589A	Beta-192957	200-210	Shell	<i>Balanus</i> sp.	5220±120	3490 (3330) 3100 B.C.	
N4-W4		Beta-170139	220-230	Shell	<i>Tivela stultorum</i>	5600±80	3800 (3700) 3630 B.C.	Farquhar (2003)
S4-W2	3713A	Beta-206360	230-240	Shell	<i>Balanus</i> sp.	5150±40	3320 (3260) 3100 B.C.	
NE1/8-N1-W22	3552	Beta-216558	240-250	Shell	<i>Tegula</i> sp.	5550±40	3710 (3650) 3630 B.C.	
N4W2	3910A	Beta-197949	250-260	Shell	<i>Mytilus californianus</i>	5700±40	3920 (3810) 3760 B.C.	
N4-W1		Beta-216556	250-260	Bone	<i>Odocoileus hemionus</i>	3260±40	1600 (1520) 1460 B.C.	
N1-E4		Beta-216555	260-270	Bone	<i>Odocoileus hemionus</i>	7110±40	6010 (5990, 5940, 5930) 5920 B.C.	
S1W12	3655A	Beta-197950	280-290	shell	<i>Mytilus californianus</i>	8340±40	6630 (6550) 6470 B.C.	
N1/W5		GAK-02044	290	Shell	<i>Haliotis</i> sp.	9780±260	9180 (8320) 7540 B.C.	Greenwood (1972)
N1-W4	3974	SR-6833	290-300	Bone	<i>Chendytes lawi</i>	8355±25	6630 (6570) 6490 B.C.	
S1 W12	3658A	Beta-204132	290-300	Shell	<i>Balanus</i> sp.	5120±40	3300 (3170, 3150, 3140) 3080 B.C.	
N1W4	2999A	Beta-197947	290-300	Shell	<i>Balanus</i> sp.	5040±40	3100 (3020) 2930 B.C.	
NE-S4-W9	3557A	Beta-192961	330-340	Shell	<i>Collisella</i> sp.	8620±50	6970 (6920) 6850 B.C.	
NE-S4-W9	3557B	Beta-192962	330-340	Shell	<i>Mytilus californianus</i>	8300±50	6590 (6480) 6440 B.C.	
S4/W9		UCLA-1686A	320-330	Bone	Human	9480±175*	9240 (8780, 8770, 8750) 8330 B.C.	Greenwood (1972)

All dating samples composed of single bone or shell fragments. Dates calibrated with the program CALIB 3.3 (Stuiver and Reimer 1993). Rounded calendar ages include midpoint (in parentheses) and age range at one sigma. ΔR from Ingram and Southon (1996).

*Rejected due to unreliability of collagen extraction techniques.

Table 2. Component Summary, CA-SLO-2.

Component	Depth (cm)	Geologic Age	Cultural Period	Radiocarbon Dates (N)	Calendric Age (calibrated)	Excavation volume (m ³)
IV	0-70	Late Holocene	Late Period	3	A.D. 1500-contact	29.0
III	70-200	Late Holocene	Middle Period (Hunting Culture)	11	1500 B.C.- A.D. 1000	49.5
II	200-280	Early Holocene	Late Millingstone	8	5000-3000 B.C.	17.4
I	280-340	Initial Holocene	Early Millingstone	7	8300-6500 B.C.	3.0
Total				29*		98.9

*Four non-superpositioned dates excluded.

ing the late Holocene is marked primarily by a Middle Period component dating 1600 cal B.C.- cal A.D. 1000 (component III), with a very minor occupation during the Late Period between cal A.D. 1500 and contact (component IV). As with many sites on the central California mainland, CA-SLO-2 was abandoned during most of the Medieval Climatic Anomaly (cal A.D. 800-1350; Stine 1994), with an occupational hiatus evident between cal A.D. 1000 and 1500. A total of 63 human burials was associ-

ated with the late Holocene occupation, contributing substantially to mixing of materials between the Middle and Late Period components. However, the superimposed early ($N = 3$) and late ($N = 63$) Holocene burial populations provide rare empirical support for population growth within the immediate site vicinity over the course of the Holocene. This renders CA-SLO-2 unusually important with respect to theoretical models that incorporate population pressure as a causal variable.

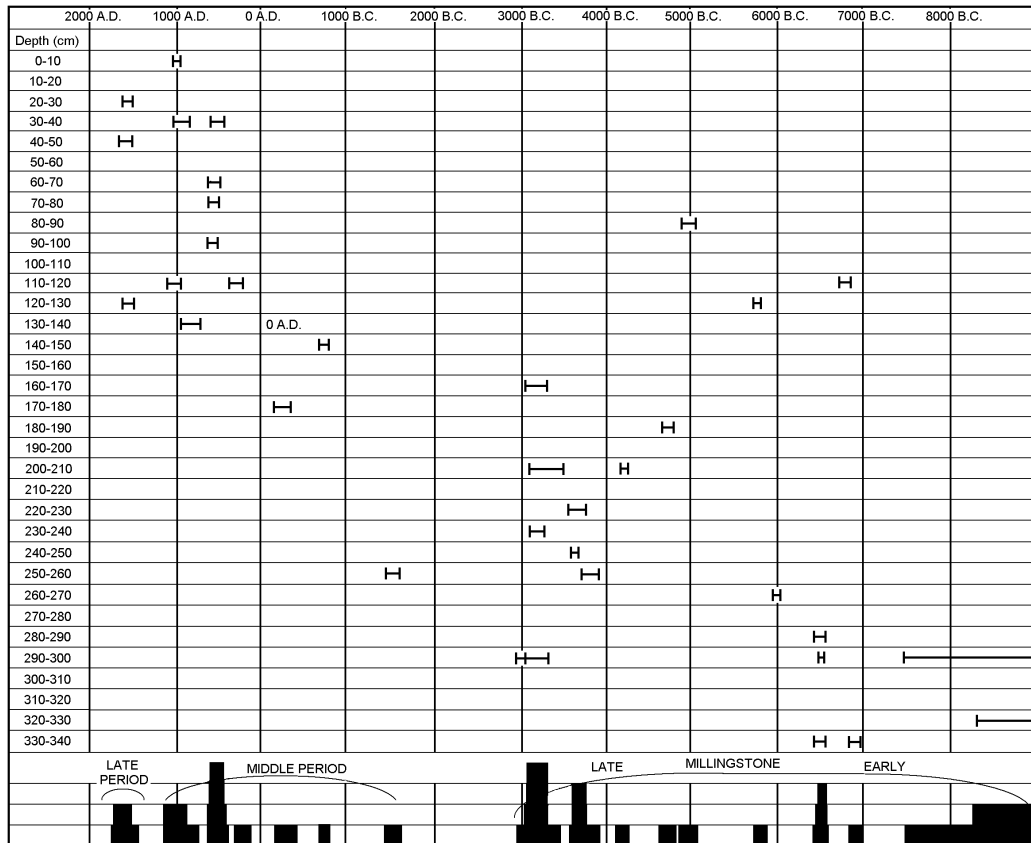


Figure 2. Depth-distribution of radiocarbon dates from CA-SLO-2.

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Table 3. Vertical Distribution of Temporal Markers, CA-SLO-2.

Component	Cottonwood Arrow points	Notched Stone Weights	Grooved Stone Net weights	Shell Fishhooks	Flightless Duck (<i>Chendytes lawi</i>) Bones	Total
IV (Late Period)	1	18	3	18	1	41
III (Middle Period)	1	5	6	22	7	41
II (Late Millingstone)	0	1	0	0	50	51
I (Early Millingstone)	0	0	0	0	8	8
Total	2	24	9	40	66	141

The coarse-grained character but overall vertical integrity of the occupational components represented at Diablo Canyon are attested to by the distribution of secure temporal markers (Table 3). Bones from the flightless duck (*Chendytes lawi*) that went extinct early in the late Holocene ca. 500 cal B.C. are most abundant in the Millingstone and Middle Period levels of the deposit. One bone recovered from Late Period contexts, postdating the species' extinction, reflects upward mixing. The presence of only two Cottonwood arrow points is consistent with relatively minor use of the site during the Late Period. One of these was found in the Middle Period excavation levels as a product of downward, intercomponent mixing. Certain fishing-related implements (notched and grooved stone weights, circular shell hooks) dated no ear-

lier than 1500 cal B.C. in central and southern California (Jones 2003; Jones et al. 2007; King 1990; Rick et al. 2002), were almost wholly restricted to the Middle and Late Period levels at Diablo Canyon. Only one of these late Holocene artifacts was recovered from below 200 cm.

Component Function

Interpretation of the Diablo Canyon fauna cannot be disassociated from the site's role in regional settlement systems since any change in the character of site use could contribute substantially to variation in the relative frequency of taxa (Binford 1978, 1980). While some variation in flaked stone technology has been noted (Farquhar 2003), the overall Diablo tool assemblages show consistent diversity (Table 4) that Greenwood (1972) attrib-

Table 4. Component Artifact Assemblages, CA-SLO-2.

Artifact	IV		III		II		I		Total N
	N	%	N	%	N	%	N	%	
Milling slabs	1	.08	1	.13	0	.00	0	.00	2
Handstones	2	.16	1	.13	8	2.91	1	2.44	12
Mortars	17	1.39	6	.78	3	1.09	0	.00	26
Pestles	17	1.39	8	1.04	4	1.45	0	.00	29
Pitted stones	387	31.75	188	24.51	31	11.27	7	17.07	613
Projectile points	161	13.21	104	13.56	31	11.27	2	4.88	298
Other bifaces	144	11.81	122	15.91	62	22.55	5	12.20	333
Scrapers/Flake tools	374	3.68	250	32.59	110	4.00	17	41.46	751
Choppers	19	1.56	16	2.09	9	3.27	2	4.88	46
Hammerstones	33	2.71	16	2.09	10	3.64	2	4.88	61
Shell fishhooks	18	1.48	22	2.87	0	.00	0	.00	40
Notched stones	18	1.48	5	.65	1	.36	0	.00	24
Grooved stones	3	.25	6	.78	0	.00	0	.00	9
Tarring pebbles	7	.57	6	.78	1	.36	0	.00	14
Bone awls	15	1.23	12	1.56	4	1.45	5	12.20	36
Bipointed bone gorges	3	.25	4	.52	1	.36	0	.00	8
Subtotal	1219	10.00	767	10.00	275	10.00	41	10.00	2302
Margalef Diversity Index*	2.111	-	2.258	-	2.136	-	1.885	-	1.938
Shell beads	233	-	1,246	-	23	-	4	-	1506
Grand total	1,452	-	2,013	-	298	-	45	-	3808

* Index calculated for all artifacts except shell beads; formula from Magurran (1988).

uted to continuity in the basic adaptation through time. Artifacts associated with the site's basal occupation (component I) were relatively sparse, but all of the temporal components yielded diverse arrays of ground stone (handstones, milling slabs, mortars, pestles, and/or pitted stones), bone awls, projectile points, bifaces, scrapers, and debitage that reflect a wide range of domestic and subsistence activities. CA-SLO-2 clearly functioned as a residential base during all four periods of its habitation, an assessment further supported by the association of human interments with each temporal component. The only significant change in the tool inventory over time was the addition of fishing implements (circular shell hooks, notched and grooved stones) during the late Holocene that we interpret as technological innovations unrelated to any change in the overall character of site use.

Analytical Methods

The faunal sample included all bird, mammal, reptile, and fish remains recovered from the excavation of 1-x-2-m units processed with 6 m mesh. Faunal identifications were made through direct comparison with museum-curated specimens. For birds, mammals, and reptiles, reference collections from the Los Angeles County Museum of Natural History and the Zooarchaeology Laboratory at the Cotsen Institute of Archaeology at University of California, Los Angeles were used, while reference materials on file at the Department of Biology, California State University, Bakersfield, were used for fish remains. All specimens were identified to the most discrete taxonomic level possible based on diagnostic features. In the absence of such features, unidentifiable bones were assigned to classes (i.e., mammal, aves, etc.), and (for birds and mammals) to size categories (small, medium, or large). In addition, the element, part of element, side, age, number, weight, and evidence of modification (i.e., burned, gnawed, cut, or worked) were, to the degree possible, recorded for each specimen. For fish remains only the element and its weight were recorded. For deer bones, which were a major part of the assemblage, MNIs were calculated for each unit level. All artiodactyl elements were also assigned values based on Metcalfe and Jones's (1988; see also Binford 1978) standardized whole bone food utility index (FUI), to examine variability in element representation and butchering strate-

gies. Overall dietary trends were evaluated by calculating the Margalef Index to evaluate diet breadth and the Berger-Parker index (in reciprocal form) to evaluate evenness or relative specialization (Magurran 1988) using the combined sample of bird, mammal, and fish remains recovered with the same sampling technique (6 mm mesh). Fish bone data reported by Fitch (1972) based on micro-recovery techniques (1 mm mesh) were considered in tandem with the findings from the larger mesh sampling to compensate for the fish bone that was likely missed with the larger aperture mesh used to excavate units. Fitch used a microscope to sort and identify fish bones, and took ca. 900 hours to complete his identifications (Fitch 1972:102). Most of the micro-elements he identified were otoliths, teeth, and vertebrae.

Bird, Mammal, and Reptile Remains

A total of 13,517 bird, mammal, and reptile remains was identified, including specimens from of a variety of small burrowing animals (e.g., the Botta's pocket gopher [*Thomomys bottae*], and California ground squirrel [*Spermophilus beecheyi*]). Eliminating all of these possibly intrusive elements and further restricting analysis to specimens identified to the genus level or better, the sample includes 2789 NISP (Table 5), representing 29 species of birds, 15 terrestrial mammals, 7 marine mammals, and one reptile (the western pond turtle [*Clemmys marmorata*]). Overall, the collection is dominated by the remains of black-tailed deer (NISP = 1201; 43 percent), sea otters (*Enhydra lutris*; NISP = 431; 15.5 percent), cottontail rabbits (*Sylvilagus* sp.; NISP = 365; 13.1 percent), and cormorants (*Phalacrocorax* sp.; NISP = 278; 9.9 percent). All of these species are present in the site vicinity today with deer and cottontails abundant in the chaparral, grassland, and woodlands in the Irish Hills immediately to the east.

The site's basal component (NISP = 44) showed a preponderance of black-tailed deer (NISP = 18; 40.1 percent), cottontail rabbit (NISP = 8; 18.2 percent), and the extinct flightless duck (*Chendytes lawi*; NISP = 8; 18.2 percent). Aquatic birds overall, including the sooty shearwater (*Puffinus griseus*) and the flightless duck account for 38.6 percent of the NISP. Component II (Late Millingstone) was dominated by black-tailed deer (NISP = 187; 44.6 percent), cottontail rabbit (NISP = 66;

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Table 5. Bird, Mammal, and Reptile Remains from CA-SLO-2 identified to the Genus Level or Better.

Taxon	Common Name	Late Period		Middle Period		Late Millingstone		Early Millingstone		Total	
		NISP	%	NISP	%	NISP	%	NISP	%	NISP	%
Terrestrial Mammals											
<i>Canis</i> sp.	Dog/Coyote	19	2.76	77	4.70	10	2.39	1	2.27	107	3.84
<i>Lepus californicus</i>	Jack rabbit	0	.00	2	.12	1	.24	0	.00	3	.11
<i>Odocoileus hemionus</i>	Black-tailed deer	323	46.95	673	41.09	187	44.63	18	4.91	1201	43.06
<i>Sylvilagus</i> sp.	Cottontail rabbit	70	1.17	221	13.49	66	15.75	8	18.18	365	13.09
Other Terrestrial Mammals (n = 11)		16	5.80	23	3.46	4	2.58	0	.00	43	3.86
Subtotal		428	62.21	996	6.81	268	63.96	27	61.36	1719	61.63
Marine Mammals											
<i>Enhydra lutris</i>	Sea otter	136	19.77	278	16.97	17	4.06	0	.00	431	15.45
<i>Phoca vitulina</i>	Harbor seal	26	3.78	70	4.27	21	5.01	0	.00	117	4.20
<i>Zalophus californianus</i>	California sea lion	12	1.74	15	.92	2	.48	0	.00	29	1.04
Other Marine Mammals (n = 4)		5	.97	5	.39	3	.79	0	.00	13	.59
Subtotal		179	26.26	368	22.55	43	1.34	0	.00	590	21.28
Reptile											
<i>Chelmyis marmorata</i>	Western pond turtle	4	.58	9	.55	1	.24	0	.00	14	.50
Subtotal		4	.58	9	.55	1	.24	0	.00	14	.50
Non-Marine Birds											
Non-Marine Birds (n = 5)		3	.44	11	.49	0	.00	1	2.27	14	.43
Subtotal		3	.44	11	.67	0	.00	1	2.27	15	.54
Marine Birds											
<i>Chendytes lawi</i>	Flightless duck	1	.15	7	.43	50	11.93	8	18.60	66	2.38
<i>Pelecanus</i> sp.	Pelican	2	.29	13	.80	3	.72	0	.00	18	.65
<i>Phalacrocorax</i> sp.	Common murre	56	8.18	195	11.99	26	6.21	1	2.33	278	1.02
<i>Uria aalge</i>	Common murre	4	.58	6	.37	8	1.91	1	2.33	19	.68
Other Marine Birds (n = 20)		11	1.77	33	2.35	20	6.02	6	18.18	70	2.93
Subtotal		74	1.76	254	15.51	107	25.54	16	41.44	451	16.17
Grand total		688	10.25	1638	10.09	419	10.08	44	105.07	2789	10.12

Table 6. Identified Artiodactyl and Leporid Specimens and Artiodactyl Index (AI) Values per Component, CA-SLO-2.

Component	Artiodactyl (NISP)	Leporid (NISP)	AI
IV (Late Period)	888 (2.96)	141 (-2.96)	.863
III (Middle Period)	705 (-1.81)	155 (1.81)	.820
II (Late Millingstone)	295 (-1.28)	67 (1.28)	.815
I (Early Millingstone)	27 (-1.07)	8 (1.07)	.771

Parentetical values represent the A.D. justed standardized residuals from χ^2 test performed on the element counts presented in this table ($\chi^2 = 9.38$, $p < .05$; χ^2 trend = 12.37, $p < .001$).

15.8 percent), and the flightless duck (*Chendytes lawi*; NISP = 50; 11.9 percent). Component III (Middle Period) also showed black-tailed deer (NISP = 673; 41.1 percent) as the dominant taxon, followed by sea otter (NISP = 278; 16.9 percent) and cottontail rabbit (NISP = 221; 13.5 percent). Component IV (Late Period) was dominated by black-tailed deer (NISP = 323; 46.9 percent), sea otters (NISP = 136; 19.8 percent), and cottontail rabbit (NISP = 70; 10.2 percent). Clearly, deer were the most important taxon throughout the site's occupation, remaining nearly constant in relative abundance. Variation in other species over time was also apparent as sea otters increased while the flightless duck was gradually exploited into extinction. Other marine mammals were insignificant in the overall assemblage and showed no change. Harbor seals (*Phoca vitulina*), the only pinniped represented in meaningful numbers, accounted for ca. 5 percent of NISP from the late Millingstone Period onward. Marine birds decreased incrementally through the Holocene (from 38.6 percent to 11.2 percent) as did cottontail rabbits, albeit from only 18.2 percent to 10.2 percent.

Black-tailed Deer. Given the evidence in other parts of western North America for minimal use of deer during the early Holocene, the preponderance of deer bone in the Diablo Canyon collections was unexpected, although similar patterns showing the dominance of large game have been noted elsewhere including sites that cross the Pleistocene-Holocene boundary (Jochim 1998). In light of ongoing debate about the efficiency, variability, and social role of hunting large animals like deer (Broughton and Bayham 2003; Byers and Broughton 2004; Codding and Jones 2007; Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005; McGuire et al. 2007), and because the Diablo deer assemblage was so substantial, addi-

tional analyses were completed on these remains relying on Cannon's (2003) central place forager prey choice model.

Cannon's (2003) model essentially relies on two variables: (1) the relative importance of artiodactyls in the diet and (2) the representation of artiodactyl skeletal elements that are used as a proxy for foraging range and thus, relative reliability. First, an Artiodactyl Index was calculated as the ratio of all artiodactyl specimens relative to all artiodactyl specimens plus leporid specimens (e.g., Bayham 1979; Broughton 1994b, 2002; Byers and Broughton 2004; Cannon 2000, 2003; Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005), which shows a relative increase through time (Table 6). A χ^2 test of these values shows that differences in artiodactyl relative abundance between components was significant ($\chi^2 = 9.38$, $p < .05$). Further, to test whether or not the diachronic increase was significant, data were subjected to Cochran's test of linear trend among proportions (cf. Cannon 2000, 2001, 2003), which showed that the temporal increase in artiodactyl proportions over time was highly significant ($\chi^2_{\text{trend}} = 12.37$, $p < .001$), which is consistent with patterns observed elsewhere in western North America (e.g., Byers and Broughton 2004; Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005). This trend is also mirrored in the weight of deer bone/m³ in the deposit over time (Table 7). It should not be overlooked, however, that this relative trend differs substantially from the wholesale replacement of rabbits by deer suggested in arguments made by Hildebrandt and McGuire (2002) and McGuire and Hildebrandt (2005) as deer constituted over 40 percent of all the non-fish vertebrate NISP throughout the entire occupation of CA-SLO-2, including component I. The cause underlying this pattern, however, is ultimately the

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Table 7. Volumetric Bone and Shell Densities per Cubic Meter and Ratios from CA-SLO-2.

Component	Deer Bone Weight (g)/m ³	Fish Bone Weight (g)/m ³	Fish Bone NISP/m ³ (6 mm)	Fish Bone NISP/m ³ (1 mm)	Shell (kg)/m ³	Shell Weight/Deer Bone Weight	Shell Weight/Fish Bone Weight	Deer Bone Weight/Fish Bone Weight
IV	48.2	18.1	98.9	81,325	314.0	6.5	17.3	2.7
III	68.2	22.3	123.9	86,621	364.7	5.3	16.3	3.1
II	45.0	7.2	27.3	21,660	379.7	8.4	52.7	6.3
I	2.1	5.2	23.0	13,760	26.9	13.0	5.2	3.9

Table 8. Mean Artiodactyl Body Part Utility from CA-SLO-2 by Component.

Component	Mean (S)FUI	NISP*	SD	Results of <i>t</i> -tests for difference from mean of null sample†
IV (Late Period)	36.0	99	24.3	$t = -.72, p = .236$
III (Middle Period)	37.1	250	24.2	$t = -.32, p = .374$
II (Late Millingstone)	35.6	64	23.4	$t = -.79, p = .217$
I (Early Millingstone)	44.0	4	38.3	$t = .54, p = .592$

*Number of identified adult and sub-adult specimens to which (S)FUI values could be assigned.

†Mean = 38.2, $n = 118$, $SD = 2.3$.

root of the Hildebrandt and McGuire/Broughton and Bayham debate *vis-à-vis* whether late to mid-Holocene deer increases reflect efficient hunting decisions resulting from higher prey densities spurred by climatic amelioration, or an increased propensity for males to engage in social competition via costly signaling.

In an attempt to determine which explanation best fits with the Diablo data, we relied on the second variable in Cannon's (2003) model, which examines the relative abundance of deer on the landscape through differential butchering practices. Based on the formal model developed by Metcalfe and Barlow (1992; see also Orians and Pearson 1979), changes in butchering practices leading to the deposition of artiodactyl parts with high economic value relative to low economic value would be an anticipated outcome of increases in the distances that hunters were traveling to pursue large game such as deer.² A total of 417 identifiable and nonrepetitive (per unit level) elements was eligible for inclusion in this analysis and was used to calculate mean (S)FUI values for each temporal component (Table 8). An analysis of variance of these values shows no significant difference over time ($F = .249, p = .861$). Moreover, component values did not vary significantly from the FUI values of a null set of elements (i.e., from a whole artiodactyl skeleton). This indicates that throughout the Holocene, foragers from CA-SLO-2 were consistently pro-

cessing and transporting the same sets of skeletal elements back to the residential base; further, these sets never differed significantly from a whole artiodactyl skeleton. This signifies that hunters were frequently able to locate artiodactyls within a relatively short distance, and had no need to extensively process carcasses in preparation for extended transport. While this does suggest that hunting returns did not decrease throughout the Holocene, it says nothing about whether or not returns improved. These results could be due to significantly large hunting parties, which could potentially divide up the load rather than differentially butcher, or to density mediated attrition (see Lyman 1984, 1985, 1994). While the former variable is an unknown, the latter has been shown to be insignificant in a number of other studies (e.g., Cannon 2003; Lupo 1995), and soil acidity, which is the major cause of deterioration of faunal remains in California, was not a problem at CA-SLO-2, which showed soil pH values between 7.0 and 8.4 (Greenwood 1972:49). Furthermore, an examination of deer age profiles also suggests that deer were relatively abundant throughout the Holocene, as there was no obvious change in the deer age profile over time (Table 9). The Diablo Canyon inhabitants apparently exploited a consistently reliable deer population in the adjacent Irish Hills throughout the Holocene, increasing their exploitation slightly during the late Holocene, but never to the degree that

Table 9. Age Distribution of Black-tailed Deer (*Odocoileus hemionus*) from CA-SLO-2.

	Late Period (Component IV)		Middle Period (Component III)		Late Millingstone (Component II)		Early Millingstone (Component I)		Total NISP
	NISP	%	NISP	%	NISP	%	NISP	%	
Adult	147	85	342	82	90	80	6	86	587
Juvenile	17	10	44	11	13	12	1	14	75
Juvenile (neonate or fetal)	0	0	6	1	2	2	0	0	8
Sub-adult	9	5	26	6	8	7	0	0	43
Total	173	100	418	100	113	100	7	100	714

populations became sparse, or that deer became less important than rabbits.

Fish

A total of 9,646 fish bones was identified from the 6 mm sample; 6,070 to the family level or better (Table 10). Among the 30 taxonomic classes represented in the identifiable sample, the remains of rockfish (*Sebastes* sp.; NISP = 2,788) and cabezon (*Scorpaenichthys marmoratus*; NISP = 2,176) were most abundant, both of which are common in the kelp beds and rocky areas along the Diablo coast today. Cabezon are relatively large fish (up to 75 cm) that were probably taken with hook and line, although they might have been collected on occasion by hand from tidepools (Fitch 1973:106; Salls 1988:558). Sixty-two species of rockfish are known from the Pacific coast; most are fairly large and also would have been caught by line or net fishing. Together, rockfish and cabezon dominate all temporal components by considerable margins, representing between 67 percent and 85 percent of NISP. The density of fish bone/m³ in the midden showed a gradual increase through most of the Holocene, reaching a peak value of 123.9 bones/m³ during the Middle Period (component III) and decreasing slightly thereafter to 98.9 bones/m³ (Table 8).

Not surprisingly, the micro-samples (processed with 1 mm mesh) reported by Fitch (1972) show greater representation of smaller taxa and dramatically higher volumetric concentrations of fish bone (Table 11). He also identified a wider range of taxa (45 taxonomic classes). The majority ($N = 10,834$) of his sample of 12,165 elements was unidentifiable. Among the identifiable specimens, surfperches (Embiotocidae) dominated all temporal components accounting for 32.6 percent of the component I sample (NISP = 43), 41.7 percent of component II (NISP = 271), 34.1 percent of component III (NISP = 703),

and 33.8 percent of component IV (NISP = 314). Other important taxa were wolf-eel (*Anarrhichthys ocellatus*; NISP = 9), that accounted for 20.9 percent of component IV; 16.6 percent of component III, but only 8.1 percent and 1.6 percent of the early Holocene components. In sharp contrast with the 6 mm sample, the micro-sample shows an increase in exploitation of rockfish through the Holocene. Northern anchovies (*Engraulis mordax*) were also of some importance (ca. 14 percent) among the two late Holocene components. Both surfperches and anchovies are most suited for capture by nets (Love 1996; Salls 1988). Fitch (1973:108) felt that the anchovy bones in the SLO-2 midden most likely arrived via the stomach content of larger fish and marine mammals, and that site inhabitants did not use nets, but he was apparently unaware that the site's artifact collection contains grooved stones that are commonly interpreted as net sinkers. The contribution of stomach contents to the midden deposit, however, helps explain the remarkably high volumetric concentration of fish bone reported in Fitch's study. Relying on a microscope to complete identifications, he documented over 13,000 fish bones and bone fragments/m³ in the basal component of CA-SLO-2 and an increase to a peak of over 86,000 bones/m³ in the Middle Period component (Table 7). This relative trend parallels the findings from the larger mesh excavation units that also show an apex in density during the Middle Period. Fishing clearly increased over time at Diablo Canyon from 8300 cal B.C. through cal A.D. 1000, but declined afterwards between cal A.D. 1500 and the time of contact.

Shellfish

Shell findings from the 1-x-1-m control column were reported in detail in the original site report (Greenwood 1972:49-51). As with most sites on

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Table 10. Fish Remains from CA-SLO-2 (6 mm mesh) identified to the Genus Level or Better.

Taxon	Common name	IV		III		II		I		Total	
		NISP	%	NISP	%	NISP	%	NISP	%	NISP	%
Elasmobranchiomorphi	Sharks, skates, rays	0	.00	5	.13	1	.27	0	.00	6	.10
Carcharhinidae	Requiem sharks	12	.66	33	.86	16	4.35	1	2.78	62	1.02
<i>Squalina californica</i>	Angel shark	0	.00	1	.03	0	.00	0	.00	1	.02
<i>Rhinobatis productus</i>	Shovelnose guitarfish	2	.11	1	.03	1	.27	0	.00	4	.07
Rajiformes	Skates	2	.11	2	.05	1	.27	0	.00	5	.08
<i>Myliobatis californica</i>	Bat ray	0	.00	2	.05	0	.00	0	.00	2	.03
Clupeidae	Herrings	0	.00	10	.26	0	.00	0	.00	10	.16
<i>Sardinops sagax</i>	Pacific sardine	0	.00	1	.03	0	.00	0	.00	1	.02
<i>Merluccius productus</i>	Pacific hake	7	.39	18	.47	0	.00	0	.00	25	.41
<i>Porichthys</i> sp.	Specklefin, or plainfin midshipman	0	.00	13	.34	3	.82	1	2.78	17	.28
Atherinidae	Silversides	0	.00	1	.03	0	.00	0	.00	1	.02
<i>Sebastes</i> sp.	Rockfishes	961	53.06	1733	44.95	88	23.91	6	16.67	2,788	45.93
<i>Hexagrammos</i> sp.	Kelp or rock greenling	12	.66	30	.78	2	.54	0	.00	44	.72
<i>Ophiodon elongatus</i>	Lingcod	47	2.60	128	3.32	19	5.16	6	16.67	200	3.29
<i>Scorpaenichthys marmoratus</i>	Cabezon	587	32.41	1372	35.59	199	54.08	18	5.00	2,176	35.85
<i>Seriola lalandi</i>	Yellowtail	1	.06	0	.00	0	.00	0	.00	1	.02
<i>Genyonemus lineatus</i>	White croaker	0	.00	3	.08	0	.00	0	.00	3	.05
Embiotocidae	Surfpetches	41	2.26	166	4.31	16	4.35	2	5.56	225	3.71
<i>Amphistichus</i> sp.	Barred, calico, or redtail surfperch	1	.06	0	.00	0	.00	0	.00	1	.02
<i>Embiotoca</i> sp.	Black perch, or striped seaperch	0	.00	3	.08	1	.27	0	.00	4	.07
<i>Rhacochilus</i> sp.	Rubberlip seaperch, or pile perch	0	.00	2	.05	0	.00	0	.00	2	.03
<i>Rhacochilus toxotes</i>	Rubberlip seaperch	0	.00	2	.05	0	.00	0	.00	2	.03
<i>Rhacochilus vacca</i>	Pile perch	6	.33	6	.16	1	.27	0	.00	13	.21
<i>Sphyræna argentea</i>	Pacific barracuda	0	.00	1	.03	0	.00	0	.00	1	.02
<i>Oxyjulis californica</i>	Señorita	0	.00	0	.00	0	.00	0	.00	0	.00
Stichæidae	Pricklebacks	96	5.30	244	6.33	16	4.35	1	2.78	357	5.88
<i>Cebidichthys violaceus</i>	Monkeyface prickleback	7	.39	6	.16	0	.00	0	.00	13	.21
<i>Xiphister</i> sp.	Rock or kelp prickleback	29	1.60	71	1.84	3	.82	1	2.78	104	1.71
Scorbridae	Mackerels	0	.00	1	.03	0	.00	0	.00	1	.02
<i>Mola mola</i>	Ocean sunfish	0	.00	0	.00	1	.27	0	.00	1	.02
Total		1,811	10.00	3,855	10.00	368	10.00	36	10.00	6,070	10.00

Table 11. Summary of Fish Bone Identifications from .25 x .25 m Column Sample (1 mm mesh) from CA-SLO-2 (from Fitch 1972).

Taxon	Common Name	Late Period (Component IV)		Middle Period (Component III)		Late Millingstone (Component II)		Early Millingstone (Component I)		Total
		NISP	%	NISP	%	NISP	%	NISP	%	
<i>Anarrhichthys ocellatus</i>	Wolf-eel	5	1.6	57	8.1	45	16.6	9	2.9	116
<i>Embiotocides</i>	Surfperch	106	33.8	240	34.1	113	41.7	14	32.6	473
<i>Engraulis mordax</i>	Northern anchovy	44	14.0	104	14.8	27	9.9	1	2.3	176
<i>Sebastes</i> spp.	Rockfishes	98	31.2	87	12.4	24	8.9	5	11.6	214
Other		61	19.4	215	3.6	62	22.9	14	32.6	352
Subtotal		314	100.0	703	100.0	271	100.0	43	100.0	1,331
Unidentified		3,244		6335		1083		172		10,834
Grand total		3,558		7038		1354		215		12,165

Table 12. Shell Weights (3 mm mesh) from 1-x-1-m Column Sample, CA-SLO-2 (from Greenwood 1972).

Taxon	Common Name	Component IV (0-70 cm; .175 m ³)		Component III (70-200 cm; 1.3 m ³)		Component II (200-280 cm; 8 m ³)		Component I (280-340 cm; .6 m ³)		Total Shell Weight (kg)
		%	Shell weight (kg)	%	Shell weight (kg)	%	Shell weight (kg)	%	Shell weight (kg)	
<i>Mytilus californianus</i>	California sea mussel	72.7	159.8	84.3	399.8	88.1	267.6	88.3	138.2	159.8
<i>Haliotis rufescens</i>	Red abalone	11.6	25.5	2	9.5	1.9	5.8	.4	.6	25.5
<i>Haliotis cracherodii</i>	Black abalone	1.6	3.5	.5	2.4	*	*	.1	.2	3.5
<i>Haliotis</i> sp.	Abalone	.2	.4	.1	.5	.1	.3	.1	.2	.4
<i>Tegula</i> spp.	Turban snails	8.2	17.9	7.6	36.0	3.8	11.5	3.8	5.9	17.9
<i>Balanus</i> sp.	Barnacles	3.2	7.0	2.8	13.3	2.8	8.5	2.4	3.8	7
<i>Strongylocentrotus purpuratus</i>	Purple sea urchin	.1	.2	.1	.5	*	*	*	.0	.2
Other		2.4	5.5	2.6	12.2	3.3	1.7	4.9	7.6	5.5
Total		10.0	219.8	100	474.2	100	304.4	100	156.5	219.8

*Trace

the open coast of central California, the deposit was dominated by the remains of species common to the high energy, exposed rocky habitats found near Diablo Canyon today: California mussels (*Mytilus californianus*), turban snails (*Tegula* spp.), abalone (*Haliotis* spp.), and limpets (*Collisella* sp.). Mussels dominate component I (88.3 percent) and all later components, decreasing slightly to 72.7 percent in component IV (Table 12). Continuity of this basic open coast assemblage speaks to the stability of Diablo Canyon intertidal environments through the Holocene. This contrasts significantly with the estuaries and islands of the California coast that show taxonomic variation in shellfish related to sediment accumulation and changes in sea surface temperatures (see Glassow et al. 1994; Kennett 2005; Kennett and Kennett 2000, among others). Sea surface temperatures along the Diablo coast are influenced primarily by the cold, southward-flowing California Current. The southern California islands, in contrast, are influenced by multiple eddying currents, including the southern California Countercurrent (Browne 1994). Shifts in the flow of these currents and eddies has no doubt contributed substantially to the much heralded variability in sea surface temperature around the islands (e.g., Arnold 1992a; Glassow et al. 1994; Kennett and Kennett 2000). The Diablo coast, in contrast, shows the influence of one cold, southward flowing current over time. While the California Current is influenced by ENSO events and there is also some evidence for longer-term variability in SST along the open coast of central California (Jones and Kennett 1999), such variation was clearly less dramatic than that around the islands. In general, the limited taxonomic variation in the Diablo shell remains suggests relative stability of littoral and nearshore habitats through the Holocene.

Some change through time was noted in the density of shell/m³, which showed a peak value of 379.7kg/m³ during the Late Millingstone (component II), declining slightly thereafter (Table 7). More importantly, the ratio of shell:deer bone weight declined from the early to late Holocene with a peak value in component I of 13.0 to a low of 5.3 in component III. This suggests that shellfish were of greater dietary importance to early Holocene foragers which has been demonstrated repeatedly in California before (e.g., Erlandson

1994; Erlandson et al. 2005; Jones 1992, 2003; Porcasi 2008). A similar progression is evident in the ratio of shell:fish bone weight, suggesting that fish also increased in dietary importance relative to shellfish through the Holocene (Table 7). The absolute percentage values of shellfish versus deer and fish in the actual diet of site inhabitants is a more complicated if not irresolvable issue since recent studies have shown that different approaches to dietary reconstruction yield vastly different results (cf. Glassow 2000; Mason et al. 1998). For our purposes, we are content to identify the relative trend over time, but we also note that tool assemblages with hundreds of bifaces and projectile points are probably not consistent with a diet composed mostly of shellfish. The only other changes through time in the shellfish remains are modest increases in abalone (*Haliotis* spp.) and turban snails (*Tegula* spp.) (Table 12). California mussels that decrease during this same period generally occur higher in the intertidal zone than do abalone, which suggests that foragers were collecting from progressively deeper habitats over the course of the Holocene. This is further supported by models of differential processing, which suggest that, all else being equal, as travel time to a foraging patch increases, shellfish species with lower ratios of meat to shell (e.g., *Mytilus*) should be preferentially processed in the field before those species with low ratios (e.g., *Haliotis*) (Bird et al. 2002). The modest increase in low-ranked, labor-intensive turban snails through the Holocene is consistent with incremental labor intensification.

Summary I: Early Holocene Lifeways

The basal component at CA-SLO-2 conflicts at least partially with recent generalizations about early foraging practices in western North America that emphasize a lack of large game (e.g., Erlandson 1994; Hildebrandt and McGuire 2002; Jones et al. 2002; Rick et al. 2001). As with all of the oldest mainland coastal sites (dating between 8300 and 7000 cal. B.C.) in California, CA-SLO-2 postdates megafaunal extinctions, so the absence of those large taxa is readily understandable. Likewise, the southern California islands, which have yielded the oldest radiocarbon evidence for human occupation in the northeastern Pacific (ca. 9700 cal B.C.), had no populations of large terrestrial mam-

Table 13. Estimated Return Rates for Resources Represented at Diablo Canyon and Similar Species.

Resource	Taxon	Acquisition Method	Return Rate (kcal/hr.)			Reference
			Low	Mean	High	
Deer	<i>Odocoileus hemionus</i>	Encounter Hunting	17,971	24,710	31,450	Simms (1987)
Jackrabbit	<i>Lepus californicus</i>	Encounter Hunting	13,475	14,438	15,400	Simms (1987)
Ringed seal	<i>Phoca hispida</i>	Encounter Hunting	10,550	11,780	13,010	Smith (1991)
Cottontail Rabbit	<i>Sylvilagus</i> sp.	Encounter Hunting	8,983	9392	9,800	Simms (1987)
Canadian goose	<i>Branta canadensis</i>	Canoe	-	4,930	-	Smith (1991)
Sardine, herrings, schooling fry	-	Netting	-	3806	-	Bliege Bird and Bird (1997)
Canadian goose	<i>Branta canadensis</i>	Blind	-	3,460	-	Smith (1991)
Waterfowl	-	Encounter Hunting	-	3000	-	Winterhalter (1981)
Black-tailed jackrabbit	<i>Lepus californicus</i>	Trapping	1,495	2656	-	Ugan (2005)
Jackrabbit	<i>Lepus californicus</i>	Drive	628	2436	4,243	Simms (1985)
Ducks	<i>Anas</i> sp.	Encounter Hunting	1,975	2342	2,709	Simms (1985)
Canadian goose	<i>Branta canadensis</i>	Encounter Hunting	-	1,720	-	Smith (1991)
Ducks	Anatidae	Drive during molt	561	939	1,317	Simms (1985)
Med.-Large bottom-fish, pelagics	-	Handline (reef slope)	-	900	-	Bliege Bird and Bird (1997)
Med.-Large carnivorous fish	-	Handline (beach)	-	900	-	Bliege Bird and Bird (1997)
Small fish, octopus, squid	-	Spearfishing (reef flat)	-	600	-	Bliege Bird and Bird (1997)
California mussel	<i>Mytilus californianus</i>	Plucking	543	559	574	Jones and Richman (1995)
Small carnivorous fish	-	Handline (reef flat)	-	400	-	Bliege Bird and Bird (1997)
California mussel	<i>Mytilus californianus</i>	Stripping	214	330	446	Jones and Richman (1995)
Turban snail	<i>Tegula funebris</i>	Picking	-	73	-	Jones and Ferneau (2002)

mals, and human subsistence there always included major contributions from shellfish and fish. The basal component at Diablo Canyon, however, shows substantial evidence for the hunting of deer even though a nearby contemporaneous site (Cross Creek) and other coastal and peri-coastal deposits (e.g., the Duncan's Landing Rockshelter in northern California [Wake and Simons 2000]) have produced few if any remains of large animals. With substantial quantities of deer in both the basal and late Millingstone components, CA-SLO-2 shows that a focus on small game was by no means a universal in western North America during the early Holocene. Comparison of the relative frequencies of taxa represented at CA-SLO-2 with resource rankings based on experimental return rates (Table 13) suggests that the high frequency of deer remains is consistent with the potential caloric value of the resource, as long as the taxa are abundant enough to mitigate potential variance caused by high search and pursuit failures, which seems to have been the case at CA-SLO-2. Of course, the high ranking of deer is contested because of high variability in hunting success (Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005), and does not explain the absence of deer bone from the nearby Cross Creek and other sites. Nonetheless, the Diablo findings show that hunters took deer in greater numbers than rabbits when deer were available, suggesting that artiodactyls were relatively abundant within the site vicinity. The alternative that hunters were mainly targeting rabbits but settled for deer as a fallback, or for social competition, seems implausible. Given the proclivity for deer hunting represented at Diablo Canyon, we feel that the best explanation for the lack of deer bones from other sites is the absence of the species from many areas during the early-mid Holocene as suggested by Broughton and Bayham (2003) and Byers and Broughton (2004); however, the Diablo data clearly show that the supposed dearth of deer during the early Holocene was not universal across all of western North America, and this variability probably reflects differences in the local ecology as others have suggested (e.g., Hockett 2005; Zeanah 2004). Early Holocene foragers in western North America were apparently confronted with a landscape in which the distribution of deer herds was uneven, which fostered varied inter-

regional emphasis on target species. At Diablo Canyon, a reliable population of deer provided a primary target for hunting for nearly 10,000 years.

Of course, this does not mean that the earliest foragers at Diablo Canyon focused exclusively on the terrestrial environment. The inhabitants of Diablo Canyon 9,000–10,000 years ago exploited marine birds (flightless and otherwise) as 37 percent of their large vertebrates and also pursued such low-return activities as line fishing and shellfish collection. Shellfish, of course, are a gathered resource that might best be weighed against other gathered foods, most of which were floral not faunal. While ethnographic and experimentally derived return rates for waterfowl are potentially low, data from Smith (1991; see Table 13) indicate that return rates are considerably higher when the birds are hunted from boats. Moreover, flightless ducks that were probably adapted to predator-free islands and offshore rocks would certainly have constituted an attractive prey item. It is possible that this resource was so attractive that it encouraged terrestrially based mainland foragers to develop watercraft, but the pursuit of other marine birds, line-fishing, and shellfish collection represented in the basal component at Diablo Canyon seem more consistent with populations already intensely adapted to the linear interface between sea and land represented by the coastline of the northeastern Pacific (e.g., people with boats). Erlandson et al. (2007) have emphasized the importance of kelp forests along this interface, but the Diablo finds suggest that these people were also interested in terrestrial game in land habitats adjacent to the sea. This is probably due to the high density of deer in the site vicinity (e.g., in the adjacent Irish Hills). As their exploitative activities brought them further inland, these early populations encountered areas lacking deer and apparently shifted their attention to more plentiful smaller animals. In this instance, optimal foraging theory exposes behavior that can only be understood by recognizing historical contingencies related to coastal colonization (e.g., boating technology) and particulars of the local environment (e.g., deer abundance). While archaeological applications of behavioral ecological models often ignore these local variables (despite their explicit importance in most models), the Diablo case suggests that this approach is untenable.

Summary II: Economic Intensification/Resource Suppression

Evidence for change through time at Diablo Canyon is generally of a more muted character than the dramatic variation often reported from the California Islands. This modest variability is partially a product of the coarse-grained or blurred character of the mainland record caused by bioturbation; however, the site's shellfish and fish assemblages also indicate that nearshore environments were relatively stable through the Holocene and that environmental inducements to cultural change were limited. Still, three types of diachronic variation are apparent: (1) modest incremental changes in volumetric densities, ratios, and percentages; (2) gradual but qualitatively and quantitatively significant changes in certain taxa, including one (the flightless duck) that was hunted into extinction; and (3) punctuated, multidirectional change during the late Holocene.

Nearly all of the gradual but modest changes that occurred between ca. 8300 cal B.C. and cal A.D. 1000 (components I through III) can be correlated with population growth reflected in the Diablo burial record. Small, incremental increases in volumetric density of fish bone correlate well with an overall increase in diet breadth reflected by Margalef Index values (Figure 3). Through the course of the Holocene, the Diablo foragers progressively broadened their diets at the same time they harvested increasing quantities of fish. As Arnold et al. (2004:15) note, such small incremental changes do not match the formal predictions of economic intensification (*sensu* Boserup 1965) in that they imply no major reorganization of human labor, nor do they in themselves indicate resource suppression. Indeed, they suggest a reliable resource base that accommodated increasing harvesting pressure over most of the Holocene. Still, these changes are not wholly insignificant either. Bone weight-based ratios show that shellfish became less important relative to both deer and fish over time, highlighting a fundamental difference in shellfish vs. fish in potential to contribute to economies affected by population growth; while shellfish became relatively less important in the overall diet, fish increased in both absolute and relative importance. The overall decrease in dietary evenness through the Holocene (Figure 3) seems to reflect the emer-

gence of a modest specialization in fishing in the late Holocene albeit one dramatically less intensive than those of the Santa Barbara Channel Islands. This specialization is also apparent in the late Holocene artifact assemblage (Table 4). We suggest that the qualitative increase in fishing through the Holocene represents a legitimate case of intensification, albeit a modest and gradual one.

Certain resources at Diablo Canyon exhibit more significant diachronic variation, particularly the flightless duck, sea otters, and abalone. Changes in the relative importance of these resources are ecologically interrelated since the three species were all residents of littoral/nearshore marine habitats. The case of the flightless duck is particularly important as it constitutes the only unequivocal case in precontact North America of resource over-exploitation so extreme that it led to extinction. This highly vulnerable species that accounted for 18.2 percent of the large vertebrate remains in component I decreased through the Holocene and is the main cause underlying an overall decrease in exploitation of marine birds. Radiocarbon dates from other sites indicate that the flightless duck was extinct by ca. 500 cal B.C. (Morejohn 1976), which correlates well with the patterning at Diablo Canyon. At the same time this taxon declined and exploitation of all marine birds decreased, sea otters increased in relative importance. Elsewhere, the initial exploitation of otters as a presumably low-ranked resource (exploitable only with boats) has been attributed to suppression of larger, more highly ranked pinnipeds (Hildebrandt and Jones 1992; Jones and Hildebrandt 1995). No such pattern is evident at Diablo Canyon where sea otters were the only marine mammal exploited in significant numbers. Rather, the more substantive decline of the flightless duck preceded the initial exploitation of otters. This seems to reflect the replacement of one prey item exploited by watercraft with another. The increased exploitation of abalone that parallels the increase in otter bones through the Holocene must be partially a reflection of the reduction in otter populations (a major predator on abalone) as a result of increased human predation. Although many other factors (e.g., sea temperature variation, diseases) influence abalone populations, the likely impact of increased human predation on otters cannot be overlooked. Erlandson, Rick, Estes, Graham, Braje, and Vellanoweth (2005) and Braje et al.

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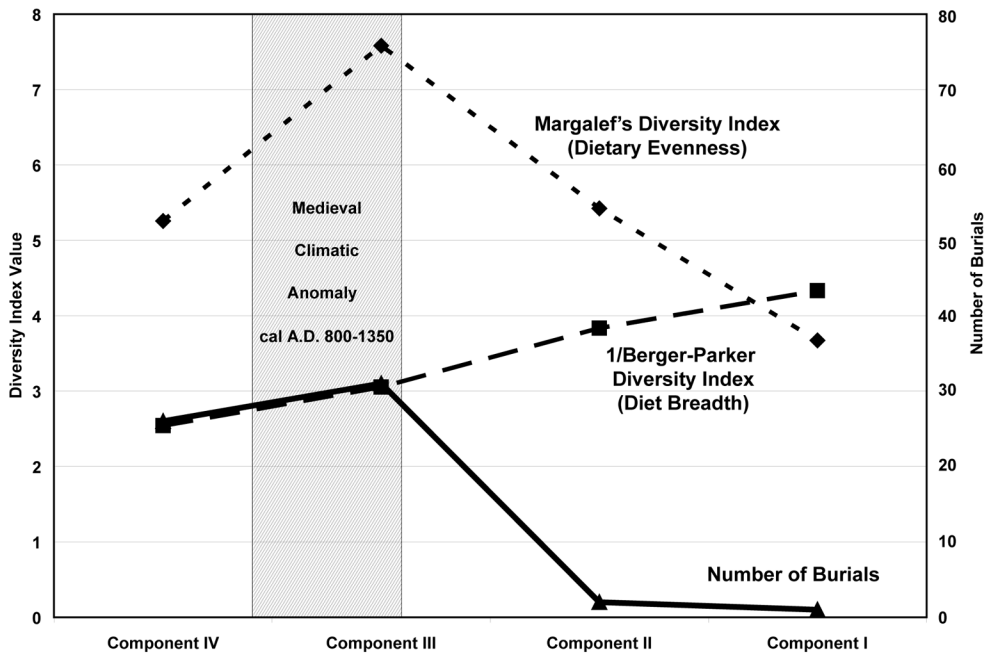
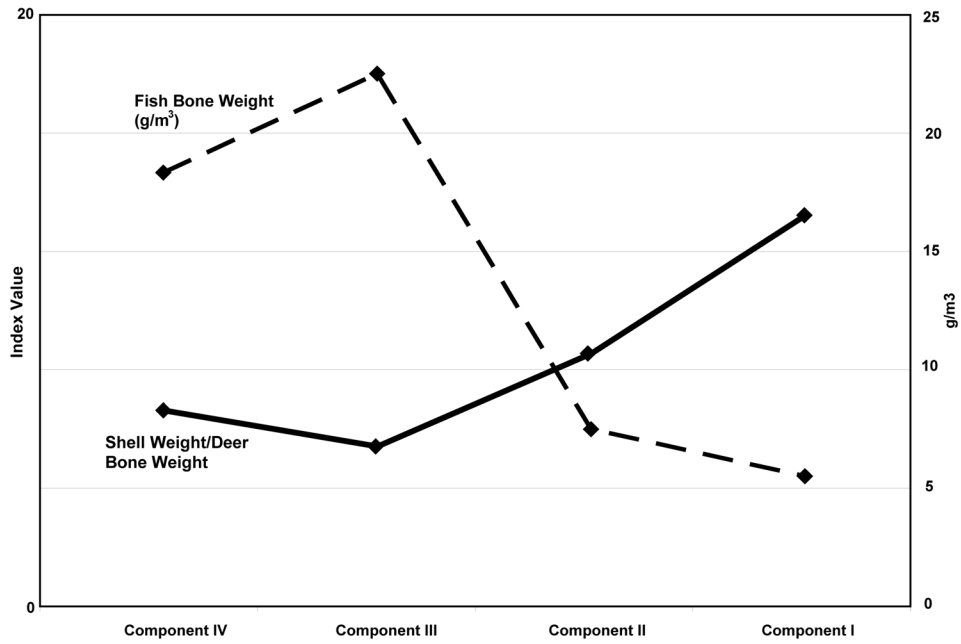


Figure 3. Diversity Indices from combined Bird, Mammal, and Fish (6 mm) remains from CA-SLO-2 compared with burial populations, shell:deer bone weight, and fish bone weight over time.

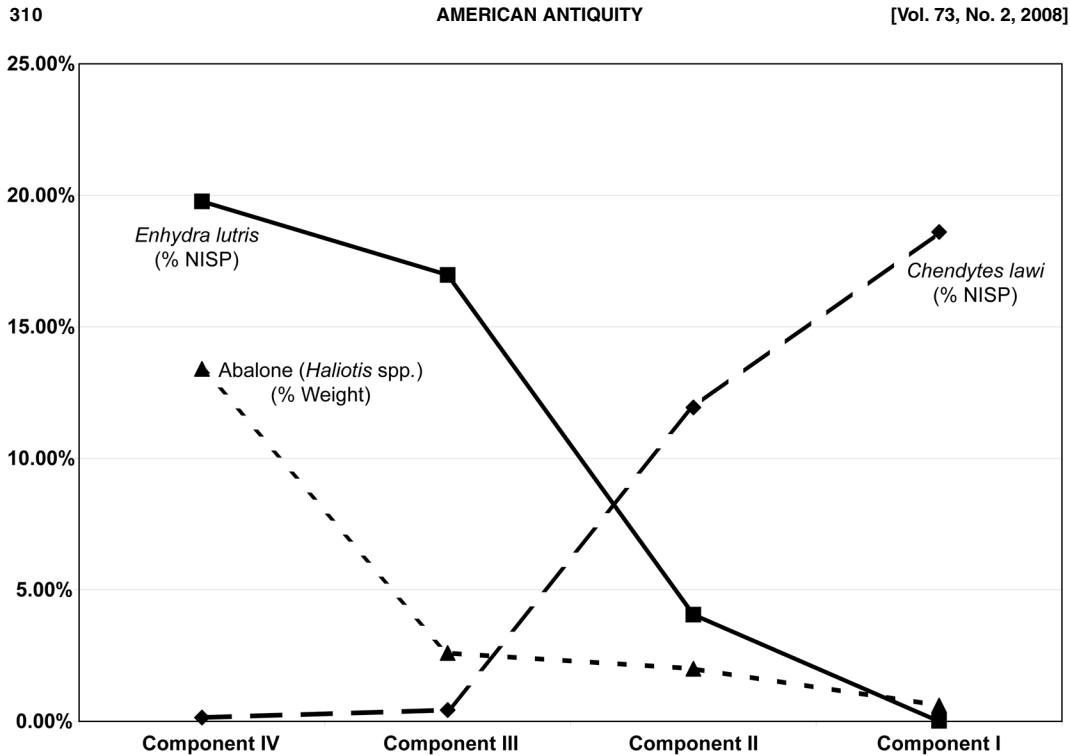


Figure 4. Relative frequency of flightless duck (*Chendytes lawi*), sea otter (*Enhydra lutris*), and abalone (*Haliotis* spp.) remains from CA-SLO-2.

(2007) have made similar observations on the Channel Islands. At Diablo Canyon, an apparent coharvesting strategy ultimately yielded certain food benefits for human populations. Over the course of the Holocene, foragers at Diablo Canyon simultaneously helped wipe out one species while they reduced the population of a key nearshore predator with whom they were in competition. The net result was greater absolute productivity—albeit in the form of more lower-ranked resources.³

The Diablo data also highlight the relative importance of large terrestrial mammals throughout the Holocene. Despite the predictions of some (e.g., Hildebrandt and McGuire 2002) and findings from other sites on the California coastal margin (e.g., Cross Creek), the Diablo collection reflects a local deer population abundant enough to support sustained levels of exploitation and provide a reliable and efficient resource for over 10,000 years. The Diablo case supports other recent studies (e.g., Elston and Zeanah 2002; Hockett 2005; Zeanah 2004) that highlight the importance of understanding how *local* environmental factors directly affect the distribution of *local* fauna. The local

abundance of deer at Diablo Canyon, and their inferred reliability suggest that artiodactyls would not be the best target prey for males wishing to distinguish themselves from others via costly signaling, as even lower-quality (or less-skilled) hunters would be capable of obtaining deer in this situation due to their ready availability—although it remains possible that individual hunters were attempting to signal their ability to provision, which is a possible signaling strategy (see Gintis et al. 2001; Smith and Bliege Bird 2005). This form of signaling seems a greater match to the record at Diablo Canyon, suggesting that male hunters procured large game with enough consistency that it was part of a provisioning strategy in which foragers acquired these large terrestrial mammals efficiently throughout the Holocene without measurably depressing their populations.

The late Holocene provides the only substantive suggestion of environmentally induced cultural change in the Diablo record. Like many sites in the region, CA-SLO-2 was abandoned during most of the Medieval Climatic Anomaly when there is evidence for widespread droughts throughout

much of western North America (Stine 1994); after ca. A.D. 1000, the site was occupied only from ca. A.D. 1500–1770. This relatively minor, post-drought occupation is reflected by reduced numbers of artifacts and burials, and coincident declines in shell and fish bone volumetric density. However, unlike most of the developments during the first 9,000 years of the site's occupation, there is less overall consistency in the directionality of faunal change. Diet breadth and evenness, for example, converge for the first time (Figure 3). The most parsimonious explanations for the varied character of these late cultural changes are historical contingencies related to the Medieval droughts (Jones et al. 1999) and Protohistoric diseases (Erlandson and Bartoy 1995; Preston 1996). In her original analysis of CA-SLO-2, Greenwood (1972) recognized that the most recent occupation was less intensive than earlier ones and suggested that early historic disruptions were the cause. Our analysis of the site's fauna leads to the same conclusion although we envision Medieval drought as an additional disruptive variable.

Discussion

CA-SLO-2 has produced one of the largest trans-Holocene faunal assemblages from the west coast of North America. The site's basal component illuminates an initial Holocene coastal adaptation in which foragers exploited a wide range of terrestrial and marine foods including deer, marine birds (especially the extinct flightless duck), rabbits, open-coast shellfish, and fish. While this subsistence mode is partially consistent with life "on the kelp highway" suggested by Erlandson et al. (2007) in that it almost certainly involved the use of watercraft, it also included heavy exploitation of terrestrial foods from land habitats adjacent to the sea. The suite of resources exploited by Diablo's earliest residents can be seen as optimal only for a population already invested in development of watercraft and who were intensely adapted to the interface of land and sea along the coastline of the northeastern Pacific. The heavy representation of deer in basal and later components at Diablo Canyon suggests that recent generalizations about an emphasis on small game by early Holocene foragers (e.g., Hildebrandt and McGuire 2002) are premature and that early colonists exploited larger

game when it was available. Uneven distribution of deer herds in western North America during the early-middle Holocene probably explains the recovery of deer bones from some areas and not others (Byers and Broughton 2004; Hockett 2005; Zenah 2004). The historical contingencies of coastal colonization and gradual, uneven post-Pleistocene expansion of deer populations following terminal Pleistocene megafauna extinctions may explain the dietary choices available to and made by the earliest coastal inhabitants.

The Diablo record further includes unequivocal evidence of population growth in the site area in the form of superimposed burial populations. Correlated changes in faunal consumption patterns imply the influence of incremental population growth although a basic, broad-spectrum mixed economy persisted throughout the Holocene. With a stable marine environment influenced by one cold, southward-flowing current (the California Current), Diablo Canyon shows relatively muted variation consistent with gradual diet broadening, and emergence of a very modest specialization in nearshore fishing. There is no evidence for over-exploitation of pinnipeds or fish, and the importance of the latter as the key resource that accommodated population growth is clearly demonstrated, raising questions about arguments advanced elsewhere (e.g., Broughton 1994a, 1999; Salls 1992) for prehistoric fish overexploitation. The site does show the only unequivocal case of gradual overpredation leading to extinction in North America, although the flightless duck was rendered extinct through the combined efforts of foraging groups all along the California and Oregon coasts not by the Diablo Canyon hunters alone. Disappearance of the species was followed by significant changes related to exploitation of a less vulnerable, more elusive (and presumably lower-ranked) taxon, the sea otter. At the time of historic contact when the final use of CA-SLO-2 ended, the prevailing adaptation was slightly more intensive than that of the early Holocene and there was one less Native species present in the region. However, an overall broad-spectrum foraging strategy was still present.

Diachronic changes at Diablo Canyon are much less dramatic than those on the southern California Islands, partially due to more extreme variability in marine environments off the islands as

well as the exaggerated selective pressures that operate on human and animal populations in insular situations. While the islands provide dramatic evidence for the same principles of foraging efficiency discussed here, the uniqueness of island cultural trajectories is also illuminated by comparison with the mainland. The effects of several of the same historical contingencies are apparent in both areas (e.g., coastal colonization, the Medieval Climatic Anomaly, protohistoric diseases), the mainland record illuminates foraging decisions made by gradually growing human population on a less circumscribed, continental land mass.

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Notes

1. One date, obtained by Greenwood (1972:4) from a sample of human bone, yielded a calibrated age of 8770 cal B.C., which is anomalously older than all other dates from the site. Given the uncertainties about collagen extraction techniques used in 1972, it seems best to reject this date.

2. While researchers have argued over the specifics of such utility indices in ethnographic situations (see reviews in Monahan 1998), treating these measures as qualitative measures comparable between time periods has been shown to clarify archaeological situations of resource depression (Cannon 2003). This paper treats utility indices as relative, qualitative measures that are useful for comparison between different temporal components within a single site. Utilized in this way, an *increase* in the proportion of high utility remains deposited at the site indicates a *decrease* in the abundance of artiodactyls on the landscape. This is so because as the relative abundance of artiodactyls decreases, foragers will have to spend a greater amount of time in search and pursuit. As a consequence, they are more likely to be further away from the central place, which would increase the payoff of processing and culling artiodactyl parts that have low economic utility. A decrease in the proportion of high utility remains indicates the opposite.

3. The ranking of sea otters is also complicated by the value of their pelts which were important trade items in Native California.

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