The Fauna from Quiroste: Insights into Indigenous Foodways, Culture, and Land Modification

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Abstract The CA-SMA-113 archaeofauna suggests that Quiroste Valley people used varied terrestrial and marine foods, generally avoided consuming birds, and maintained more open habitats than typifies the valley's natural climax vegetation. We contextualize habitat-diagnostic rodent taxa from the site with data from a recent live trapping transect only a few kilometers south of Quiroste. California voles, an open country species, were never trapped in closed vegetation but are the second most common identifiable rodent species in the CA-SMA-113 archaeofauna, a divergence that is extremely statistically significant. Based upon the modern live-trapping data, voles should not have been present at all, if Quiroste Valley habitats were unmodified. Their robust presence implies processes favoring grassland maintenance.

Resumen La arqueofauna del sitio CA-SMA-113 indica que la gente del valle de Quiroste aprovechó varios recursos faunisticos, tanto terrestres como marinos, en general evitando el consumo de aves, y manteniendo habitats más abiertos que los que caracterizan la vegetación clímax natural del valle. Contextualizamos los taxa de roedores diagnósticos de ciertos hábitats recuperados en el sitio con los datos de una transecta de trampeo de roedores vivientes ubicada unos pocos km al sur de Quiroste. Los campañoles de California, una especie de los pastizales, nunca fueron atrapados en el habitat cerrado del interior como el de Quiroste actual, pero es la segunda especie más numerosa de roedor en la arqueofauna de CA-SMA-113, una diferencia de la más alta

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significación estadística. Sobre la base de los resultados del trampeo contemporneo, los campañoles no deberían estar presentes en el valle de ninguna manera, sin una modificación del hábitat. Su importante presencia sugiere la existencia de procesos que favorecieron el mantenimiento intencional del pastizal.

Zooarchaeological analyses of the vertebrate fauna from CA-SMA-113 had three main goals: (1) to assess whether and how vertebrate remains from the site could elucidate possible land modification practices in Quiroste Valley; (2) to obtain insights into prey choice, based on evidence recovered by very fine-grained excavation methods, especially with regard to terrestrial microfauna and fishes; and (3) to gather extensive evidence for culinary processing, again based upon fine-grained excavation and recovery of data from various features. While we have extensive data on the latter, here we concentrate on the first two topics as the most germane to the focus of this special issue. The last topic, as well as CA-SMA-113's place in the broader trajectories of vertebrate use over time, will be dealt with in other publications.

We present findings on the archaeofauna in aggregate, without stratigraphic or locus subdivision. We will compare the CA-SMA-113 archaeofauna to that from nearby CA-SMA-18, a late Middle Period site in open habitat on Point Año Nuevo, about 3.5 km from Quiroste Valley. CA-SMA-18 dates to AD 700–800 (1300–1200 cal BP), while the bulk of the radiocarbon determinations from CA-SMA-113 suggest occupation between AD 1000 and 1300 (1000–700 cal BP). Gifford-Gonzalez et al. (2006) analyzed the CA-SMA-18 archaeofauna, enabling comparable levels of detail for these two temporally and spatially close locales.

The balance of this article outlines analytic materials, methods, and results, specifically discussing the use of vertebrate prey species and assessing evidence for habitat alteration in the Quiroste Valley. While most of the taxonomic abundances of vertebrates at CA-SMA-113 are consistent with those of other residential sites in the region, a few differences exist. Shorebirds, a standard component of Monterey and San Francisco Bay sites, are notable for their proportionately low numbers and diverge from other Late Period residential sites along the San Mateo coast. The extremely fine-grained recovery methods used by excavators have recovered testimony for the intensive acquisition and use of small schooling fishes, specifically anchovies, as well as several tidepool species. The latter is consistent with broader temporal trends in fish foraging around Monterey Bay.

With regard to exploring the possible use of fire to maintain open habitats, Reid's rodent live trapping transect from inland chaparral/forest to coastal scrub/marshland is highly relevant. These live trapping data provide a locally derived basis for assessing whether the archaeofaunal rodent abundances reflect a divergence from those expected, given the present-day closed vegetation in the valley. We find an extremely statistically significant difference between abundances of California voles (*Microtus californicus*), a key habitat indicator species, in the modern trapping study versus the CA-SMA-113 archaeofaunal sample.

Methods

After initial sorting of excavation lots at UC Berkeley (UCB), the vertebrate sample was sorted by advanced UC Santa Cruz (UCSC) undergraduates supervised by Boone, Gifford-Gonzalez, and Ben Curry (School of Anthropology, University of Arizona) in Gifford-Gonzalez's UCSC zooarchaeology laboratory. Gifford-Gonzalez and Curry definitively identified all artiodactyl, rodent, lagomorph, and bird specimens, and Gifford-Gonzalez identified terrestrial carnivores, pinnipeds, and cetaceans. Dr. Ken Gobalet (Department of Biology, CSU Bakersfield) and his students identified fish bones from the first three excavation seasons. Fish bone from the 2008–2009 seasons, along with some material from 2007, were analyzed, and Gobalet's data were integrated and interpreted by Boone.

Mammal and bird specimens were identified with reference materials from the UCSC Department of Anthropology's osteology collections as well as those of the Museum of Vertebrate Zoology at UCB, the University of Washington's Burke Museum of Natural History and Culture, and the National Marine Mammal Laboratory, NOAA-Seattle. Because pronghorns (*Antilocapra americana*) were identified from the Middle Period component of the Sand Hill Bluff site, CA-SCR-7 (Jones and Hildebrandt 1990), and in Early and Middle components of the Bonny Doon site CA-SCR-9 (Nims 2011), identified artiodactyl specimens were compared to pronghorn. Fish remains were identified using comparative specimens from the California Academy of Sciences and Boone's personal collection.

Reid's modern rodent data, used here for comparisons with CA-SMA-113 and CA-SMA-18, were gathered in her ongoing dissertation research on the long-term ecology of coyotes in the Monterey Bay region. Her live trapping was done in two habitats on Año Nuevo Point: coastal coyote brush and coastal willow/sedge, and two inland plant communities directly east of Año

Nuevo: inland coyote brush and inland mixed forest. The Point Año Nuevo sample locales are good analogues for the area near CA-SMA-18, and the inland sample locales are about 2.4 km due south of Quiroste Valley in the same closed vegetation. For this article, the four samples were aggregated into coastal versus inland sets and Reid's multiple, field-identified *Peromyscus* mouse species were grouped (see Table 1 for details of trapping data). Trapping procedures were in accordance with the most recent guidelines of the American Society of Mammalogists (Gannon and Sikes 2011) and conducted with the approval of the UCSC Institutional Animal Care and Use Committee.

All quantification and statistical tests were undertaken using number of identified specimens (NISP). Because of the common occurrence of zero values in data, NISP were compared using Fisher's exact tests. Avian frequencies were assessed using both a matrix of Fisher's exact probability values (Table 2) and via computation of 95 percent confidence intervals (CL) of frequencies using a formula derived from van der Veen and Fieller's (1982:396) approach to estimating archaeobotanical sample adequacy. Their formula calculates the CLs around an estimate of the proportion of a taxon in a sample, assuming a normal distribution of values, with the CL narrowing as the number of specimens in the overall sample increases, where:

Z_α is the two-sided αpercentage-point of the normal distribution,

p is the observed proportion of the target species in the sample, and

n is the total number of specimens in the sample actually taken.

The Z_α error range can be set at varied CLs. In this article, as well as in Cuthrell (this issue), the CL is set at 95 percent. This is readily calculated in an Excel spreadsheet format.

$$p \pm Z\alpha\sqrt{\frac{p(1-p)}{(\mathrm{n}-1)}}$$

Results

A total of 19,460 vertebrate specimens was analyzed, comprising 66.3 percent (n = 12,906) mammal specimens, 16.5 percent (n = 3,218) fish specimens, 1.2 percent (n = 228) bird, 0.1 percent (n = 26) reptile, and 15.8 percent (n = 3,082) long bone fragments that could not be assigned definitively to lagomorph or bird.

Table 1. Reid Live-Trapping Rodent Data.

Taxon	Reid Inland N	Reid Inland %	Reid Coastal N	Reid Coastal %	CA-SMA-113 Rodent NISP	CA-SMA-113 Rodent %	CA-SMA-18 Rodent NISP	CA-SMA-18 Rodent %
Botta's pocket gopher	0	0.0	0	0.0	190	47.6	93	57.8
Dusky-footed wood rat	15	8.5	0	0.0	36	9.0	25	15.5
Harvest mouse	16	8.5	26	15.0	0	0.0	0	0.0
California vole	0	0.0	15	8.7	127	31.8	33	20.5
Norway rat	1	0.5	0	0.0	0	0.0	0	0.0
Mouse (*Peromyscus* spp.)	145	81.9	132	76.3	30	7.5	9	5.6
California pocket mouse	0	0.0	0	0.0	1	0.3	1	0.6
Squirrels (includes chipmunk)	2	1.1	0	0.0	15	3.8	0	0.0
Total	**179**	**100.0**	**173**	**100.0**	**399**	**100.0**	**161**	**100.0**

Notes: Aggregated by inland and coastal habitats, along with identified rodent taxa from CA-SMA-113 and CA-SMA-18 (Gifford-Gonzalez et al. 2006). See Figure 1 for graphic display.

Table 2. Fisher's Exact Two-Tailed Probability Matrix for Avian NISP vs. Other Taxa NISP in 12 Regional Sites Along the Coasts of Southern San Mateo, Santa Cruz, and Northern Monterey Counties.

Site (CA-)	SMA-113	SMA-97	SMA-18	SCR-35	MNT-229	SMA-244	SMA-118	SCR-93	MNT-228	SMA-115	SMA-134	SMA-218
SMA-113	—	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	0.0335	0.0658
SMA-97		—	0.1457	0.7689	0.7563	0.0452	0.7512	***<0.0001***	***<0.0001***	***<0.0001***	0.0299	0.0895
SMA-18			—	0.3641	*0.0010*	*0.0022*	***<0.0001***	***<0.0001***	***<0.0001***	***<0.0001***	***<0.0001***	***<0.0001***
SCR-35				—	1.0000	0.0280	1.0000	***<0.0001***	***<0.0001***	***<0.0001***	0.0170	0.0430
MNT-229					—	0.3641	0.9027	***<0.0001***	0.0153	***<0.0001***	***<0.0001***	*0.0043*
SMA-244						—	0.0349	***<0.0001***	0.1586	0.0677	0.4600	0.4386
SMA-118							—	***<0.0001***	***<0.0001***	***<0.0001***	0.0198	0.0578
SCR-93								—	0.2456	***<0.0001***	***<0.0001***	***<0.0001***
MNT-228									—	***<0.0001***	***<0.0001***	***<0.0001***
SMA-115										—	***<0.0001***	***<0.0001***
SMA-134											—	0.8864
SMA-218												—

Notes: See text for note on exclusion of CA-MNT-234 Primary Midden. Shaded sites are considered residential; see Table 4 for details. ***Bold italics:*** extremely statistically significant ($p \leq 0.0001$); *italics:* very statistically significant ($p = 0.001$); underline: statistically significant ($p = 0.05$ cutoff).

Mammals

By NISP, mule deer (*Odocoileus hemionus*) and various lagomorphs combined account for about 45 percent of taxonomically identified mammals from CA-SMA-113 (Table 3). Because no identified specimens were pronghorn, CA-SMA-113's 292 more fragmentary medium-sized ruminant specimens are most likely to be from mule deer (Table 3), bringing this taxon to nearly 31 percent of identified specimens. Elk (*Cervus elaphus canadensis*) were rare, as they are at most Middle to Late Period coastal sites in this region of California (Hylkema 2002). Lagomorphs constitute 13 percent of identified mammal specimens, with brush rabbit (*Sylvilagus bachmani*) dominating (Table 3).

By NISP, rodent taxa amount to nearly 47 percent of all identified mammals. At 52 percent of identified rodents, Botta's pocket gophers (*Thomomys bottae*) are most abundant (Table 3). How gopher remains may have entered the site is discussed below. Other rodent species, California voles (*Microtus californicus*)

Table 3. Mammal Fauna at CA-SMA-113.

Taxon	**Common Name**	**NISP**	**% of LID**
Mammal indeterminate	Mammal indeterminate	7,648	66.8
Very small mammal	Very small mammal	596	5.2
Small mammal	Small mammal	808	7.1
Medium mammal	Medium mammal	330	2.9
Large mammal	Large mammal	2,025	17.7
Very large mammal	Very large mammal	32	0.3
	Less Identifiable Subtotal	**11,439**	**100.0**
		NISP	**% of ID**
Carnivora indeterminate	Carnivore indeterminate	2	0.1
Canis latrans	Coyote	6	0.4
Enhydra lutris	Sea otter	41	2.8
Mephitis mephitis	Striped skunk	6	0.4
Mustela frenata	Weasel	1	0.1
Ursus arctos horribilis	Grizzly bear	1	0.1
Procyon lotor	Raccoon	4	0.3
Pinnipedia indeterminate	Pinniped indeterminate	2	0.1
Otariidae indeterminate	Eared seal indeterminate	15	1.0

Continued

Table 3. Mammal Fauna at CA-SMA-113. (continued)

Taxon	Common Name	NISP	% of LID
Zalophus californianus	California sea lion	5	0.3
Arctocephaline indeterminate	Indeterminate fur seal	9	0.6
Callorhinus ursinus	Northern fur seal	24	1.6
Phoca vitulina	Harbor seal	4	0.3
cf. *Eschrichtius robustus*	cf. gray whale	7	0.5
Lagenorhynchus obliquidens	Pacific white-sided dolphin	1	0.1
Cervus elaphus canadensis	Elk	10	0.7
Medium Ruminantia	Medium ruminant	292	19.9
Odocoileus hemionus	Mule deer	160	10.9
Leporidae indeterminate	Rabbit or hare indeterminate	4	0.3
Lepus californicus	Black-tailed jackrabbit/hare	149	10.1
Sylvilagus cf. *bachmani*	Brush rabbit	4	0.3
Leporidae indeterminate	Rabbit or hare indeterminate	4	0.3
Rodentia indeterminate	Rodent indeterminate	322	21.9
Chaetodipus californicus	California pocket mouse	1	0.1
Sciuridae indet.	Squirrel indeterminate	10	0.7
Spermophilus beecheyi	Beechey's ground squirrel	5	0.3
Peromyscus cf. californicus	California field mouse	30	2.0
Microtine indeterminate	Vole indeterminate	91	6.2
Microtus californicus	California vole	36	2.4
Neotoma fuscipes	Dusky-footed wood rat	36	2.7
Thomomys bottae	Botta's pocket gopher	190	12.9
Scapanus latimanus	Mole	2	0.1
	Identified Mammal Subtotal	**1,471**	**100.0**
	Grand Total Mammals	**12,910**	

Notes: NSP, number of specimens; NISP, number of identified specimens; LID, less identifiable; ID, identifiable.

comprising 25 percent of identified rodent species and dusky-footed wood rats (*Neotoma fuscipes*) comprising 10 percent, both show higher rates of human modification than do gophers.

The remaining identified species are represented by relatively few elements. Sea otters comprise 2.8 percent of identified taxa (NISP = 41) and northern fur seals, 2.2 percent (NISP = 31). Both of these fur-bearers are less common than at CA-SMA-18, at a statistically significant level.

Fishes

Excellent excavation recovery methods and flotation provided large samples of small fish bones not usually represented in 3.2 mm (1/8-in) screen recovery. CA-SMA-113 is therefore especially valuable for identifying the range of species indigenous peoples collected in the past and for understanding the dietary importance of small fishes.

The taxa present are mostly typical for central California coastal sites (Table 4). Abundant anchovies, herrings or sardines, and surfperch at CA-SMA-113 suggest an emphasis on small schooling species found in the surf zone. Pricklebacks and sculpins, rocky intertidal taxa that frequent tide-pools, also comprise a large segment of the assemblage. At 30 percent of fish NISP, northern anchovy is the most common taxon. This species is rarely identified in archaeological samples screened through 1/8 in mesh, as most of their bones are extremely delicate and their vertebrae quite small. Their abundance at CA-SMA-113 compared to many other coastal sites, is thus most likely due to the use of 1.6 mm (1/16-in) mesh. At 24 percent, pricklebacks are the next most abundant taxon and are far more numerous than both rockfish (4.6 percent) and surfperch (19 percent). Pricklebacks identified to species are monkeyface and rock or black pricklebacks, all of which live in rocky intertidal habitat.

Birds

A total of 228 of 4,897 (4.7 percent) taxonomically identified specimens derive from birds (Table 5), and most are so fragmentary that only 22 were identified to species. Over half of the identified bird specimens are from water birds, and a quarter from birds of prey; none are from commonly consumed terrestrial birds, such as quail and doves (Table 5). The rate of occurrence of birds in the CA-SMA-113 archaeofauna differs significantly from those of other well-documented residential sites around Monterey Bay.

Discussion

Mammals, Habitat, and Exploitation

Deer are relatively more abundant in the CA-SMA-113 sample than in the CA-SMA-18 sample. This is perhaps expected, given the locations of the two sites. The Quiroste Valley is optimal deer habitat, a mosaic of brush and conifer woodlands, riparian habitat, and by other evidence presented in this issue (Evett and Cuthrell; Cowart and Byrne), meadows with native forbs

Table 4. Fish Fauna at CA-SMA-113.

Taxon	Common Name	NISP	%
Actinopterygii	Ray-finned fishes	2,352	100.0
	Less Identifiable Subtotal	**2,352**	**100.0**
Clupeiformes	Herrings, sardines, anchovies	8	0.9
Engraulis mordax	Northern anchovy	260	30.0
Clupeidae	Herrings, sardines	48	5.5
Sardinops sagax	Pacific sardine	7	0.8
Cypriniformes	Minnows and suckers	1	0.1
Oncorhynchus sp.	Pacific salmon, trouts	15	1.7
Oncorhynchus kisutch	Coho salmon	1	0.1
Oncorhynchus mykiss	Steelhead salmon/rainbow trout	3	0.3
Atherinopsidae	Pacific silversides	4	0.5
Sebastes sp.	Rockfishes	40	4.6
Hexagrammidae	Indeterminate greenlings	9	1.0
Hexagrammos sp.	Kelp or rock greenling	16	1.8
Ophiodon elongatus	Lingcod	10	1.2
Cottidae	Sculpins	6	0.7
Scorpaenichthys marmoratus	Cabezon	62	7.2
Embiotocidae	Surfperches	143	16.5
Embiotoca sp.	Striped or black surfperch	6	0.7
Embiotoca lateralis	Striped surfperch	1	0.1
Amphistichus sp.	Barred, calico, or redtail surfperch	2	0.2
Rhacochilus vacca	Pile perch	10	1.2
Stichaeidae	Pricklebacks	154	17.8
Cebidichthys violaceus	Monkeyface prickleback	16	1.8
Xiphister sp.	Rock or black prickleback	39	4.5
Gibbonsia sp.	Striped or crevice kelpfish	1	0.1
Gobiesox maeandricus	Northern clingfish	4	0.5
	Identifiable Fish Subtotal	**866**	**100.0**
	Total Fish NISP	**3,218**	

Notes: Salmon species identified by Ken Gobalet at CSUB. NSP, number of specimens; NISP, number of identified specimens.

Table 5. Birds at CA-SMA-113.

Taxon	Common Name	NISP	%
Aves indeterminate	Bird indeterminate	208	100.0
	Less Identifiable Bird Subtotal	**208**	
Anseriformes	Goose indeterminate	1	5.0
Anas indeterminate	Duck indeterminate	1	5.0
Aythya valisineria	Canvasback duck	2	10.0
Phalacrocorax penicillatus	Brandt's cormorant	2	10.0
Podiceps nigricollis	Eared grebe	2	10.0
Melanitta perspicillata	Surf scoter	1	5.0
Uria aalge	Common murre	3	15.0
Larus sp.	Gull indeterminate	1	5.0
Accipitres	Raptorial bird	1	5.0
Falconiformes	Falcon-like bird	1	5.0
Buteo jamaicensis	Red-tailed hawk	3	15.0
Corvus brachyrhynchos	American crow	1	5.0
Passeriformes	Perching bird	1	5.0
	Identifiable Bird Subtotal	**20**	**100.0**
	Total Bird NSP	**228**	

Notes: NSP, number of specimens; NISP, number of identified specimens.

browsed by deer. By contrast, CA-SMA-18 lies on the sandy substrate of the Point Año Nuevo peninsula, in less suitable habitat for deer, although brush and woodland are within easy walking distance in the hills to the east.

Northern fur seals (*Callorhinus ursinus*) are 12 percent of the identified mammal sample at CA-SMA-18, but constitute only 2.2 percent of the CA-SMA-113 sample, a statistically significant difference (Fisher's Exact two-tailed $p < 0.0001$; Table 2). The species was abundant in the greater Monterey Bay region for a time and was a major prey species at CA-SMA-18 and CA-SMA-218 on Point Año Nuevo, as well as at CA-SMA-118 (the Bean Hollow site) about 13 km north of Año Nuevo (Gifford-Gonzalez et al. 2006; Hylkema 2002). They disappeared from mainland California assemblages between AD 800 and 1200, but a colony of about 200,000 animals used the Farallon Islands until it was extirpated by commercial sealing in the early 1800s (Busch 1985; Gifford-Gonzalez 2011). Their presence in the CA-SMA-113 archaeofauna may reflect animals acquired early in the occupation of the site or capture of beached individuals from the Farallons in later times. Frequencies of sea otter also differ statistically significantly in the archaeofaunas of the two sites (Fisher's Exact two-tailed $p < 0.0001$). This low incidence in *Enhydra* could be said to go against predictions for the Late Period drawn from the early work of Hildebrandt and Jones (1992) and Jones and Hildebrandt (1995). However, it may be more useful to view the faunal content of sites in the context of their specific function. The archaeofaunas of at least two Late Period special purpose sites on the nearby southern San Mateo coast, CA-SMA-115 and CA-SMA-118, do reflect the differential acquisition of sea otters.

Rabbits are much less common in the CA-SMA-113 archaeofauna (10.2 percent) than in that from CA-SMA-18 (34.7 percent). This may reflect their relative abundances in vegetation zones immediately around the two sites, but also could suggest their lower ranking as an animal food by people in Quiroste. Cottontails can be captured by simple snares, but they offer only small amounts of very lean meat (Speth and Spielmann 1983), and as such, may have been lower ranked than deer, oily fishes, and fat-rich carbohydrates such as hazel nut, which offer 60 g of fat and 508 calories from fat in every 100 grams (U.S. Department of Agriculture 2012).

Rodents are discussed in more detail below, but given the potential for recovery techniques and taphonomic processes to affect such small bones, it is advisable to address such questions about the nature of the rodent sample and, on the basis of this, outline what inferences from the data may be warranted. Details of the recovery techniques at CA-SMA-113 can be found in Cuthrell et al. (this issue) but excavations employed fine-mesh screens (1/8-in) along with systematic and comprehensive recovery of flotation samples to retrieve botanical evidence, microfauna, and very small artifacts using 1/16-in mesh. This suggests that excavation-based recovery bias has little effect on the frequencies of various rodent species in the sample. Furthermore, if mice (*Peromyscus*), abundant in Reid's live-trapping data from all habitats, were lost due to recovery bias, so too would have been the even smaller elements of anchovies, herrings, and small pricklebacks, which account for over 60 percent of the fishes identified at CA-SMA-113.

Taphonomic agents, especially nonhuman carnivore bone accumulators and modifiers, can strongly affect microfaunal samples. While we cannot definitively prove a low impact on rodent remains by carnivores, several lines of evidence lead us to believe that this is the case with the CA-SMA-113 sample. First, as outlined by Cuthrell et al. (this issue), after initial testing, excavation and recovery selectively focused on human-generated contexts and features, such as pits, midden fill, ash dumps, and ash and fire-altered rock concentrations, rather than randomly sampling wider zones more likely to yield nonhuman bone deposits. Bone clusters typical of carnivore coprolites or owl pellets were not encountered during excavations.

More directly, all rodent specimens (as for all analyzed faunal remains) were examined under magnification and scored for presence/absence of carnivore tooth marks and stomach acid alteration. While 135 specimens from the archaeofauna as a whole showed evidence for carnivore action, only one gopher cranial element out of 685 rodent specimens displayed a carnivore tooth mark. Most gnawed bones were derived from larger mammals, including sea otters, pinnipeds, cervids, and cetaceans. Acid-modified bones were predominantly (89.4 percent) from fishes.

One might object that such delicate bones as those of rodents would be totally destroyed through consumption by carnivores the size of dogs or coyotes, but two points argue against this as a source of bias in the archaeofaunal sample. First, at CA-SMA-18, delicate brush rabbit bones about the same size as those of larger rodents displayed 14 percent levels of carnivore modification (Gifford-Gonzalez et al. 2006). This argues against total destruction of microfaunal elements by carnivores. Second, one would have to argue that carnivores were so consistently selective in their choice of rodent species as to bias their relative abundances away from that which originally typified the site. Thus, we believe that little evidence exists for carnivores as a major accumulator or modifier of rodent remains at CA-SMA-113.

Turning specifically to the rodent taxa in the CA-SMA-113 archaeofauna, species were assessed for burrowing habits or use of burrows made by other animals, thus their greater potential to enter the site without human intervention, either during or after site formation. Each taxon was also examined for traces of human cutting tool marks and thermal alteration, based on the assumption that higher rates of modification suggest that a species was more likely to have been handled as a food item.

Three taxa are most abundant in the rodent archaeofauna. At 52 percent of identified rodent taxa, pocket gopher remains are the most common, but given their burrowing habits and ubiquity in coastal settings, many specimens may be intrusive rather than human prey (Erlandson 1984). Gophers spend up to 15 hours a day in their extensive underground burrows at around 40 cm depth and are most active in the late afternoons and early night hours (Gettinger 1984). They are thus not very vulnerable to human predation. Of 190 pocket gopher specimens, just one percent display burning, and one percent bear cut marks, significantly less than rates for the other two common rodent taxa.

California voles constitute 25 percent of CA-SMA-113's identified rodent sample. The species uses earth burrows 7 to 15 cm below the ground surface for its nests but maintains grass runways above ground, being most active at dawn and dusk (Heske and Lidicker 1999). The preferred habitats of voles are wet meadows, dry grassy hillsides, and salt and freshwater marshes; they feed on seeds and roots of sedges, grasses, and forbs (Cudworth and Koprowski 2010). Female and male home ranges are 68 m^2 and 103 m^2, respectively (Cudworth and Koprowski 2010). Members of the species are thus much more likely to be found in open habitats than in the closed ones typifying the Quiroste Valley today (see below). Some might have dug into the site, but given their small home ranges, their open habitats would have had to exist immediately adjacent to the site. Voles weigh 47 to 52 g each, individually making a very modest contribution to human diet. However, in contrast with the one percent rate among pocket gophers, 17.6 percent show thermal alteration, suggesting that at least some voles entered the site through processing by humans.

Dusky-footed wood rats, comprising 10 percent of CA-SMA-113's identified rodents, are nocturnal rodents that flourish in oak understory and brushy habitats. They do not burrow nor do they use other animals' burrows. One telemetry study put female wood rats' average home range size at 3,576 m^2, and at 4,459 m^2 for a male from the same population (Lynch et al. 1994). During the day, wood rats rest above ground in nests they construct of sticks. Individual wood rats may construct nests near one another in "villages" (Lynch et al. 1994). They would thus be a spatiotemporally predictable prey item for human foragers, either adults returning to camp without larger prey or foraging children (Bird and Bliege Bird 2002, 2005). At 230 to 300 g, they would be a good protein addition to a meal. Wood rat bones display a 14.3 percent thermal alteration rate, suggesting human handling in meal preparation.

Bird Use

The representation of bird remains at CA-SMA-113 (228 of 4,897 identified specimens, 4.7 percent) contrasts with their more common occurrence at other coastal residential sites in the Monterey region, where they average 13 percent. Table 6 shows the relative abundances of bird remains at 13 well-documented coastal sites in southern San Mateo, Santa Cruz, and northern Monterey counties. The avian index (AI) expresses the proportions of birds to other identified specimens for each site: AI = Bird NISP/Total NISP. Sites are classified as residential, short-term residential, and special purpose on the basis of descriptions in reports, discussions with Mark Hylkema (personal communication 2013), diversity of artifacts, features, and the range of vertebrate

Table 6. Faunal Summary Statistics and Avian Index.

Site (CA-)	Period	Bird NISP	NISP	Avian Index	Σ NSP	Site Type	References
SMA-113	Late	228	4,897	0.047	19,460	Residential	
SMA-97	Late	26	223	0.117	620	Residential	Hylkema (2002), personal communication (2013)
SMA-18	Late Middle	437	2,842	0.154	4,467	Residential	Gifford-Gonzalez et al. (2006)
SCR-35	Middle	26	205	0.127	3,317	Residential	Gifford and Marshall (1984)
MNT-229	Early/ Middle	557	4,407	0.126	35,492	Residential	Dietz et al. (1988)
SMA-244	Late	3	80	0.038	238	Short-term residential: fishes (50%)	Hylkema (2002), personal communication (2013)
SMA-115	Late	68	228	0.298	528	Short-term residential: sea otter (54%), deer (27%)	Hylkema (2002), personal communication (2013); Gifford-Gonzalez (2010)
SCR-93	Early/ Middle	4	468	0.009	2,571	Short-term residential? fishes (85%)	Hylkema (2002), personal communication (2013)
MNT-228	Early/ Middle	82	4,855	0.017	11,000	Short-term residential: fishes (94%), many shellfish	Jones et al. (1996)
SMA-118	Late	20	156	0.128	156	Special purpose: marine mammal (78%)	Hylkema (2002), personal communication (2013)
SMA-134	Late	36	530	0.068	1,541	Special purpose: marine mammal (8%), fishes (23%)	Hylkema (2002), personal communication (2013)
SMA-218	Early	21	294	0.071	2,571	Special purpose: fur seal (48%), fishes (16%), lithic preform production	Hylkema (2002), personal communication (2013)

Continued

Table 6. Faunal Summary Statistics and Avian Index. (continued)

Site (CA-)	Period	Bird NISP	NISP	Avian Index	Σ NSP	Site Type	References
MNT-234 Primary Midden	Middle	481	209,555	0.002	214,761	Special purpose: fur seal (1%), fishes (98%)	Milliken et al. (1999); Gifford-Gonzalez and Sunseri (2009)

Notes: Avian Index (AI) = Bird NISP/∑NISP for 13 coastal sites. Functional ascriptions are drawn from reports and interviews and based upon diversity of artifacts, features, and the range of animal species represented (Dietz et al. 1988; Gifford and Marshall 1984; Gifford-Gonzalez and Sunseri 2009; Gifford-Gonzalez et al. 2006; Hylkema 2002 and personal communication 2013; Jones et al. 1996; Milliken et al. 1999). The majority of primary midden fauna assigned to the Middle Period is based on 32 AMS radiocarbon dates by Gifford-Gonzalez and Boone (see Newsome et al. 2007; Boone 2012). Sites are presented by ascribed functional type and ordered by county.

species represented (Dietz et al. 1988; Gifford and Marshall 1984; Gifford-Gonzalez and Sunseri 2009; Gifford-Gonzalez et al. 2006; Hylkema 2002; Jones et al. 1996; Milliken et al. 1999).

The avian index is remarkably consistent among residential sites except for CA-SMA-113. Figure 1 displays the 95 percent confidence limits (CL) for all sites in Table 6, using percentages (AI normed to base 100). Here it is clear that CA-SMA-113 falls outside the CL of all other residential sites. It does fall within the 95 percent CL of a few other sites, namely CA-SMA-244, CA-SMA-118, and CA-SMA-218, all short-term or special purpose sites reflecting a focus on only a few vertebrate taxa. This may not so much reflect a functional affinity between CA-SMA-113 and these other sites as it does the highly variable nature of bird capture at these shorter term and special purpose sites.

Table 7 provides another approach to determining statistical significance, presenting probability values for 12 × 12 pair-wise Fisher's exact tests of bird NISP and total NISP for 12 of the 13 sites presented in Table 6. The relative avian abundance for CA-SMA-113 differs from those at all other residential sites at an extremely significant level.

These findings beg the question of why CA-SMA-113's avian abundance is so low, when it is clearly a residential site within easy walk to coastal areas where lipid-rich sea birds could have been acquired, as they were at other Late Period sites in the region. Amah Mutsun tribal historian Ed Ketchum has suggested that Quiroste people might have been of the Bird Clan, who avoided consuming birds (E. Ketchum, personal communication 2010).

Of the 22 identified bird specimens recovered, three are scapulae from redtail hawk (*Buteo jamaicensis*) and two are from unidentified raptorial birds. Red-tailed hawks are not consistently listed as a major spiritual animal species among Costanoan-speaking peoples, for whom the eagle was a major

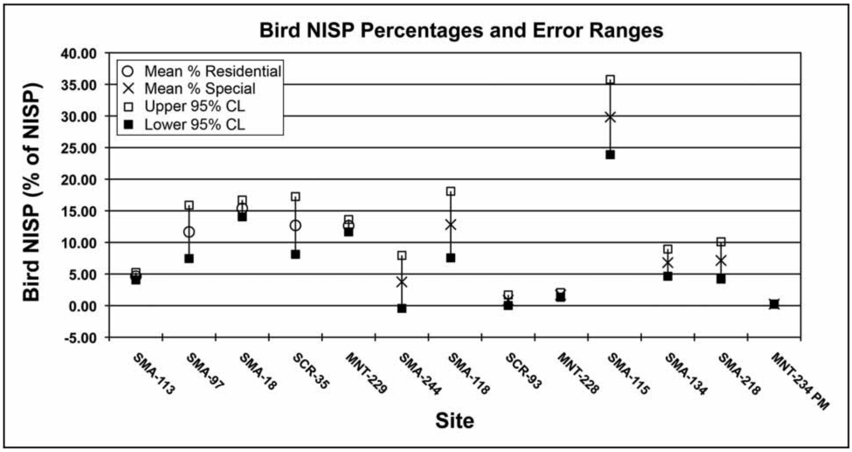

Figure 1. Confidence level (CL) for avian frequencies at 13 regional archaeological sites from southern San Mateo, Santa Cruz, and northern Monterey counties. Residential site means are marked with an open circle. Short-term residential and special purpose sites means are marked with an X. See Tables 2 and 7 and text for details of sites and formula (from van der Veen and Fieller 1982).

figure in their creation story, and owls were sometimes associated with shamans (Jones 2010; Kroeber 1907:199–200; Ortiz 1994). Simons (2007) reported one *Buteo* specimen associated with a discrete burial at Tamien (CA-SCL-690). However, bird parts are often associated with forms of spiritual power, as shown by the great diversity of large bird species, among them albatrosses, condors, cranes, and eagles, whose bones were used for flutes and later buried with high-ranking Late Period individuals at Filoli (CA-SMA-125; Jones 2010). One as-yet taxonomically unidentified humerus shaft from CA-SMA-113 is from either an albatross or condor-sized bird and displays flecks of asphaltum and polishing, indicating its use as an artifact.

Thus, more than 25 percent of the identified avian bones are from taxa known to have had spiritual significance to local indigenous peoples. While the archaeofaunal evidence cannot assess the hypothesis proposed by Ed Ketchum, it remains an open question why a commonly used food resource at other coastal sites was so seldom used at CA-SMA-113.

Fish Fauna and Temporal Trends

People living in Quiroste Valley exploited all nearby aquatic habitats and emphasized catching nearshore and intertidal species (Table 4) using a variety of

Table 7. Faunal Summary Statistics and Avian Index for 13 Coastal Sites.

Site (CA-)	Bird NISP	Σ NISP	AI	Bird %	Σ NSP	Error	BirdProp Hi	BirdProp Lo	Bird % Hi	Bird % Lo
SMA-113	228	4,897	0.047	4.66	19,460	0.0059	0.052	0.041	5.25	4.07
SMA-97	26	223	0.117	11.66	620	0.0422	0.159	0.074	15.88	7.44
SMA-18	437	2,842	0.154	15.38	4,467	0.0133	0.167	0.141	16.70	14.05
SCR-35	26	205	0.127	12.68	3,317	0.0457	0.172	0.081	17.25	8.12
MNT-229	557	4,407	0.126	12.64	35,492	0.0098	0.136	0.117	13.62	11.66
SMA-244	3	80	0.038	3.75	238	0.0419	0.079	-0.004	7.94	-0.44
SMA-118	20	156	0.128	12.82	156	0.0526	0.181	0.076	18.08	7.56
SCR-93	4	468	0.009	0.85	2,571	0.0083	0.017	0.000	1.69	0.02
MNT-228	82	4,855	0.017	1.69	11,000	0.0036	0.021	0.013	2.05	1.33
SMA-115	68	228	0.298	29.82	528	0.0595	0.358	0.239	35.78	23.87
SMA-134	36	530	0.068	6.79	1,541	0.0214	0.089	0.046	8.94	4.65
SMA-218	21	294	0.071	7.14	2,571	0.0295	0.101	0.042	10.09	4.19
MNT-234 Primary Midden	481	209,555	0.002	0.23	214,761	0.0002	0.003	0.002	0.25	0.21

Notes: Avian Index (AI) = Bird NISP/∑NISP). See text for formula for calculating error of 95% confidence level. Also see Table 6.

fishing techniques. Taxa at CA-SMA-113 are common in other coastal sites that Boone (2012) analyzed from the greater Monterey Bay, but while surfperch and rockfish typically dominate, anchovies and pricklebacks are remarkably abundant at CA-SMA-113. The high abundance of nearshore species at CA-SMA-113 is due mainly to the presence of anchovy which, as noted above, may be the product of the fine-grained recovery methods. Although beach, rocky intertidal, and freshwater habitats are all easily accessible from Quiroste Valley, CA-SMA-113's pricklebacks, cabezons, rockfishes, and greenlings suggest more focus on rocky shoreline species. Within the surfperch, some species are usually found in beach surf and others along rocky shorelines. Anchovies, sardines, and herrings would have been available in either beach or rocky habitats, but all such small, schooling species were most likely caught with nets along sandy beaches. Fishes from sandy or soft bottom and freshwater habitats, though present, are relatively rare.

Boone (2012) applied dynamic state variable modeling to predict foragers' use of different habitats and fish communities around the Monterey Bay. The model predicted that because tidepool fishes have a high probability of successful capture, they would be a consistent part of foragers' intake. Tidepool taxa appear in low (ca. 10 percent) but consistent relative abundances through much of the region's human history but then dramatically increase in Late Period sites. Pricklebacks alone are over 23 percent of the CA-SMA-113 fish NISP, while at CA-MNT-17 in Carmel Bay, tidepool species, again mostly pricklebacks, comprised 30 percent. Today, pricklebacks are caught by poke poling, with a short, baited hook and line attached to a pole and inserted into tide pool crevices. Anecdotes report that pricklebacks are tasty when roasted or boiled.

Boone (2012) interpreted the jump in tidepool harvesting as possibly indicating that aquatic resources were more reliable when the Medieval Climatic Anomaly (MCA) affected the terrestrial resource base. Increased aridity during the MCA would have rendered terrestrial plant and animal populations both less abundant and less predictable, and their recovery may have occurred slowly after the MCA ended. More Middle–Late Transition and Late Period samples are needed to assess this hypothesis, but such considerations may also have been implicated in the cultivation of hazel trees in Quiroste during the same time span (Cuthrell, herein).

Rodents, Habitat, and Fire

Rodents in any archaeological assemblage are not a random sample of the local community but rather a mix of human prey, commensals, and burrowers into middens. Nonetheless, habitat-diagnostic species can shed light on the presence or absence of land modification in the Quiroste Valley during the time that CA-SMA-113 was formed. This section first summarizes rodent vulnerability to and recovery from fires in modern California and addresses the temporal resolution of the CA-SMA-113 sample. It then turns to a comparison of species abundances in the live-trapped modern sample with those at CA-SMA-113 and neighboring CA-SMA-18, with an eye to indications of habitat modification.

California voles, dusky-footed wood rats, and different species of mice (*Peromyscus* spp.), as well as brush rabbits, forage and nest above ground and are vulnerable to fires that destroy their food supply and refuges, although California voles might be able to take refuge in earth tunnels. Pocket gophers can escape the ill effects of fires, as their burrows extend well below the super-heated soil zone, and they can continue to feed on roots in burned areas. Accounts of large modern wildfires describe panicked wood rats and brush rabbits running to roads and trails, with some female wood rats carrying their young, and their carcasses are often found in non-vegetated landscape features where they sought refuge (Lee and Tietje 2005; Salmon et al. 2007; Wirtz 1995).

However, burn depopulation is short-lived. Multi-season monitoring of burned areas indicates that seed-eating rodents, such as voles and some *Peromyscus* species, invade burned-over areas as soon the first seed-bearing plants appear, followed by rabbits, and that wood rats recolonize such areas within a year (Lee and Tietje 2005; Vreeland and Tietje 2002). Seed-eating rodents actually "boom" soon after a burn, when grasses dominate early vegetation recovery (Lee and Tietje 2005). Wood rats, which favor closed habitats and need sticks to build their houses, would seem to be more disadvantaged by fires, but Lee and Tietje (2005) found that prescribed burns of *Neotoma* habitat had less influence on the species' overall levels of success than did other factors.

Indigenous landscape manipulation with fire probably involved localized, controlled burns that, once meadowlands had been expanded, did not destroy brush or tree stands. Many small mammals and birds would have been able to find refuge in adjacent, unburned areas, despite some individual deaths, and could have recolonized burned zones when food and protective overgrowth were again available. Such burn-and-recolonization episodes are sufficiently short-term that we expect the CA-SMA-113 archaeological deposits to present a time-averaged sample of such cycles.

The time-averaged rodent sample diverges in important ways from expectations based upon the modern live trapped rodent data, and may shed light on land management practices in Quiroste Valley. Figure 2 shows the percent

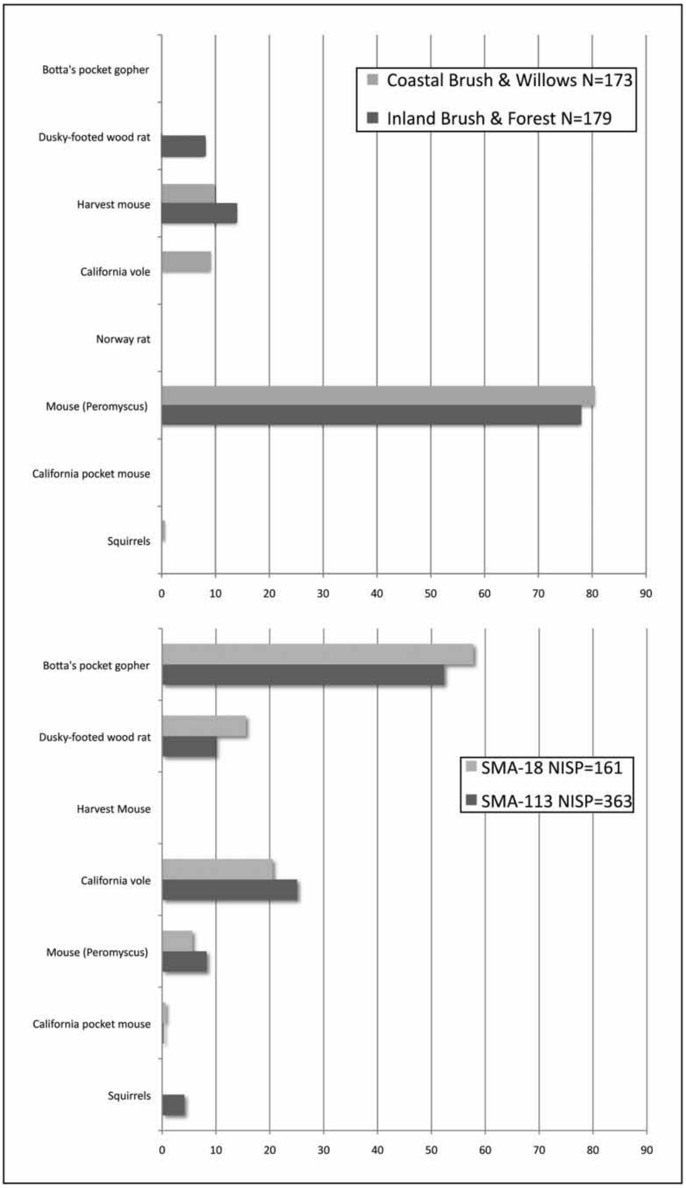

Figure 2. Rodent species live-trapped in coastal and inland habitats by Reid (upper) and identifiable rodent species from CA-SMA-113 and CA-SMA-18 (lower). Based on percent of number of individual captures (N) and number of identified specimens (NISP).

frequencies of rodent species live-trapped by Reid in coastal and inland habitats (upper) and percent NISP of identified rodent species in the CA-SMA-113 and CA-SMA-18 archaeofaunas (lower).

Several points may be made. First, Reid's live trap design did not capture pocket gophers, although they inhabit all trapping areas. Gophers' subterranean habits require other live trapping methods than employed in her study (Witmer et al. 1999). Second, the frequencies of pocket gophers at CA-SMA-113 and CA-SMA-18 are not statistically distinguishable (Fisher's Exact two-tailed $p = 0.2561$). Because the species is neither registered in the live trapping data nor a statistically significant indicator of habitat, we have excluded it from further discussion of possible habitat modification.

Third, Reid's live trapping captured modern wood rats only in closed, inland vegetation zones and voles only in more open Point Año Nuevo zones, reflecting the species' habitat preferences. Fourth, the multiple species of *Peromyscus* (*P. boylii, P. maniculatus, P. californicus*), which range from 76 to 80 percent of the live trap sample, are quite rare relative to wood rats and voles in both archaeofaunal samples, even at CA-SMA-113 where the fine-grained recovery that yielded very small fishes seldom retrieved these species (see Table 1).

Fifth, abundances of wood rats in the CA-SMA-113 archaeofauna are not statistically distinguishable from their abundances in the inland closed habitat live trap capture (Fisher's Exact two-tailed $p = 0.8689$). At first glance, their numbers would appear to argue against habitat modification. However, further circumspection is needed, because archaeological evidence from CA-SMA-18 suggests that wood rats were a targeted species, despite the travel it would have taken to reach their favored habitats. Of 179 captures, Reid's Año Nuevo coastal live trap sample captured no *Neotoma*, but they comprise 16 percent of the identified rodents in the CA-SMA-18 archaeofauna (Fisher's Exact two-tailed $p \leq 0.0001$). These findings suggest that, in at least some cases, wood rats' ease of acquisition can positively bias their numbers in local sites, even those a kilometer or more from their favored habitats. While it might be argued that the habitat around CA-SMA-18 at 700–800 AD was more closed at the time the site was occupied, no environmental records exist for conditions that would favor vegetation denser than exists today as the result of historic fire suppression in this area. In any case, wood rats' appeal to humans suggests that a less ambiguous environmental indicator is needed.

In light of Reid's live trap data, California voles' higher representation than wood rats in the CA-SMA-113 archaeofauna is remarkable. No voles were ever captured in inland forest or brush habitats. The divergence between the CA-SMA-113 archaeological and contemporary trapping data from inland closed habitats is extremely statistically significant (Fisher's Exact two-tailed $p \leq 0.0001$). Point Año Nuevo offers voles some preferred habitats: saltwater and freshwater marshes, and meadows, and voles approached 10 percent in the coastal live trap sample (Figure 1).

The high proportion of voles in the CA-SMA-113 archaeofauna, in what is today closed habitat much like Reid's inland live trap sample, strongly suggests the existence of open, forb, and grass vegetation in the Quiroste Valley in higher proportions than exist today. The zooarchaeological evidence is consistent with the botanical evidence for small seed-bearing grasses as a major part of the Quiroste Valley plant community (Cuthrell, herein; Evett and Cuthrell, herein).

Conclusion

In sum, the assemblage from CA-SMA-113 indicates that the Quiroste people regularly used a range of habitats—terrestrial, riverine, and marine—for acquiring edible and useful species. The strikingly higher than expected proportions of open habitat adapted voles in the archaeofauna is strong evidence for maintenance of a more open environment than presently characterizes the Quiroste Valley. The faunal evidence cannot specify to the nature of the processes that maintained vole-friendly plant communities near CA-SMA-113. Intentional human maintenance of such plant associations by fire, the scenario discussed in this special issue, is one such possibility.

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