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Early Limits to the Central California Acorn Economy in the Lower Sacramento Valley

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*The Sacramento Valley bottom has one of the richest archaeological records in California despite poor nut-crop resources that are the hallmark of California Indian subsistence. The nut-poor habitat fostered much earlier intensification of low-ranked small seeds in the Valley bottom than contemporaneous sites in the San Francisco Bay Area and North Coast Ranges, including a focus on use of goosefoot (*Chenopodium *spp.) seeds unique to central California. The Sacramento Valley also has the only central California record of intensive use of Themidaceae (Brodiaea complex) geophyte corms, suggesting these root crops were also low-ranked plant foods.*

Ethnographies of Native Americans of central California uniformly describe a gathering, fishing, and hunting economy based on staple acorn crops, with attendant intensive processing technology and bulk storage (e.g., Baumhoff 1963; Kroeber 1925). The California archaeological record of charred plant remains from more than 4,000 flotation samples, however, contrasts with this picture, as acorns became a staple food only during the Late Holocene in some localities, and never in other more marginal areas. Further, intensive use of a variety of small seeds of grasses and forbs arose in favored areas of central California during the last 1,000 years, revealing the limitations of a nut-based economy to provision increasingly dense populations (Wohlgemuth 1996, 2004, 2010a). As new data demonstrate, nowhere is this as pronounced as in the lower Sacramento Valley. Here I present information that distinguishes the habitat of the Sacramento Valley from other areas of central California, and fine-grained late Holocene archaeobotanical data from the Natomas reach in the lower Sacramento Valley that exhibit the earliest record of central California plant-food intensification.

POOR NUT RESOURCES OF THE SACRAMENTO VALLEY BOTTOM

A well-endowed sub-region of the 400-mile long Central Valley, the distinctive Sacramento Valley bottom habitat differs significantly from other central California lowlands. Key nut crops that were Native California staples are limited to one acorn-bearing oak species, valley oak (*Quercus lobata*). Native people's ranking of different oak acorns place valley oak in the second tier of preferences (Table 1), with the higher-ranked species all found outside the Sacramento Valley. Tan oak (*Notholithocarpus densiflora*) and black oak (*Quercus kelloggii*) grow in coastal or mid-elevation coniferous forests, while nearly all blue oak (*Quercus douglasii*) stands grow in the xeric lower foothills surrounding the valley (Fig. 1). Valley oak acorns were largely ignored in foothill regions where preferred black oaks and blue oaks grow. Even in years of crop failures for preferred

Table 1

CENTRAL CALIFORNIA INDIAN ACORN RANKINGS

Common Name	Latin Name	Average Rank
Tan oak	*L. densiflora*	1.0
Black oak	*Q. kelloggii*	1.5
Blue oak	*Q. douglasii*	1.5
Valley oak	*Q. lobata*	1.9
Coast live oak	*Q. agrifolia*	2.0
Oregon oak	*Q. garryana*	2.0
Canyon live oak	*Q. chrysolepis*	2.2
Interior live oak	*Q. wislizenii*	2.3
Scrub oak	*Q. berberidifolia*	2.5

After Baumhoff 1963, and McCarthy 1993a.

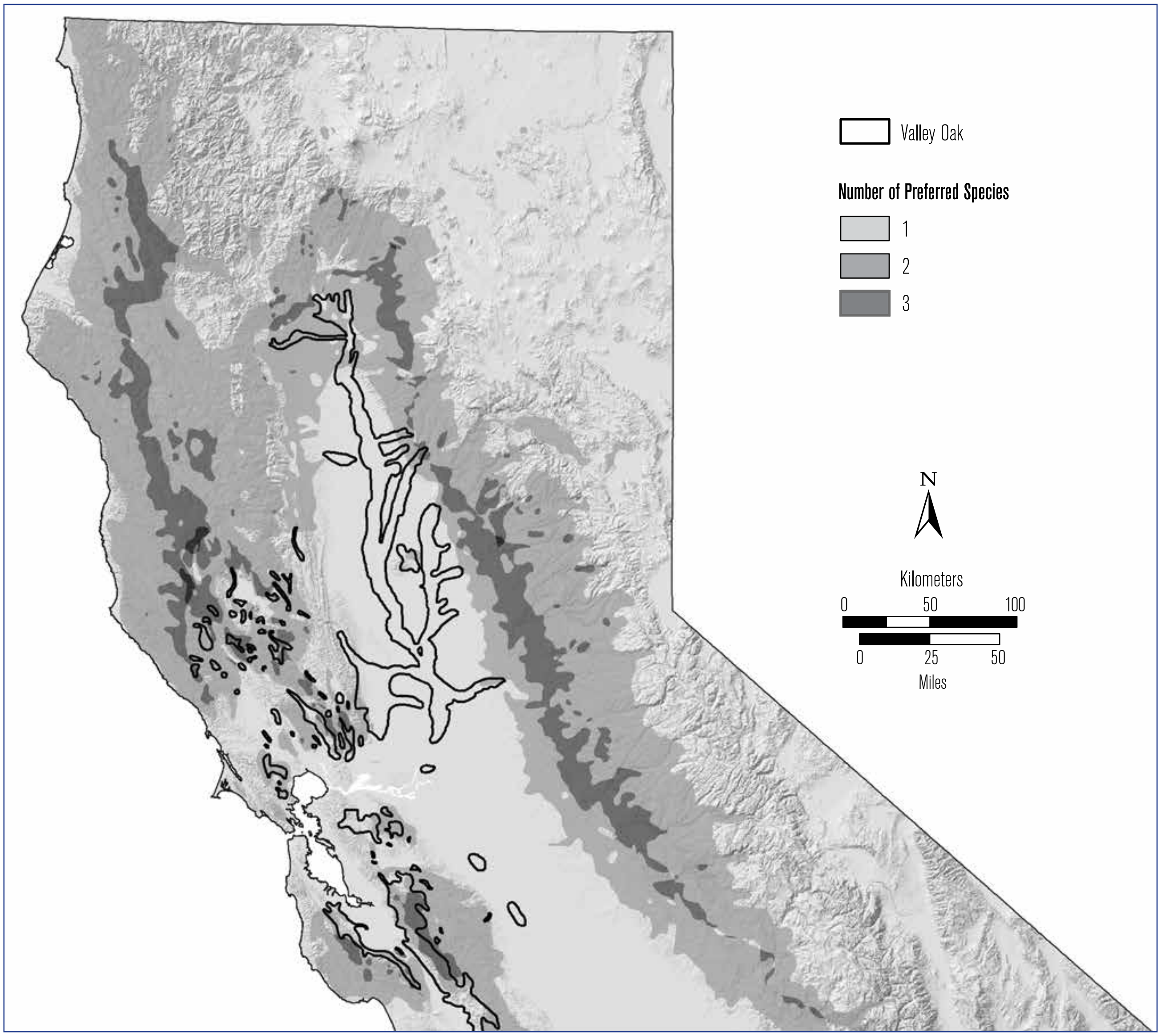

Figure 1. Distribution of Valley Oak and preferred oak species in Central California.

species, contemporary native people are documented as choosing to use stored black or blue oak acorns, and not use new crops of valley oaks (McCarthy 1993a:243–244).

Probably as critical is that no other edible nut crops such as gray pine (*Pinus sabiniana*), sugar pine (*P. lambertiana*), buckeye (*Aesculus californica*), hazel (*Corylus cornuta* var. *rostrata*), or bay (*Umbellularia californica*), which are frequent or common in other central California localities, grow in the Sacramento Valley bottom. Given the 5–6 kilometer foraging radius often assumed for plant food gathering (Kelly 1995:136–138), people living in prime Sacramento Valley bottom locations along the major rivers (the Sacramento or the Feather) would not have access to any nut crops other than valley oak; even a foraging radius triple the typical assumption would not reach productive stands of other nut crops (Griffin and Critchfield 1976; Fig. 1). Given the unpredictable nature of acorn crops of all oak species, valley oak crop failures are inevitable (Baumhoff 1963; Wolf 1945); Valley people would have experienced multiple failures during their lives for which there were no other local nut options that could serve as backup. While acorn resources are poor, grassland plants producing edible geophyte roots (especially *Brodiaea* complex corms) and a wide range of small seeds were alternative foods that flourish in the valley bottom (Wohlgemuth 2010a).

Despite the dearth of nut crops, the Sacramento Valley archaeological record displays the longest history of sedentary villages in central California, with sites along the Mokelumne Bend in the eastern Sacramento-San Joaquin Delta dating to 5,500 – 4,500 cal B.P. (Rosenthal et al. 2007:153–155). The Sacramento Valley also supported the highest contact-period population densities in native central California, estimated to have been as high as 17 per square mile (Milliken 2006:39). Inasmuch as other lowland central California regions (notably the inland valleys around the greater San Francisco Bay Area) also feature abundant corm and small seed resources, it is clear that these early Sacramento Valley villages were not established for their access to plant foods. Rather, early people probably chose to live there to take advantage of the abundant fish resources of the major streams (Wohlgemuth 2010a); some of the earliest known sites exhibit ample fish remains, including salmonid bones at mid-Holocene CA-SAC-38 (Tremaine 2008; White 2003).

Given second-tier valley oak acorns as the sole option for nut crops, native people would have had to adjust their plant resource use to sustain sedentary villages and increasing population densities. The Sacramento Valley bottom habitat would thus provide incentives for people to develop new plant use strategies, and would be one of the most likely places to look for the development of horticulture of native food plants in California. I have presented very tenuous archaeological seed metric evidence suggesting that larger seeds of two native grasses, native barley (*Hordeum* spp.) and maygrass (*Phalaris* spp.), might reflect native horticultural experimentation during the Late Prehistoric and Protohistoric periods of the Sacramento Valley cultural sequence. These two taxa were cultivated during at least the Mission Period in coastal southern California (Reddy 2015), and in prehistoric times in the Southwest or eastern North America (Adams 2014; Yarnell 1993). But the earlier comparative grass seed metric data are from riverine settings in the Colusa reach of the Sacramento River, which are not strictly comparable to data from the upland setting of terminal prehistoric site CA-YOL-69 along the small tributary Cache Creek, which is well outside the riverine zone and may reflect different grass species, subspecies, or ecotypes (Wohlgemuth 2004). Fortunately, massive archaeobotanical samples from the finest-grained sequence of occupation debris deposits known from central California were obtained from the Natomas Levee Improvement Project, just north of Sacramento (Wohlgemuth et al. 2015a, 2015b). These data allow us to examine responses of native Sacramento Valley people to limited nut resources, and contrast the findings with those from other central California localities where a wider range of nuts flourished.

THE VALIDITY OF THE PLANT MACROFOSSIL RECORD AS A PROXY FOR PLANT USE

Archaeobotanists have long struggled with the biased nature of the charred macrofloral record, as items that are processed with fire and are more robust will preserve better in archaeological sites. Preservation is more problematic with resources that are fragile and/or not processed with fire, notably fresh greens which provide important vitamins and minerals (e.g., Dennell 1976; Hastorf and Popper 1988; Pearsall 2015; see also Reddy, this volume). The approach advocated here follows Johannessen (1988), who argues that with sufficient samples from sufficient archaeological sites spanning a long sequence, meaningful patterns of data will emerge that inform us about patterns of ancient plant use. If we restrict our discussion to variability in the kinds of remains typically preserved archaeologically and do not claim to understand the entire range of plant resources consumed, meaningful patterns emerge.

While it would be rash to say that variation in plant processing, taphonomy, and preservation do not influence central California plant macrofloral data (e.g., plant remains are clearly degraded from near-surface Early Period CA-SOL-315 in Green Valley; Wohlgemuth 1992), there are good reasons to believe they are not typically important determinants. First, charred small seeds and corms have been found well-preserved in early and mid-Holocene open sites (Gill 2015; Hildebrandt and Kaijankoski 2011; Hildebrandt et al. 2012; Meyer 2015; Wohlgemuth and Tingey 2013). Second, identical or closely related plants grow in different regions of central California, and would have had identical or similar processing steps to render them into food. So there is no reason to believe that corms or small seeds would become charred and preserve much differently at sites of similar age in different regions. Finally, prior studies strongly suggest that spatiotemporal patterns in the remains of at least nuts and small seeds in central California archaeobotanical data track major shifts in people's resource selection and land use, and these are largely consistent with intensification responses to predictable increased population densities and decreased group territory size (e.g., Wohlgemuth 1996; 2004). These patterns suggest that human behavior rather than taphonomy and preservation are the principal drivers of variability in plant macrofossil data.

What may matter more in influencing the quantity of plant remains that are deposited and preserved are factors like site function and seasonal vs. sedentary occupation, and how quickly organic remains are buried and preserved. Riverine sites in the Sacramento Valley are advantaged for all of the above, with high to extremely high densities of exceptionally well-preserved plant and animal remains in large sedentary village middens periodically buried by peak flood events.

STUDY AREA, ANALYTICAL APPROACH, AND DATA SETS

The Sacramento Valley is part of a larger region I have termed "interior central California," defined as more than ten kilometers from the outer coast or San Francisco Bay shoreline. Interior central California encompasses the interior reaches of the greater San Francisco Bay Area, southern North Coast Ranges, and the adjacent Sacramento and San Joaquin valleys. Interior central California lacks marine resources, and plant foods comprised the bulk of native diets. The hallmark of the region is at least some oak woodland habitat, where acorns as well as a variety of small seeds, berries, and root crops were abundant, and native people had a choice of plant foods to eat. Interior central California stands apart from adjacent regions, like the Sierra Nevada foothills or the dry interior South Coast Ranges, in terms of settlement history and complexity, and features a dynamic archaeobotanical sequence characterized by multiple and comparatively early stages of intensification (Wohlgemuth 2004, 2010a). My prior studies conflated the greater Bay Area and the Central Valley, but with the profusion of new data I now decouple the two areas to assess the effects of variation in nut resources.

Prior studies emphasized two indices to track change and stability in prehistoric plant use. The proportion of acorn of dietary nutshell was used in conjunction with the ratio of acorn to identified small seeds. Early Period sites featured a relatively balanced array of plant remains, with a low acorn proportion in tandem with a low acorn to small seed ratio. Middle Period sites generally show increases in both acorn proportion and the acorn to small seed ratio as acorns became the staple plant food. Late Period sites also have high acorn proportions but with a lower acorn to small seed ratio, reflecting an intensified use of small seeds. These patterns were repeated in several interior central California localities, an important finding since the absolute values of the two measures are not as significant as the relative changes over time in particular settings with their unique combinations of available plant resources (Wohlgemuth 1996; 2004).

But since only valley oaks grow there, acorn proportion is not a useful measure of plant food use in the Sacramento Valley, so patterned change in its combination with the acorn to small seed ratio cannot be observed; while trace amounts of distant nuts such as buckeye or gray pine have been found in most sites along the river, they comprise far less than 1% of the total nutshell (e.g., Wohlgemuth et al. 2015a, 2015b). In addition to plotting the acorn to small seed ratio, I focus here on simple measures of key plant taxa, or group of taxa, notably median frequency (standardized per liter of flotation sample sediment volume), and to a lesser extent presence/absence, from large numbers of dated flotation samples accumulated over two decades of research in central California. This follows the pioneering studies of Johanessen in the American Bottom region of the Midwest (1988). By limiting the spatial scope of comparisons and controlling for habitat variation, we can track changes in plant use over time that follow from demographic changes, environmental shifts, and changing social relations. Alternatively, by controlling for time, we can examine spatial variation in plant use, due primarily to differences in habitat. For the problem at hand, when assemblages are securely anchored in time, simple measures are sufficient to compare the

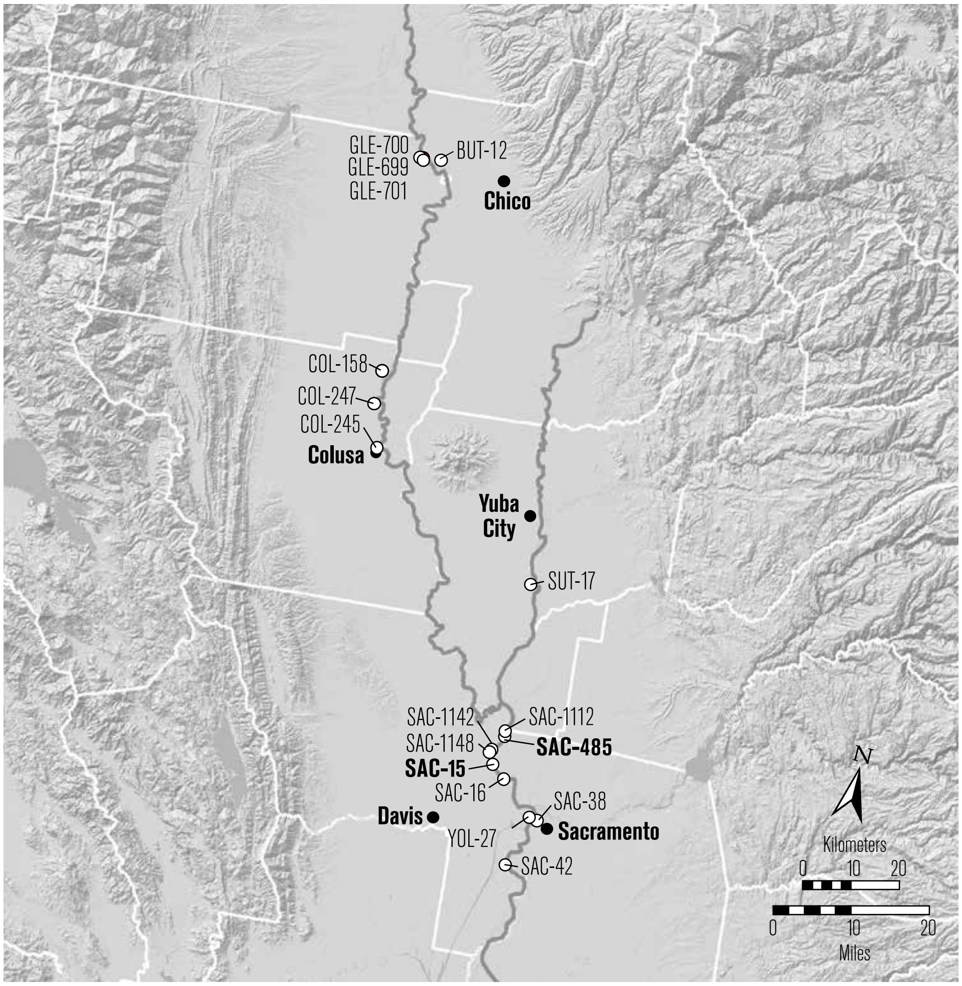

Figure 2. Sacramento Valley archaeological sites with archaeobotanical data.

nut-constrained riverine zone of the Sacramento Valley bottom with the comparatively nut-rich zones of the interior Bay Area and adjacent North Coast Ranges. Here I focus on the median frequency of acorn nutshell (in milligrams), small seeds (by count, identified to genus or species), and corms of the Themidaceae family, hereafter referred to as *Brodiaea* complex corms. Intensification here means the increased yield of resources but at decreased efficiency, whether measured per unit area or subsistence effort (Brookfield 1972). Intensification of plant foods is measured by marked increases in the frequency of particular or groups of taxa from prior periods, or within the same period in different regions, where we can say at least that plant use was more intensive in one region than another at a specific time period.

Archaeobotanical data for portions of central California outside the Sacramento Valley bottom consist of 321 analyzed flotation samples from 44 archaeological sites located in interior oak woodland valley margin or foothill settings from Gilroy north to Clear Lake, and from Santa Clara Valley east to the lee side of the Diablo Range (Marsh Creek and Los Vaqueros Reservoir) and Suisun Valley. These are organized by the simple scheme of Early Period (4,500–2,500 cal B.P.), Middle Period (2,500–930 cal B.P.), Late Period Phase 1 (930–440 cal B.P.), and Late Period Phase 2 (440–180 cal B.P.). Most sites included are residential sites or villages that feature middens, a variety of features, and burials or cemeteries (Wohlgemuth 2004), but how site function and community size influence plant frequency data remains to be explored in future studies. While the broad trends presented here also mask important regional variability (e.g., see discussion below for Fig. 5 and CA-SCL-919), they suffice to contrast with the markedly different Sacramento Valley findings.

The Sacramento Valley is represented here by 121 flotation samples analyzed from two large sedentary village sites in the Natomas reach of the lower Sacramento River, which extends from the Sacramento's confluence with the Feather River south to the mouth of the American. These span most of the period from 2,500 to 440 cal B.P. (Fig. 2). CA-SAC-485 is an Early/Middle Transition and Middle Period Phase 1 village midden occupied from 2,500–1,800 cal B.P., while SAC-15 is a deep, stratified village midden mound, where four occupation strata comprising 175–250 years each span

1,370–440 cal B.P., from Middle Period Phase 3 to Late Period Phase 1 (nomenclature and phasing follow Groza et al. 2011). While only two village sites are represented from the Natomas area, more than 30,000 charred nutshell fragments, small seeds, corms, and berry pits were identified to 52 plant genera, along with more than 4,500 pieces of wood charcoal, comprising the largest sample of identified plant remains from central California (Wohlgemuth et al. 2015b).

Archaeobotanical Trends in Interior Central California

Beginning with the one applicable intensification index, the acorn to small seed ratio for the flotation samples from interior central California in the Bay Area and southern North Coast Ranges climbs from a low Early Period value to a Middle Period peak, then declines in Late Phase 1 and again in Late Phase 2 (Fig. 3). While there are no Early Period data for the Natomas reach sites, the acorn to small seed ratio declines from a high in Early-Middle Transition/Middle Phase 1 to Middle Phase 4, and stepwise to the Middle-Late Transition and Late Phase 1, mirroring the post-Early Period trend to the west (Fig. 4). These trends confirm prior findings for the entire interior central California region (Wohlgemuth 1996; 2004).

Figure 5 shows median frequencies of acorn nutshell and small seeds from central California outside the Sacramento Valley (*Brodiaea* complex corms are so uncommon that they do not register a median frequency for any time period). Median frequencies of acorn increase steadily from the Early Period through Late Phase 1, then decline slightly during Late Phase 2 (the latter dip is due to the relatively low acorn frequency at CA-SCL-919, a small residential hamlet which supplies more than half the Late Phase 2 data; see Arpaia and Wohlgemuth, this volume). Analysis of box plot distributions of medians from a smaller sample from the larger region of interior central California also showed significant differences between the acorn medians for the Early and Middle periods. In conjunction with the increased acorn to small seed ratio and a spike in the acorn proportion of dietary nutshell, the data suggest that intensified use of acorns began in most Bay Area and southern North Coast Range places during the onset of the Middle Period around 2,500 years ago, with even more intensive acorn use during the Late Period (Wohlgemuth 2004). More recent data from CA-CCO-548 along Marsh Creek east of Mt. Diablo now may suggest acorn intensification there by perhaps 4,000 cal B.P. (Wohlgemuth 2010b). Small seed medians increase twentyfold from low values during the Early and Middle periods to Late Phase 1,

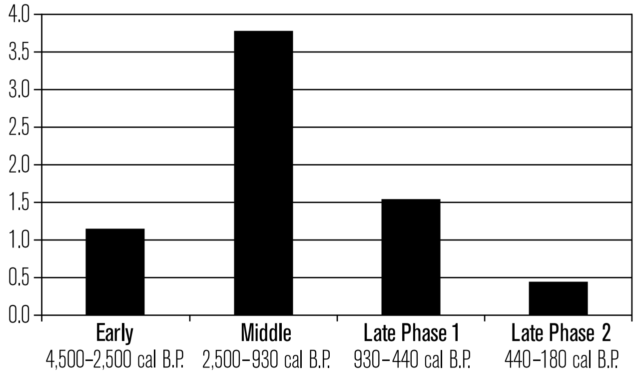

Figure 3. Bay Area and North Coast Range acorn: small seed ratio.

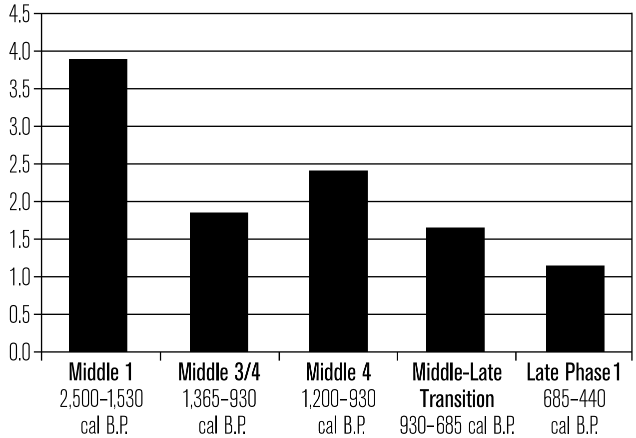

Figure 4. Natomas acorn: small seed ratio.

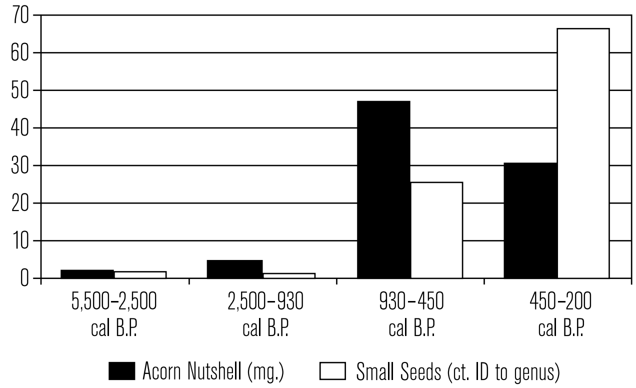

Figure 5. Bay Area and North Coast Range median plant frequency per liter of sediment.

and fortyfold to Late Phase 2, respectively, indexing intensified use of small seeds after approximately 1,000 years ago (Wohlgemuth 2004, 2010a).

In marked contrast, Natomas median acorn frequencies are much more constant between periods spanning 2,500–510 B.P., increasing only by a factor of two from the Early-Middle Transition/Middle Phase 1 to the Middle-Late Transition and Late Phase 1 (Fig. 6). However, small seed median frequencies triple after 1,100 cal B.P. and increase fivefold after 930 cal B.P. to phenomenal densities exceeding 275–350 per liter in the Middle-Late Transition and Late Period Phase 1, the highest densities known from central California. This increase and the sheer numbers clearly index increased small-seed intensification, consistent with coeval trends beginning around the Middle-Late Transition throughout interior central California (Wohlgemuth 2004). However, the small-seed median frequency of 48.7 per liter during the Early/Middle Transition and Middle Period Phase 1 at SAC-485 exceeds Middle Period values found outside the Sacramento Valley by more than forty times, and is nearly twice that of Late Period Phase 1, strongly suggesting a base level of small-seed use that was already intensified by at least 2,500 years ago, reflecting a significantly greater dietary importance of small seeds in Natomas.

Brodiaea complex corms are sufficiently abundant in Natomas to register median frequencies per liter in all time periods, ranging from 1.6 to more than 15 per liter. Charred corms represent substantial wasted labor, as they are relatively large, are dug up individually, and their units of consumption per person are in the dozens or hundreds (vs. thousands or tens of thousands for small seeds). Their far greater abundance in the lower Sacramento Valley record than in the coastal valleys is an archaeological signature of intensification in Natomas. This is reinforced by the record of a very high *Brodiaea* corm presence in the Natomas sites (in 84.3% of the 121 flotation samples) that far exceeds that from any other central California locality (Fig. 7), despite the abundance of *Brodiaea*-complex plants throughout much of lowland California.

The lower Sacramento Valley record is also distinctive in the dominance in small-seed assemblages of goosefoot (*Chenopodium* spp.). While goosefoot comprises roughly one-quarter of the small seeds (identified to genus or species) in the earlier deposit at CA-SAC-485, it comprises 43–67% of small seeds

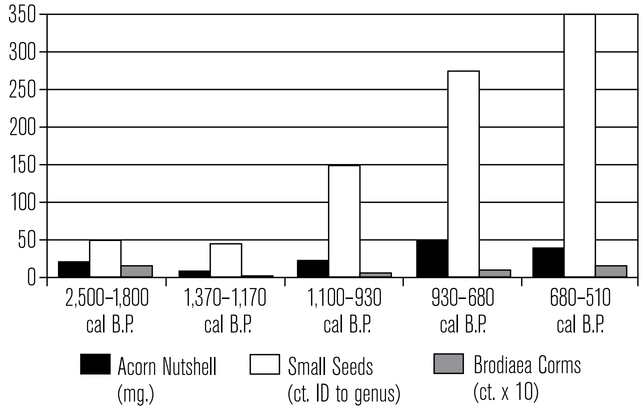

Figure 6. Natomas median plant frequency per liter of sediment.

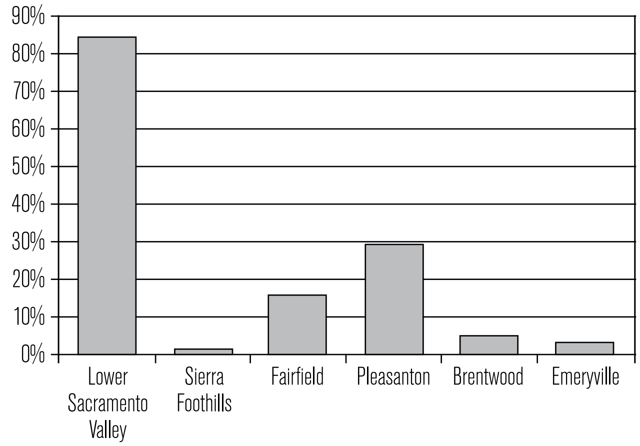

Figure 7. Central California *Brodiaea* corm percent presence by locality.

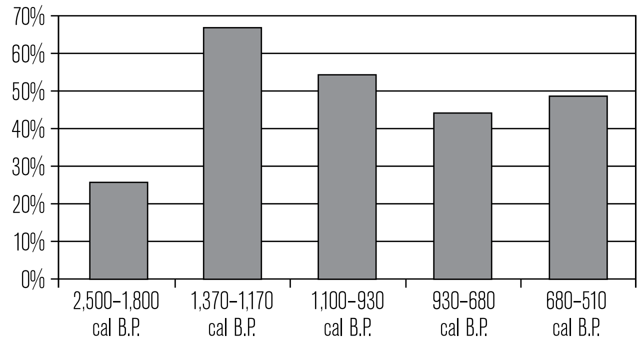

Figure 8. Goosefoot median proportion of identified small seeds from CA-SAC-485 and CA-SAC-15.

for the later Middle Period through Late Period Phase 1 at CA-SAC-15 (Fig. 8). The high proportion of goosefoot seeds is not due to a dearth of other small seed options—31 genera of small seeds were identified at CA-SAC-15, nine of them in more than half of the total flotation samples. For the pooled site data outside the Sacramento Valley, goosefoot never exceeds 16% of the small seeds, even during the Late Period (Fig. 9); Late Period small-seed use elsewhere in central California reflects diversification rather than an emphasis on a particular plant. The unparalleled focus on a single taxon in the Natomas sites not only reflects the abundance of goosefoot in the habitat, it points to the increased dietary significance of this food resource late in time.

Finally, while demonstrating an intensive use of both small seeds and *Brodiaea* corms earlier and far beyond that seen elsewhere in central California, the new data from Natomas show no evidence of increased size of maygrass or native barley caryopses in the riverine zone of the Sacramento Valley (Fig. 10). No data to date support a claim of horticultural experimentation with these grasses in the Natomas sequence, as was tentatively advanced for Protohistoric site CA-YOL-69 along Cache Creek in the drier uplands west of the valley bottom riverine zone (Wohlgemuth 2004). But it is possible that a horticultural innovation did actually occur during Late Period Phase 2 or the Protohistoric periods poorly represented in the Natomas sequence. It is also possible that maygrass and native barley horticulture may have been practiced in upland settings along Cache Creek, but the lack of antecedent comparative data from that habitat that would demonstrate an increased size of Late Period or Protohistoric caryopses from earlier time periods leaves this unresolved.

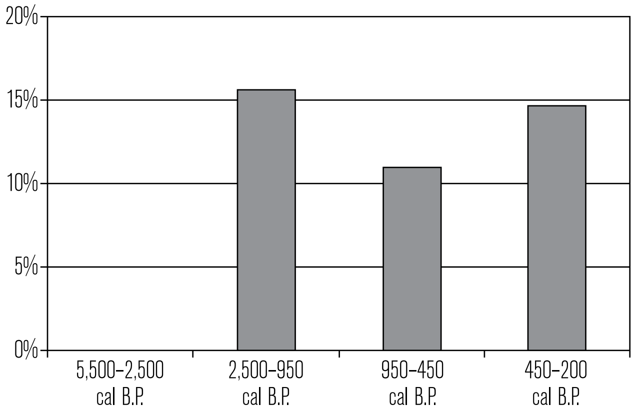

Figure 9. Goosefoot median proportion of identified Central California small seeds outside the Sacramento Valley.

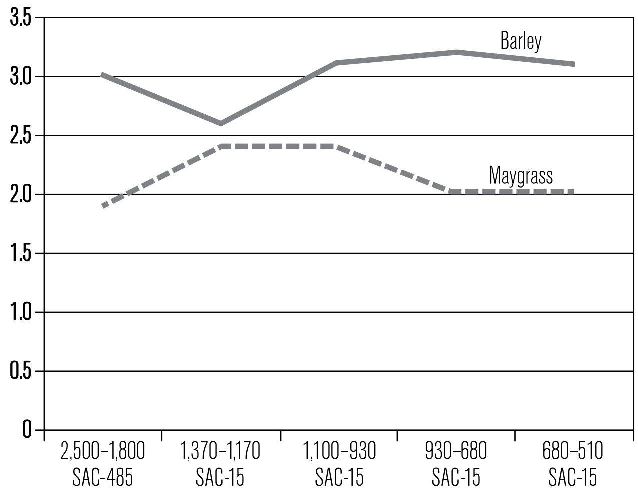

Figure 10. Length × width (in square millimeters) for maygrass and native barley caryopses from Natomas (in cal B.P.).

DOWNGRADING THE RELATIVE RANK OF *BRODIAEA* COMPLEX CORMS

Using analogies from ethnographic and experimental studies of root gathering from the Columbia Plateau that suggest very high return rates of 1,000–4,000 kilocalories per hour (Couture et al. 1986; O'Connell et al. 2008), root crops were touted as providing the highest return rates of California plant food resources, as acorns return about 830 kilocalories per hour, and small seeds only 350 per hour (Wohlgemuth 2010a). The regional archaeobotanical comparisons from central California suggest this conclusion should be revised. Despite the wide distribution of these geophytes, and consumption of the corms by most contact-period California Indians (Anderson and Rowney 1999:233), charred corms are found repeatedly and in quantity only in places with poor nut crops. Only on the Channel Islands off southern California do corms attain similar significance as in the lower Sacramento Valley (Reddy and Erlandson 2012; Gill 2015). While a diversity of oaks are present on some Channel Islands (notably Santa Cruz; Gill and Erlandson 2014), acorn nutshell is absent or rare in archaeological sites (Gill 2015:256). When contrasted with the abundant acorn debris throughout central California (Figs. 5 and 6), it is clear that acorns were not important food resources on the Channel Islands. Archaeological findings corroborate experimental studies demonstrating that *Brodiaea* complex corms provide low return rates tantamount to small seeds (Ugan and Rosenthal 2016).

EARLY PLANT INTENSIFICATION IN THE SACRAMENTO VALLEY

Broad regional population-resource imbalances appear to explain the synchronous pattern of small-seed intensification seen in dramatic increases in small-seed frequency in both the Sacramento Valley bottom and elsewhere in interior central California around 1,000–900 years ago with the advent of the Middle-Late Transition. The gap in the Valley sequence prior to 2,500 years ago may be masking a similar time depth to the appearance of an acorn-intensive economy at perhaps 4,000 years ago in the East San Francisco Bay interior valleys. Abundant acorn nutshell indexes intensification of valley oak acorns at a time depth of at least 2,500 years in Natomas, where acorn median frequency is more than four times that found contemporaneously to the west (where other nut-crop hulls are frequent to common). Prehistoric population estimates for central California are few; the best are from the Colusa reach of the Sacramento River, about 40 miles upstream from the Natomas sites, and range from a low of around 625 people at 4,500 cal B.P., to ca. 3,400 at 1,200 cal B.P., to around 12,500 at 150 cal B.P. (White 2003). Similar population increases of this magnitude probably occurred elsewhere throughout the lowlands of central California, and clearly would have led to constrictions in territorial range and restricted direct access to more distant resources that earlier were part of extensive and high-mobility land-use and subsistence strategies.

The broad correspondence of archaeobotanical trends in regions with significantly different habitats also highlights the inadequacy of nut crops to meet subsistence needs, and reflects the limits of strategies like burning and pruning to increase nut production per tree or unit area (McCarthy 1993b; Wohlgemuth 1996; 2004). Small-seed production can be increased substantially with technical innovations like the seedbeater (Bettinger 2015), by a restructuring of harvests to expand the gathering season to include unripe seeds (Barrett and Gifford 1933:152–153), by the managed burning of stands (e.g., Bean and Lawton 1973; Cuthrell 2013; Lightfoot and Lopez 2013; Lightfoot and Parish 2009), and of course by cultivation and ultimately domestication (Reddy 2015).

But the distinctive nut-poor habitat of the Valley bottom, in tandem with early sedentism, appears to have driven the intensification of *Brodiaea* corms, and to some extent small seeds, at least 1,500 years earlier than in other central California localities. This may have been a risk-minimization strategy, with intensive gathering and storage of corms and small seeds a hedge against unpredictable but inevitable valley oak acorn-crop failures. Continued increases in the frequency of acorn through the Late Period around the San Francisco Bay and in the North Coast Ranges may reflect the greater diversity of oak species there (Fig. 2), and the potential for use of other species if preferred crops failed. Lacking secondary nut-crop fallback options, by at least 2,500 cal B.P. people in the lower Sacramento Valley had intensified the use of *Brodiaea* corms and small seeds far more than in any place known within central California. The limits of an acorn-focused economy were reached throughout central California after about 1,000 years ago, but by at least 1,500 years earlier in the Sacramento Valley.

REGIONAL VARIATION IN PLANT FOOD INTENSIFICATION

In closing, while the early onset of plant food intensification in the lower Sacramento Valley may stem from poor local nut resources, the record of other interior localities and different areas around San Francisco Bay shows great variation in the emergence and timing of plant-food intensification, and in the kinds of plant foods intensified (Fig. 11; Wohlgemuth 2004; see also Reddy, this volume). This also speaks to the regional diversification of subsistence by native Californians, probably fostered by landscape management strategies (Lightfoot and Lopez 2013; Lightfoot and Parrish 2009).

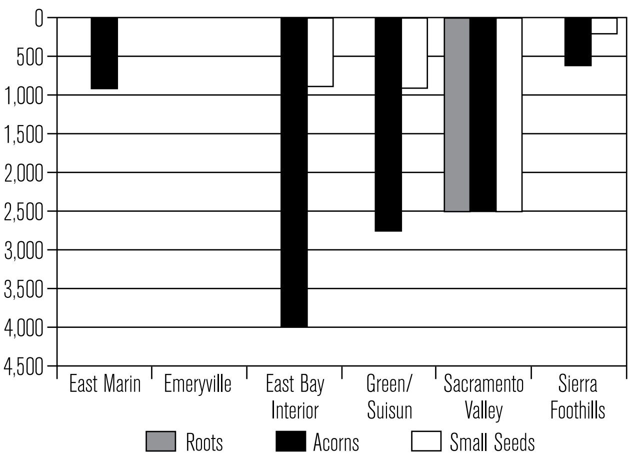

Figure 11. Plant food intensification by locality.

Differences in regional habitats, population density, and the degree of sedentism appear to be among the key factors in understanding the wide range seen in whether or when native people intensified their work effort. Along the San Francisco Bay shoreline, the distance to stands of important plant foods, distance to and variation in shellfish resources, and peoples' decisions about allocating female labor to gather plants or shellfish, may have been the most salient factors in whether plant-food production was intensified early (South Bay), later (North Bay), or not at all (Emeryville) (Arpaia and Wohlgemuth, this volume; Wohlgemuth 2014). The seasonal variation in plant-food ripening with elevation on the western slope of the Sierra Nevada foothills encouraged warm-season mobility to mid-elevation camps, which delayed sedentism and intensification in the lower foothills until population levels increased dramatically late in time. The long-term emphasis on seasonal movement between the lowland and highlands also may be the principal reason that late-spring or summer-ripening *Brodiaea* complex corms are virtually absent despite their current profusion in the region (Rosenthal et al. 2011). The lack of perennial water sources and viable fish runs in the Salinas River drainage in the South Coast Ranges seem to have precluded sedentism and plant-food intensification until native people were concentrated at the Spanish Missions (Wohlgemuth 2004). It appears that plant-food intensification was inextricably tied to sedentism and increased ties to a central place that was defended and where ancestors were buried. But site function and seasonal variation in settlement need to be considered in greater detail than in the past (e.g., Wohlgemuth 2004), and in some places sedentism developed with minimal reliance on plant foods (like Emeryville). More thorough testing of these relationships as hypotheses will require an integration of faunal and other data—such as the presence and timing of large burial populations and community sizes—and is beyond the scope of the current discussion.

CONCLUSION

The limited and poor-quality nature of the nut resources of the lower Sacramento Valley appears to be the key factor in the intensified use of low-ranked small seeds and *Brodiaea* complex corms that occurred at least 1,500 years before the onset of small-seed intensification around 1,000 years ago in interior settings in the Bay Area and southern North Coast Ranges. The unique structure of the Valley bottom also encouraged a singular focus on goosefoot seeds far beyond that seen elsewhere in central California. But there are no definitive data to date suggesting that goosefoot or native grasses like maygrass and wild barley were cultivated in central California as they were in the historic period in southern California (Reddy 2015).

Decades of diligent study of California archaeological subsistence remains are beginning to show that Baumhoff's (1963) landmark synthesis of northern and central Californian economies can be updated and fleshed out. The triad of deer, acorns, and salmon can be revised to consist of deer, acorns and small seeds (and in nut-poor regions, *Brodiaea* corms), and both resident fish and salmonids (Broughton 1994; Schulz 1981). The data at hand, while still provisional and constantly being updated, allude to the great inter-regional variability that Baumhoff emphasized for California.

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